OPERATION AND MAINTENANCE MANUAL ADDENDUM

SAGINAW GROUNDWATER REMEDIATION SYSTEM EXPANSION

Motor Wheel Disposal Site
Lansing, Michigan

Prepared By:

Sharp and Associates, Inc.
982 Crupper Avenue
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March 21, 2003

This manual is a supplement to the *Operation And Maintenance Manual – Groundwater Remediation System and Engineered Landfill Closure* dated Dec. 23, 1996 (Rev May 1, 1997).

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AND ASSOCIATES, INC.

Environmental Engineers,
Scientists, and Contractors

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March 25, 2003

Mr. John O'Grady
Remedial Project Manager
U.S. EPA Region 5 Superfund Division
77 West Jackson Boulevard
Chicago, IL 60604-3590

Subject: Transmittal of *Operation and Maintenance Manual Addendum, Saginaw Groundwater Remediation System Expansion – Motor Wheel Disposal Site (MWDS) Lansing, Michigan.*

Dear Mr. O'Grady:

Sharp and Associates, Inc. (SHARP), on behalf of The Goodyear Tire & Rubber Company, is submitting this Operation and Maintenance Manual Addendum for your records. This manual details the operation and maintenance for the groundwater remediation system expansion, which was constructed in November – December 2002. This manual is offered as an addendum to the approved *Operation And Maintenance Manual, Groundwater Remediation System And Engineered Landfill Closure – Motor Wheel Disposal Site Lansing, Michigan* dated May 1, 1997 (rev).

If you have any questions feel free to give me or Todd Struttmann a call at (614) 841-4650.

Sincerely,
SHARP AND ASSOCIATES, INC.

Brian Kiess
Project Engineer

Cc: J. Sussman, Goodyear (letter only)
D. Westjohn, USGS
N. Burwell, BWL
R. Franks, MDEQ
C. Graff, MDEQ
S. Lloyd, SHARP
E. Bloch, SHARP

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List of Tables

This manual details the operation and maintenance (O&M) procedures for the expanded groundwater extraction system at the Motor Wheel Disposal Site (MWDS) in Lansing, Michigan. It is submitted as an addendum to the *Operation and Maintenance Manual – Groundwater Remediation System and Engineered Landfill Closure*, dated December 23, 1996 (Revised May 1, 1997). This manual is a requirement specified in Section VI, subsection 11-b of the Consent Decree between U.S. EPA and Motor Wheel PRP Group dated February 13, 1994. This O&M manual, prepared by Sharp and Associates, Inc. (SHARP), is submitted on behalf of the Motor Wheel Disposal Site PRP Group.

The initial groundwater remediation system included one perched extraction well (TEW-2), six glacial extraction wells (Z1-P1, Z1-P2, Z2-P1, Z2-P2, Z3-P1, and Z3-P2), and two Saginaw extraction wells (SEW-1 and SEW-2). The piping network conveyed the majority of the groundwater to a treatment building for air stripping and then to the river via a single pipeline. The system was expanded in 2002 with the installation of two additional Saginaw extraction wells (SEW-3 and SEW-4) and additional piping to convey additional water to the river through a separate 36-inch pipeline (refer to Figure 1 – General Piping Layout of Saginaw Expansion). This addendum to the Operation and Maintenance Manual provides a description of the additional equipment added to the system in 2002.

Operation and Maintenance of any treatment system consists of running the system to ensure adequate hydraulic control and optimal operation of the system. Monitoring is performed to ensure the system is performing to meet the design goals.

This manual is organized with seven sections including:

- Introduction
- System Components
- System Startup
- System Maintenance
- Safety Plan
- References
- Appendix A – System Maintenance Manuals

1.1 Background

The MWDS is a 24-acre property located at 1401 Lake Lansing Road on the northeast edge of the City of Lansing, Michigan. The site lies in the NE ¼ of the SW ¼ of Section 3 in Lansing Township (T4N, R2W), Ingham County, Michigan. The property was used by the Motor Wheel Corporation as a disposal site for industrial wastes from 1938 until about 1978 (US EPA, 1991). The types of disposed wastes included solid and liquid industrial wastes, such as paints, solvents, liquid acids, caustics, and sludges. Wastes were disposed of on the property in tanks, barrels, seepage ponds, and open fill operations (US EPA 1991).

The site was put on the National Priorities List on October 4, 1986 (50 FR 41015). On June 26, 1987, Motor Wheel Corporation, W.R. Grace & Co., and The Goodyear Tire & Rubber Company signed an AOC agreeing to conduct a Remedial Investigation and Feasibility Study at the MWDS (US EPA, 1991). The Record of Decision for the Site was signed in September 1991. Goodyear, W.R. Grace & Co., Textron, and the Lansing Board of Water and Light entered into a consent agreement to conduct the Remedial Design for the Site in 1992.

The US EPA issued an Explanation of Significant Differences (ESD) for the MWDS on July 12, 2001. This ESD added the Saginaw aquifer cleanup to the 1991 Record of Decision (ROD) The cleanup of the Saginaw aquifer requires an enhancement of the existing groundwater extraction and treatment system installed in 1997.

A revised NPDES permit was finalized in December 2002, which allows 800 lbs/day ammonia loading to the Grand River from October 1st to June 30th and only 30 lbs/day of ammonia from July 1st to September 30th. The permit has three outfalls: 001, 002, and 003. The modifications to the permit allow for an increase in flow at Outfall 003 from 1.44 million gallons per day to 1.8 million gallons per day. The groundwater treatment system expansion allows for meeting the new permit limits and increases overall site treatment. The permit flows are listed in Table 1-1 below.

Table 1-1 Summary of Current NPDES Permit Flows:

Outall	**Flow (GPD) Oct 1 – June 30**	**Flow (GPD) July 1 – Sept 30**
001	634,000	634,000
002	144,000	144,000
003	1,800,000	1,800,000
Total Ammonia Mass Loading (#/day)	800	30

1.2 Performance Objectives

The groundwater remediation system has been designed in order to comply with the ROD. The contaminants of concern at the site are the chlorinated volatile organic compounds (VOC's) fluoride, and ammonia. These contaminants shall be removed to comply with the ROD cleanup criteria

The groundwater cleanup standards listed in the Explanation of Significant Differences (ESD) (EPA 2001) area as follows:

Contaminant	Cleanup Standard
Ammonia	34 mg/L
Fluoride	4 mg/L
Vinyl Chloride	2 ug/L

In September 2002, SHARP began site construction activities as a continued part of a groundwater remediation program for the Motor Wheel Disposal Site. Construction activities were completed the last week in December and system shakedown/startup was conducted in January 2003. This manual details the operation and maintenance procedures for the Saginaw Extraction Well 3 (SEW-3) and Saginaw Extraction Well 4 (SEW-4) and modified Saginaw Extraction Well 1 (SEW-1) and Saginaw Extraction Well 2 (SEW-2) treatment system. The *Remedial Design Modifications Expansion of Existing Groundwater Extraction and Treatment System Report* (Sharp, 2002) provides the specific details of the design.

The treatment system consists of two new extraction wells, SEW-3 and SEW-4, and the existing extraction wells, SEW-1 and SEW-2 (including pump upgrade). Groundwater is extracted and pumped through a piping system to a diversion vault where the water is diverted to the City of Lansing's sanitary sewer or the Ingham County Drain Commission's storm sewer. Extracted water diverted to the storm sewer is aerated first to increase the dissolved oxygen content before reaching the Grand River. All water will be diverted to the storm sewer until the ammonia mass loading limit is reached or in the event that the storm sewer is flowing at full capacity. SEW-4, a mass removal well, will be shut down from July 1st to September 30th.

2.1 System Telemetry

The water treatment system is equipped with a telemetry system and has the capability for remote monitoring of on-going operations. The two areas of new construction communicate with the pumphouse via wireless radio signals. Operational status, run times, cycles, flow rates, etc. can be monitored remotely using this telemetry system. An external modem and phone line are installed in the system control panel within the pumphouse so all data can be accessed off-site.

2.2 Extraction Wells and Pumps

All extraction well pumps chosen were Grundfos pumps. These pumps have built-in jam-free check valves designed for fail-safe operation. Precision form impellers are fabricated from stainless steel to provide for long pump life, maximum hydraulic efficiency, and top performance. An exclusive Prime Inducer provides maximum pump protection from dry-run damage during low water situations. The pump inlet is totally screened to prevent damage from debris.

SEW-3 is constructed with an intermediate protective casing to prevent the potential for vertical contaminant mixing between the Glacial and Saginaw aquifers. Pump rates from SEW-3 are expected to be in the range of 150 to 300 gallons per minute. The 9-7/8 inch (nominal 10-inch) diameter, open bore well allows maximum flexibility for different types of pumps, design pump rates without turbulent losses in the area of the pump, and the long term use of down hole equipment including pressure transducers and low-flow sampling pumps without clearance problems around the pump and discharge pipe. In addition, a nominal 10-inch diameter borehole reduces the risk of damaging the pump while removing/installing for service or trapping the pump in the borehole.

SEW-4 is constructed with an intermediate protective casing to prevent the potential for vertical contaminant mixing between the Glacial and Saginaw aquifers. Pumping rates from SEW-4 are expected to be in the range of 400 to 500 gallons per minute. The 11 5/8 inch (nominal 12-inch) diameter, open bore well allows maximum flexibility for different types of pumps, design pump rates without turbulent losses in the area of the pump, and the long term use of down hole equipment including pressure transducers and low-flow sampling pumps without clearance problems around the pump and discharge pipe. In addition, a nominal 12-inch diameter borehole reduces the risk of damaging the pump while removing/installing for service or trapping the pump in the borehole. To accommodate a 12-inch diameter borehole in the Saginaw aquifer, the outer casing was installed with 12-inch diameter steel well casing. As with previous Saginaw aquifer investigations, a Barber Rig was used for the well installation

2.3 Piping

All long runs of piping were directionally drilled using high density polyethylene pipe. Short runs or areas not accessible by a directional drill rig were open trenched. Figure 1 provides a schematic of the piping layout and Figure 2 provides a process flow diagram. For the plan and profile of the piping see the As-Built Drawings as presented in the *Construction Completion Report* (Sharp 2003).

2.4 Sump Pumps

Grundfos 5S03-9 submersible sump pumps are installed in well meter vaults #3 and #4 as well as Diversion Vaults #2 and #3. The pumps are placed in the bottom of the vaults to prevent buildup of water and automatically operate off of a low and high level float switch.

2.5 Aerators

It should be noted that the MTS Multi-Aspirator that was issued for construction in aeration chamber number 2 was not used. The aeration of extracted groundwater is accomplished using diffuser nozzles in both diversion vaults. These nozzles alone provide sufficient increase in dissolved oxygen to meet the 5 mg/L standard in the NPDES permit.

2.6 Flow Meters

Two types of flow meters were used for system flow measurements. SEW-3 Well Meter Vault, SEW-4 Well Meter Vault, Diversion Vault #2, and Diversion Vault #3 have the Sparling TigermagEP flow meter models FM657-065-110-1 (6") and FM657-045-110-1 (4") installed. Another flow meter, American Sigma model 980, has its transducer placed in the I.C.D.C. 36" discharge line near the Grand River outfall.

Sparling's TigermagEP flow meters are flanged obstructionless devices, which measure closed conduit flow rates. The system utilizes an auto-zeroing, bipolar, pulsed DC measuring technique and operates by the principles of magnetic induction created due to charged fluid flow between two sensing electrodes. The housing is steel with a polyurethane liner and the sensing coils are also completely encased in polyurethane. Power requirements for each unit are listed on the manufacturer nameplate. The meters are waterproof and capable of handling a wide range of abrasive and highly corrosive liquids. The FM657 series flow meters should not be used in environments when ambient temperatures will exceed 180° F.

The American Sigma model 980 is an ultrasonic level and velocity detection meter, which determines flow through a head to flow relationship. The control unit for the flow meter is encased in a NEMA 4X enclosure with a clear front and requires a 100-230 VAC single-phase input.

The following items list the steps performed during the shakedown/startup procedure in January 2003.

3.1 Initial Shakedown

1. Verify installation is complete
   a. Hydrostatic testing pipe
   b. Verify motor rotation (SEW1/2/3/4)
   c. Verify transducers are working (LT11/LT12/LT23/LT24)
   d. Actuate motor operated valves (FV42, FV43)
   e. Confirm flow element in ICDC 36-inch storm sewer (LE68)
   f. Confirm power to electrical equipment(SEW1/2/3/4,sump SEW1/2/3/4., FV42/43)

2. Verify controls programming
   a. confirm normal operation
   b. confirm alarms can be tripped
   c. confirm digital inputs/outputs
   d. confirm analog inputs/outputs
   e. confirm actuation of electrical valves
   f. confirm communication between remote sites and GW plant

3. Verify electrical equipment
   a. verify pump performance curve
   b. verify flow meters are operational
   c. confirm that local display matches remote display
   d. verify antenna communication to the main plant

4. Verify mechanical equipment
   a. confirm pressure gauges

5. Confirm electronic screens display
   a. confirm tag readings on screen match field data
   b. confirm alarms actuated are observed on screen

3.2 Gathering of System Dynamics

1. System dynamics verification of hydraulic model (Saginaw)
   a. Operate SEW-1 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   b. Operate SEW-2 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   c. Operate SEW-1 and SEW-2 – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   d. Operate SEW-3 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   e. Operate SEW-4 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)

f. Operate SEW-3 and SEW-4 – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
g. Record static and dynamic water levels and dissolved oxygen in aeration chambers during testing of items a-f.

2. System dynamics verification of hydraulic model (Glacial Zone 2)
   a. Operate Z2-P1 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   b. Operate Z2-P2 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   c. Operate Z2-P1 and Z2-P2 – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   d. Record static and dynamic water levels in wells and at plant to input to hydraulic model.

3. System dynamics verification of hydraulic model (Glacial Zone 1)
   a. Operate Z1-P1 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   b. Operate Z1-P2 alone – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   c. Operate Z1-P1 and Z1-P2 – record pressures and flows, drawdown, compare to model (run at design rate and max flow)
   d. Record static and dynamic water levels in wells and at plant to input to hydraulic model.

3.3 Evaluation of Capture and Well Interference

1. Evaluation of hydraulic conductivity of new wells (SEW-3 and SEW-4)
   a. Operate SEW-3 at design rate 48 hour test with 24 hour recovery - record levels in surrounding wells and production well, (wells SEW1/2/4 off)
   b. Operate SEW-4 at design rate 48 hour test with 24 hour recovery - record levels in surrounding wells and production well, (wells SEW1/2/3 off)
   c. Interference data and production data for SEW1/2 already gathered in 1997

2. Evaluation of hydraulic conductivity of wells not recorded during startup (Z1-P2 and Z2-P2)
   a. Operate Z1-P2 at design rate 24 hour test with 24 hour recovery - record levels in surrounding monitoring wells and production well, (wells Z1-P1 off)
   b. Operate Z2-P2 at design rate 24 hour test with 24 hour recovery - record levels in surrounding monitoring wells and production well, (wells Z2-P1 off)

3.4 Analytical Data Collection

1. NPDES permit Compliance
   a. Collect samples for NPDES weekly at AC#2 and AC#3 (grab) (Required by permit)
   b. Collect daily dissolved oxygen samples during the first week of operation from AC#2 and AC#3
   c. Collect slip stream samples from SEW-3 and SEW-4 to build a concentration profile

2. Fill out Industrial Pre-Treatment Permit for the wells entering the sanitary sewer (submitted in February 2003).

4.1 Monitoring Frequency

Operational parameters (including flow rates, run times, and water levels) of the system are monitored by the on-site representative during each site visit. The operational parameters are evaluated by operational personnel, and maintenance and repair activities are scheduled minimizing system downtime. In addition to on-site monitoring, the system is monitored daily by off-site operational personnel in the Columbus, Ohio office. These data are evaluated and operational trends are developed to assist in the operation of the system.

The site's Supervisory Control and Data Acquisition (SCADA) system as well as the program logic controls (PLC) are used to verify proper operation of the remediation system. Data extracted by the SCADA system is logged in the on-site personal computer (PC). The SCADA system monitors the system's inputs and outputs and records these data in a local file in the resident PC. These data are retrieved from the resident computer and used for developing operational trends and optimization of the yield from the treatment system.

4.2 Sampling Procedures

Water samples of the system are collected from pre-determined locations and, or specified sample ports using the laboratory supplied containers. Immediately after collection, the samples are labeled with the date, time, sample location or number, site name, and analysis requested. The completed labels are placed on the bottle and the completed samples placed in an ice filled cooler where a temperature of approximately 4°C is maintained. A chain of custody (COC) is prepared with the correct sample and site information and maintained with the samples. The samples are then transported to the laboratory via the selected method (i.e. overnight courier or hand delivery) under chain of custody control.

All samples collected at the site and sent off for laboratory analysis are analyzed in accordance with the *Amended Quality Assurance Project Plan* (Sharp, 2000) approved for the site.

The complete groundwater monitoring and sampling plan is located in Attachment F of the *Operation and Maintenance Manual – Groundwater Remediation System and Engineered Landfill Closure*, dated December 23, 1996 (Revised May 1, 1997). The monitoring wells shall be sampled for at least 10 years. At the end of 10 years U.S. EPA, after a reasonable opportunity for review and comment by the State, shall determine the need for additional monitoring. If contaminants fall below and remain below cleanup standards, the PRP Group may petition to adjust the number of monitoring wells and parameters.

4.3 System Maintenance

All system maintenance for equipment installed at the site shall be performed according to manufacturers' specifications as a minimum. Additional maintenance of the equipment may be required due to varying site conditions. The manufacturers' specification sheets are included as an attachment to this document. Table 4-1 lists a summary of the maintenance to be performed on the system.

Table 4-1 Maintenance Summary

Item	Maintenance	Frequency	Notes
Three-way valves	Visual inspection	Monthly	Clean metal parts as necessary
Actuators	Visual inspection	Monthly	Clean as necessary
Actuators	Audible inspection	Monthly	Listen for smooth cycle
Extraction wells	Visual inspection	When sampled	Check for corrosion, damage, drainage, etc.
Extraction well pumps	Record operating conditions	Quarterly	Collect data to confirm operation along manufacturer's pump curve
Flow meter (Sigma model 980)	Calibrate, clean, and maintain	As needed	Calibrate input channels, clean case, and maintain sensor.
Diffuser Nozzles	Visual inspection	Monthly	Make sure nozzles not clogged
Level Switches	Visual inspection	Monthly	Check seal in sensors & cables
Pressure Transducer	Visual inspection	Monthly	Check vent tube (if applicable) and nosecone holes
Pressure Transducer	Visual inspection	As needed	Check for clogged filter
Vault heaters	Cleaning	As needed	Remove dust and dirt

4.3.1 Three-Way Valves

The only routine maintenance is a monthly visual inspection. Clean metal parts as necessary. It is not necessary to replace the ball and stem unless the seating surfaces have been damaged by abrasion or corrosion. All soft parts should be replaced whenever the valve is disassembled for reconditioning (replacement parts can be ordered in kit form). Should stem seal leakage occur, it may be corrected without disassembly by tightening the packing gland bolts until the leakage stops. If the leakage continues or valve operating torque becomes too excessive, or the stem seals are worn, replacement will be necessary (**do not remove the packing gland while the line is under pressure**).

4.3.2 Actuators

The manufacturer documents do not have a recommended maintenance schedule; however, due to the amount of moving parts associated with the actuators, a monthly visual and audible inspection should be performed. An audible inspection should be performed to listen for unnecessary strain on the motor or for any detrimental sounds (grinding, clanking, or metal-on-metal sounds).

4.3.3 Variable Frequency Drives

No routine maintenance is required for the variable frequency drives.

4.3.4 Extraction Wells

Each extraction well should be inspected for corrosion, damage to the lock, positive drainage (damage to the concrete apron if applicable) and general integrity each time water quality samples or water level data are collected. Well numbers are checked for legibility and relabeled as necessary. The total depths of all monitoring wells are measured to the nearest 0.1 foot periodically. These measurements are compared to installed depths to evaluate changes in the depth of the well (i.e. silt build up, obstruction) with respect to the screened interval. The results of the well depth measurements are compared to the original completion depths of the wells. Wells which are damaged beyond repair or which become unusable for some other reason will either be replaced or an alternate well designated.

4.3.5 Extraction Well Pumps

Grundfos pumps are maintenance-free. Service kits and service tools are available from Grundfos. Grundfos pumps can be serviced at a Grundfos service center. If Grundfos is requested to service a pump, they must be contacted with details about the pumped liquid, etc. before the pump is returned to service.

Routine inspection of each well pump is prohibited due to the size and pump setting depth. To assist in the determination of the efficiency of the pump, quarterly readings are collected and analyzed. These readings include depth-to-water, pump voltage, pump amperage, and pump output pressure.

4.3.6 Electric Motors

The electric motors, which drive the Grundfos pumps, are Franklin Electric motors. Routine inspection of each electric motor is prohibited due to the size and setting depth. To assist in the determination of the efficiency of the motor/pump, quarterly readings are collected and analyzed. These readings include depth-to-water, voltage, amperage, and pump output pressure.

4.3.7 Flow Meters

As discussed in section 2.6, there are two types of flow meters used in this construction project. The Sparling TigerMAG flow meters, located in the well vaults and diversion vaults, require no routine maintenance. The Sigma Model 980 flow meter routine maintenance consists of calibrating input channels, cleaning the case, and maintaining the sensors as needed.

4.3.8 Output Filters

No routine maintenance is required for the output filters.

4.3.9 Pitless Adapters

No routine maintenance is required for the pitless adapters.

4.3.10 Diffuser Nozzles

No routine maintenance is required for the diffuser nozzles; however, a monthly visual inspection should be performed to ensure the nozzles are spraying in their intended pattern and are not partially or completely clogged.

4.3.11 Level Switches

Elastomer seals in the sensors and cables are subject to deterioration. Life expectancy of the seals varies with application. Aging should be checked monthly.

4.3.12 Pressure Transducers

The vent tube of the standard In-Situ PXD-261 should not be bent, kinked, or blocked. This will cause barometric pressure fluctuations to appear in measurements and may introduce large varying errors due to thermal expansion and contraction of air within the vent tube and probe body. The cable version of the PXD-621 does not have a vent tube. There is a filter located in the nosecone. If it becomes clogged, it should be flushed gently with a couple squeezes from a water bottle. The holes in the nosecone can become plugged. If this happens, take the nosecone off and clean the holes with a swab or brush. To replace the nosecone, first put the wavy spring washer over the threads, then screw the nosecone hand tight. The vent tube (if applicable) and the nosecone holes should be checked monthly and the filter should be checked as needed.

4.3.13 Vault Heaters

The vault heaters require no maintenance. Periodic cleaning to remove accumulated dust and dirt is recommended though.

4.3.14 Safety Switches

No routine maintenance is required for the safety switches. They should be replaced as needed.

The site safety plan has been prepared as a separate document and is included as Appendix C in the *Final Design, Groundwater Remediation System and Engineered Landfill Closure* (Sharp 1997)

1. U.S. EPA, 1994, Administrative Order of Consent: United States of America; Plaintiffs vs. The Motor Wheel Corporation; Defendants, Civil Action No. VW-92-C-151.

2. U.S. EPA, 1992, Scope of Work: Remedial Design Motor Wheel Disposal Site, Ingham County, Michigan, May 12, 1992.

3. U.S. EPA, 1992, Statement of Work: Remedial Action Motor Wheel Disposal Site, Ingham County, Michigan, May 12, 1992.

4. Sharp and Associates, Inc., 1996, Final Design Report for the Glacial Aquifer Groundwater Remediation System and Engineered Landfill Closure at the Motor Wheel Disposal Site in Lansing, Michigan., prepared for the Motor Wheel PRP Group, July 3, 1996.

5. U.S. EPA, 1991, Record of Decision, Motor Wheel Disposal Site, Lansing, Michigan, September 30, 1991.

6. U.S. EPA, 2001, Explanation of Significant Differences, July 12, 2001.

7. Sharp and Associates, Inc., 2002, Remedial Design Modifications Expansion of Existing Groundwater Extraction and Treatment System Report, December 2002.

8. Sharp and Associates, Inc., 1997, Final Design, Groundwater Remediation System and Engineered Landfill Closure, May 1997.

9. Sharp and Associates, Inc., 2000, Amended Quality Assurance Project Plan For The Saginaw Formation Aquifer Investigation, October 2000.

10. Sharp and Associates, Inc., 2003, Construction Completion Report, Saginaw Aquifer Pipeline Installation, March 2003.

FIGURES

SHARP AND ASSOCIATES, INC.
Environmental Engineers, Scientists, and Contractors

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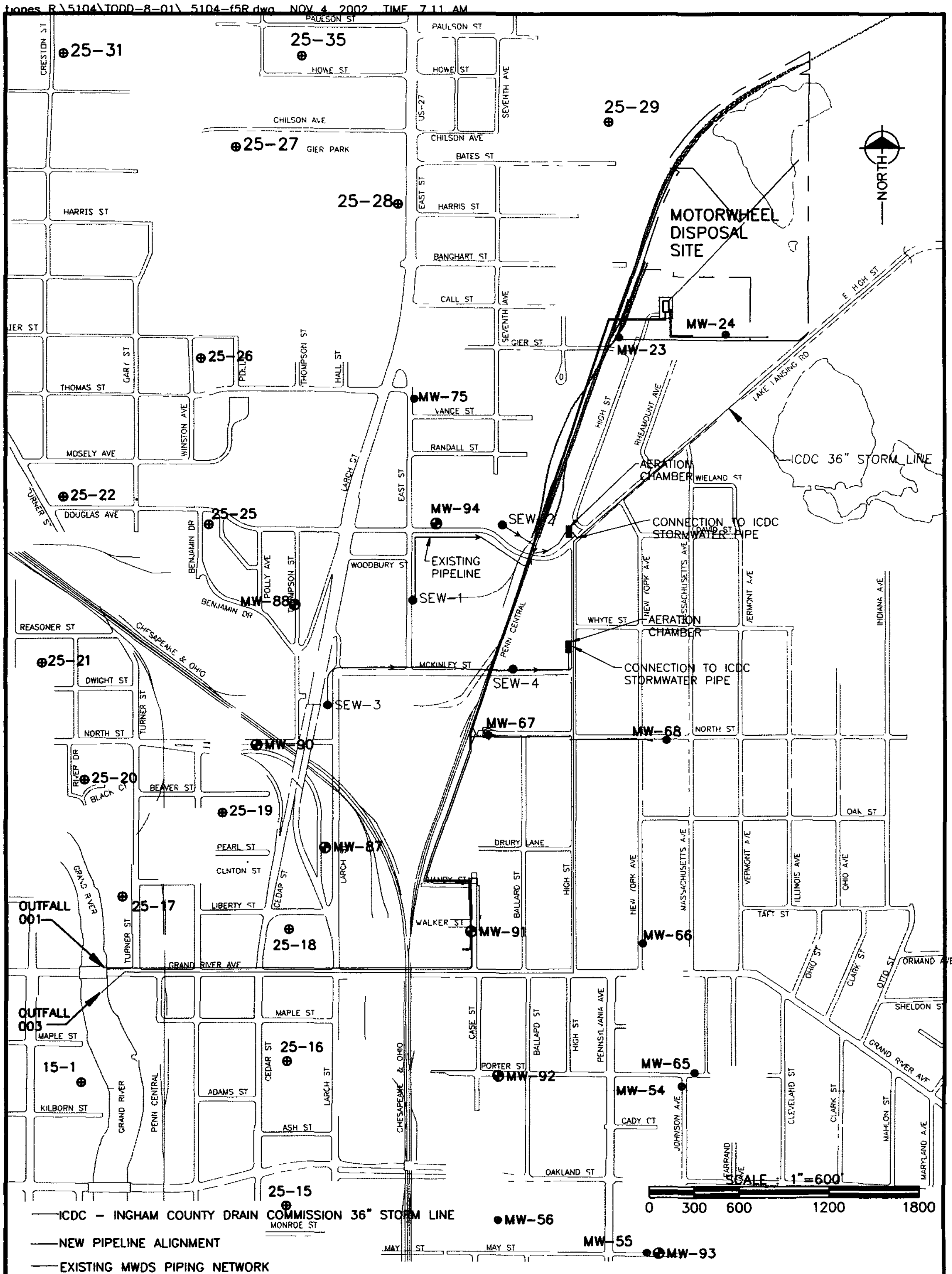

FIGURE 1

PIPING LAYOUT TO CONNECT SEW-3 AND SEW-4 TO ICDC

Project Reference: 5104-96

MOTORWHEEL DISPOSAL SITE
LANSING, MICHIGAN

Client: MWDS PRP GROUP

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
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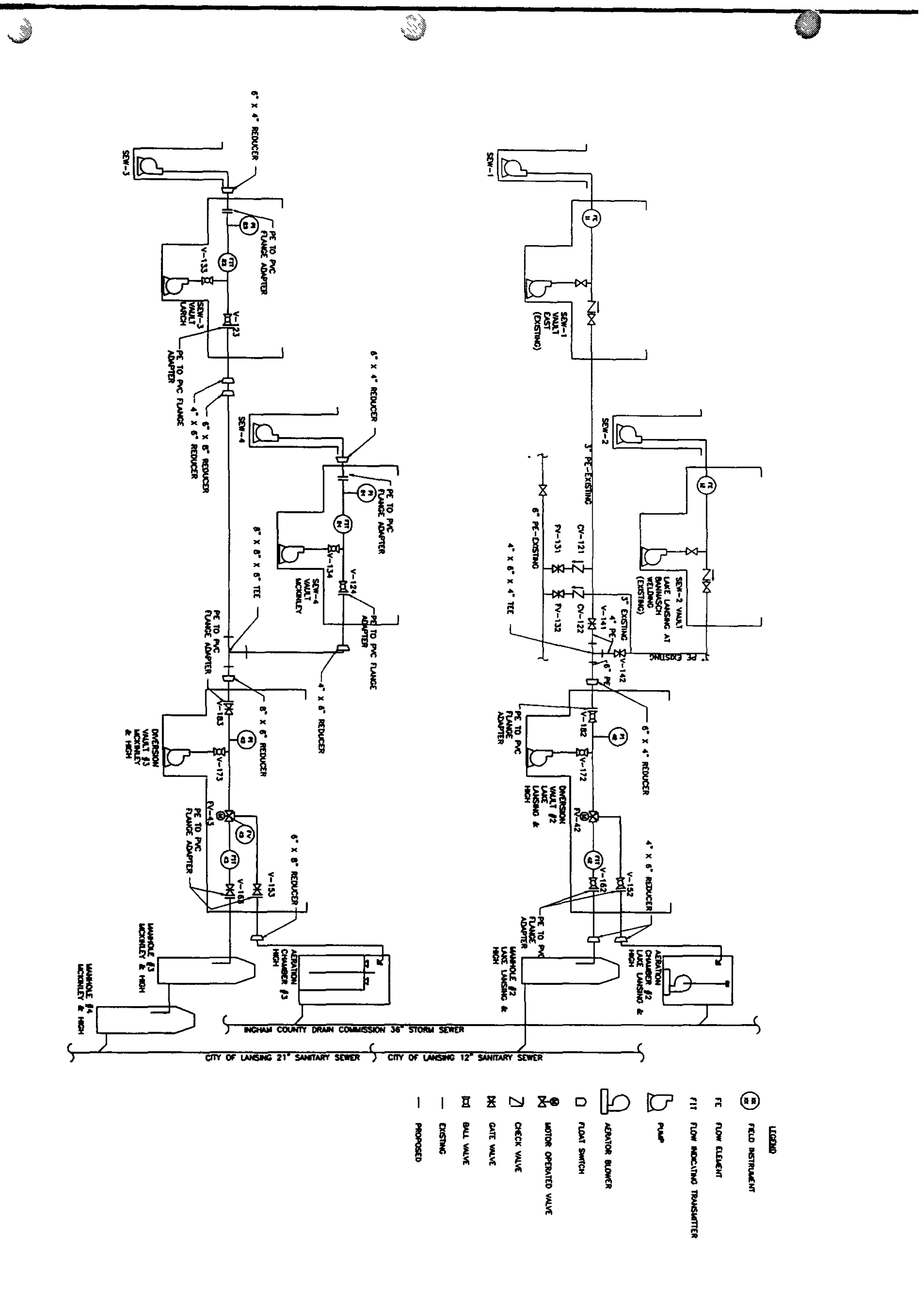

AS-BUILT

MOTOR WHEEL DISPOSAL SITE
SAGINAW AQUIFER PIPELINE INSTALLATION
LANSING, MICHIGAN

PROCESS FLOW DIAGRAM

Rev.	Date	Description	Design	Drawn	Check
3	01-24-03	AS-BUILT	JAM	TLJ	TJS
2	10-24-02	100% DESIGN-ISSUED FOR CONSTRUCTION	JAM	TLJ	TJS
1	09-20-02	100% DESIGN - BID SET	JAM	TLJ	TJS
0	08-29-02	60% DESIGN	JAM	TLJ	TJS

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File Name: SHT6.dwg
Project No. 5104-92
Sheet 6 of 43
Figure 2
Revision 3

APPENDIX A

Appendix A
System Maintenance Manuals

- **Flow-Tek** – Three-way valves
- **Bernard Controls, Inc.** – Actuators
- **Cutler Hammer** – Variable frequency drives
- **Grundfos** – Submersible pumps
- **Franklin Electric** – Submersible motors
- **Sparling** – Flow meters
- **Sigma** – Flow meters
- **TCI** – Output filters
- **Maass Midwest** – Pitless adapters
- **Bete** – Diffuser nozzles
- **Gems Sensors** – Level switches
- **In-Situ, Inc.** – Pressure transducers
- **Marley Electric Heating** – Vault heaters
- **Square D** – Safety switches

Flow-Tek
Three-Way Valves

A Bray High Performance Company

FlowTek

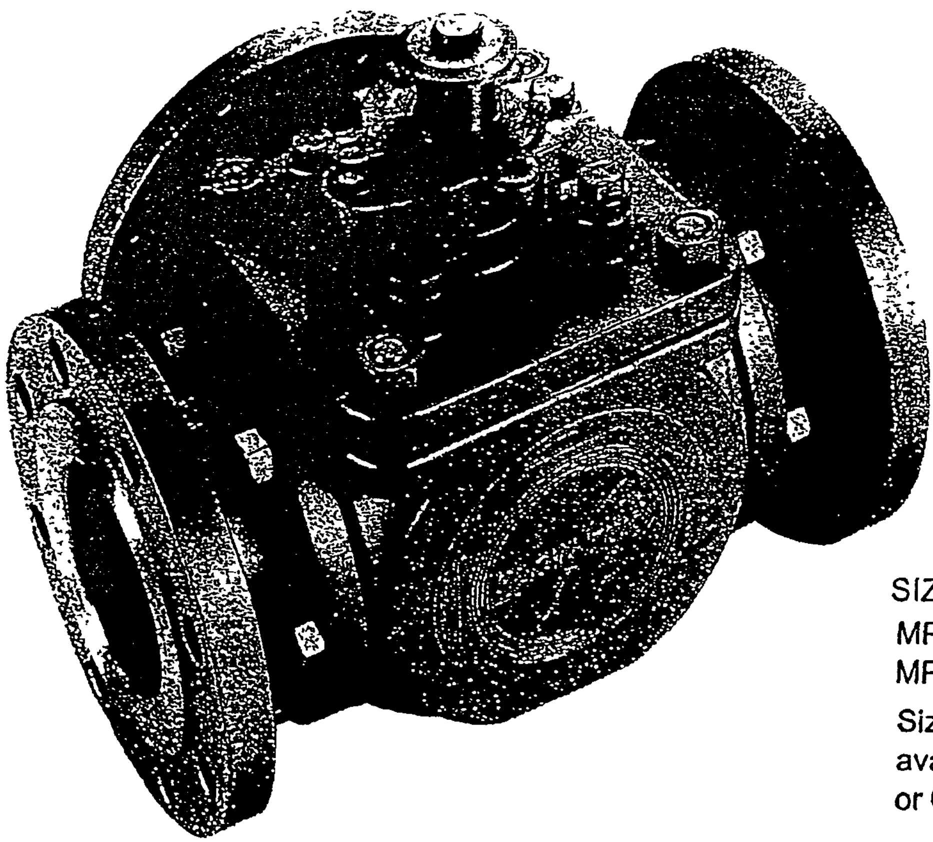
A Subsidiary of BRAY INTERNATIONAL, Inc.

MULTI-PORT SERIES FLANGED END 3 AND 4 WAY BALL VALVES

MODEL: MPF15 - Full Port MPRF15 - Standard Port

ANSI CLASS 150 / 300

Extremely Versatile Valve Design for Diversion or Mixing



Unique Body design offers simplicity in replacing Valve seats and packing

SECURE MOUNT design for ease of automation

Available in Stainless and Carbon Steel

SIZE:

MPF15	1-1/2" thru 12"
MPRF15	6" thru 12"

Sizes 1-1/2", 2", 3" are available with Threaded or Clamp Ends

ANSI Class 300 Flanges - Model: MPF30

MULTI PORT BALL VALVES

... **FEATURE ONE PIECE BALL AND STEM - TRUNNION SUPPORTED DESIGN**

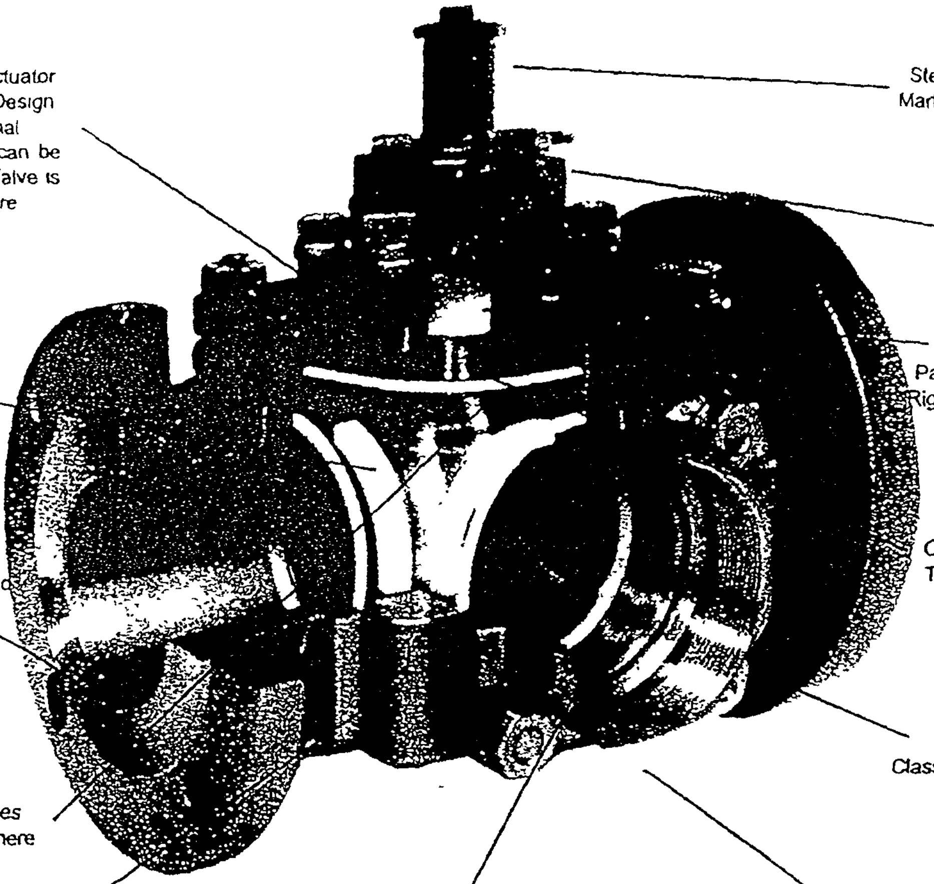
... **SIMPLIFY ALL ASPECTS OF PIPING SYSTEMS**

... **ARE COST EFFICIENT** - One 3-Way Valve can replace 2 or more Conventional Valves.

... **ELIMINATE DUPLICATION OF EXPENSIVE AUTOMATED UNITS**

Multi-port Ball Valves, ideally suited to a wide range of process flow applications, such as mixing or blending, flow diversion, by-pass of strainers, meters, heat exchangers etc, direct flow out of or into different storage tanks. Flow-Tek multi-port valves ensure safe operation while they minimize risk of line contamination and incorrect mixing.

Cut-Away View



VALVE OPTIONS AND MODELS

Body Cavity Fillers designed to reduce the possibility of contamination by entrapment of process fluids in the void normally found behind the ball and the valve body

Flow-Tek can Supply Various Seat Materials to Handle a Wide Variety of Special Applications

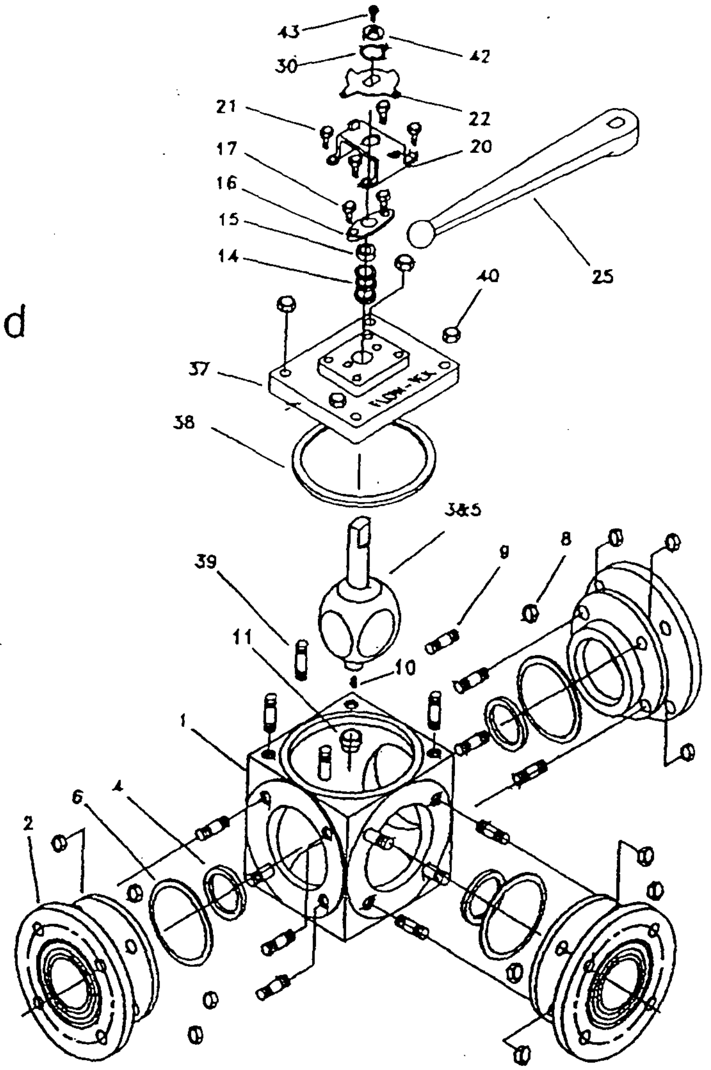
Severe Service Valves are available with hard face metal seats, shutoff class V and VI

MPF15 Full Port Flanged End Class 150, size 1-1/2" thru 12"
MPF30 Ditto, Class 300
MPRF15 Reduced Port Flanged End Class 150 size 6" thru 12"
MPT-30 Full Port Threaded 1-1/2" - 3"
MPC15 Full Port Clamp End 1-1/2" - 3"

Different End Connections may be combined to meet specific requirements. As our heavy duty body for all models conforms to ANSI Class 300, sizes 1 1/2 thru 6 inch.

Valve - Components

Exploded View



MATERIALS OF CONSTRUCTION:

ITEM	NAME	MPF15-316 MPF30-316	MPF15-WCB MPF30-WCB	ITEM	NAME	MPF15-316 MPF30-316	MPF15-WCB MPF30-WCB
1	BODY	A351 GR CF8M	A216 GR WCB	12	GLAND BOLT	A167 TYPE304	CARBON STEEL
2	END CONNECTOR	A351 GR CF8M	A216 GR WCB	20	STOP HOUSING	A351 GR CF8M	CARBON STEEL
3&5	BALL & STEM	A351 GR CF8M	A351 GR CF8	21	HOUSING BOLT	A167 TYPE304	CARBON STEEL
4	SEAT	PTFE	PTFE	22	TRAVEL STOP	A167 TYPE 304	CARBON STEEL
6	CAP GASKET	PTFE	PTFE	25	LEVER	DUCTILE IRON(FCD)	DUCTILE IRON(FCD)
8	BODY NUT	A167 TYPE304	CARBON STEEL	30	SNAP RING	SK5 CR PLATE	SK5 CR PLATE
9	BODY STUD	B8	B7	37	COVER	A351 GR CF8M	A216 GR WCB
10	ANTI-STATIC	SS316	SS316	38	COVER GASKET	PTFE	PTFE
11	THRUST BEARING	50%PTFE+50%316	50%PTFE+50%316	39	COVER STUD	B8	B7
14	STEM PACKING	PTFE	PTFE	40	COVER NUT	A167 TYPE 304	CARBON STEEL
15	GLAND RING	A167 TYPE304	CARBON STEEL	42	PORT SIGN	A167 TYPE304	A167 TYPE304
16	GLAND	A167 TYPE 304	CARBON STEEL	43	SIGN NUT	A167 TYPE304	A167 TYPE304

Notes:

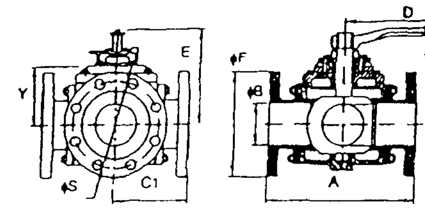
A variety of special alloys are available on request.

High quality investment casting are standard, sizes 1 1/2" thru 4 inch.

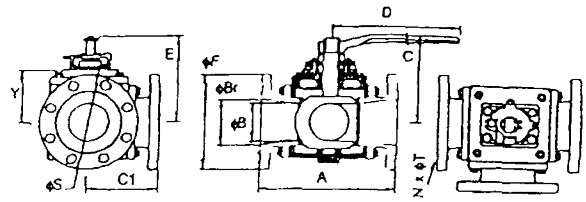
ap Gasket is also available in Grafoil and 50/50 stainless/teflon for higher temperature and pressure.

Due to continuous development of our product line, we reserve the right to change the dimensions and information contained in this catalogue as required.

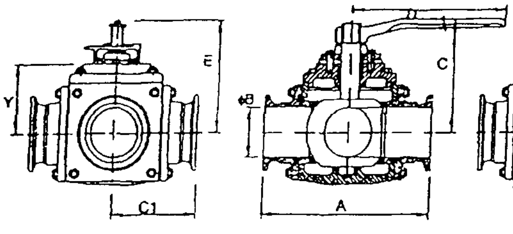
DIMENSIONS, CV, TORQUES AND WEIGHTS



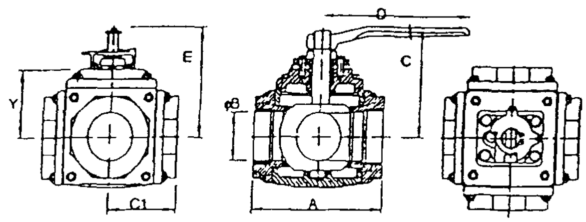
3 or 4 WAY MPF15/MPF30



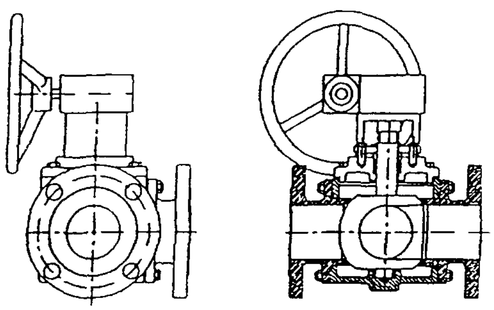
3 WAY MPRF15



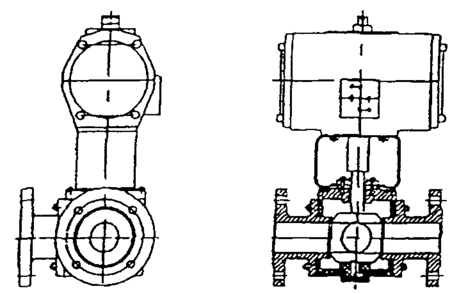
3 or 4 WAY MPC15



3 or 4 WAY MPT30



MPF15 With Gear Operator



MPF15 With Actuator

MPF15/MPF30(Full Port) DATA:

SIZE		1-1/2"	2"	2-1/2"	3"	4"	6"	8"	10"	12"
A	MPF15	7.17	8 66	11.10	11.26	13.66	16.77	20.94	27 76	29 92
	MPF30	8 75	9 37		11.85	15.12	18 43			
ϕB	MPF15	1.57	1.97	2.60	2.99	3.94	5.91	7.87	9.84	11.81
	MPF30	1 57	1.97	2.60	2.99	3.94	5.91	7.87	9 84	11.81
C	MPF15	3.58	4 33	6.50	7.20	8 43	10.75	12.40	13.35	14 76
	MPF30	3.58	4 33		7.20	8.43	10.75			
C1	MPF15	3.58	4 33	5.55	5.63	6.83	8.39	10.47	13.88	14 96
	MPF30	3 82	4.69		5.93	7.56	9.21			
D	MPF15	11.81	11.81	14.96	14.96	20.87	35.43	35.43	35.43	35 43
	MPF30	11 81	11.81		14.96	20.87	35.43			
E	MPF15	4.41	4.76	6.30	6.93	8 03	10 55	11.89	12 83	14.37
	MPF30	4 41	4.76		6.93	8.03	10.55			
ϕF	MPF15	5.00	6.00	7.00	7.50	9.00	11.0	13.5	16.0	19 0
	MPF30	6 12	6 50	7.5	8.25	10.0	12.5	15 0	17.5	20 5
N	MPF15	4	4	4	4	8	8	8	12	12
	MPF30	4	8	8	8	8	12	12	16	16
ϕS	MPF15	3.88	4.75	5.50	6.00	7.50	9.50	11.75	14.25	17.00
	MPF30	4.50	5.00	5.88	6.62	7.88	10.62	13.0	15.25	17.75
ϕT	MPF15	0.62	0.75	0.75	0.75	0.88	0.88	0.88	1.00	1.00
	MPF30	0.88	0.75	0.88	0.88	0.88	0.88	1.00	1.12	1.25
Y	MPF15	2.32	2.76	3.74	3.78	4.84	7.09	8.15	8.62	10.63
	MPF30	2 32	2.76		3.78	4.84	7.09			
CV	90°	50	100	160	240	400	970	1,850	3.500	3,500
	180°	230	390	630	930	1,650	5,000	9,000	16,000	16,000
Torque (in-lbf)	MPF15	500	800	1,200	1,800	3.100	10,000	18,000	26000	35000
	MPF30	560	900		2,000	3,500	11,200			
Weight (lbf)	MPF15	33	40	55	75	121	220	397	591	811
	MPF30	42	53		108	154	278			

#Break Torque Values at Full Operating Pressure Ratings, Derived Using a Clean Lubricated Test Medium.

*Gear Operators are recommended for valve size 6" and larger.

MPRF15 (Standard Port) DATA:

SIZE		6"	8"	10"	12"
A		16 85	20 94	26 77	29 57
ϕBr		5.91	7 87	9 84	11 81
ϕB		3.94	5.91	7.87	9 84
C		8.43	10.75	12.40	13.35
C1		7.87	10 47	13.39	14.78
D		20.87	35.43	35.43	35.43
E		8 03	10 55	11.89	12 83
ϕF		11.0	13.5	16.0	19.0
N		8	8	12	12
ϕS		9 50	11.75	14.25	17.00
ϕT		0.88	0 88	1.00	1.00
Y		7.09	8.15	8.62	10.63
CV	90°	280	500	1,050	2.300
	180°	1,300	2,400	4,500	7,500
Torque(in-lbf)		3 100	10,000	18,000	C/F
Weight(lbf)		168	278	518	683

MPC15/MPT30 DATA:

SIZE		1-1/2"	2"	2-1/2"	3"
A	MPC15	5.79	7.01	9.45	11.81
	MPT30	5 98	6.50	9.06	10.24
ϕB		1.57	1.97	2.60	2.99
C		3.58	4.33	6.50	7.20
C1	MPC15	2 89	3.50	5.55	5.63
	MPT30	2.99	3.25	4.53	5.12
D		11.81	11.81	14.96	14.96
E		4.41	4.76	6.42	6.93
Y		2.32	2.76	3.74	3.78
CV	90°	50	100	160	240
	180°	230	390	630	930
Torque (in-lbf)	MPC15	500	800	1200	1,800
	MPT30	560	900	1,350	2,000
Weight (lbf)	MPC15	26	31	43	66
	MPT30	29	33	49	97

DESIGN AND TECHNICAL DATA:

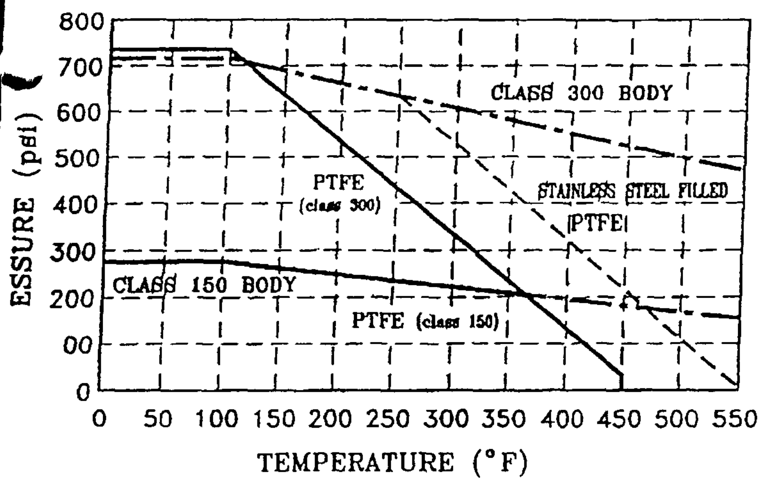
SPECIFICATION STANDARDS		Federal Specifications
Flanges	ANSI B16 5	WW-V-35B Valve, Ball, Type II
Shell/Wall	ANSI B16.34	Class C, Style 3, End Connection B

All Flow-Tek's Ball Valves are designed constructed and tested in strict accordance with the most current International Standards i.e API, ASME/ANSI, BS and DIN

Flow-Tek Quality Guarantee is established according to rigorous QA/QC procedures. We obtain high quality products by strict observance of these procedures throughout every stage of production

Material Test Reports (MTR) are available for all valve series MPF valves are rated to 150 psi saturated steam/250 SWP with "S" Seats

PRESSURE AND TEMPERATURE DATA



Pressure Test 100%
ANSI B16.34/API 6D

Class	Shell/Hydro		Seat/Air
	PSI	BAR	
150	425	30	80psi According to
300	1100	76	ASME/ANSI B16.34

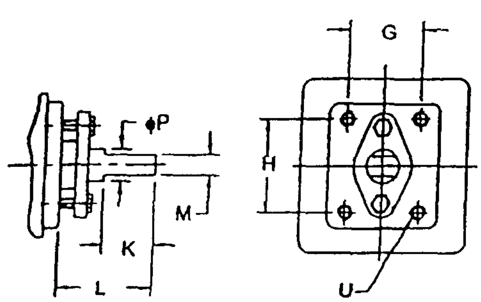
Rating Curve applies to both "L" and "T" port configurations.

Extended Pressures and temperatures may be achieved by altering designs. For specific applications, consult factory with service condition.

Fire Safe Design

Flow-Teks multiport valves can be fitted with grafoil body seals and stem packing. This will *make valve fire safe to atmosphere by preventing external leakage that may add to fire intensity.*

Flow-Tek's Secure Mount Actuator Mounting Dimensions



...tor Mounting Bracket Bolts (21) are ...ded on every valve

IMPORTANT. Verify the mounting dimensions before manufacturing mounting hardware.

SIZE	MPF15	1-1/2"	2"	2-1/2"	3"	4"	6"	8"	10"	12"
	MPRF15					6"	8"	10"	12"	
G	in	C/F	1.890	1.890	1.890	3.340	3.479	4.528	4.528	4.528
	mm	C/F	48	48	48	84.8	88.4	115	115	115
H	in	C/F	2.835	3.504	3.504	3.340	3.479	4.528	4.528	4.528
	mm	C/F	72	89	89	84.8	88.4	115	115	115
K	in	C/F	1.417	1.850	1.890	1.890	1.929	1.929	2.165	2.362
	mm	C/F	36	47	48	48	49	49	55	60
L	in	C/F	1.929	2.795	3.071	3.228	3.465	3.386	3.740	3.740
	mm	C/F	49	71	78	82	88	86	95	95
M	in	C/F	0.669	0.669	0.669	0.906	1.378	[illegible]	[illegible]	2.165
	mm	C/F	17	17	17	23	35	45	45	55
P	in	C/F	0.866	1.161	1.161	1.339	1.772	2.362	2.362	2.756
	mm	C/F	22	29.5	29.5	34	45	60	60	70
U	[illegible]	5/16 [illegible]			1/2-13UNC			5/8 [illegible]		

FLOW-TEK, INC.

INSTALLATION-MAINTENANCE MANUAL

MPF15 3 WAY BALL VALVE

DESIGN:

Central body design, three flanged end piece construction, allows ease of maintenance, without special tools. This type of valve utilizes a true trunnion ball principle. The ball is fixed, it is not free to move with line pressure. This particular feature allows tight shut off to flow in either direction or dead ended, regardless of the position of the valve in-line.

1. ON-SITE INSTALLATION

1.1 The valve may be fitted to any position on the pipeline.

1.2 Before installation, pipes must be flushed clean of dirt and debris that could result in damage to hard or soft parts of the valve.

1.3 Piping must be supported so as not to add undue stress to the valve.

2. USE:

2.1 Maximum results and long life of the valve can be maintained under normal working conditions in acccordance with proper pressure / temperature and corrosion data.

3. MANUAL OPERATION:

3.1 The manual operation for the proper flow plan is done by turning the handle 1/4 (90 degree) turn.

3.2 Visual indication of position is done by visual inspection of the markings on the top of the stem.

4. AUTOMATED OPERATION:

4.1 Valves with actuators should be checked for actuator - valve alignment. Angular or linear mis-alignment will result in high operational torque and premature packing failure.

5. DISASSEMBLY AND CLEANING PROCEDURE:

5.1 If the valve has been used to control hazardous media, it must be decontaminated before disassembly. It is recommended that the following steps be taken for safe removal and assembly.

5.2 Valves come shipped from the factory containing a lubricant. This is for break-in and may be removed if it is objectionable to a particular application by disassembly and cleaning with a proper solvent.

6. DISASSEMBLY FOR STEM AND SEAL REMOVAL:

6.1 Stem seal leakage may be corrected with out disassembly by tightening the packing gland bolts until such leakage stops. If the leakage continues or valve operating torque becomes to excessive, or the stem seals are worn, replacement will be necessary.

WARNING! DO NOT REMOVE THE PACKING GLAND WHILE LINE IS UNDER PRESSURE! UNDER NO CIRCUMSTANCES! STEM DOES NOT BACK SEAT. BEGIN WITH THE VALVE PARTIALLY OPEN IN A DEPRESSURIZED LINE.

A. Remove flange bolts and nuts and lift valve from line for servicing. NOTE: Care should be taken to avoid scratching or damaging serrated flange faces. THESE VALVES ARE HEAVY! THEY SHOULD BE ADEQUATELY SUPPORTED BEFORE REMOVAL FROM THE LINE IS BEGUN.

B. Loosen handle set screw and remove handle and stop plate. Remove gland nuts and packing gland

C. Mark each flange to the body joint (3 flanges). Mark top cap to the body joint . This is to allow ease of alignment in reinstallation.

D. Remove the nuts holding flanged pieces and top cap for disassembly.

E. Remove the three end pieces, then the top cap, leaving the ball to last.

F. **EXTREME CAUTION** should be taken upon ball removal as not to scratch seating surface or the stem, which will result in leakage after reassembly.

G. Remove all seats, seals, and the thrust bearing.

7. VISUAL INSPECTION:

7.1 Clean and inspect metal parts. It is not necessary to replace the ball and stem unless the seating surfaces have been damaged by abrasion or corrosion . We strongly recommend replacement of all soft parts whenever the valve is disassembled for reconditioning. This is the best protection against valve leakage after assembly. Replacement parts can be ordered in kit form. NOTE: The valve maybe assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with intended line content

8. ASSEMBLY:

8.1 Install the thrust bearing in the bottom center of the body.

8.2 Install the ball in the body, making sure the trunnion of the ball goes into the thrust bearing. CARE SHOULD BE TAKEN NOT TO SCRATCH THE BALL DURING THIS INSTALLATION.

8.3 Install the seats in each of the flanged end pieces with the spherical curvature facing the mating ball.

8.4 Install the top cap and body gasket making sure to align the marks made during disassembly. This will insure the valve stop or actuator is in the proper position.

8.5 Now install the packing and packing gland with the packing gland bolts.

8.6 The installation of the flanged end pieces MUST BE DONE IN THE FOLLOWING WAY TO INSURE NO SEAT DAMAGE

First install the left and right end pieces with the nuts aligning the marks made during dis-assembly. This is to insure flange to flange mating and alignment of the valve bolt holes. Make sure the ball ports are aligned with the end pieces as not to pinch the seats during tightening. Do not tighten one end piece fully until both ends are installed. Due to the location, the nuts should be torqued down evenly using a criss-cross pattern and alternating between each end to approximately 50 ft./ lbs. (See fig. 1-A) During this step check body to end piece gap and keep gap consistant. Uneven tightening may result in pinching of the seats and subsequent leakage after reassembly.

8.8 The installation of the center end piece is done first by rotating the ball until the blind side of the ball is facing the area where the end piece is being installed, aligning previous marks. Tighten the nuts using criss-cross pattern. Make sure the gap of the end piece to valve remains consistant until 50 ft./ lbs. is achieved.

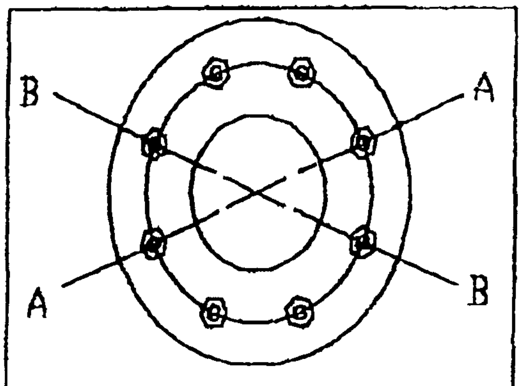


fig. 1-A

8.9 Cycling the valve slowly back to the proper flow plan by turning the ball slowly insures the seat lips assume a permanent seal against the ball . A fast turning motion may not allow proper mating to occur.

8.10 Test Valve, if at all possible, prior to placing valve back into line.

Warning: Not properly securing valve may cause it to seperate from the pressure source and result in injury. Always join the valve to the companion flanges of the same pressure rating as the valve. Use a full set of proper bolts.

TEST AS FOLLOWS:

A. Secure a blind flange to Port B and a test flange to Port A, and position ball as illustrated. (See fg. 1-B)

B. Apply 50 to 100 psi of air to the test flange and bubble check the open port. If leak occurs, tighten bolts until the seat leak stops.

C. Remove air pressure.

D. Rotate ball 90 degrees.

E. Move blind flange from Port B to Port C. Apply air pressure and bubble check the opened port.

F. Now place a blind flange on Port B so that you havea blind flange on both Port B and Port C, and a test flange on Port A. Rotate the ball 1/ 8 th of a turn. Apply air pressure. Spray all gaps with a soap and water solution to test for body seal leaks. If a leak occurs tighten the corresponding nuts until the leak stops.

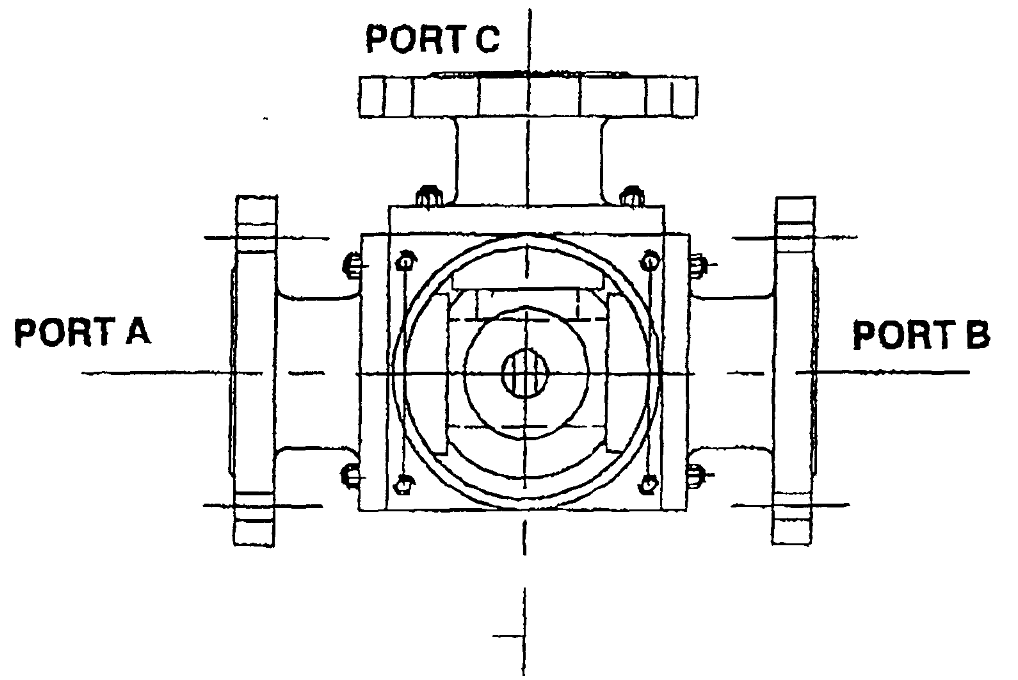


fig. 1-B

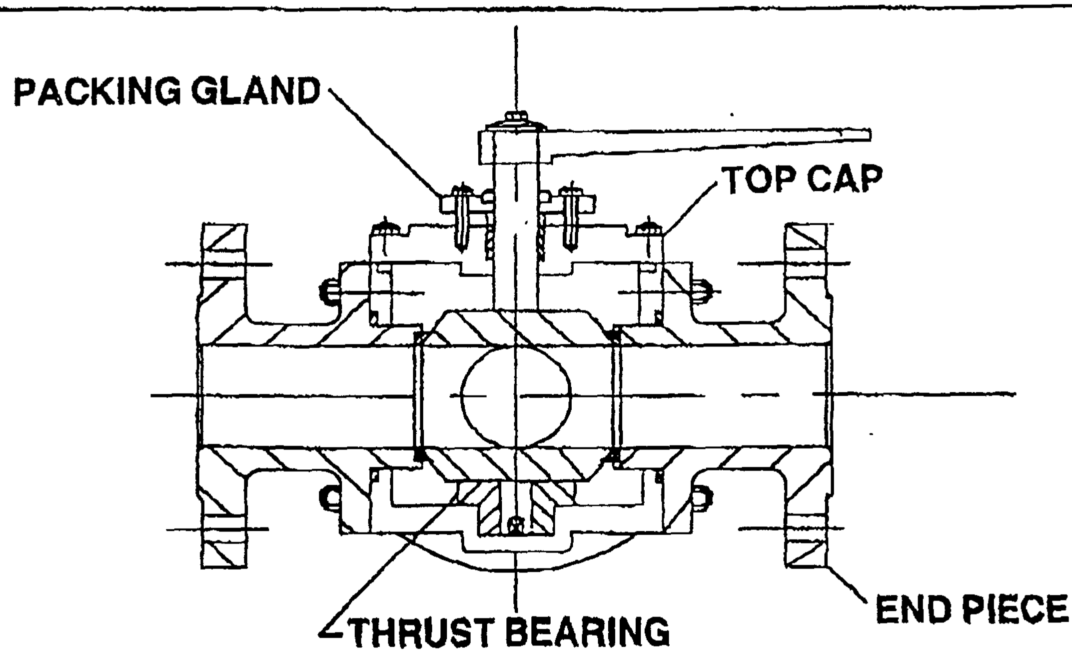


fig. 1-C

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BERNARD CONTROLS, INC.

START-UP INSTRUCTIONS FOR ACTUATORS

INSTRUCTION DE DEMARRAGE DES SERVOMOTEURS

1 - PRECAUTIONS BEFORE BEGINNING INSTALLATION
PRECAUTIONS D'UTILISATIONS

2 - ELECTRICAL CONNECTIONS
BRANCHEMENT ELECTRIQUE

3 - MECHANICAL STOPS SETTING
REGLAGES DES BUTEES MECANIQUES (QUART DE TOUR)

4 - TRAVEL LIMIT SWITCH SETTING
REGLAGE DES FINS DE COURSE

5 - POSITION INDICATOR SETTING
REGLAGE DE L'INDICATEUR DE POSITION

For more information about commissioning instructions or storage, please consult our « COMMISSIONING INSTRUCTIONS - RANGE SD » or « COMMISSIONING INSTRUCTIONS - RANGE SR/ST » literature, depending on the type of actuator

Pour des renseignements plus complets sur l'entretien ou le stockage, se repporter, suivant les appareils, à la brochure « INSTRUCTIONS DE MISE EN SERVICE ET ENTRETIEN - GAMME SD » ou « INSTRUCTIONS DE MISE EN SERVICE - GAMME SR/ST ».

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1. PRECAUTIONS BEFORE COMMISSIONING

Warning: Disconnect power before removing the cover. To insure unit protection, the cover must be promptly replaced.

2. ELECTRICAL CONNECTIONS

- Verify the power characteristics.
- Check the wiring.
- Move the valve manually to the half-open position.
- Connect the travel limits switches and the torque limit switches, then check their functioning*.

Briefly start the actuator and check that the direction of rotation is in accordance with the order given. If not, invert the direction.

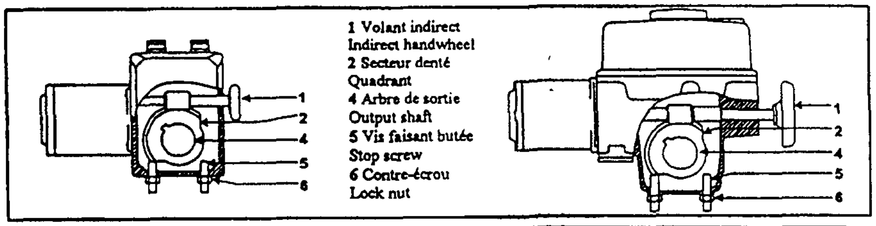
1. PRECAUTIONS D'UTILISATIONS

Attention: Débrancher l'alimentation avanat d'ouvirir l'appareil. Pour assurer la meilleure étanchéité, remettre le couvercle de protection dès que les opérations de réglage sonte terminées.

2. BRANCHEMENT ELECTRIQUE

- Vérifier la nature et la tension du courant.
- Vérifier le câblage*.
- Amener la vanne en position médiane, grâce à la commande manuelle.
- Brancher les fins de course et les limiteurs d'effort et vérifier leur fonctionnement par action manuelle sur les microcontacts.

Donner un ordre bref et vérifier que le sens de rotation du servomoteur coresopnd bien à l'ardre donné. Sinon, inverser le sens de rotation.



3. SET MECHANICAL STOPS

The 90° travel must always be limited by the travel limit switches, so they must be set to trip prior to contacting the mechanical stops.
To modify this position, increase or decrease the corresponding stop, then lock the nut on the screw to prevent a change in position.

The mechanical stops and nuts are located outside of the actuator housing

**The torque limit switches of the SD range actuators only give a short duration contact.*

3. REGLAGES DES BUTEES MECANIQUES (QUART DE TOUR)

Il est impératif que les butées soient réglées de sorte qu'à l'issue des manoeuvres électriques, le secteur en position extreme ne vienne pas en contact avec les butées mécaniques.
Pour modifier cette position, visser ou dévisser la butée corresopndeante, accessible sur le cote de l'appareil.

** Sur les SM de la gamme SD qui disposent d'un limiteur d'effort, celui-ci donne un contact impulsionel.*

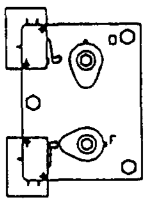
OUTPUT SOCKETS & MOUNTING DIMENSIONS

ACTUATOR MODEL	OUTPUT SOCKET DIMENSIONS (MM) SQUARE	(IN) SQUARE	ISO 5211 FLANGE	BOLT CIRCLE (INCHES)	MOUNTING BOLT QTY-SIZExDEPTH
Z3	14	0.551	F05	1.97	4-M6 x 393
OA6 & OA8	19	0.748	F05 F07	1.97 2.76	4-M6 x .59 4-M8 x .79
OA15	19	0.748	F07	2.76	4-M8 x .79
AT18 & AT25	22	0.866	F07 F10	2.76 4.02	4-M8 x .55 4-M10 x .55
AT50	27	1.063	F07 F10	2.76 4.02	4-M8 x .55 4-M10 x .55
AT80	27	1.063	F12	4.92	4-M12 x .71
BT50	27	1.063	F12	4.92	4-M12 x .59
BT100	36	1.417	F14	5.51	4-M16 x .79
BT150	36	1.417	F14	5.51	4-M16 x .79

4-1 SETTING

- Turn the valve manually to halfway position.
- Unlock the cams from their drive spindle << a >> by partially unscrewing screws << b >> (Fig. 4).
- Bring the valve manually to the closed position, then adjust limit cam << F >> so that the correct switch is operated (Fig. 5).
- Tighten locking screw << b >>.
- Turn valve manually to the open position and then adjust limit cam << 0 >> *so that the correct switch is activated (Fig. 4).*
- Tighten up locking screw << b >>.
- Adjust the cams that trip the auxiliary switches in the same way as the limit switches, but bear in mind that they must be tripped a little before the travel limit switches.

(Fig. 5)
Valve closed



5 - TORQUE LIMITER

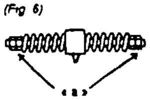
The actuator is delivered with the torque limit system calibrated at the factory to the torque required on the customers order.

If the torque limiter is activated during operation, check:
- that the valve stem is clean and well-lubricated,
- that the valve stem does not jam in the nut,
- that the valve stuffing box is not too tight.

If Torque has to be increased, consult the valve manufacturer and follow the procedures indicated in § 5-1, 5-2 or 5-3.

5-1 TORQUE LIMITER SET BY SPRING COMPRESSION
(type SRA6 - Fig. 6)

(Fig 6)



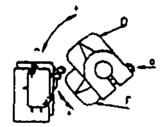
To gain access to the torque limit system, remove the cover plate between the handwheel clutch knob and the motor.

To change the torque setting, turn nuts << a >> that compress the springs of the torque limit device. The torque can be increased or decreased by tightening or loosening nuts << a >>. Lock the nuts in place after adjustment (see setting charts Appendix I).

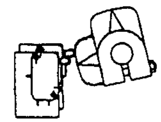
<u>REMARK:</u> THE TORQUE LIMIT DEVICE PROVIDES A SHORT DURATION CONTACT (NOT MAINTAINED ON SRA6.1 ACTUATORS AND MAINTAINED ON THE SRA6.2 ACTUATORS).

5_ TORQUE LIMITER SET BY MOVING OF CAM (FIG 7)
(type SR6 to SR50)

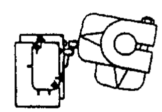
(Fig. 7)
Torque limiter in rest position



Torque limiter closing



Torque limiter opening



The torque limiter must be at rest when adjusting settings (Fig. 8)

Depending on the direction of movement for the valve of which the torque is being adjusted, unlock nut << a >> of the cam to be adjusted

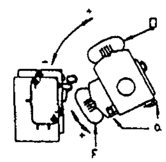
Moving the cam away from the contact switch increases torque

Lock nut << a >> after the adjustment is accomplished.

<u>REMARK:</u> THE TORQUE LIMIT DEVICE GIVES A MAINTAINED CONTACT

5-3 TORQUE LIMITER ADJUSTED BY MICROMETER SCREW (FIG 8)

(Fig. 8)
Limiter in rest position



This device is optional for the SR6 to SR50 actuators

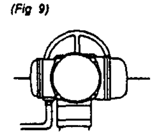
The torque limiter must be at rest when adjusting settings

Depending on the direction of movement for the valve of which the torque is to be modified, turn the micrometer screw << a >> of the cam to be adjusted. This modifies the angle of deflection of the cam within the provided limit.

The figure required for the adjustment torque is obtained from the equivalence table for the reference number given on the bottom of the casing and depends on the position given by the cam reference mark

6 - PRECAUTIONS

(Fig 9)



Replace covers immediately after start-up, making sure their seals are clean (Fig 9)

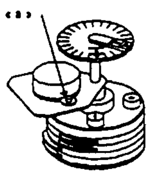
<u>Never</u> fail to replace the protection covers

If water ever enters, thoroughly dry before replacing covers

7 - PROPORTIONAL VISIBLE INDICATOR (Fig. 10)

The indicator disc is rotated by the cam block system.
Turn electrically the valve to the completely open position and rotate the disc until the ◆ symbol appears in the sight opening.
Turn electrically the valve to the completely closed position to check that the ◆ symbol is visible in the sight opening.
Adjust as required.

(Fig. 10)



8 - REMOTE TRANSMISSION (FIG. 10 and 11)

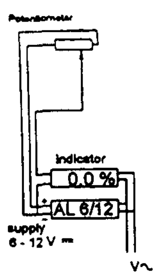
This is optional.
Transmission is performed in the standard model by a potentiometer of total resistance 1000 ohms, 3 W.
Gears drive the potentiometer slide from the cam block system. The effective maximum resistance of the potentiometer is 750 ohms.

8-1 SETTING

Example of setting with an 8v indicator (0-100%) and stabilized settable supply AL6-12.

- Turn electrically the valve to the closed position.
- Unlock the 2 screws << a >> (Fig. 8).
- Turn the potentiometer until the indicator needle is on 0%
- Lock the 2 screws << a >>.
- Verify there is a rise in indication as soon as the opening starts.
- Turn electrically the valve to the fully open position.
- Adjust the indicator needle to 100% by adjusting the supply voltage.

(Fig 11)



9 - MAINTENANCE

All SR actuators are lubricated for life and therefore require no specific maintenance.

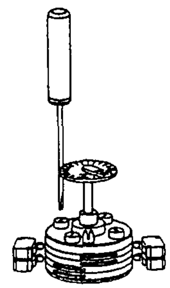
The condition of the valve stem and its nut must nevertheless be checked periodically to insure they are clean and well lubricated.

We recommend that a program of periodic maintenance be drawn up for actuators that are operated infrequently.

3 - SETTING THE TRAVEL LIMIT SWITCHES

The cams operating the limit switches are in a cylindrical block, which does not require any disassembly or special tools. Each cam can be set independently of each other. There are 4 cams included in the camblock, each marked with a different color and number:
a) 1 = white and 2 = black for end of travel limits
b) 3 = beige and 4 = gray for additional limit switches and are optional

(Fig 3)



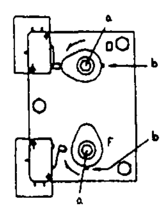
3-1 HOW TO SET THE CAMS

1. Insert a screwdriver in the slot of the button encircled by the same color as the cam to be set (Fig. 3).
2. Press lightly to disengage the cam from its locked position
3. Turning the screwdriver rotates the cam to the position that trips the limit switch.
4. Remove the screwdriver and insure that the button has returned to its original position, thus locking the cam in its selected position

3-2 TO STOP WHEN VALVES ARE IN THE CLOSED POSITION USING THE TORQUE LIMITER DEVICE

Shunt the << Closing >> limit switch at the connection plate (Fig. 5) as per the instructions given in the provided diagram.
Proceed in the same way as in §3.1, making sure when closing under power that limit switch << F >> is correctly activated a little before stopping by opening of the torque limiter contact << F >> (Fig 7) When limit switch << F >> is reversed, it serves to shunt the << Opening >> limiter contact to insure at the start of a reverse movement that an unblocking torque is applied greater than the seating torque

(Fig 4)
Valve open



4 - CHECKING AND ADJUSTING LIMIT SWITCHES USING THE PROPORTIONAL REV-COUNTER (fig. 4).

This device is optional.
It replaces the standard cam block for special purposes

If the motorized valve has been supplied by a valve manufacturer, a simple closing and opening movement must be carried out to check that the limit switches operate correctly, thus verifying the factory setting

A step-down gearing is provided for the repeater system so that the cams turn through 270° rotation

If settings need to be adjusted, proceed as follows

INSTRUCTIONS FOR START-UP AND STORAGE OF SR/ST RANGE ACTUATORS

CLOSE OPEN

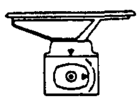
INTRODUCTION

SR/ST range motorized systems are multi-turn actuators resulting from many years of experience in the field of remote controlled valve systems.

A number of devices are provided to ensure safety when operating valves.

- Limit switches for closed and open positions
- Torque limit switches to protect against accidental overloads
- Visible indicator
- Handwheel for use in the event of a power failure

(Fig. 1)



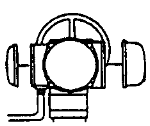
Every actuator is tested, adjusted and checked at the factory before delivery. It is lubricated for life and is able to operate in any position or location.

WARNING: The procedure described in this manual must be followed to prevent damage to the valve or to the mechanism being operated.

1 - START-UP

1-1 ANTI-CONDENSATION HEATER

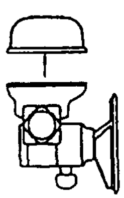
(Fig. 2)



We recommend the use of an anti-condensation heater for all outdoor installations.
As soon as the actuator is on site, apply power to the heater to prevent any condensation from forming.

1-2 MANUAL HANDWHEEL

All SR/ST range actuators are provided with an automatic declutching handwheel, with motor drive priority. Normal operating direction is indicated on the handwheel



The SRA6 actuator has a handwheel clutch knob. In order to manually operate the actuator, align the arrow of the knob with the front triangular sign (Fig. 1) on the housing (it may be necessary to slightly turn the handwheel a few degrees for engagement). When power is applied to the motor, the knob automatically returns to its declutched position.

2 - ELECTRICAL CONNECTIONS

a) Verify the power characteristics
b) Check wiring (Fig. 2).
c) Move the valve manually to the half-open position.
d) Connect the travel limits switches and the torque limit switches, then check their functioning.
e) Briefly start briefly the actuator and check that the direction of rotation is in accordance with the order given If not, invert the direction.
   Before refitting the cover, verify the position of the visual indicator.

10 - STORAGE

Introduction

The actuator includes electric equipment as well as grease lubricated gears In spite of the weatherproof enclosure, oxidation, jamming and other alterations are possible if the actuator is not correctly stored.

Storage

The actuators should be stored under a shelter in a clean, dry place and protected from constant changes in temperature

Avoid placing the actuators directly on the floor. For actuators equipped with anti-condensation heaters, it is recommended that they be connected and voltage applied especially if the place of storage is humid (standard voltage 120 volts, unless otherwise specified).

Check that the temporary sealing plugs in the cable entries are securely in place In case of humidity, metal plugs are used.

Make sure that the covers and the boxes are well closed to insure weatherproof sealing

Control after storage

1. Storage not exceeding one year:

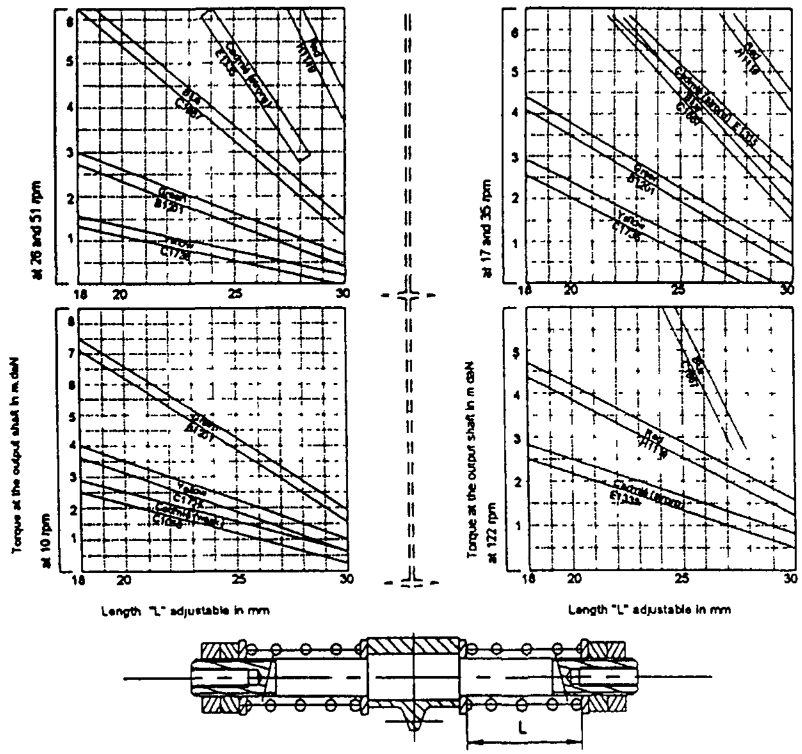
- Maintain a visual check of electric equipment
- Operate manually the microswitches, buttons, selectors, etc to insure their correct mechanical function.
- Operate apparatus manually.
- Verify the correct grease consistency.
- Follow all instructions included in these commissioning instructions

2. Storage exceeding one year

- Long time stocking changes grease consistency. The grease thinly applied on the stem dries up.
- Remove all the old grease from the actuator mechanical parts and replace it with new grease.
- Maintain a visual check of electric equipment
- Operate manually the microswitches, buttons, selectors, etc., to insure their correct mechanical function.
- Follow all instructions included in these commissioning instructions

APPENDIX I

TORQUE DEVICE SETTING ON SRA6

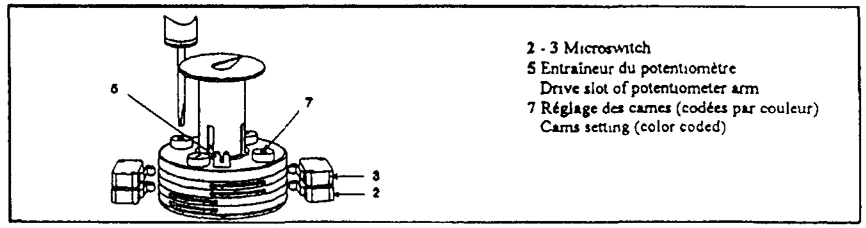


4. SET TRAVEL LIMIT SWITCHES

The cams operating the limit switches are in a cylindrical block which does not require any disassembly or special tools

4. REGLAGE DES FINS DE COURSE

Les cames actionnant les microcontacts forment un ensemble monobloc dont les quatre éléments peuvent être réglés séparément et independeamment les uns des autres



How to proceed

1. Manually operate the actuator to the position to be set
2. Insert a screwdriver in the slot of the button encircled by the same color as the cam to be set
3. Push to disengage the lock and turn clockwise or counter-clockwise according to the needed cam position
4. Remove the screwdriver and insure the button has returned upward to its original position, thus locking the cam in the selected position

Caution: Insure that the travel limit switches stop the motor before the quadrant reaches the mechanical stops

Mode operatoire

1. Amener en manual la vanne dans la position à régler
2. Placer un petit tournevis dans la fente correspondante à la came à déplacer
3. Appuyer pour libérer la came et tourner dans un sens ou l'autre pour amender la came dans la position recherchee
4. Relâcher et s assurer que la tête est remontee en position d origine ce qui verrouille automatiquement la came

Attention: Le fin de course doit couper l alimentation moteur avant d arriver sur la butée mécanique

5. POSITION INDICATOR SET

The indicator with arrow can be rotated by hand without removal Adjust this indicator to its proper position inside the cover window

Actuators with a potentiometer have an indicator plate held in place by a screw After loosing this screw adjustments are possible

5. REGLAGE DE L'INDICATEUR DE POSITION

Sur les types sans potentiométre la flèche peut être tournée à la main sans demontage pour l'amener en face du repère correspondant au hublot

Sur les types avec potentiometre l indicateur peut etre réglé apres desserrage de sa vis de fixation

Cutler Hammer
Variable Frequency Drives

Dimensions SEW-3 & SEW-4 VFD

Table 40-54. Approximate Dimensions — NEMA 1, NEMA 12 — Frames M4, M5 and M6

Enclosure Size	Frame	Voltage	Dimensions in Inches (mm)								
			W1	W2	H1	H2	H3	H4	D1	R1	R2
NEMA 1/12	M4	230/380/480	4.7 (120)	3.7 (95)	16.7 (423)	16.2 (412)	15.4 (390)	—	8.5 (215)	.28 (7.0)	.14 (3.5)
	M5	230/380/480	6.2 (157)	5.0 (127)	22.1 (562)	21.5 (545)	20.3 (515)	—	9.4 (238)	.35 (9.0)	.18 (4.5)
	M6	230/380/480	8.7 (220)	7.1 (180)	27.6 (700)	26.9 (683)	25.6 (650)	—	11.4 (290)	.35 (9.0)	.18 (4.5)

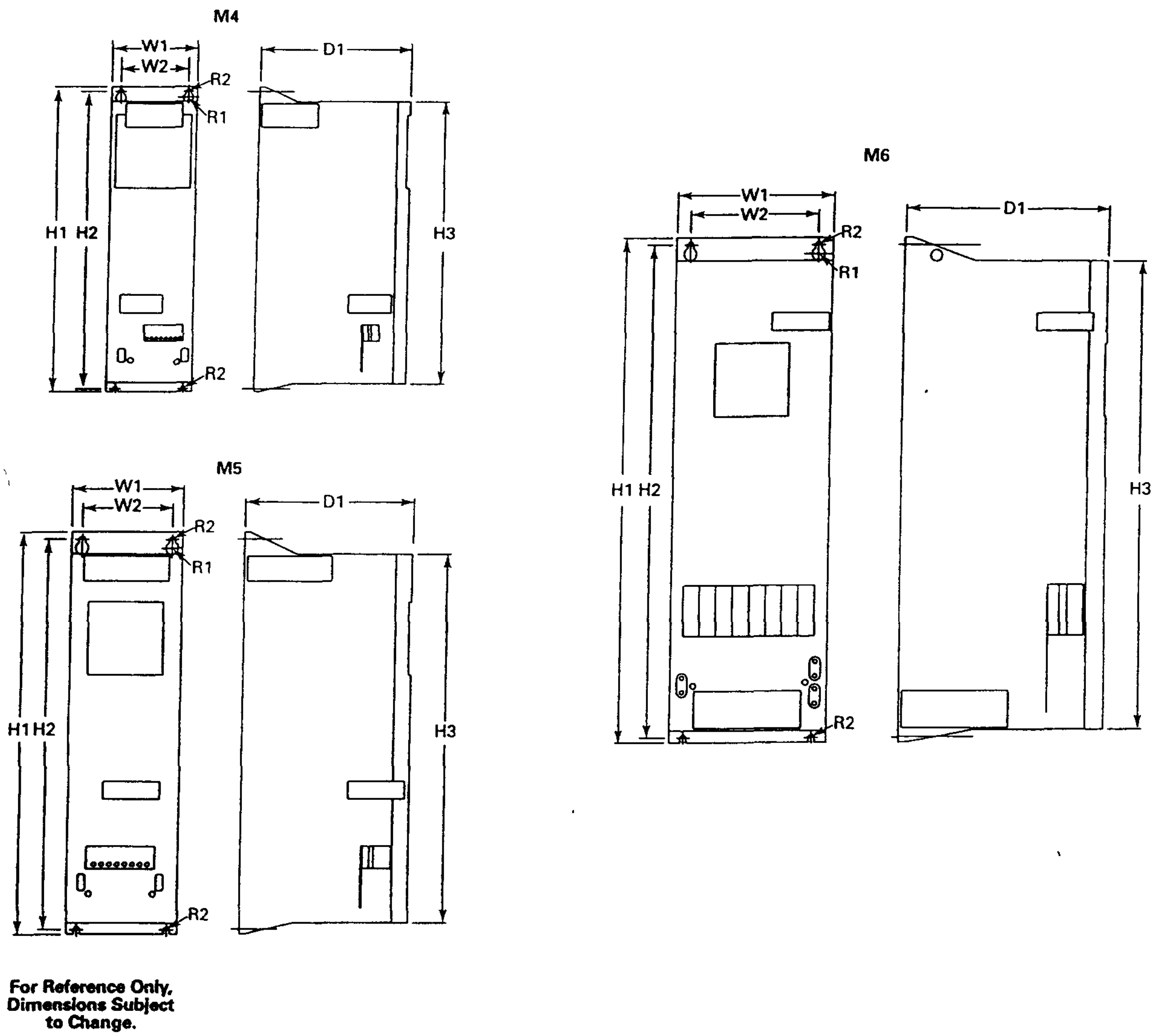


Figure 40-7. Approximate Dimensions

HOW TO USE THIS MANUAL

This manual provides you with the information necessary to install start up and operate a Cutler Hammer SV9000 drive We recommend that you read this manual carefully

At minimum the following 10 steps of the

Quick Start Guide

1 Check the equipment received compared to what you have ordered see chapter 3

2 Before doing any start up actions carefully read the safety instructions in chapter 1

3 Before mechanical installation check the minimum clearances around the unit and verify that ambient conditions will meet the requirements of chapter 5 2 and table 4 3 1a

4 Check the size of the motor cable the utility cable and the fuses Verify the tightness of the cable connections Review chapters 6 1 1 6 1 2 and 6 1 2

5 Follow the installation instructions see chapter 6 1 4

6 Control cable sizes and grounding system are explained in chapter 6 2 The signal configuration for the Basic application is in chapter 10 2

Remember to connect the common terminals CMA and CMB of the digital input groups (See figure 10 2 1)

Quick Start Guide must be done during installation and startup

If any problem occurs please call the telephone number listed on the back of this manual for assistance

7 For instructions on how to use the SVMulti line ™ panel see chapter 7

8 The basic application has only 10 parameters in addition to the motor rating plate data the parameter and application package lock All of these have default values To ensure proper operation verify the nameplate data of both the motor and SV9000

nominal voltage of the motor
nominal frequency of the motor
nominal speed of the motor
nominal current of the motor
supply voltage

Parameters are explained in chapter 10 4

9 Follow the start-up instructions see chapter 8

10 Your Cutler Hammer SV9000 is now ready for use

If a different I/O configuration or different operational functions from the basic configuration are required see chapter 12 SVReady application package for a more suitable configuration For a more detailed description see the separate SVReady application manual

Cutler Hammer is not responsible for the use of the SV9000 differently than noted in these instructions

SV9000 USER MANUAL

CONTENTS

OPEN SV9000 SVReady USER MANUAL

CUTLER HAMMER SV9000 USERS MANUAL
CONTENTS

1 SAFETY

ONLY A QUALIFIED ELECTRICIAN SHOULD PERFORM THE ELECTRICAL INSTALLATION

1.1 Warnings

1. Internal components and circuit boards (except the isolated I/O terminals) are at utility potential when the SV9000 is connected to the line. This voltage is extremely dangerous and may cause death or severe injury if you come in contact with it.
2. When the SV9000 is connected to the utility the motor connections U(T1) V(T2) W(T3) and DC link / brake resistor connections + are live even if the motor is not running.
3. The control I/O terminals are isolated from the line potential but the relay outputs and other I/O s (if jumper X4 is in OFF position see figure 6 2 2 1) may have dangerous external voltages connected even if the power is disconnected from the SV9000.
4. The SV9000 has a large capacitive leakage current.
5. An upstream disconnect/protection device is to be used as noted in the National Electric Code (NEC).
6. Only spare parts obtained from a Cutler-Hammer authorized distributor can be used.

1.2 Safety instructions

1. The SV9000 is meant only for fixed installation. Do not make any connections or measurements when the SV9000 is connected to the utility.
2. After disconnecting the utility wait until the unit cooling fan stops and the indicators on the control panel are extinguished (if no keypad is present, check the indicators in the cover). Wait 5 more minutes before doing any work on the SV9000 connections. Do not open the cover before this time has run out.
3. Do not make any voltage withstand or megger tests on any part of the SV9000.
4. Disconnect the motor cables from the SV9000 before meggering the motor cables.
5. Do not touch the IC-circuits on the circuit boards. Static voltage discharge may destroy the components.
6. Before connecting to the utility make sure that the cover of the SV9000 is closed.
7. Make sure that nothing but a three-phase motor is connected to the motor terminal, with the exception of factory recommended filters.

1.3 Grounding and ground fault protection

The SV9000 must always be grounded with a grounding conductor connected to the grounding terminal (⏚).

The SV9000's ground fault protection protects only the SV9000 if a ground fault occurs in the motor or in the motor cable.

Due to the high leakage current fault current protective devices do not necessarily operate correctly with drives. When using this type of device its function should be tested in the actual installation.

Warning Symbols

For your own safety please pay special attention to the instructions marked with these warning symbols.

Dangerous voltage

General warning

1.4 Running the motor

1. Before running the motor make sure that the motor is mounted properly.
2. Maximum motor speed (frequency) should never be set to exceed the motor's and driven machine's capability.
3. Before reversing the rotation of the motor shaft make sure that this can be done safely.

2 EU-DIRECTIVE

2.1 CE-label

The CE-label on the product guarantees the free movement of the product in the EU-area. According to the EU-rules this guarantees that the product is manufactured in accordance with different directives relating to the product.

Cutler-Hammer SV9000s are equipped with the CE label in accordance with the Low Voltage Directive (LVD) and the EMC directive.

2.2 EMC-directive

2.2.1 General

The EMC directive (Electro Magnetic Compatibility) states that the electrical equipment must not disturb the environment and must be immune to other Electro Magnetic Disturbances in the environment.

A Technical Construction File (TCF) exists which demonstrates that the SV9000 drives fulfill the requirements of the EMC directive. A Technical Construction File has been used as a statement of conformity with the EMC directive as it is not possible to test all combinations of installation.

2.2.2 Technical criteria

The design intent was to develop a family of drives, which is user friendly and cost effective while fulfilling the customer needs. EMC compliance was a major consideration from the outset of the design.

The SV9000 series is targeted at the world market. To ensure maximum flexibility yet meet the EMC needs of different regions, all drives meet the highest immunity levels while emission levels are left to the user's choice.

The SV9000 does not include the required EMC filter which is available as an option. For use within the EU the end user takes personal responsibility for EMC compliance.

2.2.3 EMC-levels

The SV9000-series does not fulfil any EMC emission requirements without an optional RFI-filter either built-in or separate. With an RFI-filter the drive fulfils the EMC emission requirements in the heavy industrial environment (standards EN50081 2 EN61800-3).

All products fulfil all EMC immunity requirements (standards EN50082 1 2 EN61800-3).

2.2.4 Manufacturer's Declaration of Conformity

Manufacturer's Declaration of Conformity are available upon request.

3 RECEIVING

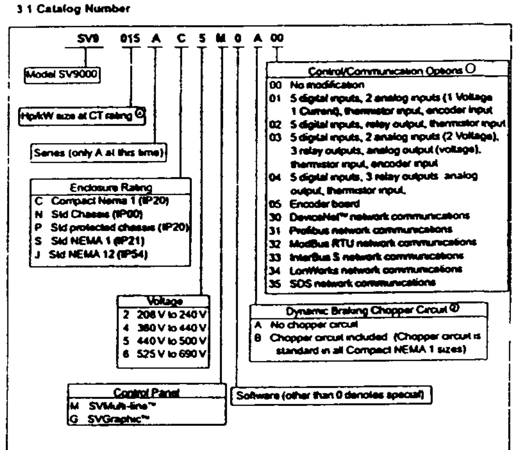
This Cutler-Hammer SV9000 drive has been subjected to demanding factory tests before shipment. After unpacking check that the device does not show any signs of damage and that the SV9000 is as ordered (refer to the model designation code in figure 3-1).

In the event of damage please contact and file a claim with the carrier involved immediately.

If the received equipment is not the same as ordered, please contact your distributor immediately.

Note! Do not destroy the packing. The template printed on the protective cardboard can be used for marking the mounting points of the SV9000 on the wall.

3.1 Catalog Number



① Control and communication options for Compact NEMA 1 are included in a separate expansion box
② Available as a factory installed option only
③ Horsepower rating for the SV9000 is selected based on the constant torque (CT) rating. Variable torque (VT) ratings are typically one Hp rating higher. Please see the tables in Technical Data for equivalent VT part number

Figure 3-1 Catalog number system.

3.2 Storing

If the SV9000 must be stored before installation and startup check that the ambient conditions in the storage area are acceptable (temperature -40°C +60°C (-40°F +140°F) relative humidity <95% no condensation allowed)

3

3.3 Warranty

This equipment is covered by the Cutler Hammer standard drive warranty policy

Cutler Hammer distributors may have a different warranty period which is specified in their sales terms and conditions and warranty terms

If any questions arise concerning the warranty please contact your distributor

4 TECHNICAL DATA

4.1 General

Figure 4.1 shows a block diagram of the SV9000 drive

The three phase *AC Choke* with the DC link capacitor forms an LC filter which together with the *Diode Bridge* produce the DC voltage for the IGBT *Inverter Bridge* block The AC-Choke smooths the HF disturbances from the utility to the drive and HF-disturbances caused by the drive to the utility It also improves the waveform of the input current to the drive

The IGBT bridge produces a symmetrical three phase pulse width modulated AC voltage to the motor The power drawn from the supply is almost entirely active power

The Motor and Application Control block is based on microprocessor software The microprocessor controls the motor according to measured signals, parameter value settings and commands from the *Control I/O* block and the *Control Panel* The Motor and Application Control block gives commands to the *Motor Control ASIC* which calculates the IGBT switching positions *Gate Drivers* amplify these signals for driving the IGBT inverter bridge

The Control Panel is a link between the user and the drive With the panel the user can set parameter values read status data and give control commands The panel is removable and can be mounted externally and connected via a cable to the drive

The Control I/O block is isolated from line potential and is connected to ground via a 1 MΩ resistor and 4.7 nF capacitor If needed the Control I/O block can be grounded without a resistor by changing the position of the jumper X4 (GND ON/OFF) on the control board

4

The basic Control interface and parameters (Basic application) make the inverter easy to operate If a more versatile interface or parameter settings are needed an optional application can be selected with one parameter from a "SVReady™" application package The application package manual describes these in more detail

An optional *Brake Chopper* can be mounted in the unit at the factory Optional I/O-expander boards are also available

Input and Output EMC-filters are not required for the functionality of the drive they are only required for compliance with the EU EMC directive

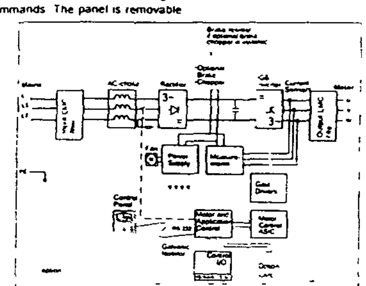


Figure 4.1 SV9000 block diagram

4.2 Power ratings

200-240 Vac. +10% / -15% 50/60 Hz. 3 ~ Input COMPACT NEMA 1 (IP20)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F07AC-2-	0.75	3.6	1	4.7	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
SV9F10AC-2-	1	4.7	1.5	5.6			
SV9F15AC-2-	1.5	5.6	2	7			
SV9F20AC-2-	2	7	3	10			
SV9F30AC-2-	3	10			M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
SV9F40AC-2-			5	16			
SV9F50AC-2-	5	16	7.5	22			
SV9F75AC-2-	7.5	22	10	30			
SV9010AC-2-	10	30	15	43	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
SV9015AC-2-	15	43	20	57			
SV9020AC-2-	20	57	25	70			

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input COMPACT NEMA 1 (IP20)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
SV9F07AC-4-	0.75	2.5	1.1	3.5	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
SV9F11AC-4-	1.1	3.5	1.5	4.5			
SV9F15AC-4-	1.5	4.5	2.2	6.5			
SV9F22AC-4-	2.2	6.5	3	8			
SV9F30AC-4-	3	8	4	10			
SV9F40AC-4-	4	10	5.5	13	M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
SV9F55AC-4-	5.5	13	7.5	18			
SV9F75AC-4-	7.5	18	11	24			
SV9011AC-4-	11	24	15	32			
SV9015AC-4-	15	32	18.5	42	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
SV9018AC-4-	18.5	42	22	48			
SV9022AC-4-	22	48	30	60			

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input COMPACT NEMA 1 (IP20)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F10AC-5-	1	2.5	1.5	3	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
SV9F15AC-5-	1.5	3	2	3.5			
SV9F20AC-5-	2	3.5	3	5			
SV9F30AC-5-	3	5	-	-			
SV9F40AC-5-	-		5	8			
SV9F50AC-5-	5	8	7.5	11	M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
SV9F75AC-5-	7.5	11	10	15			
SV9010AC-5-	10	15	15	21			
SV9015AC-5-	15	21	20	27			
SV9020AC-5-	20	27	25	34	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
SV9025AC-5-	25	34	30	40			
SV9030AC-5-	30	40	40	52			

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)
** Ivt = continuous rated input and output current (variable torque load max 40C ambient)

200 240 Vac, +10% / -15% 50/60 Hz 3 ~ Input Protected Chassis/ Chassis (IP20/IP00)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F20AP 2-	2	7	3	10	M4 / Protected	4.7 x 11.4 x 8.5	15.4
SV9F30AP 2-	3	10					
SV9F40AP 2-			5	16	M5 / Protected	6.2 x 15.9 x 9.4	33.1
SV9F50AP-2-	5	16	7.5	22			
SV9F75AP 2-	7.5	22	10	30			
SV9010AP 2-	10	30	15	43			
SV9015AP 2-	15	43	20	57	M6 / Protected	8.7 x 20.7 x 11.4	77.2
SV9020AP 2-	20	57	25	70			
SV9025AP 2-	25	70	30	83			
SV9030AP 2	30	83	40	113			
SV9040AN 2	40	113	50	139	M7 / Chassis***	9.8 x 31.5 x 12.4	135
SV9050AN 2-	50	139	60	165			
SV9060AN 2-	60	165	75	200			
SV9075AN 2-	75	200	100	264	M8 / Chassis***	19.5 x 35 x 13.9	300

200 240 Vac, +10% / -15% 50/60 Hz 3 ~ Input NEMA 1 (IP21)

Catalog Number	Rated Horsepower and output current				Frame Size Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt *			
SV9F20AS 2-	2	7	3	10	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
SV9F30AS 2-	3	10					
SV9F40AS 2-			5	16	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
SV9F50AS 2-	5	16	7.5	22			
SV9F75AS 2-	7.5	22	10	30			
SV9010AS 2-	10	30	15	43			
SV9015AS 2-	15	43	20	57	M6 / NEMA 1	8.7 x 25.6 x 11.4	84
SV9020AS-2-	20	57	25	70			
SV9025AS 2-	25	70	30	83			
SV9030AS 2-	30	83	40	113			
SV9040AS-2-	40	113	50	139	M7 / NEMA 1	14.7 x 39.4 x 13	180
SV9050AS 2-	50	139	60	165			
SV9060AS 2-	60	165	75	200			
SV9075AS 2-	75	200	100	264	M8 / NEMA 1	19.5 x 50.8 x 14	337

200-240 Vac +10% / -15% 50/60 Hz 3 ~ Input NEMA 12 (IP54)

Catalog Number	Rated Horsepower and output current				Frame Size Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict	Hp	Ivt			
SV9F20AJ 2	2	7	3	10	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
SV9F30AJ 2-	3	10					
SV9F40AJ 2-			5	16	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
SV9F50AJ 2-	5	16	7.5	22			
SV9F75AJ 2-	7.5	22	10	30			
SV9010AJ 2-	10	30	15	43			
SV9015AJ 2-	15	43	20	57	M6 / NEMA 12	8.7 x 25.6 x 11.4	84
SV9020AJ 2-	20	57	25	70			
SV9025AJ 2-	25	70	30	83			
SV9030AJ-2-	30	83	40	113			
SV9040AJ 2-	40	113	50	139	M7 / NEMA 12	14.7 x 39.4 x 13	180
SV9050AJ 2-	50	139	60	165			
SV9060AJ 2-	60	165	75	200			
SV9075AJ-2-	75	200	100	264	M8 / NEMA 12	19.5 x 50.8 x 14	337

* Ict = continuous rated input and output current (constant torque load max 50C ambient)
** Ivt = continuous rated input and output current (variable torque load max 40C ambient)
*** Protected Enclosure with Option

380 - 440Vac, +10% / -15% 50/60 Hz 3 ~ Input Protected Chassis/Chassis (IP20/IP00)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
SV9F22AP-4-	2.2	6.5	3	8	M4 / Protected	4.7 x 11.4 x 8.5	15.4
SV9F30AP-4-	3	8	4	10			
SV9F40AP-4-	4	10	5.5	13			
SV9F55AP-4-	5.5	13	7.5	18			
SV9F75AP-4-	7.5	18	11	24	M5 / Protected	6.2 x 15.9 x 9.4	33.1
SV9011AP-4-	11	24	15	32			
SV9015AP-4-	15	32	18.5	42			
SV9018AP-4-	18.5	42	22	48	M6 / Protected	8.7 x 20.7 x 11.4	77.2
SV9022AP-4-	22	48	30	60			
SV9030AP-4-	30	60	37	75			
SV9037AP-4-	37	75	45	90			
SV9045AP-4-	45	90	55	110			
SV9055AN-4-	55	110	75	150	M7 / Chassis	9.8 x 31.5 x 12.4	133
SV9075AN-4-	75	150	90	180			
SV9090AN-4-	90	180	110	210			
SV9110AN-4-	110	210	132	270	M8 / Chassis ***	19.5 x 35.0 x 13.9	309
SV9132AN-4-	132	270	160	325			
SV9160AN-4-	160	325	200	410			
SV9200AN-4-	200	410	250	510	M9 / Chassis ***	27.6 x 39.4 x 15.4	485
SV9250AN-4-	250	510	315	580			
SV9315AN-4-	315	600	400	750	M10 / Chassis	38.9 x 39.4 x 15.4	684
SV9400AN-4-	400	750	500	840			
SV9500AN-4-	500	840	630	1050	M11 / Chassis	55.1 x 39.4 x 15.4	948
SV9630AN-4-	630	1050	710	1160	M12 / Chassis	77.9 x 39.4 x 15.4	1212
SV9710AN-4-	710	1270	800	1330			
SV9800AN-4-	800	1330	900	1480			
SV9900AN-4-	900	1480					
SV9H10AN-4-	1000	1600		-			

* Ict = continuous rated input and output current (constant torque load max 50C ambient)
** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)
*** Protected Enclosure with Option

380 - 440Vac, +10% / -15% 50/60 Hz, 3 ~ Input NEMA 1 (IP21)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
SV9F22AS-4-	2.2	6.5	3	8	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
SV9F30AS-4-	3	8	4	10			
SV9F40AS-4-	4	10	5.5	13			
SV9F55AS-4-	5.5	13	7.5	18			
SV9F75AS-4-	7.5	18	11	24	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
SV9011AS-4-	11	24	15	32			
SV9015AS-4-	15	32	18.5	42			
SV9018AS-4-	18.5	42	22	48	M6 / NEMA 1	8.7 x 25.6 x 11.4	84
SV9022AS-4-	22	48	30	60			
SV9030AS-4-	30	60	37	75			
SV9037AS-4-	37	75	45	90			
SV9045AS-4-	45	90	55	110			
SV9055AS-4-	55	110	75	150	M7 NEMA 1	14.7 x 39.4 x 13.0	221
SV9075AS-4-	75	150	90	180			
SV9090AS-4-	90	180	110	210			
SV9110AS-4-	110	210	132	270	M8 / NEMA 1	19.5 x 47.6 x 13.9	309
SV9132AS-4-	132	270	160	325			
SV9160AS-4-	160	325	200	410			
SV9200AS-4-	200	410	250	510	M9 / NEMA 1	27.6 x 56.1 x 15.4	574
SV9250AS-4-	250	510	315	580			
SV9315AS-4-	315	600	400	750	Contact Factory		
SV9400AS-4-	400	750	500	840			

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input NEMA 12 (IP54)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
SV9F22AJ-4-	2.2	6.5	3	8	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
SV9F30AJ-4-	3	8	4	10			
SV9F40AJ-4-	4	10	5.5	13			
SV9F55AJ-4-	5.5	13	7.5	18			
SV9F75AJ-4-	7.5	18	11	24	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
SV9011AJ-4-	11	24	15	32			
SV9015AJ-4-	15	32	18.5	42			
SV9018AJ-4-	18.5	42	22	48	M6 / NEMA 12	8.7 x 25.6 x 11.4	84
SV9022AJ-4-	22	48	30	60			
SV9030AJ-4-	30	60	37	75			
SV9037AJ-4-	37	75	45	90			
SV9045AJ-4-	45	90	55	110			
SV9055AJ-4-	55	110	75	150	M7 / NEMA 12	14.7 x 39.4 x 13.0	221
SV9075AJ-4-	75	150	90	180			
SV9090AJ-4-	90	180	110	210			
SV9110AJ-4-	110	210	132	270	M8 / NEMA 12	19.5 x 47.6 x 13.9	309
SV9132AJ-4-	132	270	160	325			
SV9160AJ-4-	160	325	200	410			
SV9200AJ-4-	200	410	250	510	M9 / NEMA 12	27.6 x 56.1 x 15.4	574
SV9250AJ-4-	250	510	315	580			
SV9315AJ-4-	315	600	400	750	Contact Factory		
SV9400AJ-4-	400	750	500	840			

* Ict = continuous rated input and output current (constant torque load max 50C ambient)
** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input Protected Chassis/Chassis (IP20/IP00)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F30AP-5-	3	5	-		M4 / Protected	4.7 x 11.4 x 8.5	15.4
SV9F40AP-5-	-	-	5	8			
SV9F50AP-5-	5	8	7.5	11			
SV9F75AP-5-	7.5	11	10	15			
SV9010AP-5-	10	15	15	21	M5 / Protected	6.2 x 15.9 x 9.4	33.1
SV9015AP-5-	15	21	20	27			
SV9020AP-5-	20	27	25	32			
SV9025AP-5-	25	34	30	40	M6 / Protected	8.7 x 20.7 x 11.4	77.2
SV9030AP-5-	30	40	40	52			
SV9040AP-5-	40	52	50	65			
SV9050AP-5-	50	65	60	77			
SV9060AP-5-	60	77	75	96			
SV9075AN-5-	75	96	100	125	M7 / Chassis ***	9.8 x 31.5 x 12.4	133
SV9100AN-5-	100	125	125	160			
SV9125AN-5-	125	160	150	180			
SV9150AN-5-	150	180	-	-	M8 / Chassis ***	19.5 x 35.0 x 13.9	309
SV9175AN-5-	-	-	200	260			
SV9200AN-5-	200	260	250	320			
SV9250AN-5-	250	320	300	400	M9 / Chassis ***	27.6 x 39.4 x 15.4	485
SV9300AN-5-	300	400	400	460			
SV9400AN-5-	400	480	500	600	M10 / Chassis	38.9 x 39.4 x 15.4	684
SV9500AN-5-	500	600	600	672			
SV9600AN-5-	600	700	700	880	M11 / Chassis	55.1 x 39.4 x 15.4	948
SV9700AN-5-	700	880	800	1020	M12 / Chassis	77.9 x 39.4 x 15.4	1212
SV9800AN-5-	800	1020	900	1070			
SV9900AN-5-	900	1070	1000	1200			
SV9H10AN-5-	1000	1200	-	-			
SV9H11AN-5-	1100	1300	-	-			

* Ict = rated input and output current (constant torque load max 50C ambient)
** Ivt = rated input and output current (variable torque load max 40C ambient)
*** Protected Enclosure with Optional Cover

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input NEMA 1 (IP21)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F30AS-5-	3	5	-	-	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
SV9F40AS-5-	-	-	5	8			
SV9F50AS-5-	5	8	7.5	11			
SV9F75AS-5-	7.5	11	10	15			
SV9010AS-5-	10	15	15	21	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
SV9015AS-5-	15	21	20	27			
SV9020AS-5-	20	27	25	32			
SV9025AS-5-	25	34	30	40	M6 / NEMA 1	8.7 x 25.6 x 11.4	83.8
SV9030AS-5-	30	40	40	52			
SV9040AS-5-	40	52	50	65			
SV9050AS-5-	50	65	60	77			
SV9060AS-5-	60	77	75	96			
SV9075AS-5-	75	96	100	125	M7 / NEMA 1	14.7 x 39.4 x 13.0	221
SV9100AS-5-	100	125	125	160			
SV9125AS-5-	125	160	150	180			
SV9150AS-5-	150	180	-		M8 / NEMA 1	19.5 x 47.6 x 13.9	309
SV9175AS-5-	-	-	200	260			
SV9200AS-5-	200	260	250	320			
SV9250AS-5-	250	320	300	400	M9 / NEMA 1	27.6 x 56.1 x 15.4	574
SV9300AS-5-	300	400	400	460			
SV9400AS-5-	400	480	500	600	Contact Factory		
SV9500AS-5-	500	600	600	672			

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input NEMA 12 (IP54)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
SV9F30AJ-5-	3	5	-	-	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
SV9F40AJ-5-	-	-	5	8			
SV9F50AJ-5-	5	8	7.5	11			
SV9F75AJ-5-	7.5	11	10	15			
SV9010AJ-5-	10	15	15	21	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
SV9015AJ-5-	15	21	20	27			
SV9020AJ-5-	20	27	25	32			
SV9025AJ-5-	25	34	30	40	M6 / NEMA 12	8.7 x 25.6 x 11.4	83.8
SV9030AJ-5-	30	40	40	52			
SV9040AJ-5-	40	52	50	65			
SV9050AJ-5-	50	65	60	77			
SV9060AJ-5-	60	77	75	96			
SV9075AJ-5-	75	96	100	125	M7 / NEMA 12	14.7 x 39.4 x 13.0	221
SV9100AJ-5-	100	125	125	160			
SV9125AJ-5-	125	160	150	180			
SV9150AJ-5-	150	180		-	M8 / NEMA 12	19.5 x 47.6 x 13.9	309
SV9175AJ-5-	-		200	260			
SV9200AJ-5-	200	260	250	320			
SV9250AJ-5-	250	320	300	400	M9 / NEMA 12	27.6 x 56.1 x 15.4	574
SV9300AJ-5-	300	400	400	460			
SV9400AJ-5-	400	480	500	600	Contact Factory		
SV9500AJ-5-	500	600	600	672			

* Ict = continuous rated input and output current (constant torque load max 50C ambient)
** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

525 - 600Vac +10% / 15% 50/60 Hz, 3 ~ Input Nema 1/ Protected Chassis (IP20/IP20)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict	Hp	Ivt			
SV9F20AP 6-	2	3.5	3	4.5	M5 Nema 1	6.2 x 17.3 x 10.4	13.1
SV9F30AP 6-	3	4.5					
SV9F40AP 6-			5	7.5			
SV9F50AP 6-	5	7.5	7.5	10			
SV9F75AP 6-	7.5	10	10	14			
SV9010AP-6	10	14	15	19			
SV9015AP-6	15	19	20	23			
SV9020AP-6	20	23	25	26			
SV9025AP-6	25	26	30	35			
SV9030AP-6	30	35	40	42	M6 / Nema 1	8.7 x 24.3 x 11.4	83.8
SV9040AP-6	40	42	50	52			
SV9050AP-6	50	52	60	62			
SV9060AP-6	60	62	75	85			
SV9075AP-6	75	85	100	100			
SV9100AN-6-	100	100	125	122	M8 / Chassis **	19.5 x 35.0 x 13.9	300
SV9125AN-6-	125	122	150	145			
SV9150AN-6-	150	145					
SV9175AN-6-			200	222	M9 / Chassis ***	27.6 x 39.4 x 15.4	466
SV9200AN-6-	200	222	250	287			
SV9250AN-6-	250	287	300	325	M10 / Chassis	38.9 x 39.4 x 15.4	602
SV9300AN-6-	300	325	400	390			
SV9400AN-6-	400	400	500	490	M11 / Chassis	55.1 x 39.4 x 15.4	948
SV9500AN-6-	500	490	600	620	M12 / Chassis	77.9 x 39.4 x 15.4	1213
SV9600AN-6-	600	620	700	700			
SV9700AN-6-	700	700					
SV9800AN-6-	800	780					

* Ict = rated input and output current (constant torque load max 50C ambient)
* Ivt = rated input and output current (variable torque load max 40C ambient)
** Protected Enclosure with Option

4

4.3 Specifications

Utility connection	Input voltage V_{in}		200 240V 380—440V 440—500V 525 690V 15% 10%
	Input frequency		45—66 Hz
Motor Connection	Output voltage		0 V
	Continuous output current		I_{CT} ambient max 50°C overload 1.5 x I_{CT} (1min/10 min)
			I_{VT} ambient max 40 C 1.1 x I_{VT} (1min/10 min)
	Starting torque		200%
	Starting current		2.5 x I_{CT} 2 s every 20 s if output frequency < 30 Hz and if the heatsink temperature < 60 C
	Output frequency		0—500 Hz
	Frequency resolution		0.01 Hz
Control characteristics	Control method		Frequency Control (V/Hz) Open Loop Sensorless Vector Control Closed Loop Vector Control
	Switching frequency		1—16 kHz (depending on horsepower rating)
	Frequency reference	Analog I/P	Resolution 12 bit accuracy ±1%
		Panel refer	Resolution 0.01 Hz
	Field weakening point		30—500 Hz
	Acceleration time		0.1—3000 s
	Deceleration time		0.1—3000 s
	Braking torque		DC brake 30% T_n (without brake option)
Environmental limits	Ambient operating temperature		10 (no frost)— 50 C at I_{CT} (1.5 x I_{CT} max 1min/10min) 10 (no frost)— 40°C at I_{VT} (1.1 x I_{CT} max 1min/10 min)
	Storage temperature		40 C—+60 C
	Relative humidity		<95% no condensation allowed
	Air quality chemical vapors mechanical particles		IEC 721 3 3 unit in operation class 3C2 IEC 721 3 3 unit in operation class 3S2
	Altitude		1000m (3300 ft) maximum without derating
	Vibration (IEC 721 3 3)		Operation max displacement amplitude 3 mm at 2—9 Hz Max acceleration amplitude 0.5 G at 9—200 Hz
	Shock (IEC 68 2 27)		Operation max 8 G 11 ms Storage and shipping max 15 G 11 ms (in the package)
	Enclosure		Protected Chassis (IP20) and Chassis (IP20) Compact NEMA 1 (IP20) NEMA 1 (IP21) NEMA 12 (IP54)

Table 4.3.1 Specifications

4

EMC	Noise immunity	Fulfils EN50082 1 2 EN61800-3
	Emissions	Equipped with an optional external RFI-Filter fulfils EN50081 2 EN61800 3
Safety		Fulfils EN50178 EN60204 1 CE UL C-UL FI GOST R (check from the unit nameplate specified approvals for each unit)
Control connections	Analog voltage	0—+10 V R = 200 kΩ single ended (10—+10V joystick control) resolution 12 bit accur ±1%
	Analog current	0 (4) — 20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic
	Aux. voltage	+24 V ±20% max 100 mA
	Potentiometer reference	+10 V -0% — +3% max 10 mA
	Analog output	0 (4) — 20 mA, R_L <500 Ω resolution 10 bit, accur ±3%
	Digital output	Open collector output 50 mA/48 V
	Relay outputs	Max switching voltage 300 V DC 250 V AC Max switching load 8A / 24 V, 0.4 A / 250 V DC, 2 kVA / 250 V AC Max continuous load 2 A rms
Protective functions	Overcurrent protection	Trip limit 4 x I_{CT}
	Overvoltage protection	Utility voltage 220 V 230 V 240 V 380 V 400 V Trip limit 1.47xV 1.41xV 1.35xV 1.47xV 1.40xV Utility voltage 415 V 440 V 460 V 480 V 500 V Trip limit 1.35xV 1.27xV 1.47xV 1.41xV 1.35xV Utility voltage 525 V 575 V 600 V 660 V 690 V Trip limit 1.77xV 1.62xV 1.55xV 1.41xV 1.35xV
	Undervoltage protection	Trip limit 0.65 x V_n
	Ground-fault protection	Protects the inverter from an ground-fault in the output (motor or motor cable)
	Utility supervision	Trip if any of the input phases is missing
	Motor phase supervision	Trip if any of the output phases is missing
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Stall protection	Yes
	Motor underload protection	Yes
	Short-circuit protection of +24V and +10V reference voltages	Yes

Table 4.3-1 Specifications

5

5 INSTALLATION

5.1 Ambient conditions

The environmental limits mentioned in table 4.3-1 must not be exceeded

5.2 Cooling

The specified space around the drive ensures proper cooling air circulation. See table 5.2.1 for dimensions. If multiple units are to be installed above each other the dimensions must be b+c and air from the outlet of the lower unit must be directed away from the inlet of the upper unit

With high switching frequencies and high ambient temperatures the maximum continuous output current has to be derated according to Table 5.2.3 and Figures 5.2.3 a-d

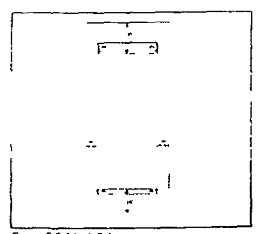


Figure 5.2.1 Installation space

Frame Size / Enclosure Style	Dimensions (in)			
	a	a2	b	c
M3 / Compact NEMA 1	1	0.5	4	2
M4 / Protected & NEMA 12				
M4 / NEMA 1	1	1	4	2
M4B / M5B Compact NEMA 1	1	0.5	5	2.5
M5 / Protected & NEMA 12				
M5 / NEMA 1	1	1	5	2.5
M6 / Protected & NEMA 12	1.5	4	6.5	3.5
M6 / NEMA 1	1.5	1.5	6.5	3.5
M7 / Chassis & NEMA 12	3 (1.5)**	3 (2.5)**	12	4
M7 / NEMA 1				
M8 / Chassis & NEMA 12	10*** (3)**	3	12	
M8 / NEMA 1				
M9 / Chassis & NEMA 12	6*** (3)**	3	12	
M9 / NEMA 1				
M10 / Chassis & NEMA 12	6*** (3)**	3	12	
M10 / NEMA 1				
M11 / Chassis & NEMA 12	Contact Factory			
M11 / NEMA 1				
M12 / Chassis & NEMA 12				
M12 / NEMA 1				

a2 Distance from inverter to inverter in multiple inverter installations
* Protected enclosure with optional cover.
** Minimum allowable space. No space available for fan change
*** Space for fan change on sides of inverter

Table 5.2.1 Installation space dimensions

Hp (kW)	Voltage / Enclosure	Required Airflow (CFM)
0.75 2	230 / Compact NEMA 1	42
2 3	230 / Protected & NEMA 1/12	
(0.75 5.5)	380 / Compact NEMA 1	
(2.2 7.5)	380 / Protected & NEMA 1/12	
1 7.5	480 / Compact NEMA 1	
3 10	480 / Protected & NEMA 1/12	
2 15	600 / Protected	
3 15	230 / Compact NEMA 1	100
5 10	230 / Protected & NEMA 1/12	
(7.5 18.5)	380 / Compact NEMA 1	
(11 30)	380 / Protected & NEMA 1/12	
10 25	480 / Compact NEMA 1	
15 - 40	480 / Protected & NEMA 1/12	
20 40	600 / Protected	
20	230 / Compact NEMA 1	216
15 30	230 / Protected & NEMA 1/12	
(22)	380 / Compact NEMA 1	
30	480 / Compact NEMA 1	
(37 45)	380 / Protected & NEMA 1/12	
50 60	480 / Protected & NEMA 1/12	
75	600 / Protected	
40 75	230 / Chassis & NEMA 1/12	363
(55 90)	380 / Chassis & NEMA 1/12	
75 125	480 / Chassis & NEMA 1/12	
(110 160)	380 / Chassis* & NEMA 1/12	765
150 200	480 / Chassis & NEMA 1/12	
100 150	600 / Chassis	
(200 250)	380 / Chassis* & NEMA 1/12	1440
250 300	480 / Chassis* & NEMA 1/12	
175 200	600 / Chassis	
(315 400)	380 / Chassis & NEMA 1/12	1736
400 500	480 / Chassis & NEMA 1/12	
250 300	600 / Chassis	
(500)	380 / Chassis	2200
600	480 / Chassis	
400	600 / Chassis	
(630 1000)	380 / Chassis	3473
700 1100	480 / Chassis	
500 800	600 / Chassis	

* Protected enclosure with optional cover

Table 5.2.2 Required cooling air

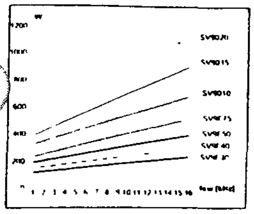


Figure 5 2 2a 3 20 hp

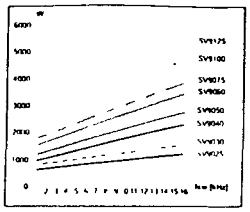


Figure 5 2 2b 25 125 HP

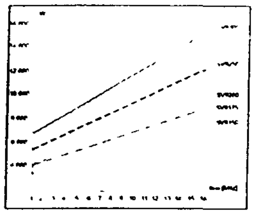


Figure 5.2-2c 150 300 HP

Figures 5 2 2a—c Power dissipation as a function of the switching frequency for 400V and 500V (I_{vt} variable torque) for standard enclosures

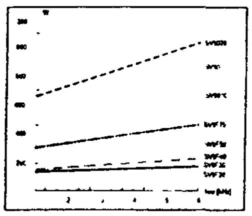


Figure 5 2-2d 2 - 20 HP

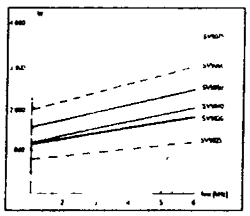


Figure 5 2-2e 25 75 HP

Figures 5.2-2d—e Power dissipation as a function of the switching frequency for 230 V (I_{vt} variable torque) for standard enclosures

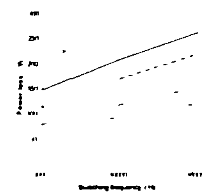


Figure 5 2 2f

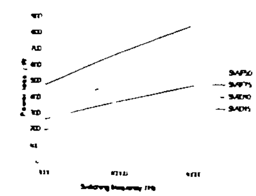


Figure 5 2 2g

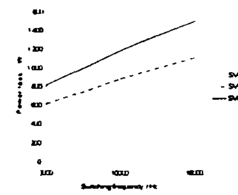


Figure 5 2 2h

Figures 5 2 2 f—h Power dissipation as a function of the switching frequency for 400V and 500V (I_{vt} variable torque) Compact Nema 1

Type (HP)	Curve		
	3 6kHz	10kHz	16kHz
1-6	no derating	no derating	no derating
7.5	no derating	1	2
10	no derating	no derating	no derating
15	no derating	no derating	no derating
20	no derating	no derating	3
25	no derating	no derating	no derating
30	no derating	no derating	4
40	no derating	5	not allowed
50	no derating	6	not allowed
60	7	8	not allowed
75	no derating	9	not allowed
100	no derating	10	not allowed
125	11	12	not allowed
150	no derating	13	not allowed
175	no derating	14	not allowed
200	15	16	not allowed
250	no derating	17	not allowed
300	18	19	not allowed
400	*	*	*
500	*	*	*
600	*	*	*
700	*	*	*
800	*	*	*
900	*	*	*
1000	*	*	*
1100	*	*	*

Table 5.2-3 Constant output current derating curves for 400—500 V (I_{vt} variable torque)

* = Ask the details from the factory

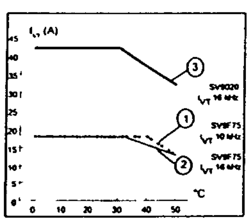


Figure 5.2 3 a

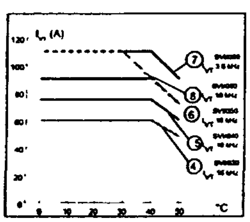


Figure 5.2 3 b

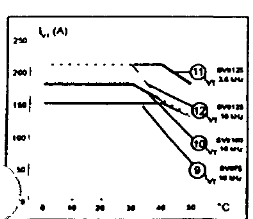


Figure 5.2 3 c

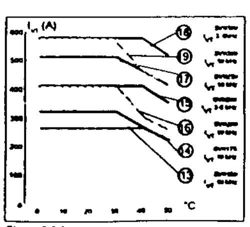


Figure 5 2-3 d

Figure 5 2-3a—d Constant output current (I_{vt}) derating curves as a function of ambient temperature and switching frequency

5 3 Mounting

The SV9000 should be mounted in a vertical position on the wall or on the back plane of a cubicle Follow the requirement for cooling see table 5 2-1 and figure 5 2-1 for dimensions

To ensure a safe installation make sure that the mounting surface is relatively flat Mounting holes can be marked on the wall using the template on the cover of the cardboard shipping package

Mounting is done with four screws or bolts depending on the size of the unit, see tables 5 3-1 and 5 3-2 and figure 5 3-1 for dimensions Units, from 25 Hp to 500 Hp, have special lifting "eyes" which must be used, see figures 5 3-2 and 5 3-3

The mounting instructions for units over 500 Hp are given in a separate manual If further information is needed contact your Cutler-Hammer distributor

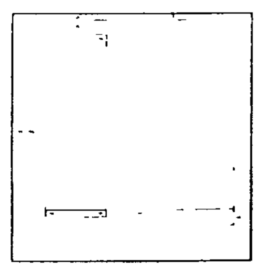


Figure 5 3-1 Mounting dimensions

Frame	Enclosure	Voltage	Dimensions (inches)								
			W1	W2	H1	H2	H3	H4	D1	R1	R2
M3	Compact NEMA 1	230 / 380 / 480	4.7	3 7	13 5	13.1	12	X	5.9	0.28	0 14
M4B		230 / 380 / 480	5.3	3 7	17	16.5	15.4	X	8 1	0.28	0 14
M5B		230 / 380 / 480	7.3	5.5	23.4	22.8	21 7	X	8.5	0.35	0 18
M4	NEMA 1 / 12	230 / 380 / 480	4.7	3.7	16.7	16.2	15.4	X	8.5	0.28	0.14
M5		230 / 380 / 480	6.2	5	22.1	21.5	20.3	X	9.4	0.35	0.18
M6		230 / 380 / 480	8.7	7.1	27.6	26.9	25.8	X	11.4	0.35	0.18
M7		230 / 380 / 480	14.7	13.6	41.3	40.6	39.4	X	13	0.35	0.18
M8		230 / 380 / 480	19.5	18	53.1	36.5	50.8	X	13.9	0.45	0.24
M9		380 / 480	27.6	26	57.9	40.2	56 1	X	15 4	0 45	0.24
M10		380 / 480	CONTACT FACTORY								
M4	Chassis / Protected	230 / 380 / 480	4 7	3 7	12 7	12.3	11 4	1 6	8.5	0.28	0 14
M5		230 / 380 / 480	6.2	5	17.8	17.1	15.9	1.8	9.4	0.35	0.18
M5		600	6.2	5	19 1	18.5	17.3	1.8	10.4	0.35	0.18
M6		230 / 380 / 480	8.7	7.1	22 6	22	20.7	3.9	11.4	0.35	0.18
M6		600	8.7	7 1	26 3	25 6	24.3	3.9	11.4	0.35	0.18
M7		230 / 380 / 480	9.8	8.7	33.6	32.9	31.5	X	12.4	0.35	0.18
M8		230 / 380 / 480 / 600	19.5	18	37.4	36.5	35	X	13.8	0.45	0.24
M9		380 / 480 / 600	27.6	26	41.1	40.2	39.4	X	15.4	0.45	0.24
M10		380 / 480 / 600	38.9	37.3	41.1	40.2	39.4	X	15.4	0.45	0.24
M11		380 / 480 / 600	CONTACT FACTORY								
M12		380 / 480 / 600									

Table 5 3-1 Dimensions for open panel units

5

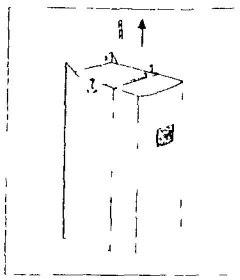


Figure 5.3.2 Lifting of 25 125 Hp units

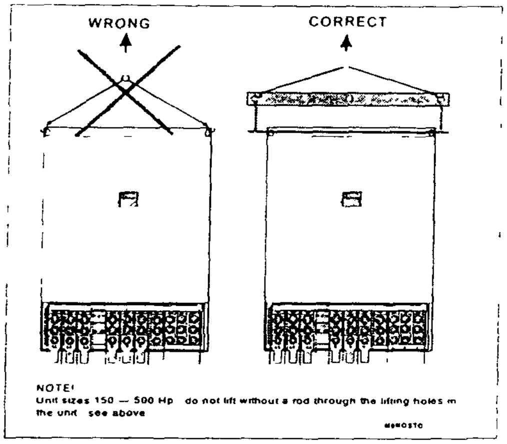


Figure 5.3-3 Lifting of 150—500 Hp units

6 WIRING

General wiring diagrams are shown in figures 6-1—6-3. The following chapters have more detailed instructions about wiring and cable connections.

