

**WORKPLAN FOR
INSTALLATION OF ALARMS AND
GAS MIGRATION SYSTEM,
OPERATION AND MAINTENANCE
AND EMERGENCY CONTINGENCY PLAN**

**SUBMITTED: MARCH 31, 1993
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Prepared by:

**Ground Water Consultants, Inc.
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1.0 PROJECT WORK PLAN DESCRIPTION

The following project involves the design, implementation and maintenance of two landfill gas monitoring systems at residential dwellings adjacent to the Rose Hill Regional Landfill Superfund Site in South Kingstown, Rhode Island. The address of the dwellings of concern are 278 and 349 Rose Hill Road. Rose Hill Road trends in a north south direction adjacent to the western edge of the landfill.

The monitoring systems have been designed to detect the presence of landfill gases within the basements of the residential dwellings. In addition, gas detectors will provide early warnings by monitoring for the presence of landfill derived gases in the soils, exterior to the basements walls, between the 278 and 349 Rose Hill Road dwellings and the Rose Hill Landfill. The gas monitoring systems will be installed by Geological Field Services, Inc., PEMCO and the Town of South Kingstown.

2.0 PROJECT WORK PLAN

The proposed monitoring systems has been designed in accordance with the specifications established in the Environmental Protection Agency's (EPA) letter to the Towns of South Kingstown and Narragansett, dated January 16, 1992, the Draft Unilateral Administrative Order for Action at the Rose Hill Regional Landfill Superfund Site date March 4, 1993 and preliminary comments of draft Work Plan, O&M Plan and Contingency Plan dated March 22, 1993. The system has been designed to provide adequate protection from hazardous conditions that may arise from the potential migration of methane gas from the Rose Hill Landfill.

2.1 278 & 349 ROSE HILL ROAD

At both of these locations the health and safety concern is for the elevated levels of vinyl chloride that have been detected in the landfill gases. Because lower concentrations of landfill gas may contain concentration levels of vinyl chloride above the 0.01 ppm action level, the methane detection system has been designed to be installed between the dwellings and the landfill as well as in the basements.

2.1.1 Methane Detection System

The methane detection systems to be installed at 278 and 349 Rose Hill Road will be equipped with two sensors to detect methane gas. A sensor will be install in each basement and another in the soils surrounding the basements. The exterior sensor (Sierra Model 4100-30) will detect the presence of methane at concentrations as low as 50 ppm in the soils providing an early warning system to the residents. Based upon telephone conversations with EPA a back-up sensor will be installed in the basement area of each dwelling. This second sensor (Sierra Model 2001-10) is an amendment to the detection systems that is not specified in the January 16, 1992 letter.

The system will be calibrated to provide an audible alarm to warn the residents of the presence of methane gas equal to or in excess of 2% of the lower explosion limit (LEL) outside of the basement wall and 2% inside the basement area. In addition, a strip chart recorder, with a maximum scale of 5% of the LEL, will be utilized to continuously record the levels detected by the exterior sensor. Each system will consist of the following components:

Sierra Monitor Corp. Model 4011-00 Single Channel Controller with Digital Display,

Sierra Monitor Corp. Model 4100-30 Combustible Gas Sensor with a range of 50-5,000 ppm,

Rustrak 2" Strip Chart Recorder

Sierra Monitor Corp. Combustible Gas Alarm Sensor, Model 2001-10,

2 Remote Audible Alarm

* For additional component information see Appendix A.

The exterior sensors will be slide mounted in a six inch PVC pipe set approximately 2 feet below the basement floor elevation to a depth of approximately 6 feet below grade. The PVC pipe will be slotted to provide communication with the surrounding soils, and fitted with a water tight cap. Each sensor module will be slide mounted, pointing downwards, with an inverse trap to reduce moisture from accumulating in the sensor. Each sensor will be calibrated in accordance with the factory specifications and coupled to a panel mounted controller located in the basement. The cable hole in the foundation wall will be sealed upon installation. An audible alarm will sound if methane concentrations of 2% or more on the outside of the foundations are detected. The interior sensors will be mounted on the ceiling in a location where gasses may accumulate and will be calibrated in accordance with the factory's specifications. An alarm level of 2% of the LEL will be set at the time of calibration. Once either sensor is tripped, an alarm will sound until a reset button is pushed. In this way, should the alarm go off while the residents are not in the building they will be warned upon entry.

The detection systems will not be outfitted with a backup battery power as approved of by EPA.

3.0 OPERATION, MAINTENANCE AND RESPONSIBILITY PLAN

During the operational life of gas detection systems monthly inspections and servicing shall be performed the Town of Kingstown's Pre-Treatment Coordinator (Mr. Peter Bates). This person shall be trained by a manufacturer's representative to perform the necessary tasks. A visual inspection of the systems will be conductive to determine the condition of each and a Maintenance Form (Appendix B) shall be completed during each inspection. In general each component of the systems will be inspected to determine its individual condition and functionality in order to determine the overall condition of the system. The systems will be inspected for excess moisture, leakage, corrosion, accurate recordings, indication of system malfunctions recorded on strip charts, alarm and recording functions will be tested and the systems will be recalibrated in accordance with the approved frequency. All calibration activities will be recorded on the Maintenance Forms. Should any defects be observed the appropriate contacts shall be notified, and repairs shall be performed within two weeks of notification. Appendix B also contains the names and telephone numbers of the appropriate contact persons.

During the monthly inspections strip charts will be changed and systems recalibrated. A calibration gas delivery system with three calibration gases (zero air, 2% LEL, and 5% LEL) will provided with the detection systems. Each of the sensors and alarms will be calibrated, in accordance with the factory specifications, prior to installation and again once installation is complete. According to the factory recommendations, the sensors should be recalibrated on a quarterly basis with exception of the Sierra Monitor 4101-02 gas sensor which requires monthly calibration. However, as a precaution, during the first quarter of operation recalibration of all sensors will be performed monthly.

The strip charts from each location will be reviewed at the time that they are changed. If methane levels are observed as having been detected at levels greater than 100 ppm the EPA and Rhode Island DEM contacts, listed below, shall be verbally notified and copies of the strip chart(s) in question shall be forwarded no latter than the next business day. Quarterly summaries of the results of the monitoring system shall also be submitted to following agency contacts within 30 days of receiving the data.

Mr. David Newton,RPM
EPA Region I
Canal Street
Boston, MA 02203
(617) 573-9612

Mr. Dean Tagliaferro
EPA Region I
60 Westview Street
Lexington, MA 02173
(617) 860-4625

Mr. Mark Dennen
Department of Environmental Management
Division of Air and Hazardous Material
Providence, RI 02903
(401) 277-2808

Mr. Stephen A. Alfred
Town Manager
Town Hall - 180 High Street
South Kingstown, RI 02879

4.0 CONTINGENCY PLAN AND ALARM RESPONSE ACTION

In the event that methane concentrations within the basement area exceeds the alarm set point of 1000 ppm or 2% of the LEL an audible alarm (Alarm I) will sound. Should this event occur, the residents have been instructed to follow the instructions provided to them (Appendix D). They will be requested to call the Union Fire District, report the incident, request assistance then evacuate the building leaving the doors and windows open to assist the ventilation the building. The appropriate fire department personnel will be advised as to the location of the detection system and will reset the alarm trigger mechanism for the residents. In this manner only persons trained in personnel protection will enter the basement areas once the alarm has been sounded. Each resident will be provided with several emergency telephone number stickers to place on the alarms and on their telephones. The Union Fire District will be provided a copy of system operating instructions.

The fire department personnel will be responsible for responding to an Alarm I sounding. They will follow standard operating procedures for clearing a potentially combustible atmosphere. Once the building has been properly ventilated the alarm reset button will be reset. Residents will be allowed to reoccupy the building when no combustible gasses are detected. Should the event last longer than 1 hour the Town will provide temporary lodging for the residents. Should an Alarm I level be exceeded four times over a 24 hour period the Town will make provisions for temporary alternative housing until the situation can be corrected.

In the event that methane concentrations in the soils gass surrounding the outside sensors exceeds the alarm set point of 1000 ppm or 2% of the LEL a red light (Alarm II) will illuminate near the control panel. Should this event occur the residents have been instructed to follow the instructions provided to them (Appendix C). They will be requested to call the Union Fire District, report the incident. Evacuation will not be necessary since the sensors for the Alarm II are located outside of the building. However, the fire department will perform a survey for combustible gasses inside the building within 24 hours of the incident. Should elevated gas levels persist in the soils surrounding the buildings the Town shall take the necessary precautions to ensure the safety of the residents.

The following people will be involved in responding to any reported incidents.

Mr. Stephen A. Alfred - Town Manager, South Kingstown

Mr. Stephen A. Alfred is responsible for the management and implementation of the project for the Town of Kingstown. All letters of correspondence should be forwarded to Mr. Alfred.

Mr. Jon Schock - Utilities Director, South Kingstown

Mr. Jon Schock is responsible for the overall project planning and operation. Mr. Schock will be responsible for ensuring that routine inspections, maintenance and reports are completed in a timely fashion. In the event of an emergency Mr. Schock will coordinate with the Union Fire District, the residents, the Rhode Island DEM and EPA Region I. Mr. Schock reports directly to Mr. Stephen A. Alfred.