The general wiring diagrams for M11 and M12 frame sizes are provided in a separate manual. If further information is required contact your Cutler Hammer distributor.

6

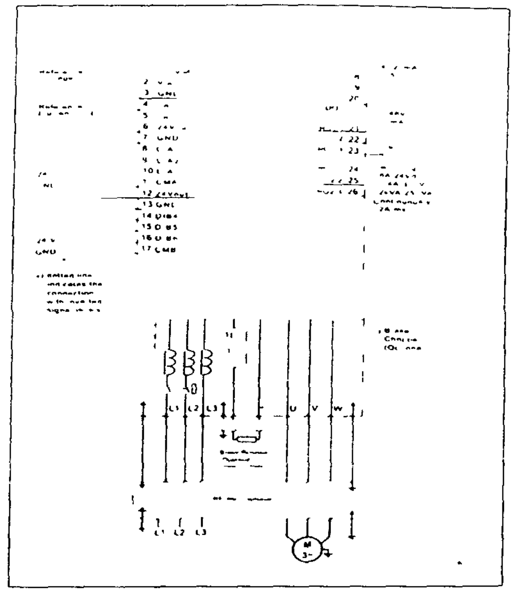


Figure 6-1 General wiring diagram open/protected chassis units frame sizes M4—M6

6

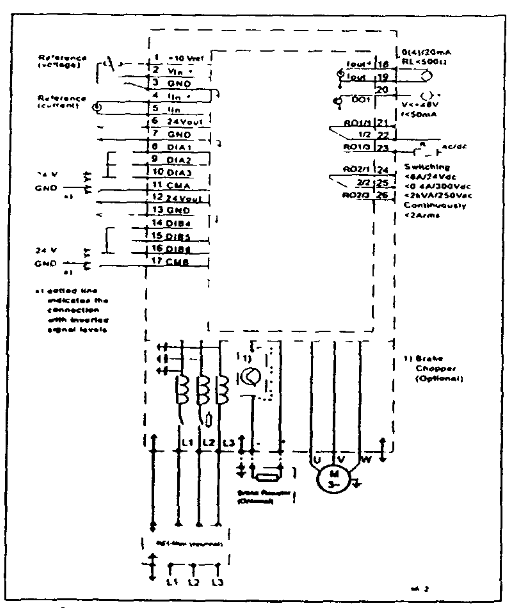


Figure 6-2 General wiring diagram open/protected chassis frame size > M7 and NEMA 1/12 units frame size > M8

6

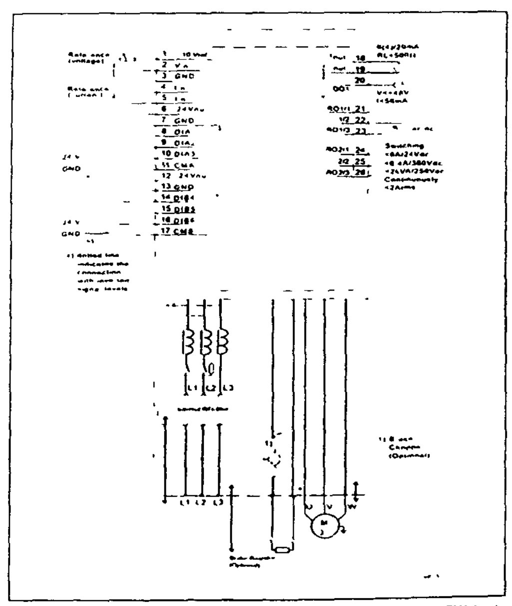


Figure 6-3 General wiring diagram NEMA 1/12 units frame sizes M4 to M7 and Compact NEMA 1 units

6 1 Power connections

Use heat resistant cables +60°C or higher The cable (and the fuses) must be sized in accordance with the rated output current of the unit Installation of the cable consistent with the UL-instructions is explained in chapter 6 1 4 1

The minimum dimensions for the Cu-cables and corresponding fuses are given in the tables 6 1 2 — 6 1-5 The fuses have been selected so that they will also function as overload protection for the cables

Consistent with UL requirements for maximum protection of the SV9000 UL recognized fuses type RK should be used

If the motor temperature protection (I²t) is used as overload protection the cables may be selected according to that If 3 or more cables are used in parallel on the larger units, every cable must have it's own overload protection

These instructions cover the case where one motor is connected with one cable to the drive

Always pay attention to the local authority regulations and installation conditions

6 1 1 Utility cable

Utility cables for the different EU EMC levels are defined in table 6 1 1

6 1 2 Motor cable

Motor cables for the different EU EMC levels are defined in table 6 1 1

6 1 3 Control cable

Control cables are specified in chapter 6 2 1

Cable	level N	level I
Utility cable	1	1
Motor cable	2	2
Control cable	3	3

Table 6 1-1 Cable types for the different EMC levels

1 = The power cable suitable for the installation ampacity and voltage
Shielded cable is not required

2 = The power cable contains a concentric protection wire, and is suitable for the ampacity and voltage
For maximum EMC protection, use of shielded cable is required.

3 = The control cable has a compact low-impedance shield

480V Hp	Ict	Fuse	Cu-cable UTILITY & MOTOR (Ground)	Ivt	Fuse	Cu-cable UTILITY & MOTOR (Ground)
1	2.5	10	16 (16)	3	10	16 (16)
1.5	3			3.5		
2	3.5			5		
3	5			8		
5	8			11	15	14 (14)
7.5	11	15	14 (14)	15	20	12 (12)
10	15	20	12 (12)	21	25	10 (10)
15	21	25	10 (10)	27	35	8 (8)
20	27	35	8 (8)	32	50	
25	34	50		40	50	
30	40	50		52	60	6 (6)
40	52	60	6 (6)	65	80	4 (6)
50	65	80	4 (6)	77	100	2 (6)
60	77	100	2 (6)	96	125	0 (4)
75	96	125	0 (4)	125	150	00 (2)
100	125	150	00 (2)	160	200	000 (0)
125	160	200	000 (0)	180	200	
150	180	200		260	300	350MCM (000)
200	260	300	350MCM (000)	320	400	2x [250MCM (00)]
250	320	400	2x [250MCM (00)]	400	500	2x [350MCM (000)]
300	400	500	2x [350MCM (000)]	460	600	2x [550MCM (250MCM)]
400	480	CONTACT FACTORY		600		
500						
1100						

Table 6 1-2 Utility motor cables and fuse recommendations according to output currents I_{CT} and I_{VT} 500V range

380V kW	Ict	Fuse	Cu-cable UTILITY & MOTOR (Ground)	Ivt	Fuse	Cu-cable UTILITY & MOTOR (Ground)
0.75	2.5	10	16 (16)	3.5	10	16 (16)
1.1	3.5			4.5		
1.5	4.5			6.5		
2.2	6.5			8		
3	8			10		
4	10			13	15	14 (14)
5.5	13	15	14 (14)	18	20	12 (12)
7.5	18	20	12 (12)	24	25	10 (10)
11	24	25	10 (10)	32	35	8 (8)
15	32	35	8 (8)	42	50	
18.5	42	50		48		
22	48			60	60	6 (6)
30	60	60	6 (6)	75	80	4 (6)
37	75	80	4 (6)	90	100	2 (6)
45	90	100	2 (6)	110	125	0 (4)
55	110	125	0 (4)	150	150	00 (2)
75	150	150	00 (2)	180	200	000 (0)
90	180	200	000 (0)	210	250	300MCM (00)
110	210	250	300MCM (00)	270	300	350MCM (000)
132	270	300	350MCM (000)	325	400	2x [250MCM (00)]
160	325	400	2x [250MCM (00)]	410	500	2x [350MCM (000)]
200	410	500	2x [350MCM (000)]	510	600	2x [500MCM (250 MCM)]
250	510	600	2x [500MCM (250 MCM)]	580	600	2x [500MCM (250 MCM)]
315	CONTACT FACTORY					
1000						

Table 6 1 3 Utility motor cables and fuse recommendations according to output currents I_{CT} and I_{VT} 400V range

600V HP	Ict	Fuse	Cu-cable UTILITY & MOTOR (Ground)	Ivt	Fuse	Cu-cable UTILITY & MOTOR (Ground)
7.5	10	10	16 (16)	14	15	14 (14)
10	14	15	14 (14)	18	20	12 (12)
15	19	20	12 (12)	23	25	10 (10)
20	23	25	10 (10)	26	35	8 (8)
25	26	35	8 (8)	35	35	
30	35	35		42	50	
40	42	50		52	60	6 (6)
50	52	60	6 (6)	62	80	
60	62	80		85	100	2 (6)
75	85	100	2 (6)	100	100	
100	100	100		122	125	0 (4)
125	122	125	0 (4)	145	100	00 (2)
150	145	150	00 (2)			
175				222	250	300MCM (00)
200	222	250	300MCM (00)	287	300	350MCM (000)
250	CONTACT FACTORY					
600						

Table 6 1-4 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT} 600V range

230V HP	Ict	Fuse	Cu-cable UTILITY & MOTOR (Ground)	Ivt	Fuse	Cu-cable UTILITY & MOTOR (Ground)
0.75	3.6	10	16 (16)	4.7	10	16 (16)
1	4.7			5.6		
1.5	5.6			7		
2	7			10		
3	10			13	15	14 (14)
		15	14 (14)	16		
5	16			22	25	10 (10)
7.5	22	25	10 (10)	30	35	8 (8)
10	30	35	8 (8)	43	50	
15	43	50		57	60	6 (6)
20	57	60	6 (6)	70	80	4 (6)
25	70	80	4 (6)	83	100	2 (6)
30	83	100	2 (6)	113	125	0 (4)
40	113	125	0 (4)	138	150	00 (2)
50	138	150	00 (2)	165	200	000 (0)
60	165	200	000 (0)	200	200	
75	200	200		264	300	350MCM (000)

Table 6 1-5 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT} 230V range

Frame	Hp (KW)	Voltage	CABLE (AWG / MCM) Main	Ground
M0	All	230 / 380 / 480	14	14
M1	All	230 / 380 / 480	10	10
M4B	All	230 / 380 / 480	6	6
M5	All	230 / 380 / 480 / 600		
M5B	10 - 20	230	2	00
	(15 - 22)	380		
	20 - 30	480		
M6	15 - 30	230		
	(18.5 - 22)	380		
	25 30	480		
	30 30	600		
	(30 45)	380	0 Cu, 00 Al	00
	40 50	480		
	60 75	600		
M7	40 75	230		
	(55 90)	380	350 MCM	000
	100 150	480		
M8	(110 160)	380	2x350 MCM Cu 2x500 MCM Al	2x500 MCM
	150 200	480		
	100 150	600		
M9	(200 250)	380	2x600 MCM	2x500 MCM
	250 300	480		
	200	600		
M10	(315 400)	380	4x500 MCM	2x500 MCM
	400 500	480		
	250 300	600		
M11	(500)	380	CONTACT FACTORY	
	500	480		
	400	600		
M12	(630 1000)	380		
	700 1100	480		
	500 800	600		

NEMA 1/12 maximum 3 parallel connected cables can be used

Table 6 1-6 Maximum cable sizes of the power terminals

6 1 4 Installation instructions

1 If a SV9000 open chassis unit is to be installed outside a control cabinet or a separate cubicle a protective IP20 cover should be installed to cover the cable connections, see figure 6 1 4-3. The protective cover may not be needed if the unit is mounted inside a control cabinet or a separate cubicle

All open chassis SV9000 units should always be mounted inside a control cabinet, or a separate cubicle.

2 Locate the motor cable away from the other cables

Avoid long parallel runs with other cables
If the motor cable runs in parallel with the other cables, the minimum distances given in table 6.1 4-1 between the motor cable and control cables should be followed.
These minimum distances apply also between the motor cable and signal cable of other systems
The maximum length of a motor cable can be 600ft (180 m) (except for ratings 1.5 Hp and below max. length is 160 ft (50 m) and 2 Hp max. length 330 ft (100 m)). The power cables should cross other cables at an angle of 90° degrees. An output dv/dt filter option is required for motor cable lengths exceeding 33ft (10m) for drive 2 Hp and below and 100ft (33m) for drives 3Hp and larger

Distance between cables ft (m)	Motor cable length ft (m)
1 (0.3)	≤165 (50)
3.3 (1)	≤600 (180)

Table 6.1 4-1 Minimum cable distances

3 See chapter 6.1.5 for cable insulation checks

4 Connecting cables.

- Motor and utility cables should be stripped according to figure 6.1 4-2 and table 6 1 4-2
  Open the cover of the SV9000 according to figure 6 1 4-3
  Remove sufficient plugs from the cable cover (open chassis) or from the bottom of the NEMA 1/12 units
  Pass cables through the holes in the cable cover
  Connect the utility, motor and control cables to the correct terminals
  See figures 6 1 4-3—16 SV9000 + external RFI-filter (See RFI-filter option manual) The installation instructions for M11 and M12 frames are explained in the separate manual for M11/M12 units Contact your Cutler-Hammer distributor for more information Cable installation consistent with UL-instructions is explained in chapter 6.1.4 1
  Check that control cable wires do not make contact with electrical components in the device
  Connect optional brake resistor cable (if required)
- Ensure the ground cable is connected to the ⏚ -terminal of the frequency converter and motor
  For open chassis units, 150—500 Hp connect the isolator plates of the protective cover and terminals according to figure 6 1 4-11

If a shielded power cable is used connect its sheath to the ground terminals of the drive motor and supply panel
Mount the cable cover (open chassis units) and the unit cover
Ensure the control cables and internal wiring are not trapped between the cover and the body of the unit

5

NOTE

The connection of the transformer inside the unit in frame sizes M7 M12 has to be changed if other than the default supply voltage the drive is used Contact your Cutler Hammer distributor if more information is needed

Voltage Code (VC)	Default Supply Voltage
2	230V
4	380V
5	480V
6	600V

6

6 1 4 1 Cable selection and installation for the UL listing

For installation and cable connections the following must be noted Use only with copper wire temperature rating of at least 60/75°C

Units are suitable for use on a circuit capable of delivering not more than the fault RMS symmetrical amperes mentioned in the table 6 1 4 1 1 480V maximum

In addition to the connecting information the tightening torque of the terminals are defined in the table 6 1 4 1 2

FRAME	Voltage	Maximum RMS symmetrical amperes on supply circuit
M3	All	35 000
M4 M12	All	100 000

Table 6 1 4 1 1 Maximum symmetrical supply current

6

FRAME	Hp (KW)	Voltage	Tightening torque (in-lbs)
M3	All	All	7
M4B	All	All	7
M5B	All	All	20
M4	All	All	7
M5	All	All	20
M6	15 20	220	35
M6	25 30	220	44
M6	(18 5 22)	380	35
M6	(30 45)	380	44
M6	25 30	480	35
M6	40 60	480	44
M6	30-40	575	35
M6	40 75	575	44
M7	All	All	44
M8	All	All	610
M9	All	All	610*
The isolated standoff of the busbar does not withstand the listed tightening torque Use a wrench to apply counter torque when tightening			

Table 6 1 4 1 2 Tightening torque

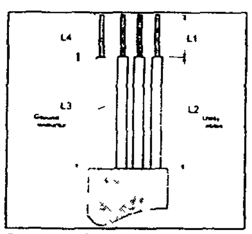


Figure 6 1 4 1 Stripping motor and utility cables.

Frame	Hp (KW)	Voltage	Stripping Lengths (m) s1	s2	s3	s4
M3	All	230 / 380 / 480	0.47	2.2	2.2	0.47
M4	All	230 / 380 / 480	0.24	1.4	2.4	0.6
M4B	All	230 / 380 / 480	0.35	1.6	4	0.6
M5	All	230 / 380 / 480 / 600				
M5B	16 20	230	0.6	1.6	4	0.6
	(15 22)	380				
	20 30	480				
M6	15 30	230				
	(18.5 22)	380				
	25 30	480				
	30 50	600				
	(30 45)	380	1	1.6	4	0.6
	40 60	480				
	60 75	600				
M7	40 75	230				
	(55 90)	380	2			1
	100 150	480				
M8	(110 160)	380	CONTACT FACTORY			
	150 200	480				
	100 150	600				
M9	(200 250)	380				
	250 300	480				
	200	600				
M10	(315 400)	380				
	400 500	480				
	250 300	600				
M11	(500)	380				
	600	480				
	400	600				
M12	(630 1000)	380				
	700 1100	480				
	500 600	600				
NEMA 1 / 12 maximum 3 parallel connected cables can be used						

Table 6 1 4-2 Stripping lengths of the cables (m)

① Loosen screws (2 pcs)
② Pull cover bottom outwards
③ Push cover upwards

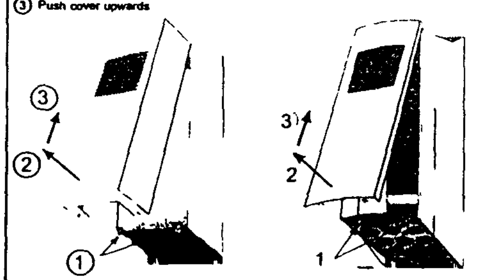


Figure 6 1 4-2 Opening the cover of the SV9000

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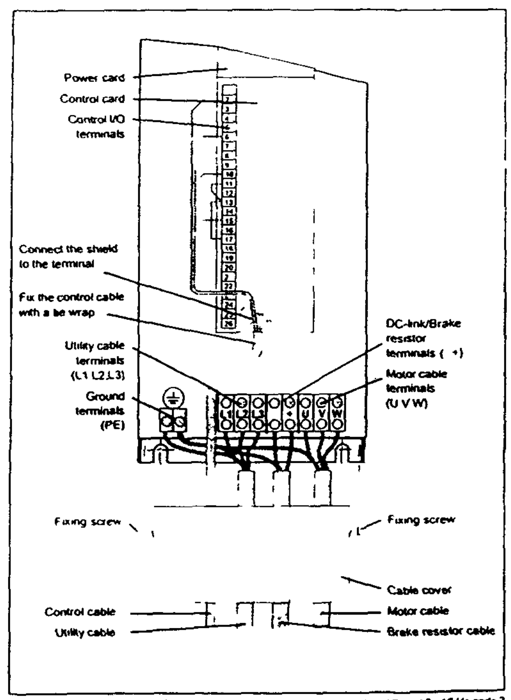


Figure 6 1 4 3 Cable assembly for open chassis 3 20 Hp voltage code 4 and 5 and 2 10 Hp code 2

6

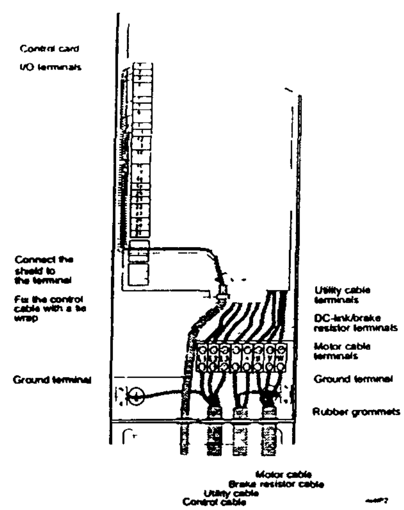


Figure 6 1 4-4 Cable assembly for Standard NEMA 1 3 7 5 Hp voltage code 4 and 5 and 2 3 Hp code 2

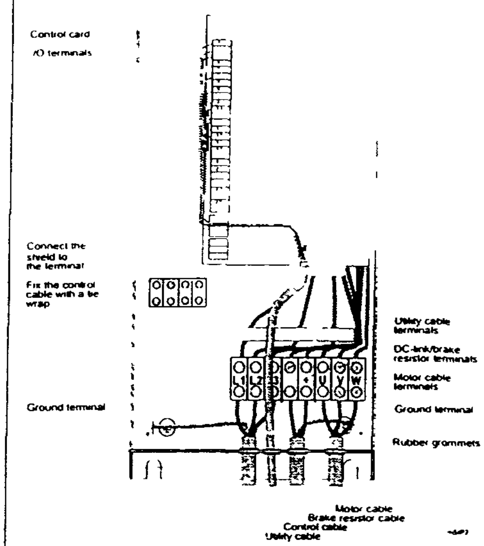
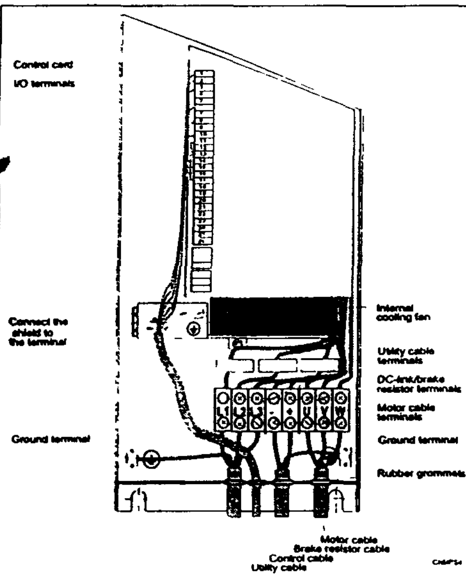


Figure 6 1 4-5 Cable assembly for Standard NEMA 1 10 20 Hp voltage code 4 and 5 and 5 10 Hp code 2



16 1 4-6 Cable assembly for Standard NEMA 12 10 20 Hp voltage code 4 and 5, and 5 10 Hp code 2

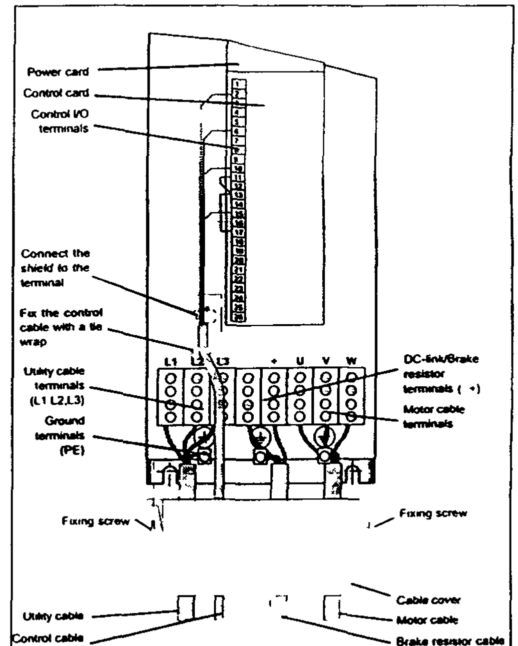


Figure 6 1 4 7 Cable assembly for open chassis 25 60 Hp voltage code 4 and 5, and 15 30 Hp code 2

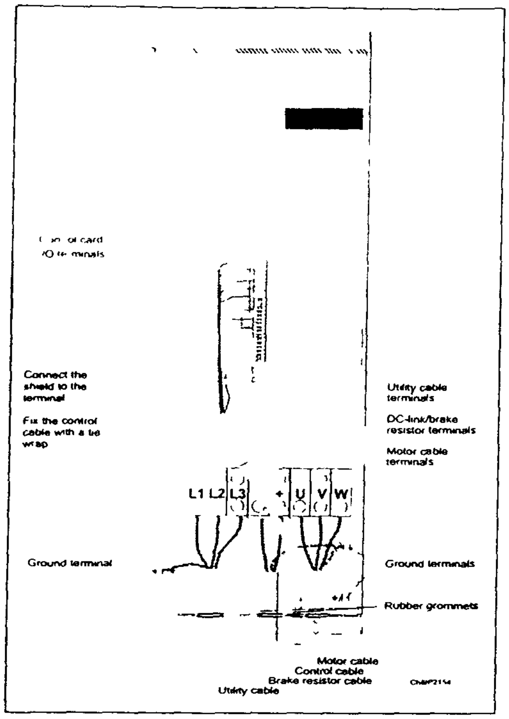


Figure 6 1 4-8 Cable assembly for Standard NEMA 1 25 60 Hp voltage code 4 and 5 and 15 30 Hp code 2

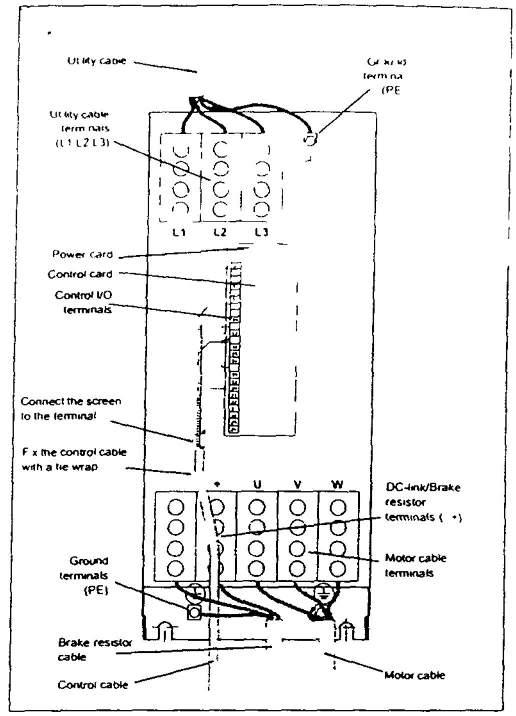


Figure 6 1 4 9 Cable assembly for open chassis 75 125 Hp voltage code 4 and 5 40 60 Hp code 2

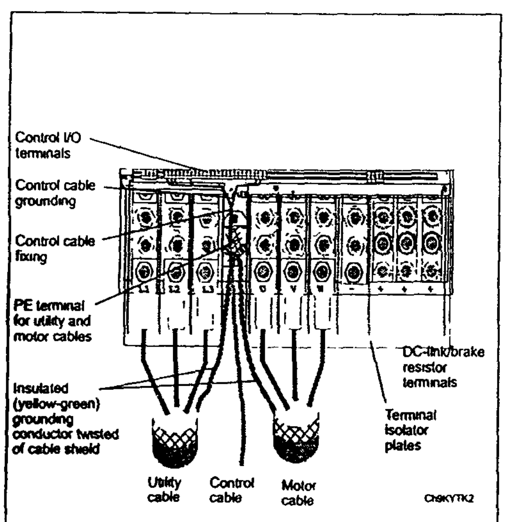
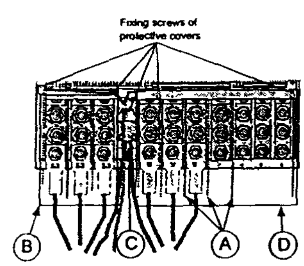


Figure 6 1 4 10 Cable assembly for open chassis 150 500 Hp voltage code 4 and 5 and 125 400 Hp code 6 and 75 Hp code 2 for NEMA 1 150 500 Hp code 4 and 5 and NEMA 1 75 Hp code 2



After cable connections before switching on the utility supply, ensure

1 Insert all 10 terminal isolator plates (A) in the slots between the terminals see figure below
2 Insert and fix three plastic protective covers (B C and D) over the terminals

Securing the terminal isolation plates

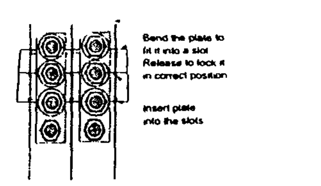


Figure 6 1 4 11 Cable cover and terminal assembly for open chassis 150 500 Hp voltage code 4 and 5 125 400 Hp code 6 and 75 Hp code 2 and NEMA 1 150 500 Hp code 4 and 5 and 75 Hp code 2

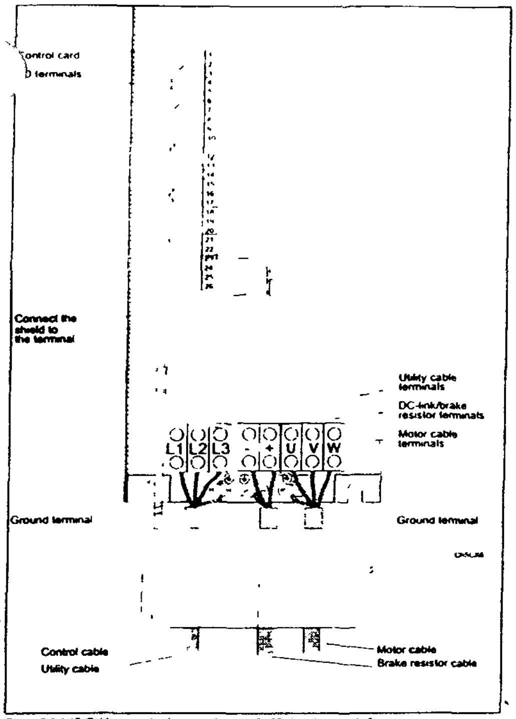


Figure 6 1 4 12 Cable assembly for open chassis 10 30 Hp voltage code 6

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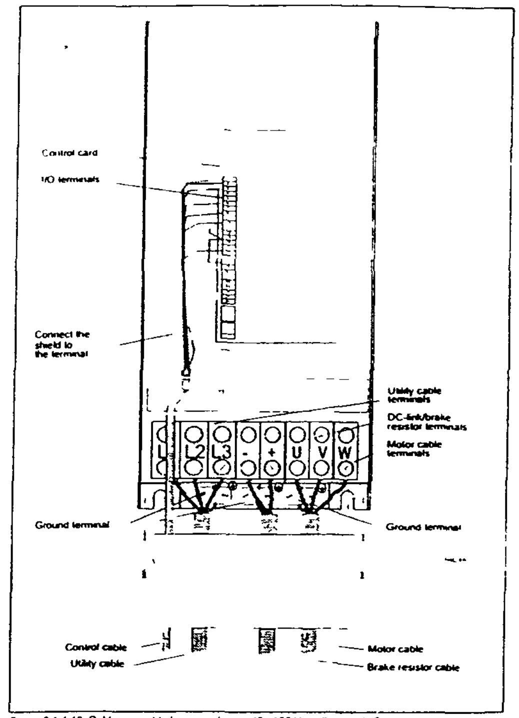

Figure 6 1 4 13 Cable assembly for open chassis 40 100 Hp voltage code 6

6

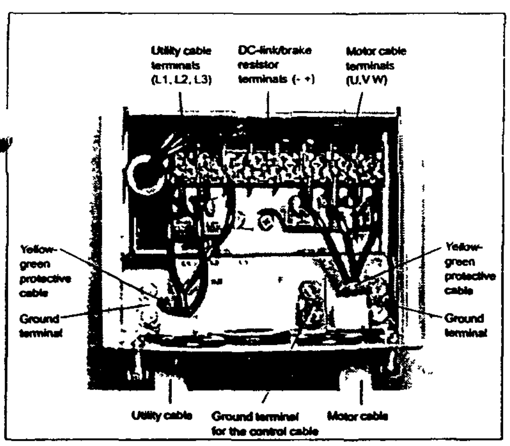

Figure 6 1 4-14 Cable assembly Compact NEMA 1 0.75 2 Hp, voltage code 2, 1-3 Hp voltage code 5

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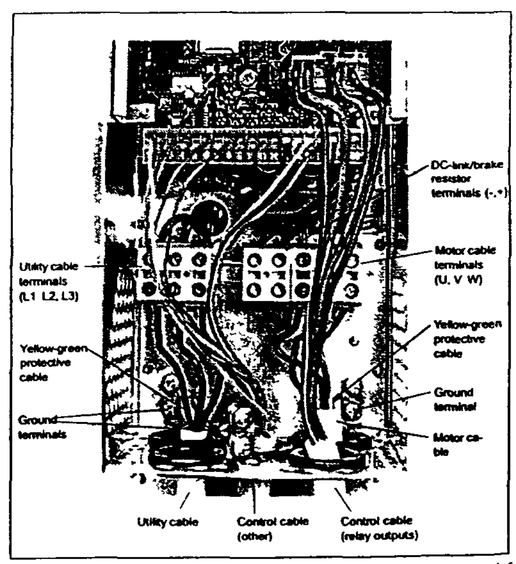

Figure 6 1 4 15 Cable assembly for Compact NEMA1 3 - 7 5 voltage code 2 and 5 - 15 Hp voltage code 5

6

6 1 5 Cable and motor insulation checks

1 Motor cable insulation checks

Disconnect the motor cable from the terminals U V and W of the SV9000 unit and from the motor

Measure the insulation resistance of the motor cable between each phase conductor Also measure the insulation resistance between each phase conductor and the protective ground conductor
The insulation resistance must be >1MΩ

2 Utility cable insulation checks

Disconnect the utility cable from terminals L1 L2 and L3 of the SV9000 unit and from the utility

Measure the insulation resistance of the utility cable between each phase conductor Also measure the insulation resistance between each phase conductor and the protective ground conductor The insulation resistance must be >1MΩ

3 Motor insulation checks

Disconnect the motor cable from the motor and open any bridging connections in the motor connection box

Measure insulation resistance of each motor winding The measurement voltage has to be at least equal to the utility voltage but not exceed 1000V
The insulation resistance must be >1MΩ

6 2 Control connections

Basic connection diagram is shown in the figure 6 2 1

The functionality of the terminals for the Basic application is explained in chapter 10 2 If one of the SVReady applications is selected check the application manual for the functionality of the terminals for that application

6 2 1 Control cables

The control cables should be minimum of #20 gauge shielded multicore cables see table 6 1 1 The maximum wire size rating of the terminals is #14

6 2 2 Galvanic isolation barriers

The control connections are isolated from the utility potential and the I/O ground is connected to the frame of the SV9000 via a 1 MΩ resistor and 4 7 nF capacitor The control I/O ground can also be connected directly to the frame by changing the position of the jumper X4 to ON position, see figure 6 2 2 1

Digital inputs and relay outputs are isolated from the I/O ground

6

Terminal		Function	Specification
1	+10V ref	Reference voltage output	Burden max 10 mA *
2	V in *	Analog signal input	Signal range 10 V +10 V DC
3	GND	I/O ground	
4	I in	Analog signal (+input)	Signal range 0(4) 20 mA
5	I in	Analog signal (-input)	
6	24V out	24V supply voltage	±20% load max 100 mA
7	GND	I/O ground	
8	DIA1	Digital input 1	R min 5 kΩ
9	DIA2	Digital input 2	
10	DIA3	Digital input 3	
11	CMA	Common for DIA1 -DIA3	Must be connected to GND or 24V of I/O terminal or to external 24V or GND
12	24V out	24V supply voltage	Same as terminal # 6
13	GND	I/O ground	Same as terminal # 7
14	DIB4	Digital input 4	R min 5 kΩ
15	DIB5	Digital input 5	
16	DIB6	Digital input 6	
17	CMB	Common for DIB4 — DIB6	Must be connected to GND or 24V of I/O- terminal or to external 24V or GND
18	I out *	Analog signal (+output)	Signal range 0(4)—20 mA
19	I out	Analog ground (-output)	R max 500 Ω
20	DO1	Open collector output	Transistor output max V 48 VDC max current 50 mA
21	RO1/1	Relay output	Max switch voltage 250 VAC 300 VDC
22	RO1/2		Max switch current 8 A / 24 VDC
23	RO1/3		0 4 A / 250 VDC
24	RO2/1	Relay output 2	Max switch power <2 kVA / 250 VAC
25	RO2/2		Max cont current <2 A rms
26	RO2/3		

Figure 6 2 1 Control I/O-terminal signals

* If the potentiometer reference is used potentiometer R 1—10 kΩ

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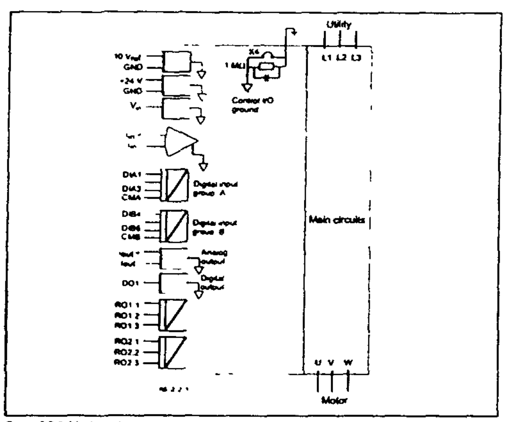


Figure 6 2 2 1 Isolation barriers

6.2 3 Digital input function inversion

The active signal level of the digital input logic depends on how the common input (CMA, CMB) of the input group is connected The connection can be either to +24 V or to ground See figure 6 2 3-1

The +24V or ground for the digital inputs and common terminals (CMA, CMB) can be either external or internal (terminals 6 and 12 of the drive)

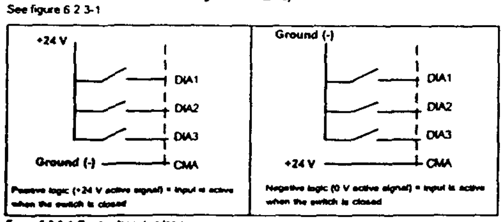


Figure 6.2 3-1 Positive/negative logic

6

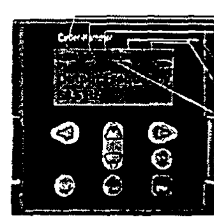
7 CONTROL PANEL

7 1 Introduction

The control panel of SV9000 drive features an alphanumeric Multiline Display with five indicators for the Run status (RUN READY FAULT, ⟲ ⟳ STOP) and two indicators for the control source The panel embodies three indicator lines for the menu/submenu descriptions and the value/amount of the submenus The eight push buttons on the panel are used for panel programming and monitoring

The panel is detachable and isolated from the input line potential

The display examples in this chapter present the text and numeric lines of the Multiline Display only The drive status indicators are not included in the examples



DRIVE STATUS INDICATORS

RUN = lights when motor is running

⟲ ⟳ = shows the selected rotation

STOP = lights when motor is not running

READY = lights when input voltage is supplied and the unit is ready for use

FAULT = lights when a fault in frequency drive occurs

Panel/ Remote = Shows the active control source

Figure 7 1 1 Control panel with LED display

= *Menu button (left)*
Move forward in the menu

= *Menu button (right)*
Move backward in the menu

= *Browser button (up)*
Move in the main menu and between pages inside the same submenu
Change value.

= *Browser button (down)*
Move in the main menu and between pages inside the same submenu
Change value

= Enter button
Acknowledgement of changed value
Fault history reset
Function as programmable button

= *Reset button*
Fault resetting

= *Start button*
Starts the motor if the panel is the active control source

= Stop button
Stops the motor if the panel is the active control source

7

7.2 Panel operation

The panel is arranged in menus and submenus. The menus are used for measurement and control signals, parameter settings, reference values, fault displays, contrast and the programmable buttons. The desired submenu can also be entered from the main menu by using the menu buttons when the letter M and the number of the menu in question are visible on the first line of the display. *See the SV9000 User's Manual and* the SVReady Application Manual for the specific parameters available for the SV9000 setup needed.

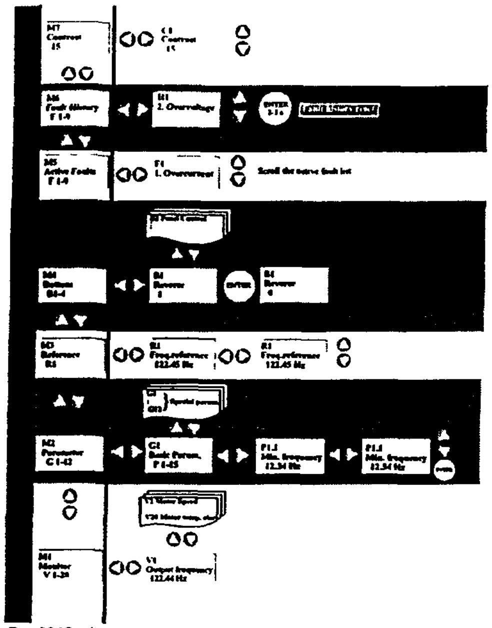


Figure 7.2.1 Panel operation

7.3 Monitoring menu

The monitoring menu can be entered from the main menu when the symbol M1 is visible on the first line of the Multiline display. How to browse through the monitored values is presented in Figure 7.3.1. All monitored signals are listed in Table 7.3.1. The values are updated once every 0.5 seconds. This menu is meant only for signal checking. The values cannot be altered here. See 7.4 Parameter group menu.

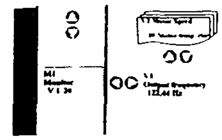


Figure 7.3.1 Monitoring menu

Number	Signal name	Unit	Description
V1	Output frequency	Hz	Frequency to the motor
V2	Motor speed	rpm	Calculated motor speed
V3	Motor current	A	Measured motor current
V4	Motor torque	%	Calculated actual torque/nominal torque of the unit
V5	Motor power	%	Calculated actual power/nominal power of the unit
V6	Motor voltage	V	Calculated motor voltage
V7	DC-link voltage	V	Measured DC-link voltage
V8	Temperature	°C	Heat sink temperature
V9	Operating day counter	DD.dd	Operating days[1], not resettable
V10	Operating hours "trip counter"	HH.hh	Operating hours[2], can be reset with programmable button #3
V11	MW hours counter	MWh	Total MWh, not resettable
V12	MW hours "trip counter"	MWh	Resettable with programmable button B4, section 7.6
V13	Voltage/analog input	V	Voltage of terminal V_{in}+ (term. #2)
V14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
V15	Digital input status, gr. A		See Figure 7.3-2
V16	Digital input status, gr. B		See Figure 7.3-3
V17	Digital and relay output status		See Figure 7.3-4
V18	Control program		Version number of the control software
V19	Unit nominal power	HP	Unit power size of the unit
V20	Motor temperature rise	%	100% = nominal motor temperature has been reached

DD = full days, dd = decimal part of day   HH = full hours, hh = decimal part of hour

Table 7.3.1 Monitored signals

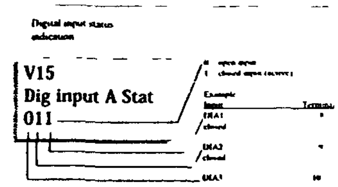


Figure 7.3-2 Digital inputs, Group A status

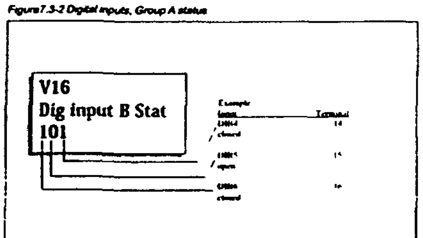
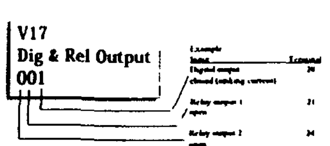


Figure 7.3-3 Digital inputs, Group B status



...ure 7.3-4 Output signal status

7.4 Parameter group menu

The parameter group menu can be entered from the main menu when the symbol M2 is visible on the first line of the Multiline display. Parameter values are changed in the parameter menu as shown in Figure 7.4.1.

Push the menu button (right) once to move into the parameter group menu (G) and twice to enter the desired parameter menu. Locate the parameter you want to change by using the browser buttons. Push the menu button (right) once again to enter the edit menu. Once you are in the edit menu, the symbol of the parameter starts to blink. Set the desired new value with the browser buttons and confirm the change by pushing the Enter button. Consequently, the blinking stops and the new value is visible in the value field. The value will not change unless the Enter button is pushed.

Several parameters are locked, i.e. uneditable, when the drive is in RUN status. If you try to change the value of such a parameter the text *"locked"* will appear on the display.

You can return to the main menu anytime by pressing the Menu button (left) for 2-3 seconds.

The basic application embodies only those parameters necessary for operating the device. The parameter group 0 is accessible only by opening the Application package lock. See Chapter 11 of the SV9000 User's Manual.

Other applications include more parameter groups.

Once in the last parameter of a parameter group, you can move directly to the first parameter of that group by pressing the browser button (up).

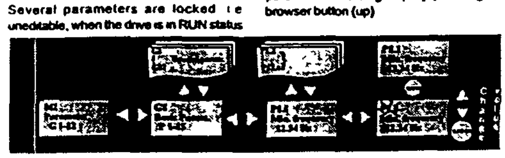


Figure 7.4.1 Parameter value change procedure

7.5 Reference menu

The reference menu can be entered from the main menu when the symbol M3 is visible on the first line of the Multiline panel

If the control panel is the active control source the frequency reference can be changed by changing the value on the display with the browser buttons (for the selection of the active control source see Chapter 7.6 Programmable push button menu). See *Figure 7.5-1*

Move deeper in the menu with the menu button (right) until the symbol R1 starts to blink. Now you are able to alter the frequency reference value with the browser buttons. Pressing the Enter button is not necessary. Motor speed changes as soon as the frequency reference changes or the load inertia allows the motor to accelerate or decelerate.

In some applications there might be several references.

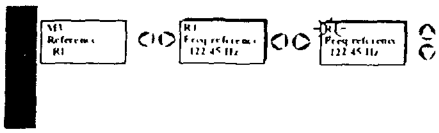


Figure 7.5-1 Reference setting on the control panel

7.6 Programmable push-button menu

The programmable push button menu can be entered from the main menu when the symbol M4 is visible on the first line of the Multiline display. In this menu there are four functions for the Enter button. The functions are available in this menu only. In other menus the button is used for its original purpose. The status of the controlled function is shown through a feedback signal.

Enter the edit menu with the menu button (right). Then the symbol B1 starts to blink.

To change the button value push the Enter button after which the new feedback value appears and the button sign B is replaced with a black square blinking together with the button number. After releasing the Enter button the black square reverts to B. The new value stops blinking when the new value (e.g. reverse direction) has been received and put into operation. See Figure 7.6-1

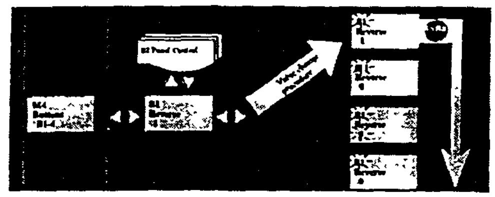


Figure 7.6-1 Programmable push-button

Button number	Button description	Function	Feedback information		
			0	1	Note
B1	Reverse	Changes the rotation direction of the motor. Available only when the control panel is the active control source	Forward	Reverse	Feedback information flashes as long as the command is carried out.
B2	Active control	Selection between I/O terminals and control panel	Control via I/O terminals	Control from the panel	
B3	Operating hours trip counter reset	Resets the operating hours trip counter when pushed	No resetting	Resets the operating hours trip counter	
B4	MWh counter reset	Resets the MWh trip counter when pushed	No resetting	Resets the MWh trip counter	

Table 7.6-1 Programmable push-button descriptions

7.7 Active faults menu

The active faults menu can be entered from the main menu when the symbol M5 is visible on the first line of the Multiline display as shown in Figure 7.7-1

When a fault brings the frequency converter to a stop, the fault code (F#) and the description of the fault are displayed. If there are several faults at the same time, the list of active faults can be browsed with the browser buttons

The display can be cleared with the Reset button and the read-out will return to the same display it had before the fault trip

The fault remains active until it is cleared with Reset button or with a reset signal from the I/O terminal

Note! Remove any external Start signal before resetting the fault to prevent an unintentional restart.

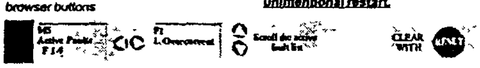


Figure 7.7-1 Active faults menu

Fault codes	Fault	Possible cause	Checking
F1	Overcurrent	SV9000 frequency converter has measured too high a current (>4*In) in the motor output: sudden heavy load increase; short circuit in the motor cables; unsuitable motor	Check loading. Check motor size. Check cables
F2	Overvoltage	The voltage of the internal DC-link of the SV9000 frequency converter has exceeded the nominal voltage by 35%: deceleration time is too fast; high overvoltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero: - insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	SV9000 frequency converter has detected faulty operation in the gate drivers or IGBT bridge: - interference fault; component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler-Hammer distributor
F5	Charging switch	Charging switch open when START command active: interference fault; component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler-Hammer distributor
F9	Undervoltage	DC-bus voltage has gone below 65% of the nominal voltage: most common reason is failure of the utility supply; internal failure of the SV9000 frequency converter can also cause an undervoltage trip	In case of temporary supply voltage break, reset the fault and start again. Check utility input. If utility supply is correct an internal failure has occurred. Contact your Cutler-Hammer distributor
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	brake resistor not installed; brake resistor broken; brake chopper broken	Check brake resistor. If resistor is OK the chopper is broken. Contact your Cutler-Hammer distributor
F13	SV9000 undertemperature	Temperature of heat sink below -10°C	

Table 7.7-1 Fault codes

Fault codes	Fault	Possible cause	Checking
F14	SV9000 overtemperature	Temperature of heat sink over 75°C. For Compact NEMA 1 over 80 °C	Check the cooling air flow. Check that the heat sink is not dirty. Check ambient temperature. Check that the switching frequency is not too high compared with ambient temperature and motor load
F15	Motor stalled	The motor stall protection has tripped	Check the motor
F16	Motor overtemperature	The SV9000 frequency drive motor temperature model has detected motor overheat: motor is overloaded	Decrease motor load. Check the temperature model parameters if the motor was not overheated
F17	Motor underload	The motor underload protection has tripped	Check the motor and possible belts etc.
F18	Analog input hardware fault	Component failure on control board	Contact your Cutler-Hammer distributor
F19	Option board identification	Reading of the option board has failed	Check the installation. If installation is correct contact your Cutler-Hammer distributor
F20	10 V voltage reference	+10 V reference shorted on control board or option board	Check the cabling from +10 V reference voltage
F21	24 V supply	+24 V supply shorted on control board or option board	Check the cabling from +24 V reference voltage
F22 F23	EEPROM checksum fault	Parameter restoring error: interference fault; component failure	On resetting this fault the drive will automatically load the parameter default settings. Check all parameter settings after reset. If the fault occurs again contact your Cutler-Hammer distributor
F25	Microprocessor watchdog	interference fault; component failure	Reset the fault and restart. If the fault occurs again contact your Cutler-Hammer distributor
F26	Panel communication error	The connection between panel and the SV9000 frequency drive is not working	Check the panel cable
F29	Thermistor protection	Thermistor input of the I/O expander board has detected increase of the motor temperature	Check motor cooling and loading. Check the thermistor connection. If there are no thermistors, make sure the inputs are short circuited
F36	Analog input I_{in} < 4mA (signal range selected 4-20 mA)	The analog input current I_{in} is below 4 mA: signal source has failed; control cable is broken	Check the current loop circuitry
F41	External fault	An external fault has been detected at the digital input	Check the external fault source

Table 7.7-1 Fault codes (cont.)

7 8 Fault history menu

The fault history menu can be entered from the main menu when the symbol M6 is displayed on the first line of the Multiline panel

The memory of the drive can store the up to the 9 latest faults in the order of appearance The most recent fault has the number 1 the second latest number 2 etc If there are 9 uncleared faults in the memory the next fault will erase the oldest from the memory

Pressing the Enter button for about 2 3 seconds will reset the whole fault history Then the symbol F# will change to 0

Figure 7 8-1 Fault history menu

7 9 Contrast menu

The contrast menu can be entered from the main menu when the symbol M7 is visible on the first line of the Multiline display

Use the menu button (right) to enter the edit menu You are in the edit menu when the symbol C starts to blink Then change the contrast using the browser buttons The changes take effect immediately

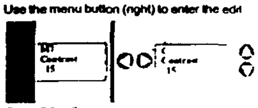


Figure 7.9-1 Contrast setting

7 10 Active warning display

When a warning occurs a text with a symbol A# appears on the display Warning codes are explained in Table 7 10 1

The display does not have to be cleared in any special way

The warning on the display does not disable the normal functions of the push buttons

Code	Warning	Checking
A15	Motor stalled (Motor stall protection)	Check motor
A16	Motor overtemperature (Motor thermal protection)	Decrease motor loading
A17	Motor underload (Warning can be activated in SVReady applications)	Check motor loading
A24	The values in the Fault History MWh counters or operating day/hour counters might have been changed in the previous mains interruption	Does not need any actions Take a critical attitude to these values
A28	The change of application has failed	Choose the application again and push the *Enter button*
A30	Unbalance current fault the load of the segments is not equal	Contact your Cutler-Hammer distributor
A45	SV9000 frequency converter overtemperature warning, Temperature >70°C	Check the cooling air flow and the ambient temperature
A46	Reference warning the current of input I_{in} <4 mA (Warning can be activated in SVReady applications	Check the current loop circuitry
A47	External warning (Warning can be activated in SVReady applications)	Check the external fault circuit or device

Table 7 10 1 Warning codes

7 11 Controlling the motor from the panel

The SV9000 can be controlled from either the I/O terminals or the control panel. The active control source can be changed with the programmable push button b2 (see chapter 7 6) The motor can be started, stopped and the direction of rotation can be changed from the active control source

7 11 1 Control source change from I/O terminals to the panel

After changing the control source the motor is stopped. The direction of rotation remains the same as with I/O control
If the Start button is pushed at the same time as the programmable pushbutton B2, the Run state direction of rotation and reference value are copied from the I/O terminals to the panel

7 11.2 Control source change from panel to I/O

After changing the control source, the I/O terminals determine the run state, direction of rotation and reference value.

If the motor potentiometer is used in the application the panel reference value can be copied as the motor potentiometer reference by pushing the start button at the same time as the programmable push button B2. The motor potentiometer function mode must be "resetting at stop state" (Local/Remote Application. param. 1 5 =4, Multi-purpose Application param. 1 5 = 9)

8 STARTUP

8 1 Safety precautions

Before startup observe the following warnings and instructions

1 Internal components and circuit boards (except the isolated I/O terminals) are at line potential when the SV9000 drive is connected to the utility This voltage is extremely dangerous and may cause death or severe injury if you come in contact with it

2 When the SV9000 drive is connected to the utility the motor connections U V W and DC-link / brake resistor connections + are live even if the motor is not running.

3 Do not make any connections when the SV9000 drive is connected to the utility line

4 After disconnecting the utility wait until the cooling fan on the unit stops and the indicators in the panel are turned off (if no panel check the indicators on the cover). Wait at least 5 minutes before doing any work on the SV9000 drive connections. Do not open cover before this time has run out.

5 The control I/O terminals are isolated from the utility potential but the relay outputs and other I/O's (if jumper X4 is in the OFF position, see fig. 6.2.2-1) may have dangerous external voltages connected even if the power is off from the SV9000 drive.

6 Before connecting the utility make sure that the cover of the SV9000 drive is closed.

8 2 Sequence of operation

1 Read and follow the safety precautions

2 After installation ensure that the

- Drive and motor are connected to ground
- Utility and motor cables are in accordance with the installation and connection instructions (chapter 6 1)
- Control cables are located as far as possible from the power cables (table 6.1 3-1), shields of the control cables are connected to the protective ground and wires do not have contact with any electrical components in the SV9000
- The common input of digital input groups is connected to +24 V or ground of the I/O-terminal or external supply (See 6 2 3)

3 Check the quantity and quality of the cooling air (chapters 5 1 and 5 2)

4 Check that moisture has not condensed inside the SV9000 drive

5 Check that all Start/Stop switches connected to the I/O terminals are in the Stop state

6 Connect the SV9000 to the utility and switch the power ON

7 Ensure that the parameters of the Group 1 match the application

Set the following parameters to match the motor nameplate

nominal voltage of the motor
nominal frequency of the motor
nominal speed of the motor
nominal current of the motor
supply voltage

Look up the values from the nameplate of the motor

8 Start up test without motor

Perform either test A or B

A Control from the I/O terminals

turn Start/Stop switch to ON position

change the frequency reference

check from the Monitoring page of the control panel that the output frequency follows the frequency reference

turn Start/Stop switch to OFF position

B Control from the Control Panel

change control from the I/O terminals to the control panel with the programmable button B2 see chapter 7 6

push the Start button

go to the Reference Page and change the frequency reference

with the buttons see chapter 7 5

go to the Monitoring Page and check that the output frequency follows the reference see chapter 7 3

push the Stop button

9 If possible make a start up test with a motor which is not connected to the process. If the inverter has to be tested on a motor connected to the process ensure it is safe to be powered up. Inform all possible co-workers about the tests

switch the utility power OFF and wait until the SV9000 has powered down according to chapter 8 1/ point 4

connect the motor cable to the motor and the power terminals of the SV9000

check that all start/stop switches connected to the I/O terminals are in the OFF state

switch the utility power ON

repeat test A or B of the test #8

10 Connect the motor to the process (if the previous tests were done without the process)

ensure it s safe to power up
inform all possible co-workers about the tests
repeat test A or B of the test #8

9 FAULT TRACING

When a fault trip occurs the fault indicator is illuminated and the fault code and its description are displayed. The fault can be cleared with the Reset button or via an I/O terminal. The faults are stored to the fault history from where they can be viewed (see chapter 7 8). The fault codes are explained in table 9-1

Fault codes	Fault	Possible cause	Checking
F1	Overcurrent	SV9000 frequency converter has measured too high a current (>4*In) in the motor output sudden heavy load increase short circuit in the motor cables unsuitable motor	Check load Check motor size Check cables
F2	Overvoltage	The voltage of the internal DC-link of the SV9000 frequency converter has exceeded the nominal voltage by 35% deceleration time is too fast high overvoltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	SV9000 frequency converter has detected faulty operation in the gate drivers or IGBT bridge interference fault component failure	Reset the fault and restart again If the fault occurs again contact your Cutler Hammer distributor
F5	Charging switch	Charging switch open when START command active interference fault component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler Hammer distributor
F9	Undervoltage	DC-bus voltage has gone below 65% of the nominal voltage most common reason is failure of the utility supply internal failure of the SV9000 frequency converter can also cause an undervoltage trip	In case of temporary supply voltage break reset the fault and start again Check utility input If utility supply is correct an internal failure has occurred Contact your Cutler Hammer distributor
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	brake resistor not installed brake resistor broken brake chopper broken	Check brake resistor If resistor is OK the chopper is broken. Contact your Cutler-Hammer distributor
F13	SV9000 under temperature	Temperature of heat sink below 10°C	

Fault codes	Fault	Possible cause	Checking
F14	SV9000 overtemperature	Temperature of heatsink over 75° C For Compact NEMA 1 over 80 C	Check the cooling air flow Check that the heat sink is clean Check the ambient temperature Check that the switching frequency is not too high for the ambient temperature and load
F15	Motor stalled	The motor stall protection has tripped	Check the motor
F16	Motor overtemperature	The SV9000 motor temperature calculating model has calculated a motor overtemperature	Decrease motor load Check the temperature model parameters if the motor wasn't too hot.
F17	Motor underload	The motor underload protection has tripped	Check motor and possible belts etc
F18	Analog input hardware fault	Component failure on the control card	Contact your Cutler-Hammer distributor
F19	Option board identification	Reading of the option board has failed	Check the installation of the board. If the installation is OK, contact your Cutler Hammer distributor
F20	10 V voltage reference	+ 10 V reference shorted on the control card or on an option board	Check the wiring connected to the + 10 V reference
F21	24 V supply	+ 24 V supply shorted on the control card or on an option board	Check the wiring connected to the + 24 V reference
F22 F23	EEPROM checksum failure	Parameter restoring error – interference component failure	On resetting this fault, the drive will automatically load the parameter default settings. Check all parameters before restarting the drive. If the fault occurs again, contact your Cutler-Hammer distributor
F25	Microprocessor watchdog	interference component failure	Reset the fault and restart. If the fault occurs again contact your Cutler-Hammer distributor
F26	Panel communication error	The connection between the drive and the panel doesn't work	Check the panel cable and connectors. If the fault occurs again contact your Cutler-Hammer distributor
F29	Thermistor protection	The thermistor input on the I/O boards has detected a motor temperature increase	Check the motor load and cooling Check the thermistor connection. If there are no thermistors make sure the inputs are short-circuited
F36	Analog input Iin< 4 mA (signal range 4 20 mA selected)	The analog input current is below 4 mA - signal source failed - control cable broken	Check the current loop circuitry
F41	External fault	An external fault has been detected at the digital input	Check the external fault source

10 BASIC APPLICATION

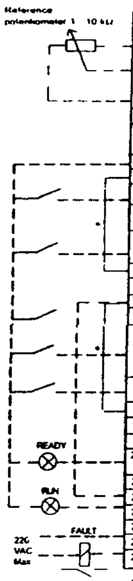
10.1 General

The Basic Application is the default setting as delivered from the factory. Control I/O signals of the Basic application are fixed (not programmable) and it only has parameter Group 1.

Parameters are explained in chapter 10.4. The function of motor thermal and stall protection in the Basic Application is explained in chapter 10.5.

10.2 Control Connections

* NOTE! Remember to connect the CMA and CMB inputs.



Terminal		Signal	Description
1	+10V	Reference output	Voltage for a potentiometer, etc.
2	V_{in}	Analog input, voltage range 0—10 V DC	Frequency reference activated if terminals 14 and 15 open and parameter 1.17 = 0 (default value)
3	GND	I/O ground	Ground for reference and controls
4	I_{in}	Analog input, current range 0—20 mA	Frequency reference activated if terminals 14 and 15 closed, or open and parameter 1.17 = 1
5	I_{in}		
6	+24V	Control voltage output	Voltage for switches, etc. max 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward	Contact closed = start forward
9	DIA2	Start reverse	Contact closed = start reverse
10	DIA3	External fault input	Contact open = no fault Contact closed = fault
11	CMA	Common for DIA1—DIA3	Connect to GND or +24V
12	+24V	Control voltage output	Voltage for switches (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	DIB4 / DIB5 / Frequency ref.
15	DIB5	Multi-step speed select 2	open / open / Ref. V_{in} (par. 1.17=0) closed / open / Multi-step ref. 1 open / closed / Multi-step ref. 2 closed / closed / Ref. I_{in} (term. #4,5)
16	DIB6	Fault reset	Contact open = no action Contact closed = fault reset
17	CMB	Common for DIB4—DIB6	Connect to GND or +24V
18	I_{out}+	Analog output 0—20 mA	0...maximum frequency (par. 1.2)
19	I_{out}-	Output frequency	R_L max 500 Ω
20	DO1	Digital output READY	activated = the SV9000 is ready to operate
21	RO1	Relay output 1 RUN	Relay activated = SV9000 is operating (motor is running)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Relay activated = fault trip has occured
25	RO2		
26	RO2		

Figure 1.2.1 Control connection example

10.3 Control Signal Logic

Figure 10.3.1 shows the logic of the I/O control signals and push buttons.

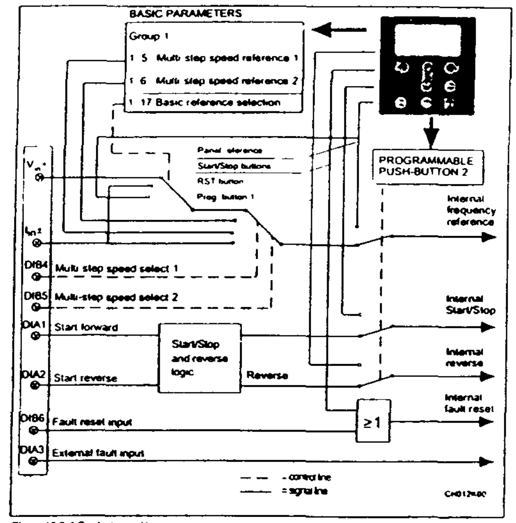


Figure 10.3-1 Control signal logic

If Start forward and Start reverse are both activated when the utility line is connected to the SV9000 then Start forward will be selected for the direction.

If Start forward and Start reverse are both activated when the control source is changed from the panel to the I/O-terminals then Start forward will be selected for the direction.

If both directions are selected the first selected direction has higher priority than the second selected.

10.4 Parameters, Group 1

Num.	Parameter	Range	Step	Default	Customer	Description	Page
1.1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			69
1.2	Maximum frequency	f_{min}–120/500 Hz	1 Hz	60 Hz		*	69
1.3	Acceleration time	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{min} (1.1) to f_{max} (1.2)	69
1.4	Deceleration time	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1.2) to f_{min} (1.1)	69
1.5	Multi-step speed reference 1	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	10 Hz			69
1.6	Multi-step speed reference 2	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	60 Hz			69
1.7	Current limit	0.1—2.5 x I_{nSV9}	0.1 A	1.5 x I_{nSV9}		Output current limit [A] of the unit	69
1.8	V/Hz ratio selection	0—1	1	0		0 = Linear 1 = Squared	69
1.9	V/Hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	70
1.10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 600 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	70
1.11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	70
1.12	Nominal speed of the motor	1—20000 rpm	1 rpm	1710 rpm **		n_n from the nameplate of the motor	70
1.13	Nominal current of the motor I_{nMot}	2.5 x I_{nSV9}	0.1 A	I_{nSV9}		I_n from the nameplate of the motor	71
1.14	Supply voltage	208—240 380—440 380—500 525—690		230 V 380 V 480 V 600 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	71
1.15	Application package lock	0—1	1	1		0 = package lock open Application is selected by parameter 0.1	71
1.16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = changes enabled 1 = changes disabled	71
1.17	Basic frequency reference selection	0—2	1	0		0 = analog input V_{in} 1 = analog input I_{in} 2 = reference from the panel	71
1.18	Analog input I_{in} range	0—1	1	0		0 = 0—20 mA 1 = 4—20 mA	71

Table 10.4-1 Group 1 basic parameters

Note! [icon] = Parameter value can be changed only when the SV9000 is stopped

* If 1.2 > motor synchr. speed, check suitability of motor and drive system

** Default value for a four pole motor and a nominal size SV9000

10.4.1 Descriptions

1.1, 1.2 Minimum/maximum frequency

Defines the frequency limits of the SV9000.

Default maximum value for parameters 1.1 and 1.2 is 120 Hz. By setting 1.2 = 120 Hz in Stop state (RUN indicator not lit) and pressing the Enter key the maximum value of parameters 1.1 and 1.2 is changed to 500 Hz. At the same time the panel reference display resolution is changed from 0.01 Hz to 0.1 Hz. The max. value is changed from 500 Hz to 120 Hz when parameter 1.2 is set to 119 Hz in Stop state and the Enter key is pressed.

1.3, 1.4 Acceleration time, deceleration time

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1.1) to the set maximum frequency (par. 1.2).

1.5, 1.6 Multi-step speed reference 1, Multi-step speed reference 2:

Parameter values are limited between minimum and maximum frequency.

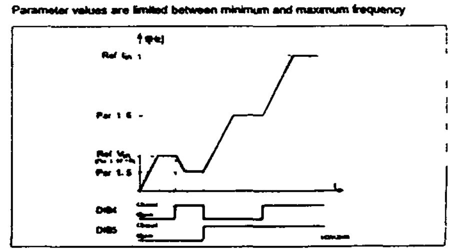


Figure 10.4.1.1 Example of Multi-step speed references

1.7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term.

1.8 V/Hz ratio selection

Linear: 0 — The voltage of the motor changes linearly with the frequency from 0 Hz to the nominal frequency of the motor. The nominal voltage of the motor is supplied at this frequency. See figure 10.4.1-2.

Linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared 1 — The voltage of the motor changes following a squared curve from 0 Hz to the nominal frequency of the motor The Nominal voltage of the motor is supplied at this frequency See figure 10 4 1 2

The motor runs undermagnetized below the nominal frequency and it produces less torque and electromechanical noise
A squared V/Hz ratio can be used in applications where the torque demand from the load is proportional to the square of the speed e g in centrifugal fans and pumps

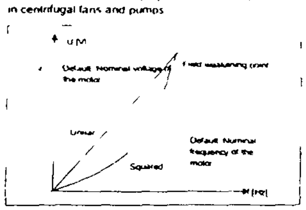


Figure 10 4 1 2 Linear and squared V/Hz curves

1 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which allows the motor to produce sufficient torque to start and run at low frequencies The voltage increase depends on the motor type and horsepower.Automatic torque boost can be used in applications where starting torque due to starting friction is high e g in conveyors

NOTE! *In high torque low speed applications it is likely the motor will overheat If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the operating temperature rise is too high*

1 10 Nominal voltage of the motor

Find the rated voltage V_n from the nameplate of the motor

Note! If the nominal motor voltage is lower than the supply voltage check that the insulation level of the motor is adequate

1 11 Nominal frequency of the motor

Find the value f_n from the nameplate of the motor

1 12 Nominal speed of the motor

Find the value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor The internal motor protection function uses this value as a reference value

1 14 Supply voltage

- Set parameter value according to the nominal voltage of the supply Values are predefined for voltage codes 2 4 5 and 6 see table 10 4 1

1 15 Application package lock

The application package lock can be opened by setting the the value of the parameter 1 15 to 0 It will then be possible to enter the parameter group 0 from parameter 1 1 by pressing arrow down button (see figure 11 1) The number of the Application can be selected from the table 11 1 and it is selected by the value of parameter 0 1 After this the new Application is in use and its parameters will be found in the SVReady Application manual

1 16 Parameter value lock

Defines access to the changes of the parameter values

0 parameter value changes enabled
1 parameter value changes disabled

1 17 Basic frequency reference selection

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5 e g a transducer
2 Panel reference is the reference set from the Reference Page (REF) see chapter 7 5

1 18 Analog input I_{in} range

Defines the minimum value of the Analog input I_{in} signal (terminals 4 5)

10 5 Motor protection functions in the Basic Application

10 5 1 Motor thermal protection

Motor thermal protection protects the motor from overheating In the Basic application Motor thermal protection uses constant settings and always causes a fault trip if the motor is overheated To switch off the protection or to change the settings see SVReady application manual

Your SV9000 is capable of supplying higher than nominal current to the motor If the load requires this high current there is a risk that motor will be thermally overloaded This is true especially at low frequencies, as the cooling effect and thermal capacity of the motor are reduced. The motor thermal protection is based on a calculated model which uses the output current of the drive to determine the load on the motor

The thermal current I_t specifies the load current above which the motor is overloaded See figure 10 5 1 1 If the motor current is above the curve the motor temperature is increasing

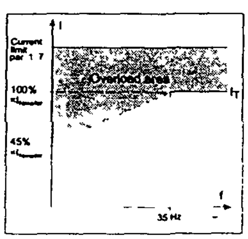


Figure 10 5 1 1 Motor thermal current I curve

CAUTION! *The calculated model does not protect the motor if the airflow to the motor is reduced by an air intake grill that is blocked*

10 5.2 Motor Stall warning

In the Basic application, motor stall protection gives a warning of a short time overload of the motor e g a stalled shaft. The reaction time of this stall protection is shorter than the motor thermal protection time The stall state is defined by Stall Current and Stall Frequency

Both parameters have constant values See figure 10 5 2 1 If the current is higher than the set limit and the output is lower than the set limit the stall state is true If the stall state lasts longer than 15 s the stall warning is given on the display To change the stall warning to a fault trip or to change the protection settings see the SVReady application manual

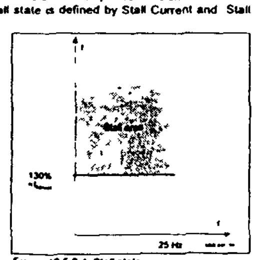


Figure 10 5 2 1 Stall state

11 System parameter group 0

When the application package lock is open (par 1 15 = 0) the system parameter group 0 can be accessed Parameter group 0 can be entered from parameter 1 1 by the pressing arrow down button The parameters of group 0 are shown in table 11 1

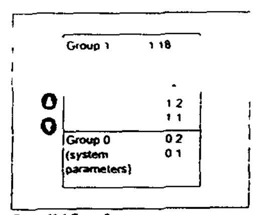


Figure 11 1 Group 0

11 1 Parameter table

Number	Parameter	Range	Description	Page
0 1	Application selection	1—7	1 = Basic Application 2 = Standard Application 3 = Local / Remote Control Application 4 = Multi-step Speed Application 5 = PI-control Application 6 = Multi-purpose Control Application 7 = Pump and fan control Application	74
0 2	Parameter loading	0—5	0 = Loading ready / Select loading 1 = Load default settings 2 = Read up parameters to user's set 3 = Load down user's set parameters 4 = Read parameters up to the panel (possible only with the graphic panel) 5 = Load down parameters from the panel (possible only with graphic panel)	75
0 3	Language selection	0—5	0 = English 1 = German 2 = Swedish 3 = Finnish 4 = Italian 5 = French	75

Table 11-1 System parameters Group 0

11 2 Parameter descriptions

0 1 Application selection

With this parameter the Application type can be selected The default setting is the Basic Application. Applications are described in chapter 12

0.2 Parameter loading

With this parameter it is possible to do several types of parameter load operations. After the operation is completed this parameter value changes automatically to 0 (loading ready)

0 Loading ready / Select loading

Loading operation has been completed and the drive is ready to operate

1 Load default settings

By setting the value of parameter 0 2 to 1 and then pressing the Enter button the parameter default values for the application selected with parameter 0 1 are loaded. Use this when you want to restore the default set

2 Read up parameters to User's set

Set the value of parameter 0 2 to 2 and press the Enter button to store the active parameter values set A in back-up memory as the User's parameter value set B. The parameter values can later be reloaded as the active set by setting parameter 0 2 to 3 and pressing the Enter button. See Figure 11 2

3 Load down user's set parameters

Set the value of parameter 0 2 to 3 and press the Enter-button to reload the users' set B as the active set A. The User's set is intended to function as a backup in the case you have a good set of parameters that for some reason is lost or changed
See Figure 11-2

4 *Read parameters up to the panel (possible only with the graphic panel)*

Copies the active parameter set A to the memory in the graphical panel

5 Load down parameters from the panel *(possible only with the graphic panel)*

Copies the parameter set in the graphical panel as the active parameter set A

NOTE! The panel read and load operations work only on drives of the same power and voltage rating.

0 3 Language selection

This parameter selects the language of the text displayed on the panel

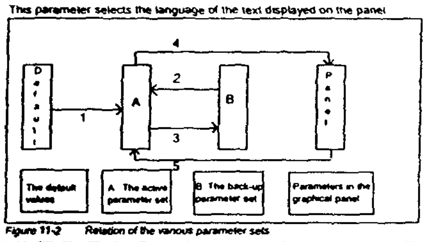


Figure 11-2 Relation of the various parameter sets

12 SVReady™ application package

12 1 Application Selection

To use one of the SVReady applications first open the Application package lock (parameter 1 15) Group 0 then comes visible (see figure 11 1). Changing the value of parameter 0 1 changes the active application. See table 11-1

Applications are presented in sections 12 2 12 7 and in more detail in the following separate SVReady application manual

12 2 Standard Application

The Standard Application has the same I/O signals and same Control logic as the Basic application

Digital input DIA3 and all outputs are freely programmable

Other additional functions

Programmable Start/Stop and Reverse *signal logic*
Reference scaling
One frequency limit supervision
Second set of ramps and choice of linear or S curve
Programmable start and stop functions
DC-braking at stop
One prohibit frequency lockout range
Programmable V/Hz curve and switching frequency
Autorestart function
Motor Thermal and Stall protection off / warning / fault programming

12 3 Local/Remote Application

Utilizing the Local/Remote Control Application the use of two different control and frequency reference sources is programmable. The active control source is *selected with digital input DIB6. All outputs* are freely programmable

Other additional functions.

Programmable Start/stop and Reverse signal logic
Analog input signal range selection
Two frequency in band limit indications
Torque in band limit indication
Reference in band limit indication
Second set of ramps and choice of linear or S curve
DC-braking at start and stop
Three prohibit frequency lockout ranges
Programmable V/Hz curve and switching frequency
Autorestart function
Motor Thermal and Stall protection fully programmable
Motor Underload protection
Unused analog input functions

12 4 Multi-step Speed Application

The Multi-step Speed Control Application can be used where fixed speed references are required. 9 different speeds can be programmed: one basic speed, 7 multi-step speeds and one jogging speed. The speed steps are selected with digital signals DIB4 DIB5 and DIB6. If the jogging speed is used DIA3 can be programmed for jogging speed select

The basic speed reference can be either voltage or current signal via analog input terminals (2/3 or 4/5). All outputs are freely programmable

Other additional functions

- *Programmable Start/stop and Reverse* signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
Reference in band limit indication
Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
Programmable V/Hz curve and switching frequency
- Autorestart function
- *Motor Thermal and Stall protection fully* programmable
Motor Underload protection
- Unused analog input functions

12

12.5 PI-control Application

In the PI-control Application, there are two I/O-terminal control sources. Source A is a PI-controller and source B is a direct frequency reference. The control source is selected with the DIB6 input.

The PI-controller reference can be selected from the analog inputs, motor potentiometer or panel reference. The actual value can be selected from the analog inputs or from a mathematical function acting on the analog inputs. The direct frequency reference can be used for control without the PI-controller *The frequency reference can be selected* from the analog inputs or the panel reference

All outputs are freely programmable

Other additional functions.

- *Programmable Start/stop and Reverse* signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection

12 6 Multi-purpose Control Application

In the Multi-purpose Control Application, the *frequency reference can be selected from* the analog inputs, joystick control, motor potentiometer, or a mathematical function of the analog inputs. Multi-step speeds and jog speed can also be selected if the digital inputs are programmed for these functions

Digital inputs DIA1 and DIA2 are reserved for Start/stop logic. Digital inputs DIA3 - DIB6 are programmable for multi-step speed select, jog speed select, motor potentiometer external fault, ramp time select, ramp prohibit, fault reset and DC-brake command function. All outputs are freely programmable

Other additional functions

- Programmable Start/stop and Reverse signal logic
- Analog input signal range selection
Two frequency in band limit indications
Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S-curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection
- Free analog input functions

12 7 Pump and Fan Control Application

The Pump and Fan Control Application can be used to control one variable speed drive and 0-3 auxiliary drives. The PI-controller of the frequency *converter controls the speed* of the variable speed drive and gives control signals to Start and Stop auxiliary drives to control the total flow

The application has two control sources on I/O terminal. Source A is Pump and fan *control and source B is direct frequency* reference. The control source is selected with DIB6 input.

All outputs are freely programmable

Other additional functions

Programmable Start/stop and reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection

12

13 Options

13 1 External filters

Information of SV9000 external input and output filters (RFI dV/dT, and Sinusoidal-filters) can be found in their separate manuals

13 2 Dynamic braking

Effective motor braking and short deceleration times are possible by using an external or internal braking chopper with an external brake resistor

The internal braking chopper is assembled in the factory (available in certain models). It has the same continuous current specification as the unit itself

Select the correct brake resistor to get the desired braking effect. More information can *be found in the separate brake manual.*

13.3 I/O- expander board

The available I/O can be increased by using the I/O- expander boards. I/O-expander boards can be installed in the option board position inside the open, protected, NEMA 1 and NEMA 12 SV9000 models. For the Compact NEMA 1 model the board needs to be installed in a separate I/O-expander box.

More information can be found in the I/O-expander board manuals.

13.4 Communication

SV9000 frequency converters can be connected to DeviceNet, Modbus RTU, Interbus-S, Profibus-DP and Lonworks systems by using the fieldbus option board

The fieldbus board can be installed in the option board position inside the open, protected, NEMA 1 and NEMA 12 SV9000 models. For the compact NEMA 1 model the board needs to be installed in a separate I/O-expander box

More information can be found in the separate communication manuals.

13 6 SVGraphic™ control panel

The SVGraphic control panel can be used inplace of the standard 3 line LCD panel. It provides.

- parameters, monitored items etc in text format
- 3 monitored items at the same time in display
- one monitored item can be shown in increased text size with a graph bar
- The selected parameter value is shown on a graph bar
- 3 monitored items can be shown on the graphical trend display
- the parameters of the frequency converter can be uploaded to the panel and then downloaded to another inverter

More information can be found in the SVGraphic™ Panel manual

13 7 SVDRIVE™

SVDrive is the PC based tool for control and monitoring of the SV9000. With SVDrive

- parameters can be loaded from the SV9000, changed, saved to a file or loaded back to the SV9000 - parameters can be printed to paper or to a file
- references can be set
- the motor can be *started and stopped*
- signals can be examined in graphical form
- actual values can be displayed

The SV9000 can be connected to a PC with a special RS232-cable, catalog number SVDRIVECABLE. The same cable can be used for downloading <u>specialized</u> applications to the SV9000

13.8 Operator panel door installation kit

An adapter kit is available to mount the operator display panel on an enclosure door

13.9 Protected chassis cable cover for 75 - 125 HP open panel units

This optional cable cover provides a protected chassis capability equivalent to IP20

13

Notes

SV9000 SVReady USER MANUAL

CONTENTS

OPEN SV9000 USER MANUAL

A General

This manual provides you with the information needed to apply these applications.

Each application is described in its own chapter Section B tells how to select the application.

B Application selection

If the Basic Application is in use first open the application package lock (parameter 1 15 = 0) group 0 appears By changing the value of parameter 0 1 a different application can be selected. See table B-1

To change from one application to another simply change the value of parameter 0 1 to that of the application desired. see table B-1

Number	Parameter	Range	Description
0. 1	Application	1 —7	1 = Basic Application 2 = Standard Application 3 = Local / Remote Control Application 4 = Multi-step Speed Application 5 = PI-control Application 6 = Multi-purpose Control Application 7 = Pump and Fan Control Application

Table B-1 Application selection parameters

Besides the parameter group 1 the applications also have parameter groups 2 — 8 available (see figure B-1)

Parameters of the groups sequentially follow each other and changing from the last parameter of one group to the first parameter of the next group or vice versa is done simply by pushing the arrow up/arrow down buttons

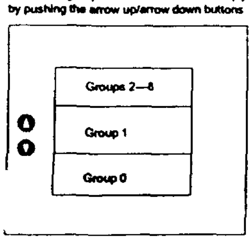


Figure B 1 Parameter Groups

C Restoring default values of application parameters

Default values of the parameters of the applications 1 to 7 can be restored by selecting the same application again with parameter 0 1 or by setting the value of parameter 0.2 to 1 See User's manual chapter 12

If parameter group 0 is not visible make it visible as follows

1 If parameter lock is set on, open the lock parameter 1 16 by setting the value of the parameter to 0

2 If parameter conceal is set on, open the *conceal parameter* 1 15 by setting the value of the parameter to 0
Group 0 becomes visible

D Language selection

The language of the text shown on the operator's panel can be chosen with parameter 0. 3. See SV9000 User's Manual, chapter 11

1

STANDARD CONTROL APPLICATION

(par 0 1 = 2)

CONTENTS

1

1 STANDARD APPLICATION

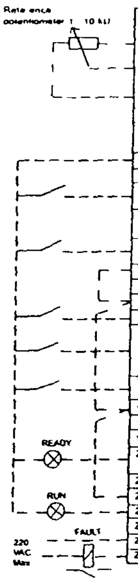
1 1 General

The Standard application has the same I/O signals and same Control logic as the Basic application Digital input DIA3 and all outputs are programmable

The Standard Application can be selected by setting the value of parameter 0 1 to 2 Basic connections of inputs and outputs are shown in the figure 1 2 1 The control signal logic is shown in the figure 1 3 1 Programming of I/O terminals is explained in chapter 1 5

1 2 Control I/O

* NOTE! Remember to connect the CMA and CMB inputs



Terminal		Signal	Description
1	+10V	Reference output	Voltage for a potentiometer etc
2	V_{in}	Analog input voltage range 0 10 V DC	Frequency reference if activated if terminals 14 and 15 open and parameter 1 17 = 0 (default value)
3	GND	I/O ground	Ground for reference and controls
4 5	I_{in} I_{in}	Analog input current range 0—20 mA	Frequency reference activated if terminals 14 and 15 closed or open and parameter 1 17 = 1
6	+24V	Control voltage output	Voltage for switches etc max 0 1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward (Programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	External fault input (Programmable)	Contact open = no fault Contact closed = fault
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	DIB4 / DIB5 / Frequency ref
15	DIB5	Multi-step speed select 2	open / open / Ref V_{in} (par 1 17=0) closed / open / Multi-step ref 1 open / closed / Multi-step ref 2 closed / closed / Ref I_{in} (term #4 5)
16	DIB6	Fault reset	Contact open = no action Contact closed = fault reset
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I_{out}	Output frequency	Programmable (par 3 1)
19	I_{out}	Analog output	Range 0—20 mA/R_L max 500 Ω
20	DO1	Digital output READY	Programmable (par 3 6) Open collector (I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 RUN	Programmable (par 3 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3 8)
25	RO2		
26	RO2		

Figure 1.2 1 Default I/O configuration and connection example of the Standard Application

1

1.3 Control signal logic

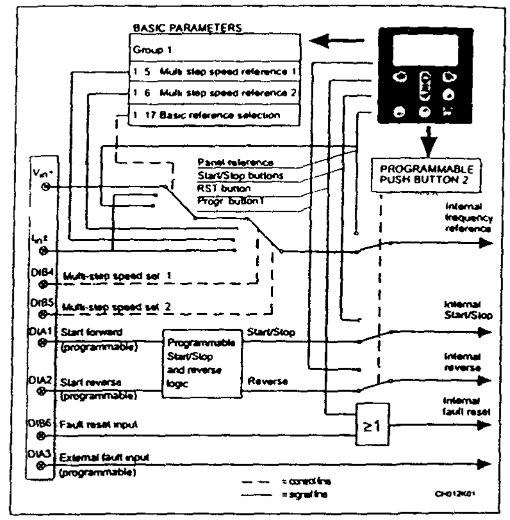


Figure 1 3 1 Control signal logic of the Standard Application

1

1.4 PARAMETERS, GROUP 1

1.4.1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			1-5
1 2	Maximum frequency	f_{min} 120/500 Hz	1 Hz	60 Hz			1 5
1 3	Acceleration time 1	0 1—3000.0 s	0 1 s	3 0 s		Time from f_{min} (1 1) to f_{max} (1 2)	1-5
1 4	Deceleration time 1	0 1—3000.0 s	0 1 s	3 0 s		Time from f_{max} (1 2) to f_{min} (1 1)	1-5
1 5	Multi-step speed reference 1	f_{min} —f_{max}	0 1 Hz	10 0 Hz			1-5
1 6	Multi-step speed reference 2	f_{min} —f_{max}	0 1 Hz	60 0 Hz			1-5
1 7	Current limit	0 1—2.5 x I_{nSV9}	0 1 A	1.5 x I_{nSV9}		Output current limit (A) of the unit	1-5
1 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	1-5
1 9	V/Hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	1-6
1 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	1 7
1 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	1 7
1 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm ~		n_n from the nameplate of the motor	1 7
1 13	Nominal current of the motor	2.5 x I_{nSV9}	0 1 A	I_{nSV9}		I_n from the nameplate of the motor	1 7
1 14	Supply voltage	208—240		230 V		Voltage code 2	1 7
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters 0 = all parameter groups visible 1 = only group 1 is visible	1 7
1 16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = changes enabled 1 = changes disabled	1 7
1 17	Basic frequency reference selection	0—2	1	0		0 = analog input V_{in} 1 = analog input I_{in} 2 = reference from the panel	1 7

Table 1 4 1 Group 1 basic parameters

Note! ■ = Parameter value can be changed only when the drive is stopped

\# 1 2 > motor synchr speed check suitability for motor and drive system
Selecting 120 Hz/500 Hz range see page 1 5
~ Default value for a four pole motor and a nominal size drive

1

1 4 2 Description of Group 1 parameters

1 1 1 2 Minimum/maximum frequency

Defines the frequency limits of the drive

The default maximum value for parameters 1 1 and 1 2 is 120 Hz By setting the value of the parameter 1 2 to 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz At the same time the resolution of the display panel is changed from 0 01 Hz to 0 1 Hz

Changing the max. value from 500 Hz to 120 Hz in done by setting parameter 1 2 to 119 Hz while the drive is stopped

1 3 1 4 Acceleration time1, deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2)

1 5 1 6 Multi-step speed reference 1, Multi-step speed reference 2

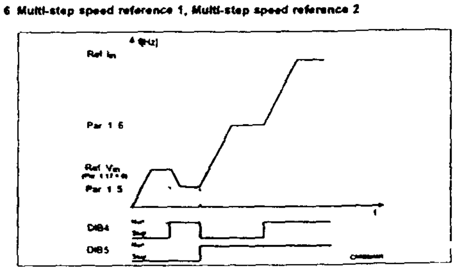


Figure 1 4 1 Example of Multi-step speed references

Parameter values are automatically limited between minimum and maximum frequency (par 1 1 1 2)

1 7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term

1 8 V/Hz ratio selection

Linear 0: The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6 3) where a constant voltage (nominal value) is supplied to the motor See figure 1 4-2

A linear V/Hz ratio should be used in constant torque applications This default setting should be used if there is no special requirement for another setting

1

Squared 1 — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6 3) where the nominal voltage is also supplied to the motor *See figure 1 4 2*

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed e g in centrifugal fans and pumps

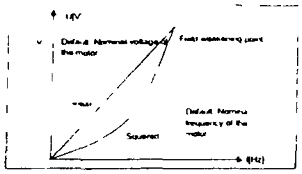


Figure 1 4 2 Linear and squared V/Hz curves

Programm V/Hz curve — The V/Hz curve can be programmed with three different points The parameters for programming are explained in chapter 1 5 2 A programmable V/Hz curve can be used if the standard settings

2 do not satisfy the needs of the application See figure 1 4-3

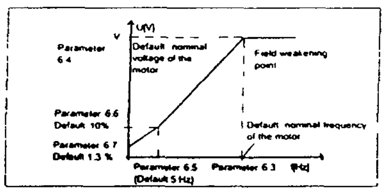


Figure 1 4-3 Programmable V/Hz curve

1 9 V/Hz optimization

Automatic torque — The voltage to the motor changes automatically which allows the motor to produce enough torque to start and run at low frequencies The boost voltage increase depends on the motor type and horsepower Automatic torque boost can be used in applications where starting torque due to starting friction is high e g in conveyors

1

NOTE! In high torque low speed applications it is likely that the motor will overheat If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the operating temperature rise is too high

1 10 Nominal voltage of the motor

Find this value from the nameplate of the motor
This parameter sets the voltage at the field weakening point parameter 6 4 to 100% x V_{nmotor}

Note! If the nominal motor voltage is lower than the supply voltage check that the insulation level of the motor is adequate

1 11 Nominal frequency of the motor

Find the nominal frequency f from the nameplate of the motor
This parameter sets the field weakening point parameter 6 3 to the same value

1 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor
The internal motor protection function uses this value as a reference value

1 14 Supply voltage

Set parameter value according to the nominal voltage of the supply
Values are predefined for voltage codes 2 4 5 and 6 See table 1 4 1

1 15 Parameter conceal

Defines which parameter groups are available

0 – all groups are visible
1 = only group 1 is visible

1 16 Parameter value lock

Permits access for changing the parameter values

0 = parameter value changes enabled
1 = parameter value changes disabled

1 17 Basic frequency reference selection

0 = Analog voltage reference from terminals 2—3 e g a potentiometer
1 = Analog current reference from terminals 4—5 e g a transducer
2 = Panel reference is the reference set from the Reference Page (REF) see chapter 7.5

1

1.5 SPECIAL PARAMETERS GROUPS 2—8

1.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description DIA1	Description DIA2	Page
2 1	Start/Stop logic selection ■	0—3	1	0		0 = Start forward 1 = Start/Stop 2 = Start/Stop 3 = Start pulse	Start reverse Reverse Run enable Stop pulse	1 12
2.2	DIA3 function (terminal 10) ■	0—6	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse (if par 2. 1 = 3)		1-13
2 3	Reference offset for current input	0—1	1	0		0 = 0—20 mA 1 = 4—20 mA		1 13
2 4	Reference scaling minimum value	0—par 2 5	1 Hz	0 Hz		Selects the frequency that corresponds to the minimum reference signal		1 13
2.5	Reference scaling maximum value	0—f_{max}	1 Hz	0 Hz		Selects the frequency that corresponds to the maximum reference signal 0 = Scaling off >0 = Maximum frequency value		1-13
2 6	Reference invert	0—1	1	0		0 = No inversion 1 = Reference inverted		1 14
2.7	Reference filter time	0.00—10.00s	0.01s	0 10s		0 = No filtering		1 14

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analog output function ■	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0xI_{nSV}) 4 = Motor torque (0—2xT_{nMot}) 5 = Motor power (0—2xP_{nMot}) 6 = Motor voltage (0—100%xV_{nMot}) 7 = DC-link volt. (0—1000 V)	1 15
3.2	Analog output filter time	0.00—10.00 s	0.01s	1 00 s		0 = no filtering	1 15
3.3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	1 15
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	1 15
3.5	Analog output scale	10—1000%	1%	100%			1 15

Note! ■ = Parameter value can be changed only when the drive is stopped

1

Group 3 Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.6	Digital output function ■	0—14	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Multi-step speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 14 = Control from I/O-terminal	1 16
3.7	Relay output 1 function ■	0—14	1	2		As parameter 3.6	1-16
3.8	Relay output 2 function ■	0—14	1	3		As parameter 3.6	1 16
3.9	Output freq. limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	1 16
3 10	Output freq. limit supervision value	0.0—f_{max} (par 1 2)	0.1 Hz	0.0 Hz			1-16
3.11	I/O-expander option board analog output function	0—7	1	3		As parameter 3. 1	1 15
3.12	I/O-expander option board analog output scale	10—1000%	1%	100%		As parameter 3.5	1 15

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0 1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	1 17
4.2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0 1 s	0 0 s		0 = Linear >0 = S-curve acc./dec. time	1 17
4 3	Acceleration time 2	0 1—3000 0 s	0 1 s	10 0 s			1 17
4.4	Deceleration time 2	0 1—3000.0 s	0 1 s	10 0 s			1 17
4 5	Brake chopper ■	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	1 17
4 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	1 17
4 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	1 18
4 8	DC-braking current	0 15—1.5 x I_{nSV}(A)	0 1 A	0.5 x I_{nSV}			1 18
4.9	DC-braking time at Stop	0.00—250.00 s	0 01 s	0.00 s		0 = DC-brake is off	1 18

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 5 Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5 1	Prohibit frequency range low limit	f_{min}–f_{max} par 5 2	0 1 Hz	0 0 Hz			1 19
5 2	Prohibit frequency range high limit	f_{min}–f_{max} (1 1)(1 2)	0 1 Hz	0 0 Hz		0 = no prohibit frequency range (max limit = par 1 2)	1 19

Group 6 Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6	Motor control mode	0		0		0 = Frequency control 1 = Speed control	1 20
6 2	Switching frequency	1 0—16 0 kHz	0 1	10/3 6 kHz		Dependent on Hp rating	1 20
6 3	Field weakening point	30—500 Hz	1 Hz	Param 1 11			1 20
6 4	Voltage at field weakening point	15 —200% x V_{nmot}	1%	100%			1 20
6 5	V/Hz curve mid point frequency	0 0 f_{max}	0 1 Hz	0 0 Hz			1 20
6 6	V/Hz curve mid point voltage	0 00—100 00% x V_{nmot}	0 01%	0 00%			1 20
6 7	Output voltage at zero frequency	0 00—100 0% x V_{nmot}	0 01%	0 00%			1 20
6 8	Overvoltage controller	0—1	1	1		0 = Controller is off 1 = Controller is on	1 20
6 9	Undervoltage controller	0—1	1	1		0 = Controller is off 1 = Controller is on	1 20

Note! - Parameter value can be changed only when the drive is stopped

Group 7 Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7	Response to reference fault	0—3		0		0 = No action 1 = Warning 2 = Fault, stop according par 4 7 3 = Fault, always coasting stop	1 21
7 2	Response to external fault	0—3		2		0 = No action 1 = Warning 2 = Fault, stop according par 4 7 3 = Fault, always coasting stop	1 21
7 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	1 21
7 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	1 21
7 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	1 22
7 6	Stall protection	0—2		1		0 = No action 1 = Warning 2 = Fault	1 22

Group 8 Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8 1	Automatic restart number of tries	0 10	1	0		0 = no action	1 23
8 2	Automatic restart multi attempt max trial time	1—6000 s	1 s	30 s			1 23
8 3	Automatic restart start function	0		0		Ramp Flying start	1 24

Table 1 5 1 Special parameters groups 2 8

1 5.2 Description of Group 2—8 parameters

2 1 Start/Stop logic selection

0 DIA1 closed contact = start forward
DIA2 closed contact = start reverse
See figure 1 5-1

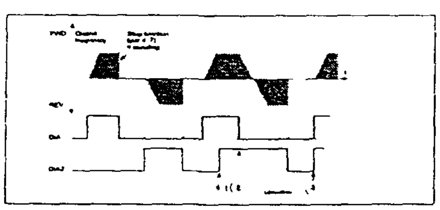


Figure 1 5-1 Start forward/Start reverse

(1) The first selected direction has the highest priority
(2) When DIA1 contact opens the direction of rotation starts to change
(3) If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously, the Start forward signal (DIA1) has priority

1 DIA1 closed contact = start open contact = stop
DIA2 closed contact = reverse open contact = forward
See figure 1 5-2

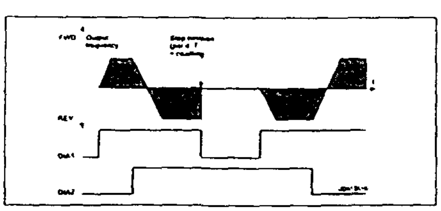


Figure 1 5-2 Start, Stop, reverse

2 DIA1 closed contact = start open contact = stop
DIA2 closed contact = start enabled open contact = start disabled

3 3-wire connection (pulse control)
DIA1 closed contact = start pulse
DIA2 closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 1 5-3

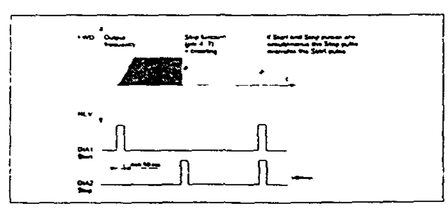


Figure 1 5-3 Start pulse/Stop pulse

2 2 DIA3 function

1 External fault, closing contact = Fault is shown and drive responds according to parameter 7 2
2 External fault, opening contact = Fault is shown and drive responds according to parameter 7.2
3 Run enable contact open = Start of the motor disabled; contact closed = Start of the motor enabled
4 Acc / Dec time select contact open = Acceleration/Deceleration time 1 selected; contact closed = Acceleration/Deceleration time 2 selected
5 Reverse contact open = Forward; contact closed = Reverse || Can be used for reversing if parameter 2 1 has value 3

2 3 Reference offset for current input

0 No offset
1 Offset 4 mA, provides supervision of zero level signal. The response to reference fault can be programmed with the parameter 7 1

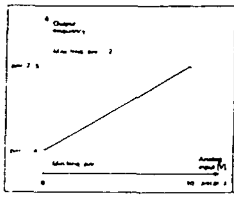


Figure 1 5-4 Reference scaling

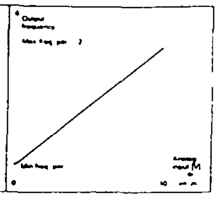


Figure 1 5-5 Reference scaling parameter 2 5 = 0

2 4 2 5 Reference scaling minimum value/maximum value

Setting value limits 0 < par 2 4 ≤ par 2 5 ≤ par 1 2
If parameter 2 5 = 0 scaling is set off See figures 1 5-4 and 1 5-5

2 6 Reference invert

Inverts reference signal.

max ref signal = min set freq
min. ref signal = max set freq
See figure 1 5-6

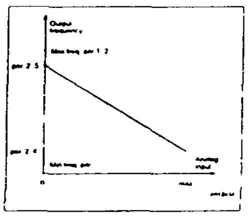


Figure 1 5-6 Reference invert

2 7 Reference filter time

Filters out disturbances from the incoming reference signal. A long filtering time makes regulation response slower See figure 1 5-7

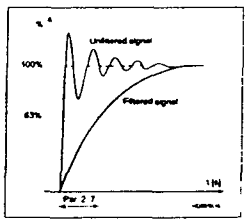


Figure 1 5-7 Reference filtering

3 1 Analog output function

See table Group 3 output and supervision parameters on the page 1-8

3 2 Analog output filter time

Filters the analog output signal See figure 1 5-8

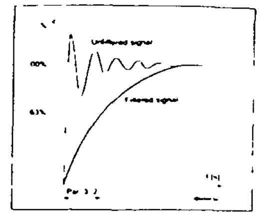


Figure 1 5-8 Analog output filtering

3 3 Analog output invert

Inverts analog output signal
max output signal = minimum set value
min output signal = maximum set value
See figure 1 5-9

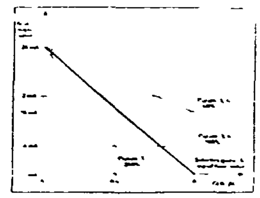


Figure 1 5-9 Analog output invert

3 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA. See figure 1 5 10

3 5 Analog output scale

Scaling factor for analog output. See figure 1 5-10

Signal	Max value of the signal
Output frequency	Max frequency (p 1 2)
Motor speed	Max speed ($n_s x f_{max}/f_n$)
Output current	$2 x I_{nSV9}$
Motor torque	$2 x T_{nMot}$
Motor power	$2 x P_{nMot}$
Motor voltage	$100\% x V_{nMot}$
DC-link volt	1000 V

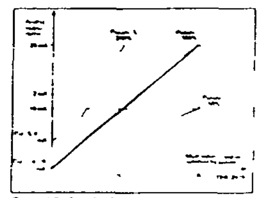


Figure 1 5-10 Analog output scale

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when.
1 = Ready	The drive is ready to operate
2 = Run	The drive operates
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10= Multi-step speed selected	A multi-step speed has been selected
11= At speed	The output frequency has reached the set reference
12= Motor regulator activated	Overvoltage or overcurrent regulator was activated
13= Output frequency supervision	The output frequency goes outside of the set supervision low limit/ high limit (par 3. 9 and 3. 10)
14= Control from I/O terminals	Ext control mode selected with progr push-button #2

Table 1.5-2 Output signals via DO1 and output relays RO1 and RO2

3. 9 Output frequency limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3 10 Output frequency limit supervision value

The frequency value to be supervised by the parameter 3 9
See figure 1.5-11

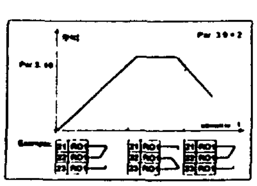


Figure 1 5-11 Output frequency supervision

4 1 Acc/Dec ramp 1 shape
4 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3 4 4 for Acc/Dec. time 2)

Setting 0 1—10 seconds for 4 1 (4 2) causes an S-shaped ramp The speed changes are smooth Parameter 1 3/ 1 4 (4 3/ 4 4) determines the ramp time of the acceleration/deceleration in the middle of the curve See figure 1.5-12

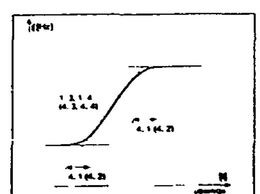


Figure 1 5-12 S-shaped acceleration/ deceleration.

4 3 Acceleration time 2
4 4 Deceleration time 2

These values correspond to the time required for the output frequency to change from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2). With this parameter it is possible to set two different acceleration/deceleration times for one application. The active set can be selected with the programmable signal DIA3. See parameter 2 2

4 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4 6 Start function

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may extend the acceleration times).

1

Flying start

1 The drive starts into a running motor by first finding the speed the motor is running at Searching starts from the maximum frequency down until the actual frequency reached The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 Stop function

Coasting

0 The motor coasts to an uncontrolled stop with the SV9000 off after the Stop command is issued

Ramp

1 After the Stop command is issued the speed of the motor is decelerated based on the deceleration ramp time parameter
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration

4 8 DC braking current

Defines the current injected into the motor during DC braking

4 9 DC braking time at stop

Determines whether DC braking is ON or OFF It also determines the braking duration time of the DC-brake when the motor is stopping The function of the DC brake depends on the stop function parameter 4 7 See figure 1 5 13

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param 4 7) The time is set by the value of parameter 4 9

Stop-function = 0 (coasting).

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC- braking starts *If the frequency is ≥ nominal frequency of the motor (par 1 11), the value* of parameter 4 9 determines the braking time When the frequency is < 10% of the nominal the braking time is 10% of the set value of parameter 4 9 See figure 1 5-13

1

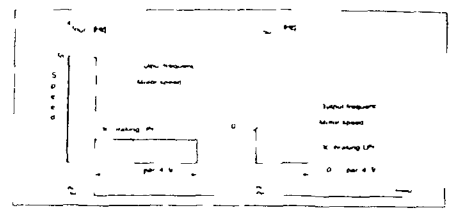


Figure 1 5 13 DC braking time when stop coasting

Stop-function 1 (ramp).

After a Stop command the speed of the motor is reduced based on the deceleration ramp parameter If no regeneration occurs due to load inertia DC-braking starts at 0 5 Hz

The braking time is defined by par 4 9 If the load has a high inertia use an external braking resistor for faster deceleration

See figure 1 5-14

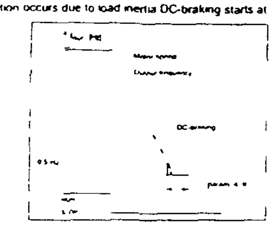


Figure 1 5-14 DC-braking time when stop function = ramp

5 1 Prohibit frequency area
5 2 Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems

With these parameters it is possible to set limits for one "skip frequency" region between 0 Hz and 120 Hz/500 Hz Accuracy of the setting is 0 1 Hz

See figure 1 5-15

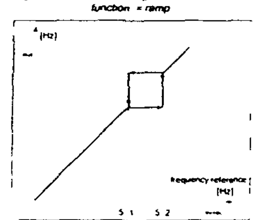


Figure 1 5 15 Example of prohibit frequency area setting

1

6 1 Motor control mode

0 = Frequency control (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq resolution 0 01 Hz)
1 = Speed control (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0 5%)

6 2 Switching frequency

Motor noise can be minimized by using a high switching frequency Increasing the switching frequency reduces the current capacity of the SV9000

Before changing the frequency from the factory default 10 kHz (3 6 kHz ≥40 Hp) check the drive derating in the curves shown in figures 5.2-2 and 5 2 3 in chapter 5.2 of the User's Manual

6 3 Field weakening point
6 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches *the set maximum value (parameter 6 4) Above that frequency the output voltage* remains constant at the set maximum value Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1 8, 1 9 6 5 6 6 and 6 7 See figure 1 5-16

When the parameters 1 10 and 1 11 nominal voltage and nominal frequency of the motor are set, parameters 6 3 and 6 4 are also set automatically to the same values If you need different values for the field weakening point and the maximum output voltage change these parameters <u>after</u> setting parameters 1 10 and 1 11

6 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1 8, this parameter defines the middle frequency point of the curve See figure 1.5-16

6 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1 8, this parameter defines the middle voltage point of the curve See figure 1 5-16

6 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage of the curve See figure 1 5-16

6 8 Overvoltage controller
6 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed If the controllers are ON they will change the motor speed in over/undervoltage cases Overvoltage = faster undervoltage = slower

Over/undervoltage trips may occur when the controllers are not used.

1

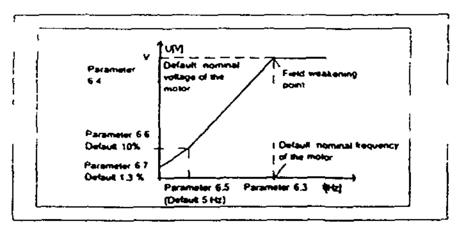


Figure 1.5-16 Programmable V/Hz curve

7 1 Response to reference faults

0 = No response
1 = Warning
2 = Fault, stop mode after fault detection according to parameter 4 7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA.
The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault detection according to parameter 4 7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3

The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2

7 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of motor phase currents is zero The standard overcurrent protection is always present and protects the drive from ground faults with high current levels

1

7 5 Motor thermal protection

Operation
- 0 = Not in use
- 1 = Warning
- 2 = Trip

The motor thermal protection protects the motor from overheating In the Standard application the thermal protection has fixed settings In other applications it is possible to set the thermal protection parameters A trip or a warning will give an indication on the display If trip is selected the drive will stop the motor and generate a fault

Deactivating the protection by setting the parameter to 0 will reset the internal thermal model to 0% heating

The SV9000 is capable of providing higher than nominal current to the motor If the load requires this high current there is a risk that motor will be thermally overloaded This is true especially at low frequencies With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor

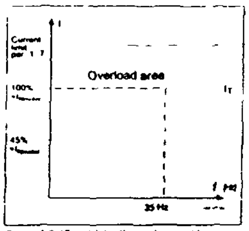


Figure 1 5-17 Motor thermal current I_T curve

The thermal current I_T specifies the load current above which the motor is overloaded See figure 1.5-17 If the motor current is over the curve the motor temperature is increasing

> CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7 6 Stall protection

Operation.
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

The Motor Stall protection provides a warning or a fault based on a short time overload of the motor e.g stalled shaft. The stall protection is faster than the motor thermal protection The stall state is defined with Stall Current and Stall Frequency In the Standard application they both have fixed values See figure 1.5-18 If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true If the stall lasts longer than 15 s a stall warning is given on the display panel. In the other applications it is possible to set the parameters of the Stall protection function. Tripping and warning will give a display indication If tripping is set on, the drive will stop and generate a fault.

1

Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero

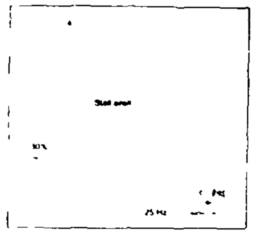


Figure 1 5 18 Stall state

8 1 Automatic restart number of tries

8 2 Automatic restart trial time

The Automatic restart function will restart the drive after the following faults

- overcurrent
- overvoltage
- undervoltage
- over/under temperature of the drive
- reference fault

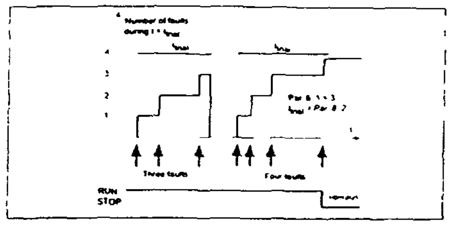


Figure 1 5-19 Automatic restart

Parameter 8 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2

The count time starts from the first autorestart. If the number of restarts does not exceed the value of the parameter 8 1 during the trial time, the count is cleared after the trial time has elapsed The next fault starts the counting again

1

8 3 Automatic restart, start function

The parameter defines the start mode
- *0 = Start with ramp*
- 1 = Flying start, see parameter 4 6

Notes

LOCAL/REMOTE CONTROL APPLICATION
(par 0 1 = 3)

CONTENTS

2

2 1 General

By utilizing the Local/Remote Control Application the use of two different contro and frequency reference sources s programmable The active control source is selected with digital input DIB6

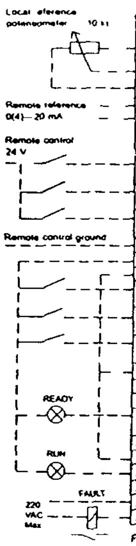
The Local/Remote Control Application can be activated from the Group 0 by setting the value of parameter 0 1 to 3

Basic connections of inputs and outputs are shown in the figure 2 2 1 The control signal logic is shown in the figure 2 3-1 Programming of I/O terminals is explained in chapter 2 5 Special parameters

2

2 2 Control I/O

NOTE! **Remember to connect the CMA and CMB inputs**



Terminal		Signal	Description
1	10Vref	Reference output	Voltage for a potentiometer etc
2	V_{in}	Analog input voltage (programmable)	Source B frequency reference range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I_{in}	Analog input current (programmable)	Source A frequency reference range 0—20 mA
5	I_{in}		
6	24V	Control voltage output	Voltage for switches, etc max 0 1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Source A Start forward (programmable)	Contact closed = start forward
9	DIA2	Source A Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or 24V
12	24V	Control voltage output	Voltage for switches (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Source B Start forward (programmable)	Contact closed = start forward
15	DIB5	Source B Start reverse (programmable)	Contact closed = start reverse
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I_{out}	Output frequency	Programmable (par 3. 1)
19	I_{out}	Analog output	Range 0—20 mA/R_L max 500 Ω
20	DO1	Digital output READY	Programmable (par 3. 6) Open collector I<50 mA, V<48 VDC
21	RO1	Relay output 1 RUN	Programmable (par 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3. 8)
25	RO2		
26	RO2		

Figure 2 2 1 Default I/O configuration and connection example of the Local/Remote Control Application

2 3 Control signal logic

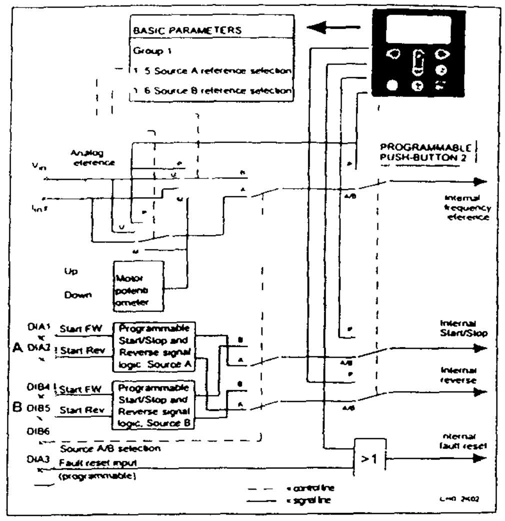


Figure 2 3 1 Control signal logic of the Local/Remote Control Application Switch positions shown are based on the factory settings

2

2 4 Basic parameters Group 1

2.4 1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			2-5
1 2	Maximum frequency	f_{min} 120/500 Hz	1 Hz	60 Hz			2 5
1 3	Acceleration time 1	0 1—3000 0 s	0 1 s	3.0 s		Time from f_{min} (1 1) to f_{max} (1 2)	2-5
1 4	Deceleration time 1	0 1—3000 0 s	0 1 s	3 0 s		Time from f_{max} (1 2) to f_{min} (1 1)	2-5
1.5	Source A reference signal ■	0—4	1	1		0 = Anal voltage input (term. 2) 1 = Anal current input (term 4) 2 = Set reference from the panel 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 is stopped	2-5
1 6	Source B reference signal ■	0—4	1	0		0 = Anal voltage input (term 2) 1 = Anal current input (term. 4) 2 = Set reference from the panel 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 unit is stopped	2 5
1 7	Current limit	0 1—2 5xI_{nSV}	0 1	1 5 x I_{nSV}		Output current limit(A) of the unit	2-5
1 8	V/Hz ratio selection ■	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	2 5
1 9	V/Hz optimization ■	0—1	1	0		0 = None 1 = Automatic torque boost	2 7
1 10	Nominal voltage of the motor ■	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	2-7
1 11	Nominal frequency of the motor ■	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	2-7
1 12	Nominal speed of the motor ■	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	2 7
1 13	Nominal current of the motor ■	2 5 x I_{nSV}	0 1 A	I_{nSV}		I_n from the nameplate of the motor	2 7
1 14	Supply voltage ■	208—240		230 V		Voltage code 2	2 7
		380—440		400 V		Voltage code 4	
		380—500		500 V		Voltage code 5	
		525—690		690 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters 0 = All parameter groups visible 1 = Only group 1 is visible	2 7
1 16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = Changes enabled 1 = Changes disabled	2 7

Table 2 4 1 Group 1 basic parameters

Note! ■ = Parameter value can be changed only when the drive is stopped

* If 1 2 > motor synchr speed check suitability for motor and drive system Selecting 120 Hz/500 Hz range see page 2 5

** Default value for a four pole motor and a nominal size SV9000

2

2 4 2 Description of Group 1 parameters

1 1 1 2 Minimum / maximum frequency

Defines the frequency limits of the drive

The default maximum value for parameters 1 1 and 1 2 is 120 Hz By setting the value of parameter 1 2 to 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz At the same time the resolution of the panel reference is changed from 0 01 Hz to 0 1 Hz

Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1 2 to 119 Hz while the drive is stopped.

1 3 1 4 Acceleration time1 deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) Acceleration/deceleration times can be reduced with a free analog input signal see parameters 2 18 and 2 19

1 5 Source A reference signal

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5 e g a transducer
2 Panel reference is the reference set from the Reference Page (REF) see chapter 7 5 in the User's Manual
3 The reference value is controlled by digital input signals DIA2 and DIA3
  switch in DIA2 closed = frequency reference increases
  switch in DIA3 closed = frequency reference decreases
  The speed range for the reference change can be set with the parameter 2 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par 2 14 or par 1 1 if par 2 15 = 0) each time the drive is stopped When the value of parameter 1 5 is set to 3 or 4 parameter 2 1 is automatically set to 4 and parameter 2 2 is automatically set to 10

1 6 Source B reference signal

See the values of the parameter 1 5

1 7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term Current limit can be set lower with a free analog input signal See parameters 2 18 and 2 19

1 8 V/Hz ratio selection

Linear 0 — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6 3) where a constant voltage (nominal value) is supplied to the motor See figure 2 4-1

A linear V/Hz ratio should be used in constant torque applications

This default setting should be used if there is no special requirement for another setting

Squared 1 — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6 3) where the nominal maximum voltage is supplied to the motor See figure 2 4 1

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed e g in centrifugal fans and pumps

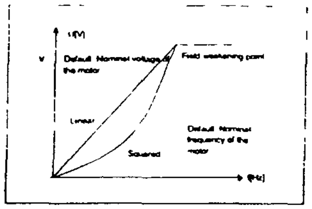


Figure 2 4-1 Linear and squared V/Hz curves

Programm V/Hz curve 2 — The V/Hz curve can be programmed with three different points The parameters for programming are explained in chapter 2 5 2
Programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application See figure 2 4 2

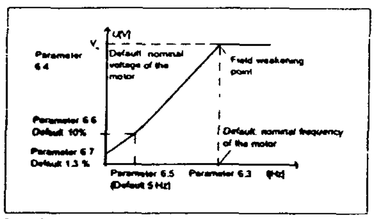


Figure 2 4-2 Programmable V/Hz curve

1 9 *V/Hz optimization*

Automatic torque boost — The voltage to the motor changes automatically which allows the motor to produce torque enough to start and run at low frequencies The voltage increase depends on the motor type and horsepower

Automatic torque boost can be used in applications where starting torque due to starting friction is high e g in conveyors

NOTE! *In high torque low speed applications it is likely the motor will overheat If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling of the motor Use external cooling for the motor if the temperature rise is too high*

1 10 **Nominal voltage of the motor**

Find this value V_n from the nameplate of the motor
This parameter sets the voltage at the field weakening point parameter 6 4 to 100% x V_{nmotor}

1 11 **Nominal frequency of the motor**

Find the nominal frequency f_n from the nameplate of the motor
This parameter sets the field weakening point parameter 6 3 to the same value

1 12 **Nominal speed of the motor**

Find this value n_n from the nameplate of the motor

1 13 **Nominal current of the motor**

Find the value I_n from the nameplate of the motor
The internal motor protection function uses this value as a reference value

1 14 **Supply voltage**

Set parameter value according to the nominal voltage of the supply
Values are pre-defined for voltage codes 2 4 5 and 6 See table 2 4 1

1 15 **Parameter conceal**

Defines which parameter groups are available

0 = all groups are visible
1 = only group 1 is visible

1 16 **Parameter value lock**

Defines access for changing the parameter values

0 = parameter value changes enabled
1 = parameter value changes disabled

If you have to adjust more of the functions of the Local/Remote Control Application, see chapter 2 5 to set up parameters of Groups 2—8

2.5 Special parameters, Groups 2—8

2.5.1 Parameter tables, Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.1	Source A Start/Stop logic selection	0—4	1	0		DIA1 / DIA2 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse 4 = Start forward / Motor pot. UP	2-15
2.2	DIA3 function (terminal 10)	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse (if par 2. 1 = 3) 6 = Jog speed 7 = Fault reset 8 = Acc/dec. operation prohibit 9 = DC-braking command 10 = Motor potentiometer DOWN	2-16
2.3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	2-17
2.4	V_{in} custom setting min.	0.00—100.00%	0.01%	0.00%			2-17
2.5	V_{in} custom setting max.	0.00—100.00%	0.01%	100.00%			2-17
2.6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	2-18
2.7	V_{in} signal filter time	0.00—10.00s	0.01s	0.10s		0 = No filtering	2-18
2.8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	2-19
2.9	I_{in} custom setting minim.	0.00—100.00%	0.01%	0.00%			2-19
2.10	I_{in} custom setting maxim.	0.00—100.00%	0.01%	100.00%			2-19
2.11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	2-19
2.12	I_{in} signal filter time	0.01—10.00s	0.01s	0.10s		0 = No filtering	2-19
2.13	Source B Start/Stop logic selection	0—3	1	0		DIB4 / DIB5 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	2-20
2.14	Source A reference scaling minimum value	0—par 2 15	1 Hz	0 Hz		Sets the frequency corresponding to the min. reference signal	2-20
2.15	Source A reference scaling maximum value	0—f_{max} (1. 2)	1 Hz	0 Hz		Sets the frequency corresponding to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	2-20
2.16	Source B reference scaling minimum value	0—par 2 17	1 Hz	0 Hz		Sets the frequency corresponding to the min. reference signal	2-20
2.17	Source B reference scaling maximum value	0—f_{max} (1 2)	1 Hz	0 Hz		Sets the frequency corresponding to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	2-20

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.18	Free analog input signal selection	0—2	1	0		0 = Not used 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	2-20
2.19	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par 1 7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervis. limit	2-20
2.20	Motor potentiometer ramp time	0 1—2000 0 Hz/s	0 1 Hz/s	10.0 Hz/s			2-22

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analog output function ■	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nmot}) 4 = Motor torque (0—2 x T_{nmot}) 5 = Motor power (0—2 x P_{nmot}) 6 = Motor voltage (0—100% x V_{nmot}) 7 = DC-link volt. (0—1000 V)	2-22
3.2	Analog output filter time	0.00—10.00 s	0.01 s	1.00 s			2-22
3.3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	2-22
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	2-22
3.5	Analog output scale	10—1000%	1%	100%			2-22
3.6	Digital output function ■	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 1 14 = Output frequency limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	2-23

Note! ■ = Parameter value can be changed only when the drive is stopped

2

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.7	Relay output 1 function	0—2	1	2		As parameter 3.6	2-23
3.8	Relay output 2 function	0—2	1	3		As parameter 3.6	2-23
3.9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3.10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			2-24
3.11	Output freq. limit 2 supervision function	0—2		0		0 = No 1 = Low limit 2 = High limit	2-24
3.12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			2-24
3.13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3.14	Torque limit supervision value	0.0—200.0% x T_{nSM}	0.1%	100.0%			2-24
3.15	Active reference limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3.16	Active reference limit supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			2-24
3.17	External brake OFF delay	0.0—100.0 s	0.1 s	0.5 s			2-25
3.18	External brake ON delay	0.0—100.0 s	0.1 s	1.5 s			2-25
3.19	Drive temperature limit supervision function	0—2		0		0 = No supervision 1 = Low limit 2 = High limit	2-25
3.20	Drive temperature limit	-10—+75°C	1	+40°C			2-25
3.21	I/O-expander board (opt.) analog output function	0—7	1	3		See parameter 3.1	2-22
3.22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01 s	1.00 s		See parameter 3.2	2-22
3.23	I/O-expander board (opt.) analog output inversion	0—	1	0		See parameter 3.3	2-22
3.24	I/O-expander board (opt.) analog output minimum	0—	1	0		See parameter 3.4	2-22
3.25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3.5	2-22

Note! ■ = Parameter value can be changed only when the drive is stopped

2

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	2-26
4.2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	2-26
4.3	Acceleration time 2	0 3000.0 s	0 s	[illegible]			2-2[illegible]
4.4	Deceleration time 2	0 1000.0 s	0	0 s			[illegible]
4.5	Brake chopper ■	0—2				0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	2-26
4.6	Start function	0		0		0 = Ramp 1 = Flying start	2-26
4.7	Stop function	0				0 = Coasting 1 = Ramp	2-27
4.8	DC braking current	0.15—1.5 x I_{nVS} (A)	0.1	0.5 x I_{nVS}			2-27
4.9	DC-braking time at Stop	0.00—250.00 s	0.01 s	0.00 s		0 = DC-brake is off at Stop	2-27
4.10	Turn on frequency of DC brake during ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			2-26
4.11	DC-brake time at Start	0.00—25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	2-28
4.12	Jog speed reference	f_{min}—f_{max}	0.1 Hz	10.0 Hz			2-29

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	f_{min}— par. 5.2	0.1 Hz	0.0 Hz			2-29
5.2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 1 is off	2-29
5.3	Prohibit frequency range 2 low limit	f_{min}— par. 5.4	0.1 Hz	0.0 Hz			2-29
5.4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 2 is off	2-29
5.5	Prohibit frequency range 3 low limit	f_{min}— par. 5.6	0.1 Hz	0.0 Hz			2-29
5.6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 3 is off	2-29

Note! ■ = Parameter value can be changed only when the drive is stopped

2

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode ■	0—1	1	0		0 = Frequency control 1 = Speed control	2-29
6.2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6 kHz		Depends on Hp rating	2-29
6.3	Field weakening point ■	30—500 Hz	1 Hz	Param. 1.11			2-29
6.4	Voltage at field weakening point ■	15—200% x V_{nmot}	1%	100%			2-29
6.5	V/Hz-curve mid point frequency ■	0.0—f_{max}	0.1 Hz	0.0 Hz			2-30
6.6	V/Hz-curve mid point voltage ■	0.00—100.00 % x V_{nmot}	0.01%	0.00%			2-30
6.7	Output voltage at zero frequency ■	0.00—100.00 % x V_{nmot}	0.01%	0.00%			2-30
6.8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	2-30
6.9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	2-30

Note! ■ = Parameter value can be changed only when the drive is stopped

2

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	2-30
7.2	Response to external fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	2-31
7.3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	2-31
7.4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	2-31
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	2-32
7.6	Motor thermal protection break point current	50.0—150.0% x I_{nMOTOR}	1.0%	100.0%			2-32
7.7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0%	45.0%			2-32
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	2-33
7.9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			2-33
7.10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	2-34
7.11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			2-34
7.12	Stall time	2.0—120.0 s	1.0 s	15.0 s			2-34
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			2-34
7.14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	2-35
7.15	Underload prot., field weakening area load	10.0—150.0% x T_{nMOTOR}	1.0%	50.0%			2-35
7.16	Underload protection zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			2-35
7.17	Underload time	2.0—600.0 s	1.0 s	20.0s			2-36

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8.1	Automatic restart number of tries	0—10	1	0		0 = Not in use	2 36
8.2	Automatic restart multi attempt maximum trial time	1—6000 s	1 s	30 s			2 36
8.3	Automatic restart start function	0—1	1	0		0 = Ramp 1 = Flying start	2 37
8.4	Automatic restart of undervoltage	0—1		0		0 = No 1 = Yes	2 37
8.5	Automatic restart of overvoltage	0—1	1	0		0 = No 1 = Yes	2 37
8.6	Automatic restart of overcurrent	0—1	1	0		0 = No 1 = Yes	2 37
8.7	Automatic restart of reference fault	0—1	1	0		0 = No 1 = Yes	2 37
8.8	Automatic restart after over/undertemperature fault	0—1	1	0		0 = No 1 = Yes	2 37

Table 2 5-1 Special parameters Groups 2—8

2.5.2 Description of Groups 2—8 parameters

2.1 Start/Stop logic selection

0 DIA1 closed contact = start forward
DIA2 closed contact = start reverse
See figure 2 5-1

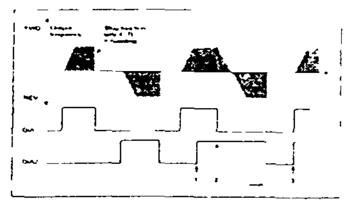


Figure 2 5-1 Start forward/Start reverse

(1) The first selected direction has the highest priority
(2) When DIA1 contact opens the direction of rotation starts to change
(3) *If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously* the Start forward signal (DIA1) has priority

1 DIA1 closed contact = start open contact = stop
DIA2 closed contact = reverse open contact = forward
See figure 2 5-2

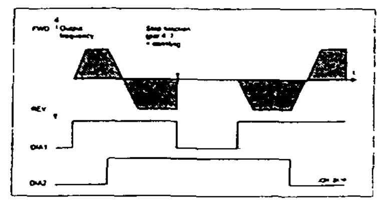


Figure 2 5-2 Start, Stop reverse

2: DIA1 closed contact = start open contact = stop
DIA2 closed contact = start enabled open contact = start disabled

3: 3-wire connection (pulse control)
DIA1 closed contact = start pulse
DIA2 closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 2 5-3

4: DIA1 closed contact = start forward
DIA2 closed contact = reference increases (motor potentiometer reference, par 2 1 is automatically set to 4 if par 1. 5 is set to 3 or 4).