Chief David Hall - Union Fire District

Chief David Hall will be responsible for ensuring that the Union Fire District response to all calls regarding triggered alarms. In the event that a number 1 alarm should be triggered Chief Hall will ensure that the Union Fire District personnel respond promptly to the calls and ensure safe reentry to the buildings. Chief Hall will be responsible for ensuring that all Incident Report forms are submitted to Mr. Schock

Mr. Peter Bates - Pre-Treatment Coordinator

Mr. Bates will be responsible for performing the monthly inspections of the gas detection and mitigation systems. He will also be responsible for changing strip charts and calibrating the sensors in accordance with the approved schedule. Mr. Bates will report to Mr. Jon Schock.

Mr. David Lang - Ground Water Consultants, Inc.

Mr. David Lang will be responsible for reviewing the strip charts collected during monthly inspections and alarm incidents. Mr. Lang will be responsible for complying the quarterly reports to EPA Region I. Quarterly reports shall include copies of all maintenance reports, calibration sheets, and incident response reports. The submittal shall also include an evaluation of the strip chart data and incident responses.

5.0 OPERATION COST REIMBURSEMENTS

The annual costs for operating the gas detection systems have been determined based upon their power consumption. The PRP will arrange the terms of reimburse to the residents.

278 & 349 Rose Hill Road

Gas Detection System	\$ 20.00/year each
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APPENDIX A

Component Specifications, Guidelines and Calibration Documents

INSTRUCTION MANUAL

**MODEL 1200-26
CALIBRATION GAS DELIVERY SYSTEM**



sierra monitor corporation

1991 Tarob Court, Milpitas, CA 95035

Sierra Monitor Corporation
1991 Tarob Court, Milpitas, CA 95035
(408) 262-6611

MODEL 1200-26
CALIBRATION GAS DELIVERY SYSTEM



APPLICABILITY & EFFECTIVITY

This manual provides instructions for the following Sierra Monitor products:

<u>Model</u>	<u>Description</u>
1200-26	Model 26 Calibration Gas Delivery System

The instructions are effective for the above models as of October 1, 1992

Instruction Manual Part Number: T13002
IM22/1092

Applicability & Effectivity

1. FRMC APPROVAL

The Model 26 (1200-26) Calibration Gas Delivery System and Methane calibration gas cylinders are approved for calibration of Factory Mutual Research Corporation (FRMC) Approved Sierra Monitor Combustible Gas sensors.

2. PRODUCT DESCRIPTION

The Calibration Gas Delivery System consists of a disposable pressure vessel containing calibration gas and a non-disposable pressure and flow regulating system. The hardware is designed to maintain a low flow of gas to increase the life of the disposable cylinder.

Calibration gas cylinders can be ordered from Sierra Monitor Corporation in any concentration of combustible gas, carbon monoxide gas or oxygen mixed in air. Each

cylinder is labelled with the gas content.

3. OPERATION INSTRUCTIONS

3.1. CYLINDER INSTALLATION AND FLOW ADJUSTMENT

- Turn the regulator adjust (brass knob on top of calibrator) counter clock-wise two turns to be sure valve is "off" before gas cylinder is installed.
- Turn flow meter off clock-wise.
- Press the connector release tab on the cylinder valve to position it to receive the connector to the calibrator unit. Press the male connector on the blue gas tube firmly into the cylinder valve until the click indicates that the fitting has seated. (Moistening the O-ring may facilitate insertion).

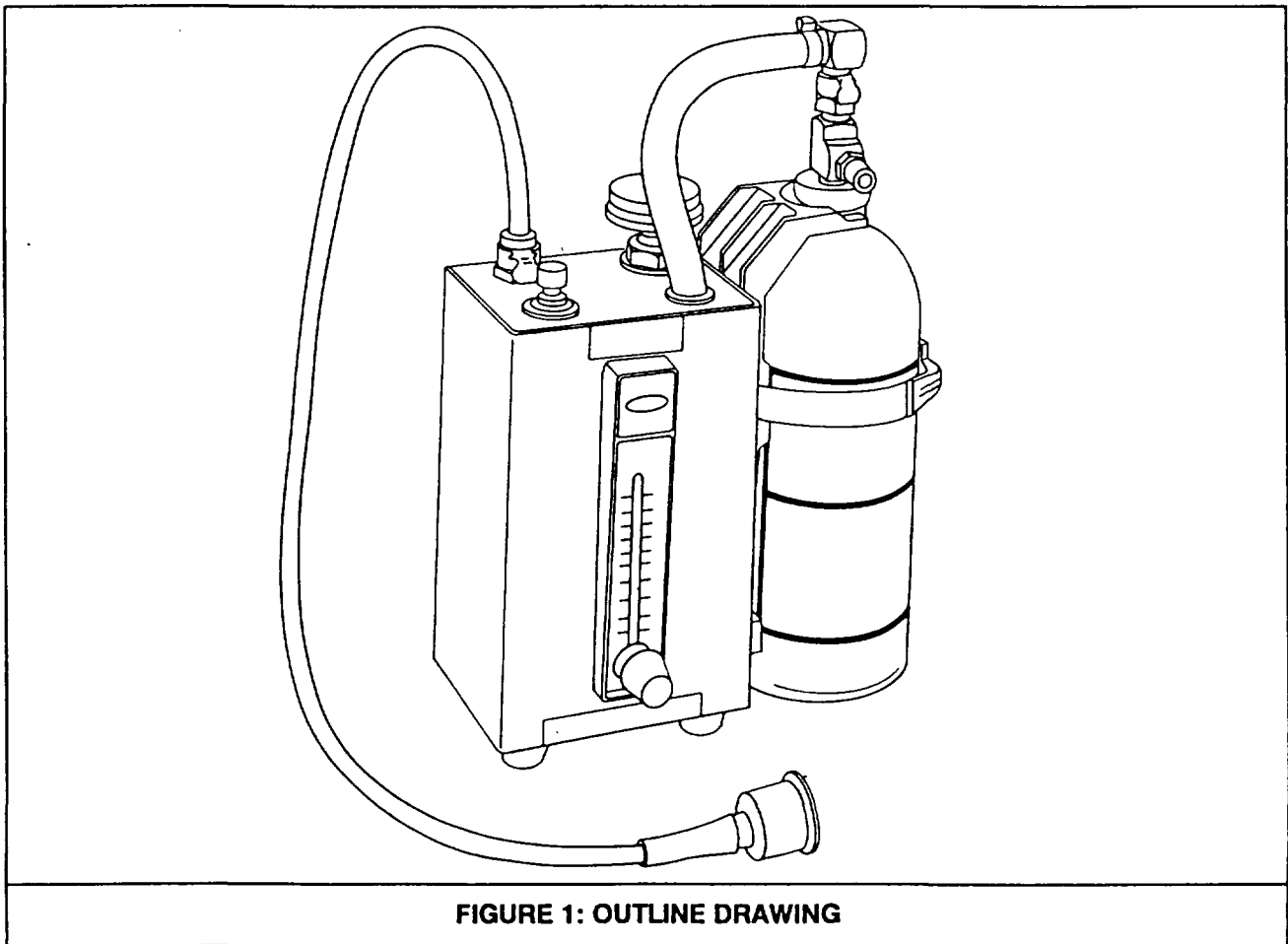


FIGURE 1: OUTLINE DRAWING

- Install the cylinder into the bracket on the side of the monitor.
- At this time the cylinder pressure can be read on the gauge on the top of the calibrator. New cylinders are shipped packed at a maximum of 150 psi.
- Turn the pressure regulator adjust clockwise to provide pressure to the flow meter.
- Adjust the flow meter flow fine adjust to provide a flow rate as specified below and in the specific gas sensor module instruction manual. (If the float is not stable, turn the regulator adjust clockwise to provide more back pressure to the flow meter.
- Remember to turn the flow meter "off" to save gas at any time calibration is interrupted.

- When calibration is complete, disconnect the cylinder from the blue tube by pressing the quick release tab.

SAFETY NOTE: Removal of the blue tube from the cylinder while the cylinder is pressurized will cause the tube to "pop" out with a loud noise. Point the cylinder away from personnel prior to pressing the release tab.

3.2. CALIBRATION

- The fitting on the end of the delivery tube is different for each sensor package. Follow the calibration instruction for the specific device as outlined in the respective monitor instruction manual.

Model/Product	Recommended Calib. Filter	Recommended Rate	Flow Time
20X/200X	22048	50	0.5 min.
2400	22048	50	0.5 min.
4101-02	5358-00/01	100	2-3 min.
4101-04	5358-02/03	100	2-3 min.
4101-07	5358-02/03	100	2-3 min.
4101-16	5358-02/03	100	2-3 min.
5100-02	5358-00	100	2-3 min.
5100-04	5358-00	100	2-3 min.
5100-07	5358-00	100	2-3 min.