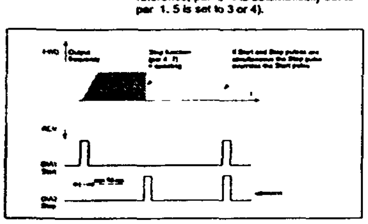


Figure 2.5-3 Start pulse /Stop pulse

2. 2 DIA3 function

1: External fault, closing contact = Fault is shown and drive responds according to parameter 7.2
2: External fault, opening contact = Fault is shown and drive responds according to parameter 7.2
3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled
4: Acc. / Dec time select contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected
5: *Reverse* contact open = *Forward* contact closed = Reverse — *Can be used for reversing if* parameter 2 1 has value 3
6: Jog freq. contact closed = Jog frequency selected for freq refer
7: Fault reset contact closed = Resets all faults
8: Acc./Dec. operation prohibited contact closed = *Stops acceleration and deceleration until* the contact is opened
9: DC-braking command contact closed = In the stop mode, the DC-braking operates until the contact is opened, see figure 2 5-4 Dc-brake current is set with parameter 4 8
10 Motor pot. meter down contact closed = Reference decreases until the contact is opened

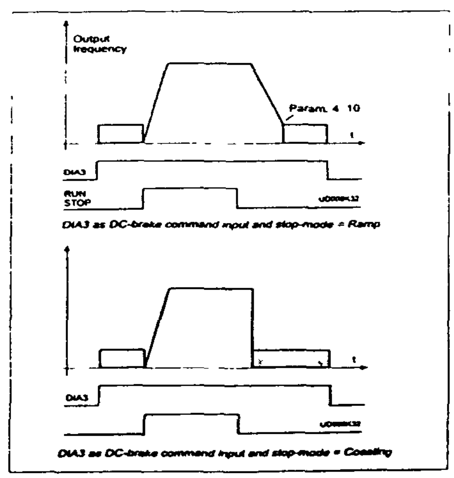


Figure 2 5-4 DIA3 as DC-brake command input: a) Stop-mode = Ramp, b) Stop-mode = Coasting

2 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par 2. 4) to custom maximum (par 2 5)

2.4-2.5 V_{in} custom setting minimum/maximum

With these parameters you can set V_{in} for any input signal span within 0—10 V

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2 4 press the Enter button
Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2. 5 press the Enter button

Note! *The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)*

2

2 6 V_{in} signal inversion

V_{in} is source B frequency reference par 1 6 1 (default)

Parameter 2 6 = 0 no inversion of analog V_{in} signal

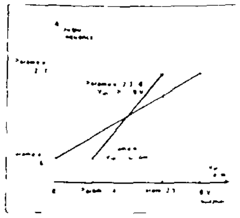


Figure 2 5-5 V_{in} no signal inversion

Parameter 2 6 = 1 inversion of analog V_{in} signal
max V_{in} signal = minimum set speed
min V_{in} signal = maximum set speed

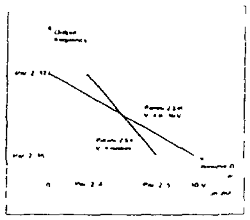


Figure 2 5-6 V_{in} signal inversion

2 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal. A long filtering time makes drive response slower. See figure 2 5-7

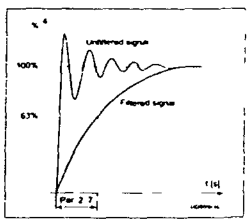


Figure 2 5 7 V_{in} signal filtering

2

2 8 Analog input I_{in} signal range

0 0—20 mA
1 4—20 mA
2 Custom signal span

See figure 2 5-8

2 9 / 2 10 Analog input I_{in} custom setting minimum/maximum

With these parameters you can scale the input current to correspond to a minimum and maximum frequency range. See figure 2 5-8

Minimum setting
Set the I_{in} signal to its minimum level, select parameter 2 9, press the Enter button
Maximum setting
Set the I_{in} signal to its maximum level, select parameter 2 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

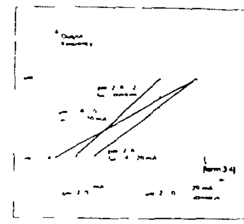


Figure 2 5 8 Analog input I_{in} scaling

2 11 Analog input I_{in} inversion

I_{in} is source A frequency reference par 1 5 0 (default)

Parameter 2 11 0 no inversion of I_{in} input
Parameter 2 11 1 inversion of I_{in} input. See figure 2 5 9

max I_{in} signal minimum set speed

min I_{in} signal maximum set speed

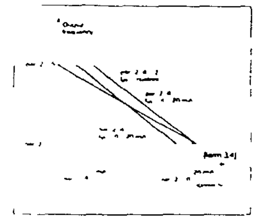


Figure 2 5-9 I_{in} signal inversion

2 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes drive response slower.
See figure 2 5-10

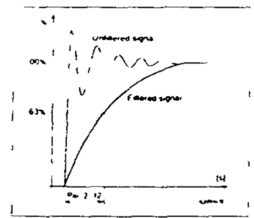


Figure 2 5 10 Analog input I_{in} filter time

2

2 13 Source B Start/Stop logic selection
See parameter 2. 1 settings 0—3

2 14 / 2 15 Source A reference scaling minimum value/maximum value
Setting limits. 0 < par 2. 14 < par 2 15 < par 1 2
If par 2 15 = 0 scaling is set off. See figures 2 5-11 and 2 5-12

(In the figures below voltage input Vin with signal range 0—10 V selected for source A reference)

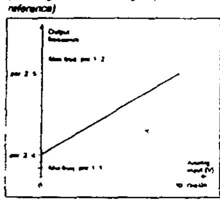


Figure 2 5-11 Reference scaling

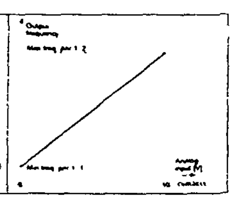


Figure 2 5-12 Reference scaling par 2 15 = 0

2 16 / 2 17 Source B reference scaling minimum value/maximum value
See parameters 2 14 and 2 15

2 18 Free analog input signal
Selection of input signal of a free analog input (an input not used for reference signal)

0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2 19 Free analog input signal function

Use this parameter to select a function for a free analog input signal:

0 = Function is not used
1 = Reducing motor current limit (par 1 7)

This signal will adjust the maximum motor current between 0 and par 1 7 set max limit. See figure 2 5-13

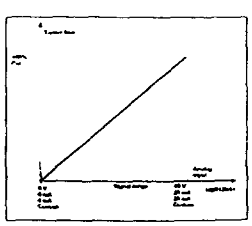


Figure 2 5-13 Scaling of max motor current

2

2 = Reducing DC brake current

The DC braking current can be reduced with the free analog input signal between current 0 15 x I_{nSV9} and the current set by parameter 4 8. See figure 2 5-14

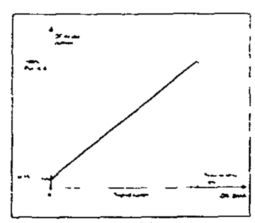


Figure 2 5-14 Reducing DC brake current

3 = Reducing acceleration and deceleration times

The acceleration and deceleration times can be reduced with the free analog input signal according to the following formulas

Reduced time = set acc./decel time (par 1 3, 1 4, 4 3, 4 4) divided by the factor R from figure 2 5-15

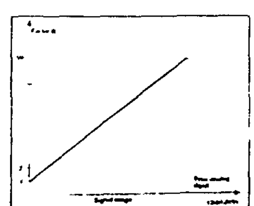


Figure 2 5-15 Reducing acceleration and deceleration times.

4 = Reducing torque supervision limit

Torque supervision limit can be reduced with a free analog input signal between 0 and the set supervision limit (par 3 14). See figure 2 5-16

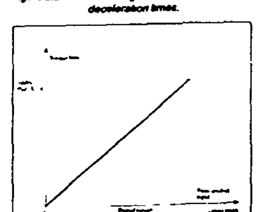


Figure 2 5-16 Reducing torque supervision limit

2 20 **Motor potentiometer ramp time**

Defines how fast the electronic motor potentiometer value changes

3 1 **Analog output Content**

See table for parameter 3 1 on page 2 9

3 2 **Analog output filter time**

Filters the analog output signal
See figure 2 5-17

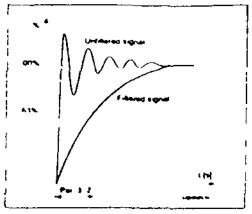


Figure 2 5-17 Analog output filtering

3 3 **Analog output invert**

Inverts analog output signal
max output signal = minimum set value
min output signal = maximum set value

3 4 ***Analog output minimum***

Defines the signal minimum to be either 0 mA or 4 mA
See figure 2 5-19

3 5 **Analog output scale**

Scaling factor for analog output
See figure 2.5-19

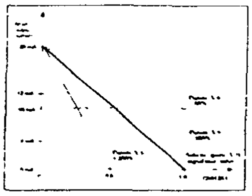


Figure 2 5-18 Analog output invert.

Signal	Max value of the signal
Output frequency	Max frequency (p 1 2)
Motor speed	Max speed ($n_n x f_{max}/f_n$)
Output current	$2 \times I_{nSV9}$
Motor torque	$2 \times T_{nMot}$
Motor power	$2 \times P_{nMot}$
Motor voltage	$100\% \times V_{nMot}$
DC-link volt	1000 V

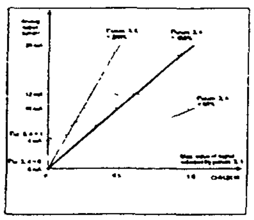


Figure 2 5-19 Analog output scale

3 6 **Digital output function**
3 7 **Relay output 1 function**
3 8 **Relay output 2 function**

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 9 and 3 10)
14 = Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 11 and 3. 12)
15 = Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par 3. 13 and 3. 14)
16 = Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with prog pushbutton #2
19 = Drive temperature limit supervision	Temperature on drive is outside the set supervision limits (par 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par 3 17 and 3 18) output active when brake control is OFF

Table 2 5-2 Output signals via DO1 and output relays RO1 and RO2

3 9 **Output frequency limit 1, supervision function**
3 11 **Output frequency limit 2, supervision function**

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8

3. 10 **Output frequency limit 1, supervision value**
3. 12 **Output frequency limit 2, supervision value**

The frequency value to be supervised by the parameter 3. 9 (3 11) See figure 2 5-20.

3. 13 **Torque limit , supervision function**

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3.14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8

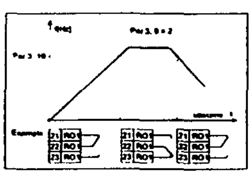


Figure 2.5-20 Output frequency supervision

3. 14 **Torque limit , supervision value**

The calculated torque value to be supervised by the parameter 3. 13. Torque supervision value can be reduced below the setpoint with a free analog input signal, see parameters 2. 18 and 2. 19

3 15 **Reference limit , supervision function**

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8. The supervised reference is the current active reference It can be source A or B reference depending on DIB6 input or panel reference if panel is the active control source

3. 16 **Reference limit , supervision value**

The frequency value to be supervised by the parameter 3. 15.

3 17 **External brake-off delay**
3 18 **External brake-on delay**

The function of the external brake can be delayed from the start and stop control signals with these parameters See figure 2 5-21

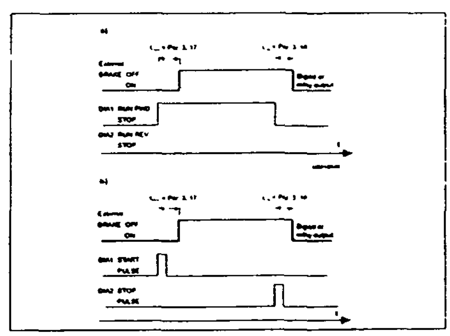


Figure 2 5-21 Ext. brake control: a) Start/Stop logic selection par 2. 1 = 0, 1 or 2
b) Start/Stop logic selection par 2. 1 = 3

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2 see parameters 3. 6—3. 8.

3 19 **Drive temperature limit supervision**

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If temperature of the unit goes under/over the set limit (par 3 20) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3. 8

3 20 **Drive temperature supervision limit value**

The set temperature value to be supervised with the parameter 3. 19

4 1 Acc/Dec ramp 1 shape
4 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters

Setting the value = 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3 4 4 for Acc/Dec time 2)

Setting 0 1—10 seconds for 4 1 (4 2) causes an S shaped ramp The speed changes are smooth Parameter 1 3/ 1 4 (4 3/ 4 4) determines the ramp time of the acceleration/deceleration in the middle of the curve See figure 2 5-22

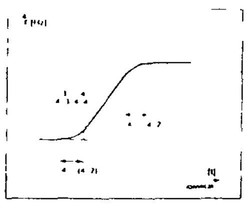


Figure 2 5-22 S shaped acceleration/deceleration

4 3 Acceleration time 2
4 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) With this parameter it is possible to set two different acceleration/deceleration times for one application The active set can be selected with the programmable signal DIA3 See parameter 2 2 Acceleration/deceleration times can be reduced with a free analog input signal See parameters 2 18 and 2 19

4 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual

4 6 Start function

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may cause prolonged acceleration times)

Flying start

1 The drive starts into a running motor by first finding the speed the motor is running at Searching starts from the maximum frequency down until the actual frequency reached The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 Stop function

Coasting
0 The motor coasts to an uncontrolled stop with the SV9000 off after the Stop command

Ramp
1 After the Stop command the speed of the motor is decelerated based on the deceleration ramp time parameter

If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration

4 8 DC braking current

Defines the current injected into the motor during DC braking
The DC braking current can be reduced from the setpoint with a external free analog input signal, see parameters 2 18 and 2 19

4 9 DC braking time at stop

Determines whether DC braking is ON or OFF It also determines the braking duration time of the DC-brake when the motor is stopping The function of the DC-brake depends on the stop function parameter 4 7 See figure 2 5-23

0 DC-brake is not used

>0 DC brake is in use and its function depends of the stop function (parameter 4 7) The time is set by the value of parameter 4 9

<u>Stop-function = 0 (coasting).</u>

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection, the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is ≥ nominal frequency of the motor (par 1 11), the value of parameter 4 9 determines the braking time When the frequency is ≤ 10% of the nominal the braking time is 10% of the set value of parameter 4 9 See figure 2 5-13

<u>Stop-function = 1 (ramp).</u>

After a Stop command the speed of the motor is reduced based on the deceleration ramp parameter If no regeneration occurs due to load inertia DC braking starts at a speed defined by parameter 4 10

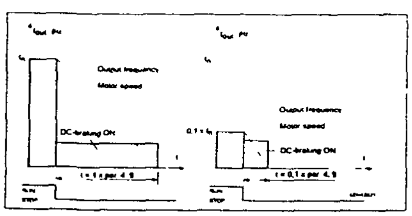


Figure 2 5-23 DC-braking time when par 4 7 = 0

The braking time is defined by par 4 9 If the load has a high inertia, use an external braking resistor for faster deceleration. See figure 2 5-24

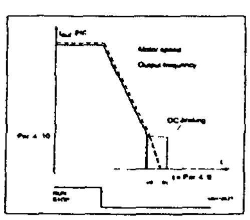


Figure 2.5-24 DC-braking time when par 4. 7 = 1

4 10 Execute frequency of DC-brake during ramp Stop

See figure 2 5-24

4 11 DC-brake time at start

0 DC-brake is not used

>0 The DC-brake is activated by the start command given. This parameter defines the time before the brake is released After the brake is released the output frequency increases according to the set start function parameter 4 6 and the acceleration parameters (1 3, 4 1 or 4 2 4 3) See figure 2 5-25

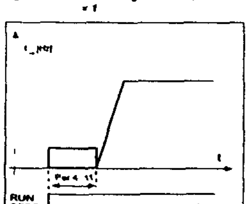


Figure 2 5-25 DC-braking time at start

4 12 Jog speed reference

This parameter value defines the jog speed if the DIA3 digital input is programmed for Jog and is selected See parameter 2 2

5 1 5 6 Prohibit frequency area Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems

With these parameters it is possible to set limits for three "skip frequency" regions between 0 Hz and 500 Hz The accuracy of the setting is 0 1 Hz. See figure 2 5-26

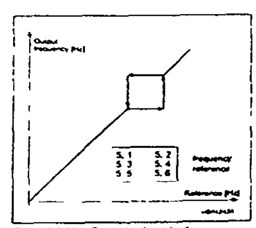


Figure 2 5-26 Example of prohibit frequency area setting

6 1 Motor control mode

0 = Frequency control (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq resolution 0 01 Hz)
1 = Speed control (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%)

6 2 Switching frequency

Motor noise can be minimized by using a high switching frequency Increasing the switching frequency reduces the current capacity of the SV9000

Before changing the frequency from the factory default 10 kHz (3 6 kHz >40 Hp) check the drive derating in the curves shown in figures 5 2 2 and 5 2 3 in chapter 5 2 of the User's Manual

6 3 Field weakening point
6 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (parameter 6 4) Above that frequency the output voltage remains constant at the set maximum value Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1 8 1 9 6 5 6 6 and 6 7 See figure 1.5-16

When the parameters 1 10 and 1 11, nominal voltage and nominal frequency of the motor are set, parameters 6 3 and 6 4 are also set automatically to the same values If you need different values for the field weakening point and the maximum output voltage change these parameters <u>after</u> setting parameters 1 10 and 1 11

6 5 **V/Hz curve middle point frequency**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle frequency point of the curve See figure 2 5-27

6 6 **V/Hz curve, middle point voltage**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle point voltage (% of motor nominal voltage) of the curve See figure 2 5-27

6 7 **Output voltage at zero frequency**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage (% of motor nominal voltage) of the curve See figure 2 5-27

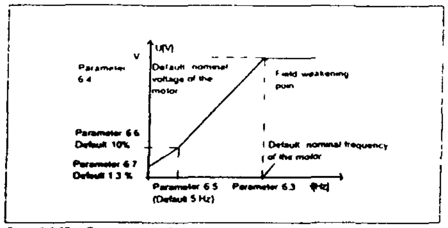


Figure 2 5-27 Programmable V/Hz curve

6 8 **Overvoltage controller**
6 9 **Undervoltage controller**

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than 15%—+10% and the application requires a constant speed If the controllers are ON they will change the motor speed in over/undervoltage cases Overvoltage = faster undervoltage = slower

Over/undervoltage trips may occur when controllers are not used

7 1 **Response to the reference fault**

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 **Response to external fault**

0 = No response
1 = Warning
2 = Fault stop mode after fault according to parameter 4 7
3 = Fault always coasting stop mode after fault detection

A warning or a fault action and message is generated from the external fault signal on digital input DIA3 The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2

7 3 **Phase supervision of the motor**

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current

7 4 **Ground fault protection**

0 - No action
2 - Fault message

Ground fault protection ensures that the sum of the motor phase currents is zero The standard overcurrent protection is always present and protects the frequency converter from ground faults with high current levels

Parameters 7 5—7 9 Motor thermal protection

General

Motor thermal protection protects the motor from overheating The SV9000 drive is capable of supplying higher than nominal current to the motor If the load requires this high current there is a risk that motor will be thermally overloaded This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with a separately powered external fan, the load derating at low speed is small

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor When the motor is powered from the drive, the calculated model uses the heatsink temperature to determine the initial thermal state of the motor The calculated model assumes that the ambient temperature of the motor is 40°C

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded This current level is a function of the output frequency The curve for I_T is set with parameters 7 6 7 7 and 7 9 See figure 2 5-28 The default values of these parameters are set from the motor nameplate data

With the output current at I_T the thermal state will reach the nominal value (100%) The thermal state changes by the square of the current. With output current at 75% of I_T the thermal state will reach 56% and with output current at 120% of I_T the thermal stage would reach 144% The function will trip the drive (refer par 7 5) if the thermal state reaches a value of 105% The response time of the thermal model is determined by the time constant parameter 7 8 The larger the motor, the longer it takes to reach the final temperature

The thermal state of the motor can be monitored through the display Refer to the table for monitoring items. (User's Manual, table 7 3-1)

CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7 5 **Motor thermal protection**

Operation
0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is selected the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0, will reset the thermal stage of the motor to 0%

7 6 **Motor thermal protection, break point current**

This current can be set between 50 0—150 0% x I_{nMotor}
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve Refer to the figure 2.5-28

The value is set as a percentage of the motor nameplate nominal current , parameter 1. 13, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct online use without being overheated.

If parameter 1 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

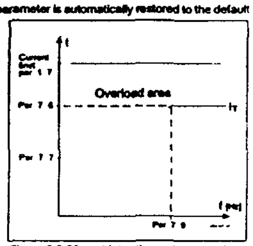


Figure 2 5-28 Motor thermal current, I_T curve

7 7 **Motor thermal protection, zero frequency current**

This current can be set between 10.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at zero frequency Refer to the figure 2.5-28

The default value is set assuming that there is no external fan cooling the motor If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage of the motor's nominal nameplate current parameter 1 13 not the drive's nominal output current The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated

If you change parameter 1 13 this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect to the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

7 8 **Motor thermal protection, time constant**

This time can be set between 0.5—300 minutes
This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1 12 and 1 13. If either of these parameters is reset, then this parameter is set to default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to $2xt_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is stopped the time constant is internally increased to three times the set parameter value Cooling in the stop stage is based on convection with an increased time constant

7 9 **Motor thermal protection, break point frequency**

This frequency can be set between 10—500 Hz.
This is the frequency break point of the thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant Refer to the figure 2 5-28

The default value is based on the motor's nameplate data, parameter 1 11 It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor More generally it is 70% of the frequency at the field weakening point (parameter 6. 3). Changing either parameter 1 11 or 6 3 will restore this parameter to its default value

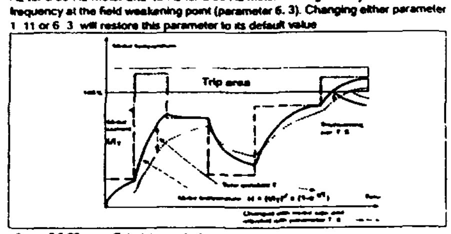


Figure 2 5-29 Calculating motor temperature

Parameters 7 10— 7 13 Stall protection

General

Motor stall protection protects the motor from short time overload situations like a stalled shaft The reaction time of stall protection can be set shorter than with motor thermal protection The stall state is defined with two parameters 7 11 Stall Current and 7 13 Stall Frequency If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true There is no true detection of shaft rotation Stall protection is a type of overcurrent protection

2

7 10 Stall protection

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is set on the drive will stop and generate a fault Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero

7 11 Stall current limit

The current can be set between 0 0—200% x I_{nMotor}

In a stall the current has to be above this limit See figure 2 5-30 The value is set as a percentage of the motor name-plate nominal current, parameter 1 13 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

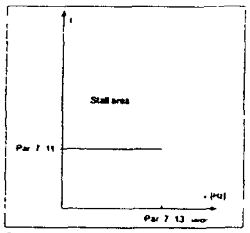


Figure 2 5-30 Setting the stall characteristics

7 12 Stall time

The time can be set between 2 0—120 s

This is the maximum allowed time for a stall There is an internal up/down counter to count the stall time See figure 2 5-31 If the stall time counter value goes above this limit, this protection will cause a trip (refer to the parameter 7 10)

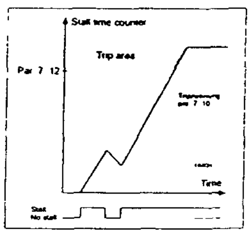


Figure 2 5-31 Counting the stall time

7 13 Maximum stall frequency

This frequency can be set between 1—f_{max} (param 1 2) In the stall state the ouput frequency has to be smaller than this limit See figure 2 5-30

Parameters 7 14— 7 17 Underload protection

General

The purpose of motor underload protection is to ensure there is a load on the motor while the drive is running If the motor load is reduced there might be a problem in the process e g broken belt or dry pump

Motor underload protection can be adjusted by setting the underload curve with parameters 7 15 and 7 16 The underload curve is a squared curve set between zero frequency and the field weakening point The protection is not active below 5Hz (the underload counter value is stopped) See figure 2 5 32

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor The motor s nameplate data parameter 1 13 the motor's nominal current and the drive s nominal current I_{CT} are used to create the scaling ratio for the internal torque value If other than a standard motor is used with the drive the accuracy of the torque calculation is decreased

2

7 14 Underload protection

Operation

0 = Not in use
1 = Warning message
2 = Fault message

Tripping and warning will give a display indication with the same message code If tripping is set active the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0 will reset the underload time counter to zero

7 15 Underload protection, field weakening area load

The torque limit can be set between 20 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point Refer to the figure 2 5-32 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

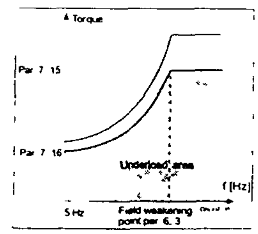


Figure 2 5-32 Setting of minimum load

7 16 Underload protection zero frequency load

The torque limit can be set between 10 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque with zero frequency See figure 2 5-32 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

7 17 Underload time

This time can be set between 2 0—600 0 s.

This is the maximum allowed time for an underload state There is an internal up/down counter to accumulate the underload time See figure 2.5-33 If the underload counter value goes above this limit, the underload protection will cause a trip (refer to the parameter 7 14) If the drive is stopped the underload counter is reset to zero

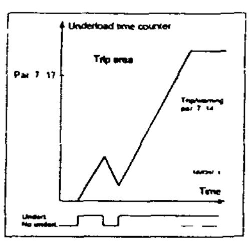


Figure 2 5-33 Counting the underload time

2

8 1 Automatic restart: number of tries
8 2 Automatic restart trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8 4—8 8 The Start type for Automatic restart is selected with parameter 8 3 See figure 2 5-34

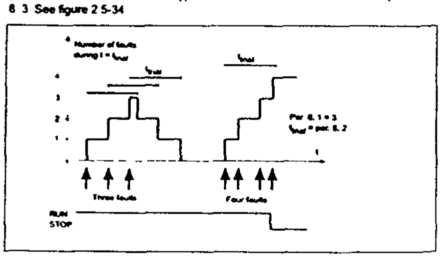


Figure 2 5-34 Automatic restart

Parameter 8 1 determines how many automatic restarts can be made during the trial time set by the parameter 8 2

The count time starts from the first autorestart If the number of restarts does not exceed the value of parameter 8 1 during the trial time the count is cleared after the trial time has elapsed The next fault starts the counting again

8 3 Automatic restart, start function

The parameter defines the start mode

0 = Start with ramp
1 = Flying start, see parameter 4 6

8 4 Automatic restart after undervoltage

0 = No automatic restart after undervoltage fault
1 = Automatic restart after undervoltage fault condition returns to normal (DC-link voltage returns to the normal level)

2

8 5 Automatic restart after overvoltage

0 = No automatic restart after overvoltage fault
1 = Automatic restart after overvoltage fault condition returns to normal (DC-link voltage returns to the normal level)

8 6 Automatic restart after overcurrent

0 = No automatic restart after overcurrent fault
1 = Automatic restart after overcurrent faults

8 7 Automatic restart after reference fault

0 = No automatic restart after reference fault
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8 8 Automatic restart after over-/undertemperature fault

0 = No automatic restart after temperature fault
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C

Notes

MULTI STEP SPEED CONTROL APPLICATION
(par 0 1 4)

CONTENTS

3.1 GENERAL

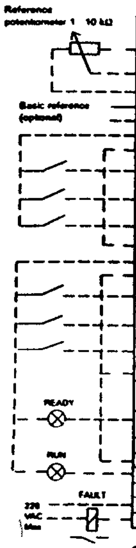
The Multi-step Speed Control Application can be used in applications where fixed speeds are needed in total 9 different speeds can be programmed: one basic speed, 7 multi-step speeds and one jog speed. The speed steps are selected with digital signals DIB4 DIB5 and DIB6 If jog speed is used DIA3 can be programmed from fault reset to jog speed select.

The basic speed reference can be either a voltage or a current signal via analog input terminals (2/3 or 4/5) The other analog input can be programmed for other purposes

All outputs are freely programmable

* NOTE! Remember to connect the CMA and CMB inputs.

3.2 CONTROL I/O



Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	V$_{in}$+	Input for reference voltage	Basic reference (programmable), range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I$_{in}$+	Input for reference current	Basic reference (programmable)
5	I$_{in}$-		range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start forward (Programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (Programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	sel 1 sel 2 sel 3 0 0 0 basic speed
15	DIB5	Multi-step speed select 2	1 0 0 speed 1 0 1 0 speed 2
16	DIB6	Multi-step speed select 3	1 1 1 speed 7
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I$_{out}$+	Analog output	Programmable (par 3. 1)
19	I$_{out}$-	Output frequency	Range 0—20 mA/R$_L$ max. 500 Ω
20	DO1	Digital output READY	Programmable (par 3. 6) Open collector I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 RUN	Programmable (par 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3 8)
25	RO2		
26	RO2		

Figure 3.2-1 Default I/O configuration and connection example of the Multi-step speed Control Application

3 3 Control signal logic

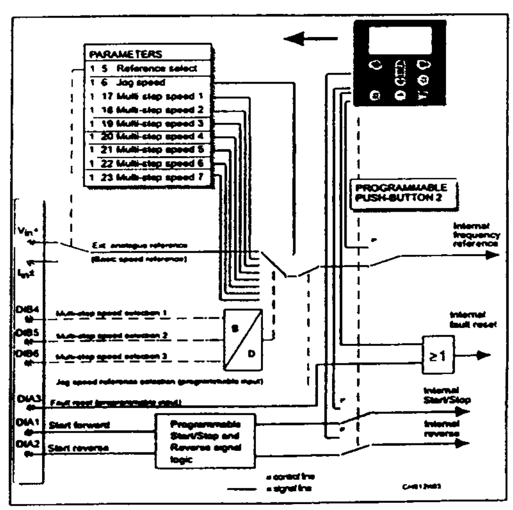


Figure 3 3 1 Control signal logic of the Multi-step Speed Control Application. Switch positions shown are based on the factory settings

3

3 4 Basic parameters Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1	Minimum frequency	0 f_{max}	1 Hz	0 Hz			3 5
1 2	Maximum frequency	f_{min} 120/500Hz	1 Hz	60 Hz		—	3 5
1 3	Acceleration time 1	0 1 3000 0 s	0 1 s	3 0 s		Time from f_{min} (1 1) to f_{max} (1 2)	3 5
1 4	Deceleration time	0 1 3000 0 s	0 1 s	3 0 s		Time from f_{max} (1 2) to f_{min} (1 1)	3 5
1 5	Basic reference selection	0		0		0 Analog voltage input term 2 1 Analog current input term 4	3 5
1 6	Jog speed reference	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	5 0 Hz			3 5
1 7	Current limit	0 1 2 5 x $I_{n SV9}$	0 1A	1 5 x $I_{n SV9}$		Output current limit [A] of the unit	3-5
1 8	V/Hz ratio selection	0- 2	1	0		0 = Linear 1 Squared 2 = Programmable V/Hz ratio	3-6
1 9	V/Hz optimization	0—1	1	0		0 None 1 = Automatic torque boost	3 7
1 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	3 7
1 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	3 7
1 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	3 7
1 13	Nominal current of the motor	2 5 x $I_{n SV9}$	0 1 A	$I_{n SV9}$		I_n from the nameplate of the motor	3 7
1 14	Supply voltage	208—240		230 V		Voltage code 2	3 7
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters 0 = all parameter groups visible 1 = only group 1 is visible	3-7
1 16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = changes enabled 1 = changes disabled	3 7

Note! [icon] = Parameter value can be changed only when the frequency converter is stopped

* If 1 2 > motor synchr speed check suitability for motor and drive system
Selecting 120/500 Hz range see page 3 5

** Default value for a four pole motor and a nominal size SV9000

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 17	Multi step speed reference 1	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	10 0 Hz			3 7
1 18	Multi step speed reference 2	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	15 0 Hz			3 7
1 19	Multi step speed reference 3	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	20 0 Hz			3 7
1 20	Multi step speed reference 4	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	25 0 Hz			3 7
1 21	Multi step speed reference 5	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	30 0 Hz			3 7
1 22	Multi step speed reference 6	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	40 0 Hz			3 7
1 23	Multi step speed reference 7	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	50 0 Hz			3 7

Table 3 4 1 Group 1 basic parameters

3

3 4 2 Description of Group 1 parameters

1 1 1 2 Minimum/maximum frequency

Defines the frequency limits of the SV9000

The default maximum value for parameters 1 1 and 1 2 is 120 Hz By setting 1 2 120 Hz in the when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz. At the same time the resolution of the panel reference is changed from 0 01 Hz to 0 1 Hz
Changing the max value from 500 Hz to 120 Hz is done by setting parameter 1 2 to 119 Hz while the drive is stopped

1 3 1 4 Acceleration time 1 deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) Acceleration/deceleration times can be reduced with a free analog input signal see parameters 2 18 and 2 19

1 5 Basic reference selection

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5 e g a transducer

1 6 Jog speed refrence

The value of this parameter defines the jog speed selected with the DIA3 digital input which if it is programmed for Jog speed See parameter 2 2

Parameter value is automatically limited between minimum and maximum frequency (par 1 1 1 2)

1 7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term Current limit can be set lower with a free analog input signal see parameters 2 18 and 2 19

1 8 *V/Hz ratio selection*

Linear 0 — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6. 3) where a constant voltage (nominal value) is supplied to the motor See figure 3 4-1

A linear V/Hz ratio should be used in constant torque applications

This default setting should be used if there is no special requirement for another setting

Squared 1 — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6 3), where the nominal voltage is supplied to the motor See figure 3 4 1

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed e g in centrifugal fans and pumps

3

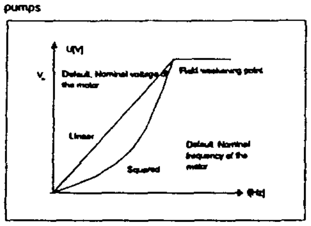


Figure 3.4 1 Linear and squared V/Hz curves

Programm V/Hz curve 2 — The V/Hz curve can be programmed with three different points The parameters for programming are explained in chapter 3 5 2
A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 3 4-2

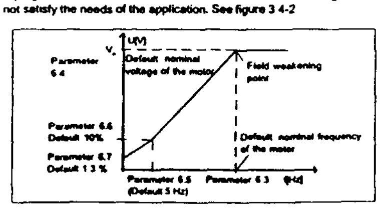


Figure 3 4 2 Programmable V/Hz curve

1 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which allows the motor to produce enough torque to start and run at low frequencies. The voltage increase depends on the motor type and horsepower Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g in conveyors

NOTE! In high torque low speed applications it is likely the motor will overheat

If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the temperature rise is too high

1 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor
This parameter sets the voltage at the field weakening point parameter 6 4 to 100% x V_{nmotor}

3

1 11 Nominal frequency of the motor

Find then nominal frequency f_n from the nameplate of the motor
This parameter sets the field weakening point, parameter 6. 3, to the same value

1 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor
The internal motor protection function uses this value as a reference value

1 14 Supply voltage

Set parameter value according to the nominal voltage of the supply
Values are pre-defined for voltage codes 2 4 5 and 6. See table 3 4-1

1 15 Parameter conceal

Defines which parameter groups are available

0 = all parameter groups are visible
1 = only group 1 is visible

1 16 Parameter value lock

Defines access to the changes of the parameter values.

0 = parameter value changes enabled
1 = parameter value changes disabled

1 17 1 23 Multi-step speed reference 1—7

These parameter values define the Multi-step speeds selected with the DIA4 DIB5 and DIB6 digital inputs

These values are automatically limited between minimum and maximum frequency (par 1 1 1 2)

Speed reference	Multi step speed select 1 DIB4	Multi step speed select 2 DIB5	Multi step speed select 3 DIB6
Par 1 6	0	0	0
Par 1 17	1	0	0
Par 1 18	0	1	0
Par 1 19	1	1	0
Par 1 20	0	0	1
Par 1 21	1	0	1
Par 1 22	0	1	1
Par 1 23	1	1	1

Table 3 4-2 Selection of multi step speed reference 1—7

3 5 Special parameters Groups 2—8

3 5 1 Parameter tables

Input signal parameters Group 2

Code	Parameter	Range	Step	Default	Custom	Description	Page
2 1	Start/Stop logic selection	0 3		0		DIA1 / DIA2 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	3-15
2 2	DIA3 function (terminal 10)	0 9		7		0 = Not used 1 = Ext fault closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /Dec time selection 5 = Reverse (if par 2 1 = 3) 6 = Jog speed 7 = Fault reset 8 = Acc /Dec operation prohibit 9 = DC-braking command	3-16
2 3	V_{in} signal range	0—1	1	0		0 = 0 — 10 V 1 = Custom setting range	3-17
2 4	V_{in} custom setting min.	0 00-100 00%	0 01%	0 00%			3-17
2 5	V_{in} custom setting max	0 00-100 00%	0 01%	100 00%			3-17
2 6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-18
2 7	V_{in} signal filter time	0 00 — 10 0 s	0 01s	0 10 s		0 = No filtering	3-18
2 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	3-19
2 9	I_{in} custom setting minim.	0 00-100 00%	0 01%	0 00%			3-19
2 10	I_{in} custom setting maxim.	0 00-100 00%	0 01%	100 00%			3-19
2 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-19
2 12	I_{in} signal filter time	0 01 —10 00s	0 01s	0 10 s		0 = No filtering	3-19
2 13	Reference scaling minimum value	0— par 2 14	1 Hz	0 Hz		Selects the frequency that corresponds to the min. reference signal	3-20
2 14	Reference scaling maximum value	0— f_{max} (1 2)	1 Hz	0 Hz		Selects the frequency that corresponds to the max reference signal 0 = Scaling off >0 = Scaled maximum value	3-20
2 15	Free analog input, signal selection	0—2		0		0 = Not use 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	3-20
2 16	Free analog input, function	0—4		0		0 = No function 1 = Reduces current limit (par 1 7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervision limit	3-20

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3 1	Analog output function ■	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2 0 x I_{nSV}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100% x V_{nMot}) 7 = DC-link volt. (0—1000 V)	3-22
3 2	Analog output filter time	0.00—10.00 s	0.01 s	1.00 s			3-22
3 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-22
3 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	3-22
3 5	Analog output scale	10—1000%	1%	100%			3-22
3 6	Digital output function ■	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv 1 14 = Output frequency limit superv 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O-terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	3-23
3 7	Relay output 1 function ■	0—21	1	2		As parameter 3 6	3-23
3 8	Relay output 2 function ■	0—21	1	3		As parameter 3 6	3-23
3 9	Output freq limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-23
3 10	Output freq limit 1 supervision value	0.0—f_{max} (par 1 2)	0 1 Hz	0.0 Hz			3-23

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
3 11	Output freq limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-23
3 12	Output freq limit 2 supervision value	0.0—f_{max} (par 1 2)	0 1 Hz	0.0 Hz			3-23
3 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-24
3 14	Torque limit supervision value	0.0—200.0 % xT_{nSV}	0.1%	100.0%			3-24
3 15	Reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-24
3 16	Reference limit supervision value	0.0—f_{max} (par 1 2)	0 1 Hz	0.0 Hz			3-24
3 17	Extern. brake Off-delay	0.0—100.0 s	0 1 s	0.5 s			3-24
3 18	Extern. brake On-delay	0.0—100.0 s	0 1 s	1.5 s			3-24
3 19	Drive temperature limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-25
3 20	Drive temperature limit value	-10—+75°C	1	40°C			3-25
3 21	I/O-expander board (opt.) analog output function ■	0—7	1	3		See parameter 3 1	3-22
3 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01 s	1.00 s		See parameter 3 2	3-22
3 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3 3	3-22
3 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3 4	3-22
3 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3 5	3-22

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4 1	Acc /Dec ramp 1 shape	0.0—10.0 s	0 1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	3-25
4 2	Acc /Dec ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	3-25
4 3	Acceleration time 2	0 1—3000.0s	0 1 s	10.0 s			3-25
4 4	Deceleration time 2	0 1—3000.0s	0 1 s	10.0 s			3-25
4 5	Brake chopper ■	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	3-26
4 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	3-26

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
4 7	Stop function	0 1		0		0 = Coasting 1 = Ramp	3-26
4 8	DC-braking current	0 15—1 5 x I_{nVS}(A)	0 1 A	0 5 x I_{nVS}			3 26
4 9	DC-braking time at Stop	0 00-250 00s	0 01 s	0 00 s		0 DC-brake is off at Stop	3-26
4 10	Turn on frequency of DC brake during ramp Stop	0 1 10 0 Hz	0 1 Hz	1 5 Hz			3-28
4	DC-brake time at Start	0 00 25 00 s	0 0 s	0 00 s		DC brake is off at Start	3-28

Group 5 Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5	Prohibit frequency range 1 low limit	f_{min}—par 5 2	0 Hz	0 0 Hz			3-28
5 2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1 1) (1 2)	0 Hz	0 0 Hz		0 Prohibit range is off	3 28
5 3	Prohibit frequency range 2 low limit	f_{min}—par 5 4	0 1 Hz	0 0 Hz			3-28
5 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1 1) (1 2)	0 1 Hz	0 0 Hz		0 = Prohibit range 2 is off	3-28
5 5	Prohibit frequency range 3 low limit	f_{min}—par 5. 6	0 1 Hz	0.0 Hz			3-28
5 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1 1) (1 2)	0 1 Hz	0 0 Hz		0 = Prohibit range 3 is of	3-28

Group 6 Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6 1	Motor control mode ■	0—		0		0 = Frequency control 1 = Speed control	3-29
6. 2	Switching frequency	1.0—16 0 kHz	0 1 kHz	10/3 6 kHz		Dependant on Hp rating	3-29
6 3	Field weakening point ■	30—500 Hz	1 Hz	Param. 1 11			3-29
6 4	Voltage at field weakening point ■	15—200% x V_{nmot}	1%	100%			3-29
6 5	V/Hz curve midpoint frequency ■	0 0—f_{max}	0 1 Hz	0 0 Hz			3-29
6 6	V/Hz-curve midpoint voltage ■	0.00—100 00% x V_{nmot}	0 01%	0.00%			3-29
6 7	Output voltage at zero frequency ■	0.00—100.00% x V_{nmot}	0 01%	0.00%			3-29
6 8	Overvoltage controller	0—1	1			0 = Controller is turned off 1 = Controller is operating	3-30
6 9	Undervoltage controller	0—1	1	1		0 = Controller is turned off 1 = Controller is operating	3-30

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 7 Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7	Response to reference fault	0 3		0		0 = No action = Warning 2 = Fault stop according to par 4 7 3 Fault always coasting stop	3 3
7 2	Response to external fault	0 3				0 = No action Warning 2 Fault stop according to par 4 7 3 = Fault always coasting stop	3 30
7 3	Phase supervision of the motor	0 2	2	2		0 = No action 2 = Fault	3 30
7 4	Ground fault protection	0 2	2	2		0 = No action 2 Fault	3 1
	Motor thermal protection	0 2				0 No action Warning 2 Fault	3
7 6	Motor thermal protection break point current	50 0—150 0 % x I_{nMOTOR}	0 %	100 0%			3-32
7 7	Motor thermal protection zero frequency current	5 0—150 0% x I_{nMOTOR}	1 0 %	45 0%			3-32
7 8	Motor thermal protection time constant	0 5—300 0 minutes	0 5 min	17 0 min		Default value is set according to motor nominal current	3-33
7 9	Motor thermal protection break point frequency	10—500 Hz	Hz	35 Hz			3 33
7 10	Stall protection	0—2				0 No action = Warning 2 = Fault	3 3
7 1	Stall current limit	5 0—200 0% x I_{nMOTOR}	0%	30 0			3 34
7 2	Stall time	2 0 120 0 s	0 s	15 0 s			3-34
7 13	Maximum stall frequency	1—f_{max}	Hz	25 Hz			3-34
7 14	Underload protection	0—2		0		0 = No action 1 = Warning 2 = Fault	3 35
7 15	Underload prot field weakening area load	10 0—150 0 % x T_{nMOTOR}	1 0%	50 0%			3-35
7 16	Underload protection zero frequency load	5 0—150 0% x T_{nMOTOR}	0%	10 0%			3 35
7 17	Underload time	2 0—600 0 s	0 s	20 0s			3-36

Group 8 Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = not in use	3-36
8 2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			3-36
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	3-37
8. 4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	3-37

Table 3 5-1 Special parameters Groups 2—8

3 5 2 Description of Groups 2—8 parameters

2 1 **Start/Stop logic selection**

0: DIA1 closed contact = start forward
DIA2 closed contact = start reverse
See figure 3 5-1

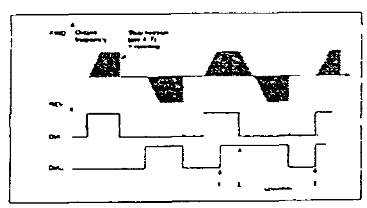


Figure 3 5-1 Start forward/Start reverse

(1) The first selected direction has the highest priority

(2) When DIA1 contact opens the direction of rotation starts to change

(3) If Start forward (DIA1) and start reverse (DIA2) signals are active simultaneously, the start forward signal (DIA1) has priority

1: DIA1 closed contact = start open contact = stop
DIA2 closed contact = reverse open contact = forward
See figure 3 5-2

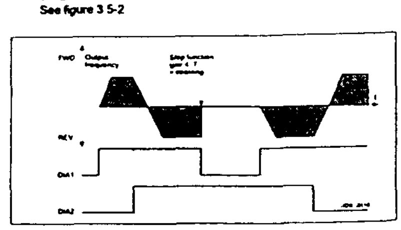


Figure 3 5-2 Start, Stop, reverse

2 DIA1 closed contact = start open contact = stop
DIA2 closed contact start enabled open contact = start disabled

3 3-wire connection

DIA1 closed contact = start pulse
DIA2 closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 3 5-3

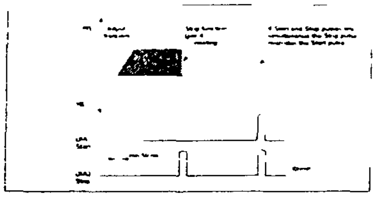


Figure 3.5-3 Start pulse /Stop pulse

2 2 **DIA3 function**

1 External fault closing contact = Fault is shown and drive responds according to parameter 7 2

2 External fault, opening contact = Fault is shown and drive responds according to parameter 7.2

3 Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4 Acc. / Dec time select contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5 Reverse contact open = Forward || Can be used for reversing if
contact closed = Reverse || parameter 2 1 has value 3

6 Jog speed contact closed = Jog speed selected for freq refer

7 Fault reset contact closed = Resets all faults

8 Acc./Dec operation prohibited
contact closed = Stops acceleration or deceleration until the contact is opened

9 DC-braking command
contact closed = In Stop mode the DC-braking operates until the contact is opened see figure 3 5-4
DC-brake current is set with parameter 4 8

3

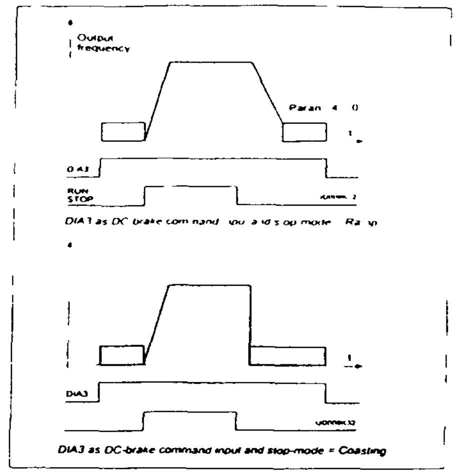


Figure 3 5-4 DIA3 as DC-brake command input. a) Stop mode = Ramp
b) Stop mode = Coasting

2 3 **V_{in} signal range**

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par 2 4) to custom maximum (par 2 5)

2 4 **V_{in} custom setting minimum/maximum**

2 5 These parameters set V_{in} for any input signal span within 0—10 V

Minimum setting Set the V_{in} signal to its minimum level select parameter 2 4 press the Enter button
Maximum setting Set the V_{in} signal to its maximum level, select parameter 2 5 press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/ arrow down buttons)

3

2 6 **V_{in} signal inversion**

V_{in} is source B frequency reference par 1 6 = 1 (default)

Parameter 2 6 = 0 no inversion of analog V_{in} signal

Parameter 2 6 = 1 inversion of analog V_{in} signal
max. V_{in} signal = minimum set speed
min. V_{in} signal = maximum set speed

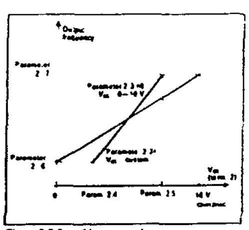


Figure 3.5-5 V_{in} no signal inversion

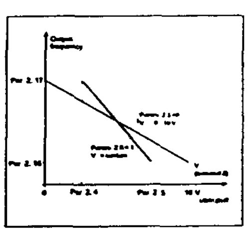


Figure 3.5-6 V_{in} signal inversion

2 7 **V_{in} signal filter time**

Filters out disturbances from the incoming analog V_{in} signal. A long filtering time makes drive response slower See figure 3.5-7

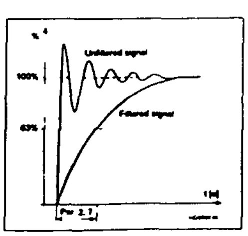


Figure 3.5-7 V_{in} signal filtering

3

2 8 **Analog input I_{in} signal range**

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

See figure 3 5-8

2. 9
2 10 **Analog input I_{in} custom setting minimum/maximum**

With these parameters you can scale the input current to correspond to a minimum and maximum frequency range See figure 3.5-8.

Minimum setting Set the I_{in} signal to its minimum level, select parameter 2. 9 press the Enter button
Maximum setting
Set the I_{in} signal to its maximum level, select parameter 2 10 press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons).

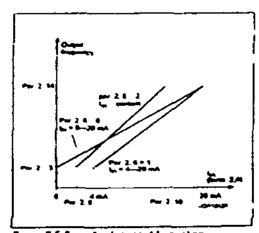


Figure 3.5-8 Analog input I_{in} scaling

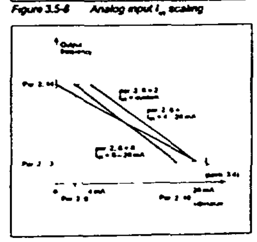


Figure 3.5-9 I_{in} signal inversion

2 11 **Analog input I_{in} inversion**

I_{in} is source A frequency reference par 1 5 = 0 (default)

Parameter 2 11 = 0 no inversion of I_{in} input

Parameter 2 11 = 1 inversion of I_{in} input, see figure 3.5-9

max. I_{in} signal = minimum set speed
min I_{in} signal = maximum set speed

2 12 **Analog input I_{in} filter time**

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes drive response slower See figure 3 5-10

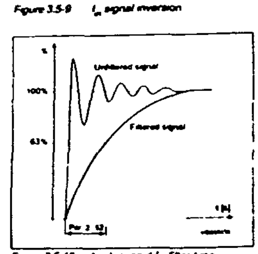


Figure 3.5-10 Analog input I_{in} filter time

3

2 13 2 14 Reference scaling minimum value/maximum value

Scales the basic reference

Setting limits par 1 1 <par 2 13<par 2 14 <par 1 2
If par 2 14 0 scaling s set off See fig res 3 5-11 and 3 5-12

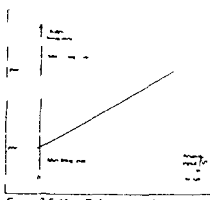


Figure 3 5-11 Reference scaling

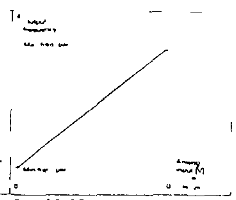


Figure 3 5-12 Reference scaling par 2 14 0

2 16 Free analog input signal

Selection of input signal of free analog input (an input not used for reference signal)

0 = *Not in use*
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2 18 Free analog input signal function

Use this parameter to select a function for a free analog input signal

0 = Function is not used

1 = *Reducing motor current limit* (par 1 7)

This signal will adjust the maximum motor current between 0 and the maximum set with parameter 1 7
See figure 3 5-13

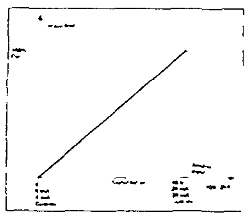


Figure 3 5-13 Reducing max motor current

2 = Reducing DC brake current

DC braking current can be reduced with the free analog input signal between current 0 15 x I_{SV9} and current set by the parameter 4 8 See figure 3 5-14

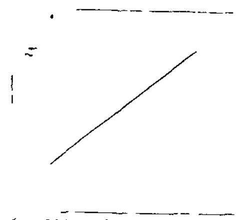


Figure 3 5 14 Reducing DC brake current

3 Reducing acceleration and deceleration times

Acceleration/deceleration times can be reduced with a free analog input signal according to the following formulas

Reduced time set acc / deceler time (par 1 3 1 4 4 3 4 4) divided by the factor R from the figure 3 5 15

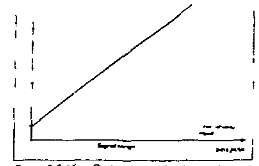


Figure 3 5-15 Reducing acceleration and deceleration times

4 Reducing torque supervision limit

Torque supervision limit can be reduced with a free analog input signal between 0 and set supervision limit (par 3 14) see figure 3 5-16

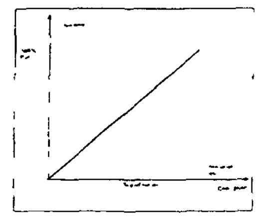


Figure 3 5-16 Reducing torque supervision limit

3 1 Analog output function

See table for parameter 3 1 on page 3-9

3 2 Analog output filter time

Filters the analog output signal
See figure 3 5-17

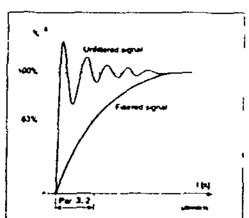


Figure 3 5-17 Analog output filtering

3 3 Analog output invert

Inverts analog output signal.
max output signal = minimum set value
min. output signal = maximum set value

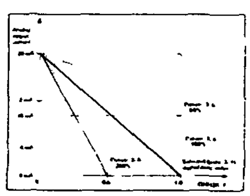


Figure 3 5-18 Analog output invert

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA (living zero)
See figure 3 5-19

3 5 Analog output scale

Scaling factor for analog output
See figure 3 5-19

Signal	Max value of the signal
Output frequency	Max frequency (p 1 2)
Output current	2 x I_{nSV9}
Motor speed	Max speed (n_n x f_{max}/f_n)
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt	1000 V

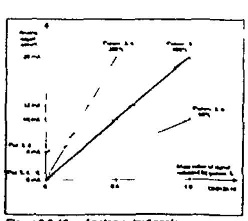


Figure 3.5-19 Analog output scale

3 6 Digital output function
3 7 Relay output 1 function
3 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation Digital output DO1 sinks current and programmable relay (RO1 RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10= Jog speed selected	The Jog speed has been selected with digital input
11= At speed	The output frequency has reached the set reference
12= Motor regulator activated	Overvoltage or overcurrent regulator was activated
13= Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par 3. 9 and 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par 3. 11 and 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par 3. 13 and 3. 14)
16= Active reference	Active reference goes outside of the set supervision limit supervision Low limit/ High limit (par 3. 15 and 3. 16)
17= External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18= Control from I/O terminals	External control mode selected with prog push-button#2
19= Drive temperature supervision	Temperature on drive goes outside the set supervision limits (par 3. 19 and 3. 20)
20= Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21= External brake control inverted	External brake ON/OFF control (par 3 17 and 3 18) output active when brake control is OFF

Table 3 5-2 Output signals via DO1 and output relays RO1 and RO2

3 9 Output frequency limit 1 supervision function
3 11 Output frequency limit 2 supervision function

0 = No supervision
1 = *Low limit supervision*
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10 3 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3 8

3 10 Output frequency limit 1, supervision value
3 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3 11)
See figure 3 5-20

3 13 Torque limit supervision function

0 = No supervision
1 Low limit supervision
2 High limit supervision

If the calculated torque value goes under/over the set limit (3 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

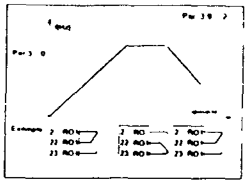


Figure 3 5-20 Output frequency supervision

3 14 Torque limit supervision value

The calculated torque value to be supervised by the parameter 3 13 Torque supervision value can be reduced below the setpoint with a free analog input signal, see parameters 2 18 and 2 19

3. 15 Reference limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3 16) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8 The supervised reference is the current active reference It can be the source A or B reference depending on DIB6 input or the panel reference if the panel is the active control source

3 16 Reference limit supervision value

The frequency value to be supervised by the parameter 3 15

3 17 External brake-off delay
3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 3.5-21

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2, see parameters 3 6—3. 8

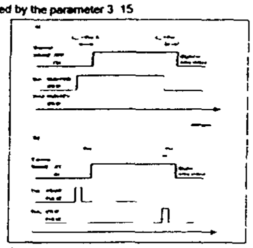


Figure 3 5-21 External brake control
a) Start/Stop logic selection par 2 1 = 0, 1 or 2
b) Start/Stop logic selection par 2 1 = 3

3 19 Drive temperature limit supervision

0 No supervision
1 Low limit supervision
2 High limit supervision

If the temperature of the unit goes under/over the set limit (3 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

3 20 Drive temperature limit value

The temperature value to be supervised by the parameter 3 19

4 1 Acc/Dec ramp 1 shape
4 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters

Setting the value 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3 4 4 for Acc/Dec time 2)

Setting 0 1—10 seconds for 4 1 (4 2) causes an S-shaped ramp The speed changes are smooth Parameter 1 3/1 4 (4 3/4 4) determines the ramp time of the acceleration/deceleration in the middle of the curve See figure 3 5-22

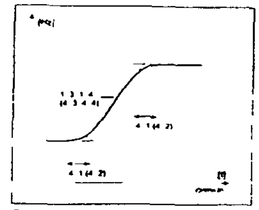


Figure 3 5-22 S-shaped acceleration/deceleration

4 3 Acceleration time 2

4 4 Deceleration time 2

These values correspond to the time required for output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) With this parameter it is possible to set two different acceleration/deceleration times for one application The active set can be selected with the programmable signal DIA3 See parameter 2 2. Acceleration/deceleration times can be reduced with a free analog input signal See parameters 2 18 and 2 19

4 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration See the separate Brake resistor installation manual

4 6 Start function

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may cause prolonged acceleration times)

Flying start

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 Stop function

Coasting

0 The motor coasts to an uncontrolled stop with the SV9000 off, after the Stop command.

Ramp

1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

4 8 DC braking current

Determines whether DC braking is ON or OFF It also determines the braking duration time of the DC-brake when the motor is stopping The function of the DC-brake depends on the stop function, parameter 4. 7 See figure 3 5-23

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param. 4 7). The time is set by the value of parameter 4 9

Stop-function = 0 (coasting):

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection, the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC- braking starts If the frequency is ≥ nominal frequency of the motor (par 1 11) the value of parameter 4 9 determines the braking time When the frequency is ≤ 10% of the nominal, the braking time is 10% of the set value of parameter 4 9

Stop-function = 1 (ramp):

After a Stop command the speed of the motor is reduced based on the deceleration ramp parameter If no regeneration occurs due to load inertia DC-braking starts at a speed defined by parameter 4 10

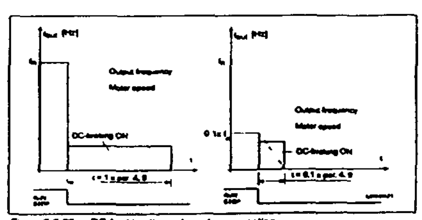


Figure 3 5-23 DC-braking time when stop = coasting

The braking time is defined with parameter 4 9

If a high inertia exists it is recommended to use an external braking resistor for faster deceleration. See figure 3.5-24

4 10 Execute frequency of DC-brake during ramp Stop

See figure 3 5-24

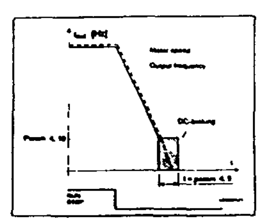


Figure 3 5-24 DC-braking time when stop function = ramp

4 11 DC brake time at start

0 DC brake is not used

>0 DC-brake is active when the start command is given This parameter defines the time before the brake is released After the brake is released the output frequency increases according to the set start function parameter 4 6 and the acceleration parameters (1 3 4 1 or 4 2 4 3) See figure 3 5-25

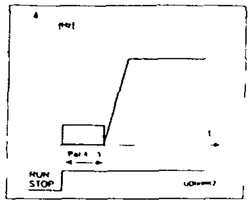


Figure 3 5-25 DC-braking time at start

5 1 5 6 Prohibit frequency area Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems

With these parameters it is possible to set limits for three "skip frequency" regions between 0 Hz and 500 Hz The accuracy of the setting is 0 1 Hz See figure 3 5-26

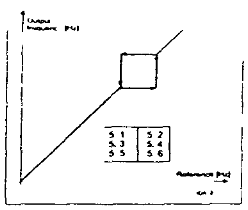


Figure 3 5-26 Example of prohibit frequency area setting

6 1 Motor control mode

0 = Frequency control (V/Hz) The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq resolution 0 01 Hz)

1 Speed control (sensorless vector) The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0 5%)

6 2 Switching frequency

Motor noise can be minimized by using a high switching frequency Increasing the switching frequency reduces the current capacity of the SV9000

Before changing the frequency from the factory default 10 kHz (3 6 kHz >40 Hp) check the drive derating in the curves shown in figures 5 2 2 and 5 2 3 in chapter 5 2 of the User's Manual

6 3 Field weakening point

6 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value Above that frequency the output voltage remains at the set maximum value
Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1 8 1 9 6 5 6 6 and 6 7 See figure 3 5-27

When the parameters 1 10 and 1 11 nominal voltage and nominal frequency of the motor are set, parameters 6 3 and 6 4 are also set automatically to the corresponding values If you need different values for the field weakening point and the maximum output voltage change these parameters after setting parameters 1 10 and 1 11

6 5 V/Hz curve middle point frequency

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle frequency point of the curve See figure 3 5 27

6 6 V/Hz curve middle point voltage

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle point voltage (% of motor nominal voltage) of the curve See figure 3 5 27

6 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage of the curve See figure 3 5-27

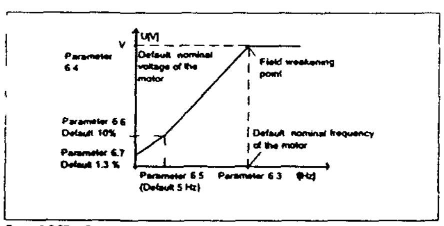


Figure 3.5-27 Programmable V/Hz curve

6.8 Overvoltage controller

6.9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than 15%—+10% and the application requires a constant speed. If the controllers are ON they will change the motor speed in over/undervoltage cases Overvoltage = faster undervoltage = slower

Over/undervoltage trips may occur when controllers are not used

7 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3 The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2

7 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current

7 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero The standard overcurrent protection is always working and protects the frequency converter from ground faults with high current levels

Parameters 7 5—7 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating The SV9000 drive is capable of supplying higher than nominal current to the motor If the load requires this high current there is a risk that motor will be thermally overloaded This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with a separately powered external fan, the load derating at low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor When the motor is powered from the drive the calculated model uses the heatsink temperature to determine the initial thermal state of the motor The calculated model assumes that the ambient temperature of the motor is 40°C

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded This current limit is a function of the output frequency The curve for I_T is set with parameters 7 6, 7 7 and 7 9 refer to the figure 3.5-28 The default values of these parameters are set from the motor nameplate data

With the output current at I_T the thermal stage will reach the nominal value (100%) The thermal stage changes with the square of the current. With output current at 75% of I_T the thermal stage will reach 56% and with output current at 120% of I_T the thermal stage would reach 144% The function will trip the drive (refer par 7 5) if the thermal state reaches a value of 105% The response time of the thermal stage is determined by the time constant parameter 7 8 The larger the motor the longer it takes to reach the final temperature

The thermal state of the motor can be monitored through the display Refer to the table for monitoring items. (User's Manual, table 7.3-1).

CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt*

7 5 Motor thermal protection

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is selected, the drive will stop and activate the fault stage

Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero

7 6 Motor thermal protection break point current

The current can be set between 50 0—150 0% x I_{nMotor}
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve See figure 3 5-28

The value is set as a percentage of the motor nameplate nominal current, parameter 1 13 not the drive s nominal output current

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated

If parameter 1 13 is adjusted this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

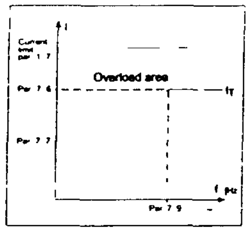


Figure 3 5 28 Motor thermal current I curve

7 7 Motor thermal protection zero frequency current

The current can be set between 10 0—150 0% x I_{nMotor}
This parameter sets the value for thermal current at zero frequency Refer to figure 3.5-28

The default value is set assuming that there is no external fan cooling the motor If an external fan is used this parameter can be set to 90% (or higher)

The value is set as a percentage of the motor's nameplate nominal current, parameter 1 13 not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated If you change parameter 1 13 this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect to the maximum out put current of the drive Parameter 1 7 alone determines the maximum output current of the drive

7 8 Motor thermal protection, time constant

This time can be set between 0 5—300 minutes This is the thermal time constant of the motor The larger the motor the greater the time constant The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value

The motor thermal time is specific to a motor design and it varies between different motor manufacturers

The default value for the time constant is calculated based on the motor nameplate data from parameters 1 12 and 1 13 If either of these parameters is reset then this parameter is set to default value

If the motor's t_6 time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 time As a rule of thumb the motor thermal time constant in minutes equals to $2 x t_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current) If the drive is stopped the time constant is internally increased to three times the set parameter value Cooling in the stop stage is based on convection with an increased time constant

7 9 Motor thermal protection break point frequency

The frequency can be set between 10—500 Hz This is the frequency break point of the thermal current curve With frequencies above this point the thermal capacity of the motor is assumed to be constant. See figure 3 5-28

The default value is based on the motor's nameplate data, parameter 1 11 It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor More generally it is 70% of the frequency at the field weakening point (parameter 6 3) Changing either parameter 1 11 or 6 3 will restore this parameter to its default value

7 10 Stall protection

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is set on, the drive will stop and activate the fault stage Setting the parameter to 0 will deactivate the protection and will reset the stall time counter to zero

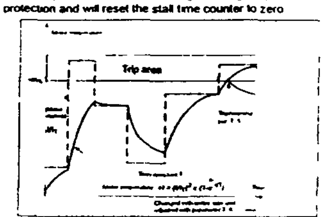


Figure 3.5-29 Calculating motor temperature

Parameters 7 10—7 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7 11 Stall Current and 7 13 Stall Frequency If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection

7 11 Stall current limit

The current can be set between 0 0—200% x I_{nMotor}

In a stall the current has to be above this limit. See figure 3 5-30 The value is set as a percentage of the motor's nameplate nominal current, parameter 1 13 If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

7 12 Stall time

The time can be set between 2.0—120 s. This is the maximum allowed time for a stall. There is an internal up/down counter to count the stall time. See figure 3.5-31 If the stall time counter value goes above this limit the protection will cause a trip (refer to parameter 7 10).

7 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (parameter 1 2).
In a stall, the output frequency has to be smaller than this limit. See figure 3.5-30

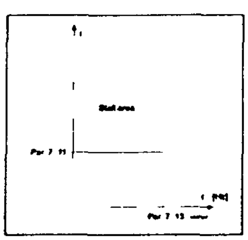


Figure 3.5-30 Setting the stall characteristics.

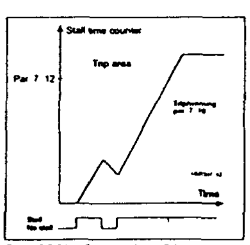


Figure 3 5-31 Counting the stall time

Parameters 7 14—7 17
Underload protection, General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g broken belt or dry pump

Motor underload protection can be adjusted by setting the underload curve with parameters 7 15 and 7 16 The underload curve is a squared curve set between zero frequency and the

field weakening point. The protection is not active below 5Hz (the underload counter value is stopped) See figure 3 5-32

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor The motor's nameplate data parameter 1 13 the motor's nominal current and drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value If other than a standard motor is used with the drive the accuracy of the torque calculation is decreased

7 14 Underload protection

Operation.

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload *time counter to zero*

7 15 Underload protection, field weakening area load

The torque limit can be set between 20 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. See figure 3.5-32 If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

7 16 Underload protection, zero frequency load

The torque limit can be set between 10 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque with zero frequency Refer to the figure 3.5-32. If parameter 1 13 is adjusted this parameter is automatically restored to its default value.

7 17 Underload time

This time can be set between 2 0—600 0 s

This is the maximum allowed time for an underload state There is an internal up/down counter to accumulate the underload time Refer to the figure 3 5 33 If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7 14) If the drive is stopped the underload counter is reset to zero

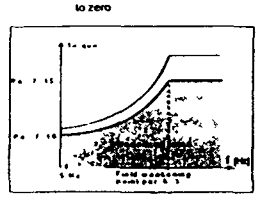


Figure 3.5-32 Setting of minimum load.

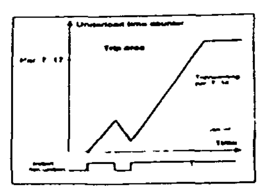


Figure 3 5-33 Counting the underload time

3

8 1 Automatic restart number of tries

8 2 Automatic restart trial time

The Automatic restart function restarts the drive after the faults selected with *parameters 8 4 8 8 The Start function for Automatic restart is selected with* parameter 8 3 See figure 3 5-34

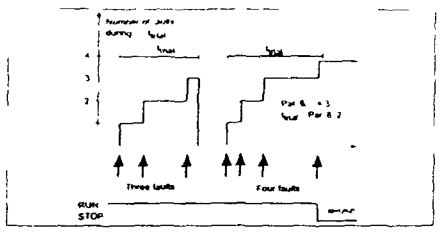


Figure 3 5-34 Automatic restart

Parameter 8 1 determines how many automatic restarts can be made during the trial time set by the parameter 8 2

The time counting starts from the first autorestart If the number of restarts does not exceed the value of the parameter 8 1 during the trial time the count is cleared after the trial time has elapsed The next fault starts the count ng again

8 3 Automatic restart, start function

The parameter defines the start mode

0 = Start with ramp
1 Flying start see parameter 4 6

8 4 Automatic restart after undervoltage trip

0 = No automatic restart after undervoltage fault
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 5 Automatic restart after overvoltage trip

0 = No automatic restart after overvoltage fault
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 6 Automatic restart after overcurrent trip

0 No automatic restart after overcurrent fault
1 = Automatic restart after overcurrent faults

8 7 Automatic restart after reference fault trip

0 No automatic restart after reference fault
1 Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (>4 mA)

8 8 Automatic restart after over-/undertemperature fault trip

0 No automatic restart after temperature fault
1 Automatic restart after heatsink temperature has returned to its normal level between 10 C—+75 C

Notes

3

Notes

3

PI CONTROL APPLICATION
(par 0 1 = 5)

CONTENTS

4

4 1 General

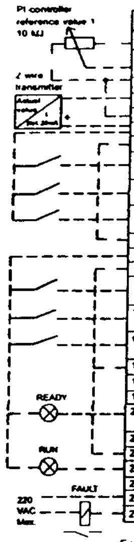
In PI control application there are two I/O terminal control sources Source A is the PI controller and source B is the direct frequency reference The control source is selected with DIB6 input

The PI-controller reference can be selected from an analog input motorized (digital) potentiometer or panel reference The actual value can be selected from the analog inputs or from mathematical functions of the analog inputs

The direct frequency reference can be used for control without the PI controller The frequency reference can be selected from analog inputs or panel reference

* NOTE! **Remember to connect CMA and CMB inputs**

4 2 Control I/O



Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for a potentiometer etc
2	V_{in}+	Analog input voltage (programmable)	PI-controller reference value range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I_{in}	Analog input	PI controller actual value
5	I_{in}	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches etc. max 0 1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start/Stop Source A (PI-controller)	Contact open = stop Contact closed = start
9	DIA2	External fault (programmable)	Contact open = no fault Contact closed = fault
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Start/Stop Source B (Direct freq ref)	Contact open = stop Contact closed = start
15	DIB5	Jog speed select (programmable)	Contact open = no action Contact closed = Jog speed
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I_{out}+	Analog output	Programmable (par 3. 1)
19	I_{out}	Output frequency	Range 0—20 mA/R_L max 500 Ω
20	DO1	Digital output READY	Programmable (par 3. 6) Open collector I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 RUN	Programmable (par 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3. 8)
25	RO2		
26	RO2		

Figure 4 2 1 Default I/O configuration and connection example of the PI-Control Application with 2-wire transmitter

4 3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 4 3-1

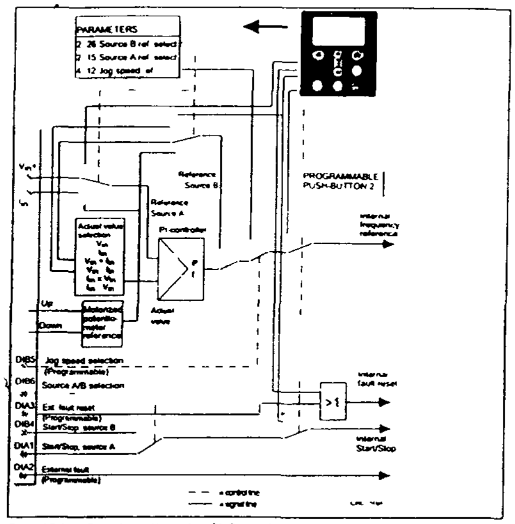


Figure 4 3-1 Control signal logic of the PI- Control Application Switch positions shown are based on the factory settings

4 4 Basic parameters, Group 1

4.4 1 Parameter table, Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			4-6
1 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz			4-5
1 3	Acceleration time 1	0.1—3000.0 s	0 1 s	1.0 s		Time from f_{min} (1 1) to f_{max} (1 2)	4-5
1 4	Deceleration time 1	0 1—3000 0 s	0 1 s	1.0 s		Time from f_{max} (1 2) to f_{min} (1 1)	4-5
1. 5	PI-controller gain	1—1000%	1 %	100%			4-5
1. 6	PI-controller I-time	0.00—320.00 s	0.01s	10.00 s		0 = no integral time in use	4-6
1 7	Current limit	0 1—2.5 x I_{nSV}	0 1 A	1.5 x I_{nSV}		Output current limit [A] of the unit	4-6
1 8	V/Hz ratio selection ■	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	4-6
1 9	V/Hz optimization ■	0—1	1	0		0 = None 1 = Automatic torque boost	4-6
1 10	Nominal voltage of the motor ■	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	4-7
1 11	Nominal frequency of the motor ■	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	4-7
1. 12	Nominal speed of the motor ■	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	4-7
1. 13	Nominal current of the motor ■	2.5 x I_{nSV}	0 1 A	I_{nSV}		I_n from the nameplate of the motor	4-7
1. 14	Supply voltage ■	208—240		230 V		Voltage code 2	4-7
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters 0 = All parameter groups visible 1 = Only group 1 is visible	4-7
1 16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = Changes enabled 1 = Changes disabled	4-7

Table 4 4-1 Group 1 basic parameters

Note! ■ = Parameter value can be changed only when the drive is stopped

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system Selecting 120 Hz/500 Hz range see page 4-5

** Default value for a four pole motor and a nominal size SV9000

4 4 2 Description of Group 1 parameters

1 1 1 2 Minimum / maximum frequency

Defines frequency limits of the SV9000

The default maximum value for parameters 1 1 and 1 2 is 120 Hz. By setting 1 2 = 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz. At the same time the resolution of the panel is changed from 0 01 Hz to 0 1 Hz

Changing the max value from 500 Hz to 120 Hz is done by setting parameter 1 2 = 119 Hz while the drive is stopped

1 3 1 4 Acceleration time 1, deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1. 2)

1 5 PI-controller gain

This parameter defines the gain of the PI-controller

If this parameter is set to 100% a 10% change in error value causes the controller output to change by 1.0 Hz.

If the parameter value is set to 0, the PI-controller operates as an I-controller

1 6 PI-controller I-time

Defines the integration time of the PI-controller

1 7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term.

1 8 V/Hz ratio selection

Linear 0: The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6. 3) where a constant voltage (nominal value) is supplied to the motor See figure 4 4-2
A linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting

Squared: 1: The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6. 3) where the nominal voltage is supplied to the motor See figure 4 4-2

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e g. in centrifugal fans and pumps.

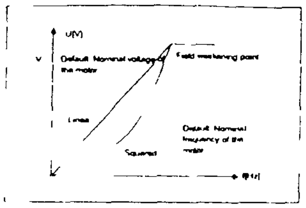


Figure 4 4 2 Linear and squared V/Hz curves

Programm V/Hz curve 2 — The V/Hz curve can be programmed with three different points The parameters for programming are explained in chapter 4 5 2
A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application See figure 4 4-3

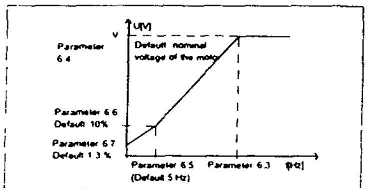


Figure 4 4 3 Programmable V/Hz curve

1 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which makes the motor produce enough torque to start and run at low frequencies The voltage increase depends on the motor type and horsepower

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e g in conveyors

NOTE! *In high torque low speed applications it is likely the motor will overheat. If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the temperature rise is too high*

1 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor
This parameter sets the voltage at the field weakening point parameter 6 4 to 100% x V_{nmot}

1 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor
This parameter sets the frequency of the field weakening point parameter 6 3 to the same value

1 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor The internal motor protection function uses this value as a reference value

1 14 Supply voltage

Set parameter value according to the nominal voltage of the supply
Values are pre-defined for voltage codes 2 4 5 and 6 See table 4 4 1

1 15 Parameter conceal

Defines which parameter groups are available

0 = all parametergroups are visible
1 = only group 1 is visible

1 16 Parameter value lock

Defines access to the changes of the parameter values

0 = parameter value changes enabled
1 = parameter value changes disabled

To adjust more of the functions of the PI-Control application see chapter 4 5 to modify the parameters of Groups 2—8

4 5 Special parameters Groups 2—8

4 5 1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2 1	DIA2 function (terminal 9) ■	0—10	1	1		0 = Not used 1 = Ext fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc/dec/decel time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command 10 = Motor (digital) pot. UP	4-15
2.2	DIA3 function (terminal 10) ■	0—10	1	7		0 = Not used 1 = Ext fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc /dec time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command 10 = Motor (digital) pot. DOWN	4-16
2.3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	4-16
2.4	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			4-16
2.5	V_{in} custom setting max	0.00-100.00%	0.01%	100.00%			4-16
2.6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-16
2.7	V_{in} signal filter time	0.00—10.00 s	0.01 s	0.10 s		0 = No filtering	4-17
2.8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	4-17
2 9	I_{in} custom setting min.	0 00-100.00%	0.01%	0.00%			4-17
2 10	I_{in} custom setting max	0 00-100 00%	0 01%	100 00%			4-17
2 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-17
2 12	I_{in} signal filter time	0 01 —10.00 s	0 01s	0.10 s		0 = No filtering	4-18
2 13	DIB5 function (terminal 15) ■	0—9	1	6		0 = Not used 1 = Ext fault, closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /dec time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command	4-18

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2 14	Motor (digital) potentiometer ramp time	0 1—2000 0 Hz/s	0 1 Hz/s	10 0 Hz/s			4 18
2 15	PI-controller reference signal (source A) ■	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r2) 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 is stopped	4-19
2 16	PI-controller actual value selection ■	0—3	1	0		0 = Actual value 1 1 = Actual 1 + Actual 2 2 = Actual 1 Actual 2 3 = Actual 1 * Actual 2	4-19
2 17	Actual value 1 input ■	0—2	1	2		0 = No 1 = Voltage input 2 = Current input	4-19
2 18	Actual value 2 input ■	0—2	1	0		0 = No 1 = Voltage input 2 = Current input	4 19
2 19	Actual value 1 min scale	-320.00%—+320.00%	0 01%	0.00%		0 % = No minimum scaling	4-19
2 20	Actual value 1 max scale	-320.00%—+320.00%	0 01%	100.0%		100 % = No maximum scaling	4-19
2 21	Actual value 2 min scale	-320 00%—+320.00%	0 01%	0.00%		0 % = No minimum scaling	4 19
2 22	Actual value 2 max scale	-320.00%—+320.00%	0 01%	100.0%		100 % = No maximum scaling	4 19
2 23	Error value inversion	0—1	1	0		0 = No 1 = Yes	4-19
2 24	PI-controller min. limit	f_{min}—f_{max} (1 1) (1 2)	0 1 Hz	0.0 Hz			4 20
2 25	PI-controller max. limit	f_{min}—f_{max} (1. 1) (1 2)	0.1 Hz	50.0 Hz			4-20
2 26	Direct frequency reference source B ■	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r1) 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 stopped	4-20
2 27	Source B reference scaling minimum value	0—par 2 28	1 Hz	0 Hz		Selects the frequency that corresponds to the min reference signal	4 20
2 28	Source B reference scaling maximum value	0—f_{max} (1 2)	1 Hz	0 Hz		Selects the frequency that corresponds to the max reference signal 0 = Scaling off >0 = Scaled maximum value	4-20

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 3 Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 × I_{nMotor}) 4 = Motor torque (0—2 × T_{nMot}) 5 = Motor power (0—2 × P_{nMot}) 6 = Motor voltage (0—100% ×V_{nMot}) 7 = DC-link volt (0—1000 V)	4-21
3.2	Analog output filter time	0.00—10.00 s	0.01s	1.00s			4-2
3.3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-21
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	4-21
3.5	Analog output scale	10—1000%	%	100%			4-21
3.6	Digital output function	0—2	1			0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	4-22
3.7	Relay output 1 function	0—21	1	2		As parameter 3.6	4-22
3.8	Relay output 2 function	0—21	1	3		As parameter 3.6	4-22
3.9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-22
3.10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			4-22

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-22
3.12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			4-22
3.13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3.14	Torque limit supervision value	0.0—200.0% × T_{nMot}	0.1%	100.0%			4-23
3.15	Active reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3.16	Active reference limit supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			4-23
3.17	External brake off-delay	0.0—100.0 s	1	0.5 s			4-23
3.18	External brake on-delay	0.0—100.0 s		5 s			4-23
3.19	Drive temperature limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3.20	Drive temperature limit	10—75°C	1	+40°C			4-23
3.21	I/O-expander board (opt.) analog output function	0—7	1	3		See parameter 3.1	4-21
3.22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01s	1.00s		See parameter 3.2	4-21
3.23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3.3	4-21
3.24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3.4	4-21
3.25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3.5	4-21

Group 4 Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	4-24
4.2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	4-24
4.3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			4-24
4.4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			4-24
4.5	Brake chopper ■	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	4-25
4.6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	4-25

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	4-25
4.8	DC-braking current	0.15—1.5 × I_{nHD}(A)	0.1 A	0.5 × I_{nHD}			4-25
4.9	DC-braking time at Stop	0.00-250.00s	0.01 s	0.00 s		0 = DC-brake is off at Stop	4-25
4.10	Turn on frequency of DC-brake at ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			4-26
4.11	DC-brake time at Start	0.00—25.00s	0.01 s	0.00 s		0 = DC-brake is off at Start	4-27
4.12	Jog speed reference	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	10.0 Hz			4-27

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	f_{min}—par. 5.2	0.1 Hz	0.0 Hz			4-27
5.2	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27
5.3	Prohibit frequency range 2 low limit	f_{min}—par. 5.4	0.1 Hz	0.0 Hz			4-27
5.4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27
5.5	Prohibit frequency range 3 low limit	f_{min}—par. 5.6	0.1 Hz	0.0 Hz			4-27
5.6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode ■	0—1	1	0		0 = Frequency control 1 = Speed control	4-27
6.2	Switching frequency	1.0-16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	4-27
6.3	Field weakening point ■	30—600 Hz	1 Hz	Param. 1.11			4-28
6.4	Voltage at field weakening point ■	15—200% × V_{nmot}	1%	100%			4-28
6.5	V/Hz-curve mid point frequency ■	0.0—f_{max}	0.1 Hz	0.0 Hz			4-28
6.6	V/Hz-curve mid point voltage ■	0.00-100.00% × V_{nmot}	0.01%	0.00%			4-28
6.7	Output voltage at zero frequency ■	0.00-100.00% × V_{nmot}	0.01%	0.00%			4-28
6.8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	4-28
6.9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	4-28

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 7 Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	4-29
7.2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	4-29
7.3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	4-29
7.4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	4-29
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	4-30
7.6	Motor thermal protection break point current	50.0—150.0 % × I_{nMOTOR}	1.0 %	100.0%			4-30
7.7	Motor thermal protection zero frequency current	5.0—150.0% × I_{nMOTOR}	1.0 %	45.0%			4-30
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	4-31
7.9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			4-31
7.10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	4-32
7.11	Stall current limit	5.0—200.0% × I_{nMOTOR}	1.0%	130.0%			4-32
7.12	Stall time	2.0—120.0 s	1.0 s	15.0 s			4-33
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			4-33
7.14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	4-33
7.15	Underload prot., field weakening area load	10.0—150.0 % × T_{nMOTOR}	1.0%	50.0%			4-34
7.16	Underload protection, zero frequency load	5.0—150.0% × T_{nMOTOR}	1.0%	10.0%			4-34
7.17	Underload time	2.0—600.0 s	1.0 s	20.0s			4-34

Group 8 Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8 1	Automatic restart number of tries	0 10		0		0 = not in use	4 34
8 2	Automatic restart multi attempt maximum trial time	1—6000 s	1 s	30 s			4 34
8 3	Automatic restart start function	0		0		0 = Ramp = Flying start	4 35
8 4	Automatic restart after undervoltage trip	0		0		0 = No 1 = Yes	4 35
8 5	Automatic restart after overvoltage trip	0		0		0 = No 1 = Yes	4 35
8 6	Automatic restart after overcurrent trip	0—1		0		0 = No 1 = Yes	4 35
8 7	Automatic restart after reference fault trip	0-		0		0 = No 1 = Yes	4 35
8 8	Automatic restart after over/undertemperature fault trip	0—		0		0 = No 1 = Yes	4 35

Table 4 5-1 Special parameters Groups 2—8

4 5 2 Description of Groups 2—8 parameters

2 1 DIA2 function

1 External fault	closing contact	Fault s shown and drive responds according to parameter 7 2
2 External fault,	opening contact	Fault is shown and drive responds according to parameter 7 2
3 Run enable	contact open contact closed	Start of the motor disabled Start of the motor enabled
4 Acc / Dec time select	contact open contact closed	Acceleration/Deceleration time 1 selected Acceleration/Deceleration time 2 selected
5 Reverse	contact open contact closed	Forward Reverse — If two or more inputs are programmed to reverse only one of them is required to reverse
6 Jog speed	contact closed	Jog speed selected for frequency reference
7 Fault reset	contact closed	Resets all faults
8 Acc /Dec operation prohibited	contact closed	Stops acceleration and deceleration until the contact is opened
9 DC-braking command	contact closed	In the stop mode the DC-braking operates until the contact is opened see figure 4 5-1 DC brake current is set with parameter 4 8
10 Motor(digital) pot UP	contact closed	Reference increases until the contact s opened

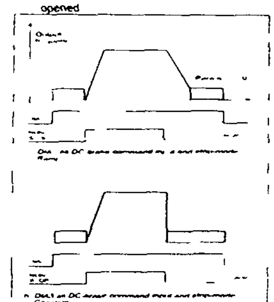


Figure 4 5-1 DIA3 as DC-brake command input
a) Stop-mode = ramp
b) Stop-mode = coasting

2 2 DIA3 function

Selections are same as in 2 1 except

10 Motor(digital) pot DOWN — contact closed = Reference decreases until the contact is opened

2 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par 2 4) to custom maximum (par 2 5)

2 4 2 5 V_{in} custom setting minimum/maximum

These parameters set V_{in} for any input signal span within 0—10 V

Minimum setting Set the V_{in} signal to its minimum level select parameter 2. 4 press the Enter button

Maximum setting Set the V_{in} signal to its maximum level, select parameter 2 5 press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2 6 V_{in} signal inversion

Parameter 2 6 = 0 no inversion of analog V_{in} signal

Parameter 2 6 = 1 inversion of analog V_{in} signal

2 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal
A long filtering time makes drive response slower
See figure 4 5-2

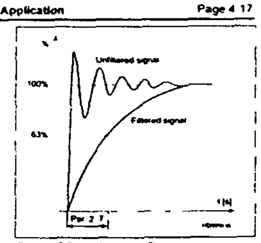


Figure 4 5-2 V_{in} signal filtering

2 8 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

2.9 2 10 Analog input I_{in} custom setting minimum/maximum

With these parameters you can scale the input current signal (I_{in}) signal range between 0—20 mA

Minimum setting Set the I_{in} signal to its minimum level, select parameter 2 9 press the Enter button
Maximum setting Set the I_{in} signal to its maximum level select parameter 2 10 press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2 11 Analog input I_{in} inversion

Parameter 2 11 = 0 no inversion of I_{in} input.

Parameter 2 11 = 1 inversion of I_{in} input.

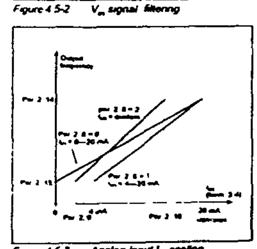


Figure 4.5-3 Analog input I_{in} scaling

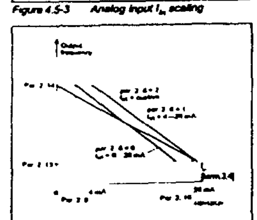


Figure 4 5-4 I_{in} signal inversion

2 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog (I_{in}) signal. A long filtering time makes drive response slower.
See figure 4 5 3

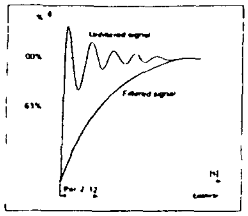


Figure 4 5-5 Analog input I_{in} filter time

2 13 DIA5 function

1 External fault	closing contact	- Fault is shown and motor is stopped when the input is active
2 External fault	opening contact	= Fault is shown and motor is stopped when *the input is not active*
3. Run enable	contact open contact closed	= Start of the motor disabled = Start of the motor enabled
4. Acc. / Dec time select.	*contact open* contact closed	*= Acceleration/Deceleration time 1 selected* = Acceleration/Deceleration time 2 selected
5. Reverse	contact open contact closed	= Forward = Reverse — If two or more inputs are programmed to reverse, only one of them is required to reverse
6. Jog speed	contact closed	= Jog speed selected for freqency reference
7 Fault reset	contact closed	- Resets all faults
8 Acc./Dec operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened
9 DC-braking command	contact closed	= In the stop mode the DC-braking operates until the contact is opened, see figure 4 5-1. DC-brake current is set with parameter 4 8

2 14 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes

2 15 PI-controller reference signal

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5 e g a transducer
2 Panel reference is the reference set from the Reference Page (REF)
Reference r2 is the PI-controller reference, see chapter 4 7
3 Reference value is changed with digital input signals DIA2 and DIA3
switch in DIA2 closed = frequency reference increases
switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2 3
4 *Same as setting 3 but the reference value is set to the minimum frequency* (par 1 1) each time the drive is stopped. When the value of parameter 1 5 is set to 3 or 4 the value of parameter 2 1 is automatically set to 4 and value of the parameter 2 2 is automatically set to 10

2 16 PI-controller actual value selection
2 17 Actual value 1
2 18 Actual value 2

These parameters select the PI-controller actual value

2 19 *Actual value 1 minimum scale*

Sets the minimum scaling point for Actual value 1 See figure 4 5-6

2 20 Actual value 1 maximum scale

Sets the maximum scaling point for Actual value 1 See figure 4 5-6

2 21 Actual value 2 minimum scale

Sets the minimum scaling point for Actual value 2 See figure 4 5-6

2 22 Actual value 2 maximum scale

Sets the maximum scaling point for Actual value 2 See figure 4 5-6

2 23 Error value inversion

This parameter allows you to invert the error value of the PI-controller(and thus the the operation of the PI-controller)

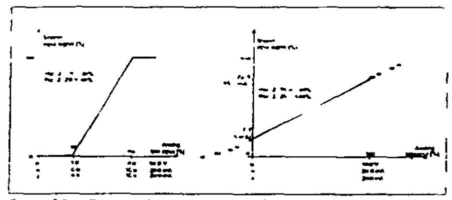


Figure 4 5-6 Examples of actual value scaling of PI-regulator

2 24 PI-controller minimum limit
2 25 PI-controller maximum limit

These parameter set the minimum and maximum values of the PI-controller output.
Parameter value limits par 1 1 <par 2 24 <par 2 2 5

2 26 Direct frequency reference Place B

0 Analog voltage reference from terminals 2—3, e g a potentiometer
1 *Analog current reference from terminals 4—5 e g a transducer*
2 Panel reference is the reference set from the Reference Page (REF)
Reference r1 is the Place B reference, see chapter 6
3 Reference value is changed with digital input signals DIA2 and DIA3
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2. 3
4 Same as setting 3, but the reference value is set to the minimum frequency (par 1. 1) each time the drive is stopped. When the value of the parameter 1.5 is set to 3 or 4, value of the parameter 2 1 is automatically set to 4 and value of the parameter 2 2 is automatically set to 10

2. 27 Source B reference scaling, minimum value/maximum value

2. 28 Setting limits. 0 < par 2 27 < par 2 28 < par 1 2
If par. 2. 28 = 0 scaling is set off.
See figures 4.5-7 and 4.5-8.

(In the figures below the voltage input V_{in} with signal range 0—10 V is selected for source B reference)

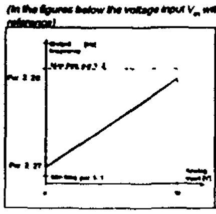


Figure 4 5-7 Reference scaling

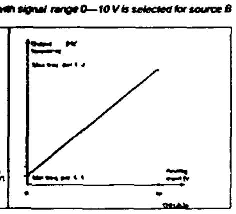


Figure 4 5-8 Reference scaling par 2 28 = 0

3 1 Analog output Content

See table on page 4 10

3 2 Analog output filter time

Filters the analog output signal
See figure 4 5-9

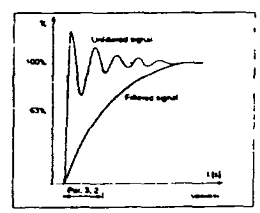


Figure 4 5-9 Analog output filtering

3 3 Analog output invert

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

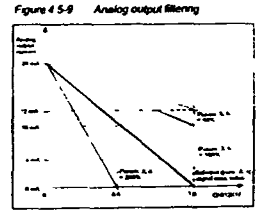


Figure 4.5-10 Analog output invert

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA. See figure 4.5-9

3 5 Analog output scale

Scaling factor for analog output
See figure 4 5-11

Signal	Max. value of the signal
Output frequency	Max frequency (p 1 2)
Motor speed	Max speed (n_nxf_{max}/f_n)
Output current	2 x I_{nSVX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

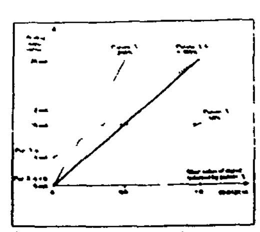


Figure 4 5-1 Analog output scale

3 6 Digital output function
3 7 Relay output 1 function
3 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	a fault trip has not occurred
5 = SV9000 overheat warning	The heat sink temperature exceeds +70 C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 if analog reference is 4 20 mA and signal is 4mA
8 = Warning	Always if a warning exists (see Table 7 10 1 in Users manual
9 = Reversed	The reverse command has been selected
10= Jog speed	Jog speed has been selected with digital input
11= At speed	The output frequency has reached the set reference
12= Motor regulator activated	Overvoltage or overcurrent regulator was activated
13= Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 9 and 3 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 11 and 3 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par 3 13 and 3 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par 3 15 and 3 16)
17= External brake control	External brake ON/OFF control with programmable delay (par 3 17 and 3 18)
18= Control from I/O terminals	External control mode selected with progr push button #2
19= Drive temperature limit supervision	Temperature on drive goes outside the set supervision limits (par 3 19 and 3 20)
20= Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par 3 18 and 3 18) output active when brake control is OFF

Table 4 5-2 Output signals via DO1 and output relays RO1 and RO2

3 9 Output frequency limit 1 supervision function
3 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3 10 3, 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

3 10 Output frequency limit 1, supervision value
3 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3 9 (3 11)

See figure 4 5-12

3 13 Torque limit supervision function

0 = No supervision
1 - Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

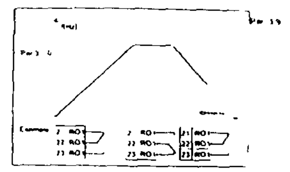


Figure 4 5-12 Output frequency supervision

3 14 Torque limit supervision value

The calculated torque value to be supervised by the parameter 3 13

3 15 Reference limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8 The supervised reference is the current active reference It can be source A or B reference depending on DIB6 input or panel reference if panel is the active control place

3 16 Reference limit supervision value

The frequency value to be supervised by the parameter 3 15

3 17 External brake-off delay
3 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters See figure 4 5-13

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2 see parameters 3 6—3 8

3 19 Drive temperature limit supervision

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

3 20 Drive temperature limit value

The temperature value to be supervised by parameter 3 19

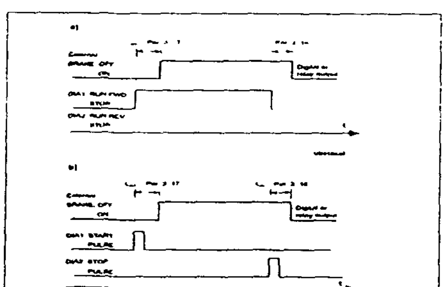


Figure 4.5-13 External brake control a) Start/Stop logic selection par 2 1 = 0 1 or 2 b)Start/Stop logic selection par 2 1 = 3

4 1 Acc/Dec ramp 1 shape
4 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters

Setting the value = 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3, 4 4 for Acc/Dec time 2).

Setting 0 1—10 seconds for 4 1 (4 2) causes an S-shaped ramp The speed changes are smooth. Parameter 1 3/ 1 4 (4 3/ 4 4) determines the ramp time of the acceleration/deceleration in the middle of the curve
See figure 4 5-14

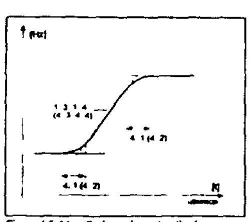


Figure 4 5-14 S-shaped acceleration/ deceleration.

4 3 Acceleration time 2
4 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) With this parameter it is possible to set two different acceleration/ deceleration times for one application. The active set can be selected with the programmable signal DIA3 of this application, see parameter 2 2

4 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual

4 6 Start function

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may extend the acceleration times)

Flying start

1 The drive starts into a running motor by first finding the speed the motor is running at Searching starts from the maximum frequency down until the actual frequency reached The output frequency then accelerates/ decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 Stop function

Coasting

0 The motor coasts to an uncontrolled stop with the SV9000 off, after the Stop command

Ramp

1 After the Stop command the speed of the motor is decelerated according to the deceleration ramp time parameter If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration

4 8 DC braking current

Defines the current injected into the motor during the DC braking

4 9 DC braking time at stop

Defines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping The function of the DC-brake depends on the stop function, parameter 4 7 See figure 4.5-15

0 DC-brake is not used

>0 DC-brake is in use and its function depends on the Stop function (param 4 7) and the time depends on the value of parameter 4 9

Stop-function = 0 (coasting).

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC-braking starts If the frequency is ≥nominal frequency of the motor (par 1 11) setting value of parameter 4 9 determines the braking time When the frequency is <10% of the nominal the braking time is 10% of the set value of parameter 4 9

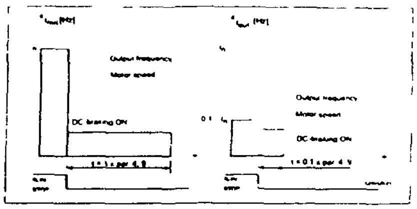


Figure 4 5-15 DC-braking time when par 4 7 = 0

Stop-function = 1 (ramp).

After the stop command the speed of the motor is reduced based on the deceleration ramp parameter If no regeneration occurs due to load inertia to a speed defined with parameter 4 10 where the DC-braking starts

The braking time is defined with parameter 4 9

If high inertia exists it is recommended to use an external braking resistor for faster deceleration. See figure 4 5-16

4 10 **Execute frequency of DC-brake during ramp Stop**

See figure 4 5-16

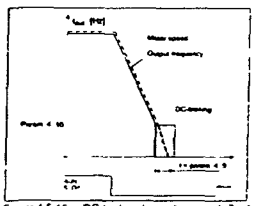


Figure 4 5-16 DC-braking time when par 4 7 = 1

4 11 **DC-brake time at start**

0 DC brake is not used

>0 DC brake is active when the start command is given This parameter defines the time before the brake is released After the brake is released the output frequency increases according to the set start function parameter 4 6 and the acceleration parameters (1 3 4 1 or 4 2 4 3) See figure 4 5-17

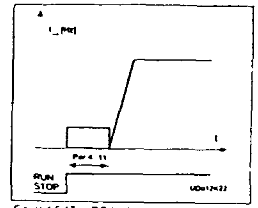


Figure 4 5 17 DC braking time at start

4 12 **Jog speed reference**

Parameter value defines the Jog speed selected with the digital input

5 1 5 6 **Prohibit frequency area Low limit/High limit**

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems

With these parameters it is possible to set limits for three "skip frequency" regions The accuracy of the setting is 0 1 Hz

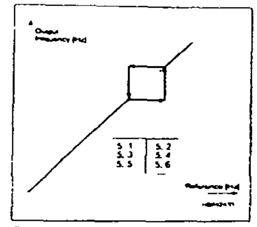


Figure 4.5-18 Example of prohibit frequency area setting

6 1 **Motor control mode**

0 = Frequency control (V/Hz) The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq resolution 0 01 Hz)

1 = Speed control (sensorless vector) The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%)

6 2 **Switching frequency**

Motor noise can be minimized using a high switching frequency Increasing the frequency reduces the capacity of the SV9000

Before changing the frequency from the factory default 10 kHz (3.6 kHz >40 Hp) check the drive derating in the curves shown in figures 5.2 2 and 5.2-3 in chapter *5.2 of the User's Manual.*

6 3 **Field weakening point**

6 4 **Voltage at the field weakening point**

The field weakening point is the output frequency where the output voltage reaches the set maximum value (par 6. 4) Above that frequency the output voltage remains at the set maximum value Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1 8 1 9 6 5 6 6 and 6. 7 See figure 4 5-19

When parameters 1. 10 and 1 11 nominal voltage and nominal frequency of the motor are set, parameters 6 3 and 6 4 are also set automatically to the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1 10 and 1 11

6 5 **V/Hz curve, middle point frequency**

If the programmable V/Hz curve has been selected with parameter 1 8, this parameter defines the middle point frequency of the curve See figure 4.5-19

6. 6 **V/Hz curve, middle point voltage**

If the programmable V/Hz curve has been selected with parameter 1 8, this parameter defines the middle point voltage (% of motor nominal voltage) of the curve See figure 4 5-19

6. 7 **Output voltage at zero frequency**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage of the curve See figure 4 5-19

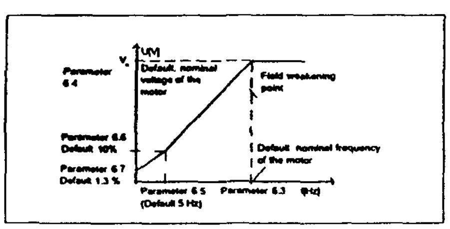


Figure 4 5-19 Programmable V/Hz curve

6 8 **Overvoltage controller**

6 9 **Undervoltage controller**

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON they will change the motor speed in over/undervoltage cases Overvoltage = faster undervoltage = slower

Over/undervoltage trips may occur when the controllers are not used

7 1 **Response to the reference fault**

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 **Response to external fault**

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7 3 **Phase supervision of the motor**

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7 4 **Ground fault protection**

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero The ground protection is always working and protects the frequency converter from ground faults with high current levels.

Parameters 7 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating The SV9000 drive is capable of supplying higher than nominal current to the motor If the load requires this high current there is a risk that the motor will be thermally over loaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan, the load derating on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor When the power is turned on to the drive, the calculated model uses the heatsink temperature to determine the initial thermal state of the motor The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_t specifies the load current above which the motor is overloaded

This current limit is a function of the output frequency The curve for I_t is set with parameters 7 6 7 7 and 7 9 refer to the figure 4 5-20 The default values of these parameters are set from the motor nameplate data

With the output current at I the thermal state will reach the nominal value (100%) The thermal state changes with the square of the current With output current at 75% of I the thermal state will reach 56% and with output current at 120% of I_t the thermal stage would reach 144% The function will trip the drive (refer par 7 5) if the thermal model reaches a value of 105% The response time of the thermal model is determined by the time constant parameter 7 8 The larger the motor the longer it takes to reach the final temperature

The thermal state of the motor can be monitored through the display Refer to the table for monitoring items (User's Manual table 7 3-1)

7 5 Motor thermal protection

CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt*

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is selected the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0 will reset the thermal stage of the motor to 0%

7 6 Motor thermal protection break point current

The current can be set between 50 0—150 0% x I_{nMotor}
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve See figure 4 5-20

The value is set as a percentage of the motor nameplate nominal current parameter 1 13 not the drive s nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated

If parameter 1 13 is adjusted this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

7 7 Motor thermal protection, zero frequency current

The current can be set between 10 0—150 0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency See figure 4 5-20

The default value is set assuming that there is no external fan cooling the motor If an external fan is used this parameter can be set to 90% (or higher)

The value is set as a percentage value of the motor's nameplate nominal current, parameter 1 13 not the drive s nominal output current The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated

If you change the parameter 1 13 this parameter is automatically *restored to the default value*

Setting this parameter (or parameter 1 13) does not affect to the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

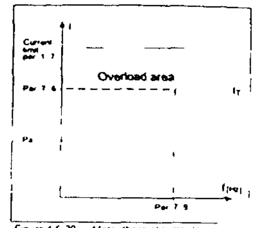


Figure 4 5-20 Motor thermal current I curve

7 8 Motor thermal protection time constant

This time can be set between 0 5—300 minutes This is the thermal time constant of the motor The larger the motor the greater the time constant The time constant is defined as the time that it takes the calculated thermal state to reach 63% of its final value

The motor thermal time is specific to a motor design and it varies between different motor manufacturers

The default value for the time constant is calculated based on the motor nameplate data from parameters 1 12 and 1 13 If either of these parameters is reset, then this parameter is set to default value

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time As a rule of thumb the motor thermal time constant in minutes equals to $2xt_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current) If the drive is stopped the time constant is internally increased to three times the set parameter value The cooling in the stop stage is based on convection with an increased time constant

7 9 Motor thermal protection, break point frequency

This frequency can be set between 10—500 Hz
This is the frequency break point of the thermal current curve With frequencies above this point, the thermal capacity of the motor is assumed to be constant See figure 4 5-20

The default value is based on the motor's nameplate data, parameter 1 11 It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor More generally it is 70% of the frequency at the field weakening point (parameter 6 3) Changing either parameter 1 11 or 6 3 will restore this parameter to its default value

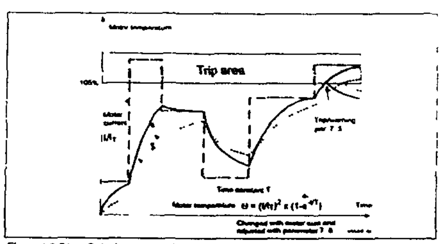


Figure 4 5-21 Calculating motor temperature

Parameters 7 10— 7 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters 7 11 Stall Current and 7 13 Stall Frequency If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true There is no true detection of shaft rotation. Stall protection is a type of overcurrent protection

7 10 Stall protection

Operation.

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is set on, the drive will stop and activate the fault stage Setting the parameter to 0 will deactivate the protection and will reset the stall time counter to zero

7 11 Stall current limit

The current can be set between 0 0—200% x I_{nMotor}

In the stall stage the current has to be above this limit. See figure 4.5-22 The value is set as a percentage of the motor's name-plate nominal current, parameter 1 13, motor's nominal current. If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

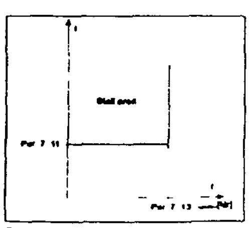


Figure 4 5-22 Setting the stall characteristics

7 12 Stall time

The time can be set between 2 0—120 s
This is the maximum allowed time for a stall There is an internal up/down counter to count the stall time See figure 4 5-23 If the stall time counter value goes above this limit the protection will cause a trip (refer to parameter 7 10)

7 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par 1 2)
In the stall state the output frequency has to be smaller than this limit Refer to figure 4 5-22

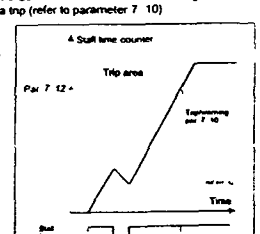


Figure 4 5-23 Counting the stall time

Parameters 7 14— 7 17 Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g broken belt or dry pump

Motor underload protection can be adjusted by setting the underload curve with parameters 7 15 and 7 16 The underload curve is a squared curve set between zero frequency and the field weakening point The protection is not active below 5 Hz (the underload counter value is stopped) See figure 4 5-24

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor The motor's nameplate data parameter 1 13 the motor's nominal current and the drive s nominal current I_{CT} are used to find the scaling ratio for the internal torque value If other than a standard motor is used with the drive the accuracy of the torque calculation is decreased

7 14 Underload protection

Operation

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code If tripping is set active the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0 will reset the underload time counter to zero

7 15 Underload protection, field weakening area load

Torque limit can be set between 20 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point See figure 4 5-24
If parameter 1 13 is adjusted this parameter is automatically restored to its default value

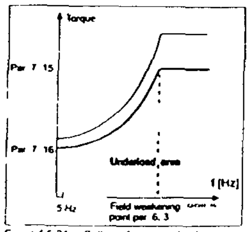


Figure 4 5-24 Setting of minimum load

7 16 Underload protection zero frequency load

Torque limit can be set between 10 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque with zero frequency See figure 4 5-24 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

7 17 Underload time

This time can be set between 2 0—600 0 s

This is the maximum allowed time for an underload state There is an internal up/down counter to accumulate the underload time See figure 4 5-25
If the underload counter value goes above this limit the protection will cause a trip (refer to the parameter 7 14) If the drive is stopped the underload counter is reset to zero

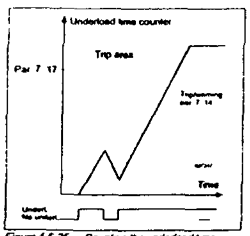


Figure 4 5-25 Counting the underload time

8 1 Automatic restart number of tries
8 2 Automatic restart trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8 8 The Start function for Automatic restart is selected with parameter 8 3 See figure 4 5-26

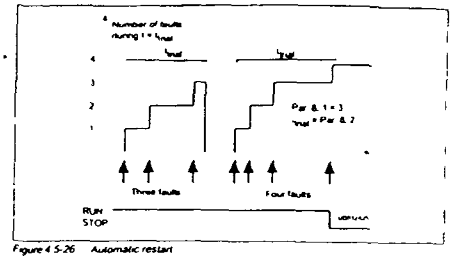


Figure 4 5-26 Automatic restart

Parameter 8 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2

The time counting starts from the first autorestart If the number of restarts does not exceed the value of the parameter 8 1 during the trial time the counting is cleared after the trial time has elapsed The next fault starts the counting again

8 3 Automatic restart, start function

The parameter defines the start mode

- 0 = Start with ramp
- 1 = Flying start, see parameter 4 6

8 4 Automatic restart after undervoltage trip

- 0 = No automatic restart after undervoltage trip
- 1 = Automatic restart after undervoltage fault condition returns to normal (DC-link voltage returns to the normal level)

8 5 Automatic restart after overvoltage trip

- 0 = No automatic restart after overvoltage trip
- 1 = Automatic restart after overvoltage fault condition returns to normal (DC link voltage returns to the normal level)

8 6 Automatic restart after overcurrent trip

- 0 = No automatic restart after overcurrent trip
- 1 = Automatic restart after overcurrent faults

8 7 Automatic restart after reference fault trip

- 0 = No automatic restart after reference fault trip
- 1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8 8 Automatic restart after over-/undertemperature fault trip

- 0 = No automatic restart after temperature fault trip
- 1 = Automatic restart after the heatsink temperature has returned to its normal level between 10°C—+75°C

4.6 Panel reference

The PI-control application has an extra reference (r2) for the PI-controller on the panel's reference page See table 4.6-1

Reference number	Reference name	Range	Step	Function
r 1	Frequency reference	f_{min}—f_{max}	0.01 Hz	Reference for panel control and I/O terminal Source B reference
r 2	PI-controller reference	0—100%	0 1%	Reference for PI-controller

4 7 Monitoring data

The PI-control application has additional items for monitoring See table 4 7-1

Number	Data name	Unit	Description
n 1	Output frequency	Hz	Frequency to the motor
n 2	Motor speed	rpm	Calculated motor speed
n 3	Motor current	A	Measured motor current
n 4	Motor torque	%	Calculated actual torque/nominal torque of the unit
n 5	Motor power	%	Calculated actual power/nominal power of the unit
n 6	Motor voltage	V	Calculated motor voltage
n 7	DC-link voltage	V	Measured DC-link voltage
n 8	Temperature	°C	Temperature of the heat sink
n 9	Operating day counter	DD.dd	Operating days [1], not resettable
n 10	Operating hours, "trip counter"	HH.hh	Operating hours [2], can be reset with programmable button #3
n 11	MW-hours	MWh	Total MW-hours, not resettable
n 12	MW-hours, "trip counter"	MWh	MW-hours, can be reset with programmable button #4
n 13	Voltage/analog input	V	Voltage at the terminal V_{in}+ (term. #2)
n 14	Current/analog input	mA	Current at terminals I_{in}+ and I_{in}- (term. #4 #5)
n 15	Digital input status gr A		
n 16	Digital input status gr B		
n 17	Digital and relay output status		
n 18	Control program		Version number of the control software
n 19	Unit nominal power	Hp	Shows the horsepower size of the unit
n 20	PI-controller reference	%	Percent of the maximum reference
n 21	PI-controller actual value	%	Percent of the maximum actual value
n 22	PI-controller error value	%	Percent of the maximum error value
n 23	PI-controller output	Hz	
n 24	Motor temperature rise	%	100%= temperature of motor has risen to nominal

Table 4 7-1 Monitored items.

[1] DD = full days dd = decimal part of a day
[2] HH = full hours hh = decimal part of an hour

Notes

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4

MULTI-PURPOSE CONTROL APPLICATION
(par 0 1 - 6)

CONTENTS

5

5 Multi purpose Control Application

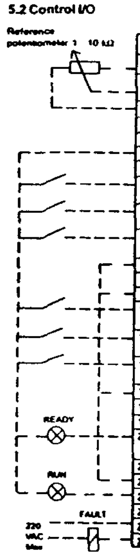
5 1 General

In the Multi-purpose control application the frequency reference can be selected from the analog inputs the joystick control the motorized (digital) potentiometer and a mathematical function of the analog inputs Multi-step speeds and jog speed can also be selected if digital inputs are programmed for these functions

Digital inputs DIA1 and DIA2 are reserved for Start/stop logic. Digital inputs DIA3—DIB6 are programmable for multi-step speed select, jog speed select, motorized (digital potentiometer external fault ramp time select, ramp prohibit fault reset and DC-brake command function All outputs are freely programmable

* **NOTE! Remember to connect the CMA and CMB inputs**

5.2 Control I/O



Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for a potentiometer etc
2	V$_{in}$+	Analog input voltage (programmable)	Frequency reference range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I$_{in}$+	Analog input,	Default setting not used
5	I$_{in}$-	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches etc. max. 0 1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward (programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Jog speed select (programmable)	Contact open = no action Contact closed = jog speed
15	DIB5	External fault (programmable)	Contact open = no fault Contact closed = fault
16	DIB6	Accel /deceler time select (programmable)	Contact open = par 1 3 1 4 in use Contact closed = par 4 3 4 4 in use
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I$_{out}$+	Output frequency	Programmable (par 3. 1)
19	I$_{out}$	Analog output	Range 0—20 mA/R$_L$ max 500 Ω
20	DO1	Digital output READY	Programmable (par 3. 6) Open collector I<50 mA V<48 VDC
21	RO1	Relay output 1 RUN	Programmable (par 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3. 8)
25	RO2		
26	RO2		

Figure 5 2-1 Default I/O configuration and connection example of the Multi-purpose Control Application

5

5 3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 5 3-1

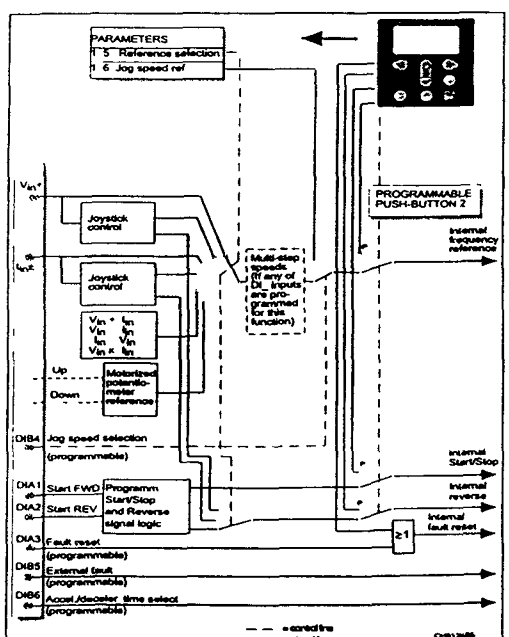


Figure 5 3-1 Control signal logic of the Multipurpose Control Application Switch positions shown are based on the factory settings

5

5 4 Basic parameters Group 1

5 4 1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 1	Minimum frequency	0— f_{max}	1 Hz	0 Hz			5-5
1 2	Maximum frequency	f_{min}-120/500Hz	1 Hz	60 Hz			5-6
1 3	Acceleration time 1	0 1—3000 0 s	0 1 s	3 0 s		Time from f_{min} (1 1) to f_{max} (1 2)	5-5
1 4	Deceleration time 1	0 1—3000 0 s	0 1 s	3 0 s		Time from f_{max} (1 2) to f_{min} (1 1)	5-5
1 5	Reference selection ■	0—8		0		0 = V_{in}; 3 = V_{in} - I_{in}; 1 = I_{in}; 4 = I_{in} - V_{in}; 2 = V_{in} + I_{in}; 5 = V_{in} * I_{in}; 6 = V_{in} joystick control; 7 = I_{in} joystick control; 8 = Signal from internal motor pot; 9 = Signal from internal motor pot reset if SV9000 is stopped	5-5
1 6	Jog speed reference ■	f_{min} — f_{max} (1 1) (1 2)	0 1 Hz	5 0 Hz			5-6
1 7	Current limit	0 1—2 5 x I_{nSV9}	0 1 A	1 5 x I_{nSV9}		Output current limit (A) of the unit	5-6
1 8	V/Hz ratio selection ■	0—2	1	0		0 = Linear; 1 = Squared; 2 = Programmable V/Hz ratio	5-6
1 9	V/Hz optimization ■	0—1	1	0		0 = None; 1 = Automatic torque boost	5-8
1 10	Nominal voltage of the motor ■	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2; Voltage code 4; Voltage code 5; Voltage code 6	5-8
1 11	Nominal frequency of the motor ■	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	5-8
1 12	Nominal speed of the motor ■	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	5-8
1 13	Nominal current of the motor ■	2.5 x I_{nSV9}	0 1 A	I_{nSV9}		I_n from the nameplate of the motor	5-8
1 14	Supply voltage ■	208—240		230 V		Voltage code 2	5-8
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters; 0 = All parameter groups visible; 1 = Only group 1 is visible	5-8
1 16	Parameter value lock	0—1	1	0		Disables parameter changes; 0 = Changes enabled; 1 = Changes disabled	5-8

Note! ■ = Parameter value can be changed only when the drive is stopped

* If 1 2 >motor synchr speed check suitability for motor and drive system
Selecting 120/500 Hz range see page 5-5

** Default value for a four pole motor and a nominal size drive

Table 5 4-1 Group 1 basic parameters

5 4 2 Description of Group 1 parameters

1 1 1 2 Minimum / maximum frequency

Defines frequency limits of the drive
The default maximum value for parameters 1 1 and 1 2 is 120 Hz By setting 1 2 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz At the same time the panel reference resolution is changed from 0 01 Hz to 0 1 Hz
Changing the max value from 500 Hz to 120 Hz is done by setting parameter 1 2 - 119 Hz when the drive is stopped

1 3 1 4 Acceleration time 1 deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2)

1 5 Reference selection

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5 e g a transducer
2 Reference is formed by adding the values of the analog inputs
3 Reference is formed by subtracting the voltage input (V_{in}) value from the current input (I_{in}) value
4 Reference is formed by subtracting the current input (I_{in}) value from the voltage input (V_{in}) value
5 Reference is formed by multiplying the values of the analog inputs
6 Joystick control from the voltage input (V_{in})

Signal range	Max reverse speed	Direction change	Max forward speed
0—10 V	0 V	5 V	+10 V
Custom	Par 2 7 x 10 V	In the middle of custom range	Par 2 8 x 10 V
-10 V—+10 V	-10 V	0 V	+10 V

Warning! Use only -10 V—+10 V signal range If a custom or 0—10 V signal range is used, the drive will run at the max reverse speed if the reference signal is lost

7 Joystick control from the current input (I_{in})

Signal range	Max reverse speed	Direction change	Max forward speed
0—20 mA	0 mA	10 mA	20 mA
Custom	Par 2 13 x 20 mA	In the middle of custom range	Par 2 14 x 20 mA
4—20 mA	4 mA	12 mA	20 mA

Warning! Use only 4—20 mA signal range If a custom or 0—20 mA signal range is used the drive will run at the max. reverse speed if the control signal is lost. Set the reference fault (par 7 2) active when the 4—20 mA range is used, then the drive will stop with a reference fault if the reference signal is lost

Note! When joystick control is used, the direction control is generated from the joystick reference signal See figure 5 4-1

Analog input scaling, parameters 2 16—2 19 are not used when joystick control is used

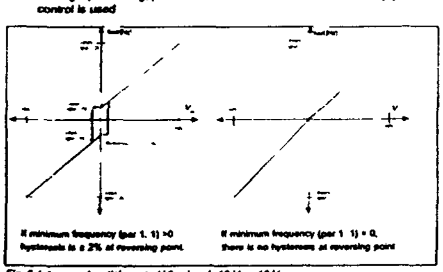


Fig. 5 4-1 Joystick control Vin signal -10 V—+10 V

8 Reference value is changed with digital input signals DIA4 and DIA5
- switch in DIA3 closed = frequency reference increases
- switch in DIA4 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2. 20

9 Same as setting 8 but the reference value is set to the minimum frequency (par. 1. 1) each time the SV9000 is stopped.
When the value of parameter 1. 5 is set to 8 or 9, the value of parameters 2. 4 and 2. 5 are automatically set to 11

1 6 Jog speed reference

Parameter value defines the jog speed selected with the digital input

1 7 Current limit

This parameter determines the maximum motor current that the SV9000 will provide short term

1 8 V/Hz ratio selection

Linear 0 — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6. 3) where a constant voltage (nominal value) is also supplied to the motor See figure 5.4 -2 A linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting

Squared 1 — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6 3) where the nominal voltage is also supplied to the motor See figure 5.4 -2

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e g in centrifugal fans and pumps

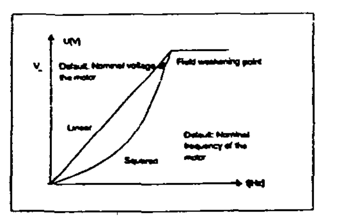


Figure 5.4 -2 Linear and squared V/Hz curves.

Programm. V/Hz curve 2 — The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 1.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 5.4 -3

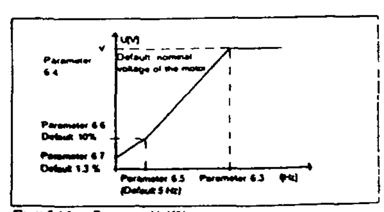


Figure 5 4-3 Programmable V/Hz curve

1 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies The voltage increase depends on the motor type and horsepower

Automatic torque boost can be used in applications where starting torque due to starting friction is high e g in conveyors

NOTE! In high torque low speed applications it is likely the motor will overheat If the motor has to run prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the temperature rise is too high

1 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor
This parameter sets the voltage at the field weakening point parameter 6 4 to 100% x V_{nmotor}

1 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor
This parameter sets the frequency of the field weakening point parameter 6 3 to the same value

1 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor The internal motor protection function uses this value as a reference value

1 14 Supply voltage

Set parameter value according to the nominal voltage of the supply Values are pre-defined for voltage codes 2 4 5 and 6 See table 5 4 1

1 15 Parameter conceal

Defines which parameter groups are available

0 = all parameter groups are visible
1 = only group 1 is visible

1 16 Parameter value lock

Defines access to the changes of the parameter values

0 = parameter value changes enabled
1 = parameter value changes disabled

To adjust more of the functions of the Multi-purpose application see chapter 5 5 to modify the parameters of Groups 2—8

5 5 Special parameters Groups 2—8

5 5 1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2 1	Start/Stop logic selection	0—3	1	0		DIA1 / DIA2: 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	5-16
2 2	DIA3 function (terminal 10)	0—9	1	7		0 = Not used 1 = Ext fault closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /dec time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command	5-17
2 3	DIB4 function (terminal 14)	0—10	1	6		0 = Not used 1 = Ext fault closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /dec time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command 10 = Multi-Step speed select	5-18
2 4	DIB5 function (terminal 15)	0—11	1	1		0 = Not used 1 = Ext. fault closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 2 11 = Motorized pot. speed up	5-18
2 5	DIB6 function (terminal 16)	0—11	1	4		0 = Not used 1 = Ext fault closing contact 2 = External fault opening contact 3 = Run enable 4 = Acc /dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc /dec operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 3 11 = Motorized pot. speed down	5-18
2 6	V_{in} signal range	0-2	1	0		0 = 0—10 V 1 = Custom setting range 2 = -10—+10 V (can be used only with Joystick control)	5-19

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 7	V_{in} custom setting min	0.00-100.00%	0.01%	0.00%			5-19
2. 8	V_{in} custom setting max	0.00-100.00%	0.01%	100.00%			5-19
2. 9	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-19
2. 10	V_{in} signal filter time	0.00 —10.00 s	0.01 s	0 10 s		0 = No filtering	5-19
2. 11	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	5-19
2. 12	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			5-20
2. 13	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			5-20
2. 14	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-20
2. 15	I_{in} signal filter time	0.01 —10.00 s	0.01 s	0 10 s		0 = No filtering	5-20
2. 16	V_{in} minimum scaling	-320.00%—+320.00 %	0.01	0.00%		0% = no minimum scaling	5-20
2. 17	V_{in} maximum scaling	-320.00%—+320.00 %	0.01	100.00%		100% = no maximum scaling	5-20
2. 18	I_{in} minimum scaling	-320.00%—+320.00%	0.01	0.00%		0% = no minimum scaling	5-20
2. 19	I_{in} maximum scaling	-320.00%—+320.00 %	0.01	100.00%		100% = no maximum scaling	5-20
2. 20	Free analog input, signal selection	0—2	1	0		0 = Not use 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	5-21
2. 21	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par 1.7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervis limit	5-21
2. 22	Motorized digital potentiometer ramp time	0 1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			5-22

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function ■	0—7	1	1		0 = Not used — Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max speed) 3 = O/P current (0—2 0 x I_{nmot}) 4 = Motor torque (0—2 x T_{nmot}) 5 = Motor power (0—2 x P_{nmot}) 6 = Motor voltage (0—100% x V_{nmot}) 7 = DC-link volt. (0—1000 V)	5-23
3. 2	Analog output filter time	0.00-10.00s	0.01 s	1 00 s			5-23
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-23
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	5-23
3. 5	Analog output scale	10—1000%	1%	100%			5-23

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
3 6	Digital output function ■	0—21	1			0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq limit superv 1 14 = Output freq limit superv 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	5-24
3. 7	Relay output 1 function ■	0—21	1	2		As parameter 3. 6	5-24
3 8	Relay output 2 function ■	0—21	1	3		As parameter 3. 6	5-24
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-24
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1 2)	0.1 Hz	0.0 Hz			5-24
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-24
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par 1 2)	0.1 Hz	0.0 Hz			5-24
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3 14	Torque limit supervision value	200 0—200.0% xT_{nmot}	0 1%	100.0%			5-25
3 15	Reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3 16	Reference limit supervision value	0.0—f_{max} (par 1 2)	0 1 Hz	0.0 Hz			5-25
3. 17	Extern. brake Off-delay	0.0—100.0 s	0 1 s	0.5 s			5-25
3. 18	Extern. brake On-delay	0.0—100.0 s	0.1 s	1.5 s			5-25
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3. 20	Drive temperature limit value	-10—+75°C	1°C	+40°C			5-25

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.21	I/O-expander board (opt.) analog output content	0—7	1	3		See parameter 3.1	5-23
3.22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01	1.00 s		See parameter 3.2	5-23
3.23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3.3	5-23
3.24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3.4	5-23
3.25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3.5	5-23

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	5-26
4.2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	5-26
4.3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			5-27
4.4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			5-27
4.5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	5-27
4.6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	5-27
4.7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	5-27
4.8	DC-braking current	0.15—1.5 x I_{nVS} (A)	0.1 A	0.5 x I_{nVS}			5-27
4.9	DC-braking time at Stop	0.00-250.00s	0.01 s	0.00 s		0 = DC-brake is off at Stop	5-28
4.10	Execute frequency of DC-brake during ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			5-29
4.11	DC-brake time at Start	0.00-25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	5-29
4.12	Multi-step speed reference 1	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	10.0 Hz			5-29
4.13	Multi-step speed reference 2	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	15.0 Hz			5-29
4.14	Multi-step speed reference 3	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	20.0 Hz			5-29
4.15	Multi-step speed reference 4	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	25.0 Hz			5-29
4.16	Multi-step speed reference 5	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	30.0 Hz			5-29
4.17	Multi-step speed reference 6	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	40.0 Hz			5-29
4.18	Multi-step speed reference 7	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	50.0 Hz			5-29

Note! = Parameter value can be changed only when the drive is stopped

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	f_{min}— par. 5.2	0.1 Hz	0.0 Hz			5-29
5.2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 1 is off	5-29
5.3	Prohibit frequency range 2 low limit	f_{min}— par. 5.4	0.1 Hz	0.0 Hz			5-29
5.4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 2 is off	5-29
5.5	Prohibit frequency range 3 low limit	f_{min}— par. 5.6	0.1 Hz	0.0 Hz			5-29
5.6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = Prohibit range 3 is off	5-29

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	5-29
6.2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6 kHz		Depends on Hp rating	5-30
6.3	Field weakening point	30—500 Hz	1 Hz	Param. 1.11			5-30
6.4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			5-30
6.5	V/Hz curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			5-30
6.6	V/Hz curve mid point voltage	0.00—100.00% x V_{nmot}	0.01%	0.00 %			5-30
6.7	Output voltage at zero frequency	0.00—100.00% x V_{nmot}	0.01%	0.00 %			5-30
6.8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	5-31
6.9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	5-31

Note! = Parameter value can be changed only when the drive is stopped

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	5-31
7.2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	5-31
7.3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	5-31
7.4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	5-31
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	5-32
7.6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			5-32
7.7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			5-33
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	5-33
7.9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			5-34
7.10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	5-34
7.11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			5-35
7.12	Stall time	2.0—120.0 s	1.0 s	15.0 s			5-35
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			5-35
7.14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	5-36
7.15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			5-36
7.16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			5-36
7.17	Underload time	2.0—600.0 s	1.0 s	20.0s			5-36

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8.1	Automatic restart: number of tries	0—10	1	0		0 = not in use	5-37
8.2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			5-37
8.3	Automatic restart start function	0—1	1	0		0 = Ramp 1 = Flying start	5-38
8.4	Automatic restart of undervoltage	0—1	1	0		0 = No 1 = Yes	5-38
8.5	Automatic restart of overvoltage	0—1	1	0		0 = No 1 = Yes	5-38
8.6	Automatic restart of overcurrent	0—1	1	0		0 = No 1 = Yes	5-38
8.7	Automatic restart of reference fault	0—1	1	0		0 = No 1 = Yes	5-38
8.8	Automatic restart after over/undertemperature fault	0—1	1	0		0 = No 1 = Yes	5-38

Table 5.5-1 Special parameters, Groups 2—8.

5 5 2 **Description of Groups 2—8 parameters**

2 1 **Start/Stop logic selection**

0 DIA1 closed contact = start forward
DIA2 closed contact = start reverse
See figure 5 5-1

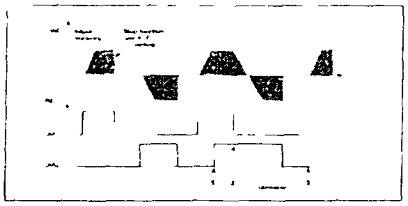


Figure 5.5-1 Start forward/Start reverse

(1) The first selected direction has the highest priority
(2) When DIA1 contact opens the direction of rotation starts to change
(3) If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously the Start forward signal (DIA1) has priority

1 DIA1 closed contact = start open contact = stop
DIA2 closed contact = reverse open contact = forward
See figure 5 5-2

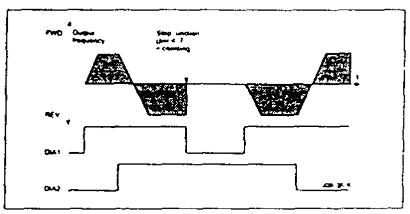


Figure 5 5-2 Start, Stop reverse

5

2 DIA1 closed contact = start open contact = stop
DIA2 closed contact = start enabled open contact = start disabled

3 3-wire connection (pulse control)
DIA1 closed contact = start pulse
DIA2 closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 5 5-3

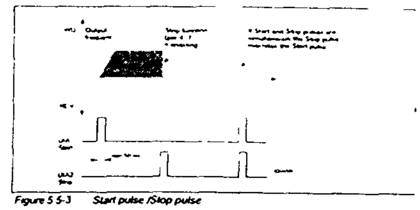


Figure 5 5-3 Start pulse /Stop pulse

2 2 **DIA3 function**

1 External fault	closing contact	= Fault is shown and drive responds according to parameter 7 2	
2 External fault	opening contact	= Fault is shown and drive responds according to parameter 7 2	
3 Run enable	contact open contact closed	= Start of the motor disabled = Start of the motor enabled	
4 Acc / Dec time select	contact open contact closed	= Acceleration/Deceleration time 1 selected = Acceleration/Deceleration time 2 selected	
5 Reverse	contact open contact closed	= Forward = Reverse	Can be used for reversing if parameter 2 1 has value 3
6 Jog speed	contact closed	= Jog speed selected for freq reference	
7 Fault reset	contact closed	= Resets all faults	
8 Acc./Dec operation prohibited	contact closed	= Stops acceleration or deceleration until the contact is opened	
9 DC-braking command	contact closed	= In Stop mode, the DC-braking operates until the contact is opened, see figure 5 5-4 DC-brake current is set with parameter 4 8	

5

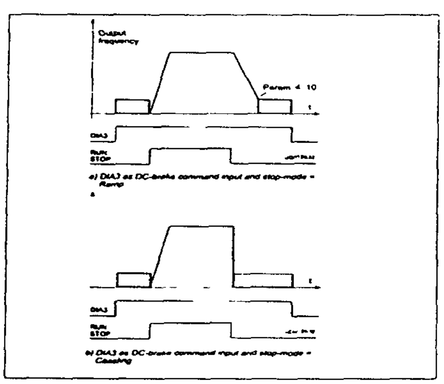


Figure 5.5-4 DIA3 as DC-brake command input a) Stop-mode = Ramp b) Stop-mode = Coasting

2 3 **DIB4 function**

Selections are same as in 2 2 except

10 **Multi-Step speed select 1** contact closed = Selection 1 active

2 4 **DIB5 function**

Selections are same as in 2 2 except

10 **Multi-Step speed select 2** contact closed = Selection 2 active

11 **Motor pot. UP** contact closed= Reference decreases until the contact is opened

2 5 **DIB6 function**

Selections are same as in 2 2 except

10 **Multi-Step speed select 3** contact closed= Selection 3 active

11 **Motor pot. DOWN** contact closed= Reference decreases until the contact is opened

5

2 6 **V_{in} signal range**

0 = Signal range 0—+10 V
1 = Custom setting range from custom minimum (par 2 7) to custom maximum (par 2 8)
2 = Signal range -10—+10 V can be used only with Joystick control

2 7 **V_{in} custom setting minimum/maximum**

2 8 With these parameters V_{in} can be set for any input signal span within 0—10 V

Minimum setting Set the V_{in} signal to its minimum level, select parameter 2 7 press the Enter button

Maximum setting Set the V_{in} signal to its maximum level, select parameter 2. 8 press the Enter button

Note! These parameters can only be set with this procedure (not with arrow up/arrow down buttons)

2 9 **V_{in} signal inversion**

Parameter 2 9 = 0 no inversion of analog V_{in} signal

Parameter 2 9 = 1 inversion of analog V_{in} signal.

2 10 **V_{in} signal filter time**

Filters out disturbances from the incoming analog V_{in} signal A long filtering time makes drive response slower See figure 5 5-5

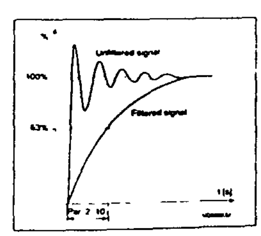


Figure 5 5-5 V_{in} signal filtering

5

2 11 **Analog input I_{in} signal range**

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

2 12
2 13 **Analog input I_{in} custom setting minimum/maximum**

With these parameters the scaling of the input current signal (I_{in}) range can be set between 0—20 mA

Minimum setting Set the I_{in} signal to its minimum level select parameter 2 12 press the Enter button

Maximum setting Set the I_{in} signal to its maximum level select parameter 2 13 press the Enter button

Note! These parameters can only be set with this procedure (not with arrow up/arrow down buttons)

2 14 **Analog input I_{in} inversion**

Parameter 2 14 = 0 no inversion of I_{in} input
Parameter 2 14 = 1 inversion of I_{in} input

2. 15 **Analog input I_{in} filter time**

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes drive response slower See figure 5 5-6

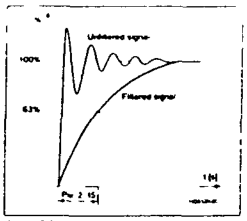


Figure 5 5-6 Analog input I_{in} filter time

2 16 **V_{in} signal minimum scaling**
Sets the minimum scaling point for V_{in} signal. See figure 5 5-7

2 17 **V_{in} signal maximum scaling**
Sets the maximum scaling point for V_{in} signal See figure 5 5-7

2. 18 **I_{in} signal minimum scaling**
Sets the minimum scaling point for I_{in} signal See figure 5.5-7

2 19 **I_{in} signal maximum scaling**
Sets the maximum scaling point for I_{in} signal. See figure 5 5-7

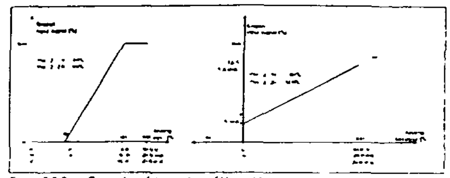


Figure 5 5-7 Examples of the scaling of V_{in} and I_{in} inputs

2 20 **Free analog input signal**

Selection of input signal of free analog input (an input not used for reference signal)
0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2 21 **Free analog input signal function**

This parameter sets the function of the free analog input:

0 = Function is not used

1 = Reducing motor current limit (par 1 7)
This signal will adjust the maximum motor current between 0 and parameter 1 7 set max limit.
See figure 5 5-8

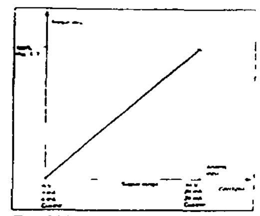


Figure 5 5-8 Reducing the max. motor current

2 = Reducing DC brake current

The DC braking current can be reduced with the free analog input signal between 0 15xI_{nSV9} and current set by parameter 4 8
See figure 5 5-9

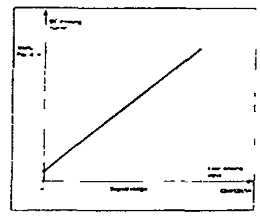


Figure 5 5-9 Reducing the DC brake current

3 Reducing acceleration and deceleration times

The acceleration and deceleration times can be reduced with the free analog input signal, according to the following formula

Reduced time = set acc./decel time (par 1. 3, 1. 4, 4. 3 4 4) divided by the factor R from figure 5 5-10

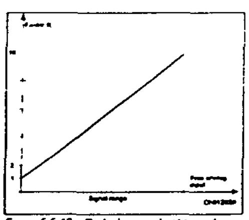


Figure 5 5-10 Reducing acceleration and deceleration times

4 Reducing torque supervision limit.

The set torque supervision limit can be reduced with the free analog input signal between 0 and set supervision limit (par 3. 14), see figure 5.5-11

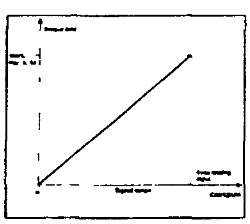


Figure 5.5-11 Reducing torque supervision limit.

2 22 **Motor potentiometer ramp time**

Defines how fast the electronic motor (digital) potentiometer value changes.

3 1 **Analog output function**

See table on page 5-10

3 2 **Analog output filter time**

Filters the analog output signal
See figure 5 5-12

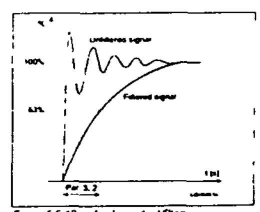


Figure 5 5-12 Analog output filtering

3.3 **Analog output invert**

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

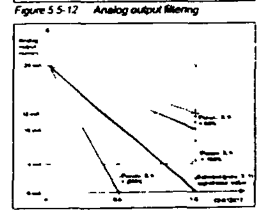


Figure 5.5-13 Analog output invert

3. 4 **Analog output minimum**

Defines the signal minimum to be either 0 mA or 4 mA. See figure 5.5-14

3 5 **Analog output scale**

Scaling factor for analog output
See figure 5 5-14

Signal	Max. value of the signal
Output frequency	Max. frequency (p 1 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	$2 x I_{nSV9}$
Motor torque	$2 x T_{nMot}$
Motor power	$2 x P_{nMot}$
Motor voltage	$100\% x V_{nMot}$
DC-link volt	1000 V

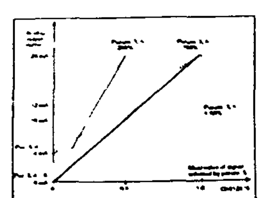


Figure 5 5-14 Analog output scale

3 6 Digital output function
3 7 Relay output 1 function
3 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat sink temperature exceeds 70 C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 - if analog reference is 4 20 mA and signal is <4mA
8 = Warning	If a warning exists. See Table 7 10 1 in the User's Manual
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 9 and 3 10)
14 = Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par 3 11 and 3 12)
15 = Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par 3 13 and 3 14)
16 = Reference limit supervision	Reference goes outside of the set supervision Low limit/ High limit (par 3 15 and 3 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3 17 and 3 18)
18 = Control from I/O terminals	External control mode selected with prog pushbutton #2
19 = Drive	Temperature on drive goes outside the set temperature supervision limits (par 3 19 and 3 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par 3 17 and 3 18) output active when brake control is OFF

Table 5 5-2 Output signals via DO1 and output relays RO1 and RO2

3 9 Output frequency limit 1 supervision function
3 11 Output frequency limit 2 supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3 10 3 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

3 10 Output frequency limit 1 supervision value
3 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3 9 (3 11) See figure 5 5-15

3 13 Torque limit supervision function

0 = No supervision
1 Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3 14) this function generates a warning message via the digital output DO1 via a relay output RO1 or RO2 depending on the settings of parameters 3 6—3 8

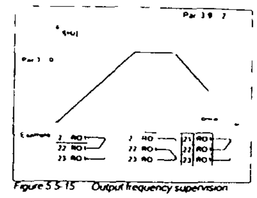


Figure 5 5-15 Output frequency supervision

3 14 Torque limit supervision value

The calculated torque value to be supervised by the parameter 3 13

3 15 Reference limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8 The supervised reference is the current active reference It can be source A or B reference depending on DIB6 input or the panel reference if panel is the active control source

3 16 Reference limit supervision value

The frequency value to be supervised by the parameter 3 15

3 17 External brake-off delay
3 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters See figure 5 5-16

The brake control signal can be programmed via the digital output DO1 or via one of relay outputs RO1 and RO2 see parameters 3 6—3 8

3 19 Drive temperature limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 o—3 8

3 20 Drive temperature limit value

The temperature value to be supervised by the parameter 3 19

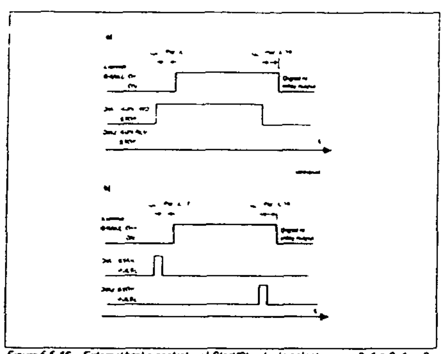


Figure 5 5-16 External brake control a) Start/Stop logic selection par 2 1 = 0 1 or 2
b)Start/Stop logic selection par 2 1 = 3

4 1 Acc/Dec ramp 1 shape
4 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3, 4 4 for Acc/Dec time 2)

Setting 0 1—10 seconds for 4 1 (4 2) causes an S-shaped ramp The speed changes are smooth. Parameter 1 3/1 4 (4 3/4 4) determines the ramp time of the acceleration/ deceleration in the middle of the curve

See figure 5 5-17

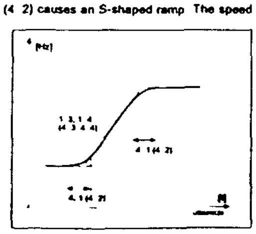


Figure 5 5-17 S-shaped acceleration/ deceleration

4 3 Acceleration time 2
4 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) With this parameter it is possibile to set two different acceleration/deceleration times for one application The active set can be selected with the programmable signal DIA3 of this application see parameter 2 2 Acceleration/deceleration times can be reduced with a external free analog input signal see parameters 2 18 and 2 19

4 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration See the separate Brake resistor installation manual

4 6 Start function

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may cause prolonged acceleration times)

Flying start.

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 Stop function

Coasting

0 The motor coasts to an uncontrolled stop with the SV9000 off after the Stop command

Ramp

1 After the Stop command the speed of the motor is decelerated according to the deceleration ramp time parameter If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration

4 8 DC braking current

Defines the current injected into the motor during DC braking

4 9 **DC braking time at stop**

Defines if braking is ON or OFF and braking time of the DC brake when the motor is stopping The function of the DC-brake depends on the stop function parameter 4 7 See figure 5 5-18

0 DC-brake is not used
>0 OC brake is in use and its function depends on the Stop function (param 4 7) and the time depends on the value of parameter 4 9

Stop-function = 0 (coasting).

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC braking starts If the frequency is > nominal frequency of the motor (par 1 11) setting value of parameter 4 9 determines the braking time When the frequency is < 10% of the nominal the braking time is 10% of the set value of parameter 4 9

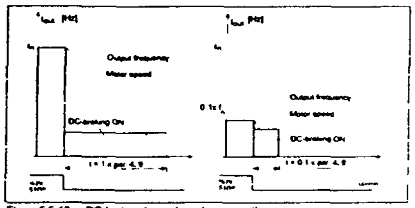


Figure 5.5-18 DC-braking time when stop = coasting

Stop-function = 1 (ramp).

After the Stop command the speed of the motor is reduced based on the deceleration parameter ramp parameter If no regeneration occurs due to load inertia, to a speed defined with parameter 4 10 where the DC-braking starts

The braking time is defined with parameter 4 9

If high inertia exists it is recommended to use an external braking resistor for faster deceleration See figure 5 5-19

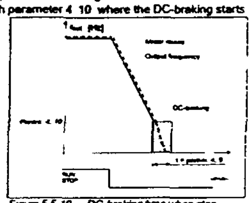


Figure 5.5-19 DC-braking time when stop function = ramp

4 10 **Execute frequency of DC-brake during ramp Stop**

See figure 5 5-19

4 11 **DC-brake time at start**

0 DC-brake is not used
>0 DC-brake is active when the start command is given This parameter defines the time before the brake is released After the brake is released the output frequency increases according to the set start function parameter 4 6 and the acceleration parameters (1 3 4 1 or 4 2 4 3) See figure 5 5-20

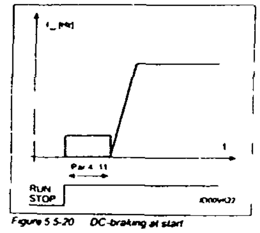


Figure 5 5-20 DC-braking at start

4 12 4 18 **Multi-Step speeds 1 7**

These parameter values define the Multi-step speeds selected with the DIA4 DIB5 and DIB6 digital inputs The selection of Multi-step speeds will occur similarly as described in the table 3 4 2 page 3-8

5 1 5 6 **Prohibit frequency area Low limit/High limit**

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems

With these parameters it is possible to set limits for three "skip frequency" regions The accuracy of the setting is 0 1 Hz

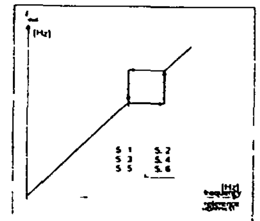


Figure 5 5-21 Example of prohibit frequency area setting

6 1 **Motor control mode**

0 = Frequency control (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output frequency resolution = 0 01 Hz)
1 = Speed control (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (regulation accuracy ± 0 5 %)

6 2 **Switching frequency**

Motor noise can be minimized using a high switching frequency Increasing the switching frequency reduces the capacity of the SV9000

Before changing the frequency from the factory default 10 kHz (3.6 kHz ≥ 40 Hp) check the drive derating from the curves in figures 5 2-2 and 5.2-3 in the User's Manual

6 3 **Field weakening point**
6 4 **Voltage at the field weakening point**

The field weakening point is the output frequency at which the output voltage reaches the set maximum value (par 6. 4). Above this frequency the output voltage remains at the set maximum value
Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1. 8, 1 9, 6. 5 6. 6 and 6. 7 See figure 5.5-22

When the parameters 1. 10 and 1 11, nominal voltage and nominal frequency of the motor are set, parameters 6 3 and 6 4 are also set automatically to the corresponding values. If you need different values for the field weakening point and the maximum output voltage change these parameters after setting parameters 1 10 and 1. 11

6 5 **V/Hz curve, middle point frequency**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle point frequency of the curve See figure 5 5-22

6 6 **V/Hz curve, middle point voltage**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle point voltage of the curve. See figure 5.5-22

6. 7 **Output voltage at zero frequency**

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage of the curve. See figure 5 5-22

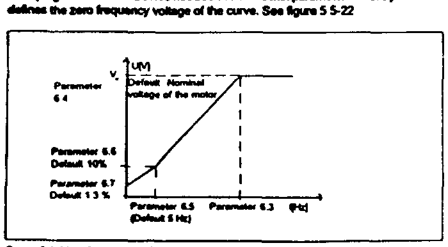


Figure 5.5-22 Programmable V/Hz curve.

6 8 **Overvoltage controller**
6 9 **Undervoltage controller**

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than 15%—+10% and the application requires a constant speed. If the controllers are ON they will change the motor speed in over/undervoltage cases. Overvoltage = faster undervoltage = slower

Over/undervoltage trips may occur when controllers are not used

7 1 **Response to the reference fault**

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 **Response to external fault**

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2

7 3 **Phase supervision of the motor**

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7 4 **Ground fault protection**

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero The standard overcurrent protection is always working and protects the frequency converter from ground faults with high current levels.

Parameters 7 5—7 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. The SV9000 drive is capable of supplying higher than nominal current to the motor If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan the load reduction on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor When the power is turned on to the drive the calculated model uses the heatsink temperature to determine the initial thermal state for the motor The calculated model assumes that the ambient temperature of the motor is 40°C

Motor thermal protection can be adjusted by setting several parameters The thermal current I_T specifies the load current above which the motor is overloaded This current limit is a function of the output frequency The curve for I_T is set with parameters 7 6 7 7 and 7 9 refer to the figure 5 5 23 The default values of these parameters are set from the motor nameplate data

With the output current at I_T the thermal state will reach the nominal value (100%) The thermal state changes with the square of the current With output current at 75% of I_T the thermal stage will reach 56% and with output current at 120% of I_T the thermal stage would reach 144% The function will trip the device (refer par 7 5) if the thermal model reaches a value of 105% The response time of the therma model is determined by the time constant parameter 7 8 The larger the motor the longer it takes to reach the final temperature

The thermal state of the motor can be monitored through the display Refer to the table for monitoring items (User's Manual table 7 3-1)

> CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt*

7 5 **Motor thermal protection**

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is selected the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0 will reset the thermal stage of the motor to 0%

7 6 **Motor thermal protection break point current**

The current can be set between 50 0—150 0% x I_{nMotor}
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve See figure 5 5-23

The value is set in percentage of the motor nameplate data of the motor parameter 1 13 not the drive's nominal output current

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated

If parameter 1 13 is adjusted, this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

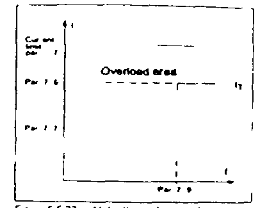


Figure 5 5 23 Motor thermal current I curve

7 7 **Motor thermal protection zero frequency current**

The current can be set between 10 0—150 0% x I_{nMotor} This parameter sets the value for thermal current at zero frequency Refer to the figure 5 5-23

The default value is set assuming that there is no external fan cooling the motor If an external fan is used this parameter can be set to 90% (or higher)

The value is set as a percentage of the motor's nameplate nominal current parameter 1 13 not the drive's nominal output current The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated

If you change the parameter 1 13 this parameter is automatically restored to the default value

Setting this parameter (or parameter 1 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

7 8 **Motor thermal protection, time constant**

This time can be set between 0 5—300 minutes
This is the thermal time constant of the motor The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value

The motor thermal time is specific to a motor design and it varies between different motor manufacturers

The default value for the time constant is calculated based on the motorname plate data from parameters 1 12 and 1 13 If either of these parameters is reset then this parameter is set to its default value

If the motor's t_6 time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 time As a rule of thumb the motor thermal time constant in minutes equals to 2xt_6 (t_6 in seconds is the time a motor can safely operate at six times the rated current) If the drive is in the stop stage the time constant is internally increased to three times the set parameter value The cooling in the stop stage is based on convection with an increased time constant

7 9 **Motor thermal protection break point frequency**

This frequency can be set between 10—500 Hz.
This is the frequency break point of thermal current curve With frequencies above this point the thermal capacity of the motor is assumed to be constant See figure 5.5-23

The default value is based on motor's nameplate data parameter 1 11 It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor More generally it is 70% of the frequency at the field weakening point (parameter 6 3) Changing either parameter 1 11 or 6 3 will restore this parameter to its default value

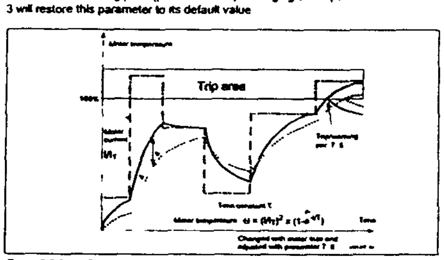


Figure 5.5-24 Calculating motor temperature

Parameters 7 10—7 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7 11 Stall Current and 7 13 Stall Frequency If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true There is no true detection of shaft rotation. Stall protection is a type of overcurrent protection.

7 10 **Stall protection**

Operation.

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is set on, the drive will stop and activate the fault stage

Setting this parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

7 11 **Stall current limit**

The current can be set between 0 0—200% x I_{nMotor}

In a stall the current has to be above this limit See figure 5 5-25 The value is set as a percentage of the motor's name-plate nominal current, parameter 1 13 motor's nominal current. If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

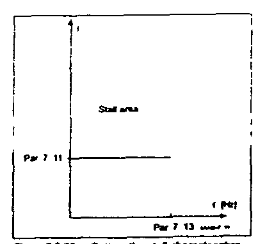


Figure 5.5-25 Setting the stall characteristics

7 12 **Stall time**

The time can be set between 2 0—120 s
This is the maximum allowed time for a stall. There is an internal up/down counter to count the stall time. See figure 5.5-26 If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7 10)

7 13 **Maximum stall frequency**

The frequency can be set between 1—f_{max} (par 1 2)
In the stall state the ouput frequency has to be smaller than this limit. See figure 5.5-25

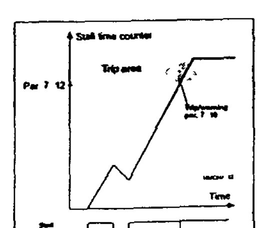


Figure 5 5-26 Counting the stall time

Parameters 7 14—7 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump

Motor underload protection can be adjusted by setting the underload curve with parameters 7 15 and 7 16 The underload curve is a squared curve set between zero frequency and the field weakening point The protection is not active below 5Hz (the underload counter value is stopped) See figure 5 5-27

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor The motor's nameplate data parameter 1 13 the motor's nominal current and the drive's nominal current I_c are used to find the scaling ratio for the internal torque value If other than a standard motor is used with the drive the accuracy of the torque calculation is decreased

7 14 **Underload protection**

Operation

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code If tripping is set active the drive will stop and activate the fault stage

Deactivating the protection by setting this parameter to 0 will reset the underload time counter to zero

7 15 **Underload protection field weakening area load**

The torque limit can be set between 20.0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. See figure 4 5-22 If parameter 1 13 is adjusted *this parameter is automatically* restored to its default value

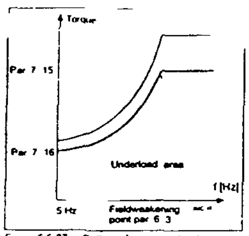


Figure 5 5-27 Setting of minimum load

7 16 **Underload protection, zero frequency load**

Torque limit can be set between 10 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque with zero frequency See figure 5 5-27 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

7 17 **Underload time**

This time can be set between 2.0—600 0 s

This is the maximum allowed time for an underload state There is an internal up/down counter to accumulate the underload time See figure 5 5-28 If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7 14) If the drive is stopped the underload counter is reset to zero

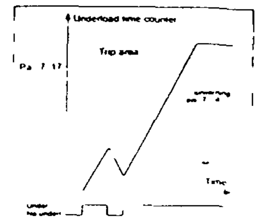


Figure 5 5 28 Counting the underload time

8 1 **Automatic restart number of tries**
8 2 **Automatic restart trial time**

The Automatic restart function restarts the drive after the faults selected with parameters 8 4—8 8 The Start function for Automatic restart is selected with parameter 8 3

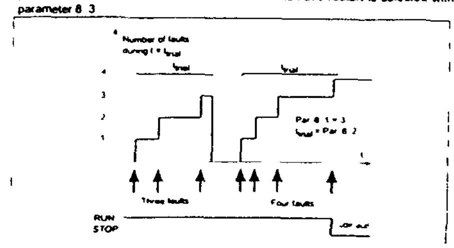


Figure 5 5-29 Automatic restart

Parameter 8 1 determines how many automatic restarts can be made during the trial time set by the parameter 8 2

The time counting starts from the first autorestart If the number of restarts does not exceed the value of the parameter 8 1 during the trial time the counting is cleared after the trial time has elapsed The next fault starts the counting again

8 3 **Automatic restart, start function**

The parameter defines the start mode

0 = Start with ramp
1 = Flying start, see parameter 4 6

8 4 **Automatic restart after undervoltage trip**

0 = No automatic restart after undervoltage fault trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 5 **Automatic restart after overvoltage trip**

0 = No automatic restart after overvoltage fault trip
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 6 **Automatic restart after overcurrent trip**

0 = No automatic restart after overcurrent fault trip
1 = Automatic restart after overcurrent faults

8 7 **Automatic restart after reference fault trip**

0 = No automatic restart after reference fault trip
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8 8 **Automatic restart after over-/undertemperature fault trip**

0 = No automatic restart after temperature fault trip
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

Notes

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5

PUMP AND FAN CONTROL APPLICATION

(par 0 1 7)

CONTENTS

6

6.1 General

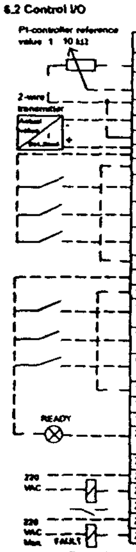
The pump and fan control application can be selected by setting the value of parameter 0 1 to 7

The application can be used to control one variable speed drive and 0-3 auxiliary drives The PI-controller of the SV9000 controls the drive speed and provides control signals to Start and Stop one to three auxiliary drives to control the total flow

The application has two control sources on the I/O terminals Source A is Pump and fan control and source B is direct frequency reference The control source is selected with DIB6 input.

* NOTE! **Remember to connect the CMA and CMB inputs.**

6.2 Control I/O



Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for a potentiometer etc.
2	V_{in}+	Analog input, voltage (programmable)	PI-controller reference value range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I_{in}+	Analog input,	PI-controller actual value
5	I_{in}	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches etc. max. 0 1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start/Stop Source A (PI-controller)	Contact open = stop Contact closed = start
9	DIA2	External fault (programmable)	Contact open = no fault Contact closed = fault
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Start/Stop Source B (Direct freq ref)	Contact open = stop Contact closed = start
15	DIB5	Jog speed select (programmable)	Contact open = no action Contact closed = jog speed
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I_{out}+	Analog output	Programmable (par 3. 1)
19	I_{out}-	Output frequency	Range 0—20 mA/R_L max 500 Ω
20	DO1	Digital output READY	Programmable (par 3. 6) Open collector I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 Auxil motor 1 control	Programmable (par 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par 3. 8)
25	RO2		
26	RO2		

Figure 6 2-1 Default I/O configuration and connection example of the Pump and Fan Control Application with 2-wire transmitter

6

6 3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 6 3-1

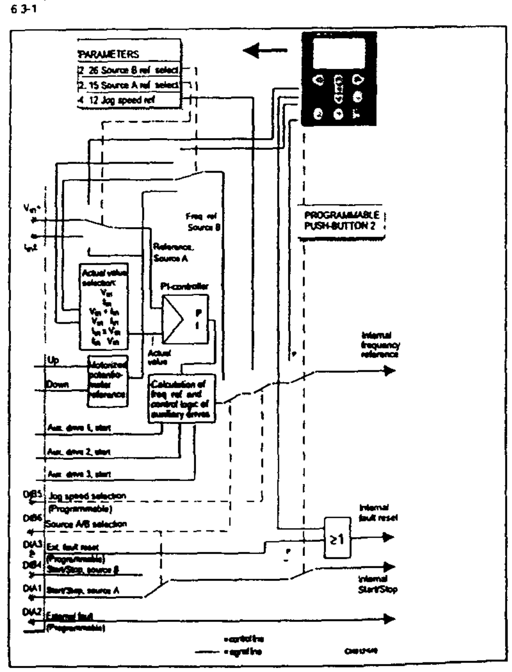


Figure 6 3-1 Control signal logic of the Pump and Fan control Application. Switch positions shown are based on the factory settings

6

6 4 Basic parameters Group 1

6 4 1 Parameter table Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			6-5
1 2	Maximum frequency	f_{min} 120/500 Hz	1 Hz	60 Hz			6-5
1 3	Acceleration time 1	0 1 3000 0 s	0 1 s	1 0 s		Time from f_{min} (1 1) to f_{max} (1 2)	6-5
1 4	Deceleration time	0 1 3000 0 s	0 1 s	1 0 s		Time from f_{max} (1 2) to f_{min} (1 1)	6-5
1 5	PI-controller gain	1 1000%	1 %	100%			6-5
1 6	PI-controller I-time	0 00—320 00 s	0 01 s	10 00 s		0= No integral time in use	6-5
1 7	Current limit	0 1—2 5 x I_{nSV}	0 1 A	1 5 x I_{nSV}		Output current limit [A] of the unit	6-5
1 8	V/Hz ratio selection ■	0 2		0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	6-5
1 9	V/Hz optimization ■	0—1	1	0		0 = None 1 = Automatic torque boost	6-6
1 10	Nominal voltage of the motor ■	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	6-7
1 11	Nominal frequency of the motor ■	30—500 Hz	1 Hz	60 Hz		f_n from the rating plate of the motor	6-7
1 12	Nominal speed of the motor ■	1—20000 rpm	1 rpm	1720 rpm **		n_n from the rating plate of the motor	6-7
1 13	Nominal current of the motor (I_{nMot}) ■	2 5 x I_{nSV}	0 1 A	I_{nSV}		I_n from the rating plate of the motor	6-7
1 14	Supply voltage ■	208—240		230 V		Voltage code 2	6-7
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1 15	Parameter conceal	0—1	1	0		Visibility of the parameters 0 = All parametergroups visible 1 = Only group 1 is visible	6-7
1 16	Parameter value lock	0—1	1	0		Disables parameter changes 0 = Changes enabled 1 = Changes disabled	6-7

Table 6 4-1 Group 1 basic parameters

Note! ■ = Parameter value can be changed only when the drive is stopped

* If 1 2 > motor synchr speed check suitability for motor and drive system
Selecting 120 Hz/500 Hz range see page 6-5

** Default value for a four pole motor and a nominal size SV9000

6

6 4 2 Description of Group 1 parameters

1 1 1 2 Minimum / maximum frequency

Defines frequency limits of the SV9000

The default maximum value for parameters 1 1 and 1 2 is 120 Hz By setting 1 2 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1 1 and 1 2 are changed to 500 Hz. At the same time the resolution of the panel reference is changed from 0 01 Hz to 0 1 Hz
Changing the max value from 500 Hz to 120 Hz is done by setting parameter 1 2 119 Hz when the drive is stopped

1 3 1 4 Acceleration time 1 deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2)

1 5 PI-controller gain

This parameter defines the gain of the PI-controller

If this parameter is set to 100% a 10% change in error value causes the controller output to change by 1 0 Hz

If the parameter value is set to 0 the PI-controller operates as I-controller

1 6 PI-controller I-time

Defines the integration time of the PI-controller

1 7 Current limit

This parameter determines the maximum motor current what the SV9000 will supply short term

1 8 V/Hz ratio selection

Linear 0 — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par 6 3) where a constant voltage (nominal value) is supplied to the motor See figure 6 4 1

Linear V/Hz ratio should be used in constant torque applications

This default setting should be used if there is no special requirement for another setting

Squared 1 — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par 6. 3) where the nominal voltage is also supplied to the motor See figure 6 4 1

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed e g in centrifugal fans and pumps

6

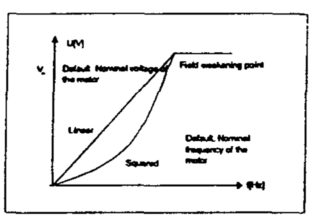


Figure 6 4 1 Linear and squared V/Hz curves.

Programm. V/Hz curve 2 — The V/Hz curve can be programmed with three different points The parameters for programming are explained in chapter 6.5.2
A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 6 4-2.

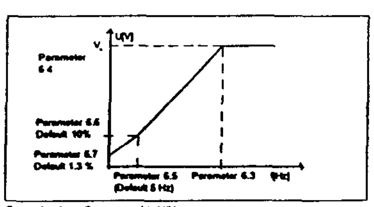


Figure 6 4 2 Programmable V/Hz curve

1 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which makes the motor to produce torque enough to start and run at low frequencies The voltage increase depends on the motor type and horsepower.

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g in conveyors.

NOTE! *In high torque - low speed applications it is likely the motor will overheat. If the motor has to run for a prolonged time under these conditions special attention must be paid to cooling the motor Use external cooling for the motor if the temperature tends to rise too high*

1 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor
This parameter sets the voltage at the field weakening point, parameter 6 4 to 100% x V_{nmotor}

1 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor
This parameter sets the frequency at the field weakening point, parameter 6 3 to the same value

1 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor

1 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor The internal motor protection function uses this value as a reference value.

1 14 Supply voltage

Set parameter value according to the nominal voltage of the supply
Values are pre-defined for voltage codes 2, 4 5 and 6. See table 6 4-1

1 15 Parameter conceal

Defines which parameter groups are available

0 = All parameter groups are visible
1 = Only group 1 is visible

1 16 Parameter value lock

Defines access to the changes of the parameter values

0 = Parameter value changes enabled
1 = Parameter value changes disabled

6

6.5 Special parameters Groups 2—9

6.5.1 Parameter tables

Group 2 Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.1	DIA2 function (terminal 9) ■	0—10				0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./decceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. UP	6-16
2.2	DIA3 function (terminal 10) ■	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./decceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. DOWN	6-17
2.3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	6-17
2.4	V_{in} custom setting min	0.00-100.00%	0.01%	0.00%			6-17
2.5	V_{in} custom setting max	0.00-100.00%	0.01%	100.00%			6-17
2.6	V_{in} signal inversion	0—	1	0		0 = Not inverted 1 = Inverted	6-17
2.7	V_{in} signal filter time	0.00—10.00 s	0.01s	1.00s		0 = No filtering	6-17
2.8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	6-17
2.9	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			6-18
2.10	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			6-18
2.11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-18
2.12	I_{in} signal filter time	0.01—10.00s	0.01s	1.00 s		0 = No filtering	6-18
2.13	DIB5 function (terminal 15) ■	0—9	1	6		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command	6-18

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.14	Motor(digital) potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			6-19
2.15	PI-controller reference signal (source A) ■	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r2) 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 unit is stopped	6-19
2.16	PI-controller actual value selection ■	0—3	1	0		0 = Actual value Actual 1 Actual 2 2 = Actual Actual 2 3 = Actual 1 Actual 2	6-19
2.17	Actual value 1 input ■	0—2	1	2		0 = No 1 = Voltage input 2 = Current input	6-19
2.18	Actual value 2 input ■	0—2	1	0		0 = No 1 = Voltage input 2 = Current input	6-19
2.19	Actual value 1 min scale	320.00%—+320.00%	0.01%	0.00%		0% no minimum scaling	6-19
2.20	Actual value 1 max scale	-320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2.21	Actual value 2 min scale	320.00%—+320.00%	0.01%	0.00%		0% = no minimum scaling	6-19
2.22	Actual value 2 max scale	320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2.23	Error value inversion	0—1	1	0		0 = No 1 = Yes	6-20
2.24	PI-controller reference value rise time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 0 % to 100 %	6-20
2.25	PI-controller reference value fall time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 100 % to 0 %	6-20
2.26	Direct frequency reference, source B ■	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r1) 3 = Signal from internal motor pot 4 = Signal from internal motor pot reset if SV9000 unit is stopped	6-20
2.27	Source B reference scaling minimum value	0—par. 2.28	1 Hz	0 Hz		Selects the frequency that corresponds to the min. reference signal	6-20
2.28	Source B reference scaling maximum value	0—f_{max}	1 Hz	0 Hz		Selects the frequency that corresponds to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	6-20

Note! ■ = Parameter value can be changed only when the drive is stopped

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analog output function	0—15	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nSV9}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100% xV_{nMot}) 7 = DC-link volt. (0—1000 V) 8—10 = Not in use 11 = PI-controller reference value 12 = PI-controller actual value 1 13 = PI-controller actual value 2 14 = PI-controller error value 15 = PI-controller output	6-21
3.2	Analog output filter time	0.00—10.00 s	0.01s	1.00s			6-21
3.3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-21
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	6-21
3.5	Analog output scale	10—1000%	1%	100%			6-21
3.6	Digital output function ■	0—30	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted 22—27 = Not in use 28 = Auxiliary drive 1 start 29 = Auxiliary drive 2 start 30 = Auxiliary drive 3 start	6-22
3.7	Relay output 1 function ■	0—30	1	28		As parameter 3.6	6-22
3.8	Relay output 2 function ■	0—30	1	3		As parameter 3.6	6-22
3.9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3.10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			6-22

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3.12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			6-22
3.13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3.14	Torque limit supervision value	0.0—200.0% xT_{nSV9}	0.1%	100.0%			6-23
3.15	Active reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3.16	Active reference limit supervision value	0.0—f_{max} (par. 1.2)	0.1 Hz	0.0 Hz			6-23
3.17	External brake off-delay	0.0—100.0 s	1	0.5 s			6-23
3.18	External brake on-delay	0.0—100.0 s	1	1.5 s			6-23
3.19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3.20	Drive temperature limit	10—75°C	1	+40°C			6-23
3.21	I/O-expander board (opt.) analog output content	0—7	1	3		See parameter 3.1	6-21
3.22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01	1.00 s		See parameter 3.2	6-21
3.23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3.3	6-21
3.24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3.4	6-21
3.25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3.5	6-21

Group 4 Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acc./dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4.2	Acc./dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4.3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4.4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4.5	Brake chopper ■	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	6-25
4.6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	6-25
4.7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	6-25

Note! ■ = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.8	DC-braking current	0.15—1.5 x I_{nSV} (A)	0.1 A	0.5 x I_{nSV}			6-25
9	DC-braking time at Stop	0.00-250.00 s	0.01 s	0.00 s		0 = DC-brake is off at Stop	6-25
10	Turn on frequency of DC brake during ramp Stop	0.1-10.0 Hz	0.1 Hz	1.5 Hz			6-27
4.11	DC-brake time at Start	0.00-25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	6-27
4.12	Jog speed reference	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	10.0 Hz			6-27

Group 5 Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	f_{min}— par 5.2	0.1 Hz	0.0 Hz			6-27
5.2	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5.3	Prohibit frequency range 2 low limit	f_{min}— par 5.4	0.1 Hz	0.0 Hz			6-27
5.4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5.5	Prohibit frequency range 3 low limit	f_{min}— par 5.6	0.1 Hz	0.0 Hz			6-27
5.6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1.1)(1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	6-27
6.2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6 kHz		Depends on Hp rating	6-28
6.3	Field weakening point	30—500 Hz	1 Hz	Param. 1.11			6-28
6.4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			6-28
6.5	V/Hz curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			6-28
6.6	V/Hz curve mid point voltage	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6.7	Output voltage at zero frequency	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6.8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29
6.9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29

Note! = Parameter value can be changed only when the drive is stopped

Group 7 Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	6-29
7.2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	6-29
7.3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	6-29
7.4	Ground protection	0—2	2	2		0 = No action 2 = Fault	6-29
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	6-30
7.6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			6-30
7.7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			6-31
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min	17.0 min		Default value is set according to motor nominal current	6-31
7.9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			6-32
7.10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	6-32
7.11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			6-33
7.12	Stall time	2.0—120.0 s	1.0 s	15.0 s			6-33
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			6-33
7.14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	6-34
7.15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			6-34
7.16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			6-34
7.17	Underload time	2.0—600.0 s	1.0 s	20.0 s			6-34

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8.1	Automatic restart: number of tries	0—10	1	0		0 = Not in use	6-35
8.2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			6-35
8.3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	6-36
8.4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8.5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8.6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	6-36
8.7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	6-36
8.8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	6-36

Group 9 Pump and fan control special parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
9.1	Number of aux. drives	0—3	1	1			6-37
9.2	Start frequency of auxiliary drive 1	f_{min}—f_{max}	0.1 Hz	51.0 Hz			6-37
9.3	Stop frequency of auxiliary drive 1	f_{min}—f_{max}	0.1 Hz	25.0 Hz			6-37
9.4	Start frequency of auxiliary drive 2	f_{min}—f_{max}	0.1 Hz	51.0 Hz			6-37
9.5	Stop frequency of auxiliary drive 2	f_{min}—f_{max}	0.1 Hz	25.0 Hz			6-37
9.6	Start frequency of auxiliary drive 3	f_{min}—f_{max}	0.1 Hz	51.0 Hz			6-37
9.7	Stop frequency of auxiliary drive 3	f_{min}—f_{max}	0.1 Hz	25.0 Hz			6-37
9.8							
9.9							
9.10	Start delay of the auxiliary drives	0.0—300.0 s	0.1 s	4.0 s			6-37
9.11	Stop delay of the auxiliary drives	0.0—300.0 s	0.1 s	2.0 s			6-37
9.12	Reference step after start of the 1 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9.13	Reference step after start of the 2 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9.14	Reference step after start of the 3 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9.15	(Reserved)						
9.16	Sleep level	0.0—120/500 Hz	0.1 Hz	0.0 Hz		Frequency below which the freq. of the speed controlled motor has go before starting the sleep delay counting (0.0 = not in use)	6-38
9.17	Sleep delay	0.0—3000.0 s	0.1 s	30.0 s		Time that freq. has to be below par 9.16 before stopping the SV9000	6-38
9.18	Wake up level	0.0—100.0 %	0.1 %	0.0 %		Level of the actual value for restarting the SV9000	6-38
9.19	Wake up function	0—1	1	0		0 = Wake up when falling below the wake up level 1 = Wake up when exceeding the wake up level	6-38
9.20	PI-regulator bypass	0—1	1	0		1 = PI-regulator bypassed	6-39

Table 6.5.1 Special parameters, Groups 2—9

6 5 2 Description of Groups 2—9 parameters

2 1 DIA2 function

1 External fault	closing contact	= Fault is shown and drive responds according to parameter 7 2
2 External fault	opening contact	= Fault is shown and drive responds according to parameter 7 2
3 Run enable	contact open contact closed	- Start of the motor disabled - Start of the motor enabled
4 Acc / Dec time select	contact open contact closed	= Acceleration/Deceleration time 1 selected = Acceleration/Deceleration time 2 selected
5 Reverse	contact open contact closed	= Forward = Reverse — If two or more inputs are programmed to reverse only one of them is required for reverse
6 Jog freq	contact closed	Jog frequency selected for freq refer
7 Fault reset	contact closed	= Resets all faults
8 Acc./Dec operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened
9 DC-braking command	contact closed	= In the stop mode the DC-braking operates until the contact is opened, see figure 6 5-1 DC-brake current is set with parameter 4 8
10 Motor (digital) pot UP	contact closed	= Reference increases until the contact is opened

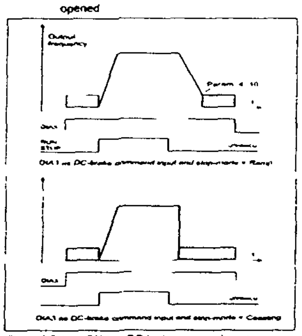


Figure 6 5-1 DIA3 as DC-brake command input
a) Stop-mode = ramp
b) Stop-mode = coasting

2 2 DIA3 function

Selections are same as in 2 1 except

10 Motor (digital) pot DOWN	contact closed	= Reference decreases until the contact is opened

2 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par 2 4) to custom maximum (par 2 5)

2 4 2 5 V_{in} custom setting minimum/maximum

These parameters set V_{in} for any input signal span within 0—10 V

Minimum setting Set the V_{in} signal to its minimum level select parameter 2 4 press the Enter button

Maximum setting Set the V_{in} signal to its maximum level select parameter 2 5 press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2 6 V_{in} signal inversion

0 = no inversion of analog V_{in} signal

1 = inversion of analog V_{in} signal

2 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal A long filtering time makes the drive response slower See figure 6 5-2

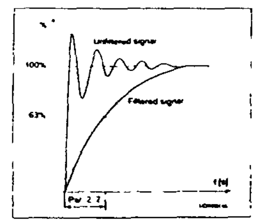


Figure 6 5-2 V_{in} signal filtering

2 8 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

2.9
2.10 Analog input I_{in} custom setting minimum/maximum

With these parameters you can scale the input current signal (I_{in}) signal range between 0—20 mA.

Minimum setting Set the I_{in} signal to its minimum level, select parameter 2. 9, press the Enter button

Maximum setting: Set the I_{in} signal to its maximum level, select parameter 2. 10 press the Enter button

Note! The parameter values can only be set with this procedure (not with the arrow up/arrow down buttons)

2 11 Analog input I_{in} inversion

0 = no inversion of I_{in} input
1 = inversion of I_{in} input.

2. 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal A long filtering time makes the drive response slower See figure 6 5-3

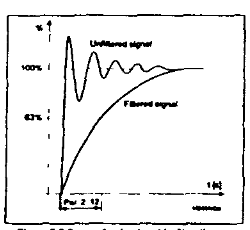


Figure 6.5-3 Analog input I_{in} filter time

2. 13 DIA5 function

1: External fault,	closing contact	= Fault is shown and motor is stopped when the input is active
2: External fault,	opening contact	= Fault is shown and motor is stopped when the input is not active
3: Run enable	contact open contact closed	= Start of the motor disabled = Start of the motor enabled
4. Acc. / Dec time select.	contact open contact closed	= Acceleration/Deceleration time 1 selected = Acceleration/Deceleration time 2 selected
5: Reverse	contact open contact closed	= Forward = Reverse — If two or more inputs are programmed to reverse only one of them is required for reverse
6: Jog freq	contact closed	= Jog frequency selected for freq. refer
7 Fault reset	contact closed	= Resets all faults
8: Acc./Dec. operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened
9: DC-braking command	contact closed	= In the stop mode, the DC-braking operates until the contact is opened, see figure 6 5-1 DC-brake current is set with parameter 4 8

2 14 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes

2 15 PI-controller reference signal

0 Analog voltage reference from terminals 2—3 e g a potentiometer
1 Analog current reference from terminals 4—5, e g a transducer
2 Panel reference is the reference set from the Reference Page (REF) Reference r2 is the PI-controller reference see chapter 6
3 Reference value is changed with digital input signals DIA2 and DIA3
 switch in DIA2 closed = frequency reference increases
 - switch in DIA3 closed = frequency reference decreases
 Speed of the reference change can be set with the parameter 2. 3
4 Same as setting 3 but the reference value is set to the minimum frequency (par 1 1) each time the drive is stopped. When the value of parameter 1 5 is set to 3 or 4, the value of parameter 2 1 is automatically set to 4 and the value of parameter 2 2 is automatically set to 10

2 16 PI-controller actual value selection
2 17 Actual value 1
2 18 Actual value 2

These parameters select the PI-controller actual value

2 19 Actual value 1 minimum scale

Sets the minimum scaling point for Actual value 1 See figure 6 5-4

2 20 Actual value 1 maximum scale

Sets the maximum scaling point for Actual value 1 See figure 6 5-4

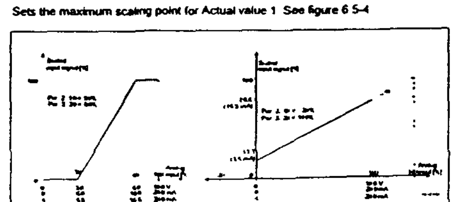


Figure 6.5-4 Examples about the scaling of actual value signal

2 21 Actual value 2 minimum scale

Sets the minimum scaling point for Actual value 2

2 22 Actual value 2 maximum scale

Sets the maximum scaling point for Actual value 2

2 23 Error value inversion

This parameter allows you to invert the error value of the PI-controller (and thus the the operation of the PI-controller)

2 24 PI-controller minimum limit
2 25 PI-controller maximum limit

These parameters set the minimum and maximum values of the PI-controller output

Parameter value limits par 1 1 <par 2 24 <par 2 25

2 26 Direct frequency reference, Place B

- 0 Analog voltage reference from terminals 2—3 e g a potentiometer
- 1 Analog current reference from terminals 4—5 e g a transducer
- 2 Panel reference is the reference set from the Reference Page (REF) Reference r1 is the Place B reference see chapter 6
- 3 Reference value is changed with digital input signals DIA2 and DIA3
  switch in DIA2 closed = frequency reference increases
  switch in DIA3 closed = frequency reference decreases
  Speed of the reference change can be set with the parameter 2 3
- 4 Same as setting 3 but the reference value is set to the minimum frequency (par 1 1) each time the drive is stopped
  When the value of parameter 1 5 is set to 3 or 4 the value of parameter 2 1 is automatically set to 4 and the value of parameter 2 2 is automatically set to 10

2 27 2 28 Place B reference scaling minimum value/maximum value

Setting limits 0 < par 2. 27 < par 2 28 < par 1 2 If par 2 28 = 0 scaling is set off See figures 6 5-5 and 6.5-6

(In the figures below the voltage input V_{in} with signal range 0—10 V is selected for source B reference)

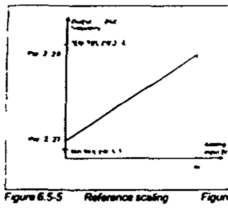


Figure 6.5-5 Reference scaling

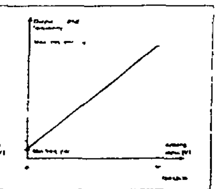


Figure 6 5-6 Reference scaling, par 2 15 = 0

3 1 Analog output function

See table on page 6-10

3 2 Analog output filter time

Filters the analog output signal
See figure 6 5-7

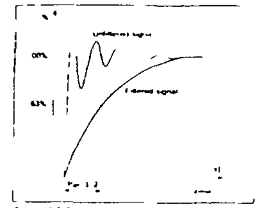


Figure 6 5 7 Analog output filtering

3 3 Analog output invert

Inverts analog output signal
max output signal = minimum set value
min output signal = maximum set value

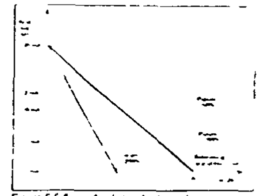


Figure 6 5-8 Analog output invert

3 4 Analog output minimum

Defines the signal minimum to *be either 0 mA or 4 mA See* figure 6.5-9

3 5 Analog output scale

Scaling factor for analog output
See figure 6.5-9

Signal	Max value of the signal
Output freq	Max frequency (p 1 2)
Motor speed	Max speed (n_n x f_{max}/f_n)
Output current	2 x I_{nSV9}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V
PI-ref value	100% x ref value max
PI-act value1	100% x act. value max
PI-act value2	100% x act value max
PI-error value	100%x error value max
PI-output	100% x output max

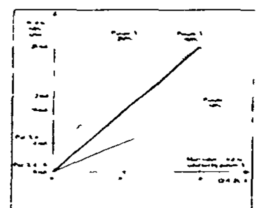


Figure 6 5-9 Analog output scale

3 6 Digital output function
3 7 Relay output 1 function
3 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7 2
7 = Reference fault or warning	Fault or warning depending on parameter 7 1 if analog reference is 4—20 mA and signal is <4mA
8 = Warning	If a warning exists. See Table 7 10-1 in User's Manual
9 = Reversed	The reverse command has been selected
10= Multi-step or jog speed	Multi-step or jog speed has been selected by digital inp
11 = At speed	The output frequency has reached the set reference
12= Motor regulator activated	Overvoltage or overcurrent regulator was activated
13= Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par 3. 9 and par. 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par 3. 11 and par 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par 3. 13 and par 3. 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par 3. 15 and par 3. 16)
17= External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18= Control from I/O terminals	External control mode selected with progr pushbutton#2
19= Drive temperature limit supervision	Temperature on drive goes outside the set supervision limits (par 3. 19 and 3. 20)
20= Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par 3 17 and 3 18) Output active when brake control is ON
22—27 = Not in use	
28 = Auxiliary drive 1 start	Starts and stops auxiliary drive 1
29 = Auxiliary drive 2start	Starts and stops auxiliary drive 2
30 = Auxiliary drive 3 start	Starts and stops auxiliary drive 3

Table 6.5-2 Output signals via DO1 and output relays RO1 and RO2

3 9 Output frequency limit 1, supervision function
3 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3 10, 3 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3 6—3 8

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3 9 (3 11) See figure 6.5-10

3 13 Torque limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3. 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

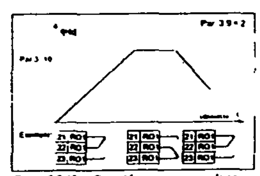


Figure 6.5-10 Output frequency supervision.

3 14 Torque limit , supervision value

The calculated torque value to be supervised by parameter 3 13

3 15 Active reference limit, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if the panel is the active control source

3 16 Active reference limit , supervision value

The frequency value to be supervised by the parameter 3 15.

3 17 External brake-off delay
3 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters See figure 6 5-11

The brake control signal can be programmed via the digital output DO1 or via one of relay outputs RO1 and RO2 see parameters 3 6—3 8

3 19 Drive temperature limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3 6—3 8

3 20 Drive temperature limit value

The temperature value to be supervised by parameter 3 19

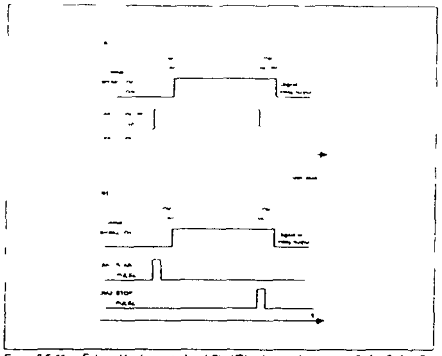


Figure 6 5-11 External brake control a) Start/Stop logic selection par 2 1 0 1 or 2
b)Start/Stop logic selection par 2 1 3

4 1 **Acc/Dec ramp 1 shape**

4 2 **Acc/Dec ramp 2 shape**

The acceleration and deceleration ramp shape can be programmed with these parameters

Setting the value 0 gives you a linear ramp shape The output frequency immediately follows the input with a ramp time set by parameters 1 3 1 4 (4 3 4 4 for Acc/Dec time 2)

Setting 0 1—10 seconds for 4 1 (4 2) causes an S shaped ramp The speed changes are smooth Parameter 1 3/ 1 4 (4 3/ 4 4) determines the ramp time of the acceleration/deceleration in the middle of the curve See figure 6 5-12

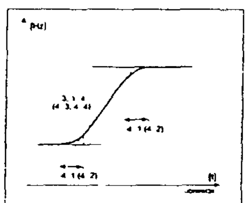


Figure 6 5-12 S-shaped acceleration/ deceleration.

4 3 **Acceleration time 2**

4 4 **Deceleration time 2**

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par 1 1) to the set maximum frequency (par 1 2) With this parameter it is possible to set two different acceleration/deceleration times for one application The active set can be selected with programmable signal DIA3 of this application See parameter 2 2 Acceleration/deceleration times can be reduced with a external free analog input signal See parameters 2 18 and 2 19

4 5 **Brake chopper**

0 No brake chopper
1 Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor the energy stored in the inertia of the motor and the load is fed into the external brake resistor If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration See the separate Brake resistor installation manual

4 6 **Start function**

Ramp

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time (Load inertia or starting friction may cause prolonged acceleration times)

Flying start

1 The drive starts into a running motor by first finding the speed the motor is running at Searching starts from the maximum frequency down until the actual frequency reached The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters

Use this mode if the motor may be coasting when the start command is given With the flying start it is possible to ride through short utility voltage interruptions

4 7 **Stop function**

Coasting

0 The motor coasts to an uncontrolled stop with the SV9000 off after the Stop command

Ramp

1 After the Stop command the speed of the motor is decelerated according to the deceleration ramp time parameter If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration

4 8 **DC braking current**

Defines the current injected into the motor during the DC braking

4 9 **DC braking time at stop**

4 9 **DC braking time at stop**

Determines whether DC braking is ON or OFF It also determines the braking duration time of the DC-brake when the motor is stopping The function of the DC brake depends on the stop function parameter 4 7 See figure 6 5-13

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param 4 7) The time is set by the value of parameter 4 9

Stop-function = 0 (coasting).

After the stop command the motor will coast to a stop with the SV9000 off

With DC-injection, the motor can be electrically stopped in the shortest possible time without using an optional external braking resistor

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is ≥ nominal frequency of the motor (par 1 11) the value of parameter 4 9 determines the braking time When the frequency is ≤ 10% of the nominal, the braking time is 10% of the set value of parameter 4 9

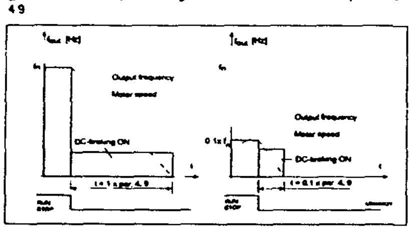


Figure 6.5-13 DC-braking time when par 4 7 = 0

Stop-function = 1 (ramp):

After the Stop command the speed of the motor is reduced based on the deceleration ramp parameter If no regeneration occurs due to load inertia to a speed defined with by parameter 4 10 where the DC-braking starts

The braking time is defined with parameter 4 9

If high inertia exists it is recommended to use an external braking resistor for faster deceleration. See figure 6 5-14

4 10 **Execute frequency of DC-brake during ramp Stop**

See figure 6 5-14

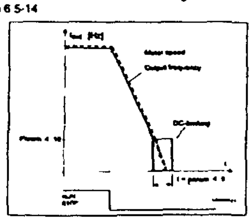


Figure 6 5-14 DC-braking time when par 4 7 = 1

4 11 DC-brake time at start

0 DC-brake is not used

>0 DC-brake is active when the start command is given This parameter defines the time before the brake is released After the brake is released the output frequency increases according to the set start function parameter 4 6 and acceleration parameters (1 3 4 1 or 4 2 4 3) see figure 6 5-15

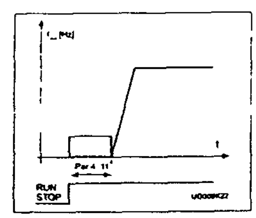


Figure 6.5-15 DC-braking time at start

4 12 **Jog speed reference**

Parameter value defines the jog speed selected with the digital input.

5 1 5.6 **Prohibit frequency area, Low limit/High limit**

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions. The accuracy of the setting is 0.1 Hz.

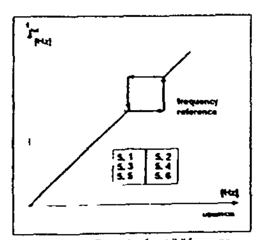


Figure 6 5-16 Example of prohibit frequency area setting

6 1 **Motor control mode**

0 = Frequency control (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq resolution 0.01 Hz)
1 = Speed control: (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6 2 **Switching frequency**

Motor noise can be minimized by using a high switching frequency Increasing the frequency reduces the capacity of the SV9000 Before changing the frequency from the factory default 10 kHz (3 6 kHz≥40Hp) check the drive derating from the curves in figure 5.2-2 and 5.2 3 of the User's Manual

6 3 *Field weakening point*
6 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (par 6 4) Above that frequency the output voltage remains at the set maximum value Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1 8 1 9 6 5 6 6 and 6. 7 See figure 6 5-17

When parameters 1 10 and 1 11 nominal voltage and nom nal frequency of the motor are set parameters 6 3 and 6 4 are also set automatically to the correspond ng values If different values for the field weakening point and the maximum output voltage are required change these parameters __after__ setting the parameters 1 10 and 1 11

6 5 V/Hz curve middle point frequency

If the programmable V/Hz curve has been selected with 2 28parameter 1 8 this parameter defines the middle point frequency of the curve See figure 6 5-17

6 6 V/Hz curve middle point voltage

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the middle point voltage (% of motor nominal voltage) of the curve See figure 6 5-17

6 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1 8 this parameter defines the zero frequency voltage of the curve See figure 6 5-17

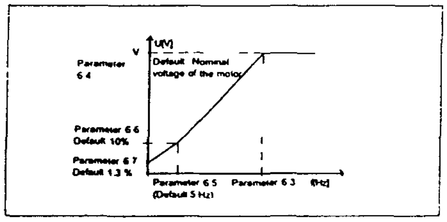


Figure 6 5-17 Programmable V/Hz curve

6 8 Overvoltage controller
6 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF This may be useful in cases where the utility supply voltage varies more than 15%—+10% and the application requires a constant speed If the controllers are ON they will change the motor speed in over/undervoltage cases Overvoltage faster undervoltage = slower

Over/undervoltage trips may occur when controllers are not used

6

7 1 *Response to the reference fault*

0 = No response
1 Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault always coasting stop mode after fault

A warning or a fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2

7 2 Response to external fault

0 No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4 7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3 The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2

7 3 Phase supervision of the motor

0 No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7 4 Ground fault protection

0 = No action
2 Fault message

Ground fault protection ensures that the sum of the motor phase currents is zero The overcurrent protection is always work ng and protects the drive from ground faults with high current levels

Parameters 7 5—7 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating The SV9000 drive is capable of supplying higher than nominal current to the motor If the load requires this high current, there is a risk that motor will be thermally overloaded This is true especially at low frequencies With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan, the load reduction on low speed is small

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor When the power is turned on to the drive the calculated model uses the heatsink temperature to determine the initial thermal state of the motor The calculated model assumes that the ambient temperature of the motor is 40°C

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded This current limit is a function of the output frequency The curve for I_T is set with parameters 7 6 7 7 and 7 9 See figure 6 5-18 The default values of these parameters are set from the motor nameplate data

6

With the output current at I_T the thermal state will reach the nominal value (100%) The thermal state changes with the square of the current. With output current at 75% of I_T the thermal state will reach 56% and with output current at 120% of I_T the thermal state would reach 144% The function will trip the drive (refer par 7 5) if the thermal model reaches a value of 105% The response time of the thermal model is determined by the time constant, parameter 7 8 The larger the motor the longer it takes to reach the final temperature

The thermal state of the motor can be monitored through the display Refer to the table for monitoring items. (User's Manual, table 7 3-1)

CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7 5 Motor thermal protection

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is selected, the drive will stop and activate the fault stage

Deactivating the protectionby setting this parameter to 0 will reset the thermal stage of the motor to 0%

7 6 Motor thermal protection, break point current

The current can be set between 50.0—150.0% x I_{nMotor}
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. See figure 6.5-18.

The value is set as a percentage of the motor nameplate nominal current, parameter 1 13, nominal current of the motor not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated

If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

Setting this parameter (or parameter 1 13) does not affect the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive

7 7 Motor thermal protection, zero frequency current

The current can be set between 10 0—150 0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency See figure 6 5-18.

The default value is set assuming that there is no external fan cooling the motor If an external fan is used this parameter can be set to 90% (or higher)

The value is set as a percentage of the motor's nameplate nominal current, parameter 1 13, not the drive s nominal output current. The motor's nominal

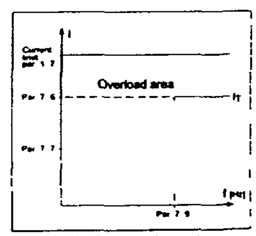


Figure 6.5-18 Motor thermal current I curve

current is the current which the motor can stand in direct on-line use without being overheated

If you change parameter 1 13, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1 13) does not affect to the maximum output current of the drive Parameter 1 7 alone determines the maximum output current of the drive.

7 8 Motor thermal protection, time constant

The time can be set between 0.5—300 minutes. This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is *defined as the time it takes the calculated thermal stage to reach 63% of its final value.*

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1 12 and 1 13 If either of these parameters is reset, then this parameter is set to its default value

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time As a rule of thumb, the motor thermal time constant in minutes equals to $2xt_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current) If the drive is in stopped, the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection with an increased time constant.

6

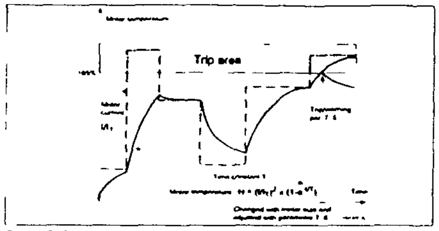


Figure 6 5-19 Calculating motor temperature

7 9 **Motor thermal protection break point frequency**

The frequency can be set between 10—500 Hz This is the frequency break point of thermal current curve With frequencies above this point the thermal capacity of the motor is assumed to be constant. See figure 6 5-18

The default value is based on motor's nameplate data parameter 1 11 It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor More generally it is 70% of the frequency at the field weakening point (parameter 6 3) Changing either parameter 1 11 or 6 3 will restore this parameter to its default value

Parameters 7 10—7 13 Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection The stall state is defined with two parameters 7 11 Stall Current and 7 13 Stall Frequency If the current is higher than the set limit and output frequency is lower than the set limit, the stall state is true There is actually no real indication of the shaft rotation Stall protection is a type of overcurrent protection.

7 10 **Stall protection**

Operation

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code If tripping is set on, the drive will stop and activate the fault stage

Setting this parameter to 0 will deactivate the protection and will reset the stall time counter to zero

7 11 **Stall current limit**

The current can be set between 0 0—200% x I_{nMotor}

In a stall the current has to be above this limit See figure 6 5-20 The value is set as a percentage of the motor's name-plate nominal current parameter 1 13 If parameter 1 13 is adjusted this parameter is automatically restored to its default value

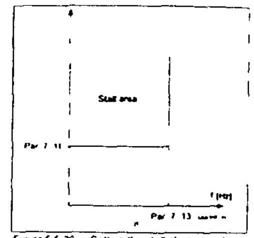


Figure 6 5-20 Setting the stall characteristics

7 12 **Stall time**

The time can be set between 2 0—120 s
This is the maximum allowed time for a stall There is an internal up/down counter to count the stall time See figure 6 5-21 If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7 10)

7 13 **Maximum stall frequency**

The frequency can be set between 1—f_{max} (par 1 2)
In the stall state the output frequency has to be smaller than this limit See figure 6 5-20

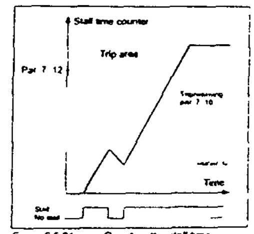


Figure 6 5-21 Counting the stall time

Parameters 7 14—7 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running If the motor load is reduced, there might be a problem in the process, e.g broken belt or dry pump

Motor underload protection can be adjusted by setting the underload curve with parameters 7 15 and 7 16 The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5Hz (the underload counter value is stopped) See figure 6 5-22

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor The motor's nameplate data, parameter 1 13, the motor's nominal current and the drive s nominal current I_{CT} are used to find the scaling ratio for the internal torque value If other than standard motor is used with the drive the accuracy of the torque calculation is decreased

7 14 **Underload protection**

Operation

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code If tripping is set active the drive will stop and activate the fault stage

Deactivating the protection, by setting this parameter to 0 will reset the underload time counter to zero.

7 15 **Underload protection, field weakening area load**

The torque limit can be set between 20 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. See the figure 6.5-22 If parameter 1. 13 is adjusted, this parameter is automatically restored to its default value

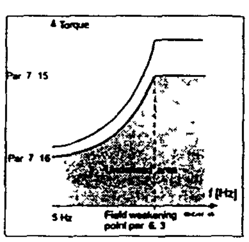


Figure 6 5-22 Setting of minimum load

7 16 **Underload protection, zero frequency load**

Torque limit can be set between 10 0—150 % x T_{nMotor}

This parameter is the value for the minimum allowed torque with zero frequency See figure 6.5-22. If parameter 1 13 is adjusted, this parameter is automatically restored to its default value

7 17 **Underload time**

This time can be set between 2 0—600 0 s

This is the maximum allowed time for an underload state There is an internal up/down counter to accumulate the underload time See figure 6.5-23 If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7 14) If the drive is stopped the underload counter is reset to zero

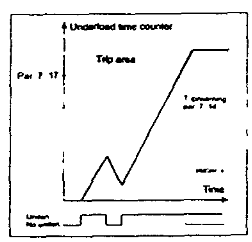


Figure 6 5-23 Counting the underload time

8 1 **Automatic restart: number of tries**
8 2 **Automatic restart trial time**

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8 6 The Start function for Automatic restart is selected with parameter 8. 3.

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2

The time counting starts from the first autorestart. If the number of restarts does not exceed the value of parameter 8 1 during the trial time the counting is cleared after the trial time has elapsed The next fault starts the counting again. See figure 6 5-2

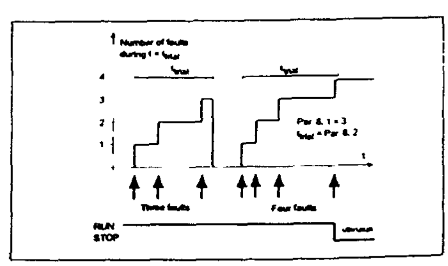


Figure 6.5-24 Automatic restart.

8 3 **Automatic restart, start function**

The parameter defines the start mode

0 = Start with ramp
1 = Flying start see parameter 4 6

8 4 **Automatic restart after undervoltage trip**

0 = No automatic restart after undervoltage trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 5 **Automatic restart after overvoltage trip**

0 = No automatic restart after overvoltage trip
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8 6 **Automatic restart after overcurrent trip**

0 = No automatic restart after overcurrent trip
1 = Automatic restart after overcurrent faults

8 7 **Automatic restart after reference fault trip**

0 = No automatic restart after reference fault trip
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8 8 **Automatic restart after over/undertemperature fault trip**

0 = No automatic restart after temperature fault trip
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C

6

9 1 **Number of auxiliary drives**

With this parameter the number of auxiliary drives in use is defined The signals to control the auxiliary drives on and off can be programmed to the relay outputs or to the digital output with parameters 3 6 3 8 The default setting is one auxiliary drive in use pre-programmed to relay output RO1

9 2 **Start frequency of auxiliary drive 1**
9 4 **Start frequency of auxiliary drive 2**
9 6 **Start frequency of auxiliary drive 3**

The frequency of the SV9000 must exceed by 1 Hz the limit defined with these parameters before the auxiliary drive is started The 1 Hz provides hysteresis to avoid unnecessary starts and stops See figure 6 5 25

9 3 **Stop frequency of auxiliary drive 1**
9 5 **Stop frequency of auxiliary drive 2**
9 7 **Stop frequency of auxiliary drive 3**

The frequency of the SV9000 must fall 1Hz below the limit defined with these parameters before the auxiliary drive is stopped The stop frequency limit also defines the frequency the drive drops to after starting the auxiliary drive *See figure 6 5-25*

9 10 **Start delay of auxiliary drives**

Starting of the auxiliary drives is delayed based on the time setting of parameter 9 10 This prevents unnecessary starts which could be caused by a flow reference request which is momentarily above the previous reference level. See figure 6 5-25

9 11 **Stop delay of auxiliary drives**

Stopping of the auxiliary drives is delayed based on the time setting of parameter 9 10 This prevents unnecessary stops which could be caused by a flow reference request which is momentarily below the previous reference level See figure 6 5-25

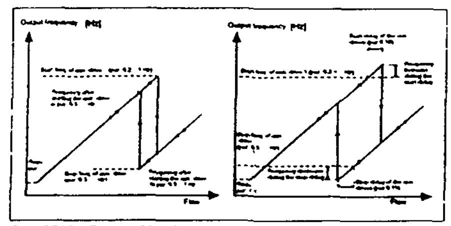


Figure 6 5-25 Example of the effect of parameters in variable speed and one auxiliary drive system

6

9 12 ***Reference step after start of the auxiliary drive 1***
9 13 **Reference step after start of the auxiliary drive 2**
9 14 **Reference step after start of the auxiliary drive 3**

A reference step will automatically be added to the reference value when the corresponding auxiliary drive is started. This allows compensation for the pressure loss in the piping caused by the increased flow *See figure 6 5-26*

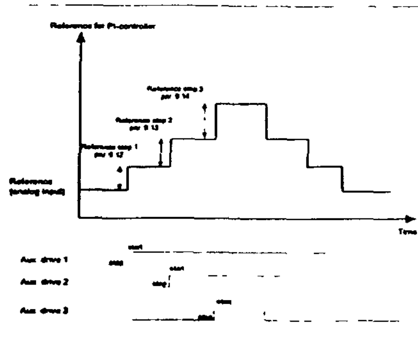


Figure 6.5-26 Reference steps after starting and stopping the auxiliary drives

9 16 **Sleep level**
9 17 **Sleep delay**

Changing this parameter from a value of 0 0 Hz activates the sleep function where the drive is stopped automatically when the frequency is below the sleep level (par 9 16) continuously over the sleep delay (9 17) time. During the stop state the Pump and fan control logic is operating and will switch the drive to the Run state when the wake up level defined with parameters 9. 18 and 9. 19 is reached See figure 6 5-27

9 18 **Wake up level**

The wake up level defines the percentage level below which the actual frequency must fall or which has to be exceeded before starting the drive from the sleep function. See figure 6.5-27

19 **Wake up function**

This parameter defines if the wake up occurs when the frequency either falls below or exceeds the wake up level (par 9 18)

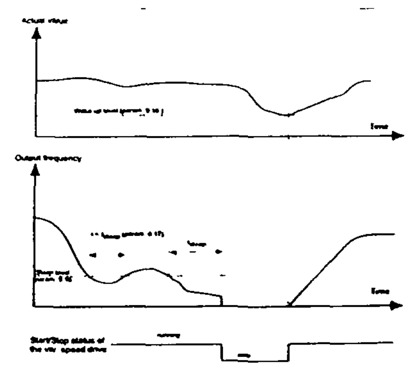


Figure 6 5-27 Example of the sleep function

9 20 **PI-regulator bypass**

With this parameter the PI-regulator can be programmed to be bypassed. Then the frequency of the drive is controlled by the frequency reference and the starting points of the auxiliary drives are also defined by this reference

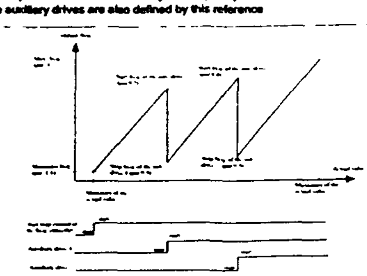


Figure 6 5-28 Example of the function of variable speed drive and two auxiliary drives when PI-regulator is bypassed with parameter 9. 20

6

6 6 MONITORING DATA

The PI-control application has additional items for monitoring (n20 - n25) See table 6 6-1

Data number	Data name	Unit	Description
n 1	Output frequency	Hz	Frequency to the motor
n 2	Motor speed	rpm	Calculated motor speed
n 3	Motor current	A	Measured motor current
n 4	Motor torque	%	Calculated actual torque/nominal torque of the unit
n 5	Motor power	%	Calculated actual power/nominal power of the unit
n 6	Motor voltage	V	Calculated motor voltage
n 7	DC-link voltage	V	Measured DC-link voltage
n 8	Temperature	°C	Temperature of the heat sink
n 9	Operating day counter	DD.dd	Operating days [1], not resettable
n 10	Operating hours, "trip counter"	HH.hh	Operating hours [2] can be reset with programmable button #3
n 11	MW-hours	MWh	Total MW-hours, not resettable
n 12	MW-hours, "trip counter"	MWh	MW-hours, can be reset with programmable button #4
n 13	Voltage/analog input	V	Voltage of the terminal V_{in}+ (term. #2)
n 14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
n 15	Digital input status, gr A		
n 16	Digital input status gr B		
n 17	Digital and relay output status		
n 18	Control program		Version number of the control software
n 19	Unit nominal power	Hp	Shows the horsepower size of the unit
n 20	PI-controller reference	%	Percent of the maximum reference
n 21	PI-controller actual value	%	Percent of the maximum actual value
n 22	PI-controller error value	%	Percent of the maximum error value
n 23	PI-controller output	Hz	
n 24	Number of running auxiliary drives		
n 25	Motor temperature rise	%	100% = temperature of motor has risen to nominal

Table 6 6-1 Monitored items

[1] DD = full days, dd = decimal part of a day
[2] HH = full hours hh = decimal part of an hour

6 7 Panel reference

The Pump and fan control application has an extra reference (r2) for PI-controller on the panel's reference page See table 6 7 1

Refrence number	Reference name	Range	Step	Function
r1	Frequency reference	f_{min}—f_{max}	0 01 Hz	Reference for panel control and I/O terminal Source B reference
r2	PI-controller reference	0—100%	0 1%	Reference for PI-controller

Table 6 7 1 Panel reference

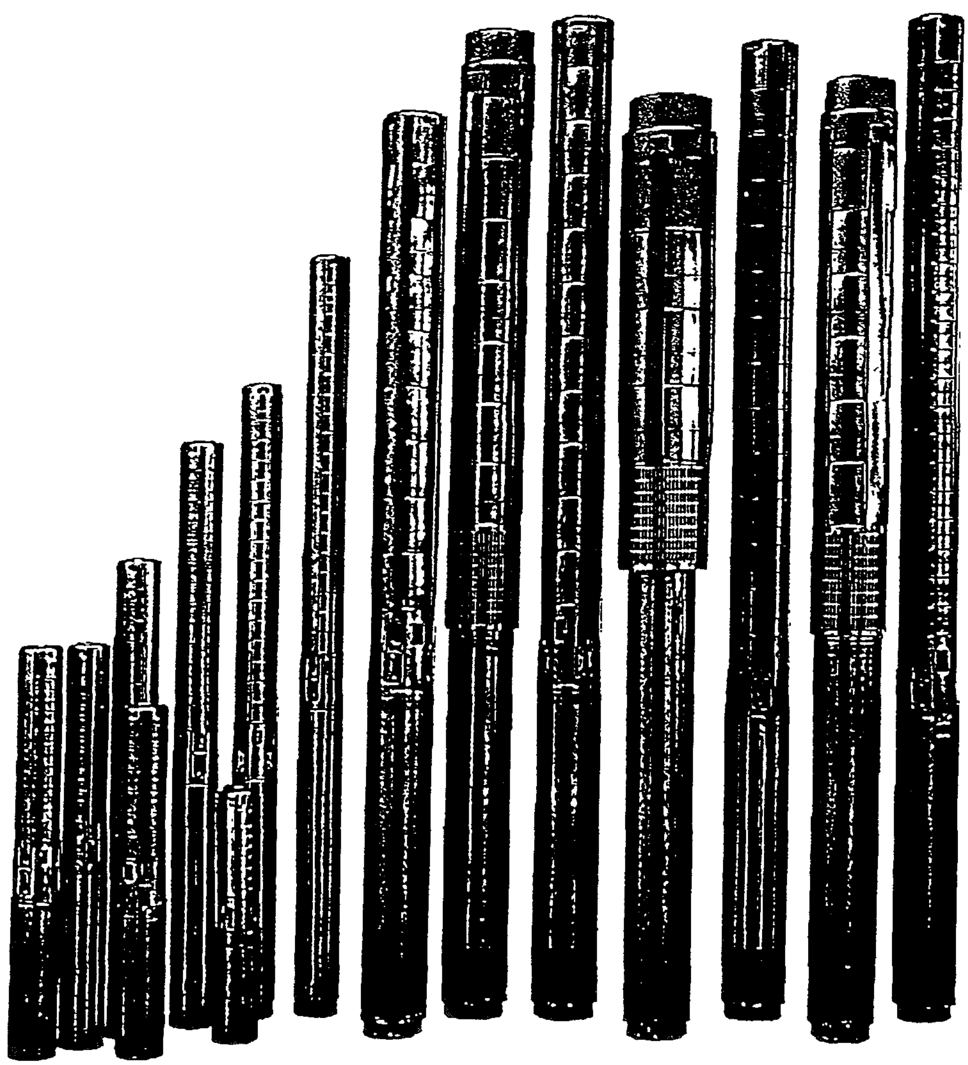
Remarks

Grundfos
Submersible Pumps

GRUNDFOS **INSTRUCTIONS**

SP

(GB) Installation and operating instructions
(D) Montage- und Betriebsanleitung
(F) Notice d'installation et d'entretien
(I) Istruzioni di installazione e funzionamento
(E) Instrucciones de instalación y funcionamiento
(P) Instruções de instalação e funcionamento
(GR) Οδηγίες εγκατάστασης και λειτουργίας
(NL) Installatie- en bedieningsinstructies
(S) Monterings- och driftsinstruktion
(SF) Asennus- ja käyttöohjeet
(DK) Monterings- og driftsinstruktion



Declaration of Conformity

We GRUNDFOS declare under our sole responsibility that the products SP to which this declaration relates, are in conformity with the Council Directives on the approximation of the laws of the EEC Member States relating to

- Machinery (98/37/EEC)
  Standard used EN 292
- Electromagnetic compatibility (89/336/EEC)
  Standards used EN 61 000 6 2 and EN 61 000 6 3
- Electrical equipment designed for use within certain voltage limits (73/23/EEC)
  Standards used EN 60 335 1 and EN 60 335 2 41

Konformitätserklärung

Wir GRUNDFOS erklären in alleiniger Verantwortung daß die Produkte SP, auf die sich diese Erklärung bezieht, mit den folgenden Richtlinien des Rates zur Angleichung der Rechtsvorschriften der EG Mitgliedstaaten übereinstimmen

- Maschinen (98/37/EWG)
  Norm die verwendet wurde EN 292
- Elektromagnetische Verträglichkeit (89/336/EWG)
  Normen die verwendet wurden EN 61 000 6 2 und EN 61 000 6 3
- Elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen (73/23/EWG)
  Normen die verwendet wurden EN 60 335 1 und EN 60 335 2 41

Déclaration de Conformité

Nous GRUNDFOS déclarons sous notre seule responsabilité que les produits SP auxquels se réfère cette déclaration sont conformes aux Directives du Conseil concernant le rapprochement des législations des Etats membres CEE relatives à

- Machines (98/37/CEE)
  Standard utilisé EN 292
- Compatibilité électromagnétique (89/336/CEE)
  Standards utilisés EN 61 000-6-2 et EN 61 000 6 3
- Matériel électrique destiné à employer dans certaines limites de tension (73/23/CEE)
  Standards utilisés EN 60 335-1 et EN 60 335-2 41

Dichiarazione di Conformità

Noi GRUNDFOS dichiariamo sotto la nostra esclusiva responsabilità che i prodotti SP ai quali questa dichiarazione si riferisce sono conformi alle Direttive del consiglio concernenti il ravvicinamento delle legislazioni degli Stati membri CEE relative a

- Macchine (98/37/CEE)
  Standard usato EN 292
- Compatibilità elettromagnetica (89/336/CEE)
  Standard usati EN 61 000 6 2 e EN 61 000 6 3
- Materiale elettrico destinato ad essere utilizzato entro certi limiti di tensione (73/23/CEE)
  Standard usati EN 60 335 1 e EN 60 335-2 41

Declaración de Conformidad

Nosotros GRUNDFOS declaramos bajo nuestra única responsabilidad que los productos SP a los cuales se refiere esta declaración son conformes con las Directivas del Consejo relativas a la aproximación de las legislaciones de los Estados Miembros de la CEE sobre

- Máquinas (98/37/CEE)
  Norma aplicada EN 292
- Compatibilidad electromagnética (89/336/CEE)
  Normas aplicadas EN 61 000-6-2 y EN 61 000 6 3
- Material eléctrico destinado a utilizarse con determinados límites de tensión (73/23/CEE)
  Normas aplicadas EN 60 335-1 y EN 60 335-2 41

Declaração de Conformidade

Nos GRUNDFOS declaramos sob nossa única responsabilidade que os produtos SP aos quais se refere esta declaração estão em conformidade com as Directivas do Conselho das Comunidades Europeias relativas a aproximação das legisla ções dos Estados Membros respeitantes a

- Máquinas (98/37/CEE)
  Norma utilizada EN 292
- Compatibilidade electromagnética (89/336/CEE)
  Normas utilizadas EN 61 000 6-2 e EN 61 000-6 3
- Material eléctrico destinado a ser utilizado dentro de certos limites de ten são (73/23/CEE)
  Normas utilizadas EN 60 335-1 e EN 60 335 2-41

Δήλωση Συμμόρφωσης

Εμείς η GRUNDFOS δηλώνουμε με αποκλειστικά δική μας ευθύνη ότι τα προϊόντα SP συμμορφώνονται με την Οδηγία του Συμβουλίου επι της σύγκλισης των νόμων των Κρατών Μελών της Ευρωπαϊκής Ενωσης σε σχέση με τα

- Μηχανήματα (98/37/EEC)
  Πρότυπο που χρησιμοποιήθηκε: EN 292
- Ηλεκτρομαγνητική συμβατότητα (89/336/EEC)
  Πρότυπα που χρησιμοποιήθηκαν EN 61 000 6 2 και EN 61 000 6 3
- Ηλεκτρικές συσκευές σχεδιασμένες γιά χρήση εντός ορισμένων ορίων ηλεκτρικής τάσης (73/23/EEC)
  Πρότυπα που χρησιμοποιήθηκαν· EN 60 335-1 και EN 60 335-2 41

Overeenkomstigheidsverklaring

Wij GRUNDFOS verklaren geheel onder eigen verantwoordelijkheid dat de produkten SP waarop deze verklaring betrekking heeft in overeenstemming zijn met de Richtlijnen van de Raad inzake de onderlinge aanpassing van de wetgevingen van de Lid-Staten betreffende

- Machines (98/37/EEG)
  Norm EN 292
- Elektromagnetische compatibiliteit (89/336/EEG)
  Normen EN 61 000-6-2 en EN 61 000-6-3
- Elektrisch materiaal bestemd voor gebruik binnen bepaalde spanningsgrenzen (73/23/EEG)
  Normen EN 60 335-1 en EN 60 335 2-41

Försäkran om överensstämmelse

Vi GRUNDFOS försäkrar under ansvar, att produkterna SP, som omfattas av denna försäkran, är i överensstämmelse med Rådets Direktiv om inbördes närmande till EU-medlemsstaternas lagstiftning, avseende

- Maskinell utrustning (98/37/EC)
  Använd standard EN 292
- Elektromagnetisk kompatibilitet (89/336/EC)
  Använda standarder EN 61 000-6-2 och EN 61 000-6-3
- Elektrisk material avsedd för användning inom vissa spänningsgränser (73/23/EC)
  Använda standarder EN 60 335-1 och EN 60 335-2-41

Vastaavuusvakuutus

Me GRUNDFOS vakuutamme yksin vastuullisesti, että tuotteet SP, jota tämä vakuutus koskee, noudattavat direktiivejä jotka käsittelevät EY n jäsenvaltioiden koneellisia laitteita koskevien lakien yhdenmukaisuutta seur

- Koneet (98/37/EY).
  Käytetty standardi. EN 292
- Elektromagneettinen vastaavuus (89/336/EY)
  Käytetyt standardit: EN 61 000-6-2 ja EN 61 000-6-3
- Määrättyjen jännitterajoitusten puitteissa käytettävät sähköiset laitteet (73/23/EY).
  Käytetyt standardit EN 60 335-1 ja EN 60 335-2-41

Overensstemmelseserklæring

Vi GRUNDFOS erklærer under ansvar, at produkterne SP, som denne erklæring omhandler, er i overensstemmelse med Rådets direktiver om indbyrdes tilnærmelse til EF medlemsstaternes lovgivning om

- Maskiner (98/37/EØF)
  Anvendt standard EN 292
- Elektromagnetisk kompatibilitet (89/336/EØF)
  Anvendte standarder EN 61 000-6-2 og EN 61 000-6-3
- Elektrisk materiel bestemt til anvendelse inden for visse spændingsgrænser (73/23/EØF)
  Anvendte standarder EN 60 335-1 og EN 60 335-2-41

Bjerringbro, 1st September 2001

Kenth Hvid Nielsen
Technical Manager

SP

CONTENTS

Before beginning installation procedures, these Installation and Operating Instructions should be studied carefully. The installation and operation should also be in accordance with local regulations and accepted codes of good practice.

These instructions apply to GRUNDFOS submersible motors, types MS and MMS, and GRUNDFOS submersible pumps, type SP, fitted with submersible motors, types GRUNDFOS MS or MMS, FRANKLIN 4"-8", MERCURY 6"-12" and PLEUGER 6"-12".

If the pump is fitted with a motor of another motor make than GRUNDFOS MS or MMS, please note that the motor data may differ from the data stated in these instructions.

1. Delivery and Storage

1.1 Delivery

GRUNDFOS submersible pumps are supplied from the factory in proper packing in which they should remain until they are to be installed.

During unpacking and prior to installation, care must be taken when handling the pump to ensure that misalignment does not occur due to bending.

he loose data plate supplied with the pump should be fixed close to the installation site.

The pump should not be exposed to unnecessary impact and shocks.

1.2 Storage and Handling

Storage temperature: Pump: –20°C to +60°C
Motor: –20°C to +70°C

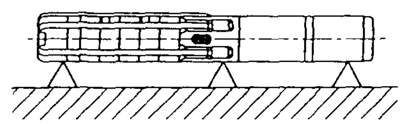
The motors must be stored in a closed, dry and well ventilated room

Note: If MMS motors are stored for more than one year, the shaft must be turned by hand at least once a month
If a motor has been stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use

The pump should not be exposed to direct sunlight

If the pump has been unpacked, it should be stored horizontally, adequately supported, or vertically to prevent misalignment of the pump. Make sure that the pump cannot roll or fall over. During storage, the pump can be supported as shown in fig. 1.

Fig. 1



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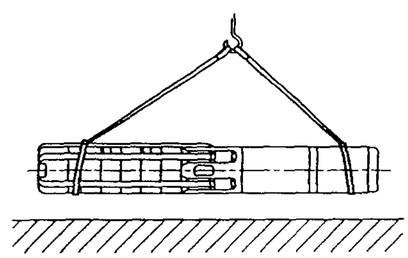
If the pump is not handled in vertical position, it must be lifted in the motor part and the pump part at the same time, see fig. 2. Note that the centre of gravity will vary, depending on pump type

Fig. 2



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1.2.1 Frost Protection

If the pump has to be stored after use, it must be stored on a frost-free location, or it must be ensured that the motor liquid is frost-proof.

2. General Data

2.1 Applications

GRUNDFOS submersible pumps, type SP, are designed for a wide range of water supply and liquid transfer applications, such as the supply of fresh water to private homes or waterworks, water supply to nursery gardens or farms, drawdown of groundwater and pressure boosting, and various industrial jobs.

The pump must be installed so that the suction interconnector is completely submerged in the liquid. The pump can be installed either horizontally or vertically, see also section *3.2 Positional Requirements*.

2.2 Pumped Liquids

Clean, thin, **non-explosive** liquids without solid particles or fibres.

The maximum sand content of the water must not exceed 50 g/m^3. A larger sand content will reduce the life of the pump and increase the risk of blocking.

When pumping liquids with a density higher than that of water, motors with correspondingly higher outputs must be used.

Note: If liquids with a viscosity higher than that of water are to be pumped, please contact GRUNDFOS.

The special SP A N, SP A R, SP N, SP R and SPE types are designed to accommodate liquids with higher aggressiveness than drinking water.

The maximum liquid temperature appears from section *3.4 Liquid Temperatures/Cooling*.

2.3 Sound Pressure Level

The sound pressure level has been measured in accordance with the rules laid down in the EC machinery directive 98/37/EEC.

Sound pressure level of pumps:

Applies to pumps submerged in water, without external regulating valve

Pump Type	L_{pA} [dB(A)]
SP 1A	<70
SP 2A	<70
SP 3A	<70
SP 5A	<70
SP 8A	<70
SP 14A	<70
SP 17	<70
SP 30	<70
SP 46	<70
SP 60	<70
SP 77	<70
SP 95	<70
SP 125	79
SP 160	79
SP 215	82

Sound pressure level of motors:

The sound pressure level of GRUNDFOS MS and MMS motors is lower than 70 dB(A).

Other motor makes: See installation and operating instructions for these motors.

3. Preparation

⚠ Before starting work on the pump, make sure that the electricity supply has been switched off and that it cannot be accidentally switched on.

3.1 Checking of Liquid in Motor

The submersible motors are factory-filled with a special non-poisonous liquid, which is frost-proof down to –20°C.

Note: The level of the liquid in the motor must be checked and the motor must be refilled, if required.

Note: If there is a risk of frost, special GRUNDFOS liquid must be used to refill the motor. Otherwise clean water may be used for refilling (however, never use distilled water).

Refilling of liquid is carried out as described below.

3.1.1 GRUNDFOS Submersible Motors MS 4000 and MS 402

The filling hole for motor liquid is placed in the following positions:

MS 4000: in one of the staybolts.

MS 402: in the bottom of the motor.

1. Position the submersible pump as shown in fig. 3. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe, fig. 3, until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

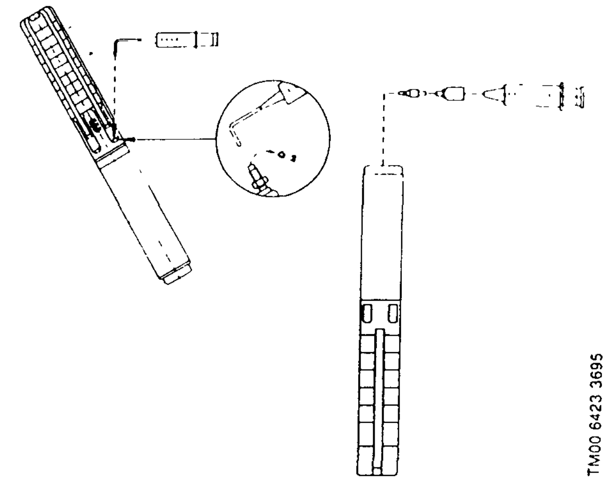
Torques:

MS 4000: 0.5 Nm.

MS 402: 2.0 Nm.

The submersible pump is now ready for installation.

Fig. 3



3.1.2 GRUNDFOS Submersible Motors MS 6000

- If the motor is delivered from stock, the liquid level must be checked before the motor is fitted to the pump, see fig. 4.
- On pumps delivered directly from GRUNDFOS, the liquid level has already been checked.
- In the case of service, the liquid level must be checked, see fig. 4.

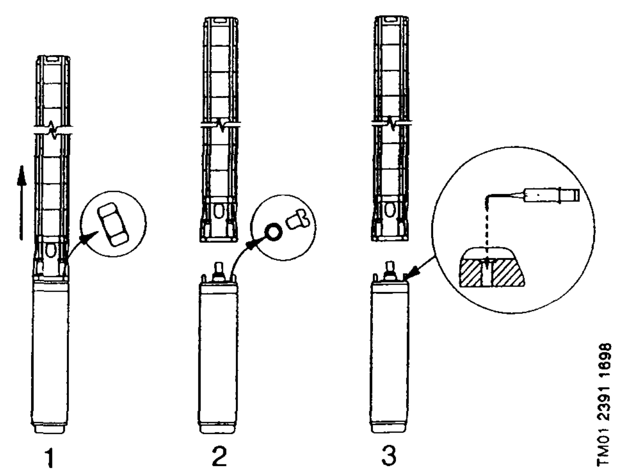
The filling hole for motor liquid is placed at the top of the motor.

1. Position the submersible pump as shown in fig. 4. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe, fig. 4, until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torque: 3.0 Nm.

The submersible pump is now ready for installation.

Fig. 4



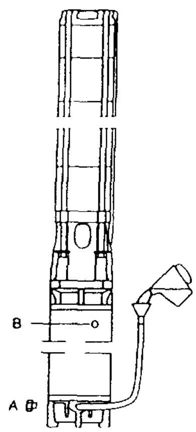
3.1.3 GRUNDFOS Submersible Motors MMS 6000, MMS 8000, MMS 10000 and MMS 12000

To refill the motor, proceed as follows:

1. Position the submersible pump as shown in fig. 5.
2. Remove the screw (A) from the filling hole and fit the nipple with pipe and funnel supplied with the motor.
3. Remove the air vent screw (B) to allow possible air in the motor to escape.
4. Hold the funnel higher than the vent hole and pour clean water into the motor until the liquid starts dripping out of the motor.
5. Stop pouring water into the motor. Refit the screw (B) to the

The submersible pump is now ready for installation

Fig. 5

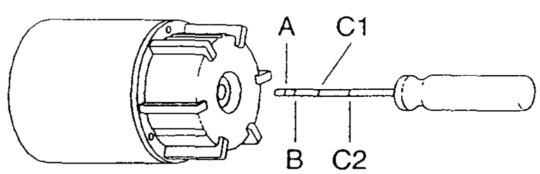


3.1.4 FRANKLIN Submersible Motors from 3 kW and up

The level of the motor liquid in FRANKLIN 4" and 6" submersible motors is checked by measuring the distance from the bottom plate to the built-in rubber diaphragm. This distance can be measured by inserting a rule or a small rod through the hole until *it touches the diaphragm, fig. 6*

Note: Take care not to damage the diaphragm

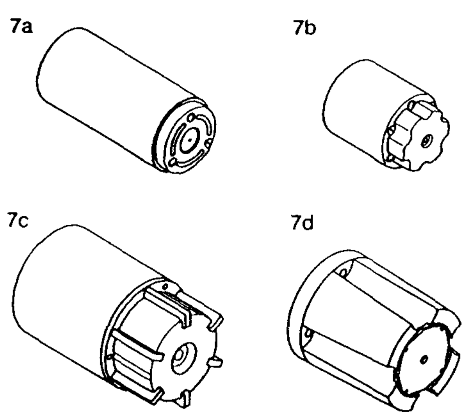
Fig. 6



The following table shows the correct distance from the outside of the bottom plate to the diaphragm.

Motor	Dimension	Distance
FRANKLIN 4", 0.25 to 3 kW (*see fig. 7a*)	A	8 mm
FRANKLIN 4", 3 to 7.5 kW (see fig. 7b)	B	16 mm
FRANKLIN 6", 4 to 45 kW (see fig. 7c)	C1	35 mm
FRANKLIN 6", 4 to 22 kW (see fig. 7d)	C2	59 mm

Fig. 7



If the distance is not correct, carry out an adjustment as described in section *3.1.5 FRANKLIN Submersible Motors.*

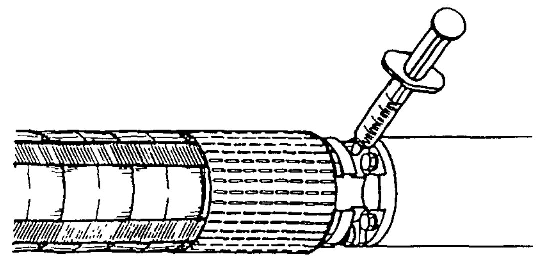
3.1.5 FRANKLIN Submersible Motors

The level of the motor liquid in FRANKLIN 8" submersible motors *is checked as follows:*

- Press the filling syringe against the valve and inject the liquid, fig. 8. If the valve cone is depressed too far, it may be damaged thus causing the valve to leak
- Remove any air in the motor by pressing the point of the filling syringe lightly against the valve
- *Repeat the process of injecting liquid and releasing air until* the liquid starts running out of the diaphragm is in its correct position (FRANKLIN 4" and 6")
- *Reinstall the filter after refilling with liquid*

The submersible pump is now ready for installation

Fig. 8



3.1.6 MERCURY Submersible Motors

The level of the liquid in the motor is checked as described for FRANKLIN 8" motors, see section *3.1.5 FRANKLIN Submersible Motors.*

3.1.7 PLEUGER Submersible Motors

The level of the liquid in the motor is checked as described for FRANKLIN 8" motors, see section *3.1.5 FRANKLIN Submersible Motors.*

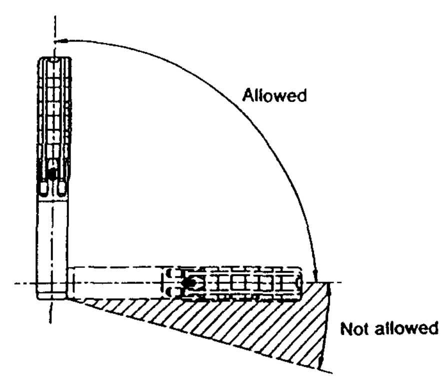
3.2 Positional Requirements

If the pump is to be installed in a position where it is accessible, the coupling must be suitably isolated from human touch. The pump can for instance be built into a flow sleeve.

Depending on motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section *3.2.1.*

If the pump is installed horizontally, the discharge port **should never** fall below the horizontal plane, see fig. 9

Fig. 9



If the pump is installed horizontally, e.g. in a tank, it is recommended to fit it in a flow sleeve.

3.2.1 Motors suitable for horizontal installation

Motor type	Power output 50 Hz [kW]	Power output 60 Hz [kW]
MS	All sizes	All sizes
MMS 6000	3.7 to 18.5	3.7 to 18.5
MMS 8000	22.0 to 63.0	22.0 to 63.0
MMS 10000	75.0 to 110.0	75.0 to 110.0

When FRANKLIN 4" submersible motors up to and including 2.2 kW are started more than 10 times a day, it is recommended to incline the motor at least 15° above the horizontal plane in order to minimize wearing of the upthrust disc.

Note: During operation, the suction interconnector of the pump must always be completely submerged in the liquid.

In special conditions, it may be necessary to submerge the pump even deeper, depending on the operating conditions of the actual pump and the NPSH value.

Note: If the pump is used for pumping hot liquids (40° to 60°C), care should be taken to ensure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

3.3 Diameter of Pump/Motor

The maximum diameter of the pump/motor is as shown in the tables on pages 136 and 137.

It is recommended to check the borehole with an inside calliper to ensure unobstructed passage.

3.4 Liquid Temperatures/Cooling

The maximum liquid temperature and the minimum liquid velocity over the motor appear from the following table.

It is recommended to install the motor above the well screen in order to achieve proper motor cooling.

Note: In cases where the stated liquid velocity cannot be achieved, a flow sleeve must be installed.

If there is a risk of sediment build-up, such as sand, around the motor, a flow sleeve should be used in order to ensure proper cooling of the motor.

3.4.1 Maximum Liquid Temperature

Out of consideration for the rubber parts in pump and motor, the liquid temperature must not exceed 40°C (~105°F). See also the following table.

The pump can operate at liquid temperatures between 40°C and 60°C (~105°F and 140°F) provided that all rubber parts are replaced every third year.

Motor	Installation		
	Flow past the motor	Vertical	Horizontal
GRUNDFOS MS and MMS	Free convection 0 m/s	20°C (~68°F)	Flow sleeve recommended
GRUNDFOS MS	0.15 m/s	40°C (~105°F)	40°C (~105°F)
GRUNDFOS MMS	0.15 m/s	25°C (~77°F)	25°C (~77°F)
FRANKLIN 4"	0.08 m/s	30°C (~85°F)	30°C (~85°F)
FRANKLIN 6" and 8"	0.16 m/s	30°C (~85°F)	30°C (~85°F)
MERCURY	0.15 m/s	25°C (~77°F)	25°C (~77°F)
PLEUGER	0.5 m/s	30°C (~86°F)	30°C (~86°F)

Note: By free convection is meant that the borehole diameter is at least 2" larger than the diameter of the submersible motor.

Other motor makes: See motor specifications.

3.5 Pipework Connection

If noise may be transmitted to the building through the pipework, it is advisable to use plastic pipes.

Note: Plastic pipes are recommended for 4" pumps only.

Make sure that the plastic pipes to be used are suitable for the actual liquid temperature and the pump pressure.

When connecting plastic pipes, a compression coupling should be used between the pump and the first pipe section.

4. Electrical Connection

Before starting work on the pump, make sure that the electricity supply has been switched off and that it cannot be accidentally switched on.

4.1 General

The electrical connection should be carried out by an authorized electrician in accordance with local regulations.

The supply voltage, rated maximum current and cos φ appear from the loose data plate that **must** be fitted close to the installation site.

The required voltage quality for GRUNDFOS **MS** submersible motors, measured at the motor terminals, is −10%/+6% of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

The required voltage quality for GRUNDFOS **MMS** submersible motors, measured at the motor terminals, is −10%/+6% of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

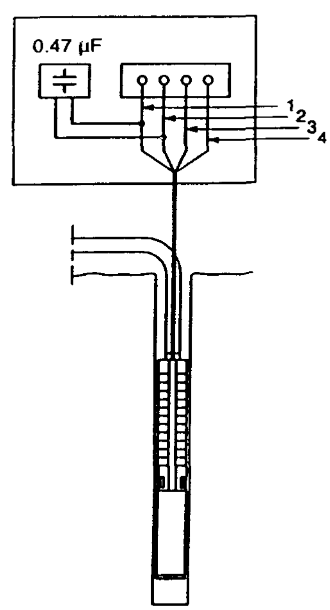
Furthermore, it must be checked that there is voltage symmetry in the electricity supply lines, i.e. same difference of voltage between the individual phases, see also section *9. Checking of Motor and Cable*, point 2.

The pump must be earthed.

The pump must be connected to an external mains switch.

In order that the GRUNDFOS MS motors with a built-in and operational temperature transmitter can meet the EC EMC Directive (89/336/EEC), a 0.47 µF capacitor (in accordance with IEC 384-14) must always be connected over the two phases to which the temperature transmitter is connected, see fig. 10.

Fig. 10



1. Black
2. Blue
3. Yellow/green
4. Brown

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The motors are wound for direct-on-line starting or star-delta starting and the starting current is between 4 and 6 times the full load current of the motor.

The run-up time of the pump is only about 0.1 second. Direct-on-line starting is therefore normally approved by the electricity supply authorities.

4.1.1 Frequency Converter Operation

GRUNDFOS Motors

Three-phase GRUNDFOS motors can be connected to a frequency converter

Note: If a GRUNDFOS MS motor with temperature transmitter is connected to a frequency converter, a fuse incorporated in the transmitter will melt and the transmitter will be inactive. The transmitter cannot be reactivated This means that the motor will operate like a motor without a temperature transmitter
If a temperature transmitter is required, a Pt100 sensor for fitting to the submersible motor can be ordered from GRUNDFOS

During frequency converter operation, it is not advisable to run the motor at a frequency higher than the nominal frequency (50 or 60 Hz) In connection with pump operation, it is important never to reduce the frequency (and consequently the speed) to such a level that the necessary flow of cooling liquid past the motor is no longer ensured

To avoid damage to the pump part, it must be ensured that the motor stops when the pump flow falls below 0 1 x nominal flow

Depending on the frequency converter type, it may expose the motor to detrimental voltage peaks.

Motors, type MS 402, for supply voltages up to and including 440 V (see motor nameplate) must be protected against voltage peaks higher than 650 V (peak-value) between the supply terminals.
It is recommended to protect other motors against voltage peaks higher than 850 V.

The above disturbance can be abated by installing an RC filter between the frequency converter and the motor

Possible increased acoustic noise from the motor can be abated by installing an LC filter which will also eliminate voltage peaks from the frequency converter.

For further details, please contact your frequency converter supplier or GRUNDFOS.

Other Motor Makes than GRUNDFOS:

Please contact GRUNDFOS or the motor manufacturer.

4.2 Motor Protection

4.2.1 Single-Phase Motors

Single-phase submersible motors, type MS 402, incorporate a thermal switch and require no additional motor protection.

When the motor has been thermally switched off, the motor terminals are still live.
When the motor has cooled sufficiently, it will restart automatically.

Single-phase submersible motors, type MS 4000, must be protected. A protective device can either be incorporated in a control box or be separate.

FRANKLIN 4" PSC motors must be connected to a motor starter.

4.2.2 Three-Phase Motors

GRUNDFOS **MS** motors are available with or without a built-in temperature transmitter.

Motors with a built-in and operational temperature transmitter must be protected by means of:

- a motor starter with thermal relay or
- an MTP 75 and a motor starter with thermal relay or
- a CU 3 and contactor(s).

Motors **without** or **with a non**-operational temperature transmitter must be protected by means of:

- a motor starter with thermal relay or
- a CU 3 and contactor(s).

GRUNDFOS **MMS** motors have no built-in temperature transmitter. A Pt100 sensor is available as an accessory.

Motors with a Pt100 sensor must be protected by means of:

- a motor starter with thermal relay or
- a CU 3 and contactor(s).

Motors **without** a Pt100 sensor must be protected by means of

- a motor starter with thermal relay or
- a CU 3 and contactor(s)

4.2.3 Required Motor Starter Settings

For cold motors, the tripping time for the motor starter must be less than 10 seconds at 5 times the rated maximum current of the motor

Note: If this requirement is not met, the motor warranty will be invalidated

In order to ensure the optimum protection of the submersible motor, the starter overload unit should be set in accordance with the following guidelines

1 Set the starter overload to the rated maximum current of the motor
2 Start the pump and let it run for half an hour at normal performance
3 Slowly grade down the scale indicator until the motor trip point is reached
4 Increase the overload setting by 5%

The highest permissible setting is the rated maximum current of the motor.

For motors wound for star-delta starting, the starter overload unit should be set as above, but the maximum setting should be as follows:

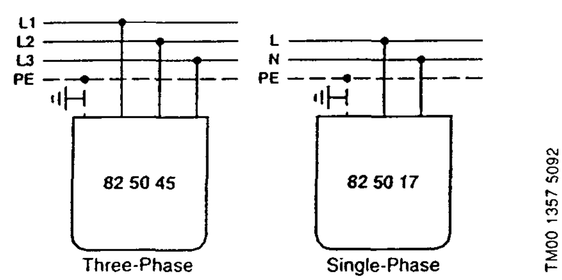
Starter overload setting = Rated maximum current x 0.58.

The highest permissible start-up time for star-delta starting or autotransformer starting is 2 seconds.

4.3 Lightning Protection

The installation can be fitted with a special overvoltage protective device to protect the motor from voltage surges in the electricity supply lines when lightning strikes somewhere in the area, see fig. 11.

Fig. 11



The overvoltage protective device will not, however, protect the motor against a direct stroke of lightning.

The overvoltage protective device should be connected to the installation as close as possible to the motor and always in accordance with local regulations.
Ask GRUNDFOS for lightning protective devices.

Submersible motors, type MS 402, however, require no further lightning protection as they are highly insulated.

Ask for a special cable termination kit with a built-in overvoltage protective device for GRUNDFOS 4" submersible motors (part no. 79 99 11 / 79 99 12).

4.4 Cable Sizing

Make sure that the submersible drop cable can withstand permanent submersion in the actual liquid and at the actual temperature.

GRUNDFOS can supply submersible drop cables for a wide range of installations.

The cross-section (q) of the cable should meet the following requirements:

1. The submersible drop cable should be dimensioned to the rated maximum current (I) of the motor.
2. The cross-section should be sufficient to make a voltage drop over the cable acceptable.

Re 1: The following table specifies the current value of GRUNDFOS submersible drop cables (i e the maximum current tolerated by the drop cable) at an ambient temperature of maximum 30 C Please contact GRUNDFOS if the ambient temperature lies above 30°C

When sizing the submersible drop cable, make sure that the rated maximum current does not exceed the current value (I_S)

For star-delta starting, however, size the cables so that 0 58 x the rated maximum current of the motor does not exceed the current value (I_S) of the cables

q [mm²]	I_S [A]
1 5	18
2 5	25
4	34
6	43
10	60
16	80
25	101
35	126

q [mm²]	I_S [A]
50	153
70	196
95	238
120	276
150	319
185	364
240	430
300	497

If GRUNDFOS submersible drop cables are not used, the cross-section should be selected on the basis of the current values of the actual cables.

Re 2:
Note: The cross-section of the submersible drop cable must be *large enough to meet the voltage quality requirements specified* in section *4.1 General.*

Determine the voltage drop for the cross-section of the submersible drop cable by means of the diagrams on pages 138 and 139, **where**

I = Rated maximum current of the motor.
For star-delta starting
I = rated maximum current of the motor x 0.58

Lx = Length of cable converted to a voltage drop of 1% of the nominal voltage.

$$Lx = \frac{\text{length of drop cable}}{\text{permissible voltage drop in \%}}$$

q = Cross-section of submersible drop cable.

Draw a straight line between the actual I-value and the Lx-value. *Where the line intersects the q-axis, select the cross-section* that lies right above the intersection.

The diagrams are made on the basis of the formulas:

Single-phase submersible motor:

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times (\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times Xl)}$$

Three-phase submersible motor:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times (\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times Xl)}$$

where

L = Length of submersible drop cable [m]
U = Nominal voltage [V]
ΔU = Voltage drop [%]
I = Rated maximum current of the motor [A]
cosφ = 0.9
ρ = Specific resistance: 0.02 [$\Omega mm^2/m$]
q = *Cross-section of submersible drop cable* [mm^2]
sinφ = 0.436
Xl = Inductive resistance: 0.078×10^{-3} [Ω/m]

The single-phase MS 402 submersible motor incorporates motor protection which cuts out the motor in case of excessive winding temperatures while the motor is still supplied with voltage. Allow for this when the motor forms part of a control system

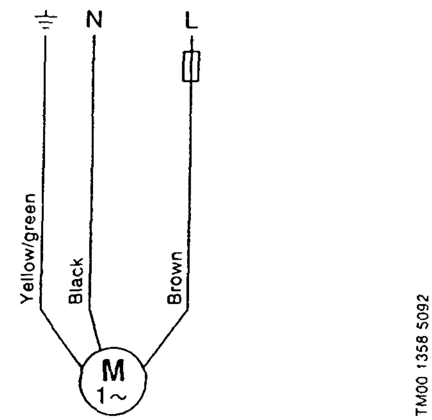
If a compressor is included in a control system together with an ochre filter, the compressor will run continuously once the motor *protection has cut out the motor, unless other special precautions* have been taken

4.6 Connection of Single-Phase Motors

4.6.1 2-Wire Motors

GRUNDFOS MS 402 2-wire motors incorporate motor protection and a starter device and can therefore be connected directly to the mains, see fig 12

Fig. 12



4.6.2 PSC Motors

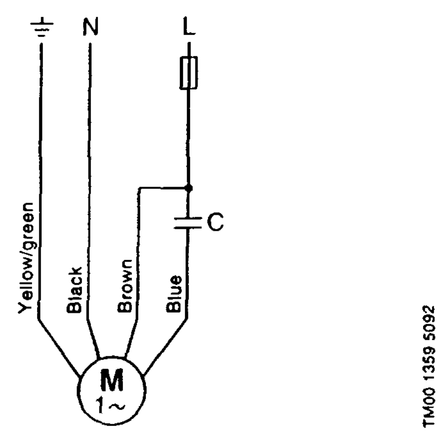
*The PSC motors are connected to the mains via an operating ca-*pacitor which should be dimensioned for continuous operation.

Select the correct capacitor size from the following table:

Motor	Capacitor
0.25 kW	12.5 µF / 400 V / 50 Hz
0.37 kW	16 µF / 400 V / 50 Hz
0.55 kW	20 µF / 400 V / 50 Hz
0.75 kW	30 µF / 400 V / 50 Hz
1.10 kW	40 µF / 400 V / 50 Hz
1.50 kW	50 µF / 400 V / 50 Hz
2.20 kW	75 µF / 400 V / 50 Hz

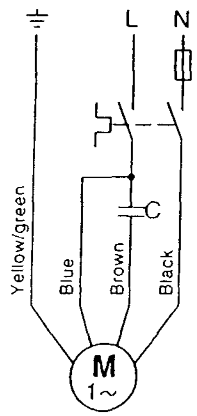
The GRUNDFOS MS 402 PSC motor incorporates motor protection and should be connected to the mains as shown in fig. 13.

Fig. 13



The FRANKLIN 4" PSC motor should be connected to the mains via the motor protection, see fig. 14.

Fig. 14



4.6.3 3-Wire Motors

GRUNDFOS MS 4000 3-wire motors should be connected to the mains via a GRUNDFOS control box SA-SPM 2 or 3 incorporating motor protection.

GRUNDFOS MS 402 3-wire motors incorporate motor protection and should be connected to the mains via a GRUNDFOS control box SA-SPM 2 or 3 without motor protection.

The connection of MS 4000 and MS 402 motors appears from the following table:

Motor	Cable	Control Box	Mains
Up to 0.75 kW	Black Brown Blue Yellow/green	1 N 2 L 3 SA-SPM 2 ⊕	N L PE
From 1.10 kW	Black Brown Blue Yellow/green	1 N 2 L 3 SA-SPM 3 ⊕	N L PE

4.7 Connection of Three-Phase Motors

Three-phase submersible motors must be protected, see section *4.2.2 Three-Phase Motors.*

For electrical connection by means of the CU 3, see the separate installation and operating instructions for this unit.

When a conventional motor starter is being used, the electrical connection should be carried out as described below.

4.7.1 Checking of Direction of Rotation

Note: The pump must not be started until the suction interconnector has been completely submerged in the liquid.

When the pump has been connected to the electricity supply, determine the correct direction of rotation as follows:

1. Start the pump and check the quantity of water and head developed.
2. Stop the pump and interchange two of the phase connections. In the case of motors wound for star-delta starting, exchange U1 by V1 and U2 by V2.
3. Start the pump and check the quantity of water and head developed
4. Stop the pump.

Compare the results taken under points 1. and 3. The connection which gives the larger quantity of water and the higher head is the correct connection.

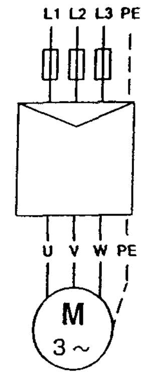
4.7.2 GRUNDFOS Motors, Direct-On-Line Starting

The connection of GRUNDFOS submersible motors wound for direct-on-line starting appears from the following table and fig. 15.

Mains	Cable/Connection
	GRUNDFOS 4" and 6" Motors
L1	U
L2	V
L3	W
PE	PE

Check the direction of rotation as described in section *4.7.1 Checking of Direction of Rotation.*

Fig. 15



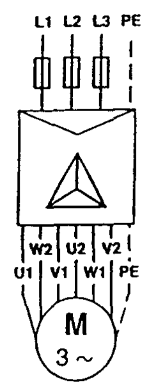
4.7.3 GRUNDFOS Motors, Star-Delta Starting

The connection of GRUNDFOS submersible motors wound for star-delta starting appears from the following table and fig. 16.

Connection	GRUNDFOS 6" Motors
U1	Brown
V1	Blue
W1	Black
W2	Brown
U2	Blue
V2	Black
PE	Yellow/green

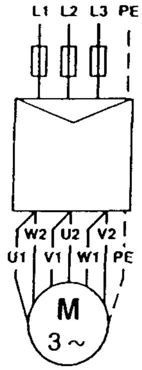
Check the direction of rotation as described in section *4.7.1 Checking of Direction of Rotation.*

Fig. 16



If star-delta starting is not required, but direct-on-line starting is, the submersible motors should be connected as shown in fig. 17.