TABLE 1: CALIBRATION ADAPTERS

PECIFICATIONS

CALIBRATOR

DIMENSIONS:	4 X 7 X 3 Inches (10.2 x 17.8 x 7.6 cm) (excluding cylinder)
WEIGHT:	2.0 pounds (1.2 Kg) (excluding cylinder)
STORAGE TEMPERATURE:	-40°F to +131°F (-40°C to +55°C)
OPERATION TEMPERATURE:	+37°F to +110°F (+3°C to +44°C)

CYLINDER

MATERIAL:	Aluminum
USE:	Non-Refillable
BURST:	Minimum burst 600 psi
TEST:	Leak Test 225 psi
PRESSURE:	Shipping Pressure: Max 150 psi
REGULATIONS:	Cylinders prepared and labeled in accordance with Federal (DOT) Regulation 39, and Title 49 CFR (DOT Registration No. M-1083)

SPARE PARTS**Calibration Gas Cylinders**

1290-01	Gas Cylinder - Air (20.9% Oxygen)
1290-02	Gas Cylinder - Methane 50% L.E.L.
1290-03	Gas Cylinder - Methane 5,000 PPM
1290-04	Gas Cylinder - Methane 1,000 PPM
1290-05	Gas Cylinder - Carbon Monoxide 100 PPM
1290-06	Gas Cylinder - Hydrogen 50% L.E.L.
1290-07	Gas Cylinder - Hydrogen 500 PPM
1290-08	Gas Cylinder - Carbon Monoxide 35 PPM
1290-98	Gas Cylinder - Non Standard Mixture
1290-99	Gas Cylinder - Non Standard Gas Type

Calibration Options & Accessories

5358-00	Calibration Adapter - Direct, Magnetic
5358-01	Calibration Adapter - Direct, Standard
5358-02	Calibration Adapter - Dispersing, Magnetic
5358-03	Calibration Adapter - Dispersing, Standard
5360-00	Calibration Gas Delivery Fitting - Fixed
SPB33048	Delivery Tube/Fitting for 1200-26
SPB64011	Delivery Tube, 3 foot
SPB69036	O-Ring for 1200-26 (5 pack)

Note: Only 1290-02 (Methane 50% L.E.L.) is FMRC Approved

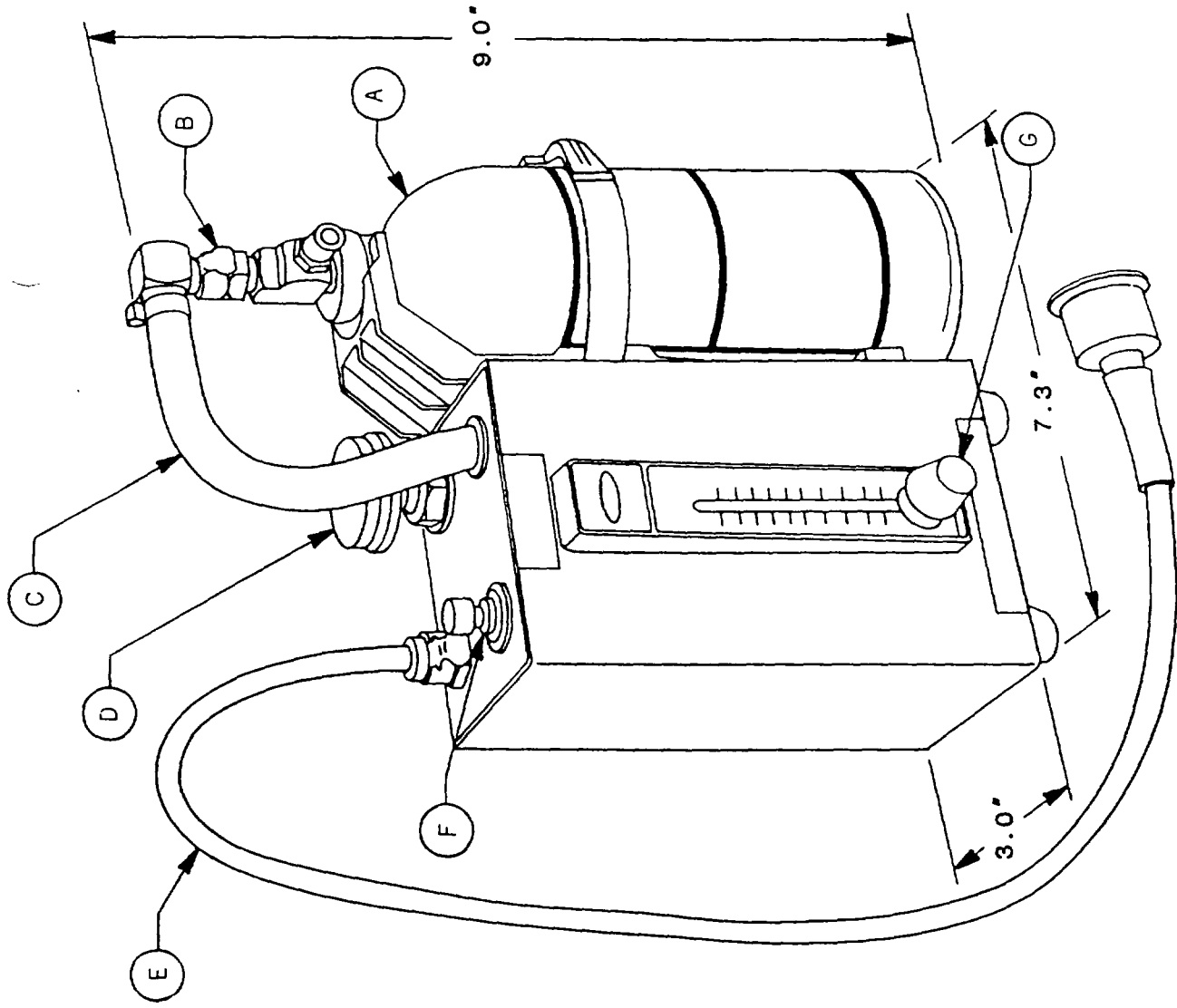
LIMITED WARRANTY

SIERRA MONITOR CORPORATION warrants its products to be free from defects in workmanship or material under normal use and service for one year after date of shipment. SMC will repair or replace without charge any equipment found to be defective during the warranty period. Final determination of the nature and responsibility for defective or damaged equipment will be made by SMC personnel.

All warranties hereunder are contingent upon proper use in the application for which the product was intended and do not cover products which have been modified or repaired without SMC approval or which have been subjected to accident, improper maintenance, installation or application, or on which original identification marks have been removed or altered. This Limited Warranty also will not apply to interconnecting cables or wires, consumables (ie. calibration gases, batteries), nor to any damage resulting from battery leakage.

In all cases SMC's responsibility and liability under this warranty shall be limited to the cost of the equipment. The purchaser must obtain shipping instructions for the prepaid return of any item under this warranty provision and compliance with such instruction shall be a condition of this warranty.

Except for the express warranty stated above, SMC disclaims all warranties with regard to the products sold hereunder including all implied warranties of merchantability and fitness and the express warranties stated herein are in lieu of all obligations or liabilities on the part of SMC for damages including but not limited to consequential damages arising out of or in connection with the use or performance of the product.



- (A)
- (B)
- (C)
- (D)
- (E)
- (F)
- (G)

DISPOSABLE GAS CYLINDER

CONNECTOR RELEASE TAB

CONNECTOR HOSE

PRESSURE GAUGE

DELIVERY TUBE

REGULATOR ADJUST

FLOW METER with FINE ADJUST

SIIC sierra monitor corporation			
MODEL 26			
GAS CALIBRATION SYSTEM			
SERIAL NO.	DATE	REV.	SCALE
A			1

INSTRUCTION MANUAL

GAS SENSOR MODULES

**MODELS 201-00 & 201-10
MODELS 203-00 & 203-10
MODELS 206-00 & 206-10**

**MODELS 2001-00 & 2001-10
MODELS 2003-00 & 2003-10
MODELS 2006-00 & 2006-10**



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GAS SENSOR MODULES

MODELS 201-00 & 201-10
MODELS 203-00 & 203-10
MODELS 206-00 & 206-10

MODELS 2001-00 & 2001-10
MODELS 2003-00 & 2003-10
MODELS 2006-00 & 2006-10

APPLICABILITY & EFFECTIVITY

This manual provides instructions for the following Sierra Monitor products:

<u>Model</u>	<u>Description</u>
201-00	Combustible Gas Monitor - Outdoor
201-10	Combustible Gas Monitor w/Relay - Outdoor
203-00	Hydrogen Sulfide Monitor - Outdoor
203-10	Hydrogen Sulfide Monitor w/Relay - Outdoor
206-00	Carbon Monoxide Monitor - Outdoor
206-10	Carbon Monoxide Monitor w/Relay - Outdoor
2001-00	Combustible Gas Monitor
2001-10	Combustible Gas Monitor w/Relay
2003-00	Hydrogen Sulfide Monitor
2003-10	Hydrogen Sulfide Monitor w/Relay
2006-00	Carbon Monoxide Monitor
2006-10	Carbon Monoxide Monitor w/Relay

The instructions are effective for the above models as of January 1, 1992

Instruction Manual Part Number: T10002
IM02/0192

Applicability & Effectivity

1. PRODUCT DESCRIPTION

1.1 Introduction

The Sierra Monitor Gas Sensor Modules consist of two series of fixed-installation, single-alarm products, the 20X Series designed for outdoor use, and the 200X Series designed indoor applications. Both series include monitors for Combustible Gas, Hydrogen Sulfide, and Carbon Monoxide. Both series also have versions of each module that includes a dry contact relay. See Table 1.1 for a full list of available configurations.

This manual provides instructions for both 20X and 200X series Gas Sensor Modules, including the relay versions.