Fig. 17



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4.7.4 Connection in the Case of Unidentified Cable Marking/Connection

If it is unknown where the individual leads are to be connected to the mains in order to ensure the correct direction of rotation, proceed as follows:

Motors wound for direct-on-line starting:

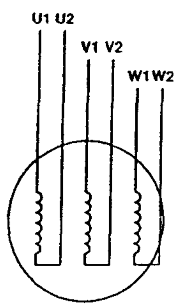
Connect the pump to the mains as is expected to be right.

Then check the direction of rotation as described in section *4.7.1 Checking of Direction of Rotation.*

Motors wound for star-delta starting:

The windings of the motor are determined by means of an ohmmeter, and the lead sets for the individual windings are named accordingly: U1-U2, V1-V2 and W1-W2, see fig. 18.

Fig. 18



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If star-delta starting is required, the leads should be connected as shown in fig. 16.

If direct-on-line starting is required, the leads should be connected as shown in fig. 17.

Then check the direction of rotation as described in section *4.7.1 Checking of Direction of Rotation.*

4.7.5 FRANKLIN, MERCURY and PLEUGER Motors

The connection of FRANKLIN, MERCURY and PLEUGER motors appears from section *4.7.4 Connection in the Case of Unidentified Cable Marking/Connection.*

5. Pump Installation

⚠ Before starting any work on the pump/motor, make sure that the electricity supply has been switched off and that it cannot be accidentally switched on.

5.1 Assembly of Motor and Pump

The bolts and nuts securing the straps to the pump must be tightened diagonally to the torques stated in the following table

Straps Bolt/Nut	Torque [Nm]
M8	18
M10	35
M12	45
M16	110
SP 215, 50 Hz, with more than 8 stages SP 215, 60 Hz, with more than 5 stages	135

Make sure that the coupling between the pump and motor engages properly.

When assembling the motor and the pump, the nuts must be tightened diagonally to the torques stated in the following table:

Pump/Motor Staybolt Diameter	Torque [Nm]
M8	18
M12	100
M16	200
M20	390

Note: Make sure that the pump chambers are aligned when assembly has been completed.

5.2 Removal and Fitting of Cable Guard

For removal and fitting of cable guard(s), see pages 140 and 141.

If the cable guard is screwed on to the pump, such as the SP 215 and sleeved pumps, the cable guard should be removed and fitted by means of screws.

Note: Make sure that the pump chambers are aligned when the cable guard has been fitted.

5.3 Fitting of Submersible Drop Cable

5.3.1 GRUNDFOS MS *Submersible Motors*

Before fitting the submersible drop cable to the motor, make sure that the cable socket is clean and dry.

To facilitate the fitting of the cable, lubricate the rubber parts of the cable plug with non-conducting silicone paste.

Tighten the screws holding the cable to the torques stated:

MS 4000: 1.5 Nm.

MS 402: 2.0 Nm.

MS 6000: 4.0-5.0 Nm.

MMS 6000: 10 Nm.

MMS 12000: 15 Nm.

5.4 Riser Pipe

If a tool, e.g. a chain pipe wrench, is used when the riser pipe is fitted to the pump, the pump must only be gripped by the pump discharge chamber.

The threaded joints on the riser pipe must all be well cut and fit together to ensure that they do not work loose when subjected to torque reaction caused by the starting and stopping of the pump.

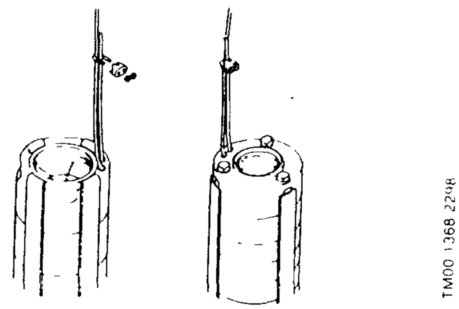
The thread on the first section of the riser pipe which is to be screwed into the pump should not be longer than the threads in the pump.

If noise may be transmitted to the building through the pipework, it is advisable to use plastic pipes.

Note: Plastic pipes are recommended for 4" pumps only.

When plastic pipes are used, the pump should be secured by an unloaded straining wire to be fastened to the discharge chamber of the pump, see fig. 19.

Fig. 19



When connecting plastic pipes, a compression coupling should be used between the pump and the first pipe section.

Where flanged pipes are used, the flanges should be slotted to take the submersible drop cable and a water indicator hose, if fitted.

5.5 Maximum Installation Depth below Water Level

GRUNDFOS MS 4000	600 m
GRUNDFOS MS 402:	150 m.
GRUNDFOS MS 6000	600 m
GRUNDFOS MMS:	250 m.
FRANKLIN motors:	350 m
MERCURY motors:	350 m.
PLEUGER motors:	350 m

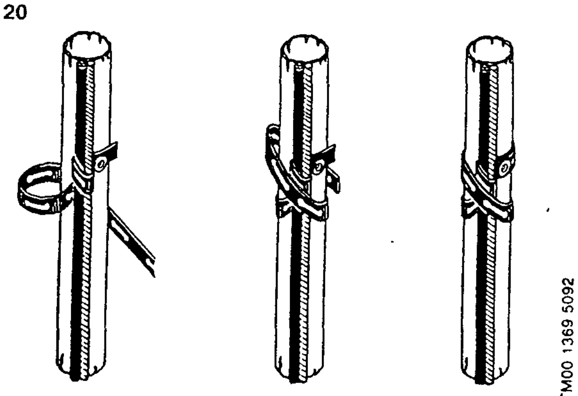
5.6 Cable Fitting

Cable clips must be fitted every 3 metres to fix the submersible drop cable and the straining wire, if fitted, to the riser pipe of the pump.

GRUNDFOS supplies cable clip sets on request. The set consists of a 1.5 mm thick rubber band and 16 buttons.

Cable Fitting: Cut off the rubber band so that the piece with no slit becomes as long as possible.
Insert a button in the first slit.
Position the wire alongside the submersible drop cable, fig. 20

Fig. 20



Wind the band once around the wire and the cable.
Then wind it tightly at least twice around the pipe, wire and the cable.
Push the slit over the button and then cut off the band

Where large cable cross-sections are used, it will be necessary to wind the band several times.

Where plastic pipes are used, some slackness must be left between each cable clip as plastic pipes expand when loaded.

When flanged pipes are used, the cable clips should be fitted above and below each joint.

5.7 Lowering the Pump

It is recommended to check the borehole by means of an inside calliper before lowering the pump to ensure unobstructed passage.

Lower the pump carefully into the borehole, taking care not to

Note: Do not lower or lift the pump by means of the motor cable.

5.8 Installation Depth

The dynamic water level should always be above the suction interconnector of the pump, see section *3.2 Positional Requirements* and fig. 21.

Minimum inlet pressure is indicated in the NPSH curve for the pump.
The minimum safety margin should be 1 metre head.

It is recommended to install the pump so that the motor part is above the well screen in order to ensure optimum cooling, see section *3.4 Liquid Temperatures/Cooling*.

When the pump has been installed to the required depth, the installation should be finished by means of a borehole seal.

Slacken the straining wire so that it becomes unloaded and lock it to the borehole seal by means of wire locks.

For pumps fitted with plastic pipes, the expansion of the pipes when loaded should be taken into consideration, when deciding on the installation depth of the pump.

6. Start-Up and Operation

6.1 Start-Up

When the pump has been connected correctly and it is submerged in the liquid to be pumped, it should be started with the discharge valve closed off to approx. 1/3 of its maximum volume of water.

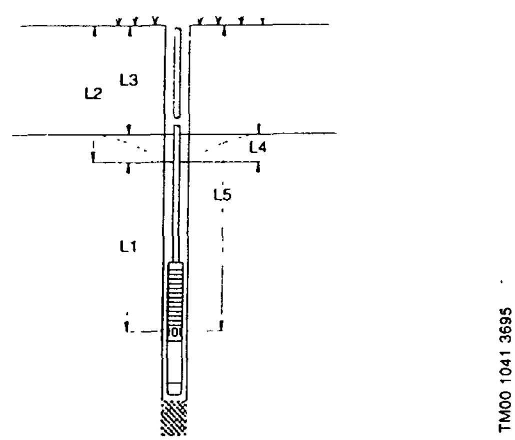
Check the direction of rotation as described in section *4.7.1 Checking of Direction of Rotation.*

If there are impurities in the water, the valve should be opened gradually as the water becomes clearer. The pump should not be stopped until the water is completely clean, as otherwise the pump parts and the non-return valve may choke up.

As the valve is being opened, the drawdown of the water level should be checked to ensure that the pump always remains submerged.

The dynamic water level should always be above the suction interconnector of the pump, see section *3.2 Positional Requirements* and fig. 21.

Fig. 21



L1:	Minimum installation depth below dynamic water level. Minimum 1 metre is recommended.
L2:	Depth to dynamic water level.
L3:	Depth to static water level.
L4.	Drawdown. This is the difference between the dynamic and the static water levels.
L5:	Installation depth.

If the pump can pump more than yielded by the well, it is recommended to fit the GRUNDFOS control unit, type CU 3, or some other type of dry-running protection.
If no water level electrodes or level switches are installed, the water level may be drawn down to the suction interconnector of the pump and the pump will then draw in air.
Long time operation with water containing air may damage the pump and cause insufficient cooling of the motor.

6.2 Operation

6.2.1 Minimum Flow Rate

To ensure the necessary cooling of the motor, the pump should never be set so low that the cooling requirements specified in section *3.4 Liquid Temperatures/Cooling* cannot be met.

6.2.2 Frequency of Starts and Stops

Motor Type	Number of Starts
GRUNDFOS MS	Minimum 1 per year is recommended Maximum 30 per hour Maximum 300 per day
MMS 6000	Minimum 1 per year is recommended Maximum 15 per hour Maximum 360 per day.
MMS 8000	Minimum 1 per year is recommended Maximum 10 per hour. Maximum 240 per day.
MMS 10000	Minimum 1 per year is recommended. Maximum 8 per hour. Maximum 190 per day
MMS 12000	Minimum 1 per year is recommended. Maximum 5 per hour. Maximum 120 per day.
FRANKLIN	Minimum 1 per year is recommended. Maximum 100 per day.
MERCURY 6"	Minimum 1 per year is recommended. Maximum 20 per hour.
MERCURY 8"	Minimum 1 per year is recommended. Maximum 15 per hour.
MERCURY 10"	Minimum 1 per year is recommended. Maximum 10 per hour.
MERCURY 12"	Minimum 1 per year is recommended. Maximum 6 per hour.
PLEUGER	Minimum 1 per year is recommended. Maximum 100 per day.

7. Maintenance and Service

The pumps are maintenance-free.

All pumps are easy to service.

Service kits and service tools are available from GRUNDFOS
The GRUNDFOS Service Manual is available on request.

The pumps can be serviced at a GRUNDFOS service centre.

⚠ If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

If GRUNDFOS is requested to service the pump, GRUNDFOS must be contacted with details about the pumped liquid, etc. before the pump is returned for service. Otherwise GRUNDFOS can refuse to accept the pump for service.

Possible costs of returning the pump are paid by the customer.

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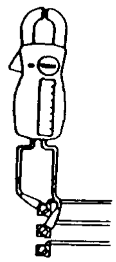
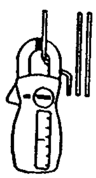
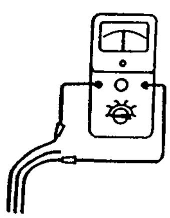
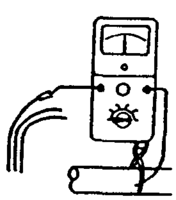
8. Fault Finding Chart

Fault	Cause	Remedy
1 The pump does not run	a) The fuses are blown	Replace the blown fuses If the new ones blow too, the electric installation and the submersible drop cable should be checked
	b) The ELCB or the voltage operated ELCB has tripped out	Cut in the circuit breaker
	c) No electricity supply	Contact the electricity supply authorities
	d) The motor starter overload has tripped out	Reset the motor starter overload (automatically or possibly manually) If it trips out again, check the voltage. Is the voltage OK, see items e) - h)
	e) Motor starter/contactor is defective.	Replace the motor starter/contactor.
	f) Starter device is defective.	Repair/replace the starter device.
	g) The control circuit has been interrupted or is defective	Check the electric installation.
	h) The dry-running protection has cut off the the electricity supply to the pump, due to low water level	Check the water level. If it is OK, check the water level electrodes/level switch
	i) The pump/submersible drop cable is defective.	Repair/replace the pump/cable
2. The pump runs but gives no water	a) The discharge valve is closed.	Open the valve.
	b) No water or too low water level in borehole.	See item 3 a).
	c) The non-return valve is stuck in its shut position.	Pull out the pump and clean or replace the valve.
	d) The inlet strainer is choked up.	Pull out the pump and clean the strainer.
	e) The pump is defective.	Repair/replace the pump.
3. The pump runs at reduced capacity.	a) The drawdown is larger than anticipated.	Increase the installation depth of the pump, throttle the pump or replace it by a smaller model to obtain a smaller capacity.
	b) Wrong direction of rotation.	See section *4.7.1 Checking of Direction of Rotation.*
	c) The valves in the discharge pipe are partly closed/blocked.	Check and clean/replace the valves, if necessary.
	d) The discharge pipe is partly choked by impurities (ochre)	Clean/replace the discharge pipe.
	e) The non-return valve of the pump is partly blocked.	Pull out the pump and check/replace the valve.
	f) The pump and the riser pipe are partly choked by impurities (ochre).	Pull out the pump. Check and clean or replace the pump, if necessary. Clean the pipes.
	g) The pump is defective.	Repair/replace the pump.
	h) Leakage in the pipework.	Check and repair the pipework.
	i) The riser pipe is defective.	Replace the riser pipe.
4. Frequent starts and stops.	a) The differential of the pressure switch between the start and stop pressures is too small.	Increase the differential. However, the stop pressure must not exceed the operating pressure of the pressure tank, and the start pressure should be high enough to ensure sufficient water supply.
	b) The water level electrodes or level switches in the reservoir have not been installed correctly.	Adjust the intervals of the electrodes/level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See Installation and Operating Instructions for the automatic devices used. If the intervals between stop/start cannot be changed via the automatics, the pump capacity may be reduced by throttling the discharge valve.
	c) The non-return valve is leaking or stuck half-open.	Pull out the pump and clean/replace the non-return valve.
	d) The volume of air in the pressure/diaphragm tank is too small.	Adjust the volume of air in the pressure/diaphragm tank in accordance with its Installation and Operating Instructions.
	e) The pressure/diaphragm tank is too small.	Increase the capacity of the pressure/diaphragm tank by replacing or supplementing with another tank.
	f) The diaphragm of the diaphragm tank is defective.	Check the diaphragm tank.

9. Checking of Motor and Cable

1 Supply voltage 	Measure the voltage between the phases by means of a voltmeter On single-phase motors, measure between phase and neutral or between two phases, depending on the type of supply Connect the voltmeter to the terminals in the motor starter.	The voltage should, when the motor is loaded, be within the range specified in section *4 1 General* The motor may burn if there are larger variations in voltage Large variations in voltage indicate poor electricity supply, and the pump should be stopped until the defect has been remedied
2. Current consumption 	Measure the amps of each phase while the pump is operating at a constant discharge head (if possible, at the capacity where the motor is most heavily loaded). For maximum operating current, see nameplate.	On three-phase motors, the difference between the current in the phase with the highest consumption and the current in the phase with the lowest consumption should not exceed 5%. If so, or if the current exceeds the full load current, there are the following possible faults: • The contacts of the motor starter burnt. Replace the contacts or the control box for single-phase operation. • Poor connection in leads, possibly in the cable joint. See item 3. • Too high or too low supply voltage. See item 1. • The motor windings are short-circuited or partly disjointed. See item 3. • Damaged pump is causing the motor to be overloaded. *Pull out the pump for overhaul.* • The resistance value of the motor windings deviates too much (three-phase). Move the phases in phase order to a more uniform load. If this does not help, see item 3.
Items 3 and 4: Measurement is not necessary when the supply voltage and the current consumption are normal.		
3. Winding resistance 	Disconnect the submersible drop cable at the motor starter. Measure the winding resistance between the leads of the drop cable.	For three-phase motors, the deviation between the highest and the lowest value should not exceed 5%. If the deviation is higher, pull out the pump. Measure motor, motor cable and drop cable separately, and repair/replace defective parts. **Note:** On single-phase, 3-wire motors, the operating winding will assume the lowest resistance value.
4. Insulation resistance 	Disconnect the submersible drop cable at the motor starter. Measure the insulation resistance from each phase to earth (frame). Make sure that the earth connection is made carefully.	If the insulation resistance is less than 0.5 MΩ, the pump should be pulled out for motor or cable repair. Local regulations may specify other values for the insulation resistance.

10. Disposal

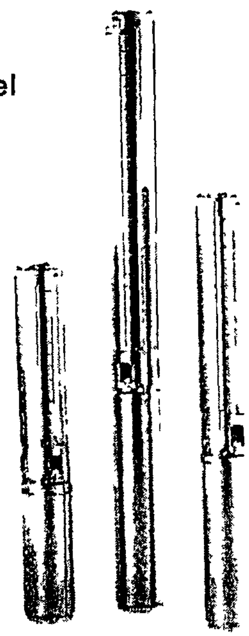
Disposal of this product or parts of it must be carried out according to the following guidelines:

1. Use the local public or private waste collection service.
2. In case such waste collection service does not exist or cannot handle the materials used in the product, please deliver the product or any hazardous materials from it to your nearest GRUNDFOS company or service workshop.

SP4"

Installation and Operating Instructions

4-Inch Stainless Steel Submersible Pumps



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DRINKING WATER SYSTEM COMPONENTS
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Please leave these instructions with the pump for future reference.

GRUNDFOS
Leaders in Pump Technology

SAFETY WARNING

Electrical Work

WARNING Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding If the means of connection to the supply connected box is other than grounded metal conduit ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment

Pre-Installation Checklist

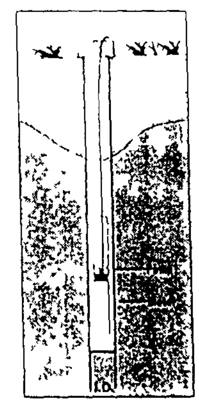
1. Well Preparation

If the pump is to be installed in a new well then the well should be fully developed and bailed or blown free of cuttings and sand The stainless steel construction of the GRUNDFOS submersibles make it resistant to abrasion however no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water

If this pump is used to replace an oil filled submersible or oil lubricated line shaft turbine in an existing well the well must be blown or bailed clear of oil

2. Make Sure You Have The Right Pump

Determine the maximum depth of the well and the draw-down level at the pump s maximum capacity Pump selection and setting depth should be based on this data



3. Pumped Fluid Requirements

CAUTION Submersible well pumps are designed for pumping clear cold water free of air or gases Decreased pump performance and life expectancy can occur if the water is not cold clear or contains air or gasses Water temperature should not exceed 102°F

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well The bottom of the motor should never be installed lower than the top of the screen or within five feet of the well bottom

Ensure that the requirement for minimum flow past the motor is met as shown in the table below

Minimum Water Flow Requirements for Submersible Pump Motors

MINIMUM DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN GPM FLOW PASSING THE MOTOR
4-Inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES

a. For Franklin Motors Only A flow inducer or sleeve must be used if the water enters the well above the motor or if there is unsufficient water flow past the motor

b. For Franklin Motors Only The minimum water velocity over 4 motors is 0.25 feet per second

c. Grundfos 4 submersible motors do not require a minimum flow or flow sleeve

Pre-Installation Checklist

4. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable

Examine the motor cable and drop cable carefully for damage Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection Be careful not to damage the copper conductor when stripping off the insulation Insert a properly sized Sta-kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon The putty should overlap on the insulation of the wire Use a good quality tape such as ***#33 Scotch Waterproof* or *Plymouth Rubber Company Slipknot Grey*** Wrap each wire and joint tightly for a distance of about 2-1/2 inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal

Installation Procedures

1. Attach the Pump to the Pipe

A back-up wrench should be used when riser pipe is attached to the pump The pump should only be gripped by the flats on the top of the discharge chamber Under no circumstances grip the body of the pump, cable guard or motor When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles The manufacturer or representative should be contacted to ensure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer Besides making sure that points are fastened, we recommend the use of a torque arrestor when using plastic pipe

Do not connect the first plastic riser section directly to the pump Always attach a metallic nipple or adapter into the discharge chamber The threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber when tightened down

Installation Procedures

2. Lower the Pump Into the Well

Make sure the electrical cables are not cut or damaged in any way when the pump is being lowered in the well Do not use the power cables to support the weight of the pump

To protect against surface water entering the well and contaminating the water source the well should be finished off above grade utilizing a locally approved well seal or pitless adaptor unit We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting

The drop cable should be secured to the riser pipe at approximately every 10 ft/3 m to prevent sagging, looping and possible cable damage Nylon cable clips or waterproof tape may be used The cable splice should be protected by securing it with clips or tape just above each joint

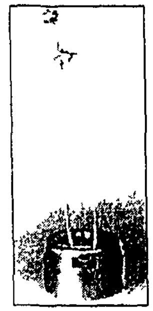


Figure 1

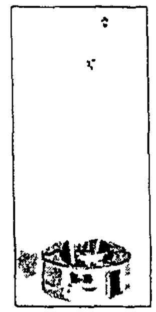


Figure 2

IMPORTANT. Plastic pipe tends to stretch under load This stretching must be taken into account when securing the cable to the riser pipe Leave three to four inches of slack between clips or taped points This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length When plastic riser pipe is used it is recommended that a safety cable be attached to the pump to lower and raise it The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable (See Figures 1 & 2)

Check Valves: A check valve should always be installed at the surface of the well and one at a maximum of 25 feet above static water level In addition, for installations deeper than 200 feet check valves should be installed at no more than 200 foot intervals

3. Electrical Connections

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to *the supply connected box is* other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor Motor electrical data can be found on page 6 If voltage variations are larger than ± 10%, do not operate the pump Single-phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor The type of wire used between the pump control boxes should be approved for submersible pump application The conductor insulation should be type RW RUW TW or equivalent

A high-voltage surge arrestor should be used to protect the motor against lightning and switching surges Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines

The correct voltage-rated surge arrestor should be installed on the supply (line) side of the control box or starter (See Figure 3a & 3b) The arrestor must be grounded in accordance with the National Electric Code and local governing regulations

PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY

The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size Ground wire should be as short a distance as possible and securely fastened to a true grounding point True grounding points are considered to be a grounding rod driven into the water strata steel well casing submerged into the water lower than the pump setting level and steel discharge pipes without insulating couplings If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel Do not ground to a gas supply line Connect the grounding wire to the ground point first then to the termianl in the control box

Single Phase Hookup

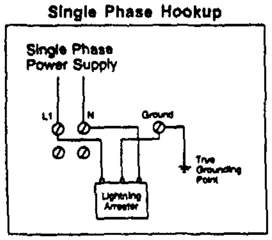


Figure 3a

Three Phase Hookup

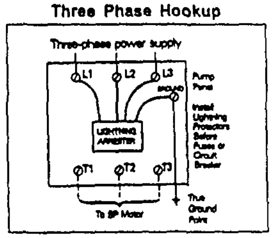


Figure 3b

Single-Phase 2-Wire Wiring Diagram for Submersible Motors

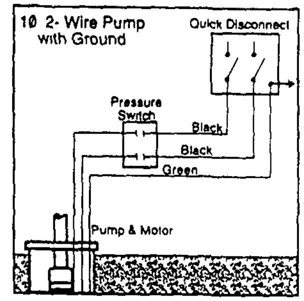


Figure 4

Three-Phase Wiring Diagram for Submersible Motors

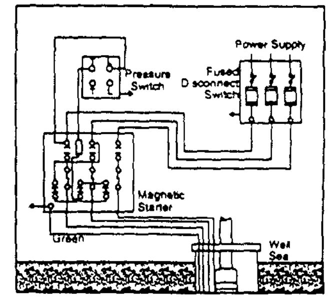


Figure 5

Single-Phase 3-Wire Control Box for Submersible Motors

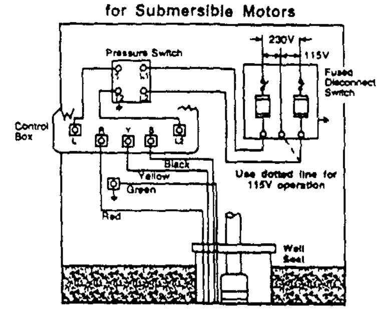


Figure 6

4. Starting the Pump for the First Time

A Attach a temporary horizontal length of pipe to the riser pipe
B Install a gate valve and another short length of pipe to the temporary pipe
C Adjust the gate valve one-third of the way open
D Verify that the electrical connections are in accordance with the wiring diagram
E After proper rotation has been checked start the pump and let it operate until the water runs clear of sand silt and other impurities
F Slowly open the valve in small increments as the water clears until the valve s all the way open The pump should not be stopped until the water runs clear
G If the water is clean and clear when the pump is first started the valve should still be opened until it is all the way open

GRUNDFOS MOTORS Submersible Pump Motors -Electrical Data 60Hz

HP	Ph	Volt	S.F	Circ. Brkr or Fuses Std.	Circ. Brkr or Fuses Delay	Amperage Start	Amperage Max.	Full Load Eff. (%)	Full Load Pwr Fact.	Max. Thrust (lbs)	Line-to-Line Resistance (Ohms) Blk-Yel	Line-to-Line Resistance (Ohms) Red-Yel	KVA Code **	3-Ph. Overload Protection Starter Size	3-Ph. Overload Protection Fuses Amb. Comp
4-Inch, Single Phase, 2-Wire Motors *(control box not required)*															
1/3	1	230	1.75	15	5	25.7	4.6	59	77	900	6.6-8.2		S	-	-
1/2	1	115	1.60	30	15	56.0	12.0	62	76	900	1.1-1.3		R	-	-
1/2	1	230	1.60	15	7	34.5	6.0	62	76	900	5.2-6.3		R	-	-
3/4	1	230	1.50	20	9	40.5	8.4	62	75	900	3.2-3.8		N	-	-
1	1	230	1.40	25	12	48.4	9.8	63	82	900	2.5-3.1		M	-	-
1-1/2	1	230	1.30	35	15	62.0	13.1	64	86	900	1.9-2.3		L	-	-
4-Inch, Single Phase, 3-Wire Motors															
1/3	1	115	1.75	25	10	29.0	9.0	59	77	900	1.55-1.9	2.4-3	M	-	-
1/3	1	230	1.75	15	5	14.0	4.6	59	77	900	6.8-8.3	17.3-21.1	L	-	-
1/2	1	115	1.60	30	15	42.6	12.0	61	76	900	0.9-1.1	1.9-2.35	L	-	-
1/2	1	230	1.60	15	7	21.6	6.0	62	76	900	4.7-5.7	15.8-19.6	L	-	-
3/4	1	230	1.50	20	9	31.4	8.4	62	75	900	3.2-3.9	14-17.2	L	-	-
1	1	230	1.40	25	12	37.0	9.8	63	82	900	2.8-3.1	10.3-12.5	K		-
1-1/2	1	230	1.30	35	15	45.9	11.6	69	69	900	1.9-2.3	7.6-9.6	H	-	-
2	1	230	1.25	30	15	57.0	13.2	72	86	1500	1.5-1.8	3.4-4.1	G	-	-
3	1	230	1.15	45	20	77.0	17.0	74	93	1500	1.2-1.4	2.45-3	F	-	-
5	1	230	1.15	70	30	110	27.5	77	92	1500	0.65-0.85	2.1-2.6	F	-	-
4-Inch, Three Phase, 3-Wire Motors															
1-1/2	3	230	1.30	15	8	40.3	7.3	75	72	750	3.9		K	0	K41
		460	1.30	10	4	20.1	3.7	75	72	750	15.9		K	0	K32
		575	1.30	10	4	16.1	2.9	75	72	750	25.2		K	0	K28
2	3	230	1.25	20	10	48	8.7	78	75	750	3.0		J	0	K50
		460	1.25	10	5	24	4.4	78	75	750	12.1		J	0	K34
		575	1.25	10	4	19.2	3.6	78	75	750	18.8		J	0	K31
3	3	230	1.15	30	15	56	12.2	77	75	1000	2.2		H	0	K54
		460	1.15	15	7	28	6.1	77	75	1000	9.0		H	0	K37
		575	1.15	15	6	22	4.8	77	75	1000	13.0		H	0	K36
5	3	230	1.15	40	25	108	19.8	80	82	1000	1.2		H	1	K61
		460	1.15	20	12	54	9.9	80	82	1000	5.0		H	0	K50
		575	1.15	15	9	54	7.9	80	82	1000	7.3		H	0	K43
7-1/2	3	230	1.15	60	30	130	25.0	81	82	1000	0.84		H	1	K67
		460	1.15	35	15	67	13.2	81	82	1000	3.24		J	1	K56
		575	1.15	30	15	67	10.6	81	82	1000	5.2		J	1	K53
10	3	460	1.15	50	25	90	18.0	81	80	1500	1.16		H	1	K61
		575	1.15	40	20	72	14.4	81	80	1500	1.84		H	1	K58

*All Grundfos 4" motors have a ground (green wire)

The Franklin 1 PH, 3 wire motors listed below require the use of the following Franklin Control Box:

RATING HP	RATING VOLT	FRANKLIN MOTOR MODEL NO. THE MODEL MAY HAVE ADDITIONAL DIGITS	CONTROL BOX THE MODEL MAY HAVE ADDITIONAL DIGITS
1/3	115	214602	28010249
1/3	230	214603	28010349
1/2	115	214604	28010449
1/2	230	214605	28010549
3/4	230	214607	28010749
1	230	214608	28010849
1.5	230	224300	2823008
2	230	224301	2823018
3	230	224302	2823028
5	230	224303	2821138
			2821139

(Refer to the Franklin Submersible Motors Application Maintenance Manual)

Maximum Cable Length
Motor Service to Entrance
(Length in feet)

Single-Phase 60 Hz

MOTOR RATING VOLTS	MOTOR RATING HP	COPPER WIRE SIZE 14	12	10	8	6	4	2	0	00
115	1/3	130	210	340	540	840	1300	1960	2910	
	1/2	100	160	250	390	620	960	1480	2160	
230	1/3	550	880	1390	2190	3400	5250	7960		
	1/2	400	650	1020	1610	2510	3880	5880		
	3/4	300	480	760	1200	1870	2890	4370	6470	
	1	250	400	630	990	1540	2380	3610	5360	6520
	1-1/2	190	310	480	770	1200	1870	2850	4260	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120	190	300	470	750	1190	1850	2890	3610
	5			180	280	450	710	1110	1740	2170

Three-Phase 60 Hz

VOLTS	HP	14	12	10	8	6	4	2
208	1-1/2	310	500	790	1260			
	2	240	390	610	970	1520		
	3	180	290	470	740	1160	1810	
		5170	280	4690	1080			1680
230	1-1/2	380	580	920	1450			
	2	280	450	700	1110	1740		
	3	210	340	540	860	1340	2080	
	5		200	320	510	800	1240	1900
460	1-1/2	1700						
	2	1300	2070					
	3	1000	1600	[illegible]				
	5	590	950	1500	2360			
575	1-1/2	2620						
	2	2030						
	3	1580	2530					
	5	920	1480	2330				

FOOTNOTES

1. If aluminum conductor is used multiply lengths by 0.5 Maximum allowable length of aluminum is considerably shorter than copper wire of same size
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to ensure reliable starter operation Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes and 250 to 300 are MCM sizes

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DRINKING WATER SYSTEM COMPONENTS
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Pump Model & Stages	Temp °C	Temp °F	Water Contact Volume in Liters for Highest Number of Stages	Contact Volume in Gallons for Highest Number of Stages	Minimum Submergence in Feet for Highest Number of Stages 4" Well ID
5S					
9-26	30	86	26	7	11
31-48	30	86	37	10	15
7S					
8-26	30	86	26	7	11
10S					
6-27	30	86	27	8	11
34-48	30	86	37	10	15
58	30	86	45	12	18
16S					
5-24	30	86	25	7	10
38	30	86	30	8	12
56-75	30	86	58	16	24
25S					
3-26	30	86	26	7	11
39	30	86	26	7	11
52	30	86	40	11	17
40S					
3-44	30	86	268	71	109
50-66	30	86	401	106	162
60S					
4-18	30	86	35	9	14
75S					
3-16	30	86	31	8	13

Troubleshooting

SUPPLY VOLTAGE

How to Measure

By means of a voltmeter which has been set to the proper scale measure the voltage at the control box or starter On single-phase units measure between line and neutral

What It Means

When the motor is under load the voltage should be within ± 10% of the nameplate voltage Larger voltage variation may cause winding damage Large variations in the voltage indicate a poor electrical supply and the pump *should not be operated until these* variations have been corrected

If the voltage constantly remains high or low the motor should be changed to the correct supply voltage

CURRENT MEASUREMENT

How to Measure

By use of an ammeter set on the proper scale measure the current on each power lead at the control box See page 6 for motor amp draw information

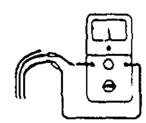
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded

What It Means

If the amp draw exceeds the listed service factor amps (SFA) check for the following

1 Loose terminals in control box or possible cable defect Check winding and insulation resistances
2 Too high or low supply voltage
3 Motor windings are shorted
4 Pump is damaged causing a motor overload

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box Using an ohmmeter set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms

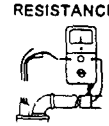
Zero-adjust the meter and measure the resistance between leads Record the values Motor resistance values can be found on page 6

What It Means

If all the ohm values are normal and the cable colors correct the windings are not damaged If any one ohm value is less than normal the motor may be shorted If any one ohm value is greater than normal there is a poor cable connection or joint The windings or cable may also be open

If some of the ohm values are greater than normal and some less the drop cable leads are mixed To verify lead colors see resistance values on page 6

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box Using an ohm or mega ohmmeter set the scale selector to Rx 100K and zero-adjust the meter Measure the resistance between the lead and ground (discharge pipe or well casing if steel)

What It Means

For ohm values refer to table below Motors of all Hp voltage phase and cycle duties have the same value of insulation resistance

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed
2 000,000 (or more)	2 0	New Motor
1 000 000 (or more)	1 0	*Used motor which can be reinstalled in the well*
		Motor in well (Ohm readings are for drop cable plus motor)
500 000 - 1 000 000	0 5 1 0	A motor in reasonably good condition
20 000 500 000	0 02 - 0 5	A motor which may have been damaged by lightning or with damaged leads Do not pull the pump for this reason
10 000 20 000	0 01 0 02	A motor which definitely has been damaged or with damaged cable The pump should be pulled and repairs made to the cable or the motor replaced The motor will still operate but probably not for long
less than 10 000	0 - 0 01	A motor which has failed or with completely destroyed cable insulation The pump must be pulled and the cable repaired or the motor replaced The motor will not run in this condition

Troubleshooting

Pump Won't Start

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY
No power at the motor	Check for voltage at the control box or panel.	If there is no voltage at the control panel check the feeder panel for tripped circuits and reset those circuits.
Fuses are blown or the circuit breakers have tripped	Turn off the power and remove the fuses. Check for continuity with an ohmmeter	Replace the blown fuses or reset the circuit breaker. If the new fuses blow or the circuit breaker trips, the electrical installation motor, and wires must be check for defects
(3-phase motors only) Motor starter overloads are burned or have tripped	Check for voltage on the line and load side of the starter. Check the amp draw and make sure the heater is sized correctly	Replace any burned heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage. Ensure that heaters are sized correctly and the trip setting is appropriately adjusted
(3-phase motors only) Starter does not energize	Energize the control circuit and check for voltage at the holding coil	If there is no voltage, check the control circuit fuses. If there is voltage, check the holding coil for week connections. Ensure that the holding coil is designed to operate with the available control voltage. Replace the coil if defects are found
Defective controls	Check all safety and pressure switches for defects. Inspect the contacts in control devices.	Replace worn or defective parts or controls
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K)	If an open or grounded winding is found, remove the motor from the well and recheck the measurements with the lead separated from the motor. Repair or replace the motor or cable
(1-phase motors only) Defective capacitor	Turn off the power and discharge the capacitor by shorting the leads together. Check it with an analog ohmmeter (set to R x 100k)	When the meter is connected to the capacitor the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (Y). Replace capacitor if it is defective
Defective pressure switch or the tubing to it is plugged	*Watch the pressure gauges as* the pressure switch operates. Remove the tubing and blow through it.	Replace as necessary
The pump is mechanically bound or stuck	Turn off the power and manually rotate the pump shaft. Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor)	If the pump shaft doesn't rotate remove the pump and examine it. If necessary dismantle it and check the impellers and seal for obstruction. Check for motor corrosion

Pump Does Not Produce Enough Flow (GPM)

POSSIBLE CAUSE	CHECK THIS BY	CORRECT THIS BY
(3-phase motors only) Shaft is turning in the wrong direction	Check to make sure the electrical connections in the control panel are correct.	Correct the wiring. For single phase motors check the wiring diagram on the motor. For three phase motors simply switch any two power leads
Pump is operating at the wrong speed (too slow)	Check for low voltage and phase imbalance	Replace defective parts or contact power company, as applicable
Check valve is stuck (or *installed backwards)*	Remove the check valve	Re-install or replace
Parts or fittings in the pump are worn – or – Impellers or Inlet Strainer is clogged	Install a pressure gauge near the discharge port, start the pump, and gradually close the discharge valve. Read the pressure at shutoff. (Do not allow the pump to operate for an extended period at shutoff.)	Convert the PSI you read on the gauge to Feet of Head by: $\frac{\text{PSI} \times 2.31\ \text{ft/PSI} = \_\_\_\_\ \text{ft}}{\text{Specific Gravity}}$ Add to this number the number of feet (vertically) from the gauge down to the water s pumping level Refer to the pump curve for the model you are working with to determine the shutoff head you should expect for that model. If that head is close to the figure you came up with (above) the pump is probably OK. If not, remove the pump and inspect impellers, chambers, etc
The water level in the well may be too low to supply the flow desired – or – Collapsed well	Check the drawdown in the well while the pump is operating	If the pumping water level (including drawdown) is not AT LEAST 3 FEET above the pump's inlet strainer, either: 1. Lower the pump further down the well 2. Throttle back the discharge valve to decrease the flow, thereby reuding drawdown
Broken shaft or coupling	Pull pump and inspect.	Replace as necessary
There are leaks in the fittings or piping	Pull the pump out of the well	The suction pipe, valves, and fittings must be made tight. Repair any leaks and retighten all loose fittings

Troubleshooting

Fuses Blow or Heaters Trip

POSSIBLE CAUSE	CHECK THIS BY	CORRECT THIS BY
Improper voltage	Check the voltage at the control box or panel	If the voltage varies by more than 10% (+ or) contact the power company
	If the incoming voltage is OK, check the wire size and the distance between the pump motor and the pump control panel	Rewire with correct gauge. Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor
The starter overloads are set too low	Cycle the pump and measure the amperage	Increase the heater size or adjust the trip setting. Do not, however, exceed the recommended rating
(3-phase motors only) The three-phase current is imbalanced	Check the current draw on each lead to the motor	The current draw on each lead must be within 5% of each other (+ or). If they are not check the wiring
The wiring or connections are faulty	Check to make sure the wiring is correct and there are no loose terminals	Tighten any loose terminals and replace any damaged wire
(1-phase motors only) Capacitor is defective	Turn off the power and discharge the capacitor. Check the capacitor with an ohmmeter (set at R x 100k). See page 15 for instructions	When the meter is connected to the capacitor the needle should jump toward 0 (zero) ohms and then slowly drift back to infinity (Y). Replace capacitor if it is defective
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts	Replace as necessary
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day - you should be able to keep your hand on it without burning	Shade, ventilate, or move the control box so its environment does not exceed 120°F
(1-phase motors only) Wrong control box	Check requirements for the motor against the control box specifications	Replace as necessary
Defective pressure switch	Watch gauges as pressure switch operates	Replace as necessary
The motor is shorted or grounded	Turn off the power and disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K) or a megaohmmeter. Compare these measurements to the rated values for your motor	If you find an open or grounded winding, remove the motor and recheck the leads. If OK, check the leads for continuity and for bad splice
Poor motor cooling	Find the internal diameter of the well casing (or sleeve, if used) For proper cooling, the flow of water must not be less than the GPM shown across the bottom scale on page __	Throttle up the pump flow (GPM) so proper cooling is possible - or - Pull the pump out of the well and add a sleeve with a smaller internal diameter

Pump Cycles Too Often

POSSIBLE CAUSE	CHECK THIS BY	CORRECT THIS BY
The pressure switch is defective or is not properly adjusted	Check the pressure setting on the switch. Check the voltage across closed contacts	Readjust the pressure switch or replace it if defective
The tank is too small	Check the tank size and amount of air in the tank. The tank volume should be approximately 10 gallons for each Gallon-Per-Minute of pump capacity. At the pump cut-in pressure the tank should be about 2/3 filled with air	Replace the tank with one that is the correct size
There is insufficient air charging of the tank or piping is leaking	Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soapy water. Check the air-to-water ratio in the tank	Repair as necessary
Plugged snifter valve or bleed orifice (causing pressure tank to be waterlogged)	Examine them for dirt or erosion	Repair or replace as necessary
Leak in the pressure tank or piping	Apply soapy water to pipes and tank, then watch for bubbles indicating leaks	Repair or replace as necessary
The level control is defective or is not properly set	Check the setting and operation of the level control.	Readjust the level control setting (according to the manufacturer s instructions) or replace it if defective
Pump is oversized for the application. It is outpumping the yield of the well and pumping itself dry	Check the yield of the well (determined by the well-test) against the pump s performance curve	Reduce the flow by throttling back the valve - or - Change the pump

Notes

Notes

Notes

LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

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The telephone number of our service and repair facilities central directory, from which you can obtain the locations of our service and repair facilities is, 1-800-333-1366

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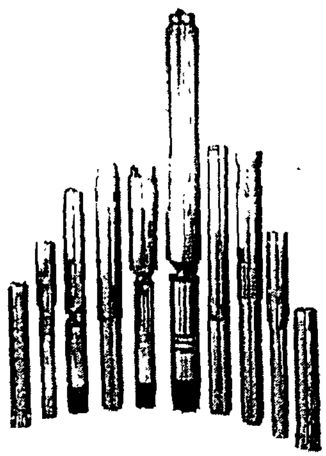
6", 8" & 10" STAINLESS STEEL SUBMERSIBLE PUMPS

Installation and Operating Instructions



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Please leave these instructions with the pump for future reference.

GRUNDFOS
Leaders in Pump Technology

SAFETY WARNING

Grundfos Stainless Steel Submersible Pumps

Your Grundfos Submersible Pump is of the utmost quality Combined with proper installation, your Grundfos pump will give you many years of reliable service

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Submersible Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage During unpacking and prior to installation, **make sure that the pump is not dropped or mishandled**

The motor is equipped with an electrical cable. Under no circumstance should the cable be used to support the weight of the pump.

You will find a loose data plate with an adhesive backing with the pump The nameplate should be completed in pen and attached to the control box

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

A. Condition of the Well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible make it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, **the well must be blown or bailed clear of oil.**

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

B. Condition of the Water

Submersible pumps are designed for pumping clear and cold water that is free of air and gases. Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gasses

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells. If water well tests determine the water has an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications

C. Installation Depth

A check should be made to ensure that the installation depth of the pump will always be at least (5) five to (10) ten feet below the maximum draw-down level of the well For flow rates exceeding 100 gpm, refer to performance curves for recommended minimum submergence

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom

If the pump is to be installed in a lake, pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling The minimum recommended water flow rates which ensure proper cooling are listed in Table A

D. Electrical Supply

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply

Wire Cable Type

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket

The conductor insulation should be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association certified wire may also be used See Table D for recommended sizes of cable lengths

Splicing the Motor Cable

A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable and will be completely watertight

Grundfos recommends using a heat shrink splice kit The splice should be made in accordance with the kit manufacture's instructions Typically a heat shrink splice can be made as follows

1 Examine the motor cable and the drop cable carefully for damage

2 Cut the motor leads off in a staggered manner Cut the ends of the drop cable so that the ends match up with the motor leads *(See Figure 4-A) On single-phase* motors, be sure to match the colors

3 Strip back and trim off 1/2 inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation

4 Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-kon" type connector on each lead, making sure that lead colors are matched Using a "Sta-kon" crimping pliers, indent the lugs (Figure 4-B) Be sure to squeeze hard on the pliers, particularly when using large cable

5 Center the heat shrink tubing over the connector Using a propane torch, lighter or electric heat gun, uniformly heat the tubing starting first in the center working towards the ends (Figure 4-C)

6 *Continue to apply the heat to the tubing* using care not to let the flame directly contact the tubing When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete (Figure 4-D)

FIGURE 4-A

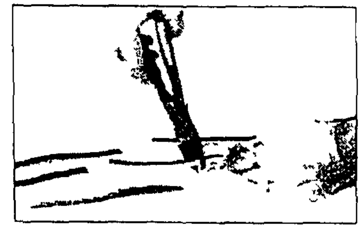


FIGURE 4-B

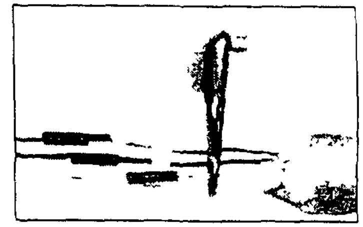


FIGURE 4-C

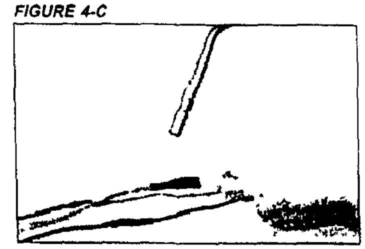
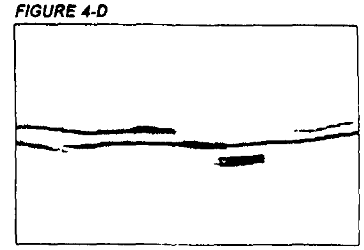
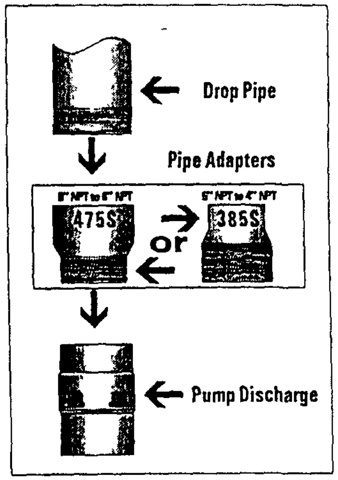


FIGURE 4-D



Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.



If An Adapter Needs To Be Installed:

It is recommended to first install the drop pipe to the pipe adapter Then install the drop pipe with the adapter to the pump discharge.

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should be gripped only by the flats on the top of the discharge chamber. The body of the pump, cable guard or motor should not be gripped under any circumstance

If Steel Riser Pipe Is Used:

We recommend that steel riser pipes always be used with the larger submersibles. An approved pipe thread compound should be used on all joints Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joins when stopping and starting

When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.

After the first secton of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used The cable splice should be protected by securing it with clips or tape just above and below the splice

If Plastic or Flexible Riser Pipe Is Used:

It is recommended that plastic type riser pipe be used only with the smaller domestic submersibles. The pipe manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, the use of a torque arrester is recommended when using plastic pipe

Installation

Do not connect the first plastic or flexible riser section directly to the pump Always attached a metallic nipple or adapter into the discharge chamber of the pump When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging looping and possible cable damage Nylon cable clips or waterproof tape may be used The cable splice should be protected by securing it with clips or tape just above each joint

IMPORTANT – **Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine who to compensate for pipe stretch**

When plastic riser pipe is used it is recommended that a safety cable be attached to the pump to lower and raise it

Check valves.
A check valve should always be installed at the surface of the well In addition for installations deeper than 200 feet check valves should be installed at no more than 200 foot intervals

Protect the well from contamination
To protect against surface water entering the well and contaminating the water source the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized

Electrical

WARNING: To reduce the risk of electrical shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations

Verification of the electrical supply should be made to ensure the voltage phase and frequency match that of the motor Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor Motor electrical data can be found In Table E

If voltage variations are larger than ± 10%, do not operate the pump

Direct on-line starting is used due to the extremely fast run-up time of the motor (0 1 second maximum), and the low moment of inertia of the pump and motor Direct on-line starting current (locked rotor amp) is between 4 and 6 5 times the full-load current If direct on-line starting is not acceptable and reduced starting current is required, an auto-transformer or resistant starters should be used for 5 to 30 HP motors (depending on cable length) *For motors over 30 HP, use auto-transformer starters*

Engine-Driven Generators

If the submersible pump is going to be operated using an engine driven generator we suggest the manufacturer of the generator be contracted to ensure the proper generator is selected and used See Table B for generator sizing guide

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation

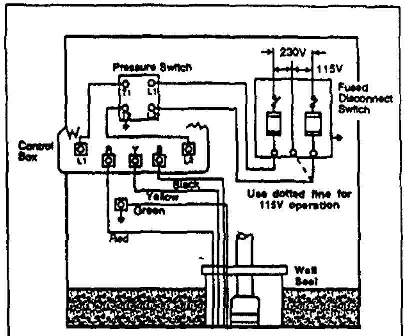
Control Box/Panel Wiring

1. Single-Phase Motors:
Single-phase motors must be connected as indicated in the motor control box A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 6-A)

2. Three-Phase Motors:
Three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with ambient-compensated extra quick-trip overloads must be used to give the best possible motor winding protection ***Each of the three motor legs must be protected with overloads.*** The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current For starter and overload protection guide, see Table H A three-phase motor wiring diagram is illustrated below (See Figure 6-B)

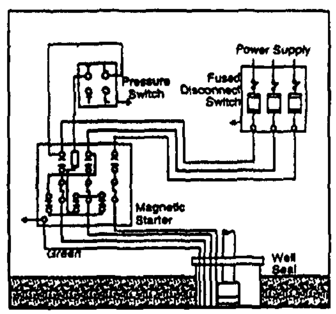
Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

FIGURE 6-A



Single-Phase Wiring Diagram for GRUNDFOS Control Boxes

FIGURE 6-B



Three-Phase Wiring Diagram for GRUNDFOS and FRANKLIN Motors

Electrical

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines

The correct voltage-rated surge arrester should be installed on the supply (line) side of the control box *(Figure 6-C and 6-D)* The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations

FIGURE 6-C

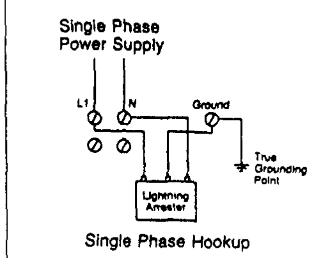
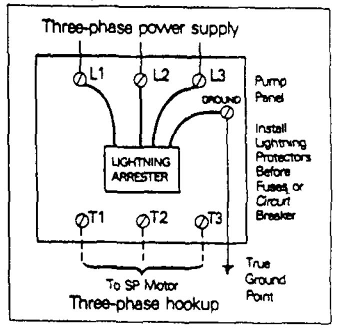


FIGURE 6-D



The warranty on all three-phase submersible motors is VOID if

1. **The motor is operated with single-phase power through a phase converter**
2. **Three-leg ambient *compensated extra quick-trip overload protectors are not* used**
3. **Three-phase current unbalance is not checked and recorded (See START-UP Section 7 for instructions)**
4. **High voltage surge arresters are not installed**

Control Box/Panel Grounding

The control box or panel shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations The ground wire should be a bare copper conductor at least the same size as the drop cable wire size The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point

True grounding points are considered to be a grounding rod driven into the water strata *steel well casing* submerged into the water lower than the pump setting level and steel discharge pipes without insulating couplings If plastic discharge pipe and well casing are used or if a grounding wire is required by local codes a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel Do not ground to a gas supply line Connect the grounding wire to the ground point first and then to the terminal in the control box or panel

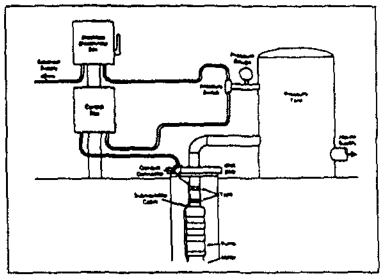
Operating Procedures

Wiring Checks and Installation

Before making the final surface wiring connection of the drop cable to the control box or panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 2,000,000 ohm Do not start the pump if the measurement is less than this.

If it is higher than 2,000,000 ohm, the drop cable should then be run through the well seal by means of a conduit connector in such a way as to eliminate any possibility of foreign matter entering the well casing. Conduit should always be used from the pump to the control box or panel to protect the drop cable (See Figure 6-E). Finish wiring and verify that all electrical connections are made in accordance with the wiring diagram Check to ensure the control box or panel and high voltage surge arrester have been grounded

FIGURE 6-E



Start-Up

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe
B. Adjust the gate valve one-third of the way open.
C. On three-phase units, check direction of rotation and current unbalance according to the instructions below For single-phase units proceed directly to "Developing the Well"
D. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve

Three-Phase Motors

1. Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50% chance that the motor will run in the proper direction. To make sure the motor is running in the proper direction, carefully follow the procedures below

A. Start the pump and check the water quantity and pressure developed
B. Stop the pump and interchange any two leads.
C. Start the pump and again check the water quantity and pressure.
D. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

Start-Up

2. Check for current unbalance

Current unbalance causes the motor to have reduced starting torque, overload tripping excessive vibration and poor performance which can result in early motor failure It is very important that current unbalance be checked in all three-phase systems **Current unbalance between the legs should not exceed 5% under normal operating conditions**

The supply power service should be verified to see if it is a two or three transformer system If two transformers are present, the system is an "open" delta or wye If three transformers are present the system is true three-phase

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See Table C

The percentage of current unbalance can be calculated by using the following formulas and procedures

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \times 100$$

To determine the percentage of current unbalance:

A Measure and record current readings in amps for each leg (hookup 1) Disconnect power
B Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3 and lead on 3 is now on 1 (hookup 2) Rolling the motor leads in this manner will not reverse the motor rotation Start the pump measure and record current reading on each leg Disconnect power
C Again shift drop cable leads from left to right so the lead on terminal 1 goes to 2 2 to 3 and 3 to 1 (hookup 3) Start pump, measure and record current reading on each leg Disconnect power
D Add the values for each hookup
E Divide the total by 3 to obtain the average
F Compare each single leg reading from the average to obtain the greatest amp difference from the average
G Divide this difference by the average to obtain the percentage of unbalance

Use the wiring hookup which provides the lowest percentage of unbalance (See Table F for a specific example of correcting for three-phase power unbalance)

Developing the Well

After proper rotation and current unbalance have been checked start the pump and let it operate until the water runs clear of sand, silt and other impurities

Slowly open the valve in small increments as the water clears until the dseired flow rate is reached Do not operate the pump beyond its maximum flow rating **The pump should not be stopped until the water runs clear**

Sigma
Flow Meter
(In I.C.D.C. 36" Storm Sewer)

980 Design Specifications

General:

- **Dimensions:** 14.62" H x 11.88" W x 8.26" D (37.13 cm x 30.18 cm x 20.98 cm)
- **Weight:** 16.80 lbs (7.62 kg)
- **Enclosure:** NEMA 4X, IP66 with front cover closed, UV resistant, -40 to 176°F, (-40 to 80°C)
- **Mounting:** Wall, Rail / Pole mount
- **Graphics Display:** Backlit liquid crystal display (LCD). 8-line x 40-character in text mode, 64 x 240 pixels in graphics mode. Displays level vs. time, flow vs. time, rainfall vs. time, pH and temperature.
- **Keypad:** 19-position, sealed-membrane switch including four "soft keys," functions defined by display.
- **Totalizers:** 8-digit resettable and 8-digit non-resettable software. *Units:* ft.^{3}, gal, m^3, liter, acre-ft.
- **Measurement Modes:**

  Flumes: Parshall, Palmer Bowlus, Leopold-Lagco, H, HL, HS, Trapezoidal

  Weirs: V-notch, Contracted/Non-contracted rectangular, Thel-Mar, Compound Cipolletti, Compound V-notch

  Manning Equation: Round, U, Rectangular, and Trapezoidal Channels

  Head vs. Flow: Two independent user-entered, look-up tables of up to 100 points each.

  Level Only: Inches, feet, centimeters, meters

  Area Velocity: Level-area table, circular pipe, U-shaped channel, trapezoidal channel, rectangular channel.

  Power Equation: $Q = K_1H^{n_1} \pm K_2H^{n_2}$
- **Data Logging:** "Smart" Dynamic memory allocation automatically partitions memory to provide the maximum logging time. No manual memory partitioning required.

  Capacity: Up to 456k bytes, 396 days of three channels of user-selected readings at 15 minute intervals. Plus 300 events.

  Memory Mode: Wrap-around

  Data Points: 116,000 data points

  Daily Statistics: Available for up to 32 days

  Recording Intervals: 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, or 60-minutes

  Time Base Accuracy: ± 6 seconds (0.007%) per day

Electrical:

- **Power Specifications:** 0.25 amp maximum
- **Power Requirements:** 100-230 VAC, 50/60 Hz, single phase, 15 W max (0.25 amp max)
- **Installation Category:** II
- **Electrical Connection:** 8 conduit hubs
- **Relay Contact Ratings:** 5 amps (30- 230 AC)
- **Sampler Output:** 15 VDC, 100 mA at 500 ms duration

Environmental:

- **Temperature Ranges:**

  Storage: -4°F to 158°F, (-20°C to 70°C)

  Operating: -4°F to 122°F, (-20°C to 50°C)

  Humidity: 0-90%, non-condensing

Integral pH Meter:

- **Control/Logging:** Field selectable to log pH independent of flow or in conjunction with flow; also controls sample collection in response to value of low/high stipends
- **pH Sensor:** Temperature compensated; impact resistant ABS plastic body. Combination electrode with porous Teflon junction.
- **Measurement Range:** 2 to 12 pH
- **Operating Temperature Range:** 0 to 176°F, (-18 to 80°C)
- **Dimensions:** 0.75" diameter x 6" long (19.5 mm x 15.24 cm) with 0.75" (19.5 mm) mpt cable end

Rain Gauge Input:

- **General Information:** For use with American Sigma Tipping Bucket Rain Gauge. Flow measurement can be initiated upon field selectable rate of rain. Flow meter records rainfall data. Shielded cable, 100' length maximum. Each tip = 0.01" (0 25 mm) of rain.

Analog Input Channels:

- **General Information:** Up to seven additional data logging channels record data from external source(s). Four channels with -4 5 to 4.5 VDC input with 1 meg ohm input impedance on each channel and three channels with 4-20 mA input.

4-20 mA Output:

- **General Information:** Two isolated output signals available. User assignable

  Maximum Resistive Load: 600 ohms

  Output Voltage: 24 VDC – no load

Alarm Relays:

- **General Information:** Four integral alarm relays; form C (common, normally open, normally closed), 5 amp. Connection to instrument through terminal blocks.
- **Relay Contact Ratings:** 5 amps, (30-230 VAC)

Communications:

- **General Information:**

  RS-232: up to 19,200 baud

  Modem: 14400 bps., V.32 bis, V.42, MNP2-4 error correction. V.42 bis MNP5 data compression. MNP 10-EC Cellular Protocol; Pager; SCADA-Modbus® communication protocol (standard) via RS-232 or optional modem

Ultrasonic Transducer:

- **Operating Frequency:** 75 kHz
- **Beam Angle:** ±12° (-10 dB)
- **Accuracy:** ±0.03 ft. over 2-ft. change in head, @ 20°C still air, ideal target, 50-ft. cable.
- **Operating Temperature Range:** -4°F to 122°F, (-20°C to 50°C)
- **Material:** PVC housing with acoustic window
- **Cable:** Low-loss cable, coax cable RG 62/U
- **Cable Length:** 25 ft. (7.6 m) standard, custom lengths to 500 ft. (contact manufacturer for performance information at custom lengths)
- **Mounting:** Permanent and adjustable mounting brackets
- **Dimensions (transducer only):** 5.0" H x 2.25" D, (12.7 cm x 5.7 cm)
- **Weight:** 1.5 lbs.
- **Connection:** Bare wire lead connection via terminal blocks

elocity Transducer:

- **> Method:** Doppler Principle
- **> Accuracy:** ±2% of reading, Zero Stability ±1 52 cms (± 0 05 fps)
- **> Range:** 5 to +20 fps (1 52 to 6 1 m/s)
- **> Resolution:** 0 01 fps (0 3 cm/s)
- **> Response Time:** 4 8 seconds
- **> Profile Time:** 4 8 seconds

Probe Dimensions:

Length 2 7" (6 9 cm)

Width 1 5 (3 81 cm)

Height 0 44 (1 1 cm)

- **> Cable:** Urethane sensor cable shielded
- **> Cable Length:** 25 ft (7 6 m) custom cable lengths up to 100 ft
- **> Mounting:** Dedicated mounting rings (mounting clips recommended for pipe diameters 8" or under), Mounting Plate (for permanent mounting- drills to pipe wall), Adjustable Mounting Band Kit
- **> Connection:** Sensor connector to quick-connect hub or bare leads connection via terminal block

Zero-Deadband In-Pipe Ultrasonic Sensor:

- **> Operating Frequency:** 75 kHz
- **> Beam Angle:** 5° (-10 dB)

Accuracy: ±0 03 ft over 2-ft change in head, @ 20°C, still air, ideal target, 50 ft cable

- **> Range:** 1 5' (minimum) to 10 4 ft (maximum), with ideal target @ 20°C, in still air, with 50-ft cable
- **> Operating Temperature Range:** 4°F to 122°F, (20°C to 50°C)
- **> Material:** StatCon ABS
- **> Cable:** Low-loss cable, coax cable RG 62/U
- **> Cable Length:** 25 ft. (7 6 m) standard, custom lengths up to 500 ft (contact manufacturer for performance information at custom lengths)
- **> Dimensions (transducer only):** 1 5" diameter x 12" L, (3 81 cm diameter x 30 cm length)
- **> Mounting:** Dedicated Mounting Rings, Permanent Mounting Bracket (installs directly to pipe wall), Adjustable Mounting Band Kit
- **> Connection:** Bare lead connection via terminal blocks

Submerged Area Velocity Probe:

- **> Method:** Doppler Principle / Pressure Transducer
- **> Material:** Polyurethane body, 316 series stainless steel diaphragm
- **> Cable:** Urethane sensor cable with air vent shielded
- **> Cable Length:** 25 ft (7 6 m) standard, custom cable lengths up to 100 ft
- **> Probe Dimentions:**

Length 5" (12 7 cm)

Width 1 5" (3 81 cm)

Height 0 8" (2 03 cm)

- **> Mounting:** Dedicated mounting rings (mounting clips recommended for pipe diameters 8" or under), Mounting Plate (for permanent mounting drills to pipe wall), Adjustable Mounting Band Kit
- **> Connection:** Sensor connector to quick connect hub, bare lead connection via terminal block or bare lead connection to junction box with bare lead junction box via terminal block
- **> Velocity:**

Velocity Accuracy ± 2% of reading, Zero Stability <0 05 fps (<0 015 m/s)

Response time 4 8 sec

Profile Time 4 8 sec

Range 5 to +20 fps, (1 52 to 6 1 m/s)

Resolution 0 01 fps, (0 0028 m/s)

Operating temperature 0° to 140°F, (18° to 60°C)

- **> Depth:**

Depth Accuracy ±2% of reading

Maximum Allowable Level 3X over pressure

Operating Temperature Range 32° to 160°F, (0° to 71°C)

Compensated Temperature Range 32° to 86°F, (0 to 30°C)

Temperature Error

0 018 to 11 5 ft ±0 004 ft/°F (0 005 to 3 5 m ±0 0022 m/°C)

0 018 to 34 6 ft ±0 012 ft/°F (0 005 to 10 5 m ±0 006 m/°C)

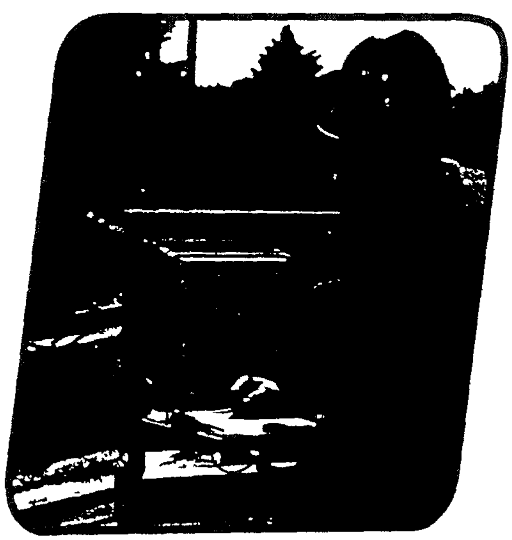
(maximum error within compensated temperature range per degree of change)

*Draw down connection** 0 to 10 fps (0 to 3 05 m/s) = 0 085% of reading

Air Intake Atmospheric pressure reference is desiccant protected

** U S Patent 5 691 914*

Specifications subject to change without notice



Cat No 97000-18

Model 980 Flow Meter

Operating and Maintenance Manual

June 2002 Ed 3

Cat No 97000 18

Model 980 Flow Meter

Operating and Maintenance Manual

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Safety Precautions

Please read this entire manual before unpacking, setting up, or operating this instrument.

Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists and indicates that only individuals qualified to work with hazardous voltages should open the enclosure or remove the barrier.
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	This symbol, when noted on the product, indicates that the marked item can be hot and should not be touched without care.
	This symbol, when noted on the product, indicates the presence of devices sensitive to Electro-static Discharge and indicates that care must be taken to prevent damage to them.

	This symbol, when noted on the product, identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment
	This symbol, if noted on the product, indicates the need for protective eye wear
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground)

Confined Space Entry

Important Note: *The following information is provided to guide users of 980 Flow Meters on the dangers and risks associated with entry into confined spaces*

DANGER
Additional training in Pre-Entry Testing, Ventilation, Entry Procedures, Evacuation/Rescue Procedures and Safety Work Practices is necessary to ensure against the loss of life in confined spaces.

DANGER
Pour éviter les accidents mortels dans les espaces confinés, il faut organiser des formations supplémentaires dans les matières suivantes: Contrôle avant entrée, Ventilation, Procédures d'entrée, Procédures d'évacuation et de secours et Méthodes de travail sûres.

PELIGRO
Para prevenir accidentes mortales en espacios reducidos se necesita una formación adicional sobre Procedimientos de Comprobación previa a la Entrada, Ventilación, Entrada y Evacuación/Rescate así como sobre Buenas Prácticas para la Seguridad en el Trabajo.

GEFAHR
Die Arbeit unter beengten Verhältnissen in geschlossenen Behältern bzw. völlig abgeschlossenen Räumlichkeiten ist nur mit spezieller Ausbildung zulässig, da sie - zur Vermeidung lebensgefährlicher Situationen - besondere Prüfungen vor dem Einstieg, Kontrollen der Belüftungsverhältnisse, Einstiegverfahren, Ausstiegs/Flucht-sicherungsmaßnahmen sowie weitere Sicherheits- und Arbeits-schutzschritte voraussetzt!

PERICOLO
Attuare esercitazioni integrative prima di iniziare un'analisi, Corretta Ventilazione dei locali, Procedure di Ingresso, Procedure di Evacuazione/Sicurezza e Pratiche di Sicurezza sul Lavoro sono necessarie per evitare incidenti mortali negli spazi adiacenti.

On April 15, 1993, OSHA's final ruling on CFR 1910 146, Permit Required Confined Spaces, became law This new standard directly affects more than 250,000 industrial sites in the United States and was created to protect the health and safety of workers in confined spaces

Definition of Confined Space

A Confined Space is any location or enclosure that presents or has the immediate potential to present one or more of the following conditions

- An atmosphere with less than 19 5% or greater than 23 5% oxygen and/or more than 10 ppm Hydrogen Sulfide (H_2S)
- An atmosphere that may be flammable or explosive due to gases vapors mists dusts or fibers
- Toxic materials which upon contact or inhalation could result in injury impairment of health or death

Confined spaces are not designed for human occupancy They have restricted entry and contain known or potential hazards

Examples of confined spaces include manholes stacks pipes vats, switch vaults, and other similar locations

Standard safety procedures must always be followed prior to entry into confined spaces and/or locations where hazardous gases vapors mists dusts, or fibers may be present

Before entering any confined space check with your employer for procedures related to confined space entry

Hazardous Locations

The 980 Flow Meter is not approved for use in hazardous locations as defined in the National Electrical Code

DANGER

Although some Sigma products are designed and certified for installation in hazardous locations as defined by the National Electrical Code, many Sigma products are not suitable for use in hazardous locations It is the responsibility of the individuals who are installing the products in hazardous locations to determine the acceptability of the product for the environment. Additionally, to ensure safety, the installation of instrumentation in hazardous locations must be per the manufacturer's control drawing specifications Any modification to the instrumentation or the installation is not recommended and may result in life threatening injury and/or damage to facilities

DANGER

Bien que certains produits Sigma soient conçus et certifiés pour être installés dans des endroits dangereux tels que définis par le National Electric Code, de nombreux produits Sigma ne conviennent pas pour de tels endroits. Il relève de la responsabilité des personnes qui placent les produits dans des endroits dangereux de déterminer s'ils sont adaptés à cet environnement. En outre, à des fins de sécurité, le placement de machines dans des endroits dangereux doit s'effectuer dans le respect des consignes des schémas de contrôle du fabricant Toute modification apportée aux machines ou tout déplacement de celles-ci est déconseillé, car susceptible de provoquer des accidents matériels et/ou corporels

PELIGRO

Aunque algunos productos Sigma están diseñados y homologados para su instalación en entornos peligrosos, entendidos éstos conforme a la definición del "National Electrical Code" (Reglamento Eléctrico Nacional), muchos de los productos Sigma no son aptos para su utilización en lugares peligrosos. Es responsabilidad de quienes instalen los productos en entornos peligrosos el asegurarse de la idoneidad de dichos productos para este tipo de entorno Además, para garantizar la seguridad, la instalación de los instrumentos en lugares peligrosos deberá realizarse conforme a las especificaciones del plano del fabricante. Se desaconseja cualquier modificación de los instrumentos o de la instalación, ya que podría provocar lesiones corporales graves, e incluso fatales, y/o daños materiales a los equipos

GEFAHR

Einige Sigma-Produkte sind für den Einbau in explosionsgefährdeten Bereichen gemäß den Festlegungen des National Electrical Code speziell geprüft und zugelassen. Dies gilt jedoch keineswegs für das gesamte Sigma-Produktangebot. Die Entscheidung, ob ein Produkt für den Einsatz in explosionsgefährden Bereichen geeignet ist oder nicht, bleibt in die Verantwortung des jeweiligen Installateurs gestellt Im Interesse der Sicherheit ist es zudem erforderlich, dass ein etwaiger Einbau des Geräts in explosionsgefährdeten Bereichen genau nach den Steuerungsanlagen-Zeichnungen des Herstellers erfolgt Von der Vornahme von Änderungen an meß- bzw. regeltechnischen Geräten bzw. abweichender Installation wird dringend abgeraten, da hierdurch lebensbedrohliche Personen- und/oder Sachschäden verursacht werden können!

PERICOLO

Nonostante alcuni prodotti Sigma, siano predisposti e certificati per l'installazione in ambienti pericolosi, come previsto dal Codice Normativo Nazionale che concerne l'elettricità, è sconsigliabile utilizzare prodotti Sigma in ambienti considerati pericolosi E' diretta responsabilità della persona che installa lo strumento in un luogo ritenuto "pericoloso" appurare se lo strumento è compatibile con tale ambiente Inoltre, per maggior sicurezza, l'installazione dello strumento in ambienti pericolosi deve seguire le specifiche di progettazione del produttore Si deve evitare qualunque manomissione allo strumento o all installazione, tali modifiche possono rappresentare una minaccia per la vita delle persone e creare guasti

Specifications

980 Flow Meter

Specifications are subject to change without notice

General	
Dimensions	14 62 H x 11 88" W x 8 26" D
Weight	7 62 kg (16 80 lb)
Enclosure	NEMA 4X IP 66 with front cover closed UV resistant
Mounting	Wall mount and Rail/Pole mount
Graphics Display	Graphics Display Back lit liquid crystal display (LCD) 8 line x 40 character in text mode 64 x 240 pixels in graphics mode Displays level vs time flow vs time rainfall vs time pH and temperature
Keypad	Keypad 19 position sealed membrane switch including four soft keys functions defined by display
Totalizers	8 digit resettable and 8 digit non resettable software Units ft³ gal m³ liter acre ft
Measurement Modes	Flumes Parshall Palmer Bowlus Leopold Lagco H HL HS Trapezoidal Weirs V notch Contracted/Non contracted rectangular Thelmar Compound Cipolletti Compound V notch Manning Equation Round U Rectangular and Trapezoidal Channels Head vs Flow Two independent user entered look up tables of up to 100 points each Level only Inches feet centimeters meters Area Velocity Level area table circular pipe U shaped channel trapezoidal channel rectangular channel Power Equation $Q = K_1H^{n_1} \pm K_2H^{n_2}$
Data Logging	Smart" Dynamic memory allocation automatically partitions memory to provide the maximum logging time No manual memory partitioning required Capacity Up to 456k bytes 402 days of level velocity and rainfall readings at 15 minute intervals plus 300 events Memory Mode Wrap around Data Points 116 000 data points Daily statistics Available for up to 32 days Recording intervals 1 2 3 5 6 10 12 15 20 30 60 minutes Time base accuracy ± 6 seconds (0 007%) per day
Electrical	
Power Specifications	0 25 amp maximum
Power Requirements	100–230 V ac 50/60 Hz single phase 15 W max (0 25 amp max)
Installation Category	II
Electrical Connection	Seven 0 5 in hubs One 1 0 in hub
Sampler Output	15 V dc 100 mA at 500 ms duration
Environmental (for Controller)	
Temperature Ranges	Storage 20 °C to 70 °C (4 °F to 158 °F) Operating 20 °C to 50 °C (4 °F to 122 °F)
Humidity	0–90% Non condensing

Integral pH Meter	
Control/Logging	*Field selectable to log pH independent of flow or in conjunction with flow* also controls sample collection in response to value of low/high stipends
pH Sensor	Temperature compensated impact resistant ABS plastic body Combination electrode with porous Teflon junction
Measurement Range	2 to 12 pH
Operating Temperature Range	18 to 80 °C (0 to 176 °F)
Dimensions	19 5 mm x 15 24 cm long (0 75 in dia x 6 in) with 19 5 mm (0 75 in) npt cable end
Rain Gauge Input	
General Information	For use with Tipping Bucket Rain Gauge Flow measurement can be initiated upon field selectable rate of rain Flow meter records rainfall data Shielded cable, 100 ft length maximum Each tip = 0 25 mm (0 01 in) of rain
Analog Input Channels	
General Information	Up to 7 additional data logging channels record data from external source(s) Four channels with -4 5 to 4 5 V dc input with 1 meg ohm input impedance on each channel and three channels with 4–20 mA input *
4–20 mA Output	
General Information	Two isolated output signals available User assignable
Maximum Resistive Load	600 ohms
Output Voltage	24 V dc—no load
Alarm Relays	
General Information	4 intergral alarm relays form C (common normally open normally closed) 5 amp Connection to instrument through terminal blocks
Relay Contact Ratings	5 amps (30–230 V ac)
Communications	
General Information	RS 232—up to 19 200 baud Modem—14400 bps V32 bis V42 MNP2 4 error correction V42 bis MNP5 data compression MNP 10 EC Cellular Protocol Pager SCADA–Modbus® communication protocol (standard) via RS232 or optional modem

Ultrasonic Transducer	
Operating Frequency	75 kHz
Beam Angle	±12° (10 dB)
Accuracy*	±0 03 ft over 2 ft change in head @ 20 °C still air ideal target 50 ft cable
Range	11 5 in (minimum) to 10 7 ft (maximum) with ideal target @ 20° C in still air with 50 ft cable
Operating Temperature Range	20 °C to 50 °C (4 °F to 122 °F)
Material	PVC housing with acoustic window
Weight	*1 5 lb*
Cable	Low loss cable coax cable RG 62/U
Cable Length	25 ft (7 6 m) standard custom lengths up to 500 ft (contact manufacturer for performance information at custom lengths)
Mounting	Permanent and Adjustable Mounting Brackets
Dimensions (transducer only)	12 7 cm x 5 7 cm (5 0" H x 2 25" D)
Connection	Bare wire lead connection via terminal blocks
In Pipe Ultrasonic Sensor	
Operating Frequency	75 kHz
Accuracy	±0 014 ft for sensor to liquid distance between 2 86 inches and 13 5 ft at ±1 ft change in head from calibration point 20 °C still air ideal target 50 ft cable
Range	Distance from sensor to liquid 0 64 inches (minimum) to 13 5 feet (maximum) @ 20 °C still air ideal target 50 ft cable
Resolution	0 0075 inches
Operating Temperature Range	20 to 60 °C (4 to 140 °F)
Storage Temperature	20 to 60 °C (4 to 140 °F)
Temperature Error	0 00005 meter/°C typical
Material	Stat Kon A E ABS Plastic
Cable Length	7 6 m (25 ft) standard custom lengths up to 200 m (500 feet)
Dimensions (transducer only)	4 44 cm (1 75 in) maximum diameter 31 435 cm (12 375 in) long
Mounting	Dedicated Mounting Rings Permanent Mounting Bracket (installs directly to pipe wall) Adjustable Mounting Band Kit
Connection	Bare lead connection via terminal blocks

Velocity Transducer	
Method	Doppler Principle
Accuracy*	±2% of reading Zero Stability ±1 52 cms (±0 05 fps)
Range	1 52 to 6 1 m (5 to +20 fps)
Resolution	0 3 cms (0 01 fps)
Response Time	4 8 seconds
Profile Time	4 8 seconds
Probe Dimensions	Length 6 9 cm (2 7 in) Width 3 81 cm (1 5 in) Height 1 1 cm (0 44 in)
Cable	Urethane sensor cable shielded
Cable Length	7 6 m (25 ft) custom cable lengths up to 100 ft
Mounting	Dedicated Mounting Rings (mounting clips recommended for pipe diameters 8 in or under) Mounting Plate (for permanent mounting—drills to pipe wall) Adjustable Mounting Band Kit
Connection	Sensor connector to Quick connect hub or bare leads connection via terminal block

Submerged Area Velocity Probe	
Method	Doppler Principle / Pressure Transducer
Material	Polyurethane body 316 series stainless steel d aphragm
Cable	Urethane sensor cable w th air vent shielded
Cable Length	7 6 m (25 ft standard custom cable up to 100 ft
Probe Dimensions	Length 12 7 cm (5 inches) Width 3 81 cm (1 5 inches) Height 2 03 cm (0 8 inches)
Mounting	Dedicated Mounting R ngs (mounting clips recommended for p pe diameters 8 n or under) Mounting Plate (for permanent mount ng—dr lls to p pe wal) Adjustable Mounting Band Kit
Connection	Sensor connector to quick-connect hub bare lead connect on via term nal block or bare lead connection to junction box with bare lead junction box via terminal block
Velocity	Velocity Accuracy ± 2% of reading Zero stab l ty <0 05 fps (<0 015 m/s)
	Response Time 4 8 sec
	Profile Time 4 8 sec
	Range 1 52 to 6 1 m/s (5 to +20 fps)
	Resolution 0 0028 m/s (0 01 fps)
	Operating Temperature 18° to 60 °C (0° to 140 °F)
Depth	Depth Accuracy ±2% of reading
	Maximum Allowable Level 3X over pressure
	Operating Temperature Range 0° to 71 °C (32° to 160 °F)
	Compensated Temperature Range 0 to 30 °C (32 to 86 °F)
	Temperature Error 0 005 to 3 5 m ±0 0022 m/°C (0 018 to 11 5 ft ±0 004 ft/°F) 0 005 to 10 5 m ±0 006 m/°C (0 018 to 34 6 ft ±0 012 ft/°F) (maximum error within compensated temperature range per degree of change)
	Draw down correction* 0 to 3 05 mps (0 to 10 fps) ± 0 085% of reading
	Air Intake Atmospheric pressure reference is des ccant protected

* See Troubleshooting Measurement Errors on page 107

* U S Patent 5 691 914

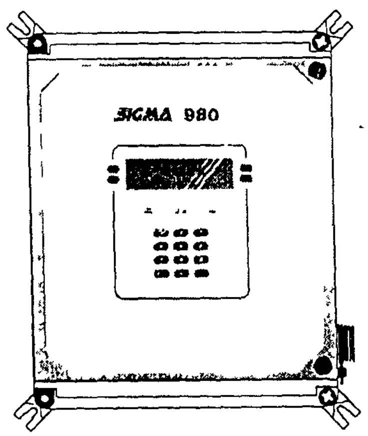
1.1 Instrument Description

The 980 Flow Meter is an ultrasonic level detection meter with rugged NEMA 4X, IP66 construction The 980 Flow Meter case has several unique features all designed to simplify installation, operation, and maintenance All controls are located within easy reach on the front panel behind a clear protective front cover

The 980 Flow Meter has eight wiring holes located along the bottom of the case The one 1 38 in and the seven 0 875 in conduit holes provide easy access for all power, sensor control, and communications wiring

Connections to the 980 Flow Meter are made in the wiring panel behind the front cover The interface connector ports are located on the bottom of the instrument The 980 Flow Meter comes standard with a quick-connect RS232 serial communications port

Figure 1 980 Flow Meter



In addition, the flow meter can connect to a wide variety of optional peripheral devices

- 4-20 mA Current Loop
- Up to three 4-20 mA Inputs
- Up to four 4 5 V dc Inputs
- Mechanical Totalizer
- Rain Gauge
- Sampler
- pH Sensor
- Modem

The 980 Flow Meter is available with one of the depth/velocity measurement technologies

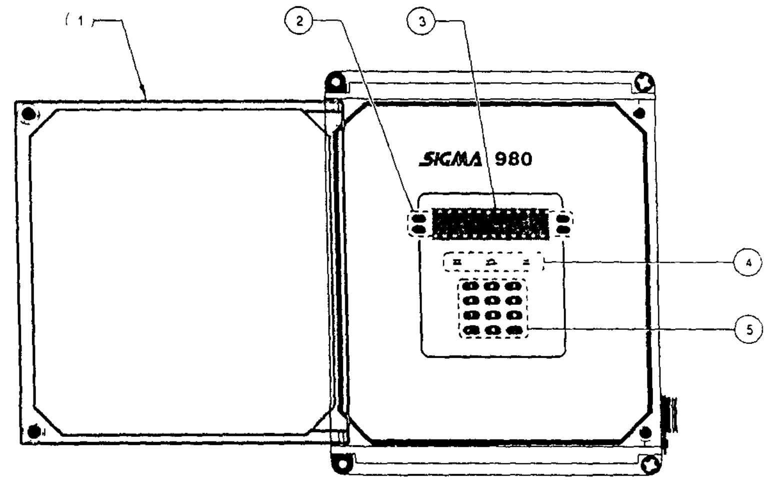
- Ultrasonic Sensor
- Velocity Sensor
- Area Velocity Submerged Sensor

1.2 Front Panel Features and Controls

The 980 Flow Meter front panel features the keypad and the liquid crystal display (LCD) The side of the 980 Flow Meter provides a connection for an RS232 serial interface temporary connection

The clear front cover of the instrument protects the control panel and display window while providing a clear view of the flow meter status on the display The cover perimeter contains a gasket seal to keep moisture and dirt from entering the front panel area This seal is required to maintain the NEMA 4X rating of the case

Figure 2 Front Panel



1	Clear Front Cover	4	Function Keys
2	Soft Keys	5	Numeric Keypad
3	LCD Display		

1.3 Keypad Description

The 980 Flow Meter keypad has three components numeric keypad soft keys and function keys (See Figure 2)

Numeric Keypad
The numeric keypad consists of the digits 0 through 9, a +/- key and a decimal key

"Soft" Keys
Soft keys are blank, white keys located to the left and right of the display The appearance of each function key depends on the display The soft key labels appear on the display and point (with a straight line) to the proper soft key to push for that action If no function is shown for a specific key that key is not currently active

In some cases during a programming step an item from a list needs to be selected The soft keys on the right side of the display will change to display "up" and "down" arrows Us then to scroll up and down the list of choices When the desired choice is highlighted press the SELECT soft key

Function Keys
Three dedicated function keys are used to allow quick access to frequently used functions They are the white keys located just above the numeric keypad

Function Key	Description
Main Menu	
	This is the starting point to access any other point in the program Press the Main Menu key at any time during programming to return to the Main Menu Screen The current action is cancelled if changes are not yet accepted
Level Adjust	
	Adjust the flow meter to match the current head (or level contributing flow) in the channel
Run/Stop	
	Runs (or resumes) a program Stops a currently running program

1.4 Liquid Crystal Display

The 980 Flow Meter liquid crystal display (LCD) works in conjunction with the four soft keys When a soft key changes function, the display shows the new function

Menu Bar
The Menu Bar appears in a black band on the top edge of the display The upper left corner of the menu bar shows the time and date The upper right corner shows the name of the current menu

Status Bar
The Status Bar appears along the bottom edge of the display The appearance of the status bar changes depending upon the function performed

The lower left corner of the Status Bar indicates whether a program is Running Halted or Ready To Start If it is not needed during a programming step it disappears

The lower right corner displays system alarm conditions such as low memory battery For a list of possible alarms see Section 3 4 on page 65

The status bar also lists the valid choices when entering certain programming information For example when selecting the units of level measurement from the Level Units menu the status bar indicates that the valid choices are cm ft in or m

1.5 Principle Operation

Measurement Capabilities
The 980 Flow Meter is often used to measure flow in conjunction with a primary measuring device (flume weir pipe etc) that has a known level to flow relationship The 980 Flow Meter directly measures the level of liquid in a channel that is contributing to flow (referred to as head") and calculates the flow rate based on the head to flow relationship of the primary device (Refer to Appendix A on page 101)

The 980 Flow Meter can also simultaneously measure and record

- Level
- pH
- Rainfall
- Velocity (AV version only)
- Temperature
- Seven discrete analog inputs (voltage and/or current)

The AV option can also measure the average velocity of the flow stream using a submerged Doppler probe and calculate flow based on the current level and the formula *Wetted Area × Velocity = Flow*

Communication Capabilities
A graphical display allows fast on site review of historical data

In addition to its extensive data logging capabilities the 980 Flow Meter is capable of

- Enabling a sampler
- Pacing a sampler
- Controlling four external devices with Normally Open/Normally Closed relays
- Controlling two external devices with 4–20 mA current outputs

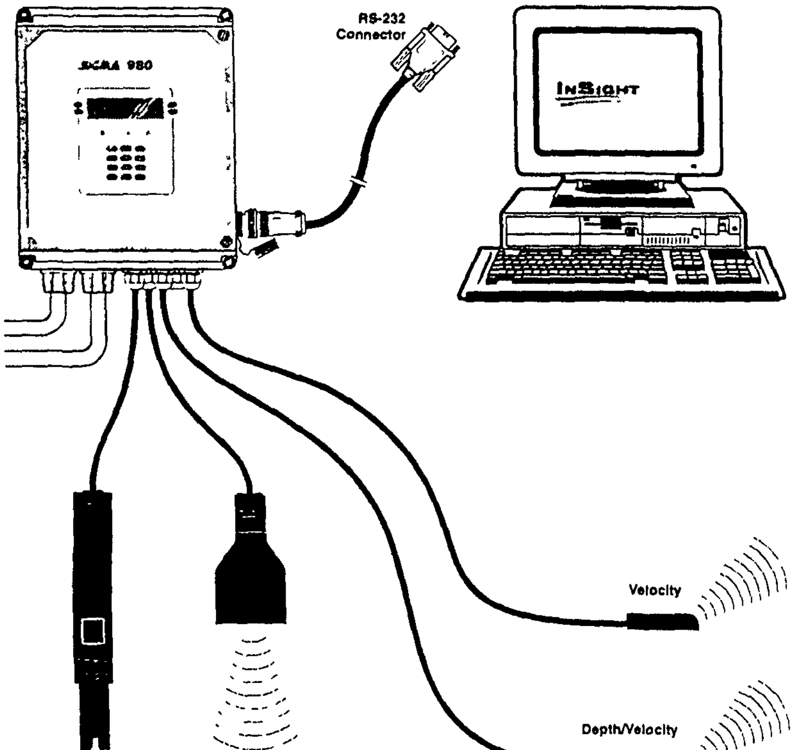
Communications capabilities include a standard RS232 port used for data transfer and updating internal embedded program using state of the art Flash Memory technology

The 980 Flow Meter also provides SCADA Communication Interface functionality using the Modbus® ASCII protocol This software protocol communicates with the instrument via an RS232 or modem connection

Using our InSight® Gold data analysis software, users can download, remotely program, view real-time current status of logged parameters and conduct other data manipulation via RS232 connection or the optional modem

To protect the meter's functionality and data, an operator may set up password security access to the meter using the front-panel keypad

Figure 3 Communication Capabilities



AMERICAN SIGMA

INSTALLATION

DANGER

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the installation/maintenance tasks described in this portion of the manual.

DANGER

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détérioration de l'appareil. Les tâches d'installation et d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

PELIGRO

Algunos de los capítulos del manual que presentamos contienen información muy importante en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de instalación y mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas

GEFAHR

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vermeiden In diesem Abschnitt beschriebene Installations- und Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

PERICOLO

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione La preghiamo di leggere attentivamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni di manutenzione descritte in questa parte del manuale.

DANGER
This instrument should be installed by qualified technical personnel to ensure adherence to all applicable electrical codes

DANGER
Cet appareil doit être installé par du personnel technique qualifié, afin d assurer le respect de toutes les normes applicables d électricité

PELIGRO
Este instrumento debe ser instalado por personal técnico capacitado para asegurar el cumplimiento con todos los códigos eléctricos y de plomería aplicables

GEFAHR
Um zu gewährleisten, daß alle elektrischen VDE-Vorschriften und gegebenenfalls die Zusatzvorschriften der zuständigen Elektrizitäts- und Wasserwerke erfüllt werden, darf dieses Gerät nur von geschultem Fachpersonal installiert werden

PERICOLO
Lo strumento deve essere installato da personale tecnico qualificato per garantire la conformità delle norme in materia di elettricità

2.1 Customer-supplied Equipment

- Four ¼–20 mounting screws
- Small flat-blade screwdriver
- Phillips screwdriver
- Needle-nose pliers
- 110–230 V single phase switched power
- Wire strippers
- Diagonal wire cutters
- Nylon wire ties
- 5/16 open end wrench

2.2 Unpacking the Instrument

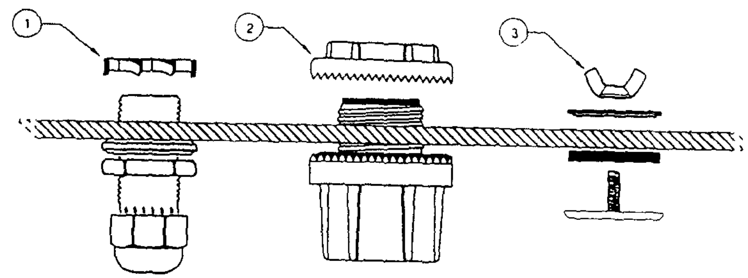
Remove the 980 Flow Meter from its shipping carton and inspect it for any damage *If the shipment arrives damaged or incomplete contact Technical support at 1 800-635-1230 or send e-mail to techhelp@hach com*

2.2.1 NEMA 4X Applications

Note The 980 Flow Meter ships with temporary push-in hole plugs which are not acceptable for use during operation If circuit connections are not required plug unused holes as shown in Figure 4

To maintain the NEMA 4X, IP66 enclosure rating, use strain-relief or conduit fittings that are a sealing type (not supplied see note in left column) To make wire connections, refer to the sections that follow Standard off the shelf NEMA-approved conduit hardware is available at most hardware and electrical appliance stores Take care to select the style of conduit hardware that will seal to the enclosure wall when using flexible or rigid conduit See Figure 4 and Parts and Accessories on page 149

Figure 4 Sealing-type Strain Reliefs, Conduit Fittings, and Sealing Plugs



1	Sealing type Strain Relief (Cat No 8773 0 20 0 35" O D cable Cat No 8786 0 23 0 47" O D cable)
2	Conduit Fitting (½" (Cat No 16483) 1" (Cat No 4913600))
3	Oil tight Sealing Plug (Cat No 42210 00)

Figure 5 Mounting Dimensions (1 of 3)

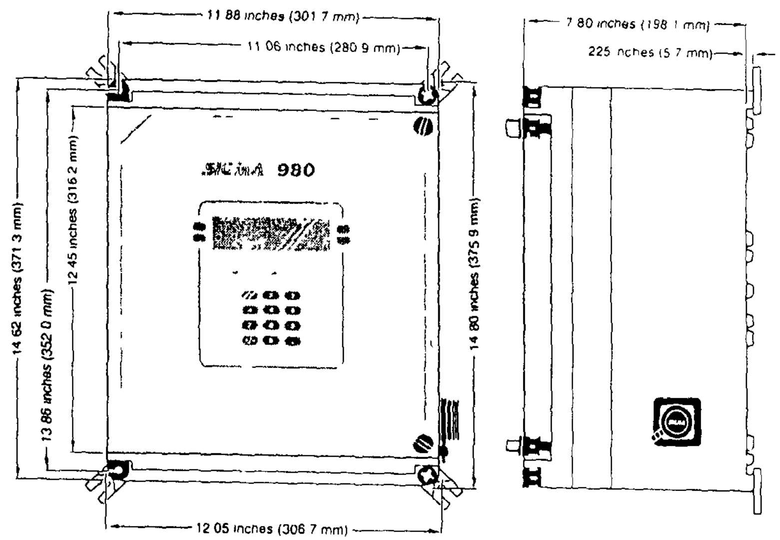
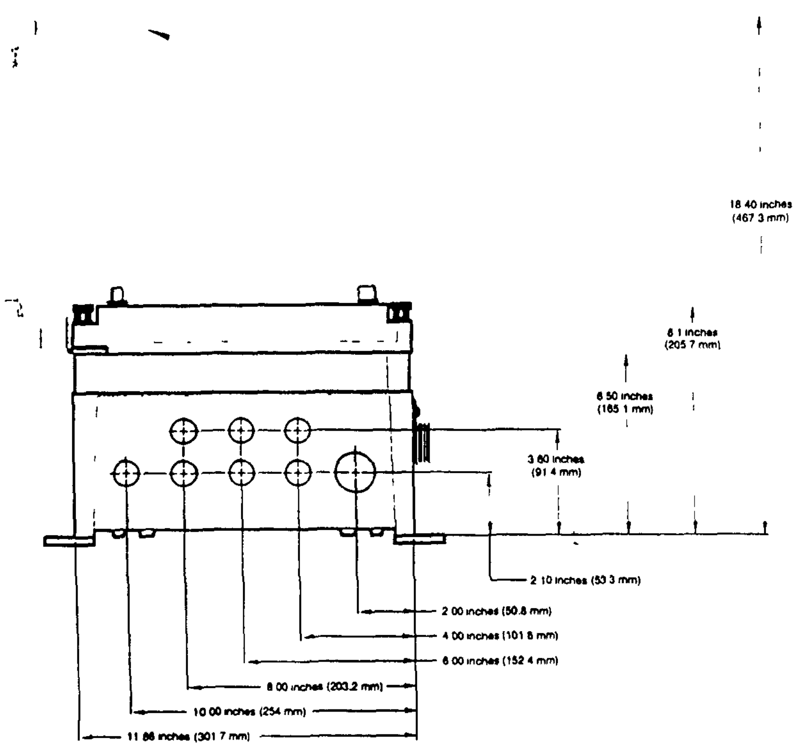


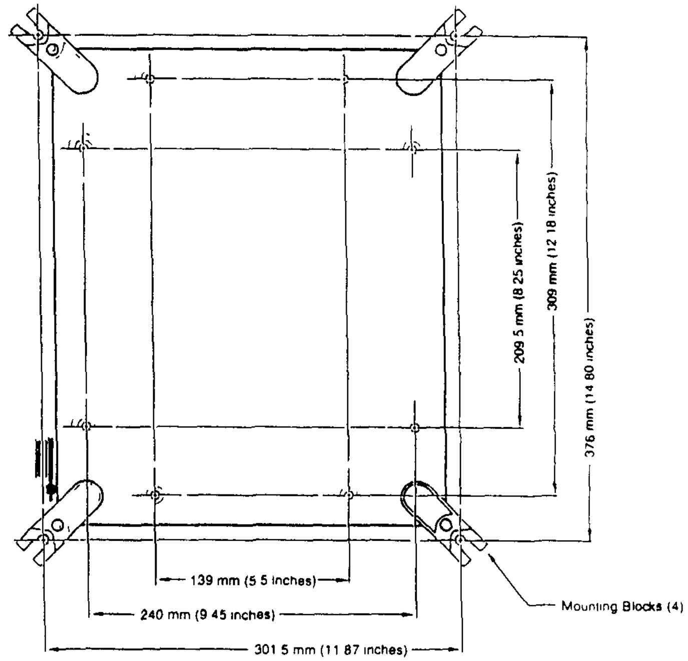
Figure 6 Mounting Dimensions (2 of 3)



2.3 Mounting Options

The 980 Flow Meter is designed for wall or rail/pole mounting Wall mounting dimensions and hole patterns are found in Figure 7 For optimal viewing of the the front panel display, mount the instrument facing north to eliminate glare from the sun

Figure 7 Mounting Dimensions (3 of 3)



2.3.1 Wall Mounting

Mount the 980 Flow Meter using the Wall Mounting Blocks that come installed on the unit, see Figure 7 These brackets provide secure mounting for the instrument To wall mount the 980 Flow Meter use four ¼-20 screws Refer to Figure 8

The 980 Flow Meter is available with one of the following depth/velocity measurement technologies

- Ultrasonic Sensor
- Area Velocity/Submerged Sensor
- Velocity Sensor

After wiring the instrument and optional devices an operator must conduct the basic programming setup (Refer to Section 3 on page 59), conduct individual programming for the optional devices, and when necessary calibrate the devices (Refer to Section 3 on page 59 for operator's setup)

2.7 ⚠ Wiring the 4–20 mA Output

Note: To minimize electromagnetic effects on the 980 Flow Meter, performance shielded cable is required To ensure that ground currents in inadequate ground systems do not result in potential shock hazards do not connect the shields at both ends of the cable

Note. Use NEMA-approved conduit hubs (Cat No. 16483) to ensure that water and dust do not enter the enclosure

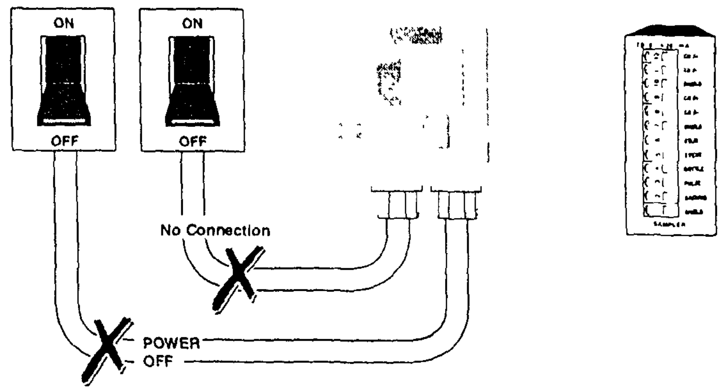
Two 4–20 mA dc outputs are available and may be independently assigned to any data channel (level, flow, pH, etc)

1. Disconnect all power to the 980 Flow Meter See Wiring Safety Information on page 31
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover
3. Strip insulation from 4–20 mA leads ¼ inch
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument, and route the 4–20 mA cable wires through this opening
5. Connect wires to the proper screw terminal block (TB10) Refer to Table 2 and Figure 13.
6. When wiring the cable sheild, connect to protective earth (ground) at the 980 Flow Meter. Do not connect the cable shield at the remote end of the cable. Cut the cable jacket far enough back to expose the conductors Remove the shield by cutting it even with the cable jacket Insulate the remaining exposed shield with tape or heat-shrink tubing

Table 2 4–20 mA Terminal Block Connections (TB10)

Pin	Signal Description
7	shield
8	channel B - (neg)
9	channel B + (pos)
10	shield
11	channel A - (neg)
12	channel A + (pos)

Figure 13 Locating TB10 for 4–20 mA Output Connections



2.8 ⚠ Wiring the Analog Input

Note: Use NEMA-approved conduit hubs (Cat No 16483) to ensure that water and dust do not enter the enclosure

Note: 4–20 mA inputs must be isolated Input impedance is 200 ohms

Note: Input impedance for voltage inputs is equal to 1 meg ohm

1. Disconnect all power to the 980 Flow Meter Refer to Wiring Safety Information on page 31
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover
3. Strip insulation from analog input leads ¼ inch
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the analog input cable wires through this opening
5. Connect wires to the proper terminal block connection TB4 for 4-20 mA dc wiring or TB9 for voltage wiring (See Figure 14) Refer to Table 3 and Table 4
6. When wiring the cable sheild, connect to protective earth (ground) at the 980 Flow Meter *Do not connect the cable shield at the remote end of the cable* Cut the cable jacket far enough back to expose the conductors Remove the shield by cutting it even with the cable jacket Insulate the remaining exposed shield with tape or heat shrink tubing

Note: To minimize electromagnetic affects on the 980 Flow Meter performance, shielded cable is required. To ensure that ground currents in inadequate ground systems do not result in potential shock hazards, do not connect the shields at both ends of the cable.

There are a total of seven analog input channels available on the 980 Flow Meter. These inputs accept 4–20 mA dc or -4.5 to +4.5 V dc analog signals. They can be logged and graphed and can also be used to trigger alarms, cause set point samples, and control 4–20 mA outputs.

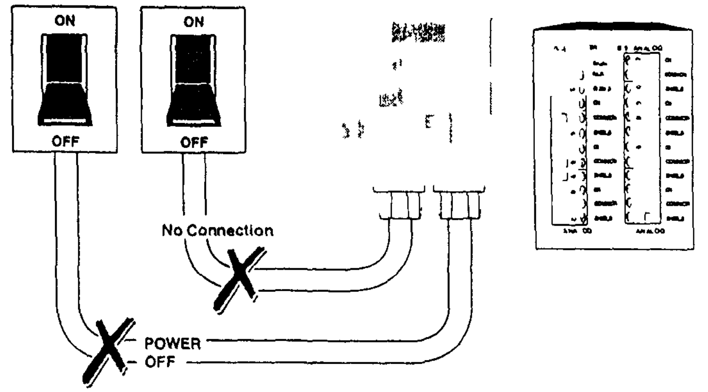
Table 3 Analog Input 4–20 mA dc Terminal Block Connections (TB4)

Input	Pin	Signal Description
Channel 1	4	4–20 mA dc
	5	common
	6	shield
Channel 2	7	4–20 mA dc
	8	common
	9	shield
Channel 3	10	4–20 mA dc
	11	common
	12	shield

Table 4 Analog Input Voltage Terminal Block Connections (TB9)

Input	Pin	Signal Description
Channel 4	12	-4.5 to +4.5 V dc
	11	common
	10	shield
Channel 5	9	4.5 to +4.5 V dc
	8	common
	7	shield
Channel 6	6	4.5 to +4.5 V dc
	5	common
	4	shield
Channel 7	3	4.5 to +4.5 V dc
	2	common
	1	shield

Figure 14 Locating TB4 and TB9 for Analog Input Connections



2.9 ⚠ Wiring the Mechanical Totalizer

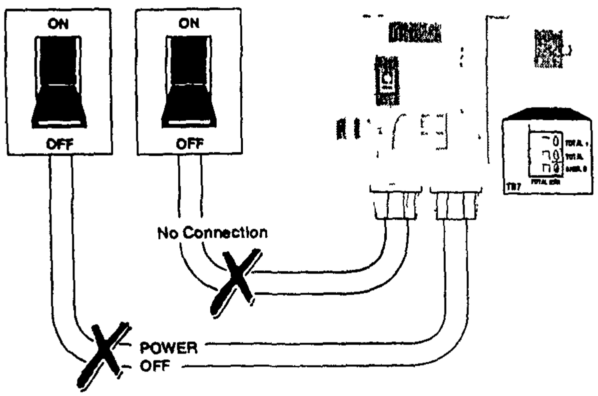
Note: Use NEMA approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.

1. Disconnect all power to the 980 Flow Meter. Refer to Wiring Safety Information on page 31.
2. Use a large flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip the insulation from the mechanical totalizer leads ¼ inch.
4. Attach a NEMA approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument and route the cable wires through this opening.
5. Connect wires to the proper terminal block connection (TB7) shown in Table 5 and Figure 15.

Table 5 Mechanical Totalizer Terminal Block Connections (TB7)

Pin	Signal Description
1	Total +
2	Total
3	Shield

Figure 15 Locating TB7 for Mechanical Totalizer Connection



2.10 ⚠ Wiring the Alarm Relays

DANGER
The relay connection area is designed for only high voltage (30-230 V ac) connections. A shock hazard can exist if low voltage (<30 V) connections are made in the relay connection area

DANGER
La zone de connexion des relais est prévue pour les connexions haute tension (30-230 Vca) uni-quement Un risque d électrocution peut exister si des connexions basse tension (<30 V) sont effectuées dans la zone de connexion des relais

PELIGRO
El sector para conexiones del relé está diseñado solamente para voltajes altos (30-230 Vca). Existe el peligro de una descarga eléctrica si se hacen conexiones de bajo voltaje (<30V) en este sector

GEFAHR
Relaisanschlüsse sind ausschließlich für Hochspannung (30-230 Vac) ausgelegt Wenn in diesem Bereich Niederspannungsanschlüsse (<30V) durchgeführt werden, besteht die Gefahr eines Stromschlags

PERICOLO
La zona del relè è progettata solo per collegamenti ad alto voltaggio (30-230 Vac) Rischio di scossa elettrica esiste quando collegamenti a basso voltaggio (< 30 V) vengono effettuate nella zona del relè

Note Current to the relay contacts must be limited to 5 amps A means to remove power from the relays locally in case of an emergency or for servicing the product must be provided by the user This can be accomplished with an external switch and a 5 amp fuse or with a switched 5 amp circuit breaker

The alarm wiring can be sized according to the load being used The relay connector will accept wire sizes from 18 AWG to 12 AWG Do not use wire smaller than 18 AWG

The alarm relays have unpowered contacts and the power to operate the load is supplied by the user Figure 16 shows a typical wiring configuration The wires are routed through the conduit hole and are connected to the circuit board Voltage range is 30–230 V ac 50/60 Hz The alarm relays can switch resistive loads of up to 5 A

Table 6 Relay Terminal Block Connections (J13)

J13	Signal Description	J13	Signal Description
1	normally closed 1	7	normally closed 3
2	common relay 1	8	common relay 3
3	normally open 1	9	normally open 3
4	normally closed 2	10	normally closed 4
5	common relay 2	11	common relay 4
6	normally open 2	12	normally open 4

1 With the power disconnected to the controller use a large flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Refer to Wiring Safety Information on page 31

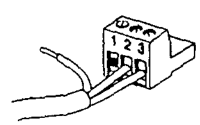
Note Use NEMA approved conduit hubs (Cat No 16483) to ensure that water and dust do not enter the enclosure

2 Open the cover

3 Strip the insulation from alarm relay leads ¼ inch

4 Attach a NEMA approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the cable wires through this opening

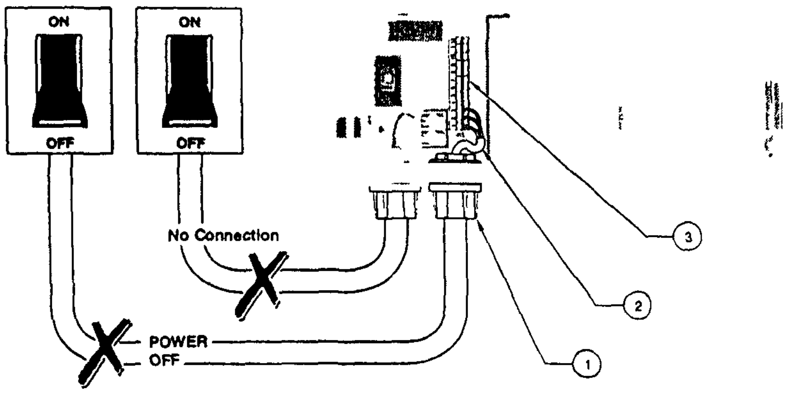
5 Pull out the twelve pin removable terminal block See Figure 16 for terminal block position



6 Insert each bare wire end into the supplied twelve pin connector until the wire insulation is sealed against the connector Do not leave any of the bare wire exposed

7 Plug the connector back onto the circuit board

Figure 16 Locating TB13 for Alarm Relay Connection



1 Appropriate strain relief or seal	2 One relay connection shown	3 J13 12 pin terminal block

2.11 ⚠ Wiring the Rain Gauge

An external "tipping bucket" rain gauge (such as Cat No 9708400) can be connected to the rain gauge connector of the 980 Flow Meter The rain gauge provides a dry contact closure to the flow meter

1 Disconnect all power to the 980 Flow Meter See Wiring Safety Information on page 31

2 Use a large flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover

3 Strip insulation from the rain gauge leads ¼ inch

4 Attach a NEMA approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the wires through this opening

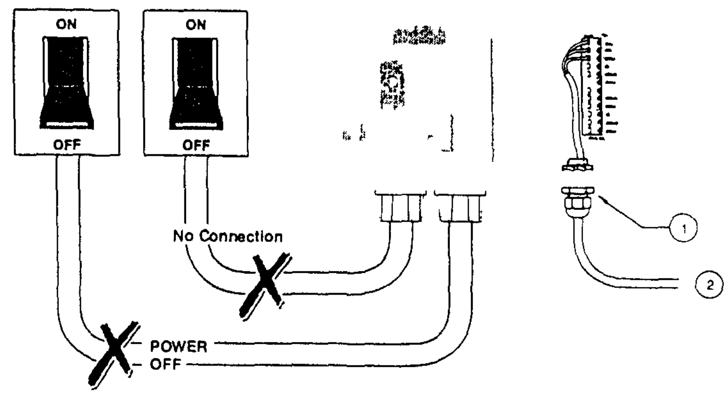
5 Connect wires to the proper screw terminal block (TB4) Refer to Table 7 and Figure 17

Note Route wires through NEMA-approved conduit hubs (Cat No. 16483) to ensure that water and dust do not enter the enclosure

Table 7 Rain Gauge Terminal Block Connections (TB4)

Pin	Signal Description
1	Rain + (pos)
2	Rain (neg)
3	Shield

Figure 17 Connecting to a Rain Gauge



1 Strain Relief	2 Input from Rain Gauge

2.12 ⚠ Wiring the Sampler

1 Disconnect all power to the 980 Flow Meter See Wiring Safety Information on page 31

2 Use a large flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover

3 Strip insulation from the sampler leads ¼ inch

4 Attach a NEMA approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the wires through this opening

5 Connect wires to the proper screw terminal block (TB10) Refer to Table 8 and Figure 18 for wire connections

Note Route wires through NEMA approved conduit hubs (Cat No. 16483) to ensure that water and dust do not enter the enclosure

Cable Required for Sampler Connections

- Multi Purpose Half Cable Assembly 10 ft (3 0 m) 6 pin connector on one end tinned wire leads on the other end (Cat No 9708700)

Figure 18 Locating TB10 for Sampler Connections

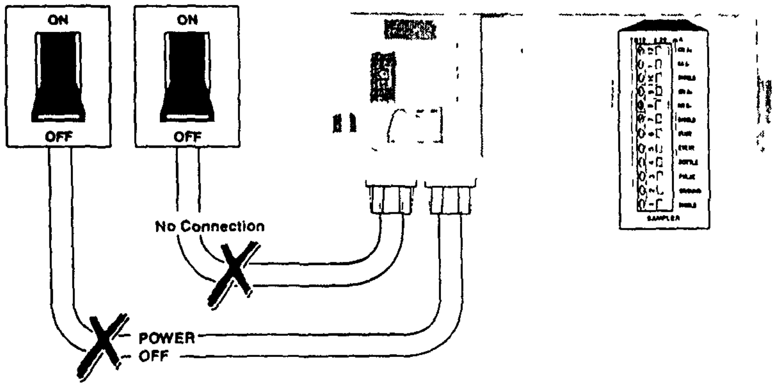


Table 8 Sampler Terminal Block Connections (TB10)

Pin	Signal Description	Wire Color	Purpose	Rating
1	shield	—	*Noise Suppression*	N/A
2	common	brown	Provides the ground line used in conjunction with the other signals on the connector	N/A
3	flow pulse output	yellow	Used in conjunction with common signal to notify that a pre determined amount of flow has accumulated	12 to 15 V dc
4	bottle number input	green	*Received from a wastewater sampler and used in conjunction with the* Event input signal It tells the flow meter which bottle was used when a sample was taken "Sample Times and Dates" information will appear in the data printout when downloaded	0 to 5 V dc input (10 K ohm pull up to 5 V)
5	event input	red	Received from a wastewater sampler and indicates that a sample has been collected "Sample Taken" information will appear in the data *printout when downloaded*	0 to 5 V dc input (11 K ohm input *resistance)*
6	sampler start output	black	Used to "wake up" a wastewater sampler when a set point condition is met so that it can begin its sampling program Configure the flow meter for this pin in Set Point Sampling on page 118 Used in conjunction with common this line is normally allowed to float and is switched to ground (by transistor) for the entire period that the set point condition exists	12 V dc (max) at 100 mA (max) open collector output

2.13 ⚠ Wiring the RS232

Note Do not connect the RS232 port to more than one external device at the same time Connecting an external device to both the side panel quick-connect fitting and the terminal circuit board inside the 980 Flow Meter can cause instrument *failure and unreliable communications*

Note To minimize electromagnetic affects on the 980 Flow Meter performance shielded cable is required To ensure that ground currents in inadequate ground systems do not result in potential shock hazards do not connect the shields at both ends of the cable

Note Route wires through NEMA approved conduit hubs (Cat No 16483) to ensure that water and dust do not enter the enclosure

The quick connect RS 232 connector is located on the side panel of the 980 Flow Meter housing The RS232 is intended for temporary connection between a PC and 980 Flow Meter using a serial interface cable (Cat No 1727) or a DTU II The 980 Flow Meter also allows for a permanent connection that is routed by an external communicat ons cable to the 980 Flow Meter through a conduit opening

Permanent Conduit Connection

1 With power to the controller off use a large flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover See Wiring Safety Information on page 31

2 Disconnect the RS232 Quick-connect attached to the TB11 pins No wires should remain in the socket

3 To prevent dangling wires from touching the circuit nodes tape each individual wire then bundle the wires and tape wires together See Figure 19

4 Attach a NEMA approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the RS232 permanent connection 6 wire cable and five conductors with shield

5 Strip the outer insulated jacket back 2 inches from the end of the RS232 cable Use care when removing the outer jacket to ensure that the insulation around the inner conductors is not nicked Nicked insulation on inner conductors can lead to shorting

6 Strip insulation of the individual wires back ¼ inch

7 Connect each bare wire end to the proper screw terminal block (TB11) Refer to Table 9 and Figure 19 Do not leave any of the bare wire exposed

8 Connect the cable shield to protective earth (ground) at the 980 Flow Meter Do not connect the cable shield at the remote end of the cable Cut the cable jacket back far enough to expose the conductors and remove the shield by cutting it even with the cable jacket Insulate the remaining exposed shield with tape or heat shrink tubing

Table 9 Conduit RS232 Terminal Block Connections (TB11)

Pin	Signal Description
2	TXD
3	DTR
4	RXD
5	DSR
6	common
7	shield

Reconnecting the RS232 Quick-Connect

1 With the power to the controller off use a flat blade screwdriver to loosen the two screws securing the 980 Flow Meter cover

Note: Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure

4 Attach a NEMA-approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument, and route the modem cable wires through this opening

5 Strip insulation ¼ in from the modem leads

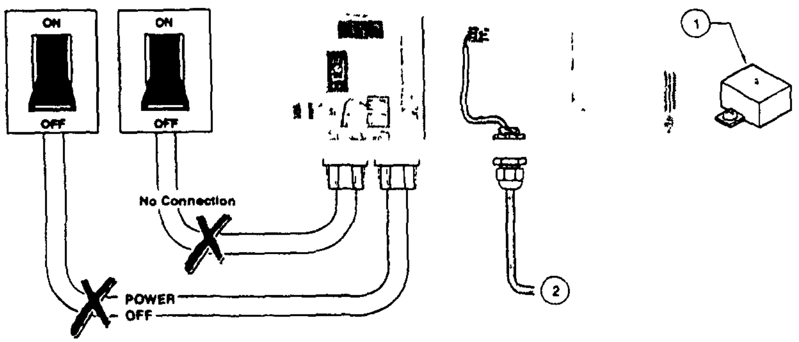
6. Connect wires to the proper screw terminal block (TB2) as shown in Table 11 and Figure 20

7 To ensure protection against electrical shock, reinstall the protective cover (Cat No 49170-00) over the modem terminal connections

Table 11 Modem Terminal Block Connections (TB2)

Pin	Signal Description
1	tip
2	ring

Figure 20 Modem Wiring Connections



1 Protective Cover for TB2	2 Cable to Modem

2.15 ⚠ Wiring the pH Sensor

The pre-amp junction box (Cat No 9708300) is used to connect the pH probe to the 980 Flow Meter The pH probe wires attach to a terminal strip in the junction box

2.15.1 ⚠ pH Junction Box to Instrument

To connect the pH junction box to the 980 Flow Meter follow the steps below and refer to Figure 21

1 Disconnect ac power from the 980 Flow Meter See warning information in Wiring Safety Information on page 31

2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover Open the cover

3 Strip the insulation from the pH junction box leads ¼ inch

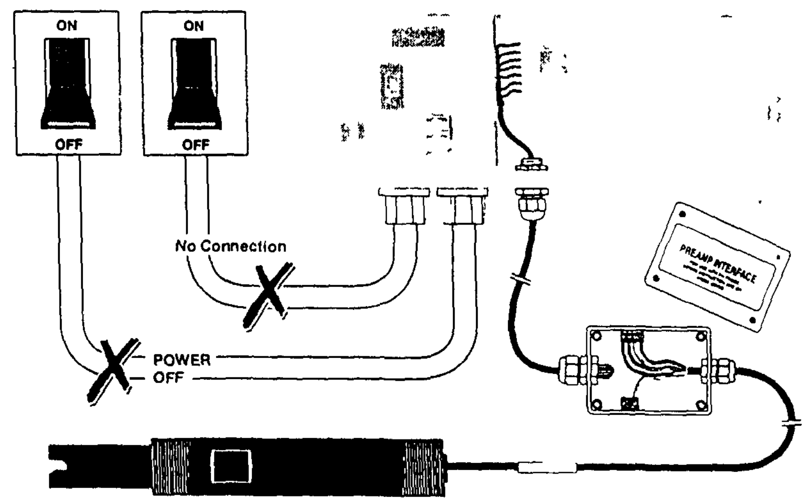
4 Route the cable (Cat No 9708800) from the pH junction box through a NEMA rated compression fitting (Cat No 16483) or conduit to one of the ½ in openings on the bottom of the 980 Flow Meter

5 Connect the wires to the proper screw terminal blocks (TB3) Refer to Table 12 and Figure 21

Table 12 pH Terminal Block Connections (TB3)

Pin	Signal Description	Wire Color
1	shield	clear
2	reference	black
3	pH	brown
4	RTD	red
5	5 V dc	orange
6	common	yellow
7	+ 5 V dc	green

Figure 21 Junction Box to Instrument



2.15 2 ⚠ pH Probe to Junction Box

Note pH sensor wire connections are found inside the junction box cover

Note Pull excess slack cable out of the junction box and tighten the compression fitting on the box

To connect the pH Sensor to the pH Junction Box

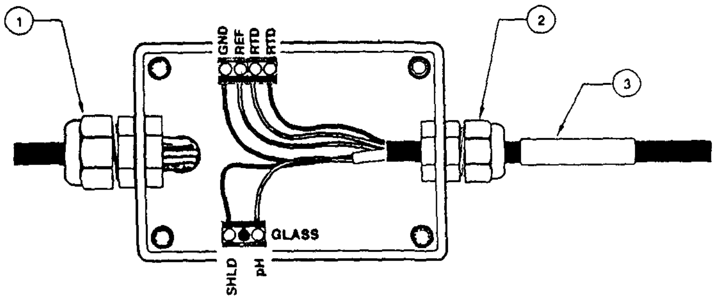
1 Remove the four hold down screws and nylon taper seals on the cover of the pH junction box with a Phillips head screwdriver Remove the cover

2 Loosen the compression fitting and route the pH sensor cable through the fitting Pull the cable into the junction box

3 Connect the pH sensor wires to the screw terminals Refer to Figure 22

4 Replace the cover the cover gasket and the nylon taper seals on all four screws

Figure 22 pH Probe to Junction Box



1 Pre wired strain relief	2 Compression Fitting (NEMA approved strain relief)	3 pH Probe Cable

2.16 ⚠ Wiring the Downlook Ultrasonic Sensor

Note To ensure protection against electrical shock reinstall cover over sensor terminal connection

Note Route wires through NEMA approved conduit hubs (Cat No. 16483) to ensure water and dust do not enter the enclosure

1 Disconnect all power to the 980 Refer to Wiring Safety Information on page 31

2 Use a large flat-blade screwdriver to loosen the two screws securing the 980 cover Open the cover

3 Remove the protective cover over the sensor terminal connection

4 Attach a NEMA-approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the ultrasonic cable through the opening

5 Install wires to the proper screw terminal block (TB5 and TB6) Refer to Table 13 and Table 14 for connection pin assignments and Figure 23

6 To ensure protection against electrical shock reinstall the protective cover over the Ultrasonic + and terminal connections

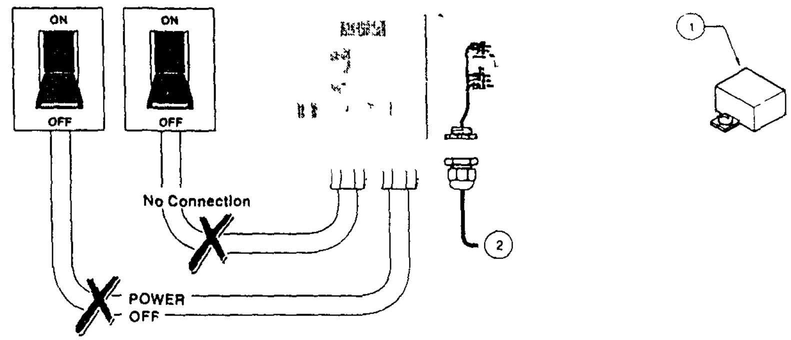
Table 13 Ultrasonic Terminal Block Connections (TB5)

Pin	Signal Description	Wire Type	Wire Color
1	Ull + (pos)	Coax Inner Conductor	yellow
2	Ull (neg)	Coax Outer Conductor	orange

Table 14 Ultrasonic Terminal Block Connections (TB6)

Pin	Signal Description	Wire Color
1	RTD + (pos)	red
2	RTD (neg)	black
3	shield	clear

Figure 23 Ultrasonic Transducer Connections



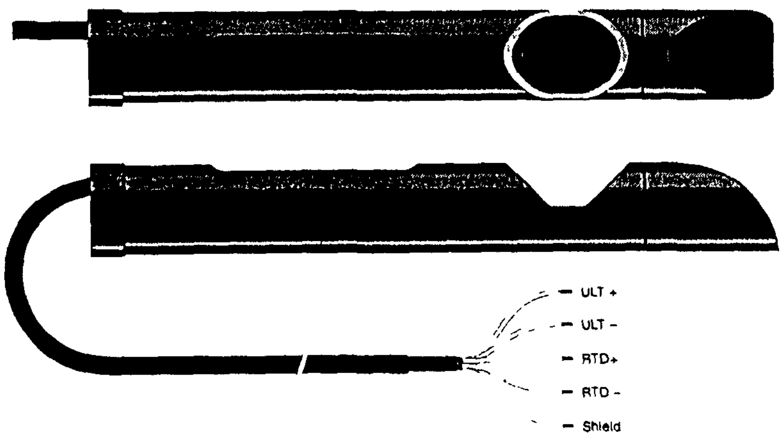
1 Protective Cover for TB5 and TB6	2 Cable to Ultrasonic Sensor

2.17 ⚠ Wiring the In-Pipe Ultrasonic Sensor

The in-pipe ultrasonic sensor is wired to the 980 Flow Meter the same way as the ultrasonic downlook Refer to section 2 16 Wiring the Downlook Ultrasonic Sensor on page 49

Only install an ultrasonic downlook or an in-pipe ultrasonic sensor to the instrument, they cannot be connected at the same time

Figure 24 In-Pipe Ultrasonic Sensor



2.18 ⚠ Wiring the Velocity-Only Sensor

2.18.1 Bare Lead Sensor Cables

Note: Bare lead connections and Quick-connections cannot be made at the same time

Bare lead sensor cables are used when the cable will be run through a conduit When conduit is used, it is recommended that the conduit be 1 in or larger

Wiring Procedure

1 Disconnect all power to the 980 Refer to the Wiring Safety Information on page 31

2 Use a large flat-blade screwdriver to loosen the two screws securing the 980 cover Open the cover

3 Attach a NEMA-approved conduit or compression fitting to one of the ½ in openings on the bottom of the instrument and route the velocity only cable wires through the opening

Note: The velocity-only probe and the submerged AV probe cannot be connected at the same time Disconnect all bare lead connections or submerged AV quick-connect connections to TB11 before connecting a velocity only bare lead connection To prevent dangling wires from touching the circuit nodes tape each individual wire then bundle the wires and tape them together

4. Connect the bare leads to the proper screw terminal block (TB11) as shown in Table 15

Table 15 Velocity-Only Sensor Terminal Block Connections (TB11)

Pin	Signal Description	Factory Wire Color*	Trimmed Cable Wire Color
10	+ 12 V dc	red	red
11	common	green	green
12	XMIT + (pos)	gray	gray
13	XMIT (neg)	violet	violet
14	RCV + (pos)	orange	orange
15	RCV (neg)	yellow	b/w shield
16	shield	clear	clear

* If the factory prepared cable end is cut off the wire colors will no longer match Use the trimmed cable wire colors

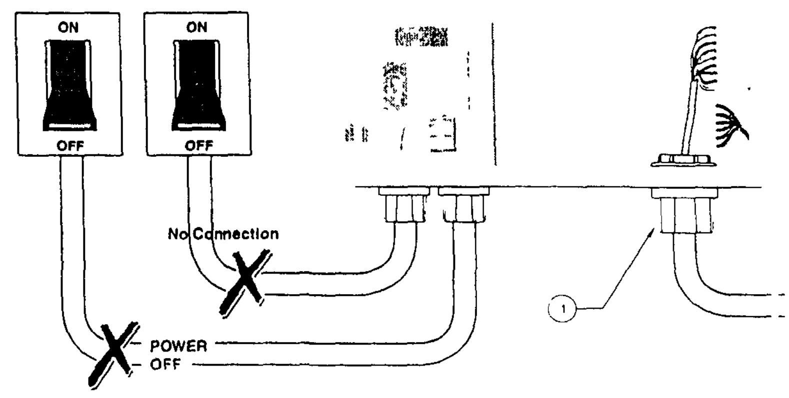
2 18.2 Velocity-Only Sensor Cable Quick-Connect

The quick-connect hub allows easy installation and removal of the velocity only sensor Refer to Figure 25 on page 52 To connect the velocity only sensor cable to the quick connect hub

1 Remove the rubber cap on the quick connect hub

2 Place the connector-end of the cable to the quick connect hub and tighten the connection by turning the cable connector securement ring clockwise

Figure 25 Quick-Connect Hub



1 Quick-connect Hub

2.19 ⚠ Wiring the Submerged Area Velocity Sensor

2.19.1 Bare Lead Sensor Cables

Note: Bare lead connections and Quick-connections cannot be made at the same time

Bare lead sensor cables are used in those cases when the cable will be run through a conduit When conduit is used, it is recommended that the conduit be 1 in or larger to the junction box and ½ in to the instrument

2.19.1.1 Junction Box Connection Procedure

Connect the bare leads to the flow meter using a junction box (Cat No 9702500) This junction box is a physical connection point for the sensor wires and breather tubing

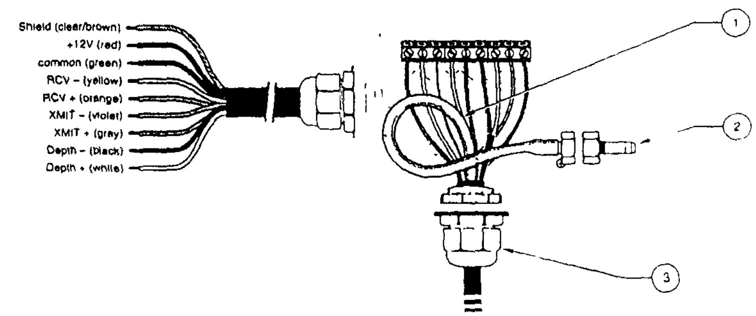
1. Disconnect all power to the 980 Flow Meter Refer to Wiring Safety Information on page 31
2. Loosen the four cover screws and remove the cover from the junction box Unscrew the cable-clamp hex nut on the box enough to allow insertion of the sensor cable
3. Insert the sensor cable into the box
4. Refer to the wiring diagram on the inside cover of the box Connect each wire to its corresponding screw terminal in the upper row, according to the wire colors listed in that diagram See Figure 26 on page 54
5. Connect the cable tubing to the clear tubing that is connected to the exit fitting in the junction box
6. Create a strain relief by slipping the cable in or out of the box to sufficiently create a slight loop in the wires and tubing Tighten the cable clamp hex nut
7. Verify that the sealing gasket is in place in the cover, then replace the cover on the junction box and tighten screws
8. Connect clear tubing between the top tubing nipple on the desiccant canister and the brass tubing nipple on the junction box
9. Connect the short, bare wire cable to TB11 Refer to Table 16 and Figure 27 on page 55

Note: The submerged AV probe and the velocity-only probe cannot be connected at the same time Disconnect all bare lead connections or submerged AV quick-connect connections to TB11 before connecting a submerged AV bare lead connection Refer to section 2 18 on page 51

Table 16 Submerged Area Velocity Sensor Terminal Board Connections (TB11)

Pin	Signal Description	Wire Color
8	Depth + (pos)	white
9	Depth (neg)	black
10	+ 12 V dc	red
11	common	green
12	XMIT + (pos)	gray
13	XMIT (neg)	violet
14	RCV + (pos)	orange
15	RCV - (neg)	yellow
16	shield	clear/brown

Figure 26 Submerged Area Velocity Junction Box Connections



1 Sensor Cable Tubing	2 Brass Tubing Nipple	3 Cable Clamp Hex Nut

AMERICAN SIGMA

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERICOLO

La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.