1.2 Application

The Gas Sensor Modules are designed for qualitative continuous area monitoring of Combustible Gas, Hydrogen Sulfide or Carbon Monoxide where the gas being monitored is not normally present.

1.3 Configuration

1. Model 20X Series

The Model 20X series consists of three separate gas modules, Model 201 for

Combustibles, Model 203 for Hydrogen Sulfide and Model 206 for Carbon Monoxide. An alarm signal is activated when the concentration of gas exceeds the factory-set (and user-adjustable) level. The signal may be used to activate a remote alarm, fan or controller. Contact Sierra Monitor for specifics on the devices that can be interfaced with these gas sensor modules. In addition, the -10 versions (201-10, 203-10, and 206-10) include a 0.5 amp, dry contact relay.

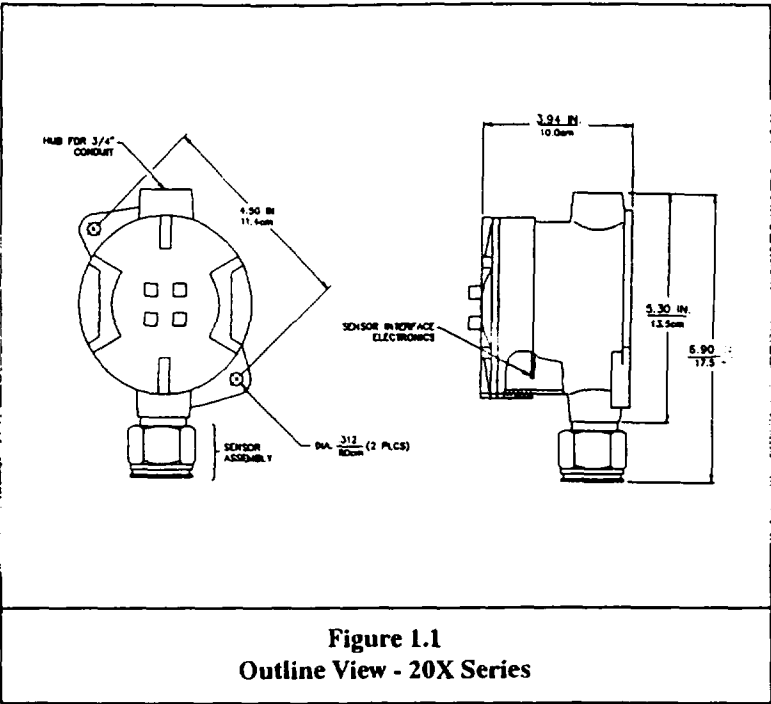


Figure 1.1
Outline View - 20X Series

Model	Gas	Outdoor	Indoor	TTL	Relay	Buzzer
201-00	Combustibles	X		X		
201-10	Combustibles	X			X	
203-00	H ₂ S	X		X		
203-10	H ₂ S	X			X	
206-00	CO	X		X		
206-10	CO	X			X	
2001-00	Combustibles		X	X		X
2001-10	Combustibles		X		X	
2003-00	H ₂ S		X	X		X
2003-10	H ₂ S		X		X	
2006-00	CO		X	X		X
2006-10	CO		X		X	

Table 1.1 Gas Sensor Module Configurations

2. QUICK START

2.1 Overview

The Gas Sensor Module has been supplied factory calibrated and ready for immediate installation and operation. An installer familiar with installation and operation of gas detection products can use this section to begin immediate use of the monitor.

2.2 Wiring

Each module requires four-conductor wiring (two wires for power and two wires for the signal). See section 6.3 and Table 6.1 for wiring instructions.

2.3 Module Installation

1. Model 20X Series

The module can either be installed on the end of a 3/4" conduit, or attached to a vertical surface using the mounting flange on the enclosure. Two important warnings:

- The installation must meet any hazardous environmental codes for AC/DC electrical instrumentation.
- The sensor module enclosure mounting must be far enough away from any vertical surface to allow removal and replacement of the sensor assembly which is threaded into the second 3/4" conduit hub.

2. Model 200X Series

The Model 200X series are designed to mount on any indoor vertical surface. Mount the monitor in the desired location using the adhesive backing provided with the module or with screws through the mounting flange. All units are shipped with the plug-in AC/DC power supply connected to the monitor so the operator simply plugs the power supply into a nearby AC outlet.

- The installation must meet any hazardous environmental codes for AC/DC electrical instrumentation.

2.4 Wiring Connection

Terminal positions on the electronics board are labeled 1, 2, 3, & 4. (see figure 4.1) corresponding as follows:

Terminal Position	Number	Function 20X	Function 200X
3	1	Relay	Safe
1	2	+VDC	+VDC
2	3	Ground	Ground
4	4	Relay	Alarm
Table 2.1			

Refer to section 6.3 for details on wiring the gas sensor module to a power supply or alarm panel.

2.5 Start-up & Operation

To begin operation of the Gas Sensor Module plug in the AC/DC power supply module (for the Model 200X Series) or provide 14-28 VDC from a regulated power supply such as one of the Sierra Monitor Alarm Panels, 2101-00, 2102-XX, or 2200-00. Each time the sensor module is powered up it will perform a warm-up for 2 - 60 minutes.

During warm-up the monitor will, first, cycle through safe/alarm/safe condition at one hertz. This will be followed by a short period of continuous alarm before warm-up is completed.

(NOTE: For Models 206 and 2006 that have been off power for extended periods, the warm-up alarm may sound for several hours.)

3. OPERATION

3.1 Introduction

Under normal conditions the gas sensor module does not require operator or technician intervention. The following are conditions under which the module requires attention:

- **Routine periodic calibration**
- **Sensor replacement on a planned schedule or when a sensor failure occurs.**
- **Periodic cleaning as necessary.**

3.2 Alarms

Three alarm conditions are possible. These can be detected visually at the optional Sierra Monitor controller and at the module (externally on the 200X Series or internally on the electronics board of the 20X Series).

Warm-Up Alarm

Oscillating (On/Off) contact closure and "red/green" visual indication when power is first connected to the module, followed by a continuous closure of approximately 2-60 minutes indicating warm-up.

Gas Alarm

Sustained contact closure and solid red light (once the warm-up time is completed) indicating the presence of gas at, or above, the pre-set alarm limit.

Trouble Alarm

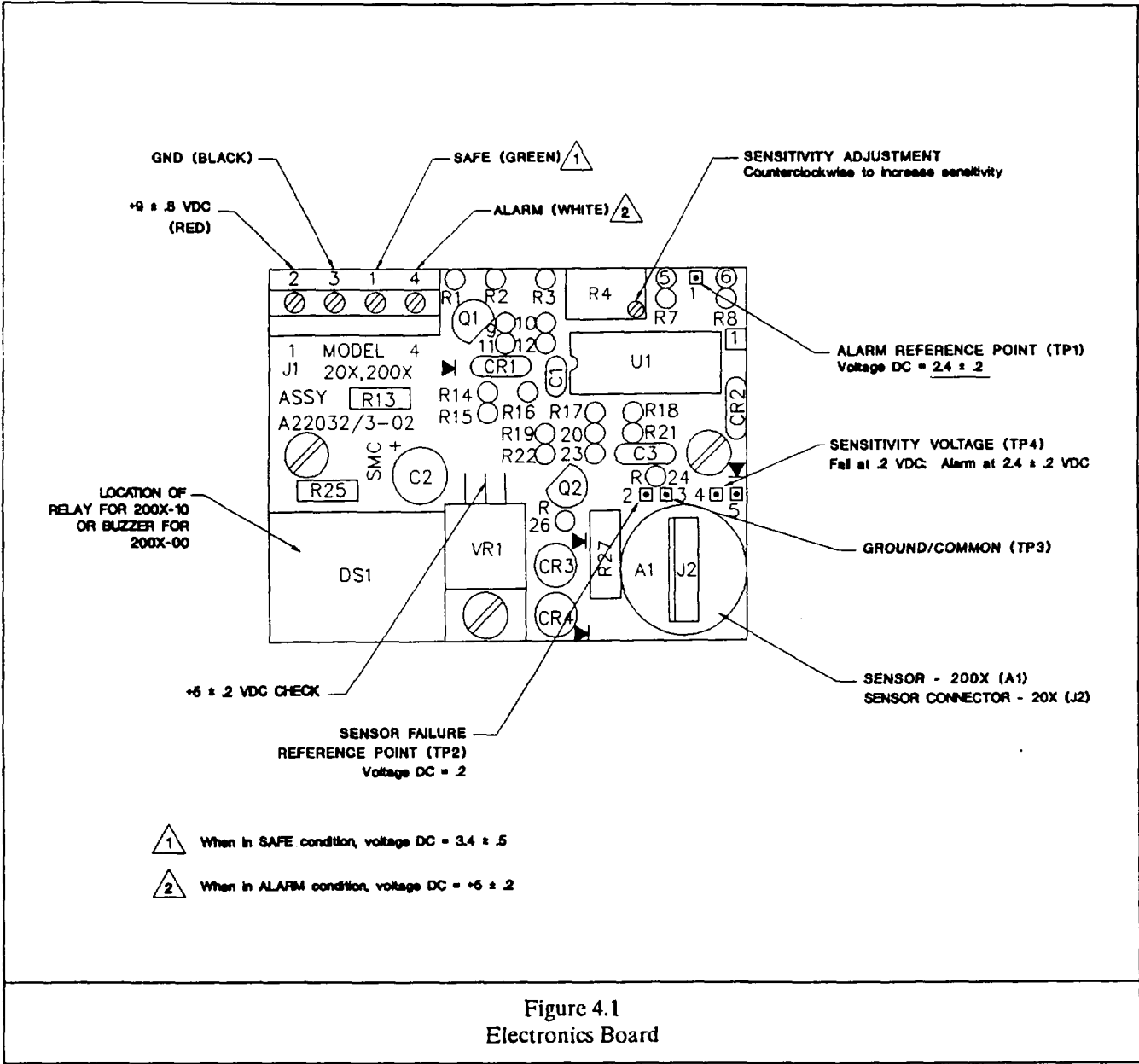
Interrupted contact closure and "red/green" visual indication (once the warm-up time is completed) after unit has been in operation, indicating either a failed sensor or calibration problems.

3.3 Outputs

On the non-relay versions (20X-00 and 200X-00) a 5 volt DC signal is provided to activate remote alarms such as the Sierra Monitor Alarm Panels. On the relay versions (20X-10 and 200X-10) the alarm conditions described above are transmitted to the annunciator as relay contact closures from the monitor.

The alarm outputs are non-latching. As soon as the gas concentration falls below the alarm set-point, the alarm will stop and the alarm output will fall immediately to zero.

During warm-up and failed sensor alarms the relay contact and the display LEDs oscillate at approximately one hertz.



6. Restore power and allow a minimum of 24 hours for stabilization before recalibration. The calibration should be re-verified after 6 days of continuous operation.

To replace the sensor on the Model 200X series:

1. Confirm that the system power has been removed.
2. Remove the cover from the main enclosure.
3. Unplug the sensor from the lower right hand corner of the electronics board.
4. Reverse the preceding steps to install the new sensor assembly.
5. Restore power and allow a minimum of 24 hours for stabilization before recalibration. The calibration should be re-verified after 6 days of continuous operation.

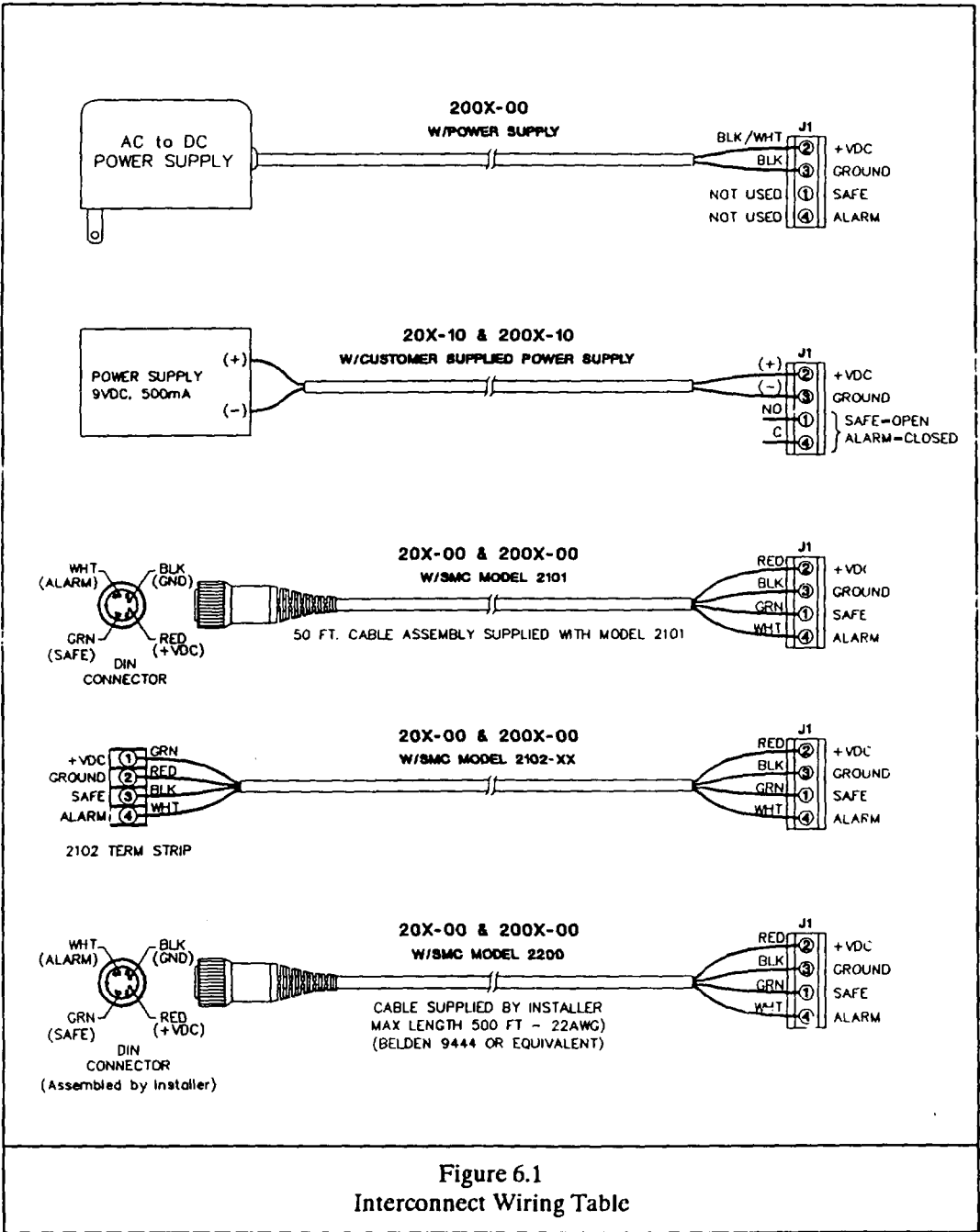


Figure 6.1
Interconnect Wiring Table

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Appendix B

Accessories and replacement parts

Alarm Panels

Model 2101-00	Alarm Panel - 1 channel
Model 2102-00	Alarm Panel - 2 channel
Model 2102-01	Alarm Panel - 2 channel with audible
Model 2200-00	Alarm Panel - 10 channel

Calibration Accessories

1200-26	Gas Sensor Calibrator w/2 gas cylinders (specify gas type/conc)
1290-02	Gas Cylinder - Methane 5000 PPM
1290-04	Gas Cylinder - Methane 1000 PPM
1290-05	Gas Cylinder - Carbon Monoxide 100 ppm
1290-07	Gas Cylinder - Hydrogen 500 PPM

Replacement parts

SPD22033-1	Electronics Assembly for 201-00
SPD22033-2	Electronics Assembly for 203-00
SPD22033-3	Electronics Assembly for 206-00
SPD32057-1	Enclosure for 20X
SPF69020	Power Supply 9 VDC for 200X
SPD22034	Sensor for 201-00/201-10
SPD21513	Sensor for 203-00/203-10
SPD22035	Sensor for 206-00/206-10
SPD33003	Sensor for 2001-00/2001-10
SPD33007	Sensor for 2003-00/2003-10
SPD33008	Sensor for 2006-00/2006-10

INSTRUCTION MANUAL

IM58/0890

MODEL 4011 SERIES

**SINGLE CHANNEL
CONTROLLER**



sierra monitor corporation

1991 Tarob Court, Milpitas, CA 95035

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1.1 PRODUCT DESCRIPTION

1.1.1 Introduction

The Model 4011 Single Channel Controller has been designed to interface to an industry standard 4-20mA Module or other standard Voltage/Current Modules (see Specifications) and provide the user with two independent adjustable alarm levels. Each alarm level can be programmed to be either non-Latching or Latching and can also be programmed to activate either when the input level is GREATER THAN the user adjusted alarm level or LESS THAN the user adjusted alarm level. When the Model 4011 is used as a 4-20mA signal loop controller a third alarm is provided which detects loop current being less than 3mA. The outputs of the three Alarms are SPDT relays with contacts rating of 10A at 28VDC or 120VAC and are independently fused at 5A.

The front panel of the Model 4011 consists of a 3 1/2 digit Liquid Crystal Display, three Alarm LEDs, a Reset Pushbutton, four display selection LEDs and a Select Pushbutton. The SELECT button steps the display through one of the four possible selections which will be indicated by the appropriate illuminated LED.

The following are the Display selections:

CONC:	The actual concentration Level (0 to 100% or PPM). (Factory Option Available: Any scale from 0 to 1,990 PPM)
ALM1:	Alarm Level 1 user adjusted Alarm Level (0-100% or PPM).
ALM2:	Alarm Level 2 user adjusted Alarm Level (0-100% or PPM).
LOOP:	Actual Loop Current (4-20mA).

The three alarm indication LEDs on the front panel are Trouble (loop current less than 3mA) Alarm Level 1 and Alarm Level 2. The RESET pushbutton is used to reset the relays when the user has selected Latching or Acknowledge Mode.

The Model 4011 is packaged in a 1/8 DIN Enclosure (1.9H x 3.8W x 6.5D inches) and can be panel mounted. Wiring connection to the controller is via a two piece terminal block which allows disassembly of the controller without disconnection of individual wires.

The controller is supplied in the following configurations.

- Model 4011-00: Controller 4-20mA input, DC, DIN
- Model 4011-10: Controller 4-20mA input, AC, DIN

1.1.2 Options

The following options are available on the Model 4011.