3.1 Initial Power-Up of Meter

After power is applied, the flow meter performs a complete diagnostic self-test and displays the menu shown when the unit was last turned off Set the instrument programming features when the Main Menu is displayed The Main Menu is the starting point for all programming operations The Main Menu offers four choices

- Setup—Basic programming
- Status—Lists all currently measured readings
- Display Data—Shows graphs and tables of logged data (See Displaying Data on page 117)
- Options—Advanced programming

Setup and Options functions lead to sub-menus and will configure the basic and advanced features of the flow meter Refer to the Main Program Flow Chart on page 149 The Display Data and Status lead to sub-menus and will provide information only Press the **STATUS** soft key to display any data channels that have enabled logging (flow pH, temp , etc)

11:00 AM 21 - APR - 01	* Main Menu*
DISPLAY DATA	SETUP
OPTIONS	STATUS
READY TO START	

3.2 Basic Programming

Note: To make changes to the program entries after the basic programming setup, press the MAIN MENU key and select SETUP>MODIFY SELECTED ITEMS Highlight the program entry using the up and down arrow soft keys

Basic programming setup must be performed, in its entirety after the instrument is installed Refer to the 980 Flow Meter Basic Programming Setup Flow Chart on page 150 for more information The basic program setup will modify all items

- Flow Units
- Primary Devices
- Program Lock
- Sampler Pacing
- Site ID
- Velocity Direction
- Velocity Units
- Velocity Cutoff/Velocity Default

Step 1 - Setup

1-A Press the **SETUP** soft key from the Main Menu to prepare the 980 Flow Meter for use

1-B Press the **MODIFY ALL ITEMS** soft key and press the **ACCEPT** soft key to begin setting up the flow units

11:00 AM 21 - APR - 01	* Main Menu*
DISPLAY DATA	SETUP
OPTIONS	STATUS
READY TO START	

11:00 AM 21 - APR - 01	* Main Menu*
LOGIN	MODIFY ALL ITEMS
REVIEW ALL ITEMS	MODIFY SELECTED ITEMS
READY TO START	

Step 2 - Flow Units

Note Different flow units can be selected in the Sampler Pacing programming section (see section 4 6 1 on page 75)

2-A From the Modify All Items screen highlight Flow Units using the up and down arrow soft keys Press the SELECT soft key to continue

2-B Press the **CHANGE CHOICE** soft key to cycle through the flow unit choices Refer to Table 17 for flow unit choices The flow unit will be used whenever a flow reading is displayed or logged

2-C When the desired choice is displayed press the ACCEPT soft key to continue and set level units

11:00 AM 21 - APR - 01		FLOW UNITS
ACCEPT	FLOW UNITS mdg	CHANGE CHOICE
		CANCEL
	SELECT APPROPRIATE UNITS	

Table 17 Flow Unit Choices

Abbreviation	Flow Unit	Abbreviation	Flow Units
gps	Gallons per second	cfs	Cubic feet per second
gpm	Gallons per minute	cfm	Cubic feet per minute
gph	Gallons per hour	cfh	Cubic feet per hour
lps	Liters per second	cfd	Cubic feet per day
lpm	Liters per minute	cms	Cubic meters per second
lph	Liters per hour	cmm	Cubic meters per minute
mgd	Million gallons per day	cmh	Cubic meters per hour
afd	Acre feet per day	cmd	Cubic meters per day

Step 3 - Level Units

3-A From the Modify All Items screen, highlight Level Units, using the up and down arrow soft keys and press the **SELECT** soft key to continue

3-B Select the units of measure to use when displaying level readings (Table 18) Level units of measure are used whenever a level reading is displayed or logged

Table 18 Level Units Choices

Abbreviation	*Level Unit*
in	inches
ft	feet
cm	centimeters
M	meters

3-C Press the **CHANGE CHOICE** soft key to cycle through each of the level unit choices Press the **ACCEPT** soft key to continue to primary device setup

Step 4 - Primary Device

4-A From the Modify All Items screen highlight Primary Device using the up and down arrow soft keys and press **SELECT** to continue

4-B Select the desired primary device, enter the calculation method shape and pipe diameter for that primary device

4-C Press the **CHANGE CHOICE** soft key to cycle through the primary device choices (See Table 19) Table 20 Table 21, and Table 22 show the size and details required for each Press the **ACCEPT** soft key to continue to Program Lock

11:00 AM 21 - APR - 01		PRIMARY DEVICE
ACCEPT	PRIMARY DEVICE WEIR	CHANGE CHOICE
	SELECT PRIMARY DEVICE	

Table 19 Primary Device Choices

Primary Device	**Description**
None—Level Only	No primary device installed Level measurement only
Weir	Compound Cipolletti Contracted rectangular Non contracted rectangular Thel mar V Notch (22 5 120°) Compound V Notch (See Table 20)
Flume	Parshall Trapezoidal H type HL-type, HS type Leopold-Lagco Palmer Bowlus (See Table 21)
Nozzle	California pipe
Power Equation	Enter variables K_1 K_2 n_1 and n_2 $Q = K_1H^{n1} + K_2H^{n2}$ K_1 (0–9999 99) K_2 (+/- 0–9999 99) n_1 and n_2 (1–9 99)

Table 19 Primary Device Choices (continued)

Primary Device	**Description**
Head vs Flow	Two independent user-entered look up tables of up to 100 points each (See Tab e 22)
Manning Equation	Rectangular channel U shaped channel or Circular pipe (See Table 22)
Area Velocity	Circular pipe U shaped channel Trapezoidal channel Rectangular channel (See Table 22)

Table 20 Weir Choices

Weir	**Description**
Cipolletti	Crest width is in or cm (1–960 in or 2 54– 2438 cm)
Contracted Rectangular	Crest width is in or cm (1–960 in or 2 54– 2438 cm)
Non Contracted Rectangular	Crest Width is in or cm (1–960 in or 2 54– 2438 cm)
Thel mar	Size in inches (6 8 10 12 or 15 in)
V Notch	Angle of notch in degrees (22 5 to 120°)
Compound V Notch	Angle of notch in degrees (22 5–120°) notch depth in inches rectangular w dth n nches (0–120 in or 0–304 cm) Contracted or non contracted

Table 21 Flume Choices

Flumes	**Description**
Parshall	Flume size in inches (1 2 3 6 9 12 18 24 30 36 48 60 72 84 96 108 120 or 144 n)
Trapezoidal	Flume size (60° S 60° L 60° XL 45° 2" 45° 12")
H Type	Flume size in feet (0 5 0 75 1 0 1 5 2 0 2 5 3 0 or 4 5 ft)
HL Type	Flume size in feet 3 5 4 0
HS Type	Flume size in feet (0 4 0 6 0 8 or 1 0 ft)
Leopold Lagco	Flume size in inches (4 6 8 10 12 15 18 20 21 24 27 30 36 42 48 54 60 66 or 72 in)
Palmer Bowlus	Flume size in inches (4 6 8 10 12 15 18 21 24 27 30 36 42 48 60 or 72 in)

Table 22 Other Primary Devices

Device or Equation	**Description**
Head Vs Flow (two head vs flow tables are provided)	Enter up to two tables of up to 100 user defined head vs flow points Head 0– 99 99 in feet or centimeters Flow 0–99999 99 in any desired units
Manning Equation	Enter pipe diameter slope & roughness coefficient Pipe dia 4–240 in or 101–6096 cm Percent Slope 0 001–1 00 [1 unit per hundred units = 0 01 slope] Example 1 m of decline every 100 m = 0 01 slope Manning Roughness
Area Velocity	Circular Pipe Enter pipe dia 4–240 in (10–610 cm) Rectangular Channel Enter width 4–999 99 in (10– 2540 cm) Trapezoidal Channel Enter width of channel bottom width of channel top and channel depth range for all 4–999 99 in (10– 2540 cm) U Shaped Channel Enter channel width 4–999 99 in (10–2540 cm)
Level vs Area Table (two level vs area tables are provided)	Enter up to two tables of up to 100 user defined level vs area points Level 0–999 9 n ft n m or cm Area 1–99999 99 in ft^2 in ^{2} m^2 or cm^2
Nozzle	Enter nozzle diameter

Step 5 - Program Lock

Program Lock provides a protective passcode to keep unauthorized personnel from tampering with the keyboard When enabled and a user attempts to change the program, a screen will ask them to enter a password The Program Lock password is set at the factory as 9800 and cannot be changed

The meter can also be password locked to prevent remote access via RS232 or modem InSight® Gold software allows you to change this password

5-A. From the Modify All Items screen, highlight Program Lock using the up and down arrow soft keys Press the **SELECT** soft key to continue

5-B Enable or Disable the program lock using the **CHANGE CHOICE** soft key Press **ACCEPT** to continue to Sampler Pacing

Step 6 - Sampler Pacing

6-A From the Modify All Items screen, highlight Sampler Pacing, using the up and down arrow soft keys Press the **SELECT** soft key to continue

6-B. Enable Sampler Pacing using the **CHANGE CHOICE** soft key

6-C. Refer to Table 23 for flow unit choices for sampler pacing

Table 23 Flow Unit Choices for Sample Pacing

Abbreviation	Volume
gal	gallons
ltr	liters
m³	cubic meters
af	acre-feet
cf	cubic-feet

6-D. Press **ACCEPT** to continue with Site ID

11:00 AM 21 - APR - 01		SAMPLER PACING
ACCEPT		CHANGE UNITS
	SAMPLER PACING 500 gal	
CLEAR ENTRY		CANCEL
	(USE NUMERIC KEYPAD)	

Step 7 - Site ID

Creates an 1–8 digit site identification number. The site ID will appear on all data printouts. This feature is useful when multiple sites are monitored using a single flow meter or if data readings from multiple flow meters are collected

7-A. From the Modified All Items screen, highlight Site ID using the up and down arrow soft keys Press **SELECT** to continue

7-B. Enter the site ID using the numeric keypad.

7-C. Press the **ACCEPT** soft key to continue to total flow units

Step 8 - Total Flow Units

8-A From the Modify All Items screen highlight Total Flow Units using the up and down arrow soft keys Press the **SELECT** soft key to continue

8-B Set the Total Flow Units using the **CHANGE CHOICE** soft key Total flow units of measure are used whenever a total flow unit is displayed or logged Refer to Table 24

Table 24 Total Flow Unit Choices

Abbreviation	Flow Unit
gal	gallons
ltr	liters
m³	cubic meters
af	acre feet
cf	cubic feet

8-C Press the **ACCEPT** soft key to continue with velocity direction

Step 9 - Velocity Direction (only when logging velocity)

9-A. From the Modify All Items screen highlight Velocity Direction using the up and down arrow soft keys Press the **SELECT** soft key to continue

9-B Set the Velocity Direction using the **CHANGE CHOICE** soft key

The Velocity Direction feature adapts to a number of difficult sites that would otherwise not be able to measure velocity properly (Upstream Downstream and Always Positive)

9-C Press the **ACCEPT** soft key to move to velocity units setup

9-D. Set the velocity units using the **CHANGE CHOICE** soft key Refer to Table 25

Table 25 Velocity Unit Choices

Abbreviation	Velocity Unit
fps	feet per second
m/s	meters per second

9-E Read the Velocity cutoff warning on the screen Press any key to continue

9-F. Enter the Velocity Cutoff, using the numeric keypad Press the **ACCEPT** soft key to continue

9-G. Enter the Velocity Default using the numeric keypad Press the **ACCEPT** soft key to end the basic programming setup

Example 1:
Velocity Cutoff = 0 20 fps
Velocity Default = 0 fps

If the velocity falls below 0 20 fps the meter will store a value of 0 fps until the velocity increases above 0 20 fps

Example 2:
Velocity Cutoff = 0 20 fps
Velocity Default = 0 20 fps

If the velocity falls below 0 20 fps, the meter will store a value of 0 20 fps until the velocity increases above 0 20 fps

3.3 Starting and Stopping Programs

Note. When selecting START FROM BEGINNING, all logged data will be cleared from memory When saving the logged data, make sure the data is downloaded to a DTU or personal computer prior to pressing the START FROM BEGINNING soft key If a program is complete the logger can only be restarted from the beginning (and will clear all logged data)

When basic programming setup is completed, "run" (or execute) the program selections Press the RUN/STOP key to run a program resume a currently halted program, or stop a program

If a program has been halted (and no changes to the program settings were made while it was stopped) press the RUN key Select either resume to previously running program (and retain all logged data) or Start From Beginning (and clear all logged data)

Status	Description
Program Is Running	
	Data Logging 4–20 mA outputs sampler control and alarm checking are active
Program Is Halted	
	Logging stops until the program is restarted It continues with the last logged value when restarted
	4–20 mA outputs remain unchanged
	Sampler control is disabled
	Alarm checking is disabled
Program Is Complete or Ready to Start	
	No data logging
	4–20 mA outputs stay at last value
	No sampler interface
	No alarm checking
Program Complete	
	A logger has been off for longer than three hours

External Device Setup

After wiring the instrument and other devices and performing the basic programming setup program and, when necessary calibrate the devices For each sensor program, calibrate and install the sensors in a pipe Refer to the 980 Quick-Start Guides on page 149 for more information on programming and calibration The following external devices are explained in Section 4

- 4–20 mA Outputs (section 4 1)
- Analog Connection (section 4 2)
- Mechanical Totalizer (section 4 3)
- Alarm Relays (section 4 4)
- Rain Gauge (section 4 5)
- Sampler (section 4 6)
- RS232 (section 4 7)
- Modem Interface (section 4 8)
- pH Sensor (section 4 9)
- Downlook Ultrasonic Sensor (section 4 10)
- In-Pipe Ultrasonic Sensor (section 4 11)
- Velocity-Only Sensor (section 4 12)
- Submerged AV Sensor (section 4 13)

4.1 4–20 mA Output

4.1.1 Programming the 4–20 mA Output

Two 4–20 mA current loop outputs are available for the 980 Flow Meter These current outputs typically pace other process equipment such as a wastewater sampler in proportion to the flow rate

The dual isolated 4–20 mA current loop outputs on the 980 Flow Meter are unique they can be assigned to any of the available channels, not just flow In addition, the 4 mA and 20 mA current levels are programmed to any desired minimum and maximum value for that channel

Note. When the 4–20 mA outputs are disabled and not completely turned off, they will continue to output a steady 4 mA

1 From the Main Menu, select OPTIONS > ADVANCED OPTIONS > 4–20 mA OUTPUTS > SELECT
2 Enable the 4–20 mA outputs by pressing the CHANGE CHOICE soft key while in the 4-20 mA output menu
3 When the display shows the outputs as enabled press the ACCEPT soft key
4 Choose either OUTPUT A or OUTPUT B Use the up and down arrow keys to highlight the choice then press the SELECT soft key

11:00 AM 21 - APR - 01		4-20 mA OUTPUTS
SELECT	OUTPUT A	↑
	OUTPUT B	
RETURN		↓

5 Select an Input Channel (e g channel 1 2 3 or flow etc) to assign to that output Press the CHANGE CHOICE soft key to cycle through the channel names When the desired channel is displayed press the ACCEPT soft key to pick that channel

11:00 AM 21 - APR - 01		4-20 mA OUTPUTS
ACCEPT	INPUT CHANNEL	CHANGE CHOICE
	FLOW	
CANCEL		
	SELECT APPROPRIATE UNITS	

6 Assign a channel value to the 4 mA current value This value is typically 0 however any value can be set In other words enter the value of the input needed to generate 4 mA of current at the output

11:00 AM 21 - APR - 01		4-20 mA OUTPUTS
ACCEPT	4 mA INPUT VALUE	
CLEAR ENTRY	0 00 mgd	CANCEL
	SELECT APPROPRIATE UNITS	

7 Assign an input value to the 20 mA current level
8 Repeat this process to configure the other 4–20 mA output

4.1.2 Calibrating the 4–20 mA Output

After wiring the 4–20 mA connection perform a 4–20 mA output calibration The 4–20 mA output calibration requires a multimeter and an interface or access to the 4–20 mA current loop wiring Two 4–20 mA outputs are available and are designated Output A and Output B Both outputs are calibrated the same way and are isolated from each other

Calibration may be performed while the 4–20 mA device is in the current loop as shown in Figure 28 or disconnected from the current loop as shown in Figure 29 In either case the multimeter must be set to a 20 milliamp dc range or greater

1 From the Main Menu select OPTIONS > ADVANCED OPTIONS > CALIBRATION > 4–20 mA OUTPUTS
2 Connect a multimeter to the 4–20 mA current outputs per Figure 28 or Figure 29
3 Make sure that the 4–20 mA output is enabled If it is not enabled press the CHANGE CHOICE soft key so that the display shows ENABLED and press the ACCEPT soft key
4 Select the output (A or B) to calibrate
5 Press any key to set the selected output to 4 00 mA dc

6 Measure the current on the selected output using the multimeter and enter the measured value using the numeric keypad Press the **ACCEPT** soft key to proceed

7 Press any key to set the output to 20 00 mA dc

8 Measure the current on the selected output using the multimeter and enter the measured value using the numeric keypad Press the **ACCEPT** soft key to complete the calibration

By entering the measured current values the microprocessor will electronically adjust the outputs to compensate for the difference between the measured values and the expected values

Figure 28 Calibration with the Meter in the Loop

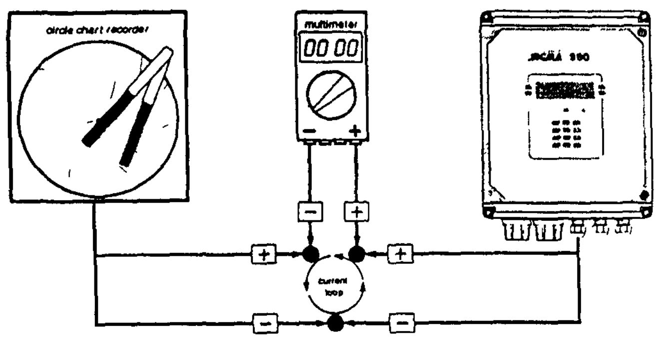
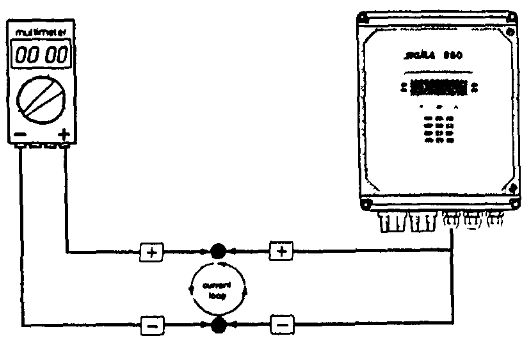


Figure 29 Calibration with the 4–20 mA Device Disconnected from the Loop



4.2 Analog Input

4.2 1 Programming the Analog Inputs

Channels 1 through 7 are analog input channels that can accept a signal from an external device This signal may range from 4 5 V dc (min) to +4 5 V dc (max) or from 4 to 20 mA dc depending on the input selected In some cases input signals from certain devices may also fall somewhere within those ranges For that reason each analog input channel must be mapped to the minimum and maximum signal limits of the external dev ce

To map an external device to an analog input channel

Select an analog input channel (1 2 and 3 are current nputs and 4 through 7 are voltage inputs)

Note If logging is enabled on any channel that channel will have an arrow in front of the channel name to signify that the channel is logged

1 Select **DATA LOG** from the Advanced Options menu

2 Highlight **SELECT INPUTS** using the up and down arrow soft keys and then press the **SELECT** soft key

3 Highlight the analog channel to log using the up and down arrow soft keys then press the **SELECT** soft key

4 Press the **CHANGE CHOICE** soft key to cycle between Logged" and Not Logged then press the **ACCEPT** soft key

5 Enter a Logging Interval

6 Select Unit of measurement (pH ft °C °F mV gal m^3 cf ltr in m cm $\%O_2$ 5 H_2S %lel V dc cfh ppm ppb afd cfs cfm cfd cms cmm cmh cmd gps gpm gph lps lpm lph or mgd)

7 Enter Low Point

8 Enter High Point

9 Select another channel to configure or press the **RETURN** soft key to back up one step or press the **MAIN MENU** function key to return to the Main Menu

Example
A dissolved oxygen meter has an analog output signal that will connect to the 980 Flow Meter analog input channel 4 The DO meter puts out an analog signal which ranges from +1 V dc to +3 V dc which is equivalent to 0 to 500 ppm The DO meter is connected to Channel 4 and logs readings from the DO meter occur once per minute

To configure data logging for this example follow the steps below

1 Select **DATA LOG** from the Advanced Options menu

2 Highlight **SELECT INPUTS** using the up and down arrow soft keys and then press the **SELECT** soft key

3 Highlight the analog channel to log (Channel 4) using the up and down arrow soft keys then press the **SELECT** soft key

4. Press the **CHANGE CHOICE** soft key to select "Logged" then press the **ACCEPT** soft key

5. Enter a 1-minute logging interval using the numeric keypad then press the **ACCEPT** soft key

6. Press the **CHANGE CHOICE** soft key to cycle through the units of measure until ppm is displayed Press the **ACCEPT** soft key

7. Apply a voltage to the desired analog input which corresponds to 0 ppm (or +1 V dc) Enter 0 ppm using the numeric keypad and then press the **ACCEPT** soft key

8. Apply a voltage to the same analog input that corresponds to 500 ppm or +3 V dc Enter 500 ppm using the numeric keypad and then press the **ACCEPT** soft key to complete the analog channel setup

4.3 Mechanical Totalizer

4.3.1 Programming the Mechanical Totalizer

The Mechanical Totalizer consists of two numeric counters that keep track of the total flow being measured The totalizers consist of a resettable totalizer and a non-resettable totalizer Both totalizers are set to zero upon program start

Scaling multipliers are provided to allow tailoring of the totalizer response to meet the requirements of the application. Some applications with high flow rates will require a high scaling factor, while low flow rates will require a low scaling factor.

The scaling factor is displayed whenever a total flow number is displayed As indicated in the Status Screen below, the total flow is displayed as "TOTAL (x1000). 465 gal" Multiplying the displayed total flow by the scaling factor (1000) gives an actual total flow of 465,000 gallons

11:00 AM 21 - APR - 01	STATUS SCREEN
LEVEL:	8.688 in.
FLOW:	71.39 mgd
TOTAL (X1000):	465 gal
pH.	7.2 pH
BATTERY:	16.9 volts
RUNNING	

1. From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > FLOW TOTALIZER** to display the Modify Setup, Reset, and View Total screen

4.3.1.1 Modify Setup

Modify Setup selects a totalizer scaling factor and a flow unit of measure

1. Highlight **MODIFY SETUP** using the up and down arrow soft keys

2 Press the **SELECT** soft key to continue

3 Set the Totalizer Scaling factor using the CHANGE CHOICE soft key All three totalizers are scaled with one of seven scaling factors X1, X10 X100 X1000 X10 000 X100,000 or X1 000 000 The selected scaling factor always applies to all totalizers Press the **CHANGE CHOICE** soft key to cycle through the available scaling choices

4 Press the **ACCEPT** soft key to continue

5 Set the Total Flow Units using the CHANGE CHOICE soft key to cycle through the choices Total Flow Units are independent of the flow units selected in the Setup Menu Flow units of measure include

- Acre-feet
- Liters
- Gallons
- Cubic Feet
- Cubic Meters

6. Press the **ACCEPT** soft key to continue

4.3.1.2 Reset (Totalizer)

Note: The mechanical totalizer cannot be reset manually

Note: If any type of condition occurs, both the resettable and the non-resettable totalizers are reset The resettable totalizer can be used to total flow over a finite period and can be reset as often as desired without affecting the other totalizers

The non-resettable totalizer will only be reset if one of the following conditions occur

- Change in totalizer scaling
- Change in primary device
- Change in totalizer units of measure
- Start of new program

1. Select **RESET** from the **TOTALIZER** menu A confirmation message will appear

2 Press the **YES** soft key to reset the totalizer or press the NO soft key to not reset the totalizer

To reset both software totalizers at once start a program with the **RUN/STOP** key

View Totals

To view the current totals of both the resettable and non resettable totalizers press **VIEW TOTALS** from the Totalizer menu Both totalizer values will appear

4.4 Alarm Relays

4.4.1 Programming the Alarm Relays

Alarms can be programmed to activate based on certain conditions (low battery low memory, etc) *Refer to 980 Alarms Flow Chart on page 152* When an alarm is tripped an action is initiated (report via modem dial a pager or set a relay) There are two types of alarms

- Trouble Alarms
- Set Point Alarms

4.4.1.1 Trouble Alarms

Trouble Alarms initiate an action when a trouble condition occurs For example a relay may close when the memory is full

Set Point Alarms look for trip points to be reached (either high or low or both) before initiating an action For example an initiated action may be the closing of a relay when the water level exceeds 24 in (60 cm) or drops below 4 in (10 cm)

1 From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > ALARMS**

2 Select an action to occur when the alarm is activated Table 26 shows each Trouble Condition and its cause

3 Enable one of the trouble conditions

Table 26 Trouble Alarms

Trouble Condition	Cause
Low Memory Battery	Internal memory battery voltage is too low Change batteries
U-Sonic Echo Loss (A pulse of sound was sent but no echo was received back)	The echo has been temporarily deflected by a change in site conditions such as floating debris or foam in the channel, wind etc
Transducer Ringing	Transducer is operating within the deadband
U-Sonic Failure	Transducer not plugged in Cable damaged Transducer thermal sensor damaged
Modem Failure	Unable to initialize modem
RS485 Timed Out	Problem with communications between the flow meter and a remote ultrasonic sensor May indicate open thermal sensor
Alarm Action(s)	
Set Relay #1	
Set Relay #2	
Set Relay #3	
Set Relay #4	
Report via Modem	

4.4.1.2 Set Point Alarms

Set Point Alarms activate when a user definable high and/or low set point is reached

1 Select an action to occur when the alarm is activated

2 Enable one of the alarm conditions

3 Set either a High trip point or a Low trip point

4 After entering the trip point enter the deadband value The deadband is the area between the alarm "turn on" and "turn off Refer to section on page 121

Set Point Alarm Conditions

- Level
- Flow Rate of Change
- Rainfall
- Temperature
- Flow
- pH
- Analog Channels 1-7
- Velocity

4.5 Rain Gauge

4 5.1 Programming the Rain Gauge

Note If logging is enabled on any channel that channel will have an arrow in front of the channel name to signify that the channel is logged

1 From the Main Menu Select **OPTIONS>ADVANCED OPTIONS>DATALOG**

2 Highlight **SELECT INPUTS** using the up and down arrow soft keys and then press the **SELECT** soft key

3 Highlight Rainfall using the up and down arrow soft keys then press the **SELECT** soft key

4 Press the **CHANGE CHOICE** soft key to cycle between Logged" and Not Logged" then press the **ACCEPT** soft key

5 Enter a logging interval using the numeric keypad then press the **ACCEPT** soft key Valid logging intervals are shown on the status bar along the bottom edge of the display

6 Select Rainfall Units (in or cm) Press the **ACCEPT soft key to continue**

7 Select another channel to configure press the **RETURN** soft key to back up one step or press the **MAIN MENU** function key to return to the Main Menu

4.6 Sampler

4.6.1 Programming a Sampler Connection

1. From the MAIN MENU, select **SETUP>MODIFY SELECTED ITEMS.**
2. Scroll down and highlight **SAMPLER PACING** using the up and down arrow soft keys. Press the **SELECT** soft key to continue
3. Enable Sampler pacing using the **CHANGE CHOICE** soft key Press the **ACCEPT** soft key to continue
4. Set the Sampler Pacing using the numeric keypad and Change Units using the **CHANGE UNITS** soft key.
5. Press the **ACCEPT** soft key

4.7 RS232

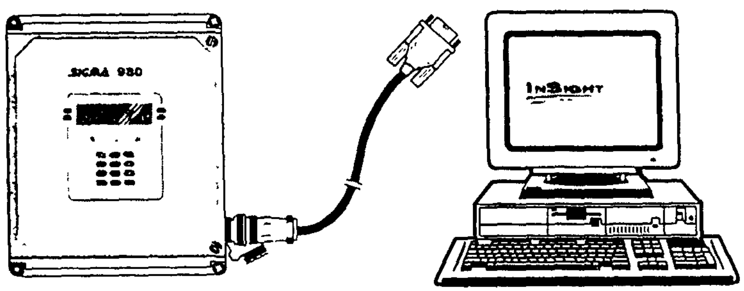
4.7.1 Programming the RS232

Note: Long runs of cable, especially if they are near large motors or fluorescent lights, can cause communication errors and may require a slower baud rate If errors develop at high baud rates, try lowering the baud rate one step at a time until error-free communications are achieved

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > RS232 SETUP**
2. Select a baud rate for data communications by pressing the **CHANGE CHOICE** soft key to cycle through the possible choices, 1200, 2400, 4800, 9600, or 19,200 baud The higher the baud rate setting, the faster data will transfer. Set the baud rate to the highest setting allowed by the computer. Press the **ACCEPT** soft key

The cable connection is shown in Figure 30

Figure 30 PC to Flow Meter Cable Connection



4.8 Modem Interface

4.8.1 Programming the Modem

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > MODEM POWER**
2. To enable the modem power, press the **CHANGE CHOICE** key until "ENABLED" shows up in the center of the display Press the **ACCEPT** soft key to continue

11:00 AM 21 - APR - 01		MODEM SETUP
ACCEPT	MODEM POWER: ENABLED	CHANGE CHOICE
RETURN		
	CHOICES: ENABLED, DISABLED	

3. Set the dial method, Tone or Pulse using the **CHANGE CHOICE** soft key Press the **ACCEPT** soft key to continue
4. Enter the phone number of the PC that the unit will call if alarms are enabled, using the numeric keypad Press the **ACCEPT** soft key to continue
5. Enable or Disable the Pager Option using the **CHANGE CHOICE** soft key Press the **ACCEPT** key to continue
6. Enter the Pager Service Number using the numeric keypad Press **ACCEPT** to continue
7. Enter the amount of pagers Press **ACCEPT** to continue
8. Enter up to three pager numbers Press **ACCEPT** to continue
9. *Set the Reporting Order (Modem only, pager only, pager then modem* modem then pager), using the **CHANGE CHOICE** soft key
10. Press the **ACCEPT** soft key to finish

Modem power must be enabled and the unit must be in running mode before the meter can answer calls from InSight, InSight® Gold or VISION software to download data, access remote program etc

4.9 pH Sensor

pH sensor function degrades over time, even under ideal conditions and therefore require periodic replacement The pre-amplifier junction box is provided to allow for fast easy replacement of the pH sensor For extra strain relief the pH cable that leads to the instrument should pass through the water tight strain relief adapter

Since the pH reading must be compensated for temperature variations a temperature sensor is built into every pH electrode After installation the pH sensor must be programmed and calibrated

4.9.1 Programming the pH Sensor

Note. If logging is enabled on any channel, an arrow in front of the channel name will appear to signify that the channel is logged

1 From the Main Menu Select **OPTIONS>ADVANCED OPTIONS>DATALOG**

2 Highlight **SELECT INPUTS** using the up and down arrow soft keys and then press the **SELECT** soft key

3 Highlight pH / mV using the up and down arrow soft keys then press the **SELECT** soft key

4 Select pH in the Item to Edit menu using the pH soft key

5 Press the **CHANGE CHOICE** soft key to cycle between "Logged" and "Not Logged", then press the **ACCEPT** soft key

6 Enter a logging interval using the numeric keypad, then press the **ACCEPT** soft key Valid logging intervals are shown on the status bar along the bottom edge of the display

7 Select another channel to configure or press the **RETURN** soft key to back up one step or press the **MAIN MENU** function key to return to the Main Menu

4.9.2 Calibrating the pH Sensor

Once the pH sensor is wired and programmed, calibrate the pH sensor Calibrating the pH sensor requires a thermometer and any two of the following buffer solutions 4, 7, or 10 pH

The pH probe is an application sensitive device When used in harsh environments, the accuracy and life expectancy of pH probes can decrease considerably

Probes must be calibrated to the flow meter each time they are cleaned or replaced Regular inspection and comparison to a hand-held pH meter can help determine the optimum cleaning and calibration schedule for your application

Note Before calibrating the pH probe make certain the probe and buffers are at ambient temperature

1 From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > CALIBRATION > pH**

2 Place the pH probe into the first buffer solution then press any key to continue

3 Enter the temperature of the first buffer solution using the numeric keypad Press the **ACCEPT** soft key to continue

4 Select the pH for the first buffer solution (4 7 or 10 pH) using the **CHANGE CHOICE** soft key then press the **ACCEPT** soft key to continue

5 Remove the probe from the first buffer solution rinse it under distilled water and place it into the second buffer solution (4 7 or 10 pH different from the first buffer used) Press any key to continue

6 Select the pH for the second buffer solution using the **CHANGE CHOICE** soft key then press the **ACCEPT** soft key to continue If the pH probe is damaged and cannot be calibrated or if the buffer solutions do not fall within an acceptable range an error message will be displayed as shown below

11:00 AM 21 - APR - 01	ERROR MESSAGE
pH CALIBRATION FAILED GAIN AND/OR OFFSET OUT OF RANGE TRY AGAIN (PRESS ANY KEY TO CONTINUE)	

Another attempt at reading the second buffer solution will be made after pressing a key If this fails it is likely that you have a bad pH probe or bad buffer solutions Try a new set of buffer solutions and if that fails try a different pH probe

4.10 Downlook Ultrasonic Sensor

Downlook ultrasonic level sensors are available with different beam angles and deadbands The 980 Flow Meter uses a 75 kHz Downlook Ultrasonic Sensor See Figure 31

The ultrasonic transducer is mounted over the flow stream at the proper location for head measurement To determine the proper location for head measurement refer to Working with Primary Devices on page 109 The transducer emits a pulse of sound at a high frequency and awaits for the echo to return from the surface of the water The time it takes for this echo to return is directly related to the distance between the transducer and the surface water As the level in the flow stream increases the time it takes for the echo to return to the transducer decreases (distance is shorter)

By continuously transmitting these pulses and timing the returning echoes the sensor measures the level of the liquid on the flow stream After measuring the level the microprocessor converts the level reading to a flow rate based on the user defined characteristics of the primary device

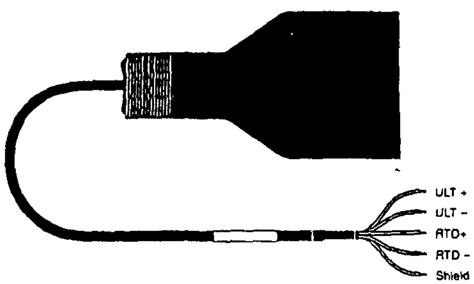
4.10.1 Installing an Ultrasonic Sensor (Downlook) at a Primary Device

Note. Do not suspend the sensor by the cable. Only use appropriate mounting hardware.

Site selection can greatly enhance system performance. Several important factors should be considered when installing the ultrasonic sensor at any primary device. Refer to Appendix A for more information on primary devices.

- Locate the ultrasonic sensor at the proper head measurement point for that primary device.
- Determine the appropriate sensor height. Refer to Figure 33 on page 80.
- Suspend the ultrasonic sensor over the center of the flow stream where there is the least surface turbulence.
- Mount the sensor to a stable, secure location, isolated from vibration.

Figure 31 Ultrasonic Sensor (Downlook)



4.10.1.1 Choosing the Appropriate Sensor Height (Ultrasonic "Downlook" Sensor)

The beam angle is half the band width at -10 dB. The beam angle from the bottom of the ultrasonic sensor spreads out at an angle of 12° for the 75 kHz sensor as it travels away from the sensor. Therefore, if you mount the sensor too high above a narrow channel, the beam may be wider than the channel when it reaches it. This can cause false echoes from the tops of the channel walls rather than from the water surface. To prevent false echoes, determine the appropriate sensor height so that the entire beam falls within the channel and does not strike any obstructions.

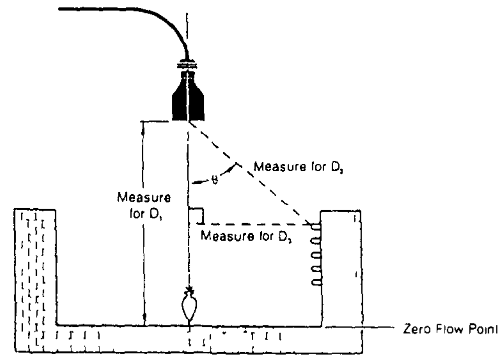
To determine the appropriate sensor mounting height:

1. Take the measurements described in Figure 32.
2. Calculate the angle of obstruction from the axis.

$$\theta = \arcsin\left(\frac{D_3}{D_2}\right) \approx \frac{57.3\,D_3}{D_2}$$ is accurate within one degree

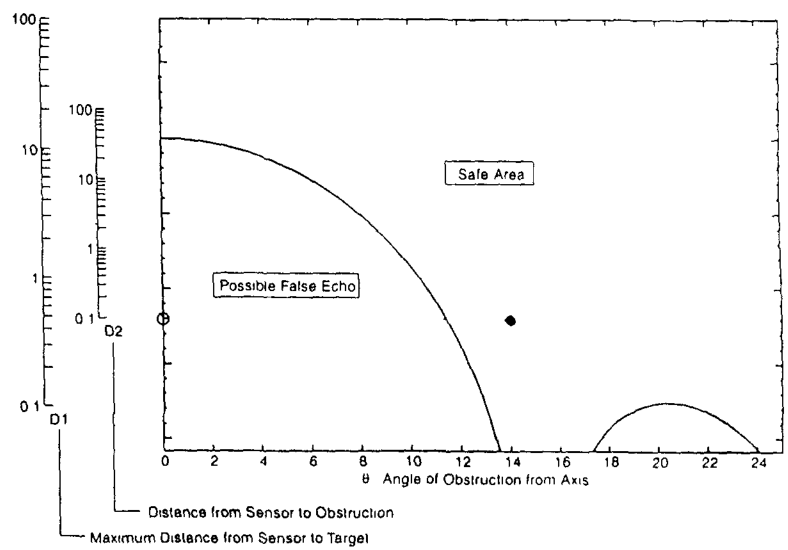
3. Plot the measurements on the graph in Figure 33 to determine if the beam width falls within the possible false echo or safe area.

Figure 32 Ultrasonic Sensor Beam Angle



This drawing is not to scale

Figure 33 Choosing the Appropriate Sensor Height



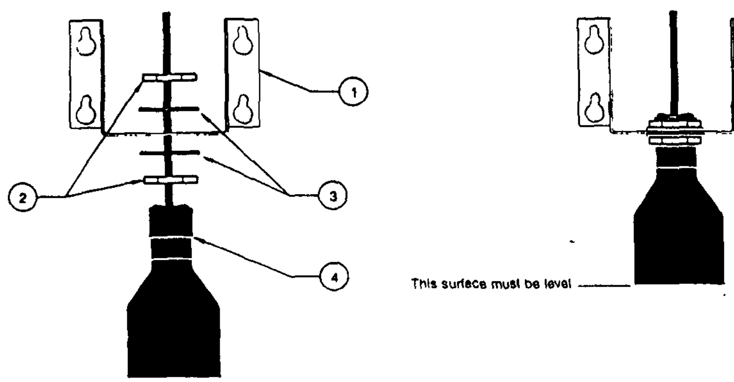
4.10.1.2 Mounting the Ultrasonic Sensor

Note: To prevent mechanical vibration ensure that the supplied isolation washers are installed as shown in Figure 34

Several brackets are available for mounting the sensor to a fixed location such as a wall or floor. See Figure 34 and Figure 35 For mounting options see Parts and Accessories on page 157. Each bracket utilizes the ¾ in (1.9 cm) NPT connector on the sensor to secure the sensor to the bracket. Always level the sensor using a level. The maximum water level must be below the deadband to ensure accurate readings

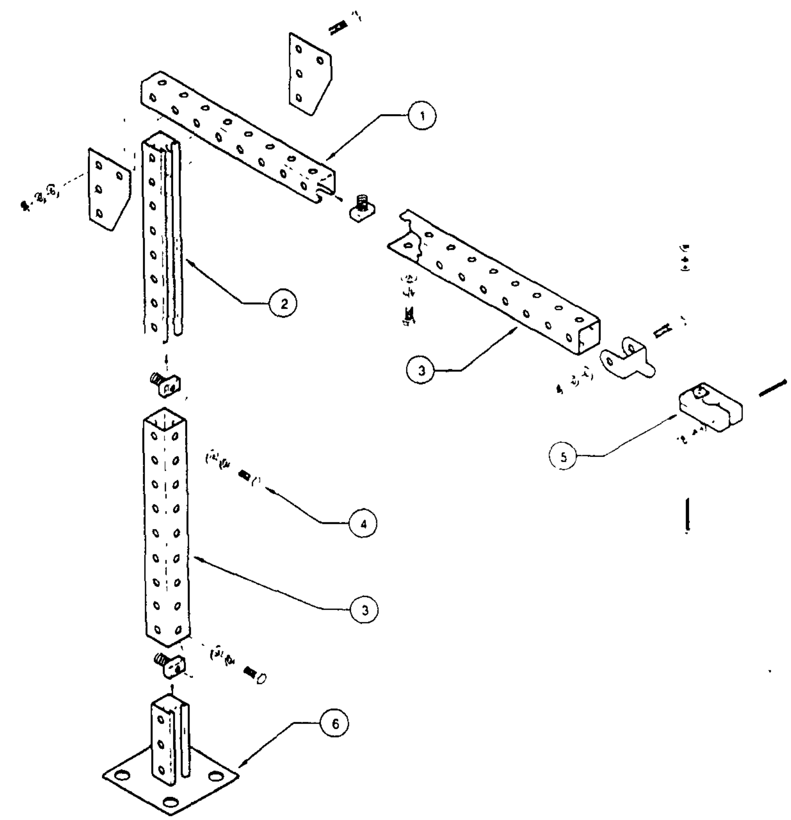
The sensor is "blind" to anything closer than the deadband and will stop reading level when the distance is shorter than that.

Figure 34 Bracket and Isolation Washers



1. Wall/Rail Mount Bracket (Cat No 2974)	3. Isolation Washers (Cat No 6620)
2. 1 inch x 0 25 Hex Nuts (Cat No 1429)	4. Ultrasonic Sensor

Figure 35 Assembling the Mounting Bracket (Cat. No. 2904)



1. 14 75 inches (Cat No 3047)	4. Horizontal and vertical sections are fully adjustable*
2. 15 25 inches (Cat No 3046)	5 Sensor Mounting Clamp
3. 16 625 inches (2) (Cat No 3048)	6 5 5 inches tall (Cat No 3108)

* Loosen the bolt, slide the section to the desired distance and re-tighten the bolt
Sensor Mounting Clamp (with built-in bubble level) Sensor adjusts to any required level

4.10 2 Ultrasonic Senor (Downlook) Installation Troubleshooting

Convection Currents
Convection components between the sensor and target will change the velocity of sound If these conditions are present install a shield around the sound beam to eliminate temperature variation due to convection currents The system is designed with averaging routines to help mitigate this problem

The acoustical impedance of foam and oil is low relative to air While the 980 is designed with an AGC (Automatic Gain Control) scheme to reduce these factors it is recommended that sites without these anomalies be selected

Obstructions
Through the use of an Invisible Range the 980 Flow Meter can select targets beyond peripheral obstructions In establishing this exclusion zone care must be taken to set the exclusion zone higher than the maximum expected level

Echo Loss
It is normal to report some temporary echo loss due to environmental effects mentioned above The 980 will determine if the sound intensity is below recommended values and automatically initiate subsequent measurements to *provide an accurate reading If echo loss events are in excess of two per hour* site conditions should be reexamined for convection currents caused by sunlight or thermal gradients at the water ambient interface Foam on the liquid s surface may also cause echo loss

Transducer Ringing
Ringing can occur if the transducer is operating within the deadband Transducer ringing means that the transducer may not have finished transmitting a pulse of sound when the echo returned Sufficient distance between the sensor and the target will eliminate transducer ringing

Problem/Error Message	**Possible Causes and Solutions**
Ultrasonic Failure (No signal from sensor)	*Check the connection between the flow meter and the sensor*
	Check the sensor cable The cable may be cut or broken
	Recalibrate the sensor Look for unusual temperature or the inability for a new calibrated level to be read
	Try a different sensor on the same flow meter to rule out instrument problems and try a different flow meter with the same sensor to rule out sensor problems
Echo Loss (Flow meter is not getting a return signal from the sensor)	Check for excessive foam on the water surface Foam may cause sound waves to be absorbed rather than reflected
	Check the sensor cable for cuts or nicks
	Check the connection between the flow meter and the sensor
	Make sure that the sensor is level The sensor must be level for proper return of the signal
	Try shielding the transducer from convection currents
	Repeat the temperature calibration procedure If the unit reads extreme high or low *temperatures the sensor may have a bad temperature sensor*
	Try a different sensor on the same flow meter to rule out instrument problems and try a different flow meter with the same sensor to rule out sensor problems

Problem/Error Message	Possible Causes and Solutions
Transducer Ringing (False return echoes mask "real" echoes)	*Try moving the transducer farther from the liquid*
	Check the area under the transducer for obstructions This includes the areas in front and to the sides of the transducer
	Check the face of the transducer for a coating This is rare but cleaning the transducer face may correct the problem If this is a constant problem due to site conditions coat the face of the sensor with a thin film of silicone grease to keep debris from clinging
	Make sure that you are using the proper rubber isolation washers on the mounting bracket *The transducer can resonate against steel mounting rails See Mounting the Ultrasonic* Sensor on page 81
RS485 Time Out (Flow meter did not receive data within the specified time)	If the CPU is having trouble communicating with the velocity board RS485 time outs may occur Wait a few minutes and see if it goes away If it continues a problem with the ultrasonic velocity or CPU board may exist
	May be caused by difficulty getting a good velocity reading If the logging interval is 1 or 2 minutes conditions are poor and the problem continues indefinitely try increasing the logging interval to capture more signals
	This condition may occur occasionally When using a combination of area velocity and ultrasonic sensors this condition may occur more frequently if site conditions are less than ideal This is not necessarily an indication of a defective sensor
	Check to see if wires were shorted Check the RS485 fuse

4 10 3 Programming the Downlook Ultrasonic Sensor

The downlook ultrasonic sensor does not require specific programming unless more than one sensor option is connected to the 980 Flow Meter

When more than one sensor option is connected to the 980 Flow Meter

1 From the Main Menu select **OPTIONS > LEVEL SENSOR**

2 Select Ultra Sonic Sensor using the **CHANGE CHOICE** soft key then press the **ACCEPT** soft key

4 10 4 Calibrating the Downlook Ultrasonic Sensor

Calibrate the current water level via one of two methods Liquid Depth or Sensor Height An Invisible Range can also be set which allows the transducer to ignore reflections from obstructions between the sensor and the water surface such as ladder rungs channel side walls etc Each method has its own advantages and disadvantages selecting the proper method will depend upon the site conditions Calibrate the ultrasonic sensor each time the sensor is installed at a new site

4 10 4 1 Liquid Depth

This method requires the head" or depth of liquid in the channel that is *contributing to flow In a round pipe* the entire depth typically contributes to flow In a weir only the depth that is flow over the weir plate contributes to flow Many flumes have specific requirements refer to Working with Primary Devices on page 109 Level Depth calibration s primarily is used when

- Access is available to the primary dev ce for a phys cal measurement of the liquid depth and
- When water is flowing during installation of the 980 Flow Meter (channel is not dry)

Note: Always re-check the Level Adjust when re-installing the flow meter

1 From the Main Menu, select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR**

2 Select Calibrate U-Sonic using the up and down arrow soft keys Press the **SELECT** soft key

3 Select Standard as the type of Ultrasonic Transducer using the **CHANGE CHOICE** soft key Press the **ACCEPT** soft key to continue

Temperature Time Constant
The speed of sound in air varies with the temperature of the air The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions The transducer must be equal to the ambient air temperature at the site prior to calibration for optimum results The manufacturer also recommends that sensors be shielded from direct sunlight for this reason

4 Enter the ambient air temperature at the transducer location For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature Press the **ACCEPT** soft key to continue

5 Select the Liquid Depth method and enter the new level

6 Take a physical measurement of the liquid depth (head) and enter the value

7 Press the **ACCEPT** soft key when finished

4.10.4.2 Sensor Height

This method requires you to enter the distance between the face of the ultrasonic sensor and the zero flow point in the primary device The zero flow point in a primary device is the level at which flow ceases In a round pipe the zero flow point would typically be the invert or bottom of the pipe In a V notch weir the zero flow point occurs when the liquid behind the weir is level with the bottom of the 'V' (There would still be liquid behind the weir plate but it would not be contributing to flow) Sensor Height calibration is generally used when

- Access to the primary device is difficult (such as confined space entry in a manhole) or
- There is no liquid flowing during installation of the flow meter

1 From the Main Menu, select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR**

2 Select Calibrate U-Sonic using the up and down arrow soft keys Press the **SELECT** soft key

3 Select Standard as the type of Ultrasonic Transducer using the **CHANGE CHOICE** soft key Press the **ACCEPT** soft key to continue

The speed of sound in air varies with the temperature of the air The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions

4 Enter the ambient air temperature at the transducer location For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature Press the **ACCEPT** soft key to continue

5 Select the Sensor Height method and enter the new level

6 Enter the distance from the face of the transducer to the zero flow point of the primary device

7 Press the **ACCEPT** soft key when finished

4 10 4 3 Setting the Invisible Range

The 980 Flow Meter is equipped with an Invisible Range feature (adjustable deadband) to prevent false echoes from tops of channel walls ladder rungs shelves, etc Refer to Figure 36 A user selected range is defined which is invisible to the flow meter Extend the invisible range to where it meets or overlaps the highest expected level in the channel A gap of at least 2 in (5 cm) should be left between the invisible range and the highest expected level Only objects beyond the invisible range can be detected

1 From the Main Menu select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR**

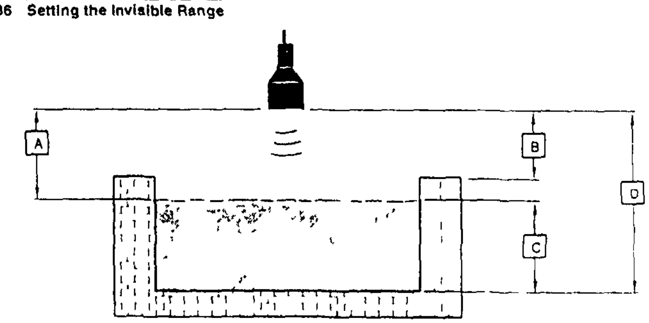
2 Select the Invisible Range option using the up and down arrow soft keys Press **SELECT** to continue

3 Enter the Distance to End of the Invisible Range using the numeric keypad

4 Select either inches or centimeters using the **CHANGE UNITS** soft key The distance must be greater than the minimum deadband of 11 5 in (29 cm) for the 75 kHz transducer Refer to Figure 36

5 Press ACCEPT soft key when finished

Figure 36 Setting the Invisible Range



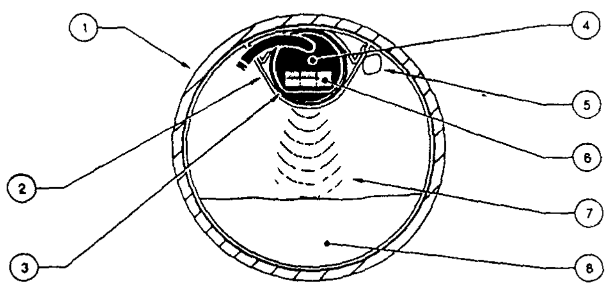
A Minimum Distance (must be at least 11 inches (29 cm)	**C** Highest expected water level
B Invisible Range (set to ignore tops of channel walls)	**D** Maximum Range

4.11 In-Pipe Ultrasonic Sensor

4 11 1 Mounting the In-Pipe Sensor

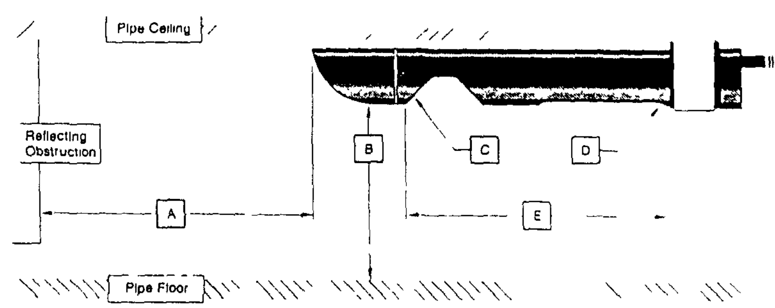
- **Mount the sensor** over the center of the flow stream where the surface turbulence is minimized (Figure 37)
- **Mount the sensor** 2 m (82 in) away from obstructions located in front of the in pipe senor to prevent inaccurate liquid level readings (Figure 38)
- **Level the sensor** using the built in bubble level
- **Ensure the isolation** gasket is in place and the mounting bracket **thumbscrews are** finger tight to avoid sensor ringing
- **Install the sensor** within 4 12 m (13 5 ft) of the lowest expected level (the **maximum range** of the sensor) The intensity of the echo decreases with distance at a maximum of 1 31 dB/m (0 4 dB/ft)

Figure 37 End View of In-Pipe



1	Pipe (size may vary)	5	Bracket Thumbscrew (3 17 cm (1 25 in) long)
2	Mounting Clip	6	Bubble Level
3	Vibration Isolation Gasket	7	Sound Waves
4	Sensor	8	Flow

Figure 38 Side View of In-Pipe



A	Minimum distance to reflecting obstruction (2 m (82 in))	D	Ultrasonic Sensor
B	Distance from Sensor (Range 1 6 cm (0 64 in) to 4 11 m (13 5 ft))	E	Internal Deadband (18 21 cm (7 17 inches))
C	45° Deflector		

4.11 2 Beam Angle

The narrow beam of sound that emanates from the bottom of the in pipe ultrasonic sensor spreads out at an angle of ±12° (10 dB) as it travels away from the sensor This means that if the sensor is mounted too high above a narrow channel the beam may be too wide when it reaches the bottom of the channel This may cause false echoes from the sides on the channel walls

4 11 3 Programming the In-Pipe Ultrasonic Sensor

The in pipe ultrasonic sensor does not require operator programming unless more than one sensor option is connected to the 980 Flow Meter When more than one sensor option is connected

1 From the Main Menu select OPTIONS > LEVEL SENSOR

2 Select Ultra Sonic Sensor using the CHANGE CHOICE soft key then press the ACCEPT soft key

4 11 4 Calibrating the In-Pipe Ultrasonic Sensor

Calibrate the in pipe sensor each time the sensor is installed at a new site Calibrate the in pipe via one of two methods Liquid Depth or Sensor Height Each method has its own advantages and disadvantages Liquid Depth calibration is the recommended calibration method use the sensor height method only when Liquid Depth calibration is not an option An Invisible Range can also be set which allows the transducer to ignore reflections from obstructions between the sensor and the water surface such as ladder rungs channel side walls etc

1 From the Main Menu select OPTIONS > ADVANCED OPTIONS

2 Highlight **Calibration**, using the up and down arrow soft keys Press the **SELECT** soft key to continue

3. Highlight **Ultra-Sonic Sensor**, using the up and down arrow soft keys Press the **SELECT** soft key to continue

4 Highlight Calibrate U-Sonic Sensor and press the **SELECT** soft key

5. Select the type of ultrasonic transducer (In-Pipe), using the **CHANGE CHOICE** soft key

6 Press the **ACCEPT** soft key

7. Enter the ambient air temperature at the transducer location For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature

The speed of sound in air varies with the temperature of the air The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions

8 Press the **ACCEPT** soft key to continue

4.11.4.1 Liquid Depth

Liquid depth requires knowing the level or depth of the liquid in the channel that is contributing to flow Liquid depth calibration is the recommended calibration method for the in-pipe ultrasonic sensor

Continue from Step 8, above

1 Select the Liquid Depth method

2. Take a physical measurement of the liquid depth (head) and enter the value

3 Press the **ACCEPT** soft key when finished

4.11.4.2 Sensor Height

Sensor height calibration is generally used when access to the primary device is difficult (such as confined space entry in a manhole) or when there is no liquid flowing during installation of the flow meter This calibration method requires compensation for the internal deadband in the sensor housing Measurement uncertainty increases to 0 85 m (0.028 ft) for a 60 cm (2 ft) change in level from the calibration point Use this method only if the Liquid Depth method is not an option

Continue from Step 8, above

1 Measure the distance from the bottom of the sensor to the zero flow point Add 18 2 cm (7.17 in) to the measured distance to obtain the total zero flow distance for the in-pipe sensor Refer to Manual Figure Side View of In-Pipe on page 4 of this change notice

2. Select the **Sensor Height** calibration method and enter the total zero flow distance from Step 1

3. Press the **ACCEPT** soft key when finished

4.11.4.3 Setting the Invisible Range

The 980 Flow Meter is equipped with an invisible range feature to prevent false echoes from tops of channel walls ladder rungs shelves etc A user selected range is defined that is invisible to the flow meter Extend the invisible range to where it meets or overlaps the highest expected level in the channel Have a gap of at least 2 in (5 cm) between the invisible range and the highest expected level Only objects beyond the invisible range can be detected

Note. When programming the invisible range 18 21 cm (7 17 in) must be added to the desired range to compensate for the internal deadband distance between the sensor the reflector and the bottom of the sensor housing See Manual Figure Side View of In-Pipe on page 4 of this change notice

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS> CALIBRATION> ULTRASONIC SENSOR**

2. Select the Invisible Range option using the up and down arrow soft keys Press **SELECT** to continue

3. Enter the Distance to End of the Invisible Range using the numeric keypad

4 Select either inches or centimeters using the **CHANGE UNITS** soft key Press the **ACCEPT** soft key when finished

4.11.5 Protecting the In-Pipe Ultrasonic Sensor

Keep the sensor and the reflector free of grease and dirt Since the logger listens" for the relatively faint sound of the returning echo a heavy coated sensor will not be able to detect the echo well and may not provide accurate level measurement

4.11.6 In-Pipe Ultrasonic Sensor Troubleshooting

During surcharged conditions the ultrasonic level will give random depth readings that will need to be edited in the application software

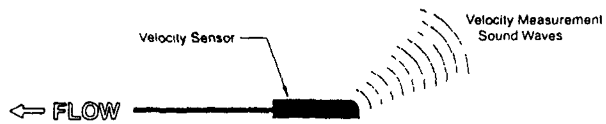
Symptoms of this hydraulic condition occur when the level appears erratic within 5 7 cm (2 25 in) of the pipe diameter The readings will first appear to flat-line Then the erratic readings (that in some cases exceed the pipe diameter) will occur

If the hydraulics are frequently in surcharge conditions use a submerged level sensor instead of an in-pipe ultrasonic sensor

4.12 Velocity-Only Sensor

The Velocity-Only Sensor is an extremely low profile velocity sensor It does not measure level The streamlined shape of the water probe allows velocity measurement in very low-flow conditions When used in conjunction with a level sensor (such as the Zero Deadband Ultrasonic Level Sensor) the meter can calculate flow Refer to Figure 39

Figure 39 Velocity-Only Sensor



4.12.1 Programming the Velocity-Only Sensor

1. From the **MAIN MENU**, select **SETUP>MODIFY SELECTED ITEMS**
2. Highlight Velocity Direction using the up and down arrow soft keys Press the **SELECT** soft key to continue
3. Set the velocity direction (upstream, downstream, or always positive) using the **CHANGE CHOICE** soft key Refer to Compensating for Velocity Direction on page 94 for more information on velocity direction
4. Press the **ACCEPT** soft key to continue
5. Highlight Velocity Units using the up and down arrow soft keys Press the **SELECT** soft key to continue
6. Set the Velocity Units (fps or m/s), using the up and down arrow soft keys Press the **ACCEPT** soft key to continue
7. Highlight Velocity Cutoff, using the up and down arrow soft keys Press **SELECT** to continue
8. Read the Velocity Cutoff information screen Press any key to continue
9. Set the Velocity Cutoff using the numeric keypad Press **ACCEPT** soft key to continue
10. Set the Velocity Default, using the numeric keypad Press the **ACCEPT** soft key Press the **RETURN** soft key to go back to the Setup Menu or the Main Menu key to return to the beginning

4.12.2 Calibrating the Velocity-Only Sensor

No calibration is required for the velocity sensor The transmit frequency is fixed with a highly accurate quartz crystal-controlled frequency generator that cannot be adjusted

4.12.3 Installing the Velocity-Only Sensor in a Pipe

4.12 3 1 Important Guidelines for Velocity-Only Sensor Installation

- Do not install more than one probe at a time in pipes less than 24 inches in diameter (61 cm) Multiple probes in smaller pipes can create turbulent or accelerated flows near the probes that may cause inaccurate measurements
- Mount the sensor as close as possible to the bottom of the pipe invert to most accurately measure low velocity levels
- Locate monitoring sites as far from inflow junctions as possible to avoid interference caused by combined flows
- Avoid any sites that contain flow obstacles within 2 to 4 pipe diameters in front of the probe installation (rocks stones pipe joints valve stems etc) as these will contribute to turbulence and generate high speed flows in the immediate vicinity of the obstruction
- Avoid any sites with slow moving flows that will encourage the buildup of silt in the invert or channel Excessive silting around the probe may inhibit the Doppler signal and decrease sensor accuracy and may affect depth measurement accuracy
- Avoid sites with deep rapid flows that will make it physically difficult or dangerous to install the probe
- Avoid sites with high velocity low depth flows Splash over and excessive turbulence will be present around the probe and data may be inaccurate

4 12 3 2 Choosing a Mounting Band

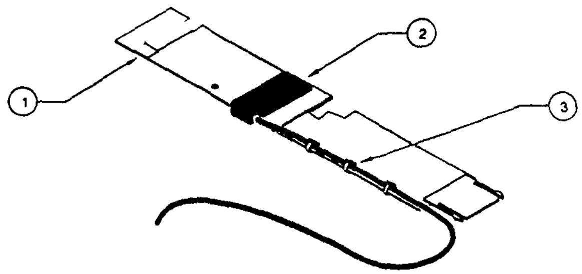
Mounting bands and rings for depth/velocity and velocity sensors are listed in Parts and Accessories on page 157 A complete mounting band assembly for pipe sizes less than 12 ft also requires one Depth/Velocity Sensor Mounting Clip (Cat No 3263) and one Scissors Jack Assembly (for band set only) (Cat No 1533)

4 12 3 3 Connecting the Sensor to the Mounting Bands

Note If there is a large amount of silt in the bottom of the pipe rotate the band until the sensor is out of the silt (Figure 41) assuring that the sensor remains below the minimum expected water level at all times Silt should not be disturbed and must be measured frequently if entered into InSight® Gold software A Level Adjust is required to offset level sensors

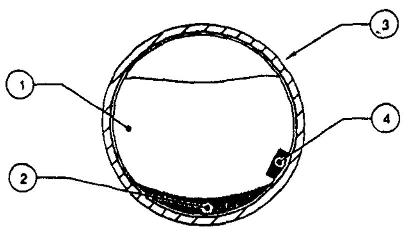
1. Attach the sensor to the sensor mounting clip using the two screws provided See Figure 40
2. Attach the clip to the mounting band Mounting Rings come with pre drilled holes for direct mounting of the sensor to the ring
3. To reduce the likelihood of debris collecting on the cable and mounting band, route the cable along the edge of the band and fasten the cable to the mounting band with nylon wire ties See Figure 40 The cable should exit the tied area at or near the top of the pipe to keep it out of the flow stream

Figure 40 Attaching the Sensor Mounting Band



1 Receptacle for Spring Clip	2 Velocity Sensor	3 Nylon Wire Ties

Figure 41 Avoiding Silt when Mounting the Sensor



1. Water	2 Silt	3 Pipe	4 Sensor

4.12.3.4 Compensating for Velocity Direction

When programming the velocity sensors you may select one of three Velocity Direction options and the velocity cutoff/velocity default

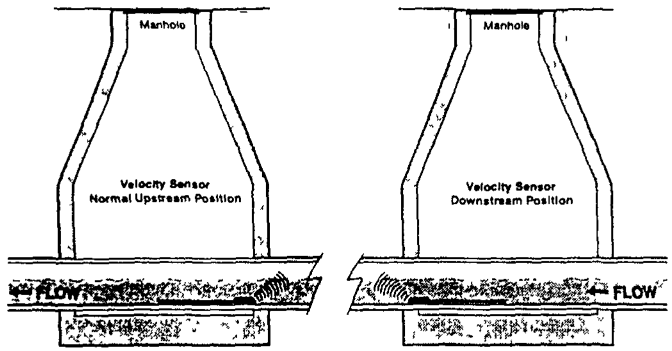
Direction	Description
Upstream	Use this option at sites with fairly consistent velocities and low to medium turbulence The flow stream over the sensor should be relatively straight with no drops or turns near the measurement point
	Mount the sensor in the pipe beveled edge facing into the flow where the flow stream enters the measurement area (See Figure 42)
Downstream	Use this option when the sensor is installed downstream of the measurement point (where the flow stream exits the site) This option is useful when more than one flow stream enters a site and the combined flow of all streams at a single exit point is measured
	Mount the sensor in the downstream direction rather than the typical upstream direction Mounting the sensor backwards in this manner (see Figure 42) causes the velocity direction readings to be the opposite of actual stream flow By selecting the Downstream choice when programming the logger reverses the measured signal to show actual flow direction (beveled edge downstream) *Note The maximum velocity obtained in this type of installation is 5 fps*
Always Positive	Extremely turbulent conditions can make it difficult to detect the flow direction Particles in the flow stream (particularly near the surface of the stream) may travel in several different directions even though most of the flow is moving in one general direction Although the velocity magnitude is generally consistent in these cases reflections from the particles moving in a positive direction (same direction as the flow stream) are so mixed up with those from particles moving in a negative direction (opposite direction as flow stream) that determining actual direction is difficult
	The Always Positive option logs all readings as positive regardless of the measured signal direction Do not select this option at sites where negative flows normally occur such as tidal effects on ocean outfalls
Velocity Cutoff/ Velocity Default	The Velocity Cutoff option compensates for problems encountered at sites with very low velocities and extremely clean water Flow is difficult to measure in these conditions because clean water contains very few reflecting particles and extremely low velocities lack the turbulence to add air bubbles (which also make good reflecting targets) to the flow stream
	The Velocity Cutoff allows you to enter a default velocity value that s used when the Velocity Cutoff set point is reached rather than report erratic velocities

4.12.3.5 Placing the Sensor and Mounting Band into the Pipe

Point the front of the sensor (the side opposite the cable entrance) into the flow See Figure 42

Slide the mounting band as far into the pipe as possible to eliminate drawdown effects near the end of the pipe Locate the sensor at the bottom most point, in the channel If excessive silt is present on the bottom of the pipe, rotate the band in the pipe until the sensor is out of the silt

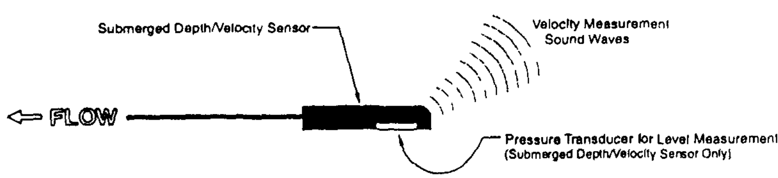
Figure 42 Placing the Sensor Into the Flow



4.13 Submerged Area Velocity Sensors

Submerged Area Velocity sensors can measure level and velocity simultaneously A submerged pressure transducer measures level Velocity is measured with sound waves using the Doppler principle Refer to Figure 43

Figure 43 Submerged Area Velocity Sensor



4.13.1 Programming the Submerged Area/Velocity Sensor

1 From the Main Menu select **OPTIONS > LEVEL SENSOR**

2 Select Submerged Xducer using the **CHANGE CHOICE** soft key then press the **ACCEPT** soft key

3 Follow Steps1-11 in section 4 12 1 on page 91

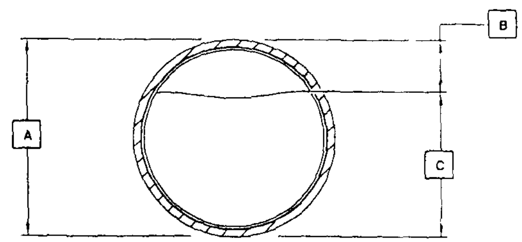
Setting the Water Level

1 Take a physical measurement of the water level and enter the number using the Level Adjust function on the instrument display

2 Measure from the surface water to the top of the pipe (B in Figure 44) then subtract this from the pipe diameter (A in Figure 44) to get the water level in the pipe (C in Figure 44)

3 This method prevents disturbances to the flow stream that might affect the measurement and keeps the tape measure or ruler clean

Figure 44 Measuring the Water Level



4.13 2 Calibrating the Submerged Area/Velocity Sensor

Calibrating the submerged area/velocity sensor synchronizes the meter electronics with the unique characteristics of each individual probe In addition the calibration compensates for a drift in the output of the sensor that may occur as the materials in the sensor age To ensure optimum accuracy the manufacturer recommends calibrating the submerged area/velocity sensor when

- The sensor is first used
- Installing a new or different sensor on a flow meter or input receptacle
- The difference between the level reading of the flow meter and the independent verification (measurement with a dipstick and ruler) is increasing

Note The data is constant if the difference between the level reading of the flow meter and the independent verification is constant recalibration is not required

Note Errors can occur with the level reading of the flow meter and the independent verification Errors are caused by variation in site conditions and measurement abilities These errors may cause slight variations in the difference therefore not indicating a true change in the difference

This calibration requires a bucket with at least 7 in (20 cm) of water and a ruler

1 From the Main Menu select **OPTIONS > ADVANCED OPTIONS > CALIBRATION > SUBMERGED PROBE**

2 Place the sensor flat on a table top or floor with the sensor (the plate with holes) facing down onto the surface (Figure 45)

3 Press any key

4 Place the sensor face up in the bucket or liquid Tap lightly to remove air bubbles If these bubbles are not removed you can receive false readings from the sensor during calibration (Figure 45)

Always check the Level Adjust when reinstalling the flow meter following a calibration (See Keypad Description on page 19)

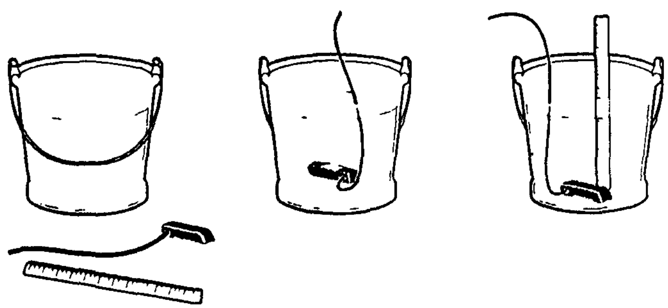
5 Place the sensor face down under at least 7 in (20 cm) of water Make sure the water surface s calm and the probe is stable

6 Press any key

7 Measure the depth from the bottom of the bucket to the surface of the water and enter the value using the numeric keypad (Figure 45)

8 Press the **ACCEPT** soft key

Figure 45 Calibrating the Submerged Area/Velocity Sensor



4 13 3 Installing a Submerged Area/Velocity Sensor In a Pipe

4 13 3 1 Important Guidelines for Submerged Area/Velocity Sensor Installation

Installing the submerged area/velocity sensor follows the same instruction as the velocity only sensor Refer to Installing the Velocity Only Sensor in a Pipe on page 92

AMERICAN SIGMA

MAINTENANCE

DANGER

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the installation/maintenance tasks described in this portion of the manual.

DANGER

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détérioration de l'appareil. Les tâches d'installation et d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire

PELIGRO

Algunos de los capítulos del manual que presentamos contienen información muy importante en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de instalación y mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas

GEFAHR

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vermeiden. In diesem Abschnitt beschriebene Installations- und Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

PERICOLO

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione. La preghiamo di leggere attentivamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina. Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni di manutenzione descritte in questa parte del manuale.

This chapter explains how to maintain, repair, and upgrade the 980 Flow Meter It describes how to open the case, inspect and replace fuses and perform operating system software upgrades

4.1 Routine Maintenance

Routine maintenance of the 980 Flow Meter consists of calibrating input channels cleaning the case and maintaining the sensors as needed

4.1.1 Calibration

Calibration should be performed on all channels at the proper interval for that type of input (See Section 3)

4 1.2 Cleaning the Case

Clean the outside of the case with a damp cloth and mild detergent Use a non abrasive plastic cleanser on the front cover if necessary Avoid harsh chemicals or solvents because they may harm the case or fog the front cover

4.2 Upgrades, Repairs, General Maintenance

Only a qualified technician should service the 980 Flow Meter For example steps that require knowledge of CMOS electrostatic discharge precautions and advanced electronics training should only be performed by a qualified technician If you need assistance in performing any of the following service steps please contact the manufacturer

4.2.1 Internal Maintenance Items

The following items require access to the inside of the case for service

- Interface connectors
- RAM memory batteries
- Fuses

4.2.2 ⚠ Opening the Front Panel

DANGER
Always disconnect external power sources to the flow meter before opening the front panel

DANGER
Débranchez toujours les sources d alimentation externe du débitmètre avant d ouvrir le panneau avant

PELIGRO
Desconectar siempre las fuentes externas de energía al medidor de flujo antes de abrir el panel delantero

GEFAHR
Vor dem Abnehmen der Frontplatte unbedingt alle externen Spannungsversorgungen zum Strömungsmessgerät unterbrechen!

PERICOLO
Scollegare sempre l alimentazione elettrica dal misuratore di portata prima di aprire il pannello frontale

To open the front panel loosen the two hold down screws with a flat blade screwdriver

4.3 ⚠ Fuse Replacement

DANGER
Internal power switch does not remove power from the fuses Remove power from all external power sources when installing a fuse

DANGER
L interrupteur d alimentation interne ne met pas les fusibles hors tension Débranchez toutes les sources d alimentation externes lorsque vous installez un fusible

PELIGRO
El interruptor de energía interno no interrumpe el flujo a los fusibles Desconectar las fuentes externas de energía cuando al instalar fusibles

GEFAHR
Der eingebaute Netzschalter unterbricht nicht die Spannungszufuhr zu den Sicherungen Vor dem Einbau einer Sicherung unbedingt alle externen Spannungsversorgungen zum Gerät unterbrechen!

PERICOLO
L interuttore interno non toglie l alimentazione ai fusibili Togliere l alimentazione dall esterno quando si installano i fusibili

DANGER
For continued protection against fire, replace fuses with only fuses of specified type and current rating

DANGER
Pour assurer la protection contre les risques d incendies remplacez les fusibles uniquement par des fusibles du même type et pour la même intensité

PELIGRO
Para una continua protección contra incendios reemplazar los fusibles unicamente por los del tipo y capacidad recomendados

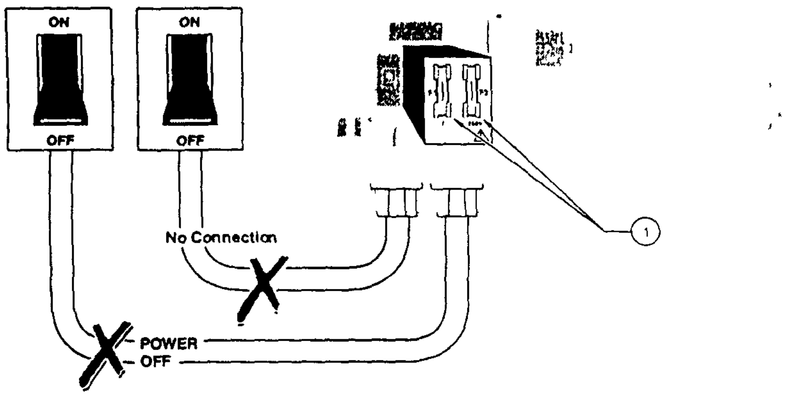
GEFAHR
Zur Wahrung des kntinuierlichen Brandschutzes durfen die Sicherungen nur mit Sicherungen des gleichen Typs und mit gleichen Stromkennwerten verwendet werden

PERICOLO
Per una continua protezione dal fuoco sostituire i fusibili solo con altri di tipo specifico e di uguale valore

The AC main fuses are located in the customer w ring area Replace the fuses as follows

1. Disconnect all power to the instrument (including relay power)
2. Open the front cover of the instrument by loosening the two corner screws
3. To remove a fuse pull it straight out of the clips that hold it in place A typical blown fuse will have a noticeable broken wire strand inside the tube Occasionally it may take an ohmmeter to ver fy f a fuse is good or not
4. Replace the fuses (F1 and F2) with the same type and amperage (T 1A 250V) (Cat No 015804) Over rat ng or bypassing a fuse could result in fire or electrical safety hazards

Figure 46 Locating the Fuses (F1 and F2)



1	F1 and F2 (T 1A 250V)

4.4 Memory Batteries

RAM (random access memory) is a very reliable data storage medium for microprocessor applications Random Access Memory requires power at all times to store its data, however If power is removed, the data stored in the RAM chip is lost Therefore it is not feasible to power the RAM chips from the meter power supply because you would lose your data and program settings every time power is disconnected A separate battery pack located inside the flow meter powers the RAM chips and the real time clock

The memory batteries consist of three AA alkaline cells They are located on the rear panel assembly and are easy to replace Use only good quality *alkaline AA battery cells as replacements*

The memory batteries (Cat No SE 989) keep the program entries and logged data stored in RAM memory when the main power fails or is removed for transport or replacement

If the memory battery voltage falls too low to properly maintain the program settings a warning "MEMORY BATTERY" will flash in the lower right corner of the display to alert you to replace the batteries The meter uses a very small amount of energy from the memory batteries during normal operation

4.5 Ultrasonic Sensor Maintenance

One of the key features of the Ultrasonic method of flow measurement is the low maintenance requirements for the level sensor (transducer) Clean the face of the transducer if it is coated by dirt and grease To clean the Ultrasonic Transducer housing, wipe with a mild soap and water Strong solvents may damage the transducer housing

4.6 Cleaning and Maintaining Submerged Area/Velocity Sensors

CAUTION
When handling materials, samples, and waste wear goggles and latex gloves to avoid illness or infection

ATTENTION
Lorsque vous manipulez des matériaux des échantillons et des déchets portez des lunettes et des gants en latex pour écarter tout risque d infection ou de maladie

ADVERTENCIA
Al manejar materiales muestras y descartes llevar gafas y guantes de látex para evitar infecciones o enfermedades

ACHTUNG LEBENSGEFAHR!
Der Umgang mit Reagenzien Proben und Abfall kann gesundheitsschädlich sein, evtl besteht Infektionsgefahr Unbedingt Schutzbrille und Latexhandschuhe tragen!

ATTENZIONE
Quando si maneggiano materiali campioni e scarichi indossare i guanti protettivi ed i dispositivi di protezione per evitare infezioni e malattie

Clean the transducer port when

- Upward drift occurs in your readings
- Level data are missing or incorrect but velocity data are valid
- Silt has deposited between the transducer and its protective cover

Do not clean the transducer unless it shows signs of drift or malfunction Do not clean it just because it appears dirty

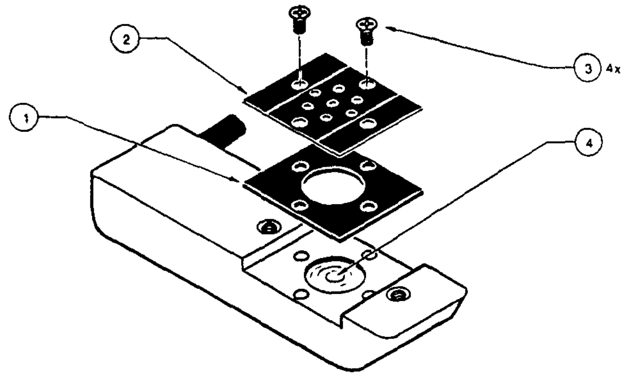
4 6 1 Submerged Area/Velocity Sensor Cleaning Procedure

When cleaning the transducer, use the most gentle technique possible Do not use any type of object to remove sediment from the face of the transducer Foreign object damage to the transducer will void the warranty!

1 Soak the sensor in soapy water for 24 hours
2 Remove the screws from the protective cover (Figure 47)
3 Remove the cover and gasket
4 Carefully swirl the sensor in soapy water to remove soil For stubborn deposits use a spray or squeeze bottle
5 Clean the gasket and cover
6 Reattach the gasket and cover Tighten the screws to 10 inch pounds or until the gasket starts to expand out from under the cover

Note Do not soak the sensor in bleach Bleach will permanently damage the sensor

Figure 47 Removing the Protective Cover



1. Gasket	3. Screws (#6–32 x 5/16)
2 Protective Cover	4. Transducer

4.6.2 Changing the Desiccant

Your sensor contains a tube that equalizes the air pressure in the transducer and the outside air pressure Moisture may become trapped in this tube A desiccant-filled canister helps remove moisture from this tube and from the sensor The canister contains beads of silica gel. When the beads are blue, they can remove moisture from the air. When they are pink, they cannot absorb any more moisture from the air.

When the beads begin to turn pink, you must replace or rejuvenate (dry out) the beads. You can permanently damage the sensor if the desiccant is not maintained. Never operate the sensor without the proper desiccant.

4.6.3 Desiccant Replacement Procedure

Note: If you are rejuvenating the beads, remove them from the canister and heat at 100–180 °C (212–350 °F) until the beads turn blue again If the beads do not turn blue, replace them with new beads Do not heat the canister It will melt

1. Use a slight twisting motion to twist the bottom end-cap until its slots align with the retaining clips
2. Gently remove the end cap by grasping it and pulling it straight out
3. Pour the desiccant beads out of the canister
4. Remove the tubing at the top of the canister (Figure 48)
5 Remove the canister from its clip

Note: Applying O-ring grease (beryllium grease) to new or dry O-rings improves the ease of insertion sealing and life span of the O ring

6. Hold the canister up to the light and inspect the hydrophobic filter for tearing or obstruction
   - If you see a small, dim light spot while looking through the hole the filter is in good condition If you see a bright light spot the filter is probably torn Replace the filter
   - If the desiccant beads were completely saturated with water or the filter may have been saturated with water or grease replace the filter

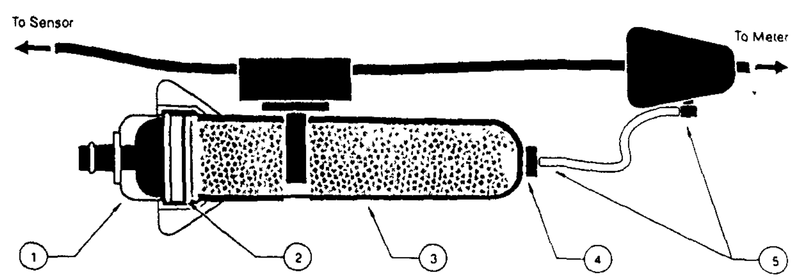
   If you need to replace the filter, complete the Hydrophobic Filter Replacement Procedure on page 99 then continue with step 8
7. Refill the canister tube with blue desiccant beads (Cat No 3624) Inspect the O-ring (Cat No 5252) on the bottom cap for cracking pits or evidence of leakage Replace if necessary
8. Make sure that the O-ring is clean and free of dirt or debris before replacing the end cap
9. Reinstall the end cap and check to make sure that the vinyl tubing is securely fastened at each fitting

4.6.4 Hydrophobic Filter Description

A single Teflon® hydrophobic filter (Cat No 3390) is installed in the top of the canister to prevent liquid from entering the vent tube This filter is very reliable

For best performance and to avoid grease buildup on the filter during submergence or surcharge conditions hang the canister vertically so that the end facing the sensor points downward

Figure 48 Removing the Tubing



1 End Cap	4 Teflon® Hydrophobic Filter (Cat No 3390)
2 O-ring	5 Vinyl Tubing
3 Desiccant Container	

4.6.5 Hydrophobic Filter Replacement Procedure

1 Using a deep-well hex socket (11 mm), unscrew the hex-head tubing nipple from the top of the canister and discard the old filter

2 Discard any remnants of Teflon tape from the nipple's threads Reapply two turns of Teflon tape (Cat No 10851-45) to the threads, pulling the tape into the threads until it conforms to the shape of the threads

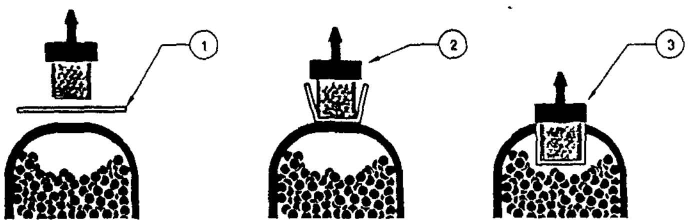
3 Place a new filter (Cat No 3390) over the hole Make sure that the smooth side of the filter faces the inside of the canister See Figure 49

4 Place the threaded nipple on top of the filter

5. With a slight pressure, press the filter into the hole with the nipple threads and begin threading the nipple into the hole The filter will deflect upward and feed completely into the thread until it disappears The filter must rotate with the nipple as it is threaded into the cap If it does not it is torn Start over with a new filter

6 Inspect the installation In the upper cap, a small, dim light spot should be visible when held up to the light A bright spot indicates a torn filter Start over with a new filter

Figure 49 Replacing the Hydrophobic Filter



1 Filter smooth side down	2 Hex head tubing nipple	3 Finished assembly

Working with Primary Devices and Sensor Operation

Installing the sensor in any primary device requires familiarity with the proper location for head measurement in that particular primary device Just as the proper installation of the primary device itself is critical to obtaining optimum flow measurement accuracy, the appropriate location of the submerged or ultrasonic sensor also greatly affects flow measurement accuracy

Always consult the manufacturer of your primary device, whenever possible, for details concerning the proper location of the sensor

Setting an Offset (For Use in a Weir)

When installing a submerged sensor behind a weir you may need to "offset" the actual reading from the submerged sensor to compensate for the difference in height between the submerged sensor and the crest of the weir This allows you to place the sensor at an arbitrary height in the weir, as long as it is located below the crest of the weir (and at the proper distance upstream from the weir plate) See Figure 50 for details on head measurement locations in a weir

In the text example below

- *The distance between the crest of the weir (bottom of the 'V) and the* submerged sensor is 4 in (10 cm)
- The distance between the surface of the water and the submerged sensor is 6 in (15 cm)
- The level of water which is contributing to flow is 2 in (5 cm) (water flowing over the weir)

Entering 2 in (5 1 cm) using the **LEVEL ADJUST** key will provide the desired offset As the water level falls to the bottom of the 'V" the flow meter will read zero level and zero flow If the level falls below the crest of the weir, due to evaporation or other reason, the level will read a negative number and the flow will remain at zero

The key to proper level setting is to adjust your level (using the **LEVEL ADJUST** key) to the level which is contributing to flow In a round pipe the level contributing to flow is the distance from the surface of the water to the invert (bottom) of the pipe In a flume the level contributing to flow is the distance from the surface of the water to the floor of the flume

Types of Primary Devices

Use the primary device illustrations that follow as general guides for proper head measurement location in commonly used primary devices Contact your primary device manufacturer for more details

Figure 50 Weir

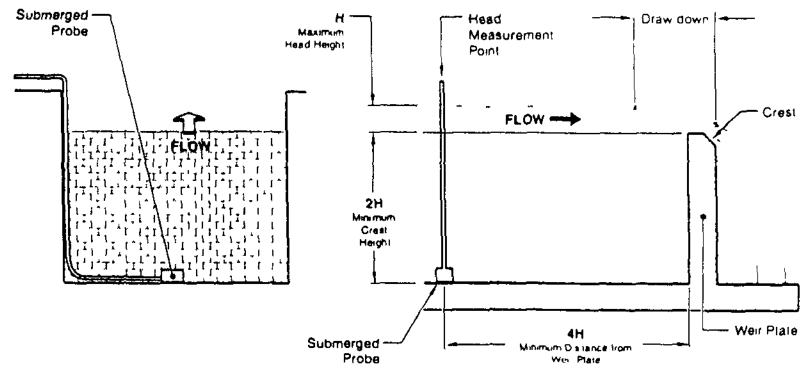


Figure 51 Parshall Flume

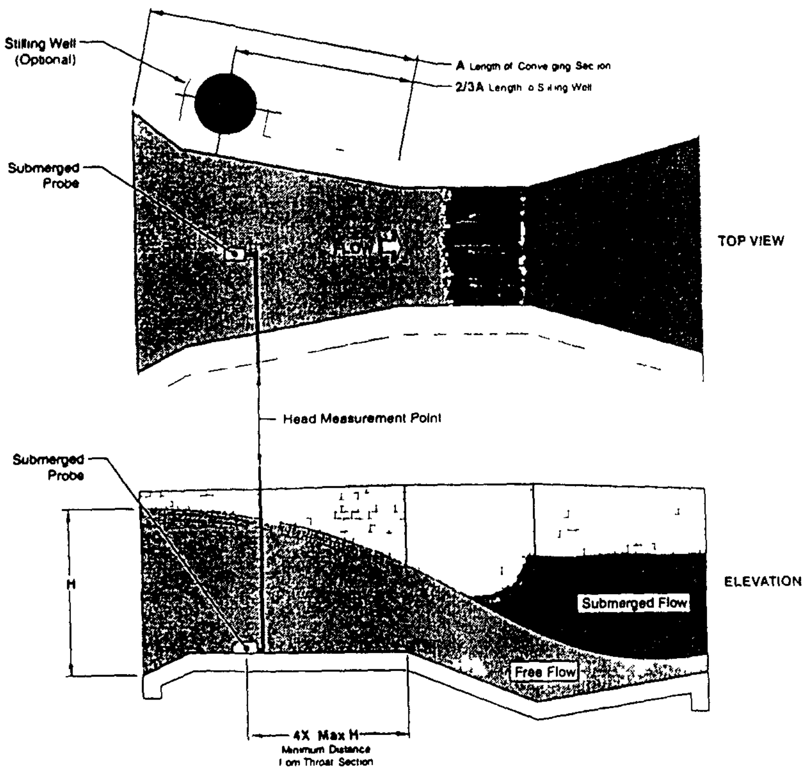


Figure 52 Palmer Bowlus Flume (with Integral Approach)

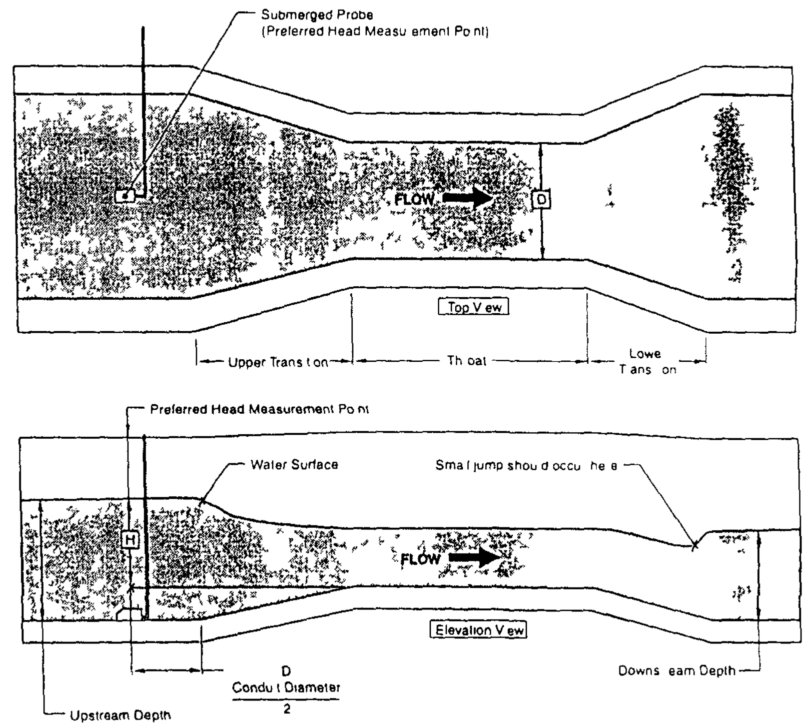


Figure 53 Leopold-Lagco Flume

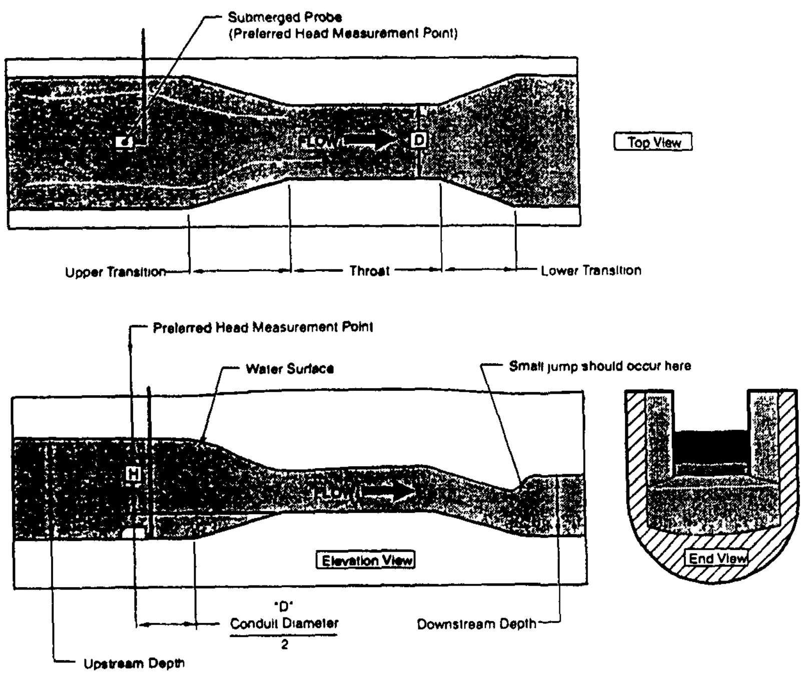


Figure 54 H-Flume

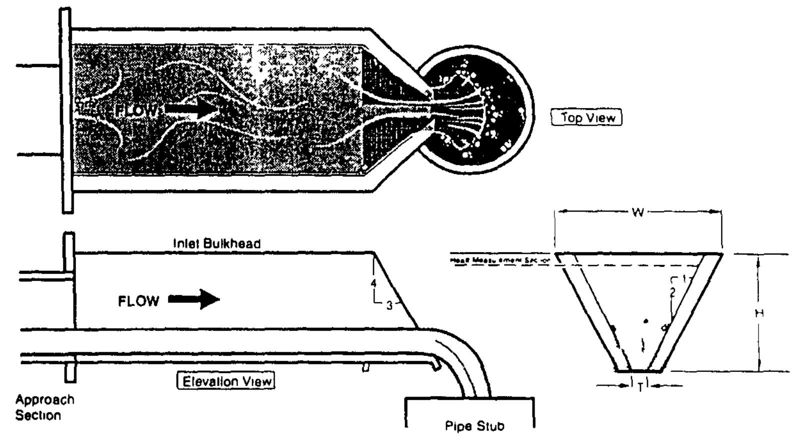
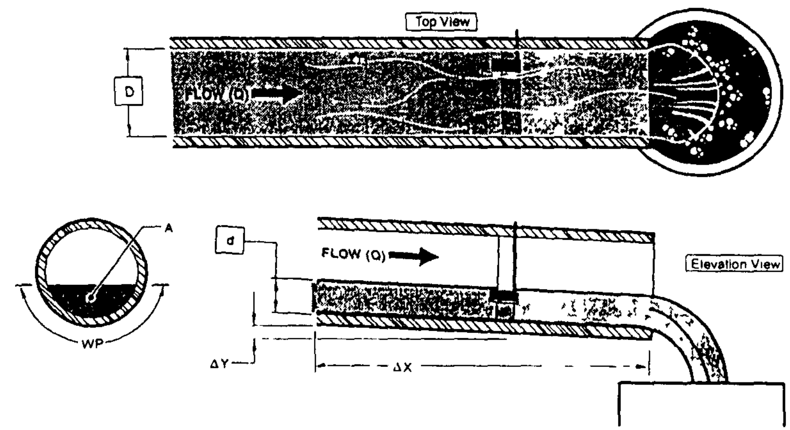


Figure 55 Round Pipes



Troubleshooting Measurement Errors From Electromagnetic Fields

Measurement inaccuracy can be affected by numerous factors, one of these factors is Radio Frequency (RF). The 980 Flow Meter is designed to be resistant to RF fields and other Electromagnetic Interference (EMI), however, RF fields at certain frequencies (at or above 10 Volt/per meter level) can cause disturbances to measurement circuits causing inaccurate measurements. If RF is causing measurement errors, the tranmitter(s) are usually located near the 980 Flow Meter When the transmitter(s) are too close to the instrument, remove or move the transmitter farther away from the 980 Flow Meter

The following tables provide RF frequencies and levels that can cause measurement errors. Compare any local transmitters and its transmitting frequency to the tables listed below

Analog Input		
Offending Frequency (mega Hz)	**Measurement Error (milli V)**	**Specification (milli V)**
90.5	28	not specified
119	12	not specified
141	11	not specified
392	9	not specified

Temperature		
Offending Frequency (mega Hz)	**Measurement Error (°C)**	**Specification (°C)**
84	1 9	not specified
93.7	2.1	not specified
106	5.6	not specified
125	3.6	not specified
127	2 2	not specified
131	3.8	not specified
150	2.3	not specified
324	1.9	not specified
382	7.5	not specified

Level Accuracy		
Offending Frequency (mega Hz)	**Measurement Error (inch)**	**Specification (inch)**
31.43	1.300	0.36
44.94	0.430	0 36
374 00	0 780	0 36

Review All Items

To view programmed entries without accidently changing any of the information, select the Review All Items from the SETUP menu. This information fills more than one screen, scroll through the setup information one page at a time with the arrow keys Press the MAIN MENU key to exit.

11:00 AM 21 - APR - 01		STATUS SCREEN
REVISION:	1.00	
FLUME TYPE:	PALMER BOWLUS FLUME	
FLUME SIZE:	12 in.	
SAMPLER PACING:	mgd	
FLOW UNITS:	gal	
LEVEL:	in	↓

11:00 AM 21 - APR - 01				STATUS SCREEN
CHANNEL 3	ppm	NOT LOGGED	1 min	↑
CHANNEL 4	ppm	NOT LOGGED	1 min	
CHANNEL 5	ppm	NOT LOGGED	1 min	
CHANNEL 6	ppm	NOT LOGGED	1 min	
CHANNEL 7	ppm	NOT LOGGED	1 min	
MEMORY MODE		WRAP		

Displaying Data

The Display Data function provides the recorded data for any channel being logged in a tabular report or a graph

In addition, for tabular reports, the data can be viewed from the beginning, from the end, or from a specific point in time A graph can display any 24-hour period zoom in to any portion of the 24-hour period for finer detail or center the graph on a specific point in time

Selecting the Channel

Note: Only the channels for which logging has been enabled will be listed

1. Press **DISPLAY DATA** from the Main Menu to display a list of logged channels
2. Highlight the desired channel using the up and down arrow soft keys then press the **SELECT** soft key

11:00 AM 21 - APR - 01		DISPLAY DATA
SELECT	FLOW	↑
	RAINFALL	
	PH	
RETURN		↓

Tabular or Graph Format

1 Highlight the desired display method using the up and down arrow soft keys then press the **Select** soft key

11:00 AM 21 - APR - 01		DISPLAY DATA
SELECT	DISPLAY DATA	↑
	DISPLAY BY GRAPH	
RETURN		↓

Table 27 Display Data Functions and Descriptions

Function	Description
Display Data by Table	
	View from start Displays the data for the selected channel beginning with the first (oldest) data point in memory
	View from end: Displays the data for the selected channel beginning from the most recent point in memory
	View from time/date. Displays the data for the selected channel beginning from any desired time and date Enters a new desired time and date
	Note: Totals displayed are calculated by summing the logged data If the date selected precedes available logged data (memory has wrapped) the total will be incorrect
Display Data by Graph	
	Graph day. Displays data for a specified date Data for the selected date is graphed from midnight to midnight
	Graph point in time: Displays data for a specified time and date The graph displays three hours of data with the selected point in the time at the corner of the graph
	Graph partial day Zooms in on a portion of the logged data

Graph Manipulation

Table 28 Graphing Functions and Descriptions

Functions	Description
Status Bar	
	Displays the time date measured value and unit of measure at the intersection of the data cursor Placing the cursor's data on the status bar eliminated the need for X or Y axis labels and provides a larger graph viewing area
Moving the Data Cursor with the Arrow Keys	
	The data cursor appears as a vertical line in the center of the graph Moves the data cursor to the left or right by using the soft keys or the numeric keypad
Moving the Data Cursor with the Numeric Keypad	
	The keys 0–9 represent a percentage of full scale Pressing a numeric key on the keypad while a graph is displayed causes the data cursor to jump to the location on the graph that is represented by that key For example pressing the 0 key moves the data cursor to the far left end or 0% position on the graph Pressing the 5 key moves the data cursor to the middle or 50% position of the graph Pressing the 9 key moves the cursor to the 90% position
Next Channel Soft Key	
	Graphs data from the next logged channel For example if the 980 is logging Level Flow and pH and the Level graph is currently displayed the **NEXT CHANNEL** soft key causes the Flow channel to be graphed Pressing Next Channel again will create a graph for pH channel Pressing **NEXT CHANNEL** again returns to the Level graph selects a time period of interest and compares different graphs

Graphic Display Averaging

The 980 Flow Meter can display a graph that consists of a maximum of 180 individual dots Since a 24 hour period could contain as many as 1 440 data points (assuming a one minute recording interval one reading each minute) it would be impossible to plot every data point on the graph

When more than three hours (more than 180 minutes worth) of data is graphed the data points must be averaged When graphing a partial day of three hours or less all data points are graphed with no averaging

When viewing a graph with more than 180 data points zoom in to the area of interest (using the Graph Partial Day option) before all of the individual data points are displayed

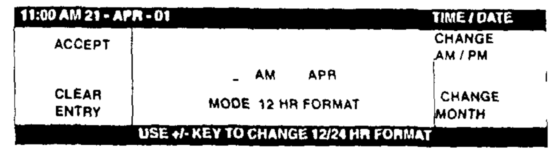
Options Features

The Options menu can set the

- Time and Date for the real t me clock n the 980 Flow Mete
- Program the advanced features of the flow meter
- Select level sensor when multiple sensors are nstalled

Setting the Time and Date

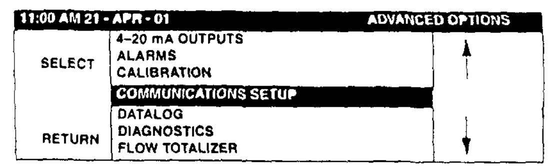
From the Main Menu select **OPTIONS > TIME/DATE**



Starting with the hours and minutes use the numeric keypad to enter numbers in the flashing cursor Use the +/ keys to toggle between 12 hour and 24 hour formats Use the soft keys on the r ght of the d splay to toggle the AM/PM and month fields to the desired selection Press the **CLEAR ENTRY** key to clear all numeric fields When complete press the **ACCEPT** soft key to save the changes

Advanced Options

1 From the Main Menu select **OPTIONS > ADVANCED OPTIONS**



2 Use the up and down arrow soft keys to h ghlight the choice then press the **SELECT** soft key to pick that item

3 Proceed through the series of screens to configure the parameters for the selected item

Advanced Options include the following

- 4-20 mA Outputs (Section 4 1 1)
- Alarms (Section 4 4 1)
- Calibration (Section 4)
- Flow Totalizer (Section 4 3 1)
- Diagnostics (Diagnostics on page 124)
- Data Log (Data Log on page 122)
- Storm Water (Storm Water on page 128)
- Set Point Sampling (Set Point Sampling on page 126)
- Languages (English Czech Danish French German Italian Portuguese and Swedish Dutch, and Spanish (The 980 supports English and one other selected language)

Alarms

Note Rainfall and Flow Rate of Change alarms are High Set Point conditions they take no deadband and they are time dependent.

Setting the Deadband

After entering the trip point enter a "Deadband" value The deadband is the area between alarm "turn on" and "turn off"

The purpose of setting a Deadband is to eliminate alarm relay chatter which may occur if the turn-on and turn-off values are too close together Small fluctuations that occur when the reading is at or near the trip point can toggle an alarm relay on and off very rapidly

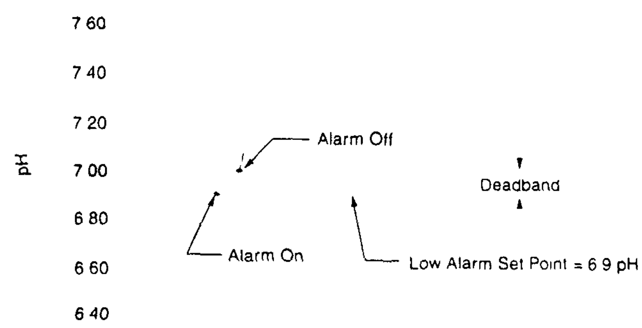
In the pH example (Figure 56) the Deadband is set to 0 10 pH When the pH reached 6 9 (lower dashed line) the alarm tripped but the alarm did not turn off until the pH came back up to 7 00 This difference is the Deadband setting which should be set according to the characteristics of the item being measured

Note You must log rainfall to use an alarm on a rainfall condition likewise you must log flow in order to implement an alarm on a flow rate of change If you forget you are reminded when the program begins

Four alarm relays are provided with SPDT (Form C) contacts The normally open, normally closed and common contacts are on the terminal wiring board

Multiple alarms can be enabled one at a time Multiple alarms can be assigned to individual trouble conditions to individual relays or assign to all the same relay

Figure 56 Deadband Concept



Data Log

From the Main Menu select **SETUP > ADVANCED OPTIONS > DATA LOG**

The 980 Flow Meter can record up to 115 630 readings from any or all input channels and store them in solid state battery backed memory for later viewing or retrieval

This option selects logged input channels the frequency of logged channels (Logging Interval) and explains what to do when the memory becomes full

Logging Intervals

Logging Intervals are designed to optimize the available memory so that readings can be logged for a longer period of time A Logging Interval is the time period over which readings are taken and then averaged

Note The Review All Items selection from the Setup menu indicates the maximum available logging hours for the channels and recording intervals you selected The flow meter calculates this information when the program is run using the RUN/STOP key

Logging Interval—Continuous Mode

When a one minute logging interval is selected a reading will be taken approximately every second but no data are logged until the logging interval ends At that time the readings are averaged over the logging interval that average is logged

When a five-minute logging interval is selected readings are still taken every second but the data are not logged until the five minute logging interval ends At that time the readings are averaged over the previous five minutes that average is logged

Longer logging intervals result in a longer total recording time Lower resolution also occurs since more averaging is done at higher logging intervals Choose the shortest logging interval possible while still making data collection convenient Pick a logging interval that almost fills memory over the course of one month if data will be collected monthly

Table 29 Logging Intervals vs. Total Recording Time for Each Memory Configuration*

Logging Interval	Total Recording Time (days) before memory is full with 512K Bytes of RAM (approx 115 630 readings)
1	80
2	160
3	240
5	401
6	481
10	803
12	963
15	1204
20	1606
30	2409
60	4818

* Assuming one logged channel

Data Logging Memory Allocation Options

The 980 Flow Meter uses a management scheme called "Dynamic Memory Allocation." All readings are logged in battery-backed Random Access Memory (RAM) RAM memory is allocated to each channel dynamically during operation If one channel is logging at 5-minute intervals and a second channel logging at 1-minute intervals, the meter automatically configures memory so that both channels fill memory at the same time Five times as much memory is assigned to the channel that is logging at 1 minute intervals than the channel that is logging at 5 minute intervals

Wrap Memory Mode

The 980 Flow Meter uses wrap memory In Wrap mode when memory becomes full, the oldest reading is discarded each time a new reading is taken When memory becomes full, the flow meter continues to operate and log data This mode is best used to receive the most recent data readings

Datalogging Configurations

To configure the 980 Flow Meter for data logging

1 From the Main Menu select OPTIONS>ADVANCED OPTIONS> DATA LOG

2 Highlight **SELECT INPUTS** using the up and down soft arrow soft keys then press the **SELECT** soft key to continue

3 Highlight the channel you wish to log using the up and down arrow soft keys Certain channels require more information refer to

4 Select Logged or Not-Logged using the **CHANGE CHOICE** soft key Press the **ACCEPT** soft key to continue

5 Enter a logging interval using the numeric keypad then press the **ACCEPT** soft key to continue Valid logging interval are shown on the status bar along the bottom edge of the display

6 Select another channel to configure or press the **RETURN** soft key to back up one step or press the **MAIN MENU** function key to return to the Main Menu

Table 30 Setup Parameters for Specific Channels

Channel Name	Configuration Options
Process Temperature	1 Select Logged or Not Logged using the CHANGE CHOICE soft key 2 Press the ACCEPT soft key to continue 3 Enter the Logging Interval using the numeric keypad 4 Select Temperature Units °F or °C (this is the only place in the software where temperature units can be changed)
Rainfall	Section 4 5 1 on page 74
pH/mV	Section 4 9 1 on page 77
Level / Flow	Flow Units on page 60 and Leve Units on page 6
Analog Inputs	Section 4 2 1 on page 70

Diagnostics

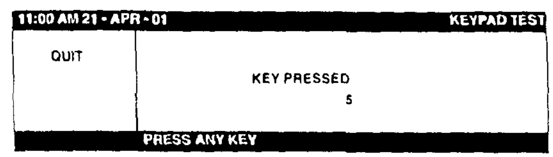
From the Main Menu select OPTIONS > ADVANCED OPTIONS > DIAGNOSTICS

In addition to the automatic diagnostics that are performed upon power up the following manual diagnostics are available

- Keypad Test
- LCD Test
- Demonstration Graph
- Velocity Analysis (only meters with area velocity capability)
- Events (log)

Keypad Test

Keypad Test provides a simple means of verifying the operation of all front panel keys Selecting **KEYPAD TEST** from the diagnostics menu will bring up the following screen



Pressing any key on the front panel (except for the upper left soft key) will cause that key label to appear in the center of the display

All numeric keypad keys soft keys and function keys may be tested in this manner

To end press the QUIT soft key (this also verifies the upper left soft key operation)

LCD Test

Display Test verifies all the pixels in the Liquid Crystal Display (LCD) are functional. *The LCD is made up of 14,400 pixels that are turned on and off as needed to create the display of graphics and text.* Each individual pixel is turned on and off by its own transistor. If a transistor fails, the pixel will not turn on, potentially causing an unreadable or confusing display.

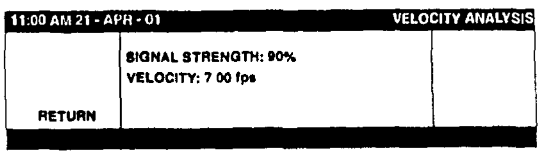
Select **LCD TEST** from the Diagnostics Menu. The display will become black for 3 seconds. To verify that all pixels are functional. A defective pixel will stand out as a white dot in the field of black dots. A message, "THE DISPLAY WILL REMAIN INVERTED FOR 3 SECONDS" is shown for 2 seconds followed by a 3-second period with all dots turned on.

Demonstration Graph

The demonstration graph provides a small portion of demonstration data to use when learning how to use the graphing screen for the first time or for training others on its operation. No data logging is required to use the demonstration graph.

Velocity Analysis

A velocity sensor must be installed in the flow stream and must be connected to the meter in order for this diagnostic to work. This diagnostic allows the viewing of 'real time' readings directly from the Submerged Area/Velocity Sensor. It shows the current velocity Signal Strength (percentage of Doppler signal returning to the sensor) and a 'real time' velocity measurement of the flow stream. Use this diagnostic to determine that the sensor is mounted for optimal velocity measurement. The closer to 100% the Signal Strength is, the more stable the velocity reading will be. If the signal seems low (50% or less) it may be due to improper installation of the sensor or a lack of particulate in the flow stream.



Event Log

The Event Log diagnostic provides a time/date stamped list of significant events occurring in the flow meter. Review these events to find out when an event occurred and what events preceded or followed the event of interest. Events may be viewed in chronological order from the beginning or end of the event list by selecting **VIEW FROM START** or **VIEW FROM END** respectively.

Fixed Alarms

Fixed alarms (Table 31) show the On/Off status associated with the alarm. For instance, U-sonic Echo Loss On at some time/date will appear. When the condition ends, U-sonic Echo Loss Off will appear.

Table 31 Event Log Fixed Alarms

Event	Explanation
MEMORY BATTERY	Internal memory battery is low
MODEM FAILURE	Modem chip/modem board failure
U-SONIC ECHO LOSS	No return signal detected
XDUCER RINGING	The return signal is detected too soon
U-SONIC FAILURE	Ultrasonic board detects an error
RS485 TIMED OUT	Communication problem with RS485

Channel Alarms

Channel alarms show the value that caused the alarm to occur or go away and show a status ON/OFF to indicate if the alarm occurred or went away at that time/date.

Event Log Channel Alarms

- LEVEL
- FLOW RATE OF CHG
- RAINFALL
- CH1
- CH2
- CH3
- CH4
- FLOW
- pH
- CH5
- CH6
- CH7
- VELOCITY
- TEMPERATURE

Set Point Sampling

In the 980 Flow Meter, set point sampling allows the control of an automatic liquid sampler from up to 14 different sources individually or simultaneously.

Upon reaching a user-defined set point trigger, the flow meter provides an output signal at the Sampler Interface (see Wiring the Sampler on page 42) for details on the sampler interface. This signal can be used to tell a sampler such as the Model 900 Sampler that a set point condition has been reached and samples should be taken.

Set Point sampling defines a set of limits that inhibit sampling until an upset condition occurs, causing the limits to be exceeded. In this manner time and money and collecting and testing samples that are within limits is not wasted, because sampling is enabled only when the waste stream falls outside the set points.

Table 32 shows all possible sampling triggers and appropriate settings

Table 32 Sampling Triggers

Sampling Trigger	Settings
Level	High and/or Low condition deadband
Flow	High and/or Low condition, deadband
Flow Rate of Change	High condition within time interval
Temperature	High and/or Low condition, deadband
pH	High and/or Low condition, deadband
Rainfall	High condition within time interval
Analog Input Channel 1	High and/or Low condition, deadband
Analog Input Channel 2	High and/or Low condition, deadband
Analog Input Channel 3	High and/or Low condition, deadband
Analog Input Channel 4	High and/or Low condition, deadband
Analog Input Channel 5	High and/or Low condition, deadband
Analog Input Channel 6	High and/or Low condition, deadband
Analog Input Channel 7	High and/or Low condition, deadband

To enable Set Point Sampling

1. From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > SETPOINT SAMPLING.**
2. Highlight **SETPOINT SAMPLING** using the up and down arrow soft keys on the Advanced Options Menu, then press the **SELECT** soft key
3. Highlight the desired sampling trigger (see Table 32), then press the **SELECT soft key**
4. Highlight either **SAMPLE ON HIGH CONDITION** or **SAMPLE ON LOW CONDITION**
5. Press the **CHANGE CHOICE** soft key to enable or disable the sampling trigger for this condition
6. Enter the desired high or low trigger point using the numeric keypad, then press the **ACCEPT** soft key
7. Enter a Deadband value (see *Setting the Deadband on page 121*) or, if programming for Flow Rate Of Change or Rainfall, enter a time interval within which the flow or rainfall change must take place

Note: You must log rainfall to use set point sampling on a rainfall condition, likewise, you must log flow in order to implement set point sampling on a flow rate of change. If you forget, you are reminded when the program begins

Sample on High Condition and Sample on Low Condition can be enabled at the same time. There is no limit to the number of sampling triggers that can be enabled at one time

Storm Water

A special Storm Water monitoring program designed specifically to meet the NPDES storm water requirements is built in to the 980 Flow Meter. Rainfall is monitored with an optional Rain Gauge. A connection is then made from the 980 Flow Meter Sampler Interface to an automatic liquid sampler

A typical storm water program might be configured to activate when a storm causes a level of at least 3 in (7 6 cm) in the outfall channel and 0 10 in (2 5 mm) of rainfall within 30 minutes. Or, it might be desirable to activate the program if either the rainfall occurs or the channel level exceeds the limit. Any combination of rainfall and level conditions can be used to activate a storm water program. Specific requirements can vary, however, from state to state. Consult state regulatory groups for recommendations on storm water permit requirements for specific applications

To configure the Storm Water program in the flow meter proceed as follows

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > STORM WATER**
2. Highlight **STORM WATER** on the Advanced Options Menu then press the **SELECT** soft key to continue
3. Press the **CHANGE CHOICE** soft key to enable Storm Water then press the **ACCEPT** soft key
4. Select a Start Condition
   - Rain
   - Level
   - Rain and Level (both conditions must be met for the program to begin)
   - Rain or Level (either condition must be met for the program to begin)
5. Enter the Start Condition limits
   - For Rain, enter the amount of rainfall and the time period within which it must fall
   - For Level, enter the level limit
   - For Rain and Level and Rain or Level enter the amount of rainfall and the time period within which it must fall and the desired level limit

Programming Worksheet

Name.	**Date·**	**Serial No :**	**ID No :**		
Program Software Versions for:					
Flow Meter.	**DTU:**	**InSight® Gold**	**InSight**	**Vision**	**StreamLog**

Basic Programming Guidelines

- Go through all items in the Setup menu and configure each one to your requirements.
- Next, review the items in the Advanced Options menu and configure any items you need.
- Always check Data Logging and Totalizer Setup Data logging channels must be enabled if you want to record the data in memory Also, the totalizer should be configured with an acceptable scaling factor for the flow rate at each site
- Go to the options menu and set the time and date if they have not already been set
- When finished, press the **RUN/STOP** key to start the program
- Photocopy the following worksheets to record your program settings at each site for easy reference

SETUP MENU

From the Main Menu, select **SETUP, MODIFY ALL ITEMS**

1 Select FLOW unit of measure (gps, gpm, gph, lps, lpm, lph, mgd, afd, cfs, cfm, cfh, cfd, cms, cmm, cmh, cmd) ________

2 Select LEVEL unit of measure (cm, m, in , ft) ________

3. Select a PRIMARY DEVICE ________

Flume Type____________ Size______________

Weir Type____________, Size______________ _

Nozzle Type____________, Size______________

Manning Formula:

Slope________, Roughness__________, Pipe Diameter__________

Power Equation:

K_1=________, n_1=________, K_2=________, n_3=________

Head vs. Flow

4 Enable PROGRAM LOCK password (Y / N)

(Password is always 9800)

5. Enable SAMPLER PACING (Y / N)

Flow interval ________, Flow unit of measure ________

6. Enter a SITE IDENTIFICATION __ _ __

7. Enter unit of measure for TOTAL FLOW (acre feet cubic feet gallons liters cubic meters) ___ ___

Applies to velocity models only

8 Enter the VELOCITY DIRECTION (Upstream (normal) Downstream or Always Positive) ________

9 Enter the VELOCITY UNITS (fps or m/s) ____

10 Enter the VELOCITY CUTOFF

Cutoff value = __ __ ___ Default Value = _

OPTIONS MENU
From the Main Menu select **OPTIONS**

1 Set Time & Date _ __ _

2 Level Sensor (Ultrasonic or Submerged Sensor)

ADVANCED OPTIONS MENU
From the Main Menu select **OPTIONS > ADVANCED OPTIONS**

1 Setup 4–20 ma Outputs (if desired)

2 Setup ALARMS (if desired) _ _

Alarm Name	High Trigger	Low Trigger	Deadband	Time Interval	Relay # Set
Low Mem Battery					
Level					
Flow					
Flow Rate of Change					
pH					
Temperature					
Rainfall					
Channel 1					
Channel 2					
Channel 3					
Channel 4					
Channel 5					
Channel 6					
Channel 7					

3. Calibrate inputs (as needed). __________chk

4. Communications Setup: (If modem is enabled) ACCEPT any baud rate displayed. [Modem will independently establish actual baud rate between 1200 and 14,400.]

Pager Phone Numbers (if enabled) Pager Service ____________

Pager #1: __________ Pager #2 __________ Pager #3 __________

Select Baud Rate for RS232 (1200, 2400, 4800, 9600 19200) ________

5. Configure DATA LOGGING for each desired channel

Channel Name	Analog Channel Signal Description	Logged (Y/N)	Units	Logging Interval (min)
Process Temperature				
Rainfall				
pH				
Level / Flow				
Analog Channel 1				
Analog Channel 2				
Analog Channel 3				
Analog Channel 4				
Analog Channel 5				
Analog Channel 6				
Analog Channel 7				

6. Configure Flow Totalizer

Scaling. ______________ (X, X1, X10, X100 X1,000,000)

Flow Units (Acre-feet, cubic feet, gallons, liters, cubic meters) ________

7. Configure SETPOINT SAMPLING if it is desired to trigger a sampler based on one of the following conditions:

Channel Name	High Trigger	Low Trigger	Deadband	Time Interval
Level				
Flow				
Flow Rate of Change				
pH				

Channel Name	High Trigger	Low Trigger	Deadband	Time Interval
Temperature				
Rainfall				
Channel 1				
Channel 2				
Channel 3				
Channel 4				
Channel 5				
Channel 6				
Channel 7				

8. Configure STORM WATER if desired

Start Condition ________ (Rain Level Rain & Level Rain or Level)

Rain Trigger ______________ Rain Time Limit __________

Level Trigger______________

Check one

___ Head Vs Flow Worksheet

___ *Level Vs Area Worksheet* (velocity units only)

Head / Level (units =________)	Flow / Area (units =________)

Introduction to SCADA - Modbus Communications

Use this section as a guide when using the Modbus ASCII protocol to communicate directly with the 980 Flow Meter via an RS232 or modem connection

This guide assumes that the user has a working knowledge of Supervisory Control and Data Acquisition (SCADA), its components, and the different topologies used to construct the communications network Because a basic understanding of the Modbus ASCII protocol is necessary a description of key pieces of the protocol will be described

This section will guide you through the setup process by describing key points that need to be addressed for successful communication This section will not outline specific implementation details of any particular Man Machine Interface (MMI) or controller although examples may reference certain manufacturers for illustrative purposes The description of the Modbus ASCII protocol is provided for reference only and is not intended as a tutorial The scope of this section is limited to the description of Modbus ASCII as it pertains to the 980 Flow Meter

Modbus, an open protocol, determines how each instrument will know its device address, recognize a message addressed to it, determine the type of action to be taken, and extract any data or other information contained in the message The flow meter and Man Machine Interface (MMI) communicate using a master-slave technique in which only the master can initiate queries to a slave (980) The 980 will always be considered the slave, never a master The master can address individual 980 Flow Meters or can broadcast a message to instruments within its scope Responses are never returned to broadcast queries from the master The Modbus protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error-checking field The flow meter's response message is constructed using the Modbus format which confirms the action to be taken any data to be returned and an error checking field

ASCII Transmission Mode

The 980 Flow Meter is designed to communicate on standard Modbus networks using Modbus ASCII In ASCII mode, messages start with a colon , and end with a 'carriage return-line feed' pair The allowable characters transmitted for all fields are hexadecimal 0–9, and A–F When a message is transmitted over a Modbus ASCII communication link, each character or byte is sent in the order of Least Significant Bit to Most Significant Bit A typical message frame looks like the following

START	ADDRESS (HEX)	FUNCTION (HEX)	DATA (HEX)	LRC (HEX)	END (HEX)
1 Char '	2 Chars	2 Chars	n Chars	2 Chars	2 Chars CRLF'

Address Field

The address field of an ASCII message frame, ranging from 0 to 247 decimals, consists of two characters that represent the slave address Individual slaves are assigned values between 1 and 247 A master addresses a slave by putting the slave's address in the address field of the message frame. When the slave sends its response, it places its own address

in the address field of the message frame to let the master know which slave is responding

The device address of the 980 Flow Meter is set via the front keypad in the 980 Communications menu

1 From the Main Menu select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > MODBUS SETUP**

2 Enter a value between 0 and 247

11:00 AM 21 - APR - 01		MODEM SETUP
ACCEPT	DEVICE ADDRESS 1	
RETURN		CLEAR ENTRY
	ENTER 0-247	

Function Field

The function code field of an ASCII message frame ranging from 1 to 255 decimals consists of two characters that represent the type of action the master is requesting from the slave Of these functions the 980 Flow Meter currently supports function 3 (Read Holding Registers) When a message is sent from the master to a slave device, the function field tells the slave what kind of action to perform For example, this may include reading the channel values of Level and Velocity When the slave responds to the master it echoes the function code field to indicate a normal response In the event of an error such as parity error, LRC error, or a request that cannot be handled the slave will not respond and the master will eventually process a time out condition

Data Field

The data field of an ASCII message frame consists of *n* pairs of ASCII characters that represent data sent to or from a slave device (flow meter) The data field contained in the master request contains additional information that is required by the slave before any action takes place This may include channel register addresses, the number of registers to read and the actual byte count in the data field For example if a master requests that the flow meter read the current status of a group of channels (function code 03) the data field specifies the starting register and how many registers are to be read If no error occurs the data field of the response from the meter to the master contains the data requested

LRC Field

The LRC field of an ASCII message frame consists of two ASCII characters that provide an additional level of error checking to verify the integrity of the communication media The LRC field is one byte that contains an 8 bit binary value The LRC value is calculated by the transmitting device which appends the LRC to the end of the message The receiving device recalculates the LRC and compares it against the LRC value of the incoming message If the two values are not equal, an error condition occurs The LRC is calculated by adding together successive 8-bit bytes of the message discarding any carries, and then complementing the result The LRC is calculated by summing all values in the ASCII message except for the leading colon and ending <CR><LF>

Communication Parameters

To successfully communicate with the 980 Flow Meter using Modbus ASCII, the communication parameters of the master device must be set at 7 bits, Even Parity, and 1 Stop bit The baud rate may be configured to any value offered by the 980 Flow Meter With the exception of baud rate the communication parameters must not vary from this format

User Memory Customizing

The most familiar component of existing SCADA networks today is the Programmable Logic Controller (PLC) Because the network integrator is most familiar with this type of device, the flow meter emulation of an existing PLC simplifies the process of integrating the manufacture s instrumentation into the SCADA network Modbus ASCII uses a referencing system to identify the various types of memory inputs and outputs Each reference number has a leading digit that identifies its data type (discrete input, discrete output register input, register output) followed by a string of digits that indicates its location in RAM (Table 24)

Table 24 Modbus ASCII Memory Input/Output Referencing System

Reference Indicator	Reference Type	Meaning
0xxxx	discrete output or coil	binary
1xxxx	discrete input	binary
3xxxx	input register -	real
4xxxx	output holding register	real
6xxxx	extended memory register	real

The memory data is stored in 16-bit words Within the predefined function codes of the Modbus ASCII protocol, the data fields are subject to interpretation by the device manufacturer For example, the 980 Flow Meter places temperature information in registers 40001-40002

Modbus ASCII Function Codes Supported

Currently, the 980 Flow Meter is capable of a read-only function to retrieve channel and total flow information All data addresses in the Modbus ASCII message are referenced to zero Therefore, a reference to holding register 40001 is addressed as register 0000 The function code field specifies the type of register accessed, therefore, the 4XXXX is implicit

Function 03: Read Holding Registers
Reads the register (4X reference) contents of the 980 Flow Meter as defined in the tables that follow

Table 25 Channels' Read Holding Register Addresses

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Temperature	Float	32	2	00	00	40001 40002
Rainfall	Float	32	2	00	02	40003 40004
pH (or ORP)	Float	32	2	00	04	40005 40006
Level 1	Float	32	2	00	06	40007 40008
Velocity 1	Float	32	2	00	08	40009 40010
Channel 1	Float	32	2	00	0A	40011 40012
Channel 2	Float	32	2	00	0C	40013 40014
Channel 3	Float	32	2	00	0E	40015 40016
Channel 4 (D O)	Float	32	2	00	10	40017 40018
Channel 5 (D O Temp)	Float	32	2	00	12	40019 40020
Channel 6 (Conductivity)	Float	32	2	00	14	40021 40022
Channel 7 (Cond Temp)	Float	32	2	00	16	40023 40024
Flow 1	Float	32	2	00	20	40033 40034
Power	Float	32	2	00	26	40039 40040

Table 26 Channels' Units of Measure Read Holding Register Addresses*

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Temperature	Integer	16	1	00	31	40050
Rainfall	Integer	16	1	00	32	40051
pH (or ORP)	Integer	16	1	00	33	40052
Level 1	Integer	16	1	00	34	40053
Velocity 1	Integer	16	1	00	35	40054
Channel 1	Integer	16	1	00	36	40055
Channel 2	Integer	16	1	00	37	40056
Channel 3	Integer	16	1	00	38	40057
Channel 4 (D O)	Integer	16	1	00	39	40058
Channel 5 (D O Temp)	Integer	16	1	00	3A	40059
Channel 6 (Conductivity)	Integer	16	1	00	3B	40060
Channel 7 (Cond Temp)	Integer	16	1	00	3C	40061
Flow 1	Integer	16	1	00	41	40066

* The addresses shown above return a code that represents the appropriate unit of measure

Table 27 Flow Totalizer Read Holding Register Addresses

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Total Flow 1	Float	32	2	00	4A	40075 40076
Total Flow Units	Integer	16	1	00	50	40081
Total Flow Multiplier	Float	32	2	00	51	40083 40084

Table 28 SCADA-Modbus Units of Measure Codes

Unit	Code	Unit	Code
ML	1	GPH	26
AF	2	LPS	27
CF	3	LPM	28
GAL	4	LPH	29
L	5	MGD	30
M3	6	PH	31
IN	7	ORP	32
CM	8	PPM	33
FT	9	PPB	34
M	10	MGL	35
CM2	11	PCTSAT	36
FT2	12	MSIEMENS	37
IN2	13	MICROSIEMENS	38
M2	14	GRAMSPERKG	39
AFD	15	PCTPERDEGC	40
CFS	16	DEGREE_C	41
CFM	17	DEGREE_F	42
CFH	18	MILS	43
CFD	19	VOLTS	44
CMS	20	FPS	45
CMM	21	MPS	46
CMH	22	PCT_O2	47
CMD	23	PCT_H2S	48
GPS	24	PCT_LEL	49
GPM	25	VOC	50

Query

The Modbus ASCII query must take the form shown below that specifies the starting register and number of registers to be read

Start	Slave Address	Function (03)	Start Address High	Start Address Low	No of Pts High	No of Pts Low	LRC	<CR>	<LF>

For example, to read the level channel of the 980 Flow Meter the query must be as indicated in Table 29

The master queries the flow meter using a Read Holding Registers request which implies a 4XXXX register reference to slave device address 01
The message requests data from holding registers 40007–40008 to obtain the level information, which requires two registers to store the floating point value
Note that registers are referenced from zero in the data field

Table 29 Channel Query to Read Level (Example)

Start	
Slave Address	01
Function	03
Starting Address High	00
Starting Address Low	06
No of Registers High	00
No of Registers Low	02
LRC	F4
Stop	<CR><LF>

Response

The 980 Flow Meter responds with the following transmission reflecting a level reading of 15 0 inches

Table 30 Transmission Response that Reflects a 15 in Level Reading

Start	
Slave Address	01
Function	03
Byte Count	04
Data High	00
Data Low	00
Data High	41
Data Low	70
LRC	47
Stop	<CR><LF>

The flow meter response echoes the address and function code which indicates that no problems exist in the communication between the master and 980 The Byte Count field specifies how many 8 bit data items are being *returned in the data field With Modbus ASCII this is one half the actual count* of ASCII characters transmitted in the data portion of the response
The contents of 40007 are shown as two byte values of 00 00 hex and the contents of register 40008 are shown as two byte values 41 70 hex
Together, these values represent the floating point IEEE representation of the level status

980 Flow Meter Response Time

As a result of time lags associated with data acquisition instrumentation could conceivably take up to 12 seconds to respond to a SCADA RS232 request Therefore the SCADA system must be designed to accommodate this potential communication lag For example in a Wonderware® application running a Modbus ASCII DDE server the com port reply time out must be set to 12 seconds This is the amount of time that the meter will be given to reply to Modbus queries via this serial port

Communication Handshaking

The 980 Flow Meter contains minimal communication handshaking For the meter to identify an RS232 connection from an outside source and to keep the RS232 hardware active once communicating the Data Terminal

Equipment (DTE) must assert and hold high the DTR line of the DB9 connector (DSR of meter) The 980 Flow Meter does not support RTS/CTS hardware handshaking Note that DTE must be capable of handling a 12-second maximum response lag

Pin	Description	Pin	Description	Pin	Description
Pin 1	Data Carrier Detect (DCD)*	Pin 4	Data Terminal Ready (DTR)	Pin 7	Request to Send (RTS)*
Pin 2	Received Data (RD)	Pin 5	Signal Ground (SG)	Pin 8	Clear to Send (CTS)
Pin 3	Transmitted Data (TD)	Pin 6	Data Set Ready (DSR)	Pin 9	Ring Indicator*

* Not used

Complications with Floating Point Values

The manufacturer's implementation of the Modbus protocol was based on the idea that we would enable our flow meters to emulate a Modicon®, Compact 984 PLC Consequently, we follow the exact same format that Modicon uses for the storing and processing of floating point numbers Additionally the Modbus protocol does not define how floating point values are packed (stored) into the internal memory addresses or "Registers" of the flow meter If you are integrating our Modbus-capable flow meters, be aware that these meters store and process floating point numbers in the exact same format as the Modicon Compact 984 PLC

All current models of Modicon PLCs, including the Compact 984, pack two bytes of data into each register This alone presents no problems Unsigned two-byte (16-bit) integer values in the range of 0 to 65535 can be stored and retrieved from these registers without any problems or complications The complications arise when the stored value is a floating point value, which by IEEE definition, require 4 bytes (32 bits) The IEEE standard for floating point values states in part that the *8 most significant bits represent the exponent* and the remaining 23 bits (plus one assumed bit) represent the mantissa and the sign of the value

Since a data "word" consists of two bytes, a floating point value is represented by two data words. Because a single Modicon register consists of one word (or 2 bytes), two consecutive Modicon registers are needed to store one floating point value.