- | | |
|-----------------------------------|---|
| A. Power Supply & Battery Charger | Model 4346: 24 VDC @ 1 Amp power supply with a trickle charge battery charger. (figure 1B) Capable of powering four Model 4011 controllers. |
| B. Battery | 12 Volt 6.5 AH |
| C. Chart Recorder | Single channel impact print chart recorder with speed of 2" per hour. |
| D. Enclosures | Various Nema and Explosion Proof Enclosures are available. |

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2.1 **INSTALLATION**

2.1.1 **Site Preparation & Installation**

The Model 4011, if panel mounted, requires a 3.58"W x 1.69"H +/- 0.010" cutout. The depth required behind the panel is 8.0" which leaves sufficient space to connect cables at the rear of the enclosure. A properly grounded AC outlet within 6 feet of the enclosure is required.

To install the controller:

1. Remove the two allen screws at the rear of the enclosure that secure the panel mounting bars on the side of the enclosure.
2. Completely remove the bars and insert the Model 4011 through the front of the panel cutout.
3. Reinstall the panel mounting bars and the allen screws. Tighten allen screws until the Model 4011 is securely mounted in panel.
4. Connect the (DC+) wire of the power supply module to the terminal block at the rear of the Controller marked (P) and connect the (DC-) wire of the power supply module to the terminal block at the rear of the Controller marked (G) (figure 1A & 1B).
5. Connect alarm or control devices to the appropriate relay terminals. It is recommended that 18 AWG wire (minimum) be used when connecting to the relay contacts.
6. Connect the 4-20mA remote Sensor Module to the terminal block labeled

"P" (Power = +24Vdc), "S" (Signal = 4-20mA) and "G" (Ground). The "P" and "G" positions are also used for connecting the DC Power Supply.

7. If external alarm acknowledge or reset is to be used connect a momentary switch to the terminals marked "GND" and "ACK"
8. If the chart recorder output is to be used connect to terminals marked "AOUT", "+12V" and "GND" for chart recorder power and signal.

Refer to the Table 1 to determine the correct wire gauge for the distance the Sensor Module will be from the Model 4011 Controller. The manufacturer recommends Belden cable UL-1007 or UL1015 of the appropriate gauge.

<u>Wire Gauge</u>	<u>Maximum Cable Length(ft)</u>
20	2,000
18	3,000
16	4,000
14	6,500
12	9,000

TABLE 1
CABLE GAUGE AND LENGTH

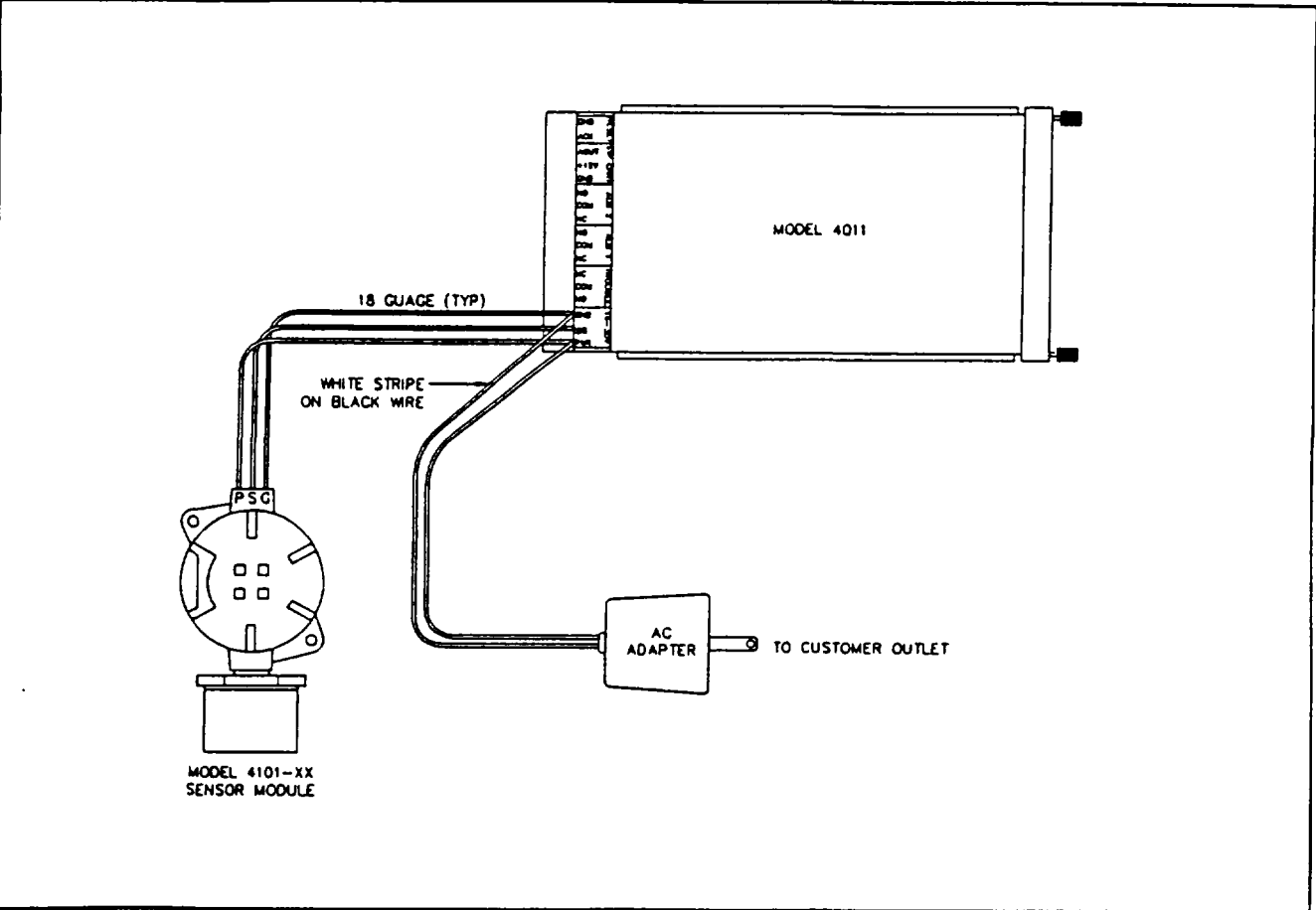


FIGURE 1-A
MODEL 4011 CONTROLLER(WITH AC ADAPTER)

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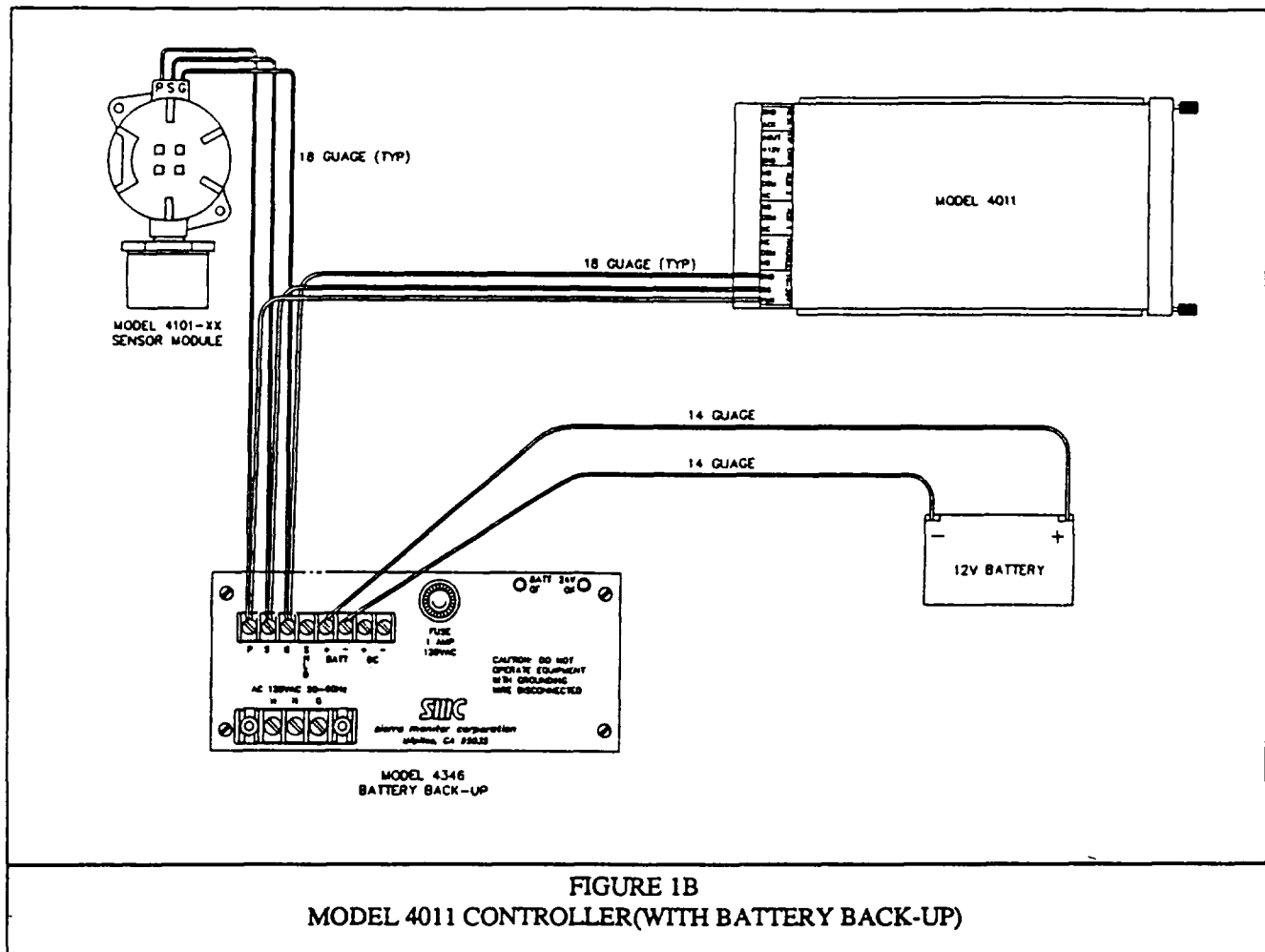


FIGURE 1B
MODEL 4011 CONTROLLER(WITH BATTERY BACK-UP)

2.1.2 Start-up Procedure

After all the wiring has been installed plug the Power supply into an AC outlet. The CONC LED (GRN LED) on the front panel should be ON and the LCD should be displaying 00.0 if the loop current is 4ma or less. If not make sure that the wiring from the power supply is correct.

If the unit has a Power Supply with trickle charged battery connect the 12v battery (see figure 1B) and turn ON power. The 24v OK LED and Battery OK LED should be ON, if not check for blown fuses. If any

fuses are blown check wiring before re-applying power.

Alarm 1 and Alarm 2 are preset at the factory to default levels of 10% and 50% full scale respectively.

2.1.2.1 Alarm Adjustments

To change the alarm levels for Alarm 1 and Alarm 2 first select the appropriate Alarm level to be displayed using the SELECT button to step through the choices available. Next loosen the two thumbscrews on the front panel to remove the face plate. Alarm 1 adjustment potentiometer is in the bottom righthand corner and above it is Alarm 2 adjustment potentiometer. Using a small jewelers screwdriver adjust the respective potentiometer until display shows the required setting. When Alarm adjustments are complete replace front panel and change display back to CONC (figure 2).

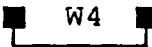
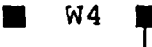
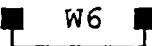
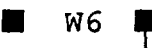
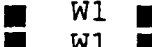
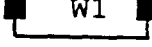
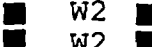
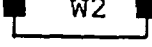
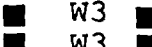
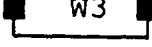
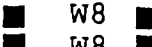
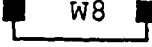
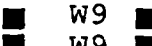
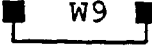
NOTE: There is a deliberate hysteresis built into the alarm function to avoid oscillation when the

input (or 4-20mA Calibrator) remains close to the set point. This hysteresis will cause the alarm to activate at the set point and turn off at a slightly lower level than the set point (or higher level if alarm level is programmed to activate on the falling edge).

2.1.2.2 Alarm and Relay Configuration

Table 2 shows the positions for the jumpers to be set for each alarm function. The default factory settings are indicated. To change settings turn OFF all power sources to the controller and unplug terminal block. Remove the two screws in the upper side of the rear clear panel and slide controller board out of the case. Lift the jumpers using needle nose pliers and remove/replace them as required.

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	W4	W5	Alarm 1 Latching
	W4	W5	Alarm 1 Non Latch (factory)
	W6	W7	Alarm 2 Latching
	W6	W7	Alarm 2 Non Latch (factory)
	W1	W1	Trouble Alarm Normally Not Energized
	W1	W1	Trouble Alarm Normally Energized (factory)
	W2	W2	Alarm 2* Alarm Low
	W2	W2	Alarm 2* Alarm High (factory)
	W3	W3	Alarm 1* Alarm Low
	W3	W3	Alarm 1* Alarm High (factory)
	W8	W8	Relay and Alarm LED Test NOT Enabled (factory)
	W8	W8	Relay and Alarm LED Test Enabled
	W9	W9	Stripchart Power OFF (factory)
	W9	W9	Stripchart Power ON

* Alarm low indicates the relay will energize when the input value is below the set point.

** Alarm high indicates the relay will energize when the input value is above the set point.

TABLE 2
ALARM AND RELAY JUMPER POSITIONS

2.1.2.3 Alarm Test

To test Alarm Relays and Alarm status LEDs loosen the two thumbscrews on the front panel to remove the face plate. The TEST jumper block is located between the two alarm adjustment pots on the display. Using a small jewelers screwdriver temporarily short the jumper posts together. See Figure 2. All three alarm relays will be energized and the three ALARM LEDs will turn ON.

NOTE: The Trouble relay is normally energized if loop current is greater than 3mA and will remain energized when the TEST jumper block is temporarily shorted. Test the trouble relay by removing 4 mA input or removing all system power.

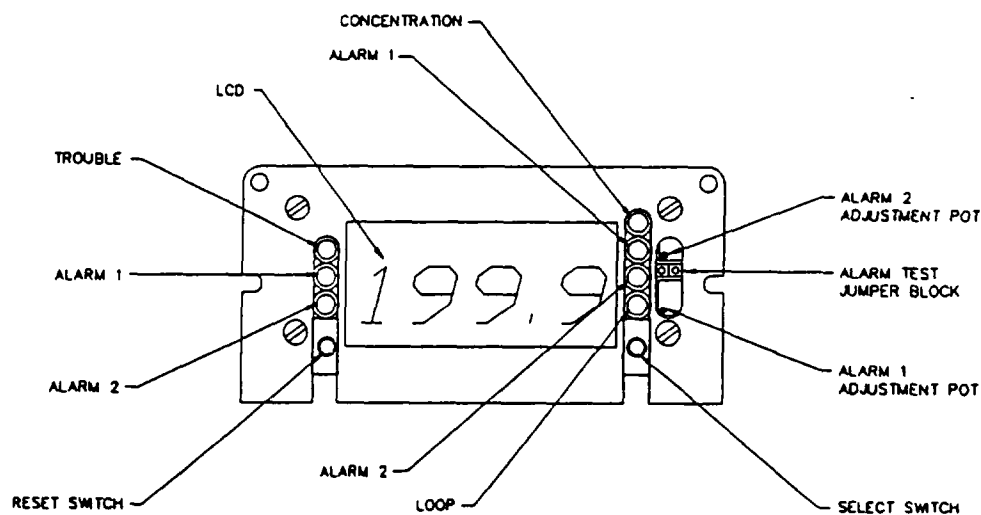


FIGURE 2
MODEL 4011 CONTROLLER DISPLAY(FRONT VIEW)