The representation of a floating point value can be broken down into a "High Order" and a "Low Order" word. Additionally, each word can be broken down into a high order byte and a low order byte

Table 31 and Table 32 depict how a IEEE floating point value is usually represented and how the Modicon stores a floating-point value

The complications arise because Modicon doesn't store floating point values in this standard (IEEE) format. Modicon stores floating point values the opposite way with the "Low-order" word in the first register and the "High-order" word in the second register

Table 31 IEEE Floating Point Representation

First Register (i.e., 4001)		Second Register (i.e., 4002)	
High Word, High Byte	High Word, Low Byte	Low Word, High Byte	Low Word, Low Byte

Table 32 Floating Point Values Representation

First Register (i.e , 4001)		Second Register (i e 4002)	
Low Word, High Byte	Low Word Low Byte	High Word High Byte	High Word Low Byte

Since the Modbus protocol doesn t define how floating point values are handled or stored, some Modbus-capable servers incorrectly use the normal 'High word — Low word" format for converting the Modbus message response to the client application Since Modicon stores the floating point values in the oppOodbus and floating point numbers

Port Expanders and Protocol Converters

In some situations there may not be a Modbus ASCII port available for use with the 980 Flow Meter A good example might be where there is a need to install a flow meter at a remote pump site that already has a single Modbus line connected to a PLC that is used to control the pumps

Port expanders are available from third party manufacturers these allow several Modbus slave devices to be connected to a single Modbus Master device Typically, a single port expander will have 3–5 separate Modbus ports on it Depending on the manufacturer, the user may be able to configure each of these ports for different communications parameters In essence not only does this type of port expander allow multiple slave devices to be connected to a single Modbus master device, but it can also be configured to convert incompatible communications parameters such as Modbus ASCII to RTU (or *vice versa*) *baud rate parity, stop bits etc*

In addition to the port expanders mentioned above other protocol converters from third-party manufacturers can be used to convert other industrial protocols to Modbus ASCII

Other Reference Material

SCADA ANSI Soecification ANSI/IEEE Std C37 1–1994

Boyer, Stuart A *SCADA supervisory control and data acquisition* Research Triangle Park, NC Instrument Society of America 1993

MODICON *Modicon modbus protocol reference guide* North Andover MA MODICON, Inc , Industrial Automation Systems 1996

AEG Schneider Automation *Modicon ladder logic block library user guide* North Andover, MA AEG Schneider Automation Inc 1996

Troubleshooting Tips

Problem: 980 Flow Meter responds to some Modbus messages but not all

Response: Check the Register Addresses
The flow meter will only respond to valid Modbus message requests If a Modbus message sent to the flow meter asks for stored register addresses for values that are outside of the address range currently supported by the meter the meter will ignore the request

The flow meter currently only supports register addresses 40001 through 40083 Consequently, a request to read the value in any register address greater then 40083 will be ignored If a range of registers is requested and that range includes register addresses greater then 40083 the entire request will be ignored

Response: Check the number of registers being polled
Additionally, the 980 Flow Meter checks all Modbus messages to see if the correct number of registers is requested for the type of data being returned The meter will ignore the request if the number of registers requested does not coincide with the correct number of registers needed to accurately display the data For example, Velocity is a floating point value stored in register 40009–40010 Because all floating point values require two registers the meter would ignore a request to read just the data in register 40009 yet it would respond correctly to a request to read the data stored in both registers 40009 AND 40010 Consequently if the meter received a single request to read both Level 40007–40008 and Velocity 40009–40010 the request would have to be for an even number of registers for the meter to respond

Problem 980 Flow Meter does not respond to any Modbus message requests

Note It is imperative that the DTR be asserted prior to the communication session and that it remains asserted throughout the entire communication session

Response: Check the DTR Signal/Line
The 980 Flow Meter will not respond to any Modbus messages until the device connected to the RS232 port asserts (raises) the DTR line (DB 9 Pin 4 on the 1727 cable)

Response: Check the Baud Rate
The baud rate of the 980 Flow Meter is configured from 1200–19 200 and must match the baud rate of the device communicating with the meter

Response: Check the Communication Parameters
The communications parameters of the 980 Flow Meter meter are fixed (except for the baud rate) and can not be changed The device communicating with the flow meter must be configured with the exact same communication parameters as the meter These parameters are as follows

- 7 Data Bits
- 1 Start bit
- 1 Stop bit
- Even parity

Response: Check the Modbus Device Address assigned to the 980 Flow Meter
Modbus devices, including the 980 Flow Meter have a unique configured device address in the range of 1 to 247 This address is embedded in the first two characters of the Modbus message The flow meter will only respond to messages encoded with the same address as the meter If the meter receives a valid Modbus message with an encoded device address other than the address the meter is configured for it will ignore that message

Response: Check the Modbus mode
There are two different forms of Modbus ASCII and RTU Currently the 980 Flow Meter only support Modbus ASCII Consequently the device communicating with the meter must be setup for Modbus ASCII The meter will not respond to Modbus RTU messages

Problem: The data values being returned by polling the meter with Modbus are not the same as the data values displayed in the current status screen of the meter

Response Confirm that the correct register addresses are being polled
Check to make sure the register address being polled corresponds to the correct data channel For example if polling for FLOW make sure the server or MMI is requesting data from registers 40033–40034

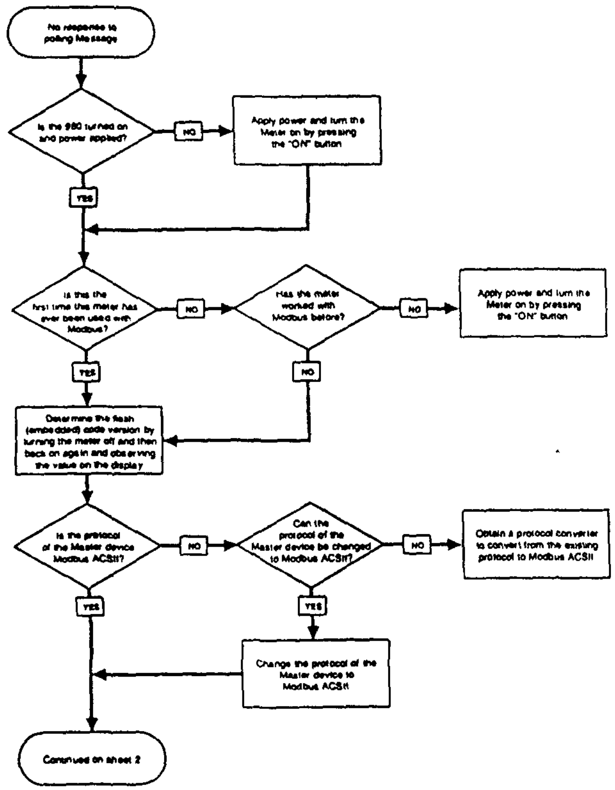
If polling for several values at the same time try changing the polling so that only one value is polled at a time Then check to see if the polled value matches a *different* data channel in the meter For example if polling for Level and it appears that you are getting the data for Velocity instead you probably are polling the wrong registers

Response. Check the data format of the Modbus server
When configuring a Modbus server or MMI application to poll a 980 Flow Meter it is absolutely essential that the correct data format is selected for that particular data channel (register) For example when polling for Flow Level or Velocity which are all floating point values the Modbus server or MMI must be configured to read these values as floating point values If the server or MMI is formatting this data as a data type other then floating point the values will not be read or displayed correctly

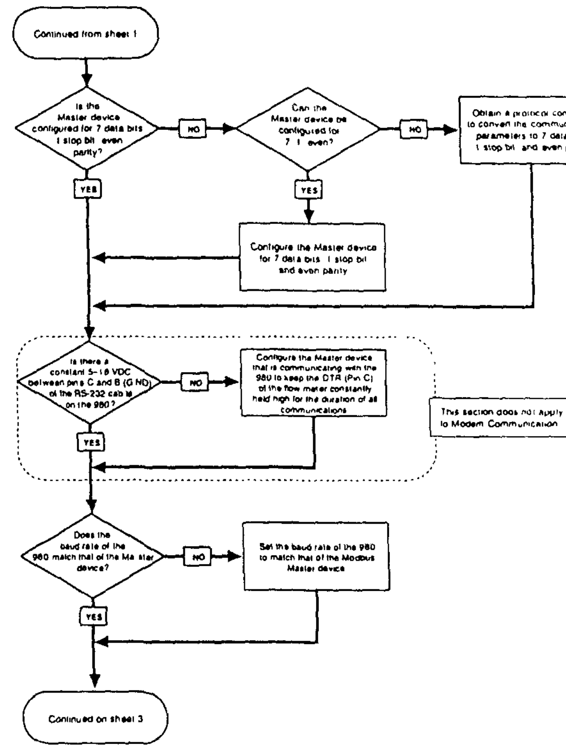
Likewise if polling the meter for engineering units which are represented by integer values such as Flow Units of Measure or Level Units of Measure the Modbus server or MMI must be configured to read these values as Integers If the server or MMI is formatting this data as any data type other than integer the values will not be read or displayed correctly

Different Modbus servers and MMI manufacturers have different methods for configuring the application to the appropriate data type contained within the register Contact the server or MMI manufacturer for details on how to configure the application to read the data in the correct format

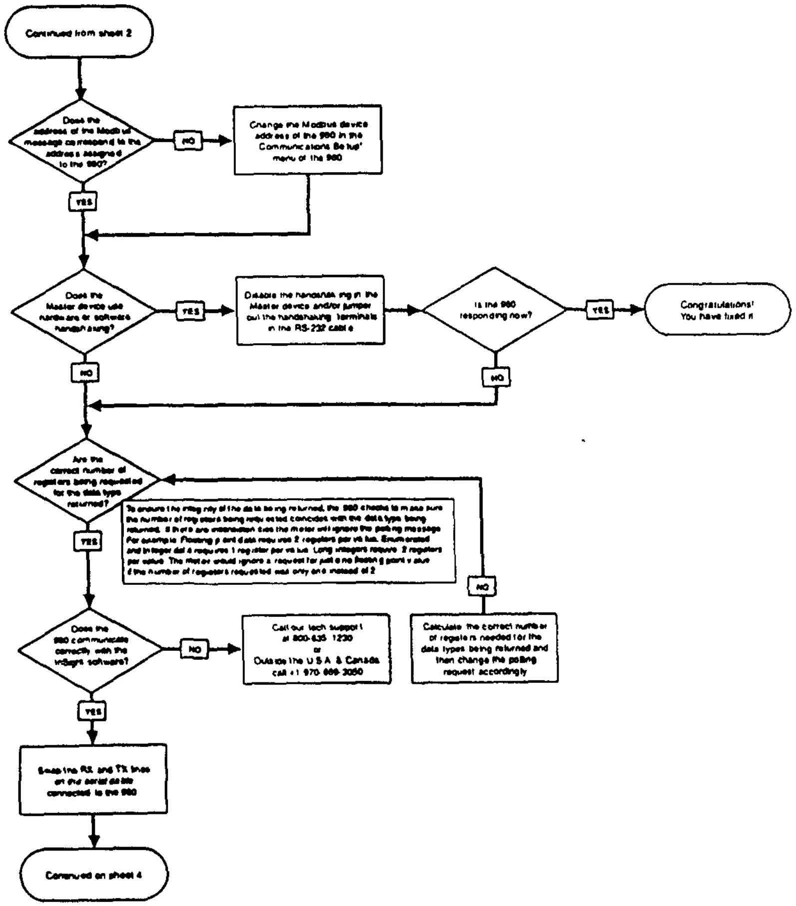
980 SCADA-Modbus "No Response" Troubleshooting Flow Chart (1 of 5)



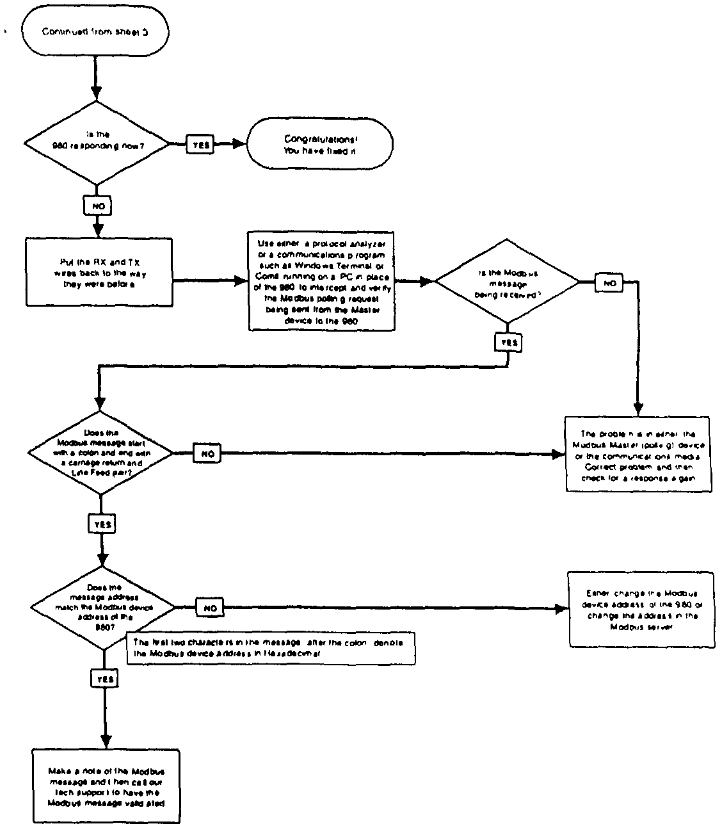
980 SCADA-Modbus "No Response" Troubleshooting Flow Chart (2 of 5)



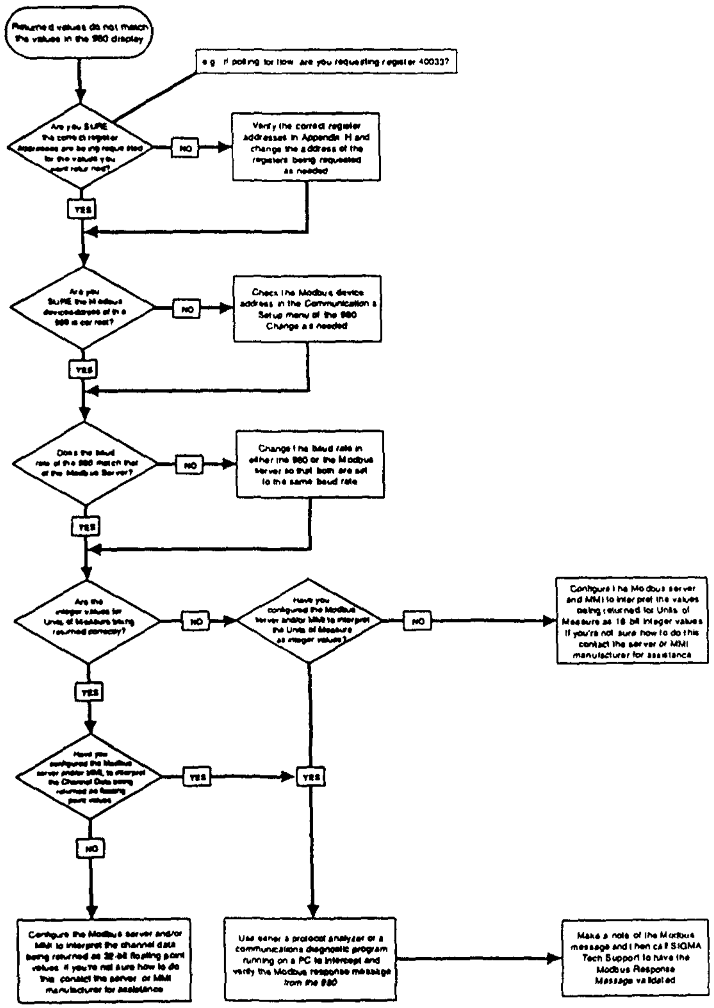
980 SCADA-Modbus "No-Response" Troubleshooting Flow Chart (3 of 5)



980 SCADA-Modbus "No-Response" Troubleshooting Flow Chart (4 of 5)

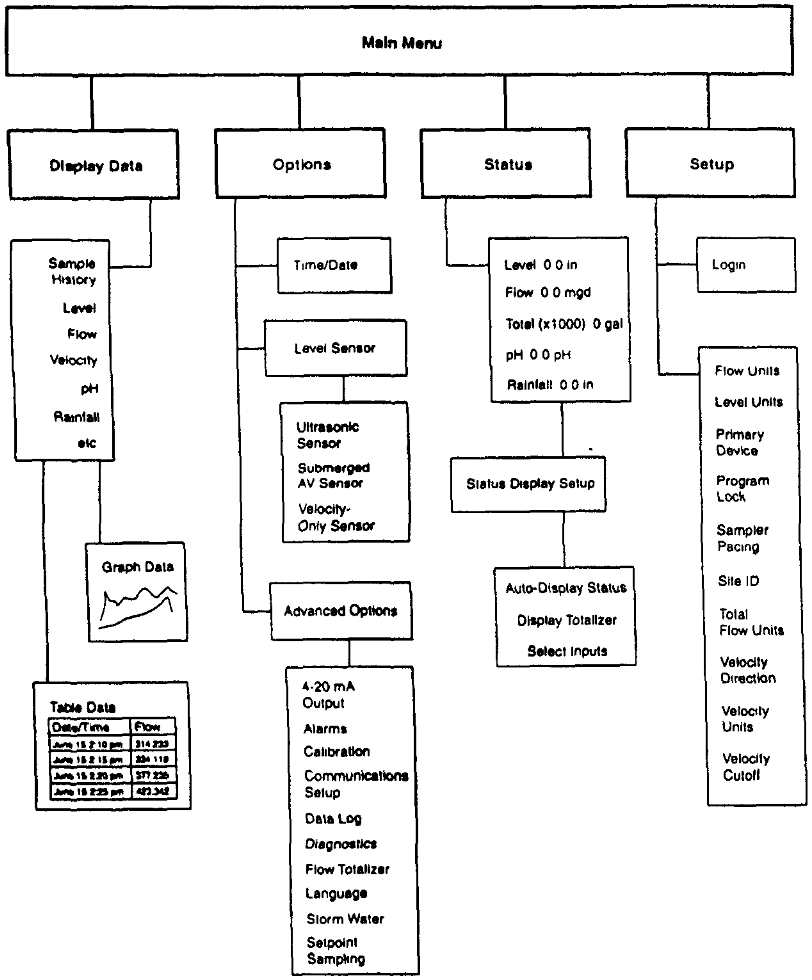


980 SCADA-Modbus "No Response" Troubleshooting Flow Chart (5 of 5)



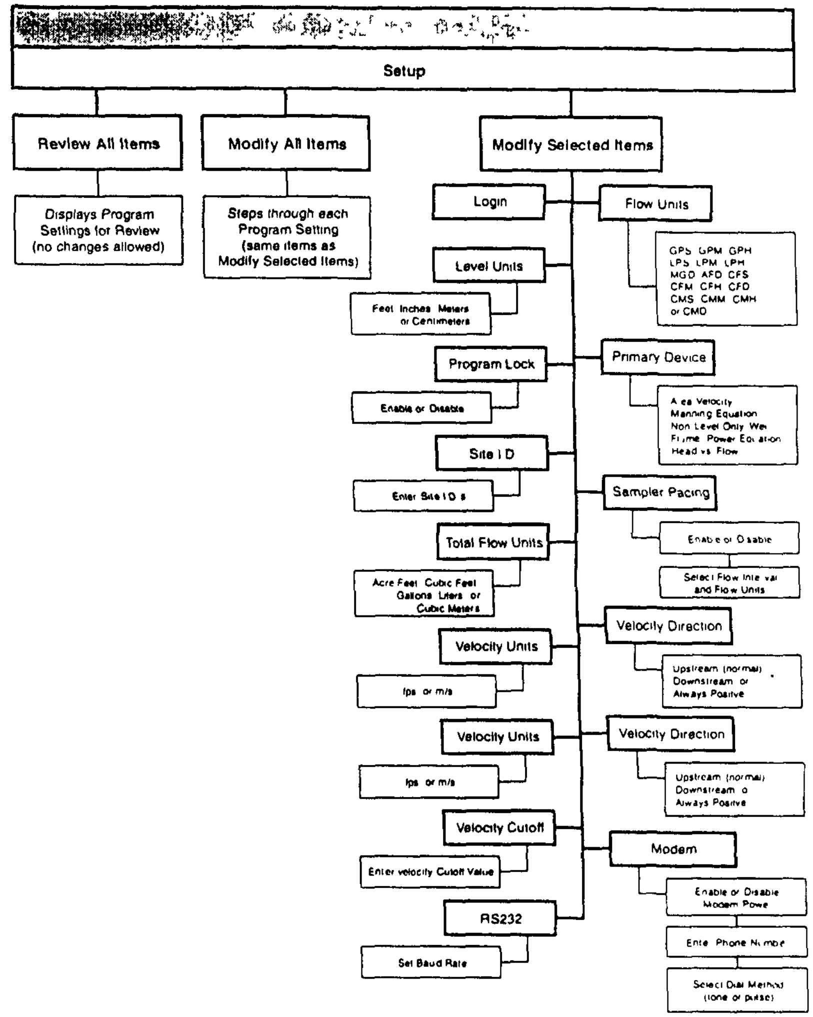
Appendix F 980 Quick-Start Guides

Main Program Flow Chart

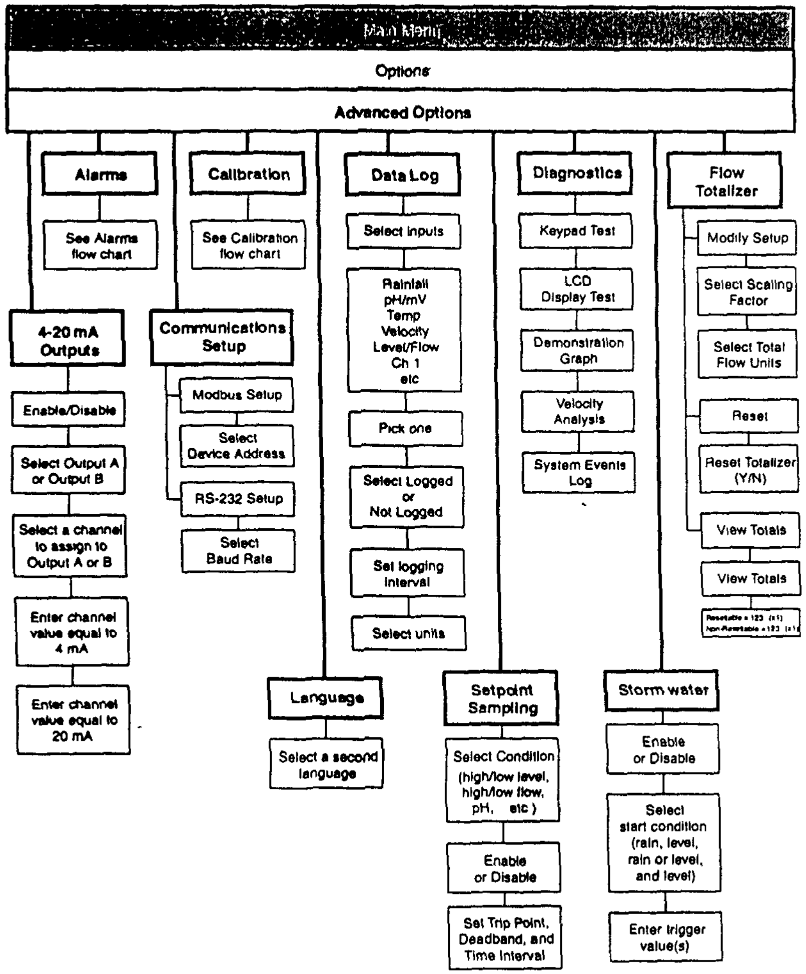


Appendix F

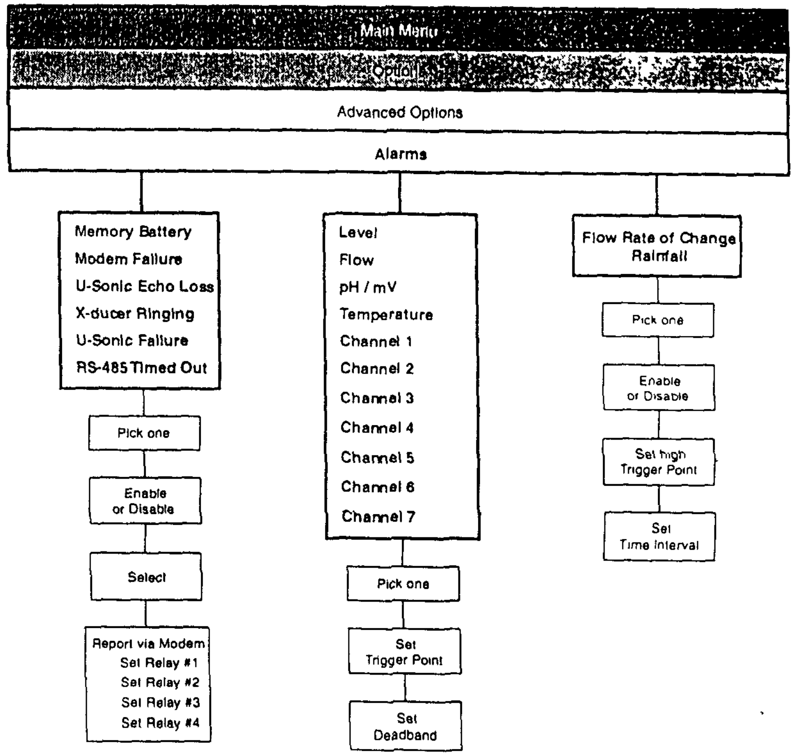
980 Flow Meter Basic Programming Setup Flow Chart



980 Flow Meter Advanced Options Flow Chart



980 Alarms Flow Chart



AMERICAN SIGMA

GENERAL INFORMATION

At American Sigma, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience

Logger Mounting Accessories

Description	Part Number
Rail / Pole Mounting	9709100
Wall Mounting Bracket	4424700

Sensors and Accessories for Use with the 980 Flow Meter

In-Pipe Ultrasonic Sensor Mounting Accessories

Mounting Band Set for 15–42" pipes	3766
Mounting Clip (for use with Cat No 3766)	3868
Mounting Clip permanent (screws to channel wall)	3875
Mounting Ring 6" with integral in pipe sensor mounting clip and velocity sensor mounting holes	4021
Mounting Ring 8" with integral in pipe sensor mounting clip and velocity sensor mounting holes	4022
Mounting Ring 10" with integral in pipe sensor mounting clip and velocity sensor mounting holes	4023
Mounting Ring 12" with integral in pipe sensor mounting clip and velocity sensor mounting holes	4024

Keppler Submerged Depth/Velocity Sensor

Cable max length 100	9702400
Junction Box	9702500
Keppler Submerged Depth/Velocity Sensor 0 10 with connector	9701600
Keppler Submerged Depth/Velocity Sensor 0 10 with bare leads	9701700
Keppler Submerged Depth/Velocity Sensor 0 30 with connector	9701800
Keppler Submerged Depth/Velocity Sensor 0 30 with bare leads	9701900

Submerged Depth/Velocity Sensor

Cable Submerged Depth/Velocity Sensors max length 100	9702400
Junction Box Submerged Depth/Velocity Sensors	9702500
Submerged Depth/Velocity Sensor 0 10 with connector	9701200
Quick-Connect Hub	9702700
Submerged Depth/Velocity Sensor 0 30 with connector	9701400
Quick Connect Hub	9702700
Submerged Depth/Velocity Sensor 0 10 with bare leads	9701300
Submerged Depth/Velocity Sensor 0 30 with bare leads	9701500

Ultrasonic Sensor

Cable Standard Length 500	*9702300*
Ultrasonic Sensor 75 kHz	9701100

Velocity-Only Sensor

Cable max length 100	9708000
Velocity Probe w connector	9707800
Velocity Probe w bare leads	9707900

Sensor Mounting Hardware

Submerged Area Velocity Sensor Mounting Accessories

Insertion Tool for street level installation of mounting rings	*9574*
Mounting Ring for 6" diameter pipe (requires Cat No 3263)	1361
Mounting Ring for 8" diameter pipe (requires Cat No 3263)	1362
Mounting Ring for 10" diameter pipe (requires Cat No 3263)	1363
Mounting Ring for 12" diameter pipe (sensor mounts directly to band)	1364
Mounting Ring for 15" diameter pipe (sensor mounts directly to band)	1365
Mounting Ring for 18" diameter pipe (sensor mounts directly to band)	1366
Mounting Ring for 20–21" diameter pipe (sensor mounts directly to band)	1353
Mounting Ring for 24" diameter pipe (sensor mounts directly to band)	1370
Mounting Plate wall mount sensor	4939
Mounting Band for 15 in Pipes	9706100
Mounting Band for 18 in Pipes	9706200

Mounting Band for 21 in Pipes	9706300
Mounting Band for 24 in Pipes	9706400
Mounting Band for 27 in Pipes	9706500
Mounting Band for 30 in Pipes	9706600
Mounting Band for 33 in Pipes	9706700
Mounting Band for 36 in Pipes	9706800
Mounting Band for 42 in Pipes	9706900
Sensor Mounting Clip for use with mounting bands	3263

Ultrasonic Sensor Mounting Hardware

Adjustable Mounting Bracket	2904
Permanent Wall Mount Bracket	2974

Description		Part Number
1 AMP 250 V Fuse		015804
AA Alkaline Batteries (1)	3 required	SE989
AC Power Cord 115 V ac (North American Style Plug) ncludes Heyco Strain Relief		4630600
AC Power Cord 230 V ac (Continental Style European Plug) includes Heyco Stra n Rel ef		4630800
Cable Sampler or Flow Meter to PC		1727
Conduit Hub ½ in sealing style		16483
Conduit Hub 1 in sealing style		4913600
Desiccant Refill		3624
DTU to PC Cable 115 V ac		3513
DTU to PC Cable 230 V ac		3580
DTU II with #1726 DTU to Sampler/Flow Meter Cable #3513 DTU to-PC Cable 115 V ac		3516
DTU II with #1726 DTU to Sampler/FLow Meter Cable #3512 DTU to PC Cable 230 V ac		3517
Heyco Fitting Fits 0 20 0 35 cable O D		9711400
Heyco Fitting Fits 0 23 0 47 cable O D		9711300
InSight® Gold Software (includes 10 ft sampler to flow meter to PC cable (P/N 1727)		6210000
Locknut ½ in Conduit (for Heyco fitting)		10596 12
Multi Purpose Half Cable 25 6 pin connector and opens leads end		9708600
Multi Purpose Half Cable 10 6 pin connector and open leads end		9708700
pH Temperature Probe 25 cable		9708100
pH Temperature Probe 50 cable		9708200
Plugs NEMA ½ in sealing style		4221000
Plugs NEMA 1 in sealing style		4052400
Rain Gauge 25 cable		9708400
Rain Gauge Cable max length 100		9708500
Washer Sealing (for Heyco fitting)		10338 14

Ordering and Technical Support

U.S.A. Customers

By Telephone:
(800) 635-4567

By Fax:
(970) 669-2932

Ordering Information by E-mail:
sigma@americansigma com

By Mail:
American Sigma
PO Box 389
Loveland Colorado 80539 0389
USA

Information Required

- American Sigma account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Ordering Outside the U.S.A.

American Sigma maintains a worldwide network of dealers and distributors To locate the representative nearest you, send E-mail to or contact intl@hach com

Technical Support in the U.S.A. or Outside Europe

Technical and Customer Service Department personnel are eager to answer questions about our products and their use In the U S.A , call 1-800-635-1230 or send E-mail to techhelp@hach com Outside the U S A and Europe send E-mail to intl@hach com

Technical Support for European Customers

Contact Bühler Montec Group, Ltd

By Telephone:
+44 (0) 161 872 1487

By Fax:
+44 (0) 161 848 7324

By E-mail:
helpdesk@bmgl com

By Mail:
Bühler Montec Group, Ltd
Pacific Way
Salford
Manchester
M5 2DL
UK

Repair Service

Authorization must be obtained from American Sigma before sending any items for repair Please contact the American Sigma Service Center serving your location

In the United States or Outside Europe

American Sigma
PO Box 389
Loveland, Colorado 80539 0389 U S A

Telephone 1-800-635-1230 or (970) 669 3050
Fax (970) 669-2932

In Europe

Bühler Montec Group Ltd
Pacific Way
Salford
Manchester
M5 2DL
UK

Fax +44 (0) 161 848 7324
E mail helpdesk@bmgl com
By Telephone +44 (0) 161 872 1487

American Sigma warrants this product to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment.

In the event that a defect is discovered during the warranty period, American Sigma agrees that, at its option, it will repair or replace the defective product or refund the purchase price, excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact American Sigma or your distributor to initiate warranty support. Products may not be returned without authorization from American Sigma.

Limitations

This warranty does not cover:

- ***Damage caused by acts of God, natural disaster, labor unrest,* acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction**
- **Damage caused by misuse, neglect, accident or improper application or installation**
- **Damage caused by any repair or attempted repair not authorized by American Sigma**
- **Any product not used in accordance with the instructions furnished by American Sigma**
- **Freight charges to return merchandise to American Sigma**
- **Freight charges on expedited or express shipment of warranted parts or product**
- **Travel fees associated with on-site warranty repair**

This warranty contains the sole express warranty made by American Sigma in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of American Sigma.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, *in no event shall American Sigma be liable for any incidental or consequential* damages of any kind for breach of warranty or negligence.

Certification

Hach Company certifies this instrument was tested thoroughly inspected and found to meet its published specifications when it was shipped from the factory The 980 Flow Meter has been tested and is certified as indicated to the following instrumentation standards

Product Safety

The 980 Flow Meter was tested with pH velocity and ultrasonic sensors connected

UL 3101-1 (ETL Listing # H0492805390)
CSA C22 2 No 1010 1 (ETLc Certification # H0492805390)
Certified by Hach to EN 61010-1 (IEC1010 1) per 73/23/EEC supporting test records by Intertek Testing Services

Immunity

The 980 Flow Meter and sensors were tested for Industrial level EMC per

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) per 89/336/EEC EMC Supporting test records by Hach Company certified compliance by Hach Company

Standards include:

IEC 1000-4-2 1995 (EN 61000-4 2 1995) Electro Static Discharge Immunity (Criteria B)
IEC 1000-4-3 1995 (EN 61000-4-3 1996) Radiated RF Electro Magnetic Field Immunity (Criteria A)
IEC 1000 4-4 1995 (EN 61000-4 5 1995) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5 1995 (EN 61000-4-5 1995) Surge (Criteria B)
IEC 1000-4-6 1996 (EN 61000-4-6 1996) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11 1994 (EN 61000-4-11 1994) Voltage Dip/Short Interruptions (Criteria B)

Additional Immunity Standard/s include.

ENV 50204 1996 Radiated Electro Magnetic Field from Digital Telephones (Criteria B)

Emissions

The 980 Flow Meter and sensors were tested for Radio Frequency Emissions as follows

Per 89/336/EEC EMC EN 61326 1998 (Electrical Equipment for measurement, control and laboratory use-EMC requirements) Class "A" emission limits Supporting test records by Hewlett Packard, Fort Collins Colorado Hardware Test Center (A2LA # 0905-01) certified compliance by Hach Company

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Additional Emissions Standard/s include:
EN 55011 (CISPR 11), Class "B" emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-causing Equipment Regulations

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada

Equipment Attachment Limitations in Canada

Notice: The Canadian Industry Canada label identifies certified equipment This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements *as prescribed in the appropriate Terminal Equipment Technical Requirements* document (s) The Department does not guarantee the equipment will operate to the user's satisfaction

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company The equipment must also be installed using an acceptable method of connection The consumer should be aware that compliance, with the above conditions, may not prevent degradation of service in some situations

Repairs to certified equipment should be coordinated by a representative of the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together This precaution may be particularly important in rural areas

FCC PART 15, Class "A" Limits

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company

This device complies with Part 15 of the FCC Rules Operation is subject to the following two conditions

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules These limits are

designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual may cause harmful interference to radio communications Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense The following techniques of reducing the interference problems are applied easily

1. Disconnect the 980 Flow Meter from its power source to verify that it s or is not the source of the interference
2. If the 980 Flow Meter is connected into the same outlet as the device with which it is interfering, try another outlet
3. Move the 980 Flow Meter away from the device receiving the interference
4. Reposition the receiving antenna for the device receiving the interference
5. Try combinations of the above

FCC Requirements

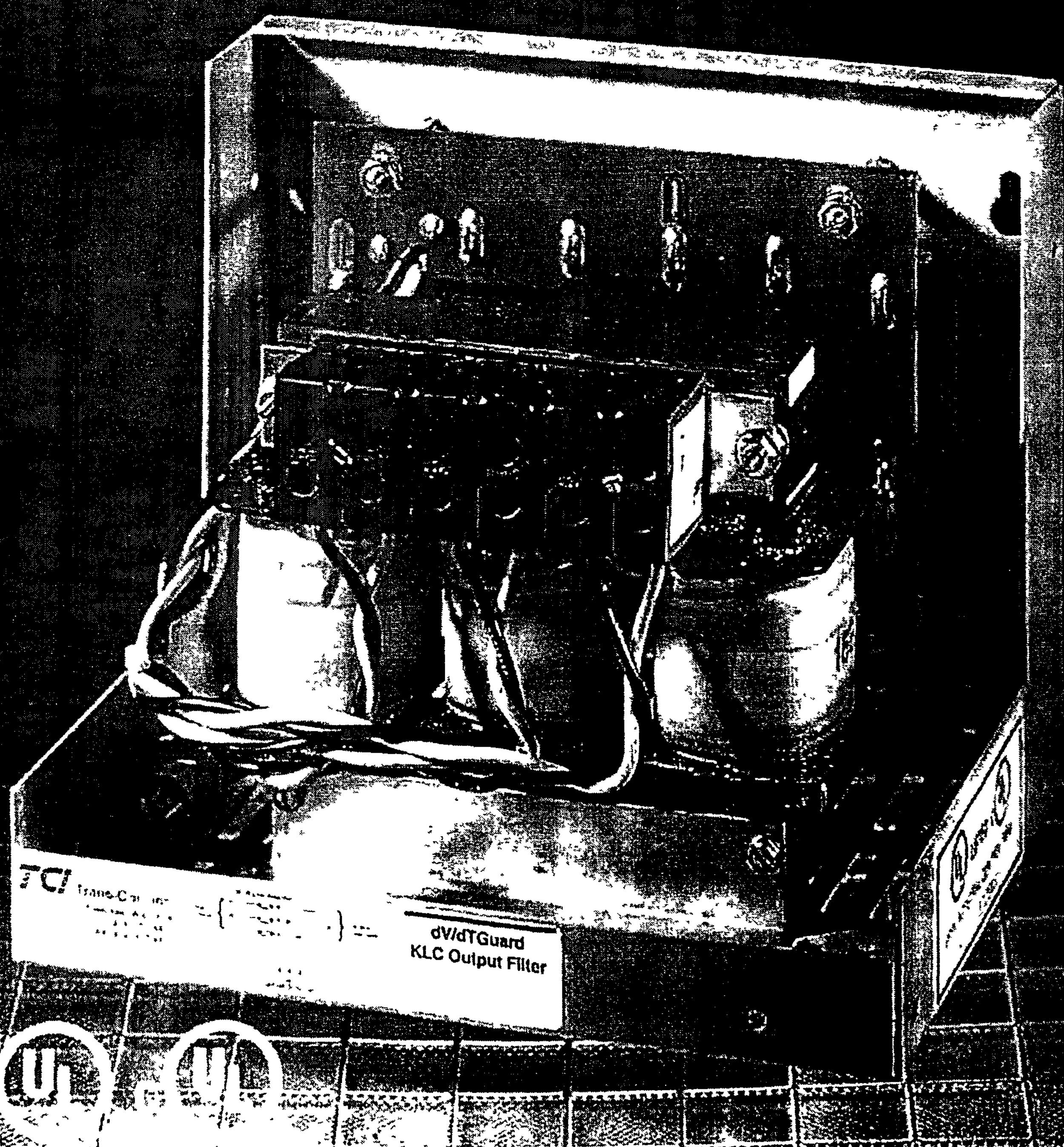
1. The Federal Communications Commission (FCC) has established Rules which permit this device to be directly connected to the telephone network Standardized jacks are used for these connections This equipment should not be used on party lines or coin lines
2. If this device is malfunctioning, it may also be causing harm to the telephone network, this device should be disconnected until the source of the problem can be determined and until repair has been made If this is not done, the telephone company may temporarily disconnect service
3. The telephone company may make changes in its technical operations and procedures, if such changes affect the compatibility or use of this device, the telephone company is required to give adequate notice of the changes
4. If the telephone company requests information on what equipment is connected to their lines, inform them of
   a. The telephone number that this unit is connected to
   b. The ringer equivalence number (1 4B)
   c. The USOC jack required (RJ11C) and
   d. The FCC Registration Number

Items (b) and (d) are indicated on the label The ringer equivalence number (REN) is used to determine how many devices can be connected to your telephone line In most areas, the sum of the RENs of all devices on any one line should not exceed five If too many devices are attached they may not ring properly

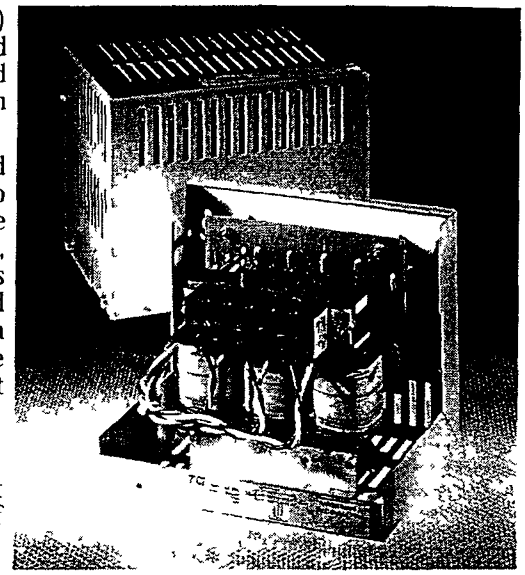
TCI
Output Filters

KLC™/KLCUL™ Output Filters

Performance and Protection for Drives



TCI's KLC & KLCUL dV/dTGuard Output Filters Provide Superior Patented Protection for Motors



As the technology of Pulse Width Modulated (PWM) Drives are incorporated into various applications and processes, the increased energy savings and decreased maintenance on Drives can be offset by increases in Motor failures

The dV/dTGuard product family has been designed as an engineered solution for motor failures due to the reflected wave phenomenon Designed to be installed at the output terminals of the Drive, dV/dTGuard Output Filters provide effortless installation, convenient accessibility and enhanced motor performance and durability Available in a UL/CUL version or in our original version, these products provide the outstanding performance that our customers have come to expect from TCI

Manufacturer's Warranty

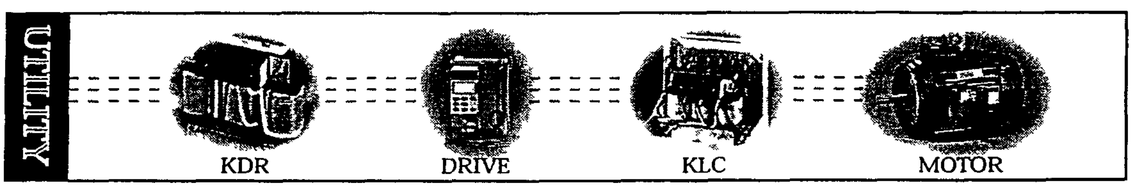
KLC and KLCUL Output Filters are warranted against Manufacturer's defect for one year from the date of original purchase.

Performance Guarantee

Properly applied and sized for the application, a KLC or KLCUL output filter is guaranteed to limit the peak voltage and reduce electrical stress on the motor insulation If a KLC or KLCUL fails to reduce peak voltages, TCI will take back the output filter and pay shipping both ways (Offer valid for 60 days from purchase date.)

Drawings/Specifications

Autocad compatible *.dxf drawings and Acrobat Reader compatible *.pdf drawings of all KLC and KLCUL dV/dTGuard Output Filters are available at www.transcoil.com or by contacting TCI at (800) 824-8282.



Typical Problems, Superior Solutions with KLC Products

The Reflective Wave Phenomenon

Variable Frequency Drives generate useful "fundamental" voltage and frequency using Pulse Width Modulation (PWM) for adjusting the speed of an AC motor. The Drive's inverter circuit "switches" (transitions from the off state to the on state) rapidly, producing a carrier containing the fundamental voltage and frequency. Voltage wave reflection is a function of the voltage rise time (dV/dT) and the length of the motor cables. The impedance on either end of the cable run does not match, causing voltage pulses to be reflected back in the direction from which it arrived. As these reflected waves encounter other waves, their values add, causing higher peak voltage. As wire length or carrier frequency increases, the overshoot peak voltage also increases. The dV/dT Motor Protecting Output Filters have been designed to limit peak voltage and increase voltage rise time. In specific applications, the KLC has peformed with cable runs of up to 3,000 feet.

dV/dT and Reflective Wave unsuppressed causes Motor failures

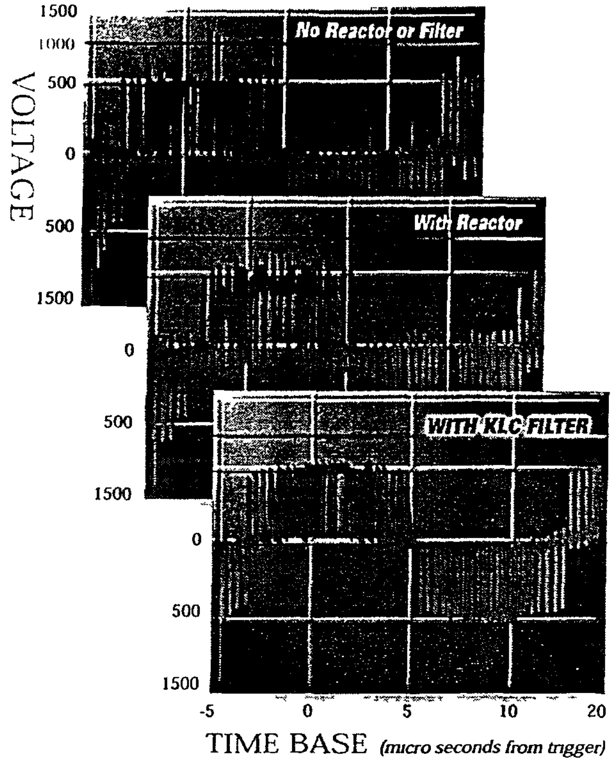
- Peak Voltages on a 460V system can reach 1200 to 1600 V, causing rapid breakdown of motor insulation, leading to motor failure. On 575 V systems, the peak voltages can easily reach 2100 V. If this is left uncontrolled, insulation failure may occur.

- The same peak voltages that damage the motor can also damage the cable. Since the KLC and KLCUL filters are designed to be placed at the output of the Drive, these units will also protect the cable runs.

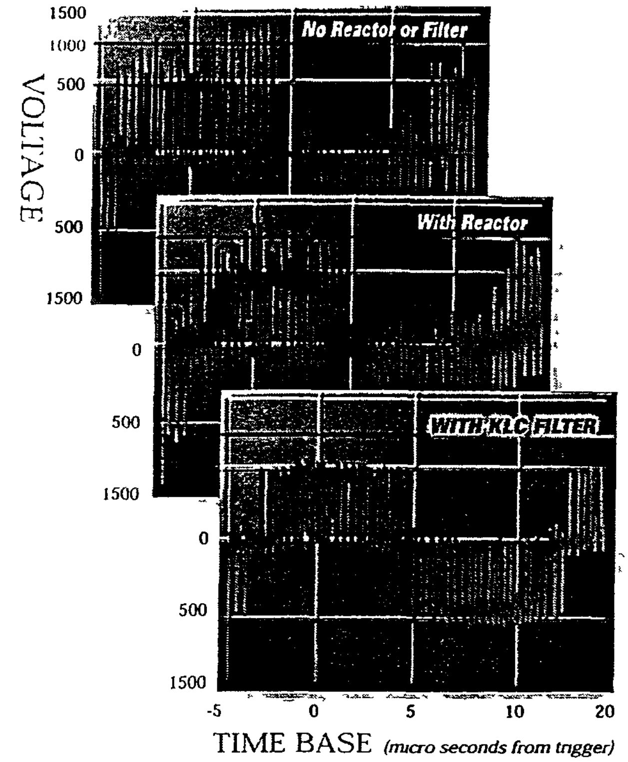
- The added inductance of a KLC or KLCUL filter will also help reduce motor heating, motor noise, and motor vibration by reducing the current harmonics in the system.

Carrier Frequency 2.5KHZ

70 Feet of Cable

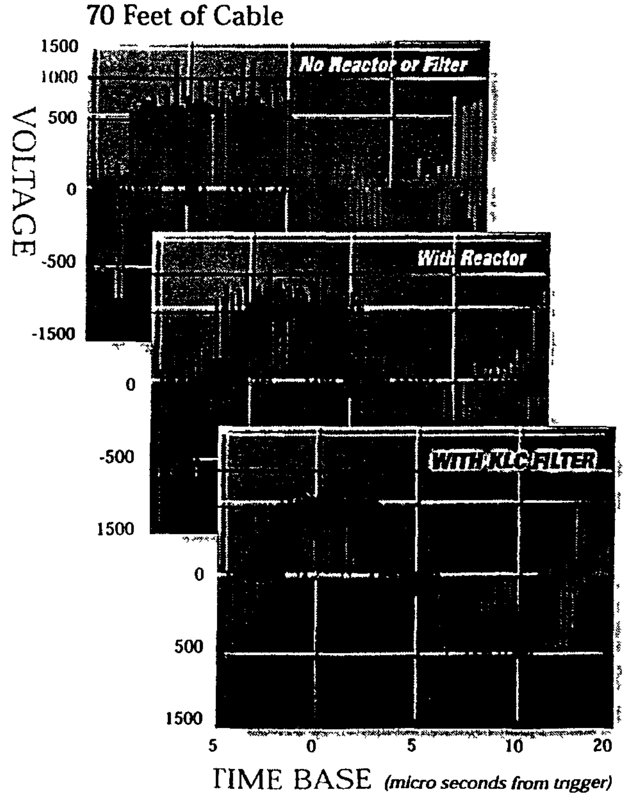


500 Feet of Cable

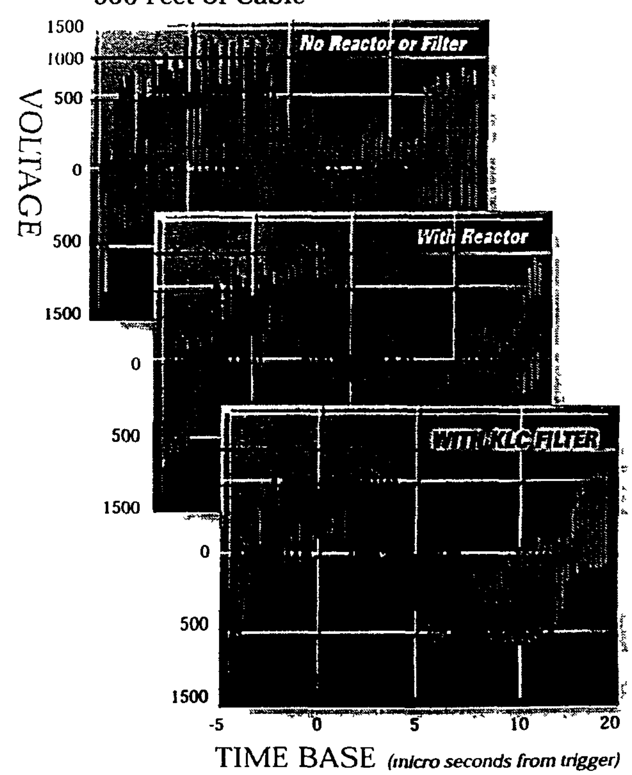


Carrier Frequency 8KHZ

70 Feet of Cable

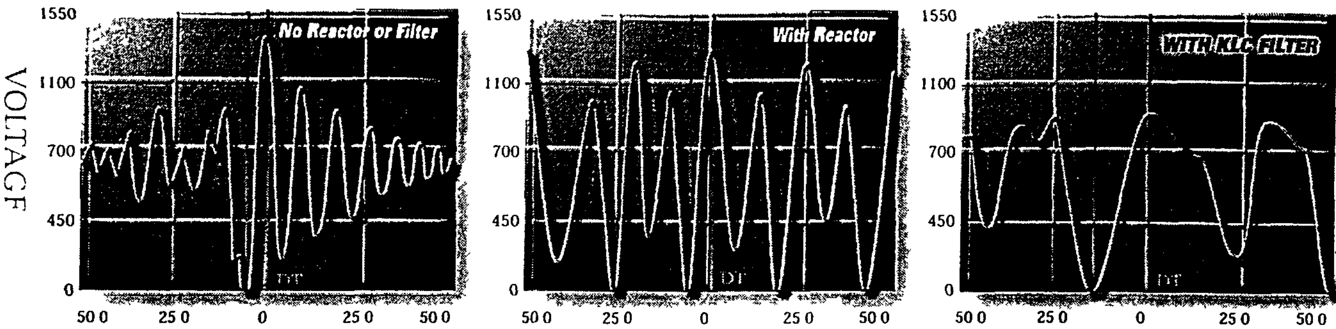


500 Feet of Cable



VOLTAGE RISE TIME

Carrier Frequency 8KHZ; 500 Feet of Cable
Rate of voltage rise at motor terminals



Standard Open dV/dT Motor Protecting Filter

PART NUMBER	RATED CURRENT	WATTS LOSS	STANDARD TERMS	DIMENSIONS (inches) HEIGHT	WIDTH	DEPTH	MTG A	MTG B	MTG C	MTG DIAGRAM	WEIGHT
KLC2B	2	75	TB	6 5	8	6	2 01	3 5	7	A	7
KLC4B	4	75	TB	6 5	8	6	2 01	3 5	7	A	7
KLC6B	6	80	TB	6 5	8	6	2 01	3 5	7	A	7
KLC8B	8	90	TB	6 5	8	6	2 01	3 5	7	A	9
KLC12B	12	95	TB	6 5	8	6	2 01	3 5	7	A	9
KLC16B	16	95	TB	6 5	8	6	2 01	3 5	7	A	11
KLC25B	25	110	TB	7 5	10	7	3 01	3 5	9	A	14
KLC35B	35	130	TB	7 5	10	7	3 01	3 5	9	A	15
KLC45B	45	135	TB	7 5	10	7	3 01	3 5	9	A	16
KLC55B	55	145	TB	7 5	10	7	3 01	3 5	9	A	17
KLC80B	80	255	RL	9	12	8	2 26	5 25	10 5	A	30
KLC110B*	110	245	CB	16	15	13	14 74	13 5	6	B	80
KLC130B*	130	270	CB	16	15	13	14 68	13 5	6	B	88
KLC160B*	160	260	CB	16	15	13	14 74	13 5	6	B	92
KLC200B*	200	265	CB	16	15	13	14 68	13 45	6	B	107
KLC250B*	250	290	CB	16	15	13	14 74	13 5	6	B	108
KLC300B*	300	325	CB	19	20	16	19 74	18 51	8	B	110
KLC360B*	360	300	CB	19	20	16	19 74	18 51	8	B	129
KLC420B*	420	450	CB	19	20	16	19 74	18 51	8	B	150
KLC480B*	480	475	CB	19	20	16	19 74	18 51	8	B	155
KLC600B*	600	515	CB	19	20	16	19 74	18 51	8	B	162
KLC750B	750	770	CB	13	15	15	Special Mount Dims	Special Mount Dims	Special Mount Dims	Special Mount Dims	165

Standard Enclosed dV/dT Motor Protecting Filter

PART NUMBER	RATED CURRENT	WATTS LOSS	STANDARD TERMS	DIMENSIONS (inches) HEIGHT	WIDTH	DEPTH	MTG A	MTG B	MTG C	MTG DIAGRAM	WEIGHT
KLC2BE	2	75	TB	6 5	8	6	2 01	3 5	7	A	9
KLC4BE	4	75	TB	6 5	8	6	2 01	3 5	7	A	9
KLC6BE	6	80	TB	6 5	8	6	2 01	3 5	7	A	9
KLC8BE	8	90	TB	6 5	8	6	2 01	3 5	7	A	11
KLC12BE	12	95	TB	6 5	8	6	2 01	3 5	7	A	11
KLC16BE	16	95	TB	6 5	8	6	2 01	3 5	7	A	13
KLC25BE	25	110	TB	7 5	10	7	3 01	3 5	9	A	16
KLC35BE	35	130	TB	7 5	10	7	3 01	3 5	9	A	17
KLC45BE	45	135	TB	7 5	10	7	3 01	3 5	9	A	18
KLC55BE	55	145	TB	7 5	10	7	3 01	3 5	9	A	19
KLC80BE	80	255	RL	9	12	8	2 26	5 25	10 5	A	32
KLC110BE*	110	245	CB	16	15	13	14 75	13 5	6	B	88
KLC130BE*	130	270	CB	16	15	13	14 68	13 5	6	B	96
KLC160BE*	160	260	CB	16	15	13	14 74	13 5	6	B	100
KLC200BE*	200	265	CB	16	15	13	14 68	13 45	6	B	115
KLC250BE*	250	290	CB	16	15	13	14 74	13 5	6	B	116
KLC300BE*	300	325	CB	19	20	16	19 74	18 51	8	B	130
KLC360BE*	360	300	CB	19	20	16	19 74	18 51	8	B	141
KLC420BE*	420	450	CB	19	20	16	19 74	18 51	8	B	162
KLC480BE*	480	475	CB	19	20	16	19 74	18 51	8	B	167
KLC600BE*	600	515	CB	19	20	16	19 74	18 51	8	B	174
KLC750BE	750	770	CB	36	28	30 19	28	26	24	B	225

The watts loss shown above are based on the effects of a sine-triangle modulated waveform at full load current, 60Hz fundamental, ith a carrier frequency setting of 4 kHz and a lead length of 500 (wire) feet using THHN cable It is important to note that ..s system specifics vary, so shall the watts loss

* Denotes the change from a wall mount unit to a floor mount unit and a change in the mounting diagram

Voltage Rise Time

While peak voltages can reach 1600V or more, it is important to note that these same spikes can have a rise time, dV/dT, in excess of 7500V/µs. Such high rise times can cause significant damage to the motor windings and the insulation system, resulting in premature motor failure. The life of the motor can be greatly extended by limiting both the magnitude of the voltage spikes to levels below 1000V and the dV/dT at the motor terminals to levels less than 1000V/µs on 480V systems.

UL Listed Open dV/dT Motor Protecting Filter

PART NUMBER	RATED CURRENT	WATTS LOSS	STANDARD TERMS	DIMENSIONS (inches) HEIGHT	WIDTH	DEPTH	MTG A	MTG B	MTG C	MTG DIAGRAM	WEIGHT
KLCUL2A	2	75	TB	6.5	8	6	2.01	3.5	7	A	9
KLCUL3A	3	75	TB	6.5	8	6	2.01	3.5	7	A	9
KLCUL4A	4	75	TB	6.5	8	6	2.01	3.5	7	A	10
KLCUL6A	6	80	TB	6.5	8	6	2.01	3.5	7	A	10
KLCUL8A	8	90	TB	6.5	8	6	2.01	3.5	7	A	10
KLCUL12A	12	95	TB	6.5	8	6	2.01	3.5	7	A	10
KLCUL16A	16	95	TB	6.5	8	6	2.01	3.5	7	A	14
KLCUL18A	18	110	TB	7.5	10	7	2.01	3.5	7	A	20
KLCUL21A	21	110	TB	7.5	10	7	2.01	3.5	7	A	20
KLCUL25A	25	110	TB	7.5	10	7	2.01	3.5	7	A	20
KLCUL27A	27	110	TB	7.5	10	7	2.01	3.5	7	A	20
KLCUL35A	35	130	TB	7.5	10	7	2.01	3.5	7	A	22
KLCUL45A	45	135	TB	7.5	10	7	2.01	3.5	7	A	22
KLCUL55A	55	145	TB	7.5	10	7	2.01	3.5	7	A	31
KLCUL80A	80	255	TB	9	12	8	2.26	5.25	10.5	A	38
KLCUL110A*	110	245	CB	16	15	13	14.74	13.5	6	B	45
KLCUL130A*	130	270	CB	16	15	13	14.74	13.5	6	B	52
KLCUL160A*	160	260	CB	16	15	13	14.74	13.5	6	B	66
KLCUL200A*	200	265	CB	16	15	13	14.74	13.45	6	B	68
KLCUL250A*	250	290	CB	16	15	13	14.74	13.5	6	B	68
KLCUL300A*	300	325	CB	19	20	16	19.74	18.51	8	B	83
KLCUL360A*	360	300	CB	19	20	16	19.74	18.51	8	B	94
KLCUL420A*	420	450	CB	19	20	16	19.74	18.51	8	B	114
KLCUL480A*	480	475	CB	19	20	16	19.74	18.51	8	B	119
KLCUL600A*	600	515	CB	19	20	16	19.74	18.51	8	B	125

UL Listed Enclosed dV/dT Motor Protecting Filter

PART NUMBER	RATED CURRENT	WATTS LOSS	STANDARD TERMS	DIMENSIONS (inches) HEIGHT	WIDTH	DEPTH	MTG A	MTG B	MTG C	MTG DIAGRAM	WEIGHT
KLCUL2A1	2	75	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	18
KLCUL3A1	3	75	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	18
KLCUL4A1	4	75	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	19
KLCUL6A1	6	80	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	19
KLCUL8A1	8	90	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	19
KLCUL12A1	12	95	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	19
KLCUL16A1	16	95	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	23
KLCUL18A1	18	110	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	26
KLCUL21A1	21	110	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	26
KLCUL25A1	25	110	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	26
KLCUL27A1	27	110	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	26
KLCUL35A1	35	130	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	27
KLCUL45A1	45	135	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	27
KLCUL55A1	55	145	TB	12.25	12.5	6.75	2.24	7.75	8.5	A	36
KLCUL80A2*	80	255	TB	19.13	15.5	15.5	15.22	13.72	10	B	64
KLCUL110A2*	110	245	CB	19.13	15.5	15.5	15.22	13.72	10	B	64
KLCUL130A2*	130	270	CB	19.13	15.5	15.5	15.22	13.72	10	B	74
KLCUL160A2*	160	260	CB	19.13	15.5	15.5	15.22	13.72	10	B	88
KLCUL200A3*	200	265	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	118
KLCUL250A3*	250	290	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	119
KLCUL300A3*	300	325	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	125
KLCUL360A3*	360	300	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	136
KLCUL420A3*	420	450	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	156
KLCUL480A3*	480	475	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	161
KLCUL600A3*	600	515	CB	22.13	20.5	24.37	20.21	18.71	17.5	B	167

Please note that although an open style KLC can be changed in the field to an enclosed version, the same is not true for the KLCUL style filters. The enclosed version of the KLCUL filters uses an entirely different style of enclosure.

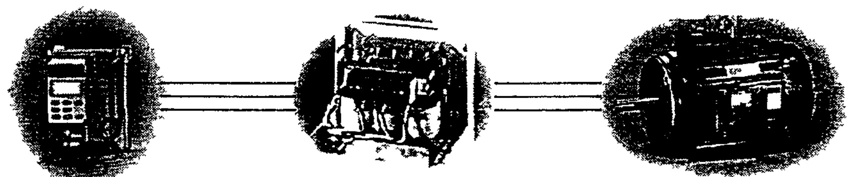
* Denotes the change from a wall mount unit to a floor mount unit and a change in the mounting diagram.

Considerations when Specifying and Selecting KLC/KLCUL Filters

KLC and KLCUL filters may be used in single Drive and Motor applications as well as a single Drive controlling multiple motors. In each case, there are some application guidelines that need to be followed in order to insure the optimum performance of your KLC or KLCUL Filter. Filters are sized based on the full load amps of the motor or motors.

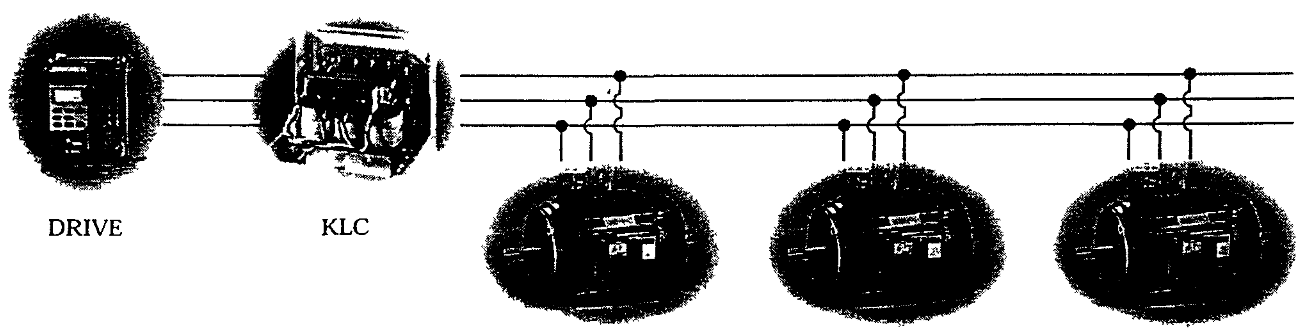
Single Drive, Single Motor

- Provide sufficient ventilation. Unit loss characteristics can be found on the selection charts on the previous pages.
- Mount the unit within ten (wire) feet from the drive
- Insure the Drive's carrier frequency is set to 8kHz or below and the operating frequency is set to 60 Hz or below. A carrier frequency of 4 kHz is recommended.
- Connect the drive output leads to the A1, B1, and C1 terminations of the KLC or KLCUL unit. A2, B2, and C2 service the wire to the motor.
- If system requirements are outside of the above recommendations, please contact the factory.



Single Drive. Multiple Motors

- Provide sufficient ventilation. Unit loss characteristics can be found on the selection charts on the previous pages.
- Mount the unit within ten (wire) feet from the drive
- Insure the Drive's carrier frequency is set to 4 kHz or below and the operating frequency is set to 60 Hz or below.
- Connect the drive output leads to the A1, B1, and C1 terminations of the KLC or KLCUL unit. A2, B2, and C2 service the wire to the motor.
- The length of each motor lead should be less than 500 feet and the sum total of all the leads should be less than 1500 feet
- Total number of motors should be 10 or below



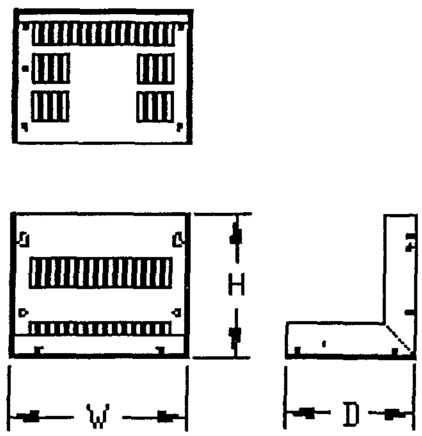
Do not operate the Drive/KLC configuration into unterminated long leads as the gross impedance mismatch will cause excessive heating in the unit's damping resistors.

It is recommended that the unit not be mounted above the Drive, as this may affect the ambient temperature of the filter.

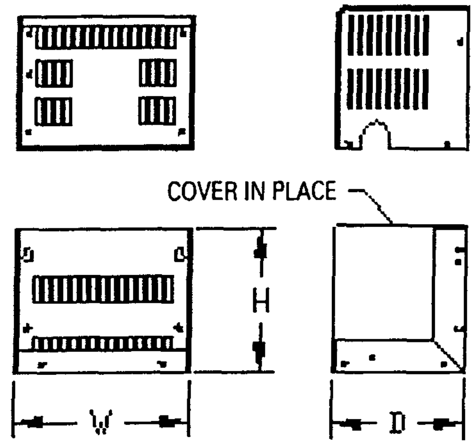
Upon system start up, observe the KLC or KLCUL unit for a minimum of 30 minutes. Under normal operating conditions, the filter components will be too hot to touch (in excess of 100 degrees C). However, if there is any noticeable component discoloration , remove the filter from the system and consult the factory.

KLC / KLCUL Open & KLC Enclosed

KLC & KLCUL OPEN



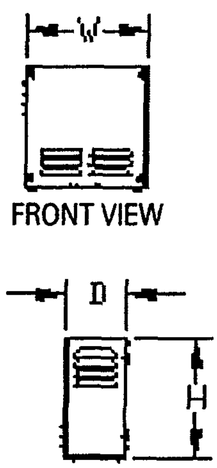
KLC ENCLOSED



KLCUL Enclosed

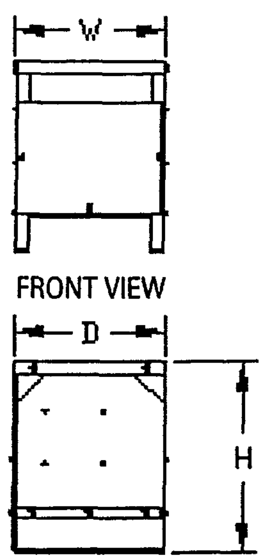
KLCUL ENCLOSED

SIZE 1



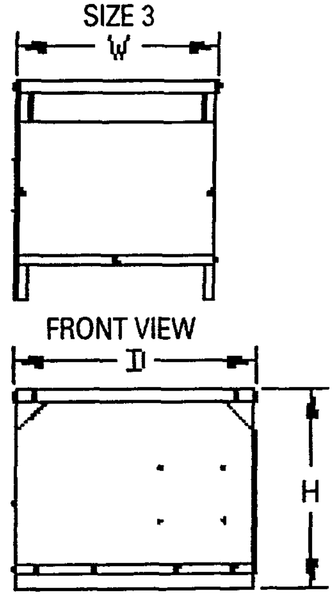
SIDE VIEW

SIZE 2



SIDE VIEW

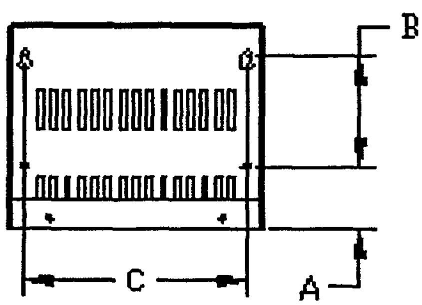
SIZE 3



SIDE VIEW

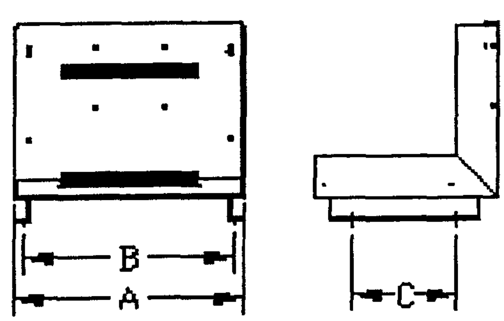
Mounting Diagrams

DIAGRAM A



WALL MOUNT

DIAGRAM B



FLOOR MOUNT

KLC/KLCUL Product Specifications

- 3 Phase, 600V Class
- KLCUL is UL and CUL Listed
- Manufacturer's Warranty
- Performance Guarantee
- High Performance
- NEMA 1 enclosures available
- Inductor uses Distributed Gap Technology
- 40 degrees C ambient temperature
- 180 degrees C or 220 degrees C Inductor insulation rating
- Specific applications can reach 3000 feet
- Single motor or multiple motor capable

Performance and Protection For Drives

TRANS-COIL, INC.

7878 North 86th Street, Milwaukee, WI 53224

PHONE 1-800-824-8282 FAX (414) 357-4484

WEB www.transcoil.com

REV.01-02-02

Installation Notes

Thank you for purchasing a TCI dV/dTGuard™ KLC filter.

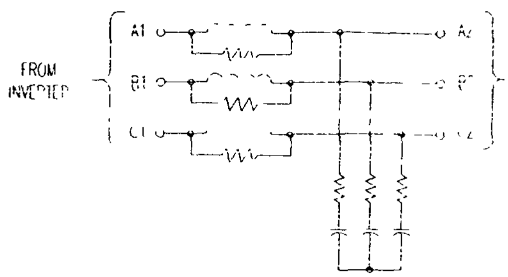
Due to the wide range of variables in any electrical system, we recommend that some consideration and care be taken during the installation and application of your new filter. Please consider the following instructions:

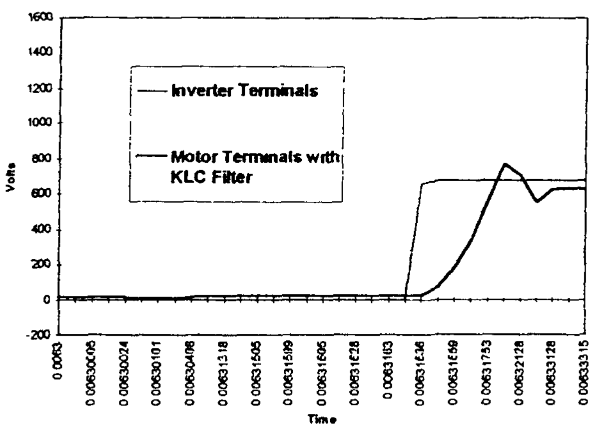
1. Mount the KLC filter so that the enclosed KLR line reactor is positioned vertically. (The line reactor labels should be facing up.)
2. Provide sufficient ventilation. KLC filter watts loss characteristics can be found in the product literature. (Or contact Technical Support at 800-824-8282.)
3. Locate the filter within ten (wire) feet from the drive that it services.
4. Connect the drive output leads to the A1, B1 and C1 terminations of the KLC. A2, B2 and C2 service the wire to the motor.
5. Set the drive's carrier frequency to 8kHz or below and operating frequency to 60Hz or below. (If the application requires frequencies above these, some special considerations may be required. Please consult Technical Support.)
6. Upon installation, observe the temperature of the device for a minimum of 30 minutes. Under normal operating condition, the filter (especially the board-mount resistors) will be too hot to touch. However, if noticeable discoloration appears, remove the filter from the system, and contact Technical Support.

Thank you again for choosing the TCI KLC filter. With a few minutes of your time, it will afford your system years of carefree service.

The Dampened Low-Pass KLC Output Filter (Patent Pending)

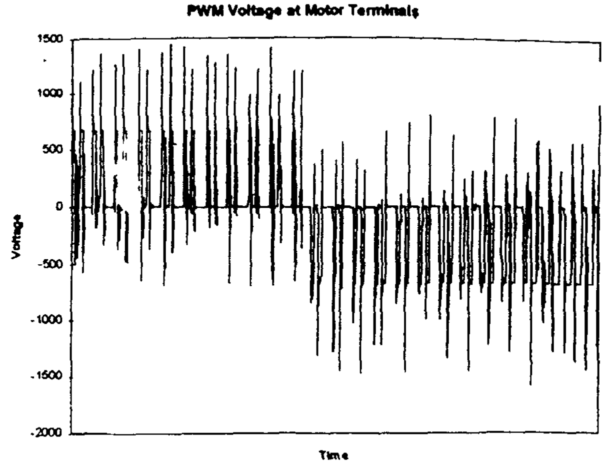
A TCI KLC filter combines inductance, capacitance, and resistance, (see schematic), to form a dampened low-pass filter with a break frequency in the range of 25 to 55 kHz.



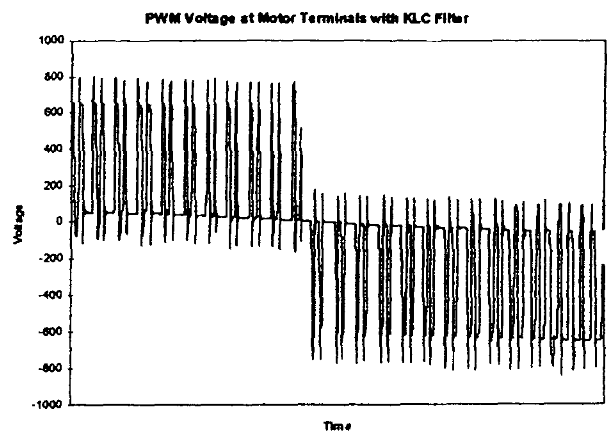


The KLC filter does not attempt to strip the entire carrier frequency. Instead, it is designed to simply slow down the steep edges of the PWM voltage waveform. It is not the carrier itself that produces motor failures. Rather, it is the high dV/dT (steep edge) of the PWM waveform that induces a damaging voltage overshoot. The KLC filter is specifically designed to reduce voltage waveform dV/dT. By doing so, it will also lower the dV/dT's associated frequency to levels well below the expected natural resonant wire frequency for runs ranging from 50 to 3000 ft. Consequently, the wire will no longer be able to resonate because the higher frequency components are gone.

KLC's high coefficient of dampening ensures minimal overshoot on even the longest leads. The voltage waveforms shown offer a full cycle view of the PWM voltage measured before and after the application of KLC.



Careful consideration was given to the selection of series inductance to minimize the insertion loss and, therefore, the voltage drop. System losses are held to well below 1% of the drive/motor rating.



Both the break frequency and the high level of dampening ensure that *KLC can be confidently applied with any drive and motor.*

Recommended Reading:

[1] A. von Jouanne, P. Enjeti, W. Gray, The Effect of Long Motor Leads on PWM Inverter Fed AC Motor Drive Systems, IEEE, 1995.

TRANS-COIL, INC.
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E-mail tcinet@execpc.com • www.transcoil.com

Application Notes and Codes

KLC output filters are current-rated devices. Therefore, know the total motor load on the inverter for proper application. KLC filters are designed to be located immediately adjacent to the output terminals of the drive and to be wired directly to the drive. Placement of the filters anywhere else in the circuit will negativelly impact performance. Therefore, never connect the KLC filter to the motor terminals when using a line bypass system.

KLC filters 80A and below are wall-mountable devices. Unrestricted air flow under and over the filter is required. KLC filters above 80A are floor or wall-mountable. Floor-mountable models are supplied with legs.

NEMA 1 shrouds are available and shown on the dimension drawings. To order a KLC filter with a NEMA 1 shroud, add an "E" to the end of the standard KLC part number.

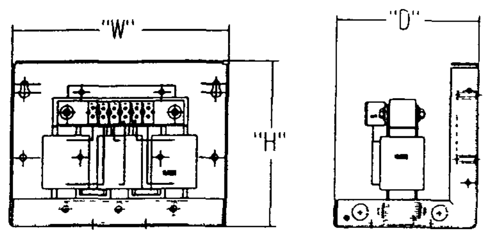
KLC is Patent-Pending

KLC Warranty: 1 year from date of purchase

The information contained in this brochure is subject to change without notice.

Part Number Code

KLC 20 B E
- KLC — Product
- 20 — AMPS
- B — Line Reactor Impedance
- E — Options



208/480/600V KLC

Part Number*	Connection Size	AMPs	Line Reactor %Z (at 480V)	Watts Loss	Dimensions (in.) Height	Width	Depth
KLC4B (E)	#12MAX	4	1.5	75	6.5	8	6
KLC6B (E)	#12MAX	6	1.5	80	6.5	8	6
KLC8B (E)	#12MAX	8	1.5	90	6.5	8	6
KLC12B (E)	#12MAX	12	1.5	95	6.5	8	6
KLC16B (E)	#4-#18	16	1.5	95	6.5	8	6
KLC25B (E)	#4-#18	25	1.5	110	7.5	10	7
KLC35B (E)	#4-#18	35	1.5	130	7.5	10	7
KLC45B (E)	#4-#18	45	1.5	135	7.5	10	7
KLC55B (E)	#4-#18	55	1.5	145	7.5	10	7
KLC80B (E)	.38"HOLE	80	1.5	255	9	12	8
KLC110B (E)	.28"HOLE	110	1.5	245	16	15	13
KLC130B (E)	.28"HOLE	130	1.5	270	16	15	13
KLC160B (E)	.34"HOLE	160	1.5	260	16	15	13
KLC200B (E)	.38"HOLE	200	1.5	265	16	15	13
KLC250B (E)	.44"HOLE	250	1.5	290	16	15	13
KLC300B (E)	.44"HOLE	300	1.5	325	19	20	16
KLC360B (E)	.56"HOLE	360	1.5	300	19	20	16
KLC420B (E)	.53"HOLE	420	1.5	450	19	20	16
KLC480B (E)	.53"HOLE	480	1.5	475	19	20	16
KLC600B (E)	.53"HOLE	600	1.5	515	19	20	16

* Letter in parenthesis indicates the addition of a NEMA 1 shroud for an enclosed KLC. This letter should be added to the end of the standard KLC part number when ordering an enclosed KLC.

MOUNT DIRECTLY UNDER VFD

TRANS-COIL, INC.
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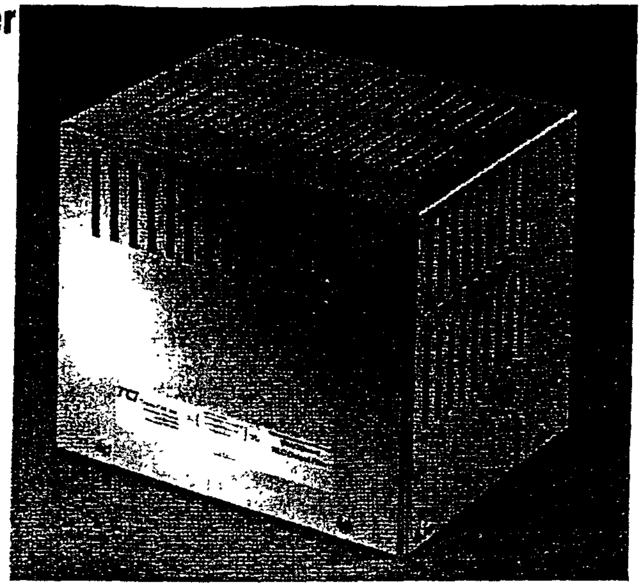
dV/dTGuard™ KLC Filter

Motor-Protecting Output Filter



PRODUCT SPECIFICATIONS

- Line Reactor is K-Rated, UL/ULC -Recognized
- 3 Phase, 600V Class
- Gapped Iron Core Inductor
- Copper Windings
- 40°C Ambient Temperature / 155°C Maximum Operating Temperature
- Available in NEMA 1 Enclosure

Bulletin # KLCCAT
Rev. Date. 6/96

Applications

TCI dV/dTGuard™ KLC filters are designed for applications with long leads (between 50 and 3,000 feet) between IGBT- (and Bipolar) switched variable frequency drives and motors. Typical installations include deep wells, process lines, and conveyor systems.

Before dV/dTGuard™ KLC

Because multiple conductor wire runs contain both parasitic inductance and capacitance, the conductors act like a series resonant tank circuit. In VFD/motor installations with long wire sets, this tank circuit will have a natural resonant frequency in the range of 1 to 10 MHz. IGBTs have an extremely fast switching time (typically 50 to 200 nanoseconds). This steep edge contains sufficiently highly effective frequencies to excite the natural resonant frequency of the lead tank circuit, resulting in exceedingly high voltage spikes at the motor terminals (See Figure 1). Because the wire's low losses do not provide sufficient dampening, spike levels can easily reach 1400-1500 volts, which will cause rapid failure of motor insulation.

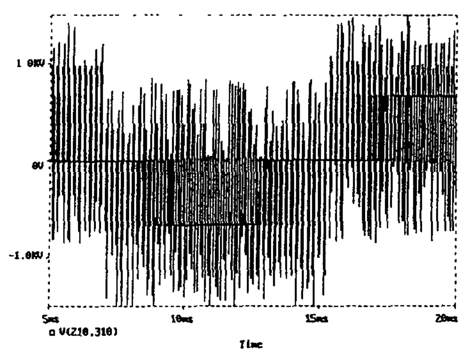


Figure 1 - PWM Voltage, at motor terminals, without KLC

After dV/dTGuard™ KLC

LOAD FILTERS
APPLICATION CONSIDERATIONS
- VFD CARRIER FREQ MUST BE ≤ 8 KHZ
- FREQ ≤ 60 HZ
- NOT GENERALLY REQD FOR 240 VOLT
- SMALLER MOTORS NEED THESE WORSE

KLC combines appropriate values of inductance, capacitance, and resistance to form a damped, low pass filter which removes the steep edges from the PWM voltage waveform (See Figure 2), sparing motors from the brutal voltage spiking.

KLC does not attempt to strip the entire carrier frequency from the output, as this would result in extremely high losses and a large filter. As KLC is designed to simply round the steep edges, losses are kept to a minimum: less than 1% of the drive/motor rating.

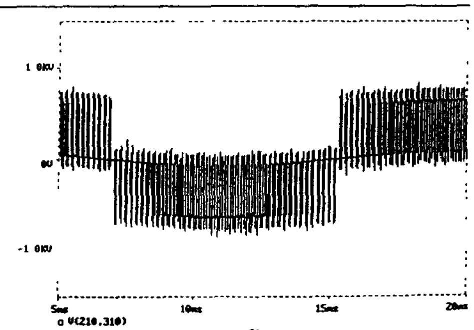


Figure 2 - PWM Voltage, at motor terminals, with KLC

KLC allows application of VFDs without concern for lead length and motor failure. KLC's unique packaging makes it extremely easy to specify and to install.

TCI

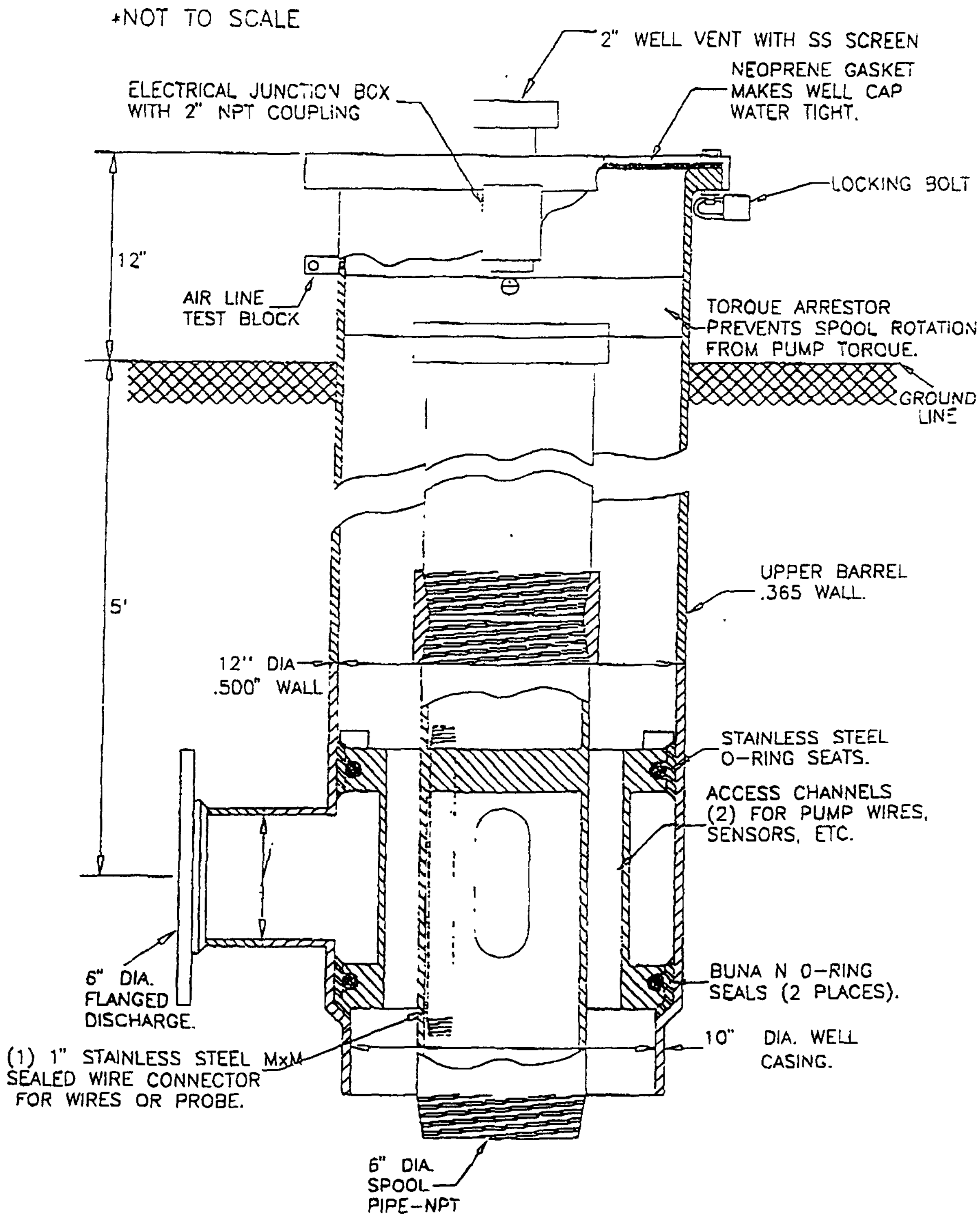
Maass Midwest
Pitless Adapters

SEW-3

MAASS MIDWEST

MANUFACTURERS OF QUALITY WATER WELL

MB,HD,S-10,12,6-FL,6-NPT,WT-5-[redacted]B-TA-LB-3/4" HYD TAP-(1) 1" SWC (1 UNIT)



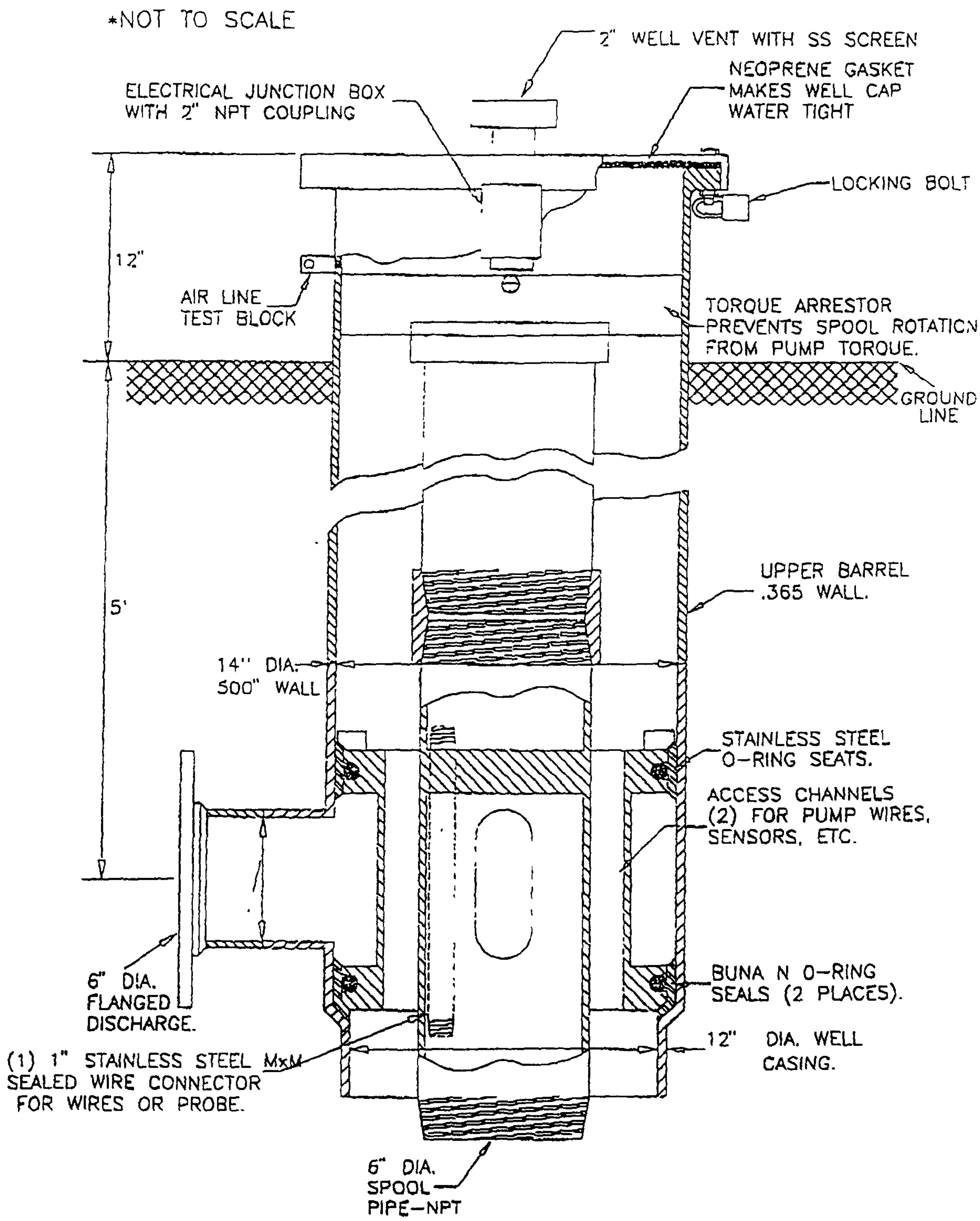
P O Box 547, 11283 Dundee Road, Huntley, IL 60142-0547 (800) 323-6259 IL AREA (847) 669-5135 FAX (847) 669-3230

SEW - 4

MAASS MIDWEST

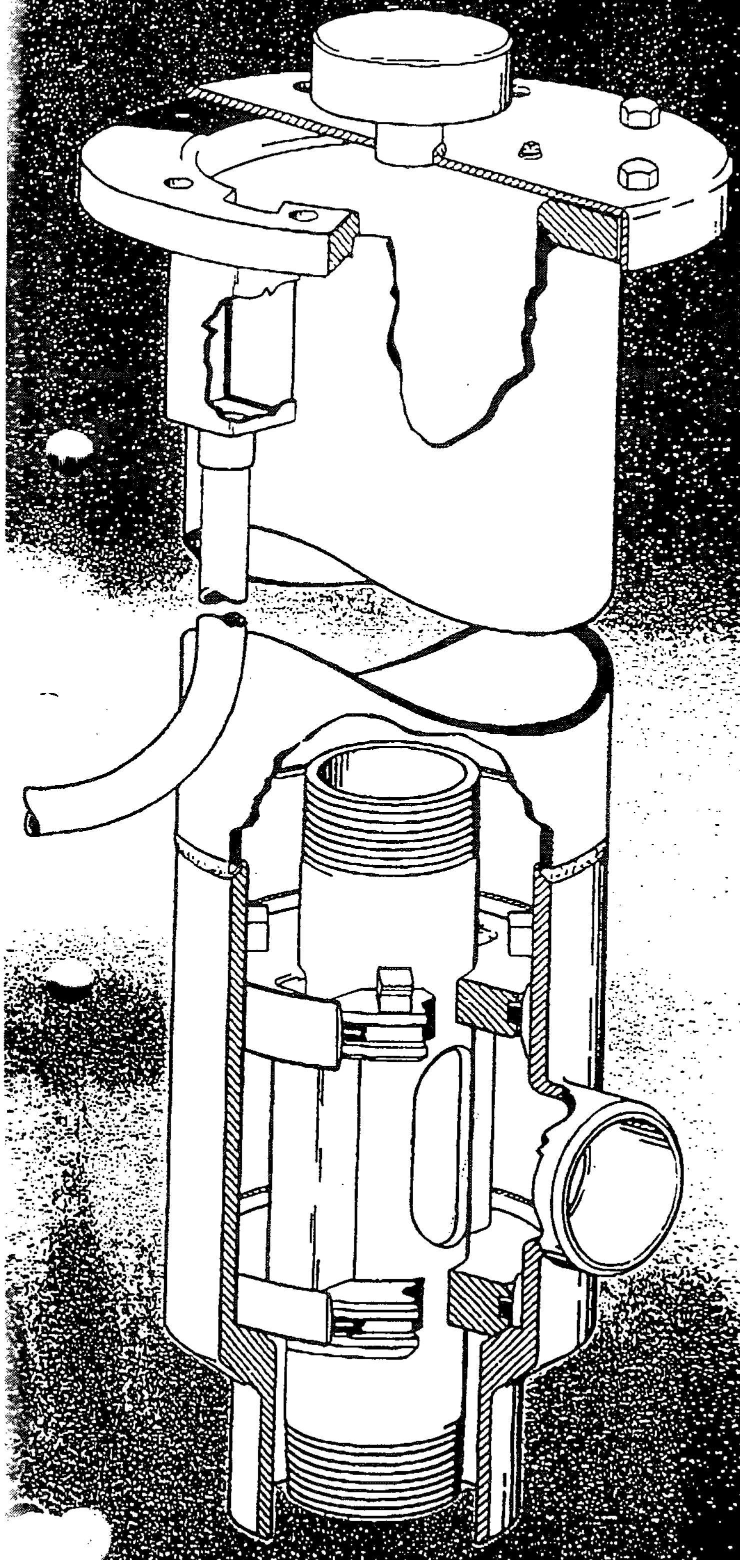
MANUFACTURERS OF QUALITY WATER WELL

Part # **MB,HD,S-12,14,6-FL,6-NPT,WT-5-[redacted]-TA-LB-3/4" HYD TAP-(1) 1" SWC (1 UNIT)**



P.O. Box 547, 11283 Dundee Road, Huntley, IL 60142-0547 (800) 323-6259 IL AREA (847) 669-5135 FAX (847) 669-3230

MODEL MB PITLESS UNIT



The Model MB pitless units are spool-type adapters with flexible design concepts for quick delivery and ease of installation.

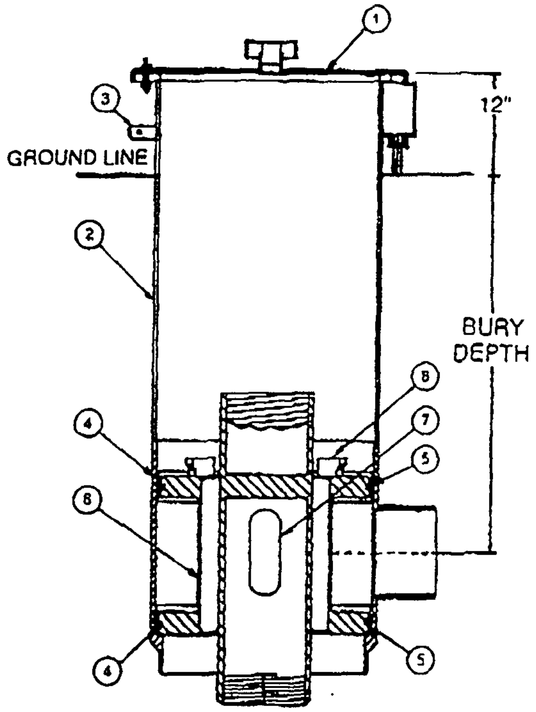
- *Designed for ease in setting and servicing pumps.*
- *Rugged construction 304 stainless steel O-ring and spool seats.*
- *Durable FDA and NSF approved coating for protection.*
- *Available as a complete bury unit or in "kit" form.*

MAASS MIDWEST

Specification #100-G

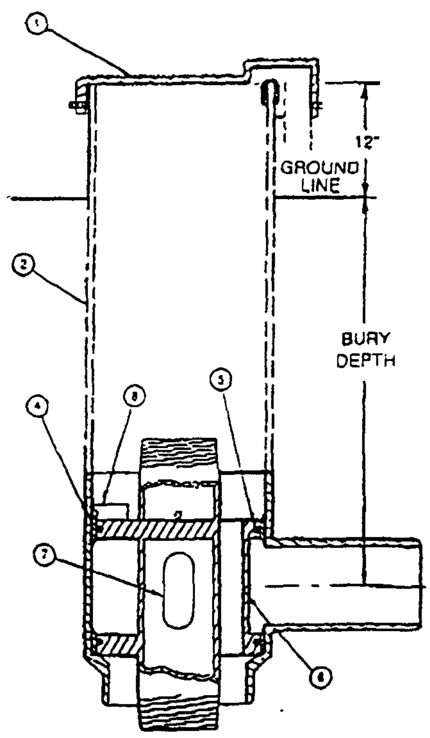
HEAVY DUTY (HD) MODEL MB PITLESS UNITS

The "HD" type unit is designed for high capacity pumps, deeper settings and turbine units. All MB units feature 304 stainless steel o-ring seats. "HD" type units are available for well casings from 8" through 24" and discharge diameters of 3" through 14". They include a vented water tight well cap and an electrical junction box. "HD" units have ½" or thicker steel housing. Spool pipe is "XS" or schedule 120.



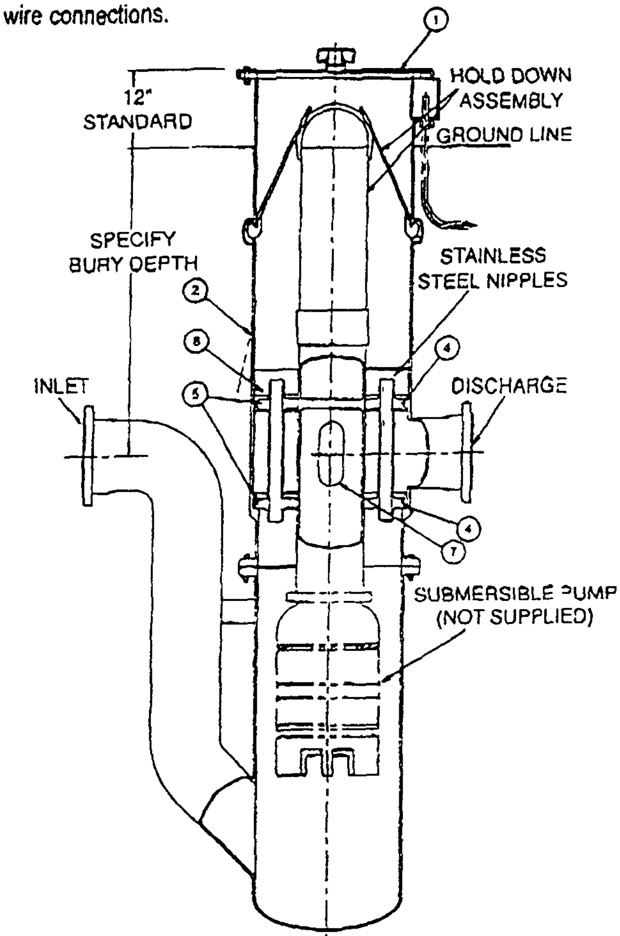
STANDARD DUTY (ST) MODEL MB PITLESS UNITS

The "ST" type unit is a quality, competitively priced unit featuring 304 stainless steel o-ring seats. The housing is schedule 40. The "ST" is for 8" and 10" wells. Discharge sizes of 3" to 6" are available. Spool pipes of 3" and 4" are available for 8" wells and 3" to 6" for 10" wells. Spool pipe is schedule 80. The "ST" type unit has a cast aluminum watertight well cap with a 2" NPT electrical conduit opening. A vented watertight steel well cap is available as an option. "Quick Kits" include AWT cap and are available from stock. Reference "Quick Kit" literature sheet.



MODEL MB BOOSTER STATION (B)

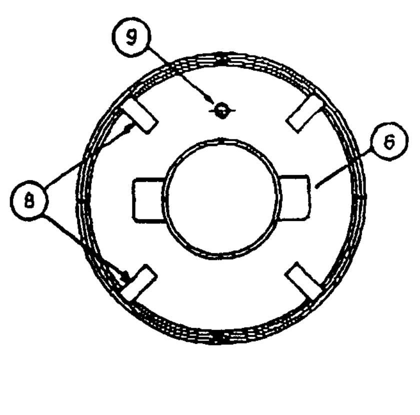
Maass-Midwest Booster Station units are ideal for applications where pressures need to be increased along a pipe line or where fluids must be circulated within a storage vessel. These units have the same features as the "HD" type units and are furnished complete with tank inlet and discharge pipes, hold-down clamps, lift-out bail, and sealed wire connections.



MODEL MB FEATURES

1. Well Cap
2. Upper Barrel (Optional).
3. Airline Test Block. (Optional).
4. 304 Stainless Steel rings and seat to defeat rust, corrosion and electrolysis.
5. O-Rings - 3/8" cross section.
6. Large wire access channels through the spool. For flowing wells, replace with optional stainless steel tubes for sealed wire connections.
7. Spool discharge openings are 100% or greater than spool pipe used.
8. Spool Centering Blocks prevent damage to O-rings and seats when setting pump.
9. Hydrant Sampling Port. (Optional).

TOP VIEW OF SPOOL



MODEL MB OPTIONS

The following features may be included with the pitless adapters to meet specific application requirements and to facilitate pump installation and well monitoring.

AIR LINE TEST BLOCK (ATB)

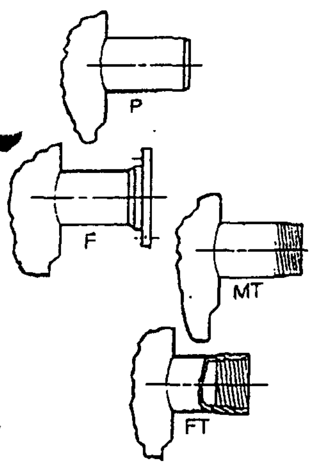
A four-way tee fitting with ¼"NPT female tappings. It is normally welded *to the upper barrel - just under the well cap flange. It provides three taps* for well monitoring. (Shown on "HD" unit on preceding page).

HYDRANT SAMPLING PORT (HYD)

A female threaded port is fitted to the top plate of the adapter spool. A line or hydrant can be attached to this port from which water samples can be collected. (See "Top View of Spool" on opposite page).

LOCKING BOLTS (LB)

Two over size bolts are provided which permit padlocks to be attached, thus securing the well cap. Note: Padlocks which are keyed alike are available from Maass-Midwest. Ask for part number LJ2.



HOUSING DISCHARGE ENDS

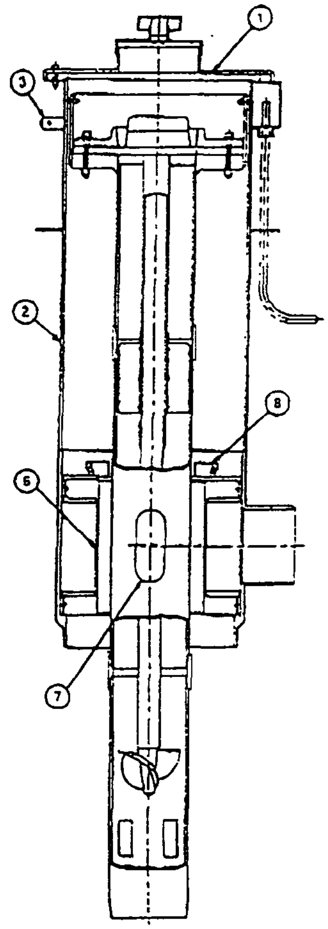
"P" = Plain end. For mechanical joint or transition coupling.
"F" = Flanged fitting.
"MT" = Male thread.
"FT" = Female thread.

UPPER BARREL

The upper barrel is made from standard well casing. When specified, this changes all units from a "kit" to a "bury unit". *Note: Maass Midwest assumes a "stick-up" of 12" above grade on all MB units. If your application is different, adjust the bury depth specification accordingly.* When supplied by the factory, the upper barrel is fitted to the MB housing. The water tight well cap flange and other accessories are assembled to produce a complete unit. This saves installation time at the well site.

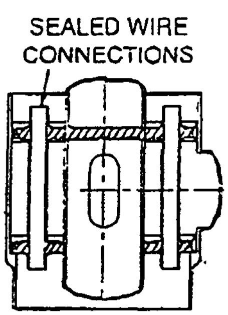
FLOW METER (FM)

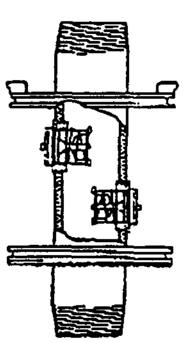
All Heavy Duty "HD" units can be furnished with an internal water meter. The Maass-Midwest design features a water tight well cap with an access port for inspecting and reading the water meter. The water meter can be removed without disturbing the spool or pump. We recommend and use Water Specialties vertical upflow meters. Meter options available are: indicator (GPM), totalizer, transmitter and remote read-out.



SEALED WIRE CONNECTIONS (SWC)

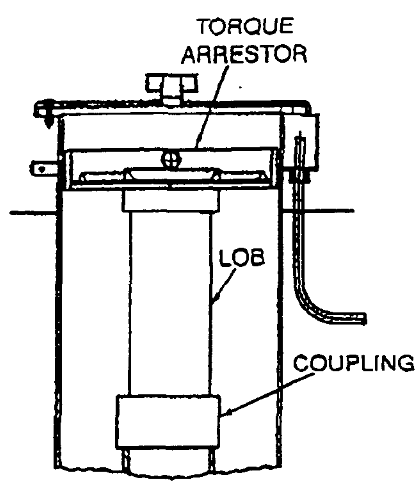
Stainless steel nipples pass through both spool plates to provide access to the base of the well. In flowing (artesian) wells, the spool access channels are replaced with these pipes. By feeding the pump control cables through these pipes, the water from below can be sealed off. Specify the size and number of nipples required.





SPOOL CHECK VALVES (CVS)

Check valves replace the spool discharge openings in the spool. The valves are of stainless steel and brass construction for long, trouble-free service.



TORQUE ARRESTOR (TA)

For applications where pump torque may cause the pump and adapter spool to rotate within the well. The torque arrestor fits inside the upper barrel just below the electrical junction box and is attached to the top of the spool using a threaded coupling and a **LIFT-OUT BAIL (LOB)**. The lift-out bail facilitates setting of the pump. When the upper barrel is supplied by the factory, the lift-out bail and bail coupling are included with the torque arrestor.

ALL STAINLESS STEEL AND LINE SHAFT TURBINE PUMP ADAPTERS AVAILABLE ON REQUEST

The Model MB pitless unit can be supplied as a fully assembled "bury" unit or as a "kit". A kit consists of all components except the upper barrel. The upper barrel is purchased separately and assembled at the job site to reduce shipping costs.

Prices apply to basic Model MB Submersible Units having a butt-weld casing attachment and a plain end discharge.

	Bury Depth	Well Casing Diameter 8"	10"	12"	14"	16"	18" & up
Type "HD" Submersible Units with steel water tight cap, "WT"	Kit	$2,074.00	$2,715.00	$3,533.00	$5,421.00	$6,664.00	Price Quoted Upon Request
	2'	2,325.00	3,033.00	3,948.00	6,228.00	7,688.00	
	3'	2,365.00	3,103.00	4,060.00	6,363.00	7,883.00	
	4'	2,405.00	3,173.00	4,172.00	6,498.00	7,978.00	
	5'	2,455.00	3,243.00	4,284.00	6,663.00	8,123.00	
	6'	2,485.00	3,313.00	4,396.00	6,768.00	8,268.00	
	7'	2,525.00	3,383.00	4,508.00	6,903.00	8,413.00	
		Add $40 / ft. for deeper bury depth	Add $90 / ft. for deeper bury depth	Add $112 / ft. for deeper bury depth	Add $135 / ft. for deeper bury depth	Add $145 / ft. for deeper bury depth	
Type "ST" Submersible Units with cast aluminum water tight cap "AWT"	Kit	$1,784.00	$2,328.00	Not Available	Not Available	Not Available	Not Available
	2'	2,000.00	2,643.00				
	3'	2,040.00	2,713.00				
	4'	2,080.00	2,783.00				
	5'	2,120.00	2,853.00				
	6'	2,160.00	2,923.00				
	7'	2,200.00	2,993.00				
Pump & Discharge Pipe Sizes	Standard	4"	6"	6"	6"	6"	6"
	Optional	3", 5"	3", 4", 5"	4", 5"	4", 5", 8"	5", 8", 10"	8", 10", 12", 14"

* 5" Pump pipe not available on Type "ST" Submersible unit for 8" wells.

** A steel water tight well cap (WT) is optional on Type "ST" units. For 8" wells, add $324.00. For 10" wells, add $427.00. Submersible cast aluminum cap (AL) is also available. For 8" wells, deduct $95.00. For 10" wells, deduct $160.00.

All prices are quoted U.S funds, F.O.B., Huntley, Illinois, U.S.A.
Call or write for specifications, prices and delivery on options, custom features, Booster Stations and Turbine pump units. Other sizes not listed can be fabricated. FDA and NSF approved epoxy coating is standard. Special coatings and materials are available. Contact the factory with your requirements.

ALL STAINLESS STEEL AND LINE SHAFT TURBINE PUMP ADAPTERS AVAILABLE ON REQUEST

EXAMPLE OF ADAPTER SPECIFICATION

MB, HD, S -10, 12 - 6, P - 6, NPT - WT - 5 - ATB

- Type: HD = Heavy Duty, ST = Standard Duty.
- Style: S = Submersible. B = Booster Station. T = Turbine.
- Well Casing Diameter: (Specify 8" -24").
- Upper Barrel diameter: (2" larger than well casing is standard).
- Discharge Diameter: (See price list for sizes available).
- Discharge Type: P = Plain End. F = Flanged End. MT = Male Thread. FT = Female Thread.
- Spool Pipe Diameter: (3" - 12").
- Spool Pipe End: NPT = Threaded. F = Flanged, lower end. APIR = API Round Threads.
- Well Cap: WT = Steel Water tight. AL = Aluminum Submersible. AWT = Aluminum Water tight
- Bury Depth: (Feet) - If upper barrel is supplied. ("0" if kit).
- Options: See description of options. Include all that are required.

MODEL NUMBER ORDERING GUIDE

OPTIONS

ATB	Airline Test Block
CVS	Check Valves in Spool
SWC	Sealed Wire Connections
FM	Flow Meter
HYD	Hydrant Sampling Port
LB	Locking Bolts
LOB	Lift-out Bail
TA	Torque Arrestor

MAASS MIDWEST
11283 DUNDEE ROAD
P.O.BOX 547
HUNTLEY, IL 60142-0547
PHONE: 847-669-5135 WATTS: 800-323-6259
FAX: 847-669-3230

Prices and specifications subject to change without notice.
PATENTED # 4,298,065; 4,416,328; 4,531,664

MAASS-MIDWEST MODEL "11MB" PITLESS UNIT INSTALLATION INSTRUCTIONS

INSTALLATION OF UPPER BARREL CASING, WATER TIGHT WELL CAP, AND ELECTRICAL JUNCTION BOX

A. Align the MB upper casing barrel and the MB housing by laying both pieces on two lengths of well casing which are clamped together. (See Diagram #1).

B. If, and only if, the unit is to be installed includes a water tight well cap, mark and cut an opening in the top end of the upper casing barrel for passage of the electrical wires into the electrical junction box. Make this cut where its convenient for the electrical junction box to be positioned relative to the discharge pipe. Smooth the edges of the cut-out to prevent damage to the electrical cables. (See Damage #2).

C. Place the flange ring on top of the upper barrel casing. The flange has a machined recess in one side this should fit over the upper barrel casing. Before welding in place, rotate the flange until the wire notch is centered over the cutout in the barrel for the [illegible]ical junction box.. Position flange bolt h[illegible] is centered be-tween two [illegible] will not inte[illegible] wel[illegible]

D. Pos[illegible] Tack and the weld completely a[illegible] electri-cal junction box - to casing and to underside of flange ring.

ATTACH PITLESS UNIT TO WELL CASING

A. Excavate a work area around the well casing two to three feet deeper than the bury depth. Shore up the hole against cave-in.

B. Find the well casing deviation from plumb. There will be two places on opposite sides of the well casing where the well casing will indicate plumb. Locate and mark these two places on the well casing using a level that's at least four feel long. Then, 90 degrees from your plumb marks, deter mine the well casing's deviation from plumb. Well casings are out of plumb by typically 1/16" to 1/2 inch. Occasionally the casing is perfectly plumb. Only in this case should the pitless unit be installed plumb. (See Diagram #3).

C. Cut off well casing so the top of the pitless unit will be at the proper height.

D. Position the pitless unit over the cut-off well casing. Align the discharge pipe with the water line. Use the level to assure the pitless is plumb in the direction of the two "plumb marks". Tack-weld the pitless unit to the well casing at the two "plumb marks", Now tilt the pitless unit until its deviation from plum equals the casing devia-tion. This procedure is necessary to prevent the pump pipe from bending and causing stress. Tack in several places.

E. To weld the pitless unit to the well casing, the first "root pass" weld is normally done with 1/8" or 5/32" #6010 (DC) or #6011 (AC or DC) welding rod. A 5/32" #6010, 6011 or 6013 (fast freeze) or #7018 (low hydrogen) may be used on subsequent weld ing passes. One to three additional passes are required depending upon conditions.

F. Prior to seating the spool, cover the o-rings and the stainless steel o-ring seats with the silicone grease provided with the pitless unit. This silicone grease is not water soluble. It provides excellent lubrication and is FDA approved for potable water and food processing applications.

G. Once the electrical connections are completed, the electrical junction box wire inlet can be sealed with silicone calking.

H. Position the well cap gasket and the well cap so all holes are in alignment. Secure the well cap with the bolts and nuts provided. Note: In applications where there are high water tables combined with shallow pump settings, additional weight may have to be applied downward to properly seat the spool.

I. Backfill the hole around the casing and pitless unit per specifications.

LIMITED WARRANTY

Maass-Midwest pitless adapters are made with finest quality material and workmanship. Maass-Midwest assumes no liability for improper installation, use. or maintenance of the pitless unit. Maass-Midwest assumes no liability for labor, expenses or losses, consequential, or inconsequential damages in connection with or by reason of defective materials and/or workmanship. Liability shall be limited to the repair and/or replacement of said defective parts.

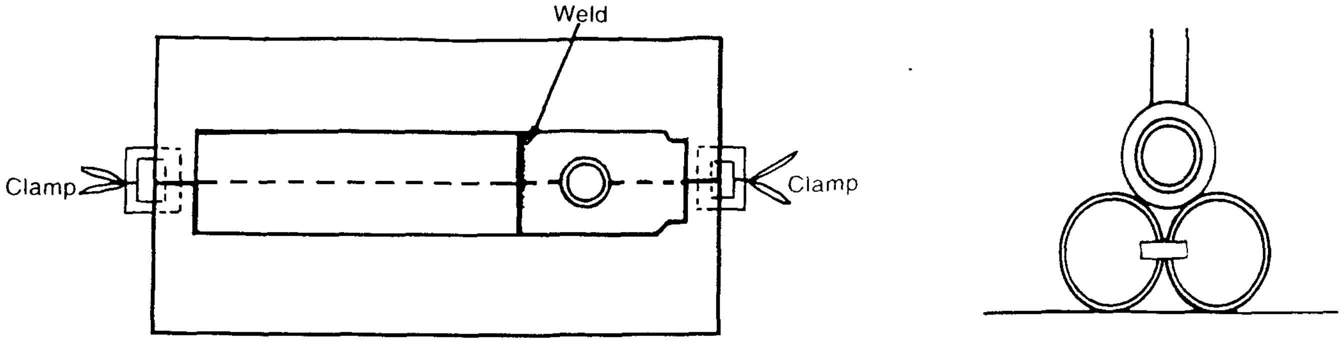


Diagram #1

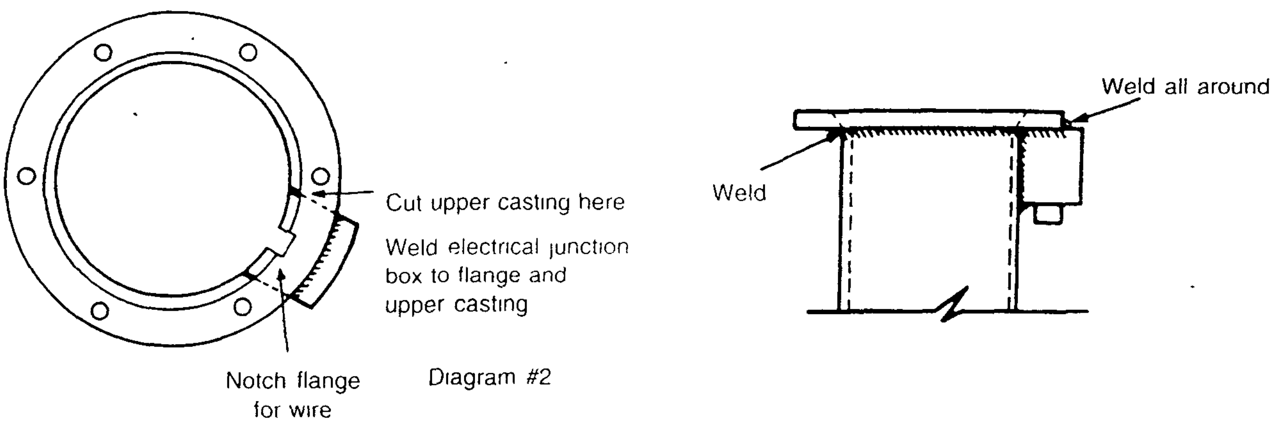


Diagram #2

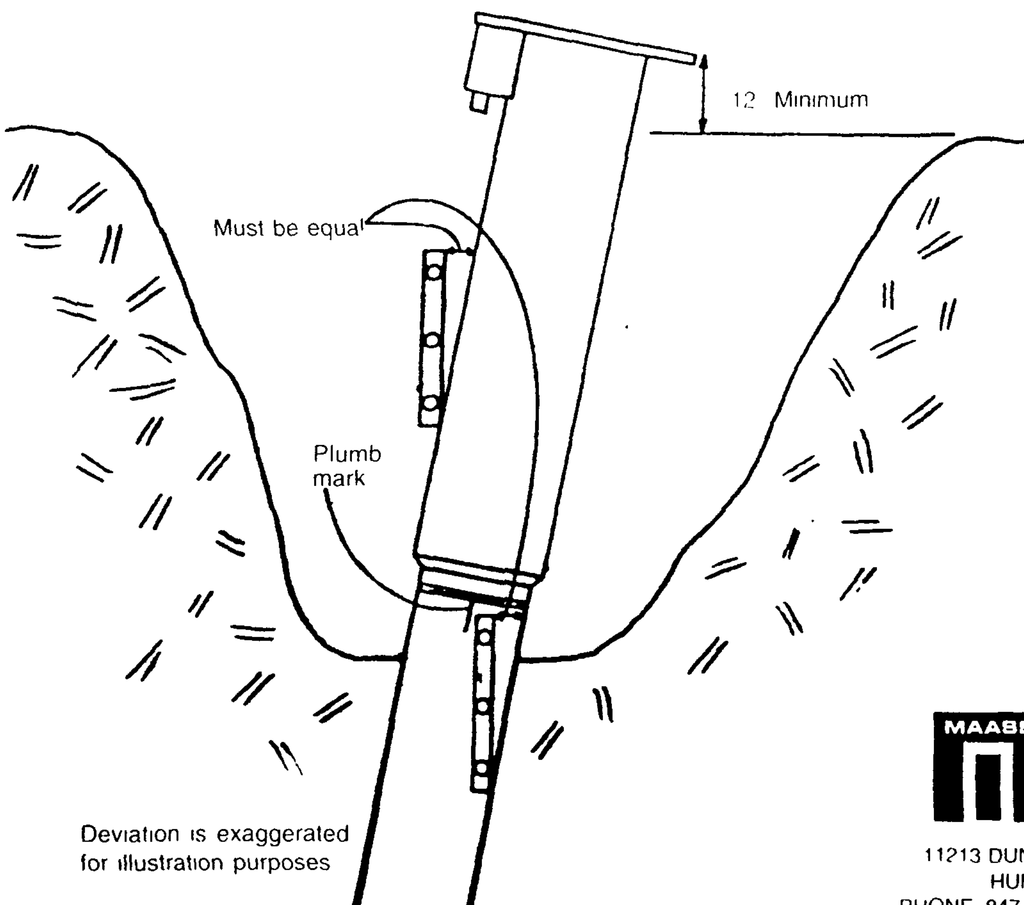


Diagram #3

MAASS MIDWEST

11213 DUNDEE ROAD, PO BOX 547
HUNTLEY, IL 60142-0547
PHONE 847-669-5135 FAX 847-669-3230

Bete
Diffuser Nozzles

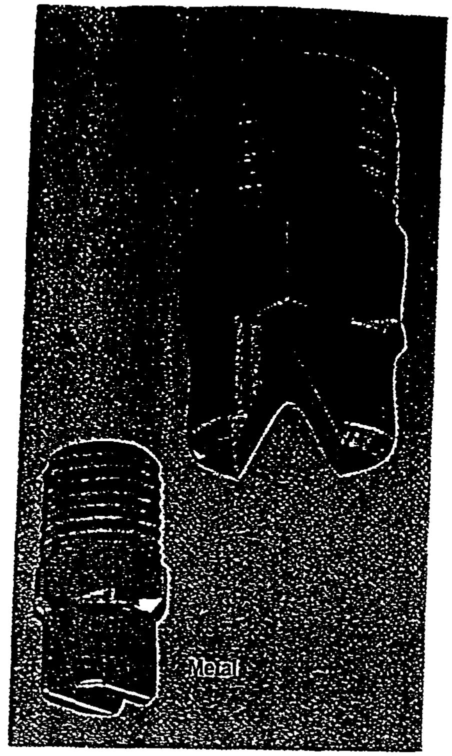
TJS 8/5/02

NF

Use 2 nozzles in Aeration Vault #2
Use 10 nozzles in Aeration Vault #3
model NF2750 3"

Standard Fan Nozzle

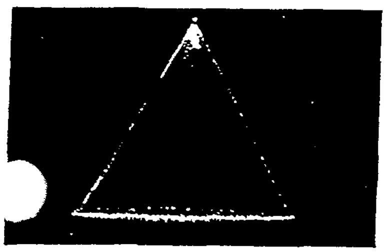
Fan nozzle 50° FAN



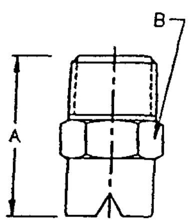
DESIGN FEATURES
- One-piece construction
- No internal parts
- Sizes for all applications
- Male connection

SPRAY CHARACTERISTICS
- High impact
- Uniform distribution with tapered edges for overlapping sprays
- Extra-wide angles available

Spray pattern: Fan and Straight Jet
Spray angles: 0° to 120°
Flow rates: 0.03 to 870 gpm



Fan 50°



Metal

NF Flow Rates

[illegible]

Male Pipe Size	Nozzle Number	K Factor	5 PSI	10 PSI	15 PSI	20 PSI	30 PSI	40 PSI	60 PSI	80 PSI	100 PSI	Orifice Dia. (in.)
			GALLONS PER MINUTE @ PSI									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1/8 or 1/4 or 3/8	NF10	0.158	0.35	0.50	0.61	0.71	0.87	1.00	1.22	1.41	1.58	0.080
	NF15	0.237	0.53	0.75	0.92	1.06	1.30	1.50	1.84	2.12	2.37	0.094
	NF20	0.316	0.71	1.00	1.22	1.41	1.73	2.00	2.45	2.83	3.16	0.109
	NF30	0.474	1.06	1.50	1.84	2.12	2.60	3.00	3.67	4.24	4.74	0.141
	NF40	0.632	1.41	2.00	2.45	2.83	3.46	4.00	4.90	5.66	6.32	0.156
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3/8 or 1/2	NF60	0.949	2.12	3.00	3.67	4.24	5.20	6.00	7.35	8.49	9.49	0.186
	NF70	1.11	2.47	3.50	4.29	4.85	6.06	7.00	8.57	9.90	11.1	0.203
	NF80	1.26	2.83	4.00	4.90	5.66	6.93	8.00	9.80	11.3	12.6	0.219
	NF90	1.42	3.18	4.50	5.51	6.36	7.79	9.00	11.0	12.7	14.2	0.234
	NF100	1.58	3.54	5.00	6.12	7.07	8.66	10.0	12.2	14.1	15.8	0.250
	NF120	1.90	4.24	6.00	7.35	8.49	10.4	12.0	14.7	17.0	19.0	0.266
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3/4	NF300	4.74	10.6	15.0	18.4	21.2	26.0	30.0	36.7	42.4	47.4	0.422
	NF400	6.32	14.1	20.0	24.5	28.3	34.6	40.0	49.0	56.6	63.2	0.500
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NF800	12.6	28.3	40.0	49.0	56.6	69.3	80.0	98.0	113	126	0.719
	NF1150	18.2	40.7	57.5	70.4	81.3	100	115	141	163	182	0.859
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	NF2750	43.5	97.2	137	168	194	238	276	337	389	435	1.31

NF Dimensions

Pipe Size	Only (in.) A	Only (in.) B	Wt. (oz.) Metal	Wt. (oz.) Plas.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1/4	1.06	0.56	1.50	0.38
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1/2	1.50	0.88	3.00	1.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	2.19	1.38	8.00	2.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1 1/2	3.00	2.00	20.0	5.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Flow Rate (GPM) $= K\sqrt{PSI}$ **Standard Materials: Brass, 303 Stainless Steel, 316 Stainless Steel, PVC and PTFE (PTFE not available in nozzle numbers below NF025).** See chart on page 17 for complete list.

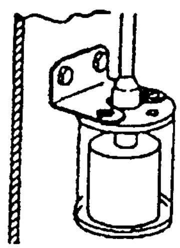
Gems Sensors
Level Switches

Gems Sensors

Bracket-Mounted Level Switches
LS-270 Series
Instruction Bulletin No. 72940

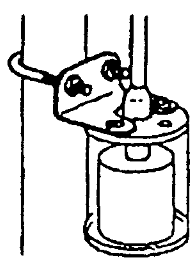
Installation
Install LS-270 units vertically. With cable upward, position unit at desired actuation level. ***(See Figures 1 and 2 for suggested mounting methods.)***

Figure 1



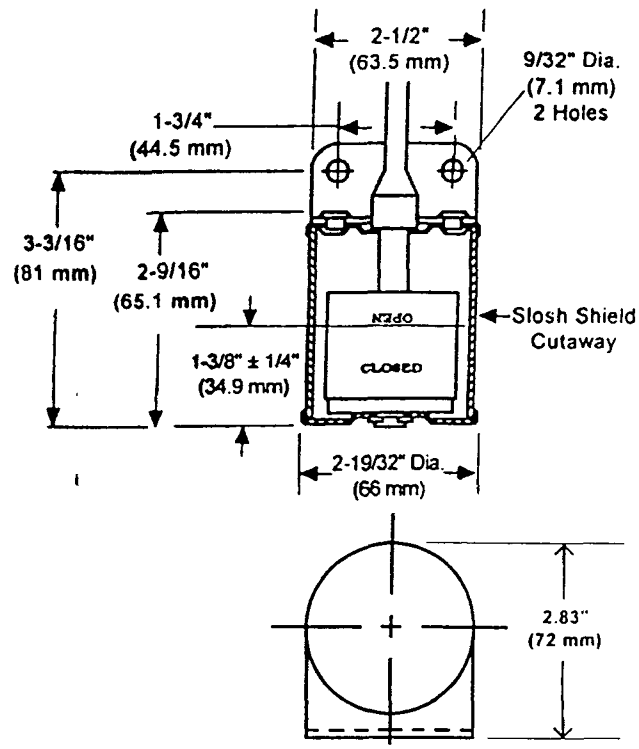
LS-270
Mounted on Tank Wall

Figure 2



LS-270
U-Bolted to Sounding Tube

Figure 3
- Dimensional Data -



Specifications

Stem/Float Material	304 Stainless Steel/Buna N
Other Wetted Material	Beryllium-Copper, Copper-Nickel
Slosh Shield Material	Lucite (Polycarbonate)
Operating Temperature	-40°F to +140°F (-40°C to +60°C)
Pressure Rating	150 PSIG, Max.
Switch	See Electrical Data (Pg 2)
Switch Actuation	Approx. half the distance from end of stem to mounting, or at halfway point of float travel (in liquid with sp. gr. of 1.0)
Lead Wires	18/2 Cable, 6 Ft. long, Neoprene® with waterproof cable
Float Specific Gravity	0.43

__Note__: To determine fluid specific gravity, add 0.1 to float specific gravity in clean fluid and 0.3 to float specific gravity in dirty or viscous liquids.

Reed Switch Protection

When switching inductive loads such as relays, solenoids, and transformers, reed switch contacts require protection to ensure long, dependable life. When current is interrupted, the inductive load generates a high voltage which can appear across the switch contacts and result in an arc. Arcing can cause the contacts to burn, weld or stick. The purpose of protection circuits is to prevent arcing by dissipating the voltage through an altern path

Recommended Protection

D.C.

A 1N4004 diode (or equivalent) connected cathode to positive ***(See Figure 5)*** is recommended. The diode does not conduct when the load is energized, but conducts and shunts out the generated voltage when the switch opens.

A.C.

A resistor and capacitor, connected in parallel with the switch ***(See Figure 6)*** is recommended. The capacitor is a high impedance to 50/60 Hz, but is essentially a short circuit to high frequencies of generated voltages.

Transients

Transient suppressors or varistors may also be used to dissipate the transient and protect the switch contacts. The devices in the table below may be used for selection.

	Maximum Ratings (25°C)			
	Continuous		Transient	
	RMS Volts	DC Volts	Energy Joules	Peak Current Amperes
V47A7	30	38	8.8	1,000
V250LA20A	250	330	72	4,500
V120LA20A	130	175	70	6,500

Figure 5

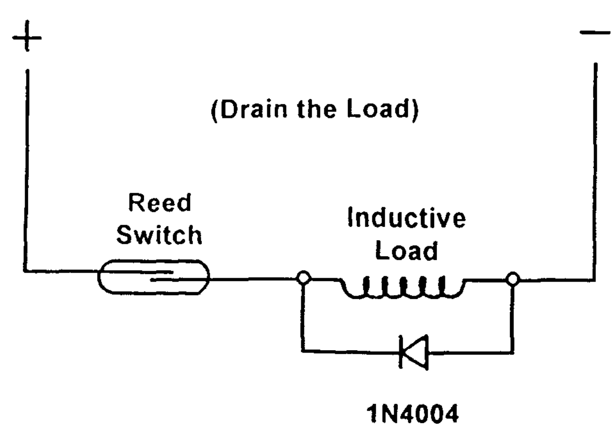
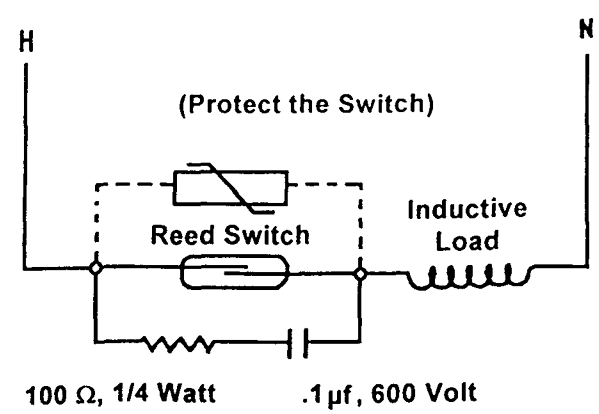


Figure 6



Electrical Data

Standard reed switches in GEMS level switches are hermetically-sealed, magnetically actuated, make-and-break type Switches are SPST or SPDT See the ***"Switch Rating" chart below*** for maximum load characteristics of GEMS level switches

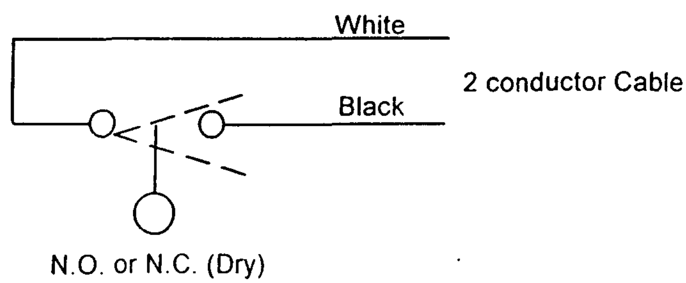
Switch Ratings - Maximum Resistive Load

VA	Volts	Amps AC	Amps DC
10 General Use	0-50	2	.13
	100	N.A	.1
	120	.08	N.A.
20 General Use	0-30	.4	.3
	120	.17	.13
	240	.08	.06
50 General Use	0-50	0.5	0.5
	120	.4	.4
	240	.2	.2
100*	0-50	.25	.25
	120	.8**	N.A.
	240	.4	N.A.

* Level switch units with 100 VA switches are not U.L. recognized or CSA approved

** Limited to 50,000 operations

Typical Wiring Diagram - SPST Switch



To Select Switch Operation ... LS-270 units are supplied with SPST switch N.C. or N.O. (dry) To convert switch operation: Remove grip ring and cap from unit, invert float on stem and reassemble unit.

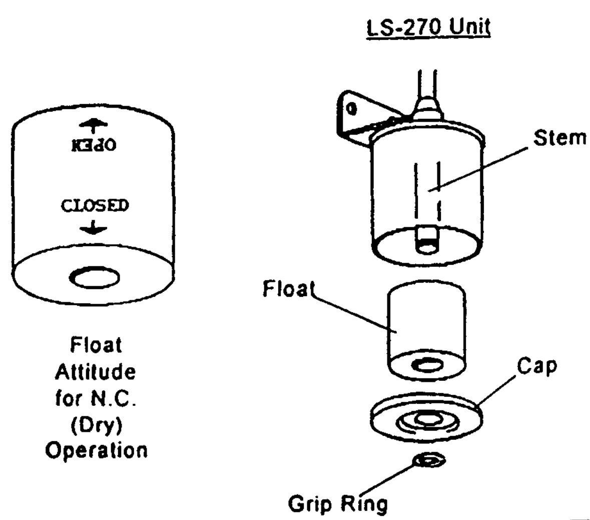
Maintenance ... Elastomer seals in sensor and cable are subject to deterioration and aging and should be periodically checked. Life expectancy of seals varies with application.

For an occasional cleaning when excessive contamination is present in the liquid: Remove float as shown in [illegible]e 4. Wipe down components and reassemble unit.

CAUTION: Be sure to reassemble float with same end upward on stem.

Figure 4

Disassemble to Select Switch Operation or Clean Unit



Important Points!

Product must be maintained and installed in strict accordance with the National Electrical Code and GEMS product catalog and instruction bulletin Failure to observe this warning could result in serious injuries or damages.

An appropriate explosion-proof enclosure or intrinsically safe interface device must be used for hazardous area applications involving such things as *(but not limited to)* ignitable mixtures, combustible dust and flammable materials

Pressure and temperature limitations shown on individual catalog pages and drawings for the specified level switches must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies

Selection of materials for compatibility with the media is critical to the life and operation of GEMS level switches. Take care in the proper selection of materials of construction, particularly wetted materials

Life expectancy of switch contacts varies with applications Contact GEMS if life cycle testing is required

Ambient temperature changes do affect switch set points, since the specific gravity of a liquid can vary with temperature.

Level switches have been designed to resist shock and vibration; however, shock and vibration should be minimized.

Liquid media containing particulate and/or debris should be filtered to ensure proper operation of GEMS products

Electrical entries and mounting points may require liquid/vapor sealing if located in an enclosed tank

Level switches must not be field repaired

Physical damaged sustained by the product may render it unserviceable

P/N 72940
Rev. K

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In-Situ, Inc.
Pressure Transducers

In-Situ Inc.
Helping monitor the earth's resources

PXD-261
Pressure Transducer
Operator's Manual

February 1998

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Contents

Guidelines and Precautions

- *The PXD-261 will not read past its designated range. If the range is exceeded, the value displayed by the data logger will remain constant.*
- *Never submerge the PXD-261 more than two times its range.*
- *When a slug test is planned, be sure that the transducer's range is sufficient to withstand the pressures it will be subjected to.*
- *Don't let the transducer "free fall" into a well or onto a water surface. Lower it gently.*
- *Be sure connectors are clean and dry before installing them.*
- *Be sure the vented cable is not kinked or blocked.*
- *Allow at least 30 minutes for the PXD-261 to stabilize to the water temperature before collecting data.*
- *When using the PXD-261 to measure water levels with a HERMIT 1000 or 2000 data logger, don't forget to set a Reference. A Reference number left in the data logger from an earlier test will probably be meaningless. Be sure to install the transducer in the water first.*
- *Secure the transducer cable so it doesn't slip during operation.*
- *When the PXD-261 is being used in a pumping well, install it above the pump.*
- *Do not attempt to disassemble the PXD-261 body. Doing so may severely damage the transducer and will void the warranty.*
- *Finally, the PXD-261 pressure transducer is a delicate electronic instrument. Please give it the care it deserves.*

1 Introduction

The PXD-261 is an accurate, stable, fully submersible pressure transducer for monitoring changes in water level. It collects fast, accurate time-drawdown data from pump and slug tests, including the recovery phase. Its small diameter permits access to 1" wells. Its Quick-Connect™ cable is easy to install, and long cable lengths do not compromise accuracy. The PXD-261 is ideal for both short-term testing and long-term monitoring.

The standard PXD-261 is a PSIG type transducer, and its cable is vented to the atmosphere. An "absolute" PSIA version on unvented cable is also available.

Operating Principle

A pressure transducer senses changes in pressure, measured in pounds per square inch (PSI), exerted by a column of water or other fluid above an internal strain gauge. This is translated electronically to a 4-20 mA signal sent to the data logger. Software calibration coefficients unique to each transducer enable the data logger to convert the 4-20 mA output to meaningful results in the desired measurement units.

PSIA and PSIG

PSIA stands for "pounds per square inch absolute," measured with respect to zero pressure. PSIA transducers measure all pressure forces detected by the strain gauge, including atmospheric pressure.

PSIG stands for "pounds per square inch gauge," measured with respect to atmospheric pressure. PSIG transducers thus exlude the atmospheric pressure component.

This difference may be represented by a simple equation.

$$P_{gauge} = P_{abs} - P_{atmos}$$

The "proof" or over-range pressure is two times (2X) the full range pressure and should never be exceeded or the transducer may be permanently offset, damaged, or destroyed.

Unpacking and Inspection

Your PXD-261 was carefully inspected before shipping and is ready to operate right out of the box. Check for any physical damage during shipment. Notify In-Situ and file a claim with the carrier if there is any such damage. If your transducer didn't come as ordered, please contact In-Situ immediately.

Description

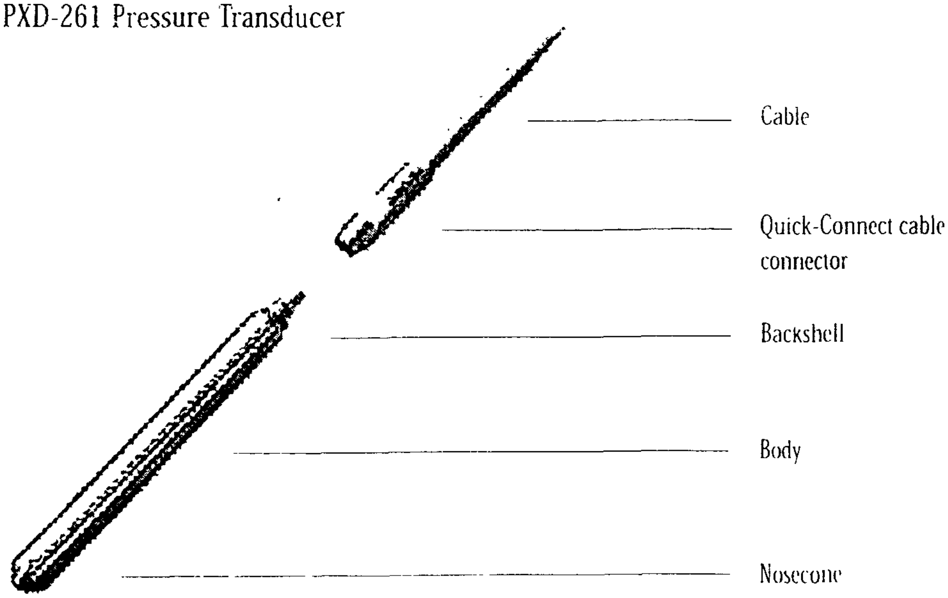
The body of the PXD-261 is 0.86 inch (22 mm) in diameter and constructed of 316 stainless steel. Seals are Viton®. The principal parts are shown in the photo below.

Calibration Documentation

Documents provided with the PXD-261 describe In-Situ's calibration process and contain the transducer's unique calibration coefficients. For convenient reference the coefficients are printed on the PXD-261 data tag, along with the following information.

- Serial Number and Calibration Date
- Range of accurate measurement (PSI)
- Proof: maximum over-range pressure (PSI)
- Linearity, Scale, Offset: calibration coefficients that enable the logger to convert the transducer's 4-20 mA output to meaningful results

PXD-261 Pressure Transducer



2 Installation

The only removable parts of the PXD-261 are the nosecone and cable. Do not take the body apart, as this may severely damage the transducer and will void the warranty.

Installation requires four steps

- Install the cable
- Connect the cable to the data logger
- Install the PXD-261 in the water.
- Program the data logger to identify the PXD-261.

These steps can be performed in any order. You might want to program the data logger in the office, then take it all to the field and set it up, or vice-versa.

Connection and installation in the water are covered in this section. Programming the data logger is summarized in Section 3

Installing the Cable

Attach the Quick-Connect cable to the PXD 261 as follows.

1. Remove the protective caps from the PXD-261 backshell and the Quick-Connect connector on the cable

   Don't discard the caps. Set them aside for later use to protect the contacts when the probe and cable are not in use. The backshell cap may display the probe's serial number and calibration coefficients—important numbers you'll need when programming the data logger.

2. Slide back the sleeve of the Quick-Connect connector.
3. Align the tab in the PXD-261 backshell with the slot inside the cable connector.
4. Slide the two parts together and press tightly. They should slip together easily, without forcing.
5. Tighten the locking sleeve hand-tight

Proper operation of a transducer depends on a clean, dry connection to the data logger. Make sure the connectors are clean and dry before trying to install them.

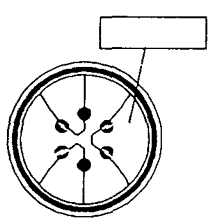
Connecting to the Logger

Transducers can be installed at any of the input channels on the connector panel of a HERMIT. If more than one transducer is being used, they should be installed consecutively beginning at channel one.

The Well Sentinel transducer connector is on the bottom of the instrument. Since it is not a weight-bearing connector, strain relief must be provided. Refer to the Well Sentinel *Operator's Manual* for suggestions.

Transducers mounted on reels are supplied with a jumper cable for convenient connection to the instrument. Transducers on cable without a reel connect directly to the instrument without a jumper cable.

To install connectors:



1. Remove the protective caps from the data logger connector and the cable.
2. Orient the connector patterns so that the large tab in the cable connector aligns with the V-shaped notch in the instrument connector.
3. Gently press the connector halves together. Excessive force should not be required.
4. Tighten the connector's lock ring to establish a tight connection and water-resistant seal.

Remove a connector as follows

1. Loosen the connector's lock ring.
2. Gently pull the connector halves apart.
3. Replace all protective caps. Store the transducer in its original container or where it will be safe from damage to the contacts.

Installing in the Water

Installing a transducer is not difficult, but it should be done with care. Here are some recommendations to bear in mind.

Vertical Installation

DON'T let a transducer "free fall" into a well or onto a water surface because of the likelihood of a pressure wave breaking the strain gauge (the "waterhammer" effect).

DO position the transducer below the lowest anticipated water level, but not so low that the range of the transducer might be exceeded at the highest anticipated level. Maximum depths in feet and meters are shown in the table on the opposite page.

For example: A 10 PSI transducer will measure 23.1 feet of change in water level. If the water level is going to drop, the transducer should be placed not more than 23.1 feet below the static (starting)

Range (PSI)	Max. Usable Depth Feet	Meters
10	23.1 ft	7.03 m
15	34.6 ft	10.5 m
20	46.1 ft	14.1 m
30	69.2 ft	21.1 m
50	115.3 ft	35.2 m
100	230.7 ft	70.3 m
250	576.7 ft	175.8 m

water level. A 10 PSI transducer positioned 18 feet below the surface will measure change from the beginning water level to a drop of 18 feet—at which time it will be out of the water. At the same position it will also measure a rise in water level up to 5.1 feet (23.1 - 18.0) from the starting water level.

Pressure Limitations. The PXD-261 will not read data above full-range pressure (the "Range" number on the data tag). Above this limit the data logger's reading will remain constant. The transducer will not be damaged as long as the pressure is less than two times the full-range pressure (the "Proof" number on the data tag). Never submerge a transducer more than two times the full-range pressure or it will be permanently offset, damaged, or destroyed.

To prevent damage to the vent tube, don't allow the cable to kink or bend tightly. The minimum recommended bend radius is one inch. This caution doesn't apply to the PSIA version of the PXD-261, as it has no vent tube.

If a transducer is subjected to excess pressure but still appears to function normally, the calibration should be verified by In-Situ. See "To Obtain Repair Service" in Section 5.

DON'T block or crimp the vent tube—a small polyethylene tube inside the transducer cable. The vent tube provides for equalization of air pressure on the water surface and inside the transducer. When a change in barometric pressure causes a change in water level (e.g. in confined aquifers), the change will not be distorted by a doubled reading caused by unequal pressure. If the vent tube becomes kinked, the internal components can be damaged without any visible harm to the outside of the cable.

DON'T set a pressure transducer below the level of the pump in a pumping well. The pressure transients generated by the pump will cause false level readings. Large pumps can swallow the transducer and cause permanent damage to both the transducer and the pump.

DO attach the transducer cable securely to the wellhead or other stationary object. If the transducer slips during the test, it will be impossible to tell from the data record whether the water level changed, the transducer moved, or both. A secure transducer placement is critical to accurate measurement.

DO allow at least a half-hour for the transducer to stabilize to the water conditions before starting a test or setting the Reference. Longer stabilization is always desirable, *Always remove the cable before screwing the PXD-261 into a pipe*

especially in long tests. Even though the cable is shielded, temperature stabilization and minor stretching can cause apparent changes in the reading. If you expect to monitor water levels to the accuracy of the transducer, it's worth allowing the extra time for the transducer to stabilize to the test environment

Check Readings. After the transducer has been installed in the water and the data logger has been programmed, it's a good idea to take a reading of the transducer depth and then move the transducer and take another reading to be sure that the transducer is giving a reasonable reading and showing change. A transducer might not be located where you think it is—for example, it could be wedged against the casing with a loop of cable hanging below it. A transducer in such a position may become dislodged and move during the test, giving a false change in level. The data logger Operator s Manual tells how to take a preliminary reading

Piping Installations

With the nosecone removed, the PXD-261 can be installed in any 1/4" NPT threaded pipe to monitor flow. Always remove the cable before screwing the transducer body into the NPT.

To install the PXD-261 in a pipe fitting:

1. If the cable is attached remove it To do so, unscrew the locking sleeve and gently pull the transducer and cable connector apart

2. Unscrew the nosecone by hand and remove it

3. Using a 7/8" open end wrench and the wrench flats on the transducer body, screw the PXD-261 onto any 1/4" NPT threaded nipple, tee, or elbow, depending on plumbing at the wellhead.
   - Apply your wrench to the wrench flats, not to the spanner holes at the back end of the transducer.
   - Thread sealing (compound or tape) may be used if necessary.

4. Reattach the cable.

Accuracy of the electronics may be affected by temperature fluctuations. Therefore, for long-term tests (several weeks), we recommend you insulate the transducer to ensure a thermally stable environment.

Using the PXD-261 with Other Equipment

This information is designed to help you interface the PXD-261 with third-party instrumentation. To make proper use of this information you should be prepared to

- Read and understand a schematic diagram
- Research other equipment manuals for interface details
- Run to an electronics store for parts
- Use a soldering iron and other small tools for electronic assembly

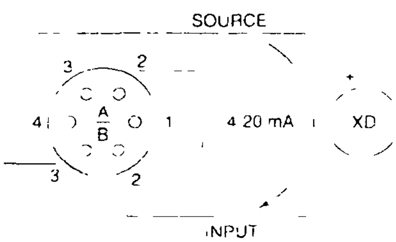
In-Situ does not warrant the PXD-261 against damages caused by use with devices not provided by In-Situ

If any of these resources are not available to you, contact In-Situ's customer service personnel for assistance, or quotes on custom cables and interfaces

The PXD-261 provides a linear current output that is proportional to the applied pressure. This output is a 4-20 mA change corresponding to a full-scale change in pressure. The voltage required by the transducer is 12-30 VDC.

Any data logger that provides the necessary voltage and can read the 4-20 mA current output can be used with the PXD-261. To insure accuracy, power should be applied for a minimum of 50 milliseconds prior to any reading

The wiring of the PXD-261 is shown here. It is a standard 2-wire, 4-20 mA transducer



Any mating connectors needed must be ordered separately from In-Situ. *Do not use any other type of connector* as this will compromise the integrity of waterproof operation. Also, remember that the vent tube in the cable must remain unobstructed to assure that the transducer is insensitive to barometric pressure changes. See Section 4. Transducer Maintenance, for additional details.

When a slug test is planned, be sure that the transducer can withstand the pressures it will be subjected to

Level Mode Application: Slug Tests

When conducting a slug test, caution must be used so that the amount of water slugged does not over-pressure the transducer

For example: You have a 20 PSI transducer down a test hole with 4-inch casing. Say the water surface is 100 ft. from the top of the casing, and the transducer is set 23 ft. below the surface of the water. (This corresponds to a transducer reading of 10 PSI.) If the hole is instantaneously slugged with 20 gallons of water, an additional pressure of 33.2 PSI would be created. Thus, the transducer would be subjected to an instantaneous pressure of 43.2 PSI, which is greater than the 40 PSI (2X) it can withstand without damage.

3 Programming the Data Logger

When in doubt about a programming step, please consult the Operator's Manual for your data logger.

The process of collecting data from the PXD-261 with In-Situ's data loggers is referred to as "running a test." This has three steps

- Enter the test conditions into the data logger.
- Enter the transducer characteristics into the data logger.
- When the data logger is programmed and the PXD-261 is in place, the test can be started.

How you carry out these steps depends on the data logger you are using. This section briefly highlights some of the differences among data loggers. Depending on the logger, the questions or "prompts" for input may be worded slightly differently. More complete information can be found in the Operator's Manual for the data logger

Definitions of Terms

Type

also called input type, channel type, probe type, transducer type, XD type, data type, measurement type

This is important because it tells the data logger how to power up, and take a reading from, the transducer connected to an input channel The type also determines the data reduction equations that are used to convert the 4-20 mA output of the transducer to meaningful results in the desired units.

Linearity, Scale, & Offset

These "calibration coefficients" are unique to each transducer and may be found on a data tag and also in the probe calibration documentation

The PXD 261 requires 50 mSec warmup time

Warmup
also called delay, warmup delay

This is the time required for the logger to power and read the transducer. The PXD-261 requires 50 milliseconds (mSec)

Specific Gravity
Pure water has a specific gravity of 1.0. A ten PSI transducer will measure 23.1 feet of change in a fluid that has a specific gravity of 1.0 (10 PSI × 2.30667 ft./PSI).

One PSI—either PSIA or PSIG—is equal to 2.30667 feet of water.

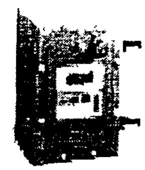
If the working fluid is not water, some situations may require that you determine its specific gravity to obtain accurate test results. Most In-Situ data loggers let you specify the fluid's specific gravity through a simple menu option. When monitoring in water, the specific gravity should usually be set to 1.0.

Mode & Reference
When measuring water levels, the Mode setting determines whether the displayed values increase or decrease in response to changes in water level. The Reference is a user-specified starting point for all the test measurements. See the box opposite.

Remember: When you choose surface mode—even if monitoring in a well—when the water level goes up, your numbers will go up, when the water level goes down, the numbers will go down.

The data loger substitutes your Reference for the transducer's raw pressure reading at the moment you enter it (HERMIT 1000, HERMIT 2000, LTM3000) or optionally at the start of the test (HERMIT 3000, LTM3100).

HERMIT 1000C



HERMIT software is integral to the data logger. Each step is performed through its own menu:

1. Set up the test in the Enter Data menu. Refer to Section 4 of the *HERMIT 1000C Operator's Manual* for details.

   Type. Select "Level" for water levels or "Func" for direct pressure readings.

2. Set up the transducer(s) in the Enter XD menu (operator's manual Section 5).

   Scale, Offs(et), Lin(earity). Enter values from the PXD-261 data tag.

   Note: With an older model HERMIT (1000B or earlier), use the "Linear" or "BFSL" coefficients printed in the calibration documentation.

   Delay. Enter 50 (milliseconds)

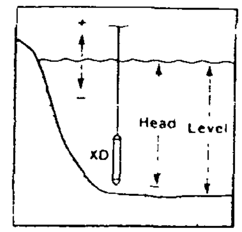
   For Level types—

   Ref. Skip the Reference your first time through the menu. Go back and enter it after the transducer is installed

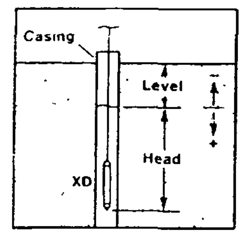
   Dsp. Combination of Units & Display Mode. Choose from

En: toc	Feet, Top of Casing mode
En: Sur	Feet, Surface mode
SI: toc	Meters, Top of Casing mode
SI: Sur	Meters, Surface mode

Mode & Reference



The Surface Mode is "positive up." In other words, *increasing* water levels will result in *increasing* readings. *Decreasing* water levels correspond to *decreasing* readings. This mode is often used to monitor surface waters such as streams and lakes, or in wells to use pressure head data directly.



The TOC (Top of Casing) Mode is "positive down." That is, *decreasing* water levels correspond to *increasing* readings, because the water level is getting further from the top of the well casing. *Increasing* water levels result in *decreasing* readings. This mode is useful when monitoring drawdown and readings referenced to the top of the well casing are required.

The Reference field provides a built-in linear offset for your data. The Reference is used to base the displayed readings on a known, user-specified starting point. (In Win-Situ, the Reference is optional, and can be changed or even removed later, when the data are displayed.) With a careful choice of Reference, you will never have to recalculate your data at the end of a test. However, it is important to understand the effect of different References. The table below shows some examples:

With this Mode .	And this Reference	The data will be displayed as ..
Surface	Present depth (e.g., a lake)	Depths
Surface	Altitude of water surface	Altitudes
Surface	Zero	Changes from the initial water level. When numbers get lower, the level is dropping, when numbers get higher, the level is rising
Surface	Present sensor depth*	Height of the column of water above the sensor
Top of Casing	Distance from TOC to starting water level	Distance from the top of the casing to the present water level
Top of Casing	Zero	Changes from the initial water level. When numbers get higher, the level is dropping, when numbers get lower, the level is rising
Head	*Not applicable*	Height of the column of water above the sensor

* *In Win-Situ, you can read the sensor depth by pressing the Read button*

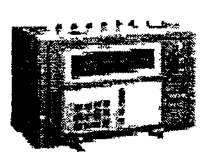
When measuring water levels with a HERMIT 1000 or 2000, it is crucial to enter a Reference for each level type input <u>with the transducer connected and set</u> before starting a test. This is because the data logger calculates the water level as you instructed it to do (up or down from your reference datum) at the moment you enter the Reference and press ENTER.

See page 11 or the operator's manual for illustrations of each mode.

3. Install the PXD 261 in the water and let it stabilize (30 40 minutes). Enter the Reference for Level type.

4. Start the test. Details are in Section 7 of the operator's manual.

HERMIT 2000



HERMIT software is integral to the data logger. Each step is performed through its own menu.

1. Set up the test in the Test Setup menu. Refer to Section 4 of the *HERMIT 2000 Operator's Manual* for details.

   Type: Select "Level" type for water level, "Func" type for direct pressure readings, or "Flow" type to measure flow rates.

2. Set up the transducer(s) in the XD menu. See Section 5 of the operator's manual.

   Lin(earity), Scale, Offs(et): Enter the values on the PXD 261 data tag.

   Delay: Enter 50 mSec (milliseconds).

   For Level types—

   Ref: Skip the Reference your first time through the XD menu. Go back and enter it after the transducer is installed and stabilized to the water temperature.

   SG (Specific gravity): Use 1.0 for water.

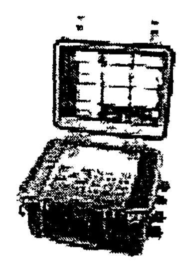
   Units: Select Feet or Meters.

   Mode: Choose Surface or TOC. Refer to page 11 or the *HERMIT 2000 Operator's Manual*.

3. Install the PXD 261 in the water and let it stabilize (30 40 minutes). Enter the Reference for Level type.

4. Start the test. Details are in Section 7 of the operator's manual.

HERMIT 3000



You can set up tests and probes for the eight channel HERMIT 3000 in two ways—

- use the HERMIT's keypad to access its own internal menus, or
- connect to a PC and use Win-Situ, In-Situ's data acquisition software for Windows®, as described on page 13 for the LTM3100.

Keypad

1. First, define the probe(s) using the Probe Menu. Refer to Section 3 of the *HERMIT 3000 Operator's Manual* for details.

Probe Type. Select Pressure

Linearity, Scale, Offset. Enter the coefficients on the PXD-261 data tag

Warmup seconds. Should be zero

Warmup millisecs. Enter 50

Compensation. Select Gauge for PSIG (normal with vented cable) or Absolute for PSIA (non-vented cable). For complete information see Section 3 of the *HERMIT 3000 Operator's Manual.*

HERMIT 3000 users can choose gauge or absolute barometric pressure compensation regardless of whether the PXD-261 cable is vented or non-vented

Specific Gravity. Use 1.0 for water.

Mode. To measure water levels choose **Surface** or **Top of Casing**. See page 11 for descriptions and illustrations of each mode. Choose **Head** to measure the pressure (or height) of the column of water above the pressure sensor.

Reference. User-specified starting point for Surface or Top of Casing mode. The default reference of 0 is equivalent to "zeroing" the probe.

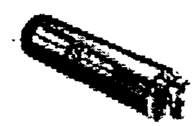
Manual Read. Displays a head reading to show where the probe is located.

When to Reference. Now: Measurements will be relative to the water level at the time of probe definition. **Start of Test:** Measurements will be relative to the water level at the time the test starts.

2. After the probe or probes are defined, use the Test Menu to define a test. Refer to Section 4 of the operator's manual.

3. Start the test

LTM3100



The four-channel Well Sentinel LTM3100 uses Win-Situ™. In-Situ's data acquisition software for Windows®.

1. Use the *Define* button in Win-Situ's Probe Facility to set up the "external" probe. See Section 4 of the *Win-Situ User's Guide.*

   Linearity, Scale, Offset. Enter the values on the PXD-261 data tag.

   Warmup. Enter 50 milliseconds.

   Type. Choose Pressure/Level.

   Specific Gravity. Use 1.0 for water.

   Mode. To measure water levels choose **Surface** or **Top of Casing**. See page 11 or the *Win-Situ User's Guide* for descriptions and illustrations of each. Choose **Head** to measure the pressure (or height) of the column of water above the sensor.

   Reference. User-specified starting point for Surface or Top of Casing mode. A reference of 0 is equivalent to "zeroing" the probe.

With Win-Situ, many of the initial probe setup parameters can be changed later, after the test, when you display, graph, or print the test data.

Take reference reading. **Now:** Measurements will be relative to the water level at the time of probe definition. **Start of test:** Measurements will be relative to the water level at the time the test starts.

2. Use the Test Facility to set up the test. Details are in Section 5 of the *Win-Situ User's Guide*.

3. A Scheduled start test will start by itself; or you can press the Start button to start a Manual test.

LTM3000

The one-channel Well Sentinel LTM 3000 uses SituCom, a separate DOS-based program to communicate with a PC. All three steps are performed through one menu option:

1. Select "Program and Activate a Test" from the main menu to enter the test and transducer information, and to start the test. See Section 5 of the *LTM 3000 Operator's Manual* for details.

XD Type. Only the Level type is available.

Units. Toggle between Metric (meters) and English (feet).

SG (Specific gravity). Use 1.0 for water.

Linearity, Scale, Offset. Enter the coefficients from the PXD-261 data tag.

XD Mode. Toggle between Top of Casing and Surface. See page 11 above for details.

Reference. Enter the Reference after the transducer is installed in the water and stabilized (30-40 minutes).

The pressure reading is calculated using the quadratic formula

$$P = LX^2 + SX + O$$

where	P	=	Pressure in PSI
	X	=	Normalized* transducer value (0-1)
	L	=	Linearity value from probe data tag
	S	=	Scale value from probe data tag
	O	=	Offset value from probe data tag

**Transducer reading (in milliAmps) minus 4 divided by 16*

4 Transducer Maintenance

The only removable parts of the PXD-261 are the nosecone and cable. Do not take the body apart, as this may severely damage the transducer and will void the warranty

Never attempt to dig foreign matter from the cavity under the filter If you have questions concerning cleaning, please contact Customer Service

Vent Tube

The pressure sensor of the standard (PSIG) PXD-261 is specifically designed to be insensitive to barometric pressure changes. A vent tube incorporated into the transducer cable assures that atmospheric pressure is the reference pressure to the sensor diaphragm. *For proper operation the vent tube should not be bent, kinked, or blocked.* Such obstructions will cause barometric pressure fluctuations to appear in measurements, and may also introduce large, varying errors due to thermal expansion and contraction of air within the vent tube and probe body.

The cable of the PSIA version of the PXD-261 does not have a vent tube.

Filter

A small mesh filter protects the pressure sensor from dirt and other foreign objects It is held in the end of the NPT threads by a small Teflon sleeve and can be seen when the nosecone is removed. The filter appears opaque when clean. If it becomes clogged with silt, try flushing it gently with a couple of squeezes from a water bottle If this doesn't do the trick, contact Customer Service as described on page 18.

Nosecone

If the holes in the nosecone become plugged, take the nosecone off and clean the holes with a swab or brush. To replace the nosecone, first put the wavy spring washer over the threads, then screw on the nosecone hand-tight.

Quick-Connect Cable

The PXD-261's Quick-Connect cable connector permits easy cable removal when changing to a different cable, installing the PXD-261 in a pipe fitting, or storing the probe.

For optimum performance, keep the threads on both halves of the cable connector clean.

To attach the cable:

1. Remove the protective caps from the PXD-261 backshell and the Quick-Connect connector on the cable.
2. Slide back the sleeve of the Quick-Connect connector.
3. Align the tab in the PXD-261 backshell with the slot inside the cable connector.
4. Slide the two parts together and press tightly. They should slip together easily, without forcing.
5. Tighten the locking sleeve hand-tight.

To remove the cable:

If you have questions about cleaning the cable, please contact Customer Service.

1. Unscrew the sleeve.
2. Gently pull the transducer and cable connector apart.
3. Replace the protective caps.

The jacket of the standard transducer cable is Teflon®. This material was selected for its toughness, abrasion resistance, and ability to stand up to harsh chemical environments. It is important not to expose the cable to sharp edges common to well casings.

A cable jacket made of polyurethane is also available. It is more flexible at low temperatures than Teflon. The same precaution as to sharp edges should be observed.

All cables are internally sealed to protect the transducer in the event that the cable is cut. Don't attempt to repair, splice, or seal any cuts found without first consulting In-Situ Customer Service personnel, as described in the next section.

Calibration

Your PXD-261 is designed to maintain its accuracy specifications through its useful service life, although annual recalibration will keep it operating at peak efficiency. Accuracy can be adversely affected by improper care and handling, exceeding operating pressure and temperature limits, physical damage or abuse.

Contact In-Situ Customer Service for information on periodic check-ups and recalibration. See page 18.

5 Warranty & Service Information

Warranty Provisions

In-Situ Inc. warrants all products sold, excluding batteries sold with such products, against defects in materials and workmanship under normal operating conditions. Such products include data loggers, probes, and accessories, and are warranted for the following periods: TROLLs for five years; Multi-Parameter TROLLs for two years; HERMIT 3000 data loggers for two years; probes for one year; and all other products, including accessories and cable, for ninety days. The warranty period for all products begins on the day the product is first delivered to the customer.

During the warranty period, In-Situ will repair, or, at its option, replace at no charge, components that have proven to be defective during the period of warranty, provided that the warranted product is shipped, pre-paid, to In-Situ Inc. In-Situ's Customer Service staff must be contacted for shipping instructions prior to shipment.

These warranties do not apply if the warranted product has been damaged by common negligence, accident or misuse. These warranties do not apply to any product that has been repaired, serviced, or modified by an unauthorized person.

THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH EXTEND BEYOND THE FACE HEREOF. NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE ARE MADE BY IN-SITU INC.

In-Situ Inc.'s obligation and liability under this warranty is expressly limited to repairing and replacing, at In-Situ Inc.'s option, any product found to be defective or otherwise not in conformity with this warranty. The obligation to repair or replace shall terminate when the warranty expires.

In-Situ Inc.'s maximum liability in damages to customer, from whatever source, including any breach of contract, shall be limited to the difference between the delivery price of the product and the market price of such product at Customer's destination at the time of such breach. IN NO EVENT SHALL IN-SITU INC BE LIABLE FOR PERSONAL INJURY, PROPERTY DAMAGE, LOSS OF PROFIT, DELAY OR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES WHETHER ARISING FROM CONTRACT, BREACH OF CONTRACT, TORT, IN SITU INC.'S NEGLIGENCE, STRICT LIABILITY OR

THE BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE

To Obtain Repair Service

If you suspect that the transducer is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call In-Situ Customer Service toll-free at 1-800-446-7488

2. Be prepared to describe in detail the exact nature (symptoms) of the problem, including how the transducer was being used and the conditions noted at the time the malfunction occurred.

Please . . . call us before you return equipment, and remember to put the RMA number on the label.

3. If service is required, obtain an RMA (Return Material Authorization) number from service personnel.

4. Write a description of the symptoms for service personnel, indicating whether the malfunction occurs intermittently or constantly. Save printouts or other materials that illustrate the problem.

5. Clean the probe and cable. Decontaminate thoroughly if the probe has been used in a toxic or hazardous environment.

6. Pack the PXD 261 in its original shipping box if possible. Include your write-up of the symptoms, a statement certifying that the probe has been decontaminated, and any other supporting documentation.

7. Send the package, shipping prepaid, to

   In-Situ, Inc
   Customer Service
   ATTN: RMA # (assigned no. here)
   210 South 3rd Street
   Laramie, WY 82070

The warranty does not cover damage during transit. In-Situ recommends the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Serial Number

Each PXD-261 carries an individual serial number engraved on the body. It is recommended that owners keep a separate record of this number. Should your transducer be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original owner's names and serial numbers.

Appendix: Specifications

General	
Wetted materials	316 Stainless steel, Viton®
Transduction principle	Integrated silicon strain gauge bridge
Dimensions	0.86" dia , 8 5" long (2 2 x 21.6 cm)
Weight	1 lb (0.45 kg)
Operating temperature	5° to 30°C (41° to 86°F)
Storage temperature	-40° to 125°C (-40° to 257°F)
Accuracy	
At 15°C (59°F)	±0 05%
Electrical	
Signal current	4-20 mA (typical throughout pressure range)
Min warmup time	*50 milliseconds*
Ranges	
Standard	10 PSI (23 ft. / 7m water)
	15 PSI (35 ft. /11 m water)
	20 PSI (46 ft. /14 m water)
	30 PSI (69 ft /21 m water)
	50 PSI (115 ft /35 m water)
	100 PSI (231 ft. /70 m water)
	250 PSI (577 ft /176 m water)

Overpressure tolerance	2X full range

Cable

Wetted materials	Teflon, polyurethane
Size	0.26" (6.7 mm) OD nominal
Maximum length	4500 ft (1372 m)
Weight	Polyurethane: 3.3 lb./100 ft. (1.5 kg/30 m) Teflon: 4.4 lb./100 ft. (2.0 kg/30 m)
Reels	ABS Plastic: up to 350 ft (107 m) capacity (standard) Small Steel: up to 550 ft. (168 m) capacity Large Steel: up to 1500 ft. (457 m) capacity

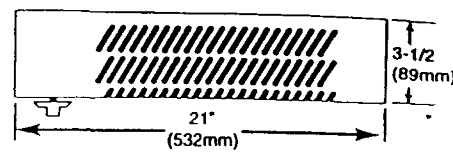
Due to continuing product development this information is subject to change without notice

Marley Electric Heating
Vault Heaters

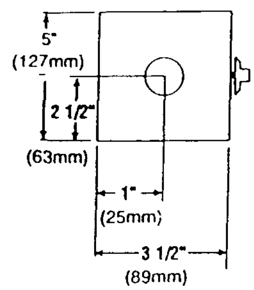
Marley Electric Heating

A United Dominion Company

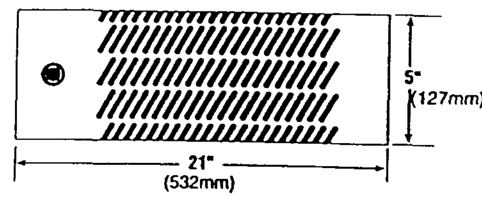
TOP VIEW



LEFT END VIEW



FRONT VIEW



Surface Mounted Utility Heater HT500

UL LISTED cUL

FILE #21609

Installation & Maintenance Instructions

Dear Owner,

Congratulations! Thank you for purchasing this new heater manufactured by a division of Marley Electric Heating. You have made a wise investment selecting the highest quality product in the heating industry. Please carefully read the installation and maintenance instructions shown in this manual. You should enjoy years of efficient heating comfort with this product from Marley Electric Heating... the industry's leader in design, manufacturing, quality and service.

... The Employees of
Marley Electric Heating

⚠ WARNING ⚠

Read Carefully - This instruction sheet contains vital information for the proper installation, use and efficient operation of the heater. Carefully read the manual before installation, operation or cleaning of the heater. Failure to adhere to the instruction could result in fire, electric shock, death, serious personal injury or property damage. Save these instructions and review frequently for continuing safe operation and instructing future users.

WARNING: HAZARD OF FIRE OR ELECTRICAL SHOCK

1. To prevent a possible electric shock, disconnect all power to heater at main service panel before wiring or servicing.
2. All wiring must be in accordance with the National and Local Electrical Codes and the heater must be grounded.
3. Do not install closer than 18" (456mm) to the floor or 12" (304mm) from the ceiling. End of heater may be next to adjacent walls. Do not install in vertical position.
4. Heater is hot when in use. Do not install the heater behind door, behind towel rack, in closet, where curtains or drapes can touch heater or where air flow through the heater may be obstructed. Keep electrical cords, bedding, furniture and other combustible away from heater.
5. Do not operate heater without cover in place. Cover must be secured with screws to prevent unintentional removal.
6. Do not insert or allow foreign objects to enter or touch the heater or heating element as this may cause an electric shock, fire or damage to heater.
7. Heater has hot and arcing or sparking parts inside. Do not use in areas where gasoline, paint, or flammable liquids are used or stored.
8. Do not use this heater in an environment where heater will be subjected to direct contact with water.
9. Do not use in a corrosive environment.
10. Supply voltage must be the same as heater voltage. Check heater nameplate and supply voltage before energizing.

SAVE THESE INSTRUCTIONS

General

The HT500 Utility Heater is designed for horizontal wall mounting only. The built-in thermostat allows for adjustment of the heat output from 40° to 70° F. The heater is factory wired for use at 240/208 volts but can be re-wired for use at 120 volts.

Installation

1. Remove the grille cover by removing the 2 screws on the front of the cover.
2. Position the heater on wall at desired mounting location maintaining the minimum clearances as noted in Warning 3 and as shown in Figure 1.

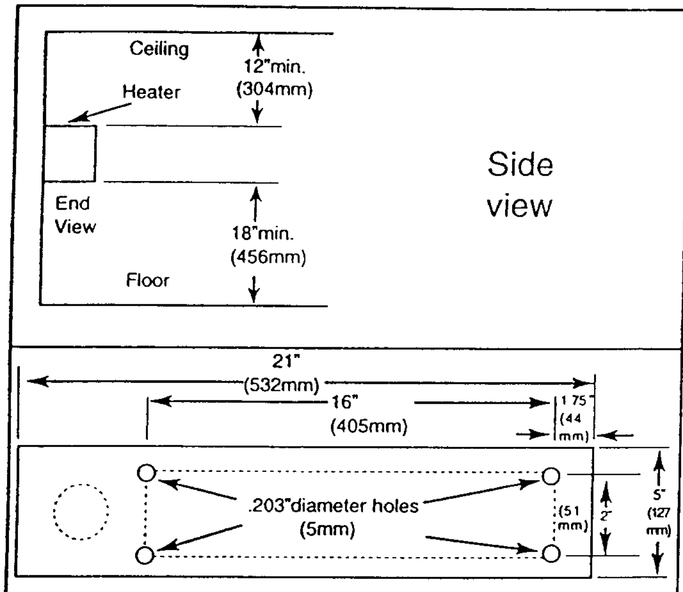


Figure 1

NOTE: The heater MUST be mounted horizontally to allow air flow freely upward through the heating element. Thermostat can be located towards either end of heater.

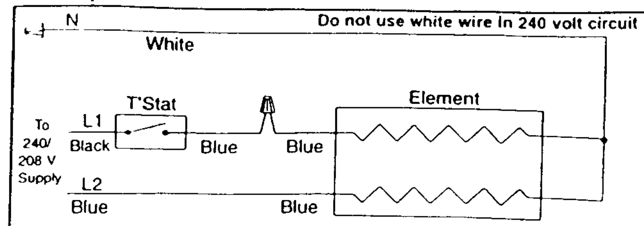
3. Securely fasten the heater to the wall with screws or bolts using the four (4) pre-drilled holes in the heater back.

Wiring

1. Bring power supply cable to heater and install into heater wiring compartment through the pre-punched 7/8" (22mm) hole in the end of control box. Be sure to use cable clamp on cable as required by the National Electric Code.
2. Connect the supply ground wire to the heater using the green colored ground screw.
3. To operate the heater at 208 through 240 volts, connect power supply wiring to heater wiring following the wiring diagram shown in Figure 2. DO NOT USE THE WHITE WIRE MARKED "N" FOR WIRING TO 208 THROUGH 240 VOLTS.
4. To operate the heater at 120 volts requires the heater to be re-wired as shown in Figure 3 by connecting blue L2 lead wire to wire connection of the other element blue lead wire and thermostat blue lead wire. Remove the L2 wire marker. Connect 120 volts to the black L1 lead and the white N lead. See Figure 3.
5. Complete the installation by replacing the grille cover using 2 screws removed earlier and 4 additional screws from parts bag. Remove thermostat knob from the parts bag and install.

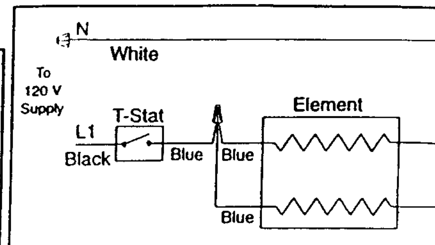
Heater Operation

1. Turn on the power supply to the heater.



HT500 - Factory wired for 240/208 volt operation

Figure 2 500 watts, 2.1 amps @ 240 V
375 watts, 1.8 amps @ 208 V



To rewire for 120 volt operation:

1. Connect Blue "L2" wire connection to other element Blue lead and thermostat Blue lead. Remove "L2" wire marker.
2. Connect 120 volts to Black "L1" & White "N".

Figure 3 **HT500 - Field re-wired for 120 volt operation**
500 watts, 4.2 amps

2. Rotate the thermostat clockwise to the warmest setting. If the air temperature is below 70°F the heater should come on and in a few moments the heating element will become warm. If the air temperature is above 70°F, the heater will not operate. A check of the thermostat setting has to occur when the air temperature is below 70°F
3. The thermostat range is from 40°F at full counterclockwise position to 70°F at full clockwise. Position thermostat at desired location. Thermostat will automatically cycle the heater on and off to maintain the desired temperature.

NOTE: The heater is designed to provide freeze protection and the thermostat may allow the heater to come on at the lowest setting if the space temperature drops below 40° F.

Cleaning and Maintenance

This heater requires no maintenance. Periodic cleaning to remove accumulated dust and dirt is recommended. This should be done using a vacuum with brush. See Warning 1.

LIMITED WARRANTY

All products manufactured by Marley Electric Heating are warranted against defects in workmanship and materials for one year from date of installation, except heating elements which are warranted against defects in workmanship and materials for five years from date of installation. This warranty does not apply to damage from accident, misuse, or alteration; nor where the connected voltage is more than 5% above the nameplate voltage; nor to equipment improperly installed or wired or maintained in violation of the product's installation instructions. All claims for warranty work must be accompanied by proof of the date of installation.

The customer shall be responsible for all costs incurred in the removal or reinstallation of products, including labor costs, and shipping costs incurred to return products to Marley Electric Heating Service Center. Within the limitations of this warranty, inoperative units should be returned to the nearest Marley authorized service center or the Marley Electric Heating Center, and we will repair or replace, at our option, at no charge to you with return freight paid by Marley. It is agreed that such repair or replacement is the exclusive remedy available from Marley Electric Heating.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH EXCEED THE AFORESAID EXPRESSED WARRANTIES ARE HEREBY DISCLAIMED AND EXCLUDED FROM THIS AGREEMENT. MARLEY ELECTRIC HEATING SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES ARISING WITH RESPECT TO THE PRODUCT, WHETHER BASED UPON NEGLIGENCE, TORT, STRICT LIABILITY, OR CONTRACT.

Some states do allow the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

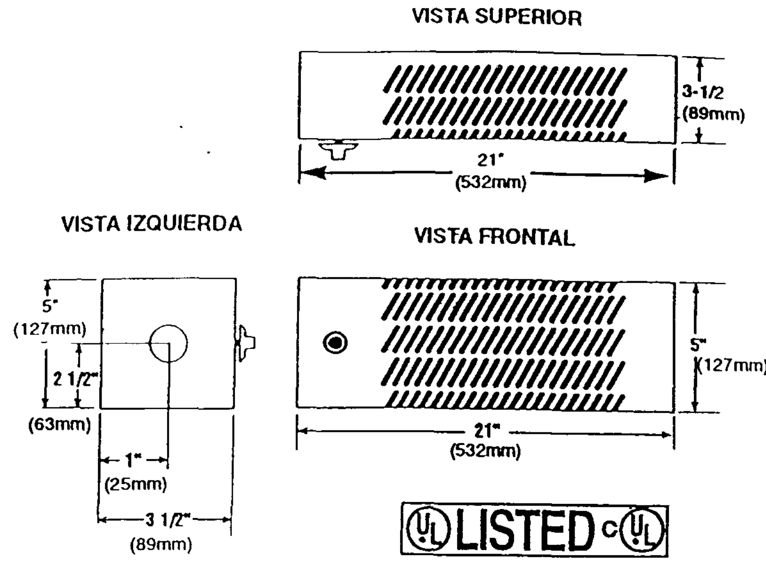
For the address of your nearest authorized service center, contact Marley Electric Heating in Bennettsville, SC, at 1-800-642-4328. Merchandise returned to the factory must be accompanied by a return authorization and service identification tag, both available from Marley Electric Heating. When requesting return authorization, include all catalog numbers shown on the products.

Marley Electric Heating
A United Dominion Company

470 Beauty Spot Rd. East
Bennettsville, SC 29512 USA

9/96 SWO 308 Part No. 5200-2314-000

Marley Electric Heating
Una compañía United Dominion



Calentador utilitario de montaje superficial HT500

LISTED
ARCHIVO Nº 21609

Instrucciones de instalación y mantenimiento

Estimado propietario:

¡Felicidades! Gracias por haber comprado este nuevo calentador fabricado por una división de Marley Electric Heating. Usted ha hecho una inversión sabia al elegir el producto de mayor calidad que existe en la industria de la calefacción. Por favor lea con detenimiento las instrucciones de instalación y mantenimiento presentadas en este manual. Así, usted disfrutará de muchos años de calefacción eficiente con este producto de Marley Electric Heating... el líder de la industria en lo referente a diseño, fabricación, calidad y servicio.

...Los empleados de
Marley Electric Heating

⚠ ADVERTENCIA ⚠

Lea con atención. Este instructivo contiene información vital para la instalación, uso y operación eficiente del calentador. Lea el manual con detenimiento antes de instalar, operar o limpiar el calentador. La inobservancia de las instrucciones puede ocasionar incendios, electrochoques, la muerte, lesiones graves o daños materiales. Guarde estas instrucciones y consúltelas con frecuencia para cerciorarse de que la operación se lleve a cabo en forma segura y para instruir a los usuarios nuevos.

ADVERTENCIA: RIESGO DE INCENDIO Y ELECTROCHOQUE

1. Para evitar la posibilidad de electrochoque, desconecte en el panel de servicio principal toda la energía que llega al calentador antes de alambrar o dar servicio a la unidad.
2. Todo el alambrado deberá efectuarse de acuerdo con los códigos eléctricos nacionales y locales. Asimismo, el calentador deberá estar puesto a tierra.
3. No instale el calentador a menos de 18" (456 mm) del piso o 12" (304 mm) del techo. El extremo del calentador puede estar junto a un muro adyacente. No instale el calentador verticalmente.
4. Este calentador se calienta mucho cuando está funcionando. No instale el calentador detrás de puertas o toalleros, en clósets, donde las cortinas puedan entrar en contacto con el calentador ni donde se obstruya el flujo de aire al calentador. Mantenga los cordones eléctricos, sábanas y colchas, muebles y otros materiales combustibles lejos del calentador.
5. No opere el calentador sin la cubierta. La cubierta deberá estar sujeta con tornillos para evitar la remoción accidental.
6. No introduzca objetos extraños ni permita que entren en el calentador o toquen el elemento calentador, ya que esto puede ocasionar electrochoques, incendios o daños al calentador.
7. El calentador tiene piezas calientes y generadoras de arcos y chispas. No se use en áreas donde se emplean o almacenan gasolina, pintura o líquidos inflamables.
8. No use el calentador en áreas donde entrará en contacto directo con el agua.
9. No use el calentador en ambientes corrosivos.
10. El voltaje de la fuente debe ser igual al voltaje del calentador. Consulte la placa del calentador y el voltaje de la fuente antes de aplicar la energía.

GUARDE ESTAS INSTRUCCIONES

Información general

El calentador utilitario HT500 ha sido diseñado exclusivamente para el montaje horizontal en paredes. El termostato incorporado permite ajustar la salida térmica entre 40° y 70° F (4,4° y 21° C). El calentador ha sido alambrado en la fábrica para funcionar con 240/208 volts, pero puede realambrarse para operar con 120 volts.

Instalación

1. Quite la cubierta de la parrilla, extrayendo los dos tornillos del frente de la cubierta.
2. Coloque el calentador en la posición deseada en la pared, manteniendo las separaciones mínimas que se indican en la advertencia 3 y se ilustran en la figura 1.

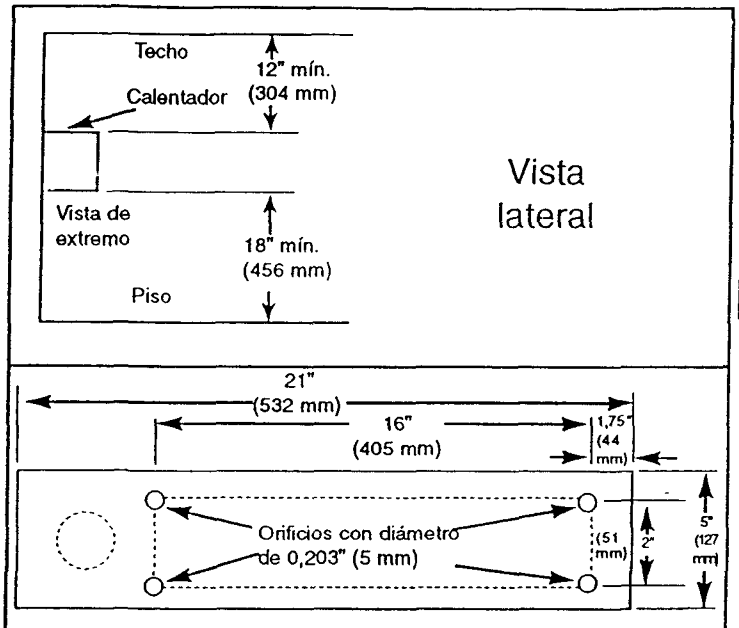


Figura 1

NOTA: El calentador DEBE montarse en posición horizontal para permitir el flujo libre del aire por el elemento calentador. El termostato puede ubicarse en cualquiera de los extremos.

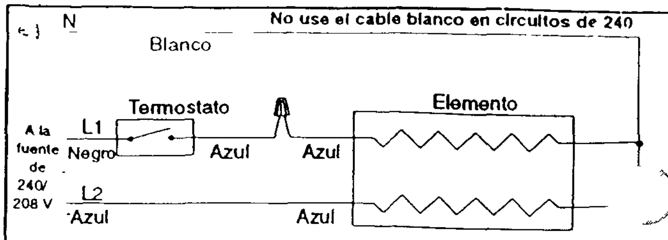
3. Sujete el calentador firmemente a la pared, usando tornillos o pernos introducidos por los cuatro orificios de la parte posterior del calentador.

Alambrado

1. Tienda el cable de energía eléctrica hasta el calentador e introdúzcalo en el compartimiento de alambrado, a través del orificio de 7/8" (22 mm) en el extremo de la caja de control. Cerciórese de usar una abrazadera para el cable, como lo exige el Código Eléctrico Nacional de EE.UU.
2. Conecte el cable de puesta a tierra de la fuente al tornillo verde de puesta a tierra del calentador.
3. Para operar el calentador con 208 a 240 volts, conecte el alambrado de la fuente eléctrica al alambrado eléctrico del calentador de acuerdo con el diagrama de alambrado de la figura 2. NO USE EL CABLE BLANCO MARCADO "N" PARA EL ALAMBRADO DE 208 A 240 VOLTS.
4. Para operar el calentador a 120 volts hay que realambrar el calentador como se ilustra en la figura 3, conectando el cable azul L2 al cable azul del otro elemento y al cable azul del termostato. Quite la marca del cable L2. Conecte los 120 volts al cable negro L1 y al cable blanco N. Consulte la figura 3.
5. Complete la instalación colocando de nuevo la cubierta de la parrilla y sujetándola con los dos tornillos que quitó previamente y cuatro tornillos adicionales de la bolsa de piezas. Saque la perilla del termostato de la bolsa e instale la perilla.

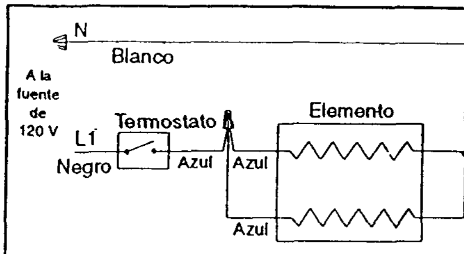
Operación del calentador

1. Encienda el calentador.
2. Gire el termostato en sentido de las manecillas del reloj, hasta la posición más caliente. Si la temperatura del aire es menor que 70°F (21°C), el calentador deberá encenderse y el elemento calentador se calentará. Si la temperatura del aire es superior a 70°F (21°C), el calentador no se encenderá.



HT500 - Alambrado en la fábrica para operar a 240/208 volts
500 watts, 2,1 amperes a 240 V
375 watts, 1,8 amperes a 208 V

Figura 2



Realambrado para la operación a 120 volts.

1. **Conecte el cable azul "L2" al cable azul del otro elemento y al cable azul del termostato. Quite la marca "L2" del cable.**
2. Conecte los 120 volts a los cables negro "L1" y blanco "N".

HT500 - Realambrado para la operación a 120 volts
500 watts, 4,2 amperes

Figura 3

Para revisar el ajuste del termostato es necesario que la temperatura del aire sea menor que 70°F (21°C).

3. El intervalo operativo del termostato es de 40°F (4,4°C), al girar la perilla totalmente en sentido contrario al de las manecillas del reloj, hasta 70°F (21°C) con la perilla gira totalmente en sentido de las manecillas del reloj. Gire el termostato a la posición deseada. El termostato encenderá y apagará el calentador automáticamente para mantener la temperatura deseada.

NOTA: El calentador ha sido diseñado con protección contra congelamiento y el termostato puede permitir que el calentador se encienda si la temperatura ambiental baja a menos de 40°F (4,4°C).

Limpieza y mantenimiento

Este calentador no requiere mantenimiento. Se recomienda la limpieza periódica con aspiradora y accesorio de cepillo eliminar el polvo y la tierra acumulados. Consulte la advertencia 1.

GARANTÍA LIMITADA

Todos los productos fabricados por Marley Electric Heating están garantizados contra defectos de mano de obra o materiales durante un año, a partir de la fecha de instalación. Esta garantía no se aplica a daños que resulten de accidentes, mal uso o alteraciones, ni a casos en los cuales el voltaje de alimentación sea más del 5% mayor que el voltaje especificado en la placa del producto. La garantía tampoco se aplica a equipo mal instalado o alambrado o cuyo mantenimiento se haya efectuado sin seguir las instrucciones de instalación del producto. Toda solicitud de trabajo amparado por la garantía deberá ir acompañada por un comprobante de la fecha de instalación.

El cliente será responsable de todos los costos incurridos por la remoción o reinstalación de los productos, incluyendo costos de mano de obra y transporte incurridos en la devolución de los productos al Centro de Servicio de Marley Electric Heating. Dentro de las limitaciones de esta garantía, la unidades inoperantes deberán devolverse al centro de servicio autorizado por Marley más cercano o al Centro de Servicio de Marley Electric Heating. Nosotros repararemos o reemplazaremos la unidad, a discreción nuestra y sin costo para el cliente, con el flete de retorno pagado por Marley. El cliente acepta que esta reparación o reemplazo será el único remedio que podrá exigir a Marley Electric Heating.

LAS GARANTÍAS ANTERIORES SUSTITUYEN A CUALQUIER OTRA GARANTÍA, YA SEA EXPLÍCITA O IMPLÍCITA. TODA GARANTÍA IMPLÍCITA DE COMERCIABILIDAD O IDONEIDAD PARA UN PROPÓSITO ESPECÍFICO QUE EXCEDA A LAS GARANTÍAS ANTERIORES QUEDARÁ EXCLUIDA DE ESTE ACUERDO. MARLEY ELECTRIC HEATING NO SERÁ RESPONSABLE DE DAÑOS CONSECUENTES RELACIONADOS CON EL PRODUCTO, YA SEA QUE ESTÉN BASADOS EN NEGLIGENCIA, AGRAVIO RESPONSABILIDAD ESTRICTA O CONTRATO.

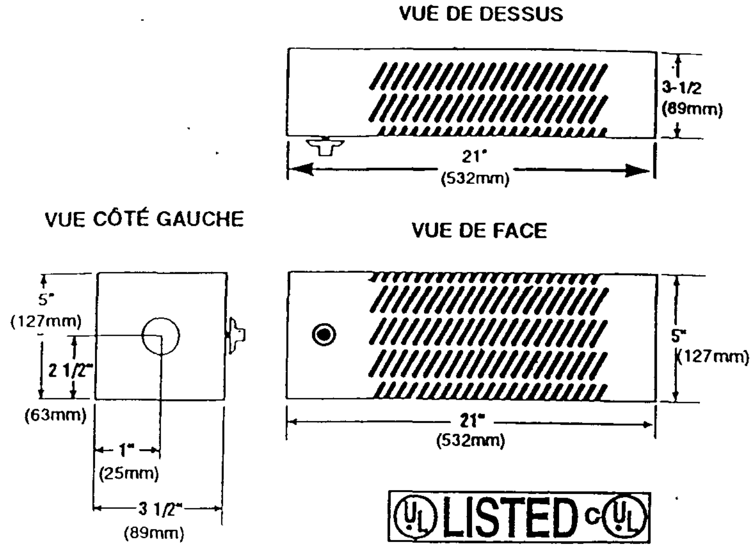
Algunos estados no permiten la exclusión o limitación de los daños incidentales o consecuentes, por lo cual es posible que la exclusión o limitación anterior no sea aplicable en su caso. Esta garantía le otorga derechos legales específicos y usted podrá tener otros derechos que varíen de un estado al otro.

Si desea conocer la dirección del centro de servicio autorizado más cercano a usted, comuníquese con Marley Electric Heating en Bennettsville, Carolina del Sur, llamando al 1-800-642-43... La mercancía devuelta a la fábrica deberá ir acompañada por autorización de devolución y un marbete de identificación de ser... cuales pueden obtenerse de Marley Electric Heating. Al solicitar la autorización de devolución, por favor incluya todos los números de catálogo que aparecen en los productos.

Marley Electric Heating
Una compañía United Dominion
470 Beauty Spot Rd. East
Bennettsville, SC 29512 EE.UU.

Marley Electric Heating
Une société United Dominion

Radiateur d'appoint apparent HT500



UL LISTED cUL
DOSSIER #21609

Instructions d'installation et d'entretien

Cher propriétaire,

Félicitations ! Nous vous remercions d'avoir acheté ce nouvel appareil fabriqué par Marley Electric Heating. Vous avez fait un bon investissement en choisissant le produit de la meilleure qualité de l'industrie du chauffage. Veuillez lire soigneusement les instructions d'installation et d'entretien indiquées dans ce manuel. Vous profiterez de nombreuses années de confort de chauffage efficace grâce à ce produit de Marley Electric Heating... le leader de l'industrie en conception, fabrication, qualité et service.

...Les employés de
Marley Electric Heating

⚠ AVERTISSEMENT ⚠

Lire soigneusement- Le présent mode d'emploi contient des informations concernant l'installation, l'utilisation et le fonctionnement approprié de l'appareil. Avant son installation, la mise en marche et le nettoyage du radiateur, lisez attentivement le présent manuel. A défaut de respecter les instructions, on peut provoquer incendie, choc électrique, mort, blessures sérieuses ou dommages matériels. Conservez ces instructions et consultez-les souvent afin de travailler dans des conditions de sécurité et de pouvoir en informer les futurs utilisateurs.

ATTENTION : RISQUE D'INCENDIE ET CHOC ÉLECTRIQUE

1. Pour empêcher un éventuel choc électrique, débranchez le câble d'alimentation du radiateur avant le câblage ou l'entretien.
2. Tout le câblage doit être conforme aux Codes électriques nationaux et locaux et l'appareil de chauffage doit être mis à la terre.
3. Ne montez pas à moins de 456 mm du sol ou 304 mm du plafond. Le bord du radiateur peut être monté à proximité de murs adjacents. Ne montez pas en position verticale.
4. Le radiateur est chaud lorsqu'il est en service. Evitez d'installer le radiateur derrière une porte, un porte-serviette, dans un placard ni en contact avec des rideaux ou tentures ou aux endroits où la ventilation du radiateur peut s'obstruer. Éloignez cordons électriques, literie, mobilier et autres objets inflammables hors de portée du radiateur.
5. Faites fonctionner le radiateur uniquement grille de protection fermée. La grille de protection doit être fixée par vis pour éviter toute ouverture involontaire.
6. Évitez de poser ou introduire des corps étrangers au contact du radiateur ou d'un de ses éléments, car ceci peut provoquer un choc électrique, un incendie ou des dégâts à l'appareil de chauffage.
7. L'appareil de chauffage a des pièces chaudes qui forment un arc ou des étincelles à l'intérieur. Ne l'utilisez pas dans des endroits où de l'essence, de la peinture ou des liquides inflammables sont utilisés ou entreposés.
8. N'utilisez pas le radiateur dans un environnement à contact direct avec de l'eau.
9. Ne l'utilisez pas dans une atmosphère corrosive.
10. Le voltage fourni doit être le même que celui de l'appareil. Se reporter sur a plaque d'identification avant la mise sous tension.

CONSERVEZ CES INSTRUCTIONS

Généralités

Le radiateur HT500 demande un montage horizontal mural. Le thermostat incorporé tient compte du réglage du débit de chaleur dans un environnement de 4° à 21°C (40 à 70° F). Le radiateur est câblé en usine pour une utilisation sous 240/208 Volts mais peut être recâblé pour l'utilisation sous 120 Volts.

Installation

1. Enlevez la grille de protection en dévissant les 2 vis sur le devant.
2. Positionnez le radiateur à l'endroit choisi en gardant un minimum d'espace libre (voir l'avertissement 3 et la figure 1)

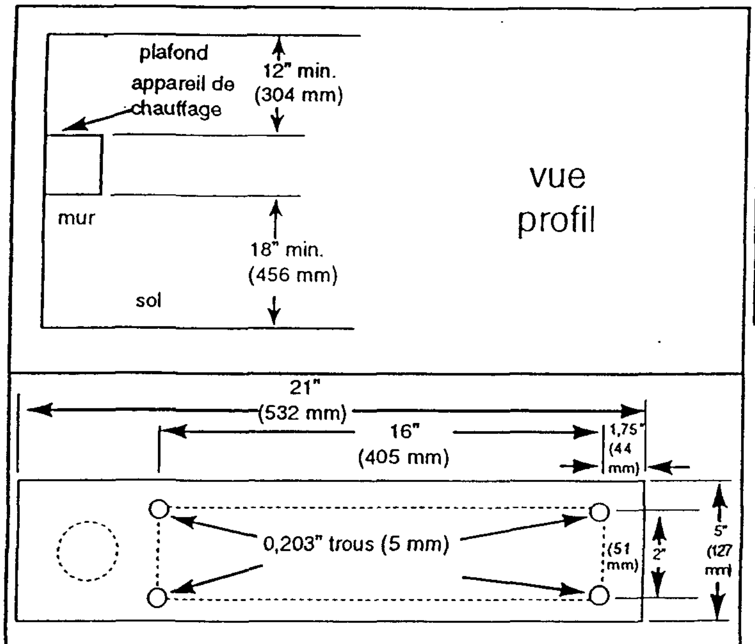


Figure 1

NOTA : 1 Le radiateur DOIT être monté à l'horizontale pour permettre une circulation d'air librement vers le haut. Le thermostat peut être monté indifféremment à gauche ou à droite du radiateur.

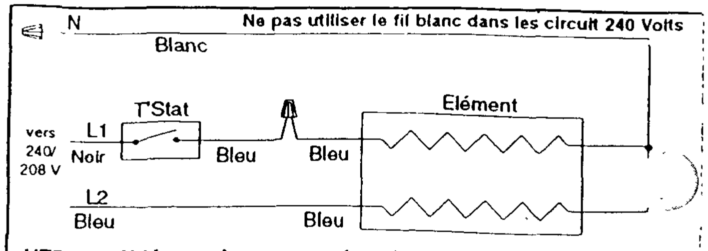
3. Fixez le radiateur solidement au mur à l'aide de vis ou boulons en utilisant les 4 trous pré-perforés sur l'arrière du radiateur.

Câblage

1. Introduisez le câble secteur du radiateur dans le trou de branchement pré-percé 7/8" (22 mm) au fond de la boîte de contrôle. Utilisez le clip câble comme recommandé par le Code National Électrique.
2. Connectez le fil de terre au radiateur en utilisant la vis de terre de couleur verte.
3. Pour faire fonctionner le radiateur à 208-240 Volts, connectez le câble d'alimentation secteur en suivant le diagramme montré dans la figure 2. NE PAS UTILISER LE CÂBLE BLANC MARQUÉ "N" POUR LE MONTAGE EN 208 - 240 VOLTS.
4. Pour faire marcher le radiateur en 120 Volts, référez-vous à la figure 3. Connectez le câble L2 bleu à l'autre câble bleu ainsi que le fil bleu du thermostat. Retirez le repère du câble L2. Connectez le câble de 120 Volts au fil noir L1 et au câble blanc N (voir figure 3).
5. Replacez la grille de protection en la revissant à l'aide des 2 vis enlevées et des 4 vis contenues dans le sachet d'accessoires. Sortez le bouton du thermostat du sac et installez-le.

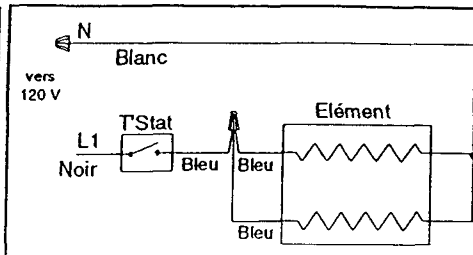
Allumage

1. Allumez le bouton Marche du radiateur.
2. Tournez le thermostat dans le sens des aiguilles d'une montre pour obtenir la chaleur maximale. Si la température de l'air est inférieure à 21°C (70°F), le radiateur se déclenche et en quelques instants l'élément chauffant devient chaud. Si la température de l'air est supérieure à 21°C (70°F), le



HT500 - câblé en usine pour un fonctionnement en 240/208 Volts

Figure 2 — 500 Watt, 2,1 Amp. @ 240 V; 375 Watt, 1,8 Amp. @ 208 V



Pour le recâblage en 120 V :

1. Connectez "L2" bleu à l'autre élément bleu et au fil du thermostat bleu. Retirez le repère de fil "L2".
2. Connectez le fil 120V à "L1" noir et le "N" blanc.

Figure 3 — HT500 - re-câblage pour fonctionnement en 120V — 500 Watt, 4,2 Amp.

thermostat ne se déclenchera pas. Un contrôle du dispositif doit avoir lieu lorsque la température de l'air est inférieure à 21° C (70°F).

3. L'échelle du thermostat s'étend de 4°C (40°F) à la position minimale en sens inverse des aiguilles d'une montre, jusqu'à 21°C (70°F) en position maximale, dans le sens des aiguilles d'une montre. Positionnez le thermostat à l'endroit désiré. Le thermostat maintient le radiateur automatiquement à la température désirée.

NOTA : Le radiateur a été conçu, muni d'une protection contre le gel; le thermostat permet de démarrer au plus bas, si la température de l'espace tombe en dessous de 4°C (40°F).

Nettoyage - Entretien

Ce radiateur ne nécessite aucun entretien . Un nettoyage périodique pour enlever poussières et saleté est recommandé, en utilisant de l'air comprimé (voir avertissement 1).

GARANTIE LIMITÉE

Tous les produits fabriqués par Marley Electric Heating sont garantis contre les défauts de main d'oeuvre et de matériaux pendant un an à compter de la date de l'installation. Cette garantie ne s'applique pas aux dégâts provenant d'accident, de mauvais emploi ou de modification ; ni là où la tension branchée est supérieure de 5 % à la tension de la plaque signalétique ; ni à un matériel incorrectement installé ou câblé ou entretenu en infraction aux instructions d'installation du produit. Toutes les réclamations relatives à la main d'oeuvre de garantie doivent être accompagnées de la preuve de la date d'installation.

Le client sera responsable de tous les frais encourus par la dépose ou la réinstallation des produits, y compris les frais de main d'oeuvre et les frais d'expédition encourus pour renvoyer les produits au Marley Electric Heating Service Center. Dans le cadre des limites de la présente garantie, les appareils défectueux devraient être retournés au centre de service après-vente autorisé le plus proche ou au Centre Marley Electric Heating, et nous les réparerons ou les remplacerons, à notre choix, gratuitement, les frais d'expédition de retour étant payés par Marley. Il est convenu qu'une telle réparation ou un tel remplacement sont les seuls recours pouvant être obtenus auprès de Marley Electric Heating.

LES GARANTIES CI-DESSUS REMPLACENT TOUTES LES AUTRES GARANTIES EXPLICITES OU IMPLICITES ET TOUTES LES GARANTIES IMPLICITES DE COMMERCIABILITÉ ET D'ADAPTATION À UN USAGE PARTICULIER QUI DÉPASSENT LES GARANTIES EXPLICITES DÉCRITES CI-DESSUS SONT RÉPUDIÉES PAR LA PRÉSENTE ET EXCLUES DE CET ACCORD. MARLEY ELECTRIC HEATING NE SERA PAS RESPONSABLE DES DOMMAGES INDIRECTS SE RAPPORTANT AU PRODUIT, QUE CE SOIT PAR NÉGLIGENCE, DÉLIT, RESPONSABILITÉ STRICTE OU CONTRAT.

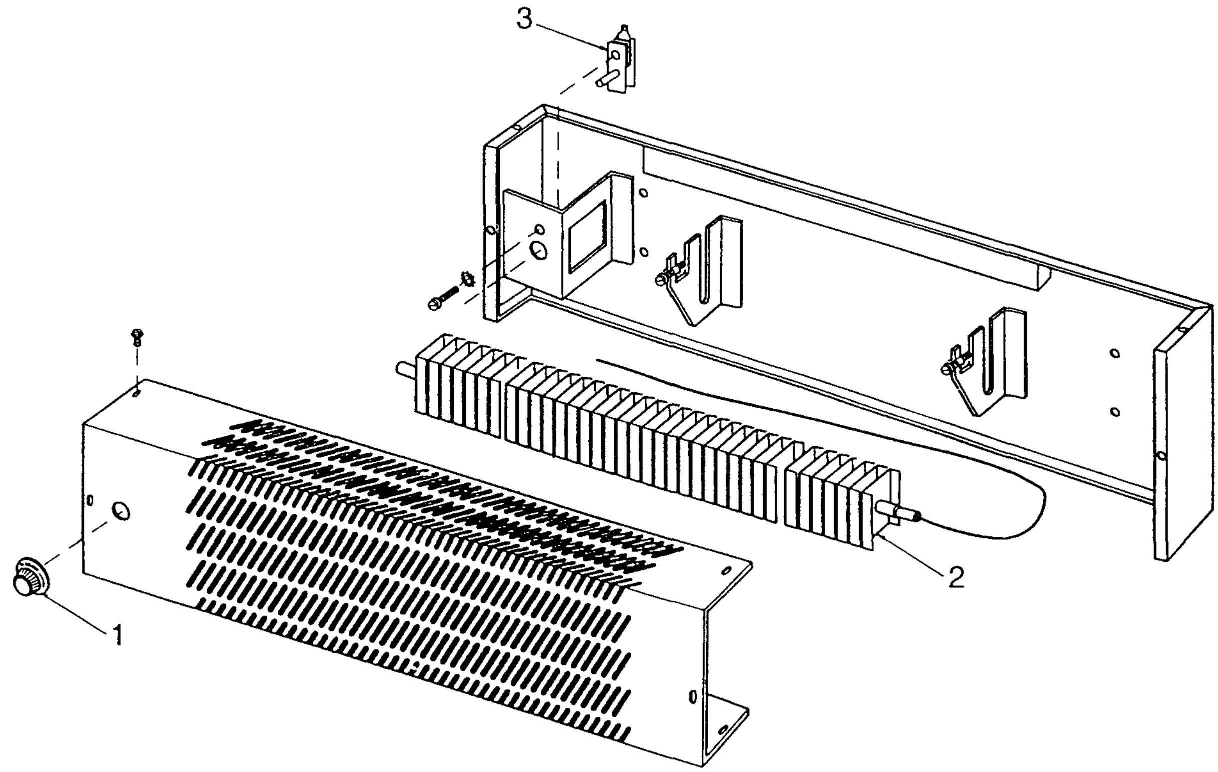
Certaines provinces n'autorisent pas l'exclusion ou la limitation de dommages-intérêts fortuits ou indirects, de sorte que l'exclusion ou la limitation ci-dessus peut ne pas s'appliquer à vous. La présente garantie vous donne des droits légaux spécifiques et vous pouvez aussi avoir d'autres droits qui varient d'une province à l'autre.

Pour l'adresse de votre centre d'entretien autorisé le plus proche, veuillez prendre contact avec Marley Electric Heating à Bennetts, Caroline du Sud, au 1-800-642-4328. La marchandise renvoyée à l'usine doit être accompagnée d'une autorisation de renvoi et d'une étiquette d'identification de service, les deux sont à votre disposition auprès de Marley Electric Heating. Lors de la demande d'autorisation de renvoi, inclure tous les numéros de catalogue qui figurent sur les produits.

WHT REPLACEMENT PARTS

WHT500

Key No.	Description	Part Number
1	Knob	3301-2020-006
2	Element	1802-2091-000
3	Thermostat	5813-2062-000



QMARK
A Division of Marley Electric Heating
470 Beauty Spot Rd East
Bennettsville, SC 29512

Square D
Safety Switches

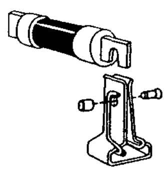
Heavy Duty Safety Switches

600 Volt
Class 3110

Class H Fuse Provisions:

Fusible Square D 30 through 600 Ampere Heavy Duty Safety Switches accept Class H fuses as standard. With Class H fuses installed the switch is UL Listed for use on systems with up to 10,000 RMS Symmetrical Amperes available fault current.

Class R Fuse Provisions:



Fusible Square D 30 through 600 Ampere Heavy Duty Safety Switches will accept Class R fuses as standard. A field installable rejection kit is available which, when installed, rejects all but Class R fuses. With the installation of the rejection kit and Class R fuses, the switch is UL Listed for use on systems with up to 200,000 RMS Symmetrical Amperes available fault current. See Class R Fuse Kits on page 3-9.

Class J Fuse Provisions:

Provisions for installing Class J fuses are included in 30 through 400 Ampere 600 Volt, and 100 through 400 Ampere 240 Volt, fusible Heavy Duty Safety Switches. Conversion to Class J fuse spacing requires relocating the load side fuse base assembly from the standard Class H fuse location to an alternate position as marked in the enclosure. With Class J fuses installed, the switch is UL Listed for use on systems with up to 200,000 RMS Symmetrical Amperes available fault current. Switches rated 600 Amperes, 240 or 600 Volt, require the addition of an adapter kit, H600J at **$304**. One kit per 3-pole switch.

Class L Fuse Provisions:

Fusible 800 A and 1200 A Safety Switches use Class L bolt-in fuses and are rated for use on systems with up to 200,000 RMS Symmetrical Amperes at 600 Vac maximum.

600 Volts – Single Throw Fusible

INSIDE VAULT

System	Amps	NEMA Type 1 Indoor		NEMA Type 3R Rainproof (Bolt-on Hubs page 3-9)		NEMA Type 4, 4X, 5 (304 Stainless Steel) Dusttight, Watertight, Corrosion Resistant All Cu Current Carrying Parts (Watertight Hubs page 3-9)		JIC-Mill & Foundry Type All Cu Current Carrying Parts (Watertight Hubs-page 3-9): NEMA Type 12K With Knockouts		JIC-Mill & Foundry Type: NEMA Type 12, 3R† Without Knockouts		Horsepower Ratings▼ 480 Vac Std.	480 Vac Max.	600 Vac Std.	600 Vac Max.	dc	
		Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	3Ø	3Ø	3Ø	3Ø	250	600
2 Wire (2 Blades and Fuseholders) – 600 Vac, 600 Vdc																	
	30	Use 3 Wire Devices For 2 Wire Applications										–	–	–	–	–	–
	60											–	–	–	–	–	–
	100											–	–	–	–	–	–
	200											–	–	–	–	–	–
	400	H265	$ 2804.	H265R	$ 3616.	H265DS	$ 9499.	–	–	H265AWK	$ 3190.	100♦	250♦	–	–	50	–
	600	H266	4435.	H266R	7124.	H266DS	13587.	–	–	H266AWK	4747.	150♦	400♦	–	–	–	–
	800	H267	6910.	H267R☆	10923.	–	–	–	–	H267AWK	9699.	–	–	–	–	50	50
	1200	H268	9713.	H268R☆	11994.	–	–	–	–	H268AWK	11456.	–	–	–	–	50	50
3 Wire (3 Blades and Fuseholders) – 600 Vac, 600 Vdc●□																	
	30	H361	$ 352.	H361RB	$ 599.	H361DS	$ 1600.	H361A	$ 644.	H361AWK	$ 607.	5	15	7½	20	–	15
	30	H361-2▲	411.	H3612RB▲	699.	–	–	H361-2A▲	657.	H3612AWK▲	620.	5	15	7½	20	–	15
	60	H362	425.	H362RB	703.	H362DS	1759.	H362A	665.	H362AWK	625.	15	30	15	50	–	30
	100	H363	792.	H363RB	1096.	H363DS■	3488.	H363A	1032.	H363AWK	977.	25	60	30	75	–	40
	200	H364	1138.	H364RB	1506.	H364DS	4879.	H364A	1615.	H364AWK	1524.	50	125	60	150	–	50
	400	H365	3034.	H365R	3688.	H365DS	9728.	–	–	H365AWK	3468.	100	250	125	350	50	–
	600	H366	5099.	H366R	7266.	H366DS	13815.	–	–	H366AWK	5843.	150	400	200	500	–	–
	800	H367	8879.	H367R★	11000.	–	–	–	–	H367AWK	10382.	200	500	250	500	50	50
	1200	H368	11671.	H368R★	13339.	–	–	–	–	H368AWK	12511.	200	500	250	500	50	50
4 Wire (3 Blades and Fuseholders, 1 Neutral) – 600 Vac																	
	30	H361N	$ 411.	H361NRB	$ 657.	Use 3 Wire Devices Field Installable Solid Neutral Assemblies. Order Separately-See page 3-10						5	15	7½	20	–	15
	60	H362N	473.	H362NRB	756.							15	30	15	50	–	–
	100	H363N	852.	H363NRB	1158.							25	60	30	75	–	–
	200	H364N	1246.	H364NRB	1605.	H364NDS	$ 4997.	H364NA	$ 1724.	H364NAWK	$ 1624.	50	125	60	150	–	50
	400	H365N	3265.	H365NR	3843.	H365NDS	9948.	–	–	H365NAWK	3697.	100	250	125	350	–	–
	600	H366N	5346.	H366NR	7369.	H366NDS	14046.	–	–	H366NAWK	6095.	150	400	200	500	–	–
	800	H367N	9362.	H367NR★	11470.	–	–	–	–	H367NAWK	10954.	200	500	250	500	50	50
	1200	H368N	12076.	H368NR★	13995.	–	–	–	–	H368NAWK	13219.	200	500	250	500	50	50
4 Wire (4 Blades and Fuseholders) – 600 Vac◊												2Ø	2Ø	2Ø	2Ø		
	30	H461	$ 580.	–	–	H461-2DS▲△	$ 1865.	–	–	H461AWK	$ 708.	7½	20	10	25	5☆	15☆
	60	H462	676.	–	–	H462DS△	1949.	–	–	H462AWK	798.	15	40	20	50	10☆	30☆
	100	H463	1129.	–	–	H463DS△	5298.	–	–	H463AWK	1227.	25	50	30	75	25☆	30☆
	200	H464	1877.	–	–	H464DS△	7997.	–	–	H464AWK	2046.	50	50	50	50	–	–
	400	H465	3943.	–	–	–	–	–	–	H465AWK	4322.	–	–	–	–	–	–
	600	H466	6415.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6 Wire (6 Blades and Fuseholders) – 600 Vac◊																	
	100	–	–	–	–	H663DS△	$16485.	–	–	H663AWK	$ 3246.	For applications requiring motor disconnect capability, use electrical interlock. Refer to page 3-9.					
	200	–	–	–	–	H664DS△	22471.	–	–	H664RWK△	7760.						

▼ Refer to page 5-13 for additional motor application data. The starting current of motors of more than standard horsepower may require the use of fuses with appropriate time delay characteristics.
† Also suitable for NEMA Type 3R application by removing drain screw from bottom endwall.
■ 250 Vdc maximum. Use two outside poles for switching DC.
♦ For grounded "B" phase systems only and with neutral assembly installed.
★ Suitable for NEMA Type 5 applications with drain screw installed.
● On 3-Pole devices, use two outside poles for switching DC.
▲ 60 Ampere switch with 30 Ampere fuse spacing and clips. Must use 60 A enclosure accessories including electrical interlocks.
◊ Not suitable for use as service equipment.
△ Not UL Listed – 6 week shipment.
□ 400 and 600 Amp – 600 Vac only.
☆ Does not apply to NEMA Type 4, 4X and 5 switches.

NOTE: One day shipment is available on DASH Program for non-stock 400 through 1200 Ampere heavy duty switches.

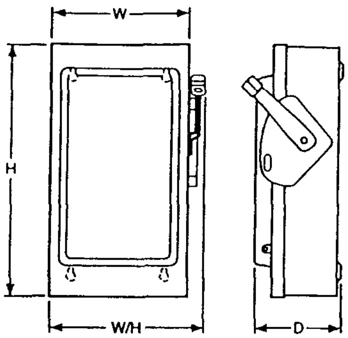
Dimensions NEMA Type 1 and 3R .... Page 3-12
NEMA Type 4, 4X and 5 Stainless and NEMA Type 12 ...... Page 3-13
Accessories .... Pages 3-9 and 3-11

For additional information, reference the Enclosed Safety Switches Catalog 3100CT9801.

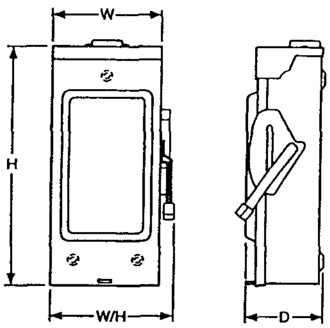
Heavy Duty Safety Switches

NEMA Type 1 and 3R – Dimensions, Lug Data
Class 3110

Square D
www.squared.com
FOR CURRENT INFORMATION



Typical NEMA Type 1



Typical NEMA Type 3R

Terminal Lug Data▲

Ampere Rating	NEMA Type Enclosure	Conductors Per Phase and Neutral	Wire Range Wire Bending Space Per NEC Table 373-6	Lug Wire Range	Optional VERSA-CRIMP Compression Lug Field Installable
30	1, 3R 4X■	1	#12-6 AWG (Al) or #14-6 AWG (Cu)	#12-2 AWG (Al) or #14-2 AWG (Cu)	. . .
60	1, 3R 4X■	1	#12-3 AWG (Al) or #14-3 AWG (Cu)	#12-2 AWG (Al) or #14-2 AWG (Cu)	
100	1, 3R 4X■	1	#12-1/0 AWG (Al) or #14-1/0 AWG (Cu)	#12-1/0 AWG (Al) or #14-1/0 AWG (Cu)	VCEL02114S1
200	1, 3R	1	#6 AWG - 250 kcmil (Al/Cu)	#6 AWG - 300 kcmil (Al/Cu)	VCEL030516H1
400	1, 3R	1 or 2	#1/0 AWG - 750 kcmil (Al/Cu) or #1/0 AWG - 300 kcmil (Al/Cu)	#1/0 AWG - 750 kcmil (Al/Cu) and #1/0 AWG - 300 kcmil (Al/Cu)	VCEL07512H1 or VCEL030516H1● and VCEL05012H1
600	1, 3R	2	#3/0 AWG - 500 kcmil (Al/Cu)	#3/0 AWG - 500 kcmil (Al/Cu)	VCEL05012H1
800	1, 3R/5	3	#3/0 AWG - 750 kcmil (Al/Cu)	#3/0 AWG - 750 kcmil (Al/Cu)	H8LKE2◊
1200	1, 3R/5	4	#3/0 AWG - 750 kcmil (Al/Cu)	#3/0 AWG - 750 kcmil (Al/Cu)	H12LKE2◊

▲ 30-100 Amp switches suitable for 60°C or 75°C conductors. 200-1200 Amp switches suitable for 75°C conductors
● Order two PK516KN mounting kits ($5.50 each. Lexington Order Point) when installing VCEL030516H1 lugs. Only one kit is required on 2-Pole switches.
◊ See page 3-11, 800 and 1200 A compression lug kits for additional information.
■ 4X Fiberglass Reinforced Polyester and KRYDON Switches.

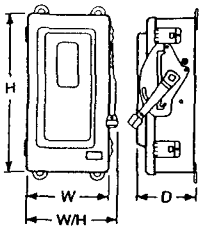
For additional information, reference Enclosed Safety Switches Catalog 3100CT9801.

Catalog Number	Series	H IN	H mm	W IN	W mm	D IN	D mm	W/H IN	W/H mm
H221N	F1	14.60	371	6.50	165	4.88	124	7.55	192
H221NRB	F1	14.88	378	6.63	168	4.88	124	7.55	192
H222N	F4	14.60	371	6.50	165	4.88	124	7.55	192
H222NRB	F4	14.88	378	6.63	168	4.88	124	7.55	192
H223N	F5	21.25	540	8.50	216	6.38	162	10.50	267
H223NRB	F5	21.25	540	8.50	216	6.38	162	10 50	267
H224N	E1	27.38	695	12.88	327	7.50	191	14 38	365
H224NRB	E1	27.38	695	13.13	334	7.75	197	14.75	375
H225, N	E1	50.25	1276	27.63	702	10.13	257	27.63	702
H225NR, R	E1	50.31	1278	27.88	708	10.13	257	27.88	708
H226, N	E1	50.25	1276	27.63	702	10.13	257	27.63	702
H226NR, R	E1	50.31	1278	27.88	708	10.13	257	27.88	708
H227, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H227NR, R	E4	69.13	1756	36.62	930	17.75	451	36 62	930
H228, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H228NR, R	E4	69.13	1756	36.62	930	17.75	451	36 62	930
H265	E2	50.25	1276	27.63	702	10.13	257	27.63	702
H265R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
H266	E2	50.25	1276	27.63	702	10.13	257	27.63	702
H266R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
H267	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H267R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H268	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H268R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H321N	F1	14.60	371	6.50	165	4.88	124	7.55	192
H321NRB	F1	14.88	378	6.63	168	4.88	124	7.55	192
H322N	F4	14.60	371	6.50	165	4.88	124	7.55	192
H322NRB	F4	14.88	378	6 63	168	4.88	124	7.55	192
H323N	F5	21.25	540	8.50	216	6.38	162	10.50	267
H323NRB	F5	21.25	540	8.50	216	6.38	162	10.50	267
H324N	E1	27.38	695	12.88	327	7.50	191	14.38	365
H324NRB	E1	27.38	695	13.13	334	7.75	197	14.75	375
H325, N	E1	50.25	1276	27.88	708	10.13	257	27.88	708
H325R, NR	E1	50.31	1278	27.88	708	10.13	257	27.88	708
H326, N	E1	50.25	1276	27.63	702	10.13	257	27.63	702
H326R, NR	E1	50.31	1278	27.88	708	10.13	257	27.88	708
H327, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H327R, NR	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H328, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H328R, NR	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H361, N	F1	14.60	371	6.50	165	4.88	124	7.55	192
H361-2	F3	17.50	445	9.00	229	6.38	162	10.50	267
H361NRB, RB	F1	14.88	378	6.63	168	4.88	124	7.55	192
H362, N	F5	17.50	445	9.00	229	6.38	162	10.50	267
H362NRB, RB	F5	17.50	445	9.00	229	6.38	162	10.50	267
H362WH	F5	18.19	462	9.00	229	6.81	173	10.50	267
H363, N	F5	21.25	540	8.50	216	6.38	162	10.50	267
H363NRB, RB	F5	21.25	540	8.50	216	6.38	162	10 50	267

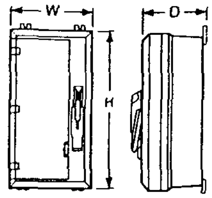
Catalog Number	Series	H IN	H mm	W IN	W mm	D IN	D mm	W/H IN	W/H mm
H364	E2	27.38	695	12.88	327	7.50	191	14.38	365
H364N	E1	27.38	695	16.25	413	7.50	191	17.38	441
H364NRB	E1	27.50	699	16.13	410	7.75	197	18.00	457
H364RB	E1	27.38	695	13.13	334	7.75	197	14.75	375
H365, N	E2	50.25	1276	27.63	702	10.13	257	27.63	702
H365R, NR	E2	50.31	1278	27.88	708	10.13	257	27.88	708
H366, N	E2	50.25	1276	27.63	702	10.13	257	27.63	702
H366NR, R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
H367, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H367NR, R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H368, N	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H368NR, R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H461	F5	20.50	521	14.75	375	6.85	174	16.13	410
H462	F5	20.50	521	14.75	375	6.85	174	16.13	410
H463	F5	20 50	521	14.75	375	6.85	174	16.13	410
H464	E1	27.38	695	16.25	413	7.50	191	17.38	441
H465	E2	50.25	1276	33.88	861	10.13	257	33.88	861
H466	E2	50.25	1276	33.88	861	10.13	257	33.88	861
HU265	E2	50.25	1276	27.63	702	10.13	257	27.63	702
HU265R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
HU266	E2	50.25	1276	27.63	702	10.13	257	27.63	702
HU266R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
HU267	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU267R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU268	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU268R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU361	F1	14.60	371	6.50	165	4 88	124	7.55	192
HU361RB	F1	14.88	378	6.63	168	4.88	124	7.55	192
HU362	F5	17.50	445	9.00	229	6.38	162	10.50	267
HU362RB	F5	17.50	445	9.00	229	6.38	162	10.50	267
HU362WH	F5	18.19	462	9.00	229	6.81	173	10.50	267
HU363	F5	21.25	540	8.50	216	6.38	162	10.50	267
HU363RB	F5	21.25	540	8.50	216	6.38	162	10.50	267
HU364	E1	27.38	695	12.88	327	7.50	191	14.38	365
HU364RB	E1	27.38	695	13.13	334	7.75	197	14.75	375
HU365	E2	50.25	1276	27.63	702	10.13	257	27.63	702
HU365R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
HU366	E2	50.25	1276	27.63	702	10.13	257	27.63	702
HU366R	E2	50.31	1278	27.88	708	10.13	257	27.88	708
HU367	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU367R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU368	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU368R	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU461	F3	20.50	521	14.75	375	6.85	174	16.13	410
HU462	F5	20.50	521	14.75	375	6.85	174	16.13	410
HU463	F5	20.50	521	14.75	375	6.85	174	16.13	410
HU464	E1	27.38	695	16.25	413	7.50	191	17.38	441
HU465	E2	50.25	1276	33.88	861	10.13	257	33.88	861
HU466	E2	50.25	1276	33.88	861	10.13	257	33.88	861

Heavy Duty Safety Switches

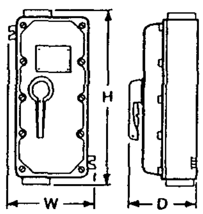
NEMA Types 4, 4X, 5, 7, 9 and 12 Dimensions, Lug and Conduit Data
Class 3110



Typical NEMA Type 4, 4X, 5, 12, 12K



Typical NEMA Type 4X Fiberglass Reinforced Polyester and KRYDON



Typical NEMA Type 7, 9

Conduit Provisions – NEMA Type 4X Fiberglass Reinforced Polyester and KRYDON, NEMA Type 7 and 9

Ampere Rating	Top and Bottom Endwall	
	NEMA Type 4X Fiberglass Reinforced Polyester and KRYDON∆	NEMA Type 7 and 9◊
30	¾"	....
60	1¼"	¾"
100	2"	1¼"
200	2½"	2½"

∆ Hubs and hub drilling templates are provided for field installation.
◊ Threaded conduit opening.

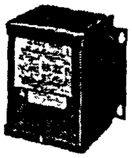
Terminal Lug Data▲

Ampere Rating	NEMA Type Enclosure	Conductors Per Phase	Wire Range Wire Bending Space Per NEC Table 373-6	Lug Wire Range	Optional VERSA-CRIMP® Compression Lug Field Installable
30●	4, 4X, 5■ 12, 12K	1	#14-6 AWG (Cu)	#14-4 AWG (Cu)	......
60●	4, 4X, 5■ 12, 12K	1	#14-4 AWG (Cu)□	#14-4 AWG (Cu)	......
100●	4, 4X, 5■ 12, 12K	1	#14-1 AWG (Cu)	#14-1/0 AWG (Cu)	VCEL02114S1
200	4, 4X, 5, 12, 12K	1	#6 AWG - 250 kcmil (Cu)♦	#6 AWG - 250 kcmil (Cu)	VCEL030516H1
400	4, 4X 5, 12	1 or 2	#1 AWG - 600 kcmil (Cu) or #1 AWG - 250 kcmil (Cu)	#1 AWG - 600 kcmil (Cu) and #1 AWG - 250 kcmil (Cu)	VCEL07512H1 or VCEL030516H1 and VCEL05012H1
600	4, 4X 5, 12	2	#4 AWG - 350 kcmil (Cu)	#4 AWG - 350 kcmil (Cu)	VCEL05012H1
800	12	3	#3/0 AWG - 750 kcmil (Al/Cu)	#3/0 AWG - 750 kcmil (Al/Cu)	H8LKE2☆
1200	12	4	#3/0 AWG - 750 kcmil (Al/Cu)	#3/0 AWG - 750 kcmil (Al/Cu)	H12LKE2☆

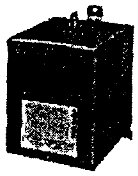
▲ 30-100 Amp switches suitable for 60°C or 75°C conductors. 200-1200 Amp switches suitable for 75°C conductors.
● NEMA Type 4X Fiberglass Reinforced Polyester and KRYDON devices, refer to page 3-12 for lug data.
☆ See page 3-11, 750 kcmil Lug kits, for additional information.
■ NEMA Type 4, 4X and 5 stainless steel.
□ H60XFA–#14-6 AWG (Cu).
♦ H225XKA–#4 AWG - 300 kcmil (Cu).

Catalog Number	Series	Approximate Dimensions H IN	H mm	W IN	W mm	D IN	D mm	W/H IN	W/H mm
H60XFA	E1	15.93	405	9.87	251	6.96	177	9.87	251
H100XFA	E1	15.93	405	9.87	251	6.96	177	9.87	251
H221AWK, A	F1	14.60	371	6.63	168	4.96	125	7.55	192
H221DS	E1	14.75	375	6.75	171	5.13	130	7.63	194
H221-2AWK	F5	16.50	419	9.00	229	7.00	178	10.50	267
H222AWK, A	F4	14.60	371	6.63	168	4.96	125	7.55	192
H222DS	E1	16.63	422	8.13	207	6.13	156	9.00	229
H223AWK, A	F5	20.50	521	9.00	229	7.00	178	10.50	267
H223DS	E2	20.62	524	10.38	264	6.50	165	11.50	292
H224AWK, A	E1	27.63	702	13.13	334	8.00	203	14.25	362
H224DS	E1	27.63	702	13.13	334	8.00	203	14.25	362
H225AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H225NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H225XKA	C2	22.56	573	10.88	276	7.75	197	10.88	276
H226AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H226NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H227AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H228AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H265AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H266AWK, A, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H267AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H268AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H321AWK, A	F1	14.60	371	6.63	168	4.96	125	7.55	192
H321DS	E1	14.75	375	6.75	171	5.13	130	7.65	194
H322AWK, A	F4	14.60	371	6.63	168	4.96	125	7.55	192
H322DS	E1	16.63	422	8.13	207	6.13	156	9.00	229
H323AWK, A	F5	20.50	521	9.00	229	7.00	178	10.50	267
H323DS	E2	20.62	524	10.38	264	6.50	165	11.50	292
H324AWK	E2	27.63	702	13.13	334	8.00	203	14.25	362
H324A, DS	E1								
H325AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H325NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H326AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H326NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H327AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H328AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H361CS	F3	21.00	533	11.00	279	7.25	184	11.56	294
H362CS	F3	21.00	533	11.00	279	7.25	184	11.56	294
H363CS	F3	23.50	597	11.00	279	7.25	184	11.56	294
H361AWK, A	F1	14.60	371	6.63	168	4.96	125	7.55	192
H361DS*	E1								
H361DF	F1	16.50	419	11.00	279	8.80	224	11.00	279
H361DX	F1	19.40	493	11.40	290	8.60	218	11.40	290
H361-2AWK, A	F3	16.50	419	9.00	229	7.00	178	10.50	267
H362AWK, A	F5	16.50	419	9.00	229	7.00	178	10.50	267
H362DS	E1	16.63	422	8.13	207	6.13	156	9.00	229
H362AWA	F5	16.50	419	9.00	229	7.00	178	10.50	267
H362AWC	F5	16.50	419	9.00	229	7.00	178	10.50	267
H362AWH	F5	16.50	419	9.00	229	7.00	178	10.50	267
H362DF	F1	16.50	419	11.00	279	8.80	224	11.00	279
H362DX	F1	19.40	493	11.40	290	8.60	218	11.40	290
H363AWK, A	F5	20.50	521	9.00	229	7.00	178	10.50	267
H363DS	E1	20.62	524	10.38	264	6.50	165	11.50	292
H363DF	F1	24.80	630	13.70	348	12.00	305	13.70	348
H363DX	F1	25.25	641	11.40	290	8.60	218	11.40	290
H364AWK, A DS	E1	27.63	702	13.13	334	8.00	203	14.25	362
H364NAWK, NA, NDS	E1	27.63	702	16.25	413	8.00	203	17.50	445
H364DF	E1	31.30	795	26.30	668	11.80	300	26.30	668
H365AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H365NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H366AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H366NAWK, NDS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
H367AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H368AWK, NAWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
H461AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
H462AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
H462DS	E1	16.63	422	8.13	207	6.13	156	9.00	229
H463AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
H463 DS	E1	15.00	381	15.25	387	8.50	216	18.25	464
H464AWK, DS	E1	27.63	702	16.25	413	8.00	203	17.50	445
H465AWK	E2	46.25	1175	32.50	826	10.13	259	32.50	826
H663AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
H663DS	E1	14.25	362	15.25	387	7.80	198	19.25	489
H664RWK	E1	27.75	705	23.00	584	7.88	200	24.25	616
H664DS	E1	33.10	841	37.72	958	11.00	279	41.12	1044
HU265AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
HU266AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
HU267AWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU268AWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU361AWK, A	F1	14.60	371	6.63	168	4.96	125	7.55	192
HU361DS	E1	14.75	375	6.75	171	5.13	130	7.63	194
HU361DF	F1	16.50	419	11.00	279	8.80	224	11.00	279
HU361DX	F1	19.40	493	11.40	290	8.60	218	11.40	290
HU362AWK, A	F5	16.50	419	9.00	229	7.00	178	10.50	267
HU362DS	E1	16.63	422	8.13	207	6.13	156	9.00	229
HU362AWA	F5	16.50	419	9.00	229	7.00	178	10.50	267
HU362AWC	F5	16.50	419	9.00	229	7.00	178	10.50	267
HU362AWH	F5	16.50	419	9.00	229	7.00	178	10.50	267
HU362DF	F1	16.50	419	11.00	279	8.80	224	11.00	279
HU362DX	F1	19.40	493	11.40	290	8.60	218	11.40	290
HU363AWK, A	F5	20.50	521	9.00	229	7.00	178	10.50	267
HU363DS	E1	20.62	524	10.38	264	6.50	165	11.50	292
HU361CS	F3	21.00	533	11.00	279	7.25	184	11.56	294
HU362CS	F3	21.00	533	11.00	279	7.25	184	11.56	294
HU363CS	F3	21.00	533	11.00	279	7.25	184	11.56	294
HU363DF	F1	24.80	630	13.70	348	12.00	305	13.70	348
HU363DX	F1	25.25	641	11.40	290	8.60	218	11.40	290
HU364DF	E1	31.30	795	26.30	668	11.80	300	26.30	668
HU364AWK, A, DS	E1	27.63	702	13.13	334	8.00	203	14.25	362
HU365AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
HU366AWK, DS	E2	46.25	1175	26.25	667	10.13	259	26.25	667
HU367AWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU368AWK	E4	69.13	1756	36.62	930	17.75	451	36.62	930
HU461AWK, DS	E1	16.63	422	9.88	251	6.13	156	11.00	279
HU462AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
HU462DS	E1	16.63	422	9.88	251	6.13	156	11.00	279
HU463AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
HU463DS	E1	19.38	492	16.00	406	8.88	226	19.50	495
HU464AWK, DS	E1	27.63	702	16.25	413	8.00	203	17.50	445
HU465AWK	E2	46.25	1175	32.50	826	10.13	259	32.50	826
HU661AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
HU661DS	E1	19.25	489	17.25	438	6.25	159	18.50	470
HU662AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
HU662DS	E1	19.25	489	17.25	438	6.25	159	18.50	470
HU663AWK	F5	20.50	521	14.75	375	6.80	173	16.13	410
HU663DS	E1	19.25	489	17.25	438	6.25	159	18.50	470
HU664DS, RWK	E1	24.38	619	23.00	584	7.88	200	24.25	616

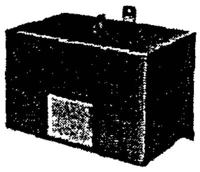
Enclosure Styles



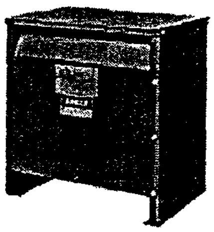
Style A–NEMA Type 3R Rated



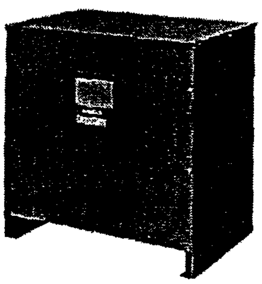
Style B–
NEMA Type 3R Rated



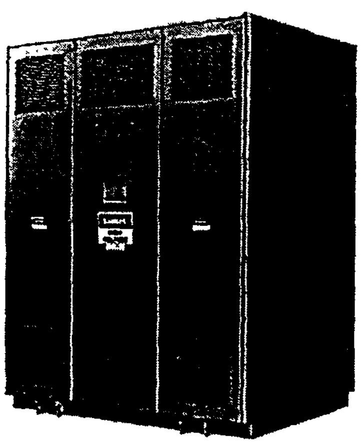
Style C –NEMA Type 3R Rated



Style D –NEMA Type 2 Rated
Converts to NEMA Type 3R with Weathershield



Style E–IP55 Rated



Style F–NEMA Type 1 Rated

Table 1: Enclosure Dimensions and Accessories (Note 1)

Enclosure Number/ Style		Height		Width		Depth		Mtg.	Weathershield	Wall Mounting Bracket	Ceiling Mounting Bracket	Insulation Class °C
		IN	mm	IN	mm	IN	mm					
1	A	5	127	4.47	114	3.44	87	Wall	Note 2	Note 3	—	105
2	A	5.5	140	4.47	114	3.44	87	Wall	Note 2	Note 3	—	105
3	A	5	127	4.85	123	3.75	95	Wall	Note 2	Note 3	—	105
4	A	5.5	140	5.23	133	4.06	103	Wall	Note 2	Note 3	—	130
5	A	6.19	157	6.19	157	4.69	119	Wall	Note 2	Note 3	—	130
6	A	6.69	170	6.19	157	4.69	119	Wall	Note 2	Note 3	—	180
7	A	8.13	270	6.94	176	5.31	135	Wall	Note 2	Note 3	—	180
8	A	8.25	210	8.68	220	6.56	167	Wall	Note 2	Note 3	—	180
9	A	9.56	243	8.68	220	6.56	167	Wall	Note 2	Note 3	—	180
10	A	10.5	267	8.62	219	6.5	165	Wall	Note 2	Note 3	—	180
11	A	12.56	319	8.62	219	6.5	165	Wall	Note 2	Note 3	—	180
12	C	13.5	343	14.75	375	9	229	Wall	Note 2	Note 3	—	180
13	B	14.75	375	9.75	248	11.75	298	Wall	Note 2	Note 3	—	180
14	C	14.75	375	19.1	485	12.25	311	Wall	Note 2	Note 3	—	180
15	B	20	508	15	381	13.5	343	Wall	Note 2	Note 3	—	180
16	C	22	559	25	635	13.5	343	Wall	Note 2	Note 3	—	180
17	D	27	686	20	508	16	406	Floor	WS363	WMB361–362	CMB363	220
	E	27	686	20	508	16	406	Floor	Note 5	WMB361–362	CMB363	220
18	D	30	762	20	508	20	508	Floor	WS363	WMB363–364	CMB363	220
	E	30	762	20	508	20	508	Floor	Note 5	WMB363–364	CMB363	220
19	D	30	762	30	762	20	508	Floor	WS364	WMB363–364	CMB364	220
	E	30	762	30	762	20	508	Floor	Note 5	WMB363–364	CMB364	220
20	D	37	940	30	762	20	508	Floor	WS364	WMB363–364	CMB364	220
	E	37	940	30	762	20	508	Floor	Note 5	WMB363–364	CMB364	220
21	D	37	940	30	762	24	610	Floor	WS364	N/A	CMB364	220
	E	37	940	30	762	24	610	Floor	Note 5	N/A	CMB364	220
22	D	43.75	1111	32	813	27	686	Floor	WS380	N/A	CMB380	220
	E	43.75	1111	32	813	27	686	Floor	Note 5	N/A	CMB380	220
23	E	48	1219	48	1219	29.5	749	Floor	Note 5	N/A	N/A	220
24	D	49.5	1257	35	889	28.5	724	Floor	WS381	N/A	CMB381	220
	E	49.5	1257	35	889	28.5	724	Floor	Note 5	N/A	CMB381	220
25	D	49.5	1257	41	1041	32	813	Floor	WS382	N/A	N/A	220
	E	49.5	1257	41	1041	32	813	Floor	Note 5	N/A	N/A	220
26	D	57.5	1461	41	1041	32	813	Floor	WS382	N/A	N/A	220
28	D	60	1524	56	1422	36	914	Floor	WS370A	N/A	N/A	220
	E	60	1524	56	1422	36	914	Floor	Note 5	N/A	N/A	220
29	D	68	1727	56	1422	36	914	Floor	WS370A	N/A	N/A	220
30	D	71	1803	48	1219	36	914	Floor	WS383	N/A	N/A	220
31	D	74	1880	56	1422	40.5	1029	Floor	WS384	N/A	N/A	220
32	F	94	2388	56	1422	54	1372	Floor	Note 4	N/A	N/A	220
33	F	94	2388	72	1829	54	1372	Floor	Note 4	N/A	N/A	220
34	F	94	2388	84	2134	54	1372	Floor	Note 4	N/A	N/A	220
35	F	94	2388	96	2438	54	1372	Floor	Note 4	N/A	N/A	220

Note 1: These dimensions are not for construction. Contact your nearest Square D/Shneider Electric sales office for certified prints.
Note 2: Transformer is NEMA Type 3R Standard. Weathershield not required for outdoor use.
Note 3: Wall mounting brackets are a standard part of transformer enclosure. Accessory not required.
Note 4: Special outdoor construction required for NEMA Type 3R applications. Contact your nearest Square D/Schneider Electric sales office for details.
Note 5: Indoor/outdoor enclosure standard. Weathershield not required.
N/A: Wall mounting/ceiling mounting bracket not available due to weight of these parts.

XFMR

SPARLING INSTRUMENTS CO., INC.

4097 N TEMPLE CITY BLVD. • P.O. BOX 5988
EL MONTE, CALIFORNIA 91731-1988 USA
PH (818) 444-0571 • FX (818) 452-0723

SERIAL NO. **M052814902**

SALES ORDER NO. **71858**

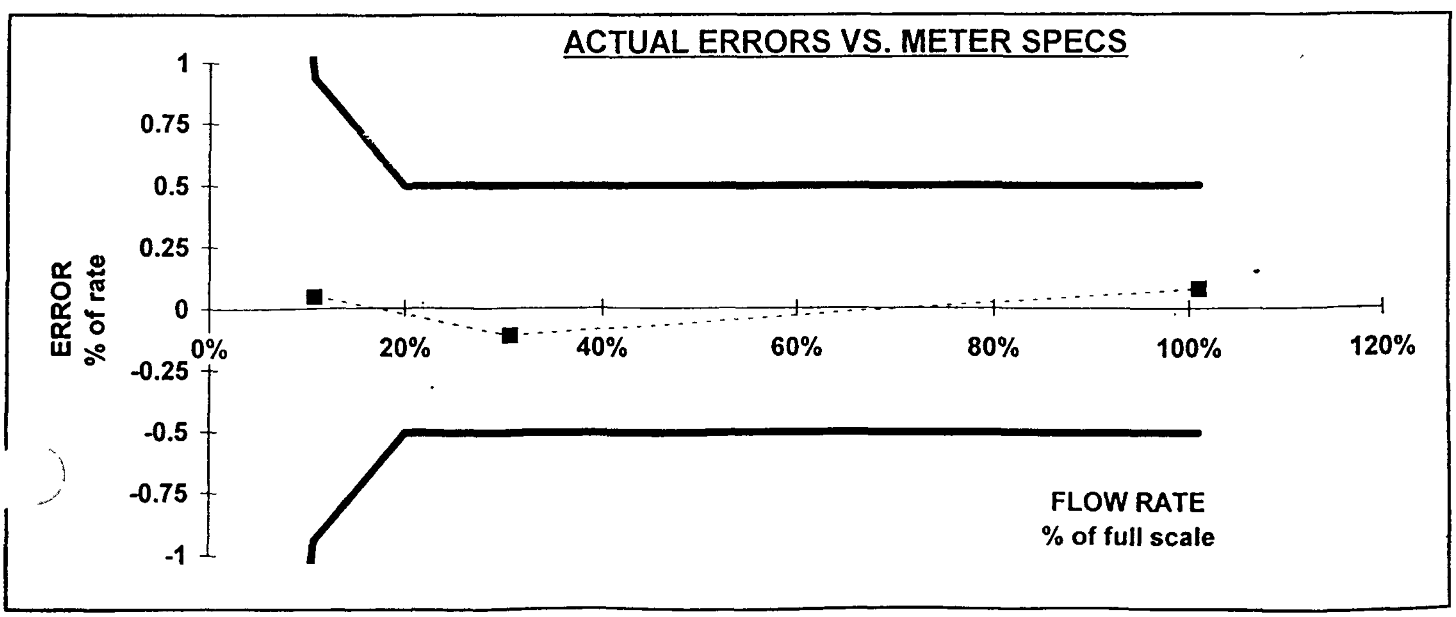
FLOW CALIBRATION TEST DATA SHEET FOR SERIES 600 FLOW METERS

CUSTOMER :	SHARP TECHNOLOGIES	OTHER PROGRAMMING PARAMETERS:			LOCKOUT: OFF
ADDRESS :	LANSING, MI	FIRMWARE	2.1		
		LINER:	POLYURETH		
MODEL NO.=	FM657-045-110-1	ELECTRODES:	SS		
TAG:		COIL FREQ=	1		
SIZE=	4.0 INCH	DISPLAY:	GPM		AL1= 99%
INSIDE DIA. 'D'=	4.06 INCH	COUNT:	FWD ONLY		AL2= 99%
F. S. VELOCITY=	9.91 FPS	REGISTR. 'R'=	100 GAL		EPD: 0
F. S. RATE 'Q'=	400 GPM				PROTOCOL: SPAR
		OUTPUT:	4-20MA		DISP DAMPING= 5
MTR CONST 'K'	233.37 PULSES/GAL				CURRENT DAMP=15
SET =	0.20	ON-TIME:	25 MS		% ZERO CUTOFF=2
SIGN:	PLUS	FLOW DIR:	FWD	PASSWORD:	0001

REMARKS: WELL WATER; TEMP: AMB.
GROUNDING RINGS. STRAPS.
12-60 VDC POWER. REV. 2.1L

TEST NO.	FLOW LAB DATA		FLOW METER DATA			AVERAGE	AVERAGE	%
	TIME SECS.	WATER GALLONS	TOTAL PULSES	MTR CONSTANT PULSES/GAL	FREQ PULSES/SEC	FLOW IN GPM	VELOCITY FT/SEC	ERROR OF RATE
	42.84	298.56	69676	233.37	1626.4	418.15	10.36	
	405.90	298.56	69594	233.1	171.5	44.13	1.09	
FLOW METER ACCURACY FOR THE FULL SCALE METER CONSTANT C= 150								
3	418.53	298.56	44805	150.07	107.1	42.8	1.06	**0.05**
4	146.46	298.56	44733	149.83	305.4	122.31	3.03	**-0.11**
5	44.37	298.56	44821	150.12	1010.2	403.73	10.01	**0.08**
6								
7								

BRATED BY: T-2 DATE: 12/5/02 12:22 PM	CERTIFIED BY: (QA 3) DATE: 12/6/02	FINALIZED BY: T-2 DATE: 12/5/02



omag 30F / 33F

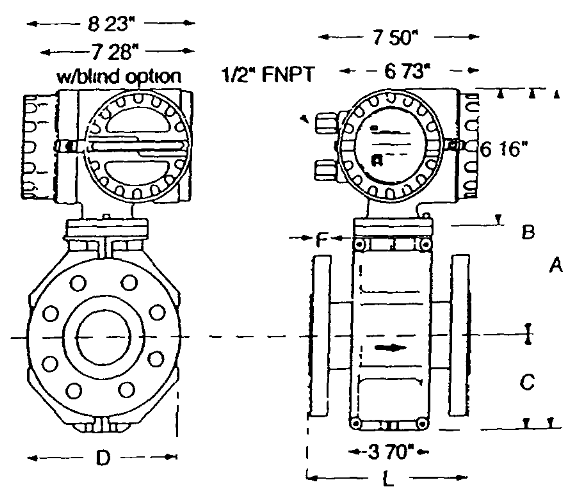
The Promag F version is for flange mounting in pipelines from 1/2" up to 78" Sizes from 1" to 4" are offered in this catalog Please consult factory for larger sizes

The Promag 30F / 33F are differentiated by the electronics The basic models listed below include Hastelloy C-22 electrodes Teflon (PTFE) liner, 150 lb ANSI A-105 steel flanges NEMA 4X compact housing with standard 3-point calibration FM approved non-incendive, Class I, Division 2, Groups A D Dust ignition proof, Class II, III, Division 1, Groups E G

Size	Range, GPM (nominal)	Description	Order Code	Price
1"	5 to 100	Pulse/frequency/current Pulse/frequency/current/HART®	30FT25-MH1ED11D31B 33FT25 MH1ED11D21A	$2180 $2750
1 5"	10 to 200	Pulse/frequency/current Pulse/frequency/current/HART	30FT40-MH1ED11D31B 33FT40-MH1ED11D21A	$2180 $2750
2"	20 to 400	Pulse/frequency/current Pulse/frequency/current/HART	30FT50-MH1ED11D31B 33FT50-MH1ED11D21A	$2255 $2815
3"	50 to 1000	Pulse/frequency/current Pulse/frequency/current/HART	30FT80-MH1ED11D31B 33FT80-MH1ED11D21A	$2425 $2985
4"	75 to 1500	Pulse/frequency/current Pulse/frequency/current/HART	30FT1H-MH1ED11D31B 33FT1H-MH1ED11D21A	$2630 $3195

Order Note
The Promag 30F/33F units listed on this page are for quantities of up to 3 for the 1", 1 5" and 2" sizes The 3" and 4" units are available in quantities of up to 2

Each unit is wet flow calibrated on our Calibration Rig Normal shipment is within 10 working days of order Should you require additional units, or quicker shipment, please consult factory Your order is important to us



Size	A	B	C	D	L
1"	13 41"	10 10"	3 31"	4 72"	7 87"
1-1/2"	13 41"	10 10"	3.31"	4 72"	7.87"
2"	13.41"	10 10"	3 31"	4 72"	7 87"
3"	15.37"	11 08"	4.29"	7 09"	7.87"
4"	14 37"	11 08"	4.29"	7 09"	9 84"

Be sure to contact Endress+Hauser for combinations of materials of construction and process connections not listed in this catalog Polyurethane lined meters are now available from stock Call for pricing and delivery

Have an application question or special requirement? Call 1-888-ENDRESS, our application specialists are ready to assist you!