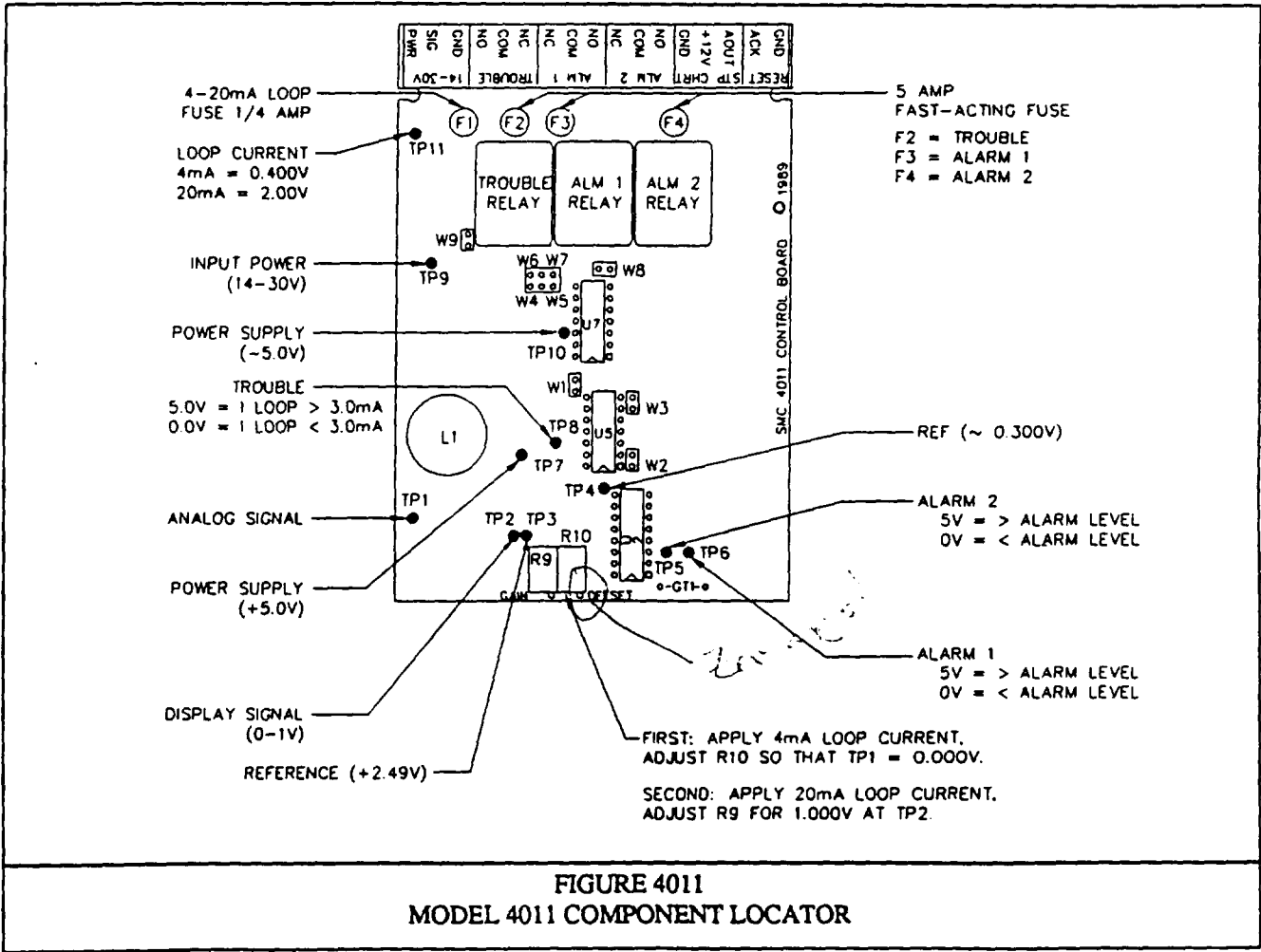
INSTRUCTION MANUAL

3.1 CALIBRATION

3.1.1 4-20mA Calibration

Calibration of the Model 4011 is only required if the CONC display does not read 00.0 +/- 00.2 with a 4.00mA loop current or the display does not read 100.0 +/- 0.2 with a 20.00mA loop current. Turn power OFF to unit. Remove front panel by unscrewing the two thumbscrews and removing the front section. Next remove the screws in the top left and right corner of the display board. Remove the display board with the

ribbon cables connected and be careful not to have any part of the circuit board touch any metal surfaces. Turn power ON to unit. Adjust R10-20K (OFFSET) potentiometer (see figure 3) for 0.000v +/- 0.001v at TP1 with 4.00mA loop current. The reading on the display when set to CONC should be 00.0 +/- 00.2. Adjust R9-10K (GAIN) potentiometer for 1.000v +/- 0.001v at TP2 with 20.000mA loop current. The reading on the display when set to CONC should be 100.0 +/- 00.2.



3.2 SERVICE

3.2.1 The only serviceable parts on the Model 4011 are the four fuses on the controller board (A27040). To check to see if fuse is blown turn OFF power and remove the rear clear face plate. Remove fuse in suspect and check for zero ohms with an ohm meter. If fuse resistance is greater than 1 ohm then replace the fuse with the same type.

F1 = 1/4 A Microfuse by Littelfuse
p/n 273250

F2-F4 = 5.0 A Microfuse by Littelfuse
p/n 273005

4.1 SPECIFICATIONS

INPUT LEVEL: Standard: 4-20mA Factory
Options: 0-5v, 0-10v, 0-20mA.

INPUT RES: The input loop resistance for the 4-20ma loop is 100 ohms.

INPUT SIGNAL: 14-30 VDC nominal 100ma @24VDC without sensor Module. 180ma @20VDC with sensor Module at 20ma loop current.

ENCLOSURE: Standard: 1/8 DIN (1.9"H x 3.8"W x 6.5"D) may be Panel mounted. Optional: Nema 4, Explosion proof

DISPLAY: 3 1/2 Digit Liquid Crystal:
Four Display Selections Available: CONCentration, ALARM 1 LEVEL, ALARM 2 LEVEL, LOOP CURRENT. Three Alarm Status LED: Trouble, Alarm 1, Alarm 2.

ALARM LEVELS: Two alarms available with user adjustable levels.

ALARM RELAYS: User jumper selectable for Latching or Non-Latching. User jumper selectable for Alarming on GREATER or LESS than Alarm Level.

TROUBLE RELAY: Relay de-energizes when loop current is LESS THAN 3mA or when power is removed.

CONTACT RATING :Relay contacts are (SPDT Form C) rated 10@28VDC/120VAC and are fused at 5A.

ALARM RESET: External Alarm reset available when alarm relays are programmed for Latching. Alarm Relays will be reset but Alarm Status LEDs will track actual condition.

STRIPCHART: Stripchart Output 0-2v with RL= 1000 ohms minimum. Power available is 12VDC @ 50mA.

OTHER: Modular terminal block that allows disassembly without removal of individual wires.

INSTRUCTION MANUAL

IM56/0590

MODEL 4100 SERIES
GAS MONITORS

4100-30 COMBUSTIBLE GAS

4100-31 CARBON MONOXIDE

4100-32 AMMONIA

<u>EFFECTIVITY</u>	
DATE	Serial Number
05/31/90	



sierra monitor corporation

1991 Tarob Court, Milpitas, CA 95035

1.0 Product Description

1.1 Introduction

Gas monitors in the Model 4100 series are for detection of part per million (PPM) concentrations of combustible gas (4100-30), carbon monoxide (4100-31) or ammonia (4100-32). The monitors operate on 24 VDC input and source a non-linear 4-20 mA current loop output. They are designed for operation in conjunction with a Sierra Monitor *Sensys* controller which provides response curve smoothing functions resulting in a linear display proportional to the sensor response.

All Model 4100 series monitors have similar instructions. This manual provides the instructions for each of the monitors and identifies those functions or procedures which differ between the models. Appendix A provides cross reference information for equivalent response of the monitors to other gases.

2.0 Installation and Start-up

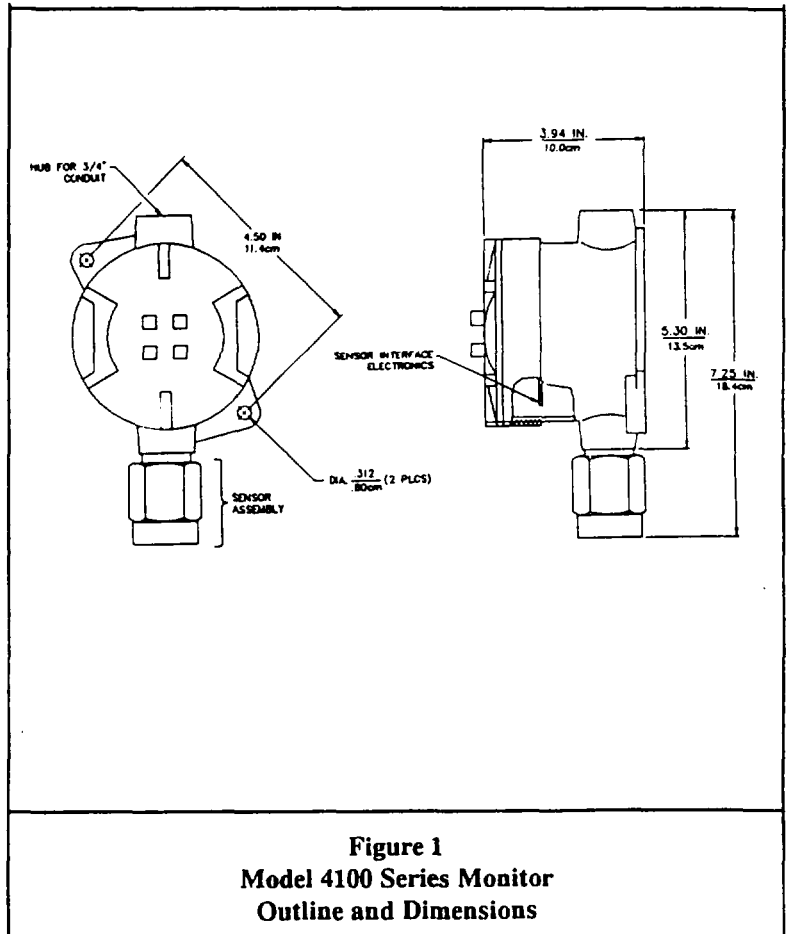
2.1 Location

Select a location for the monitor based on the following criteria.

1. The monitor enclosure accepts a 3/4" NPT male conduit or fitting. Figure 1 - Outline Drawing.
2. Determine the potential source and destination of the gas of interest and spot monitors where they are most likely to be exposed to the gas.
3. Take into account the specific gravity of the gas to be detected. Heavy gases

should be monitored close to the floor, light gases should be monitored near the ceiling.

4. Provide for calibration access which requires removal of the enclosure lid and application of span gas to the sensor.
5. Sensor **MUST** be pointed down to avoid contamination from dust collection.



2.2 Module Installation

The monitor enclosure is a dual 3/4 inch hub explosion proof electrical housing. The sensor is factory installed in one hub, the other is for wiring access. Two mounting holes spaced 4.5" on center

are located on the upper right and lower left sides of the enclosure at a 45° angle to vertical.

The monitor is to be installed on the end of rigid vertical 3/4" conduit or using the mounting flanges to secure it to a vertical surface. Access is required for application of a threaded calibration gas delivery fitting into the face of the sensor. It is recommended that both the conduit and the explosion proof housing be connected to an EARTH ground.

Table 1 shows the wire gauge requirements for the maximum cable distance between the *Sensys* Controller and the gas monitor. The recommended wire to be used should meet UL1007 or UL1015 specifications when installed in a continuous metal conduit. When cable is not installed continuously in metal conduit then the recommended shielded cable to be used is the Belden number identified in the table.

Wire Gauge (AWG)	Maximum Cable Length (feet)	Belden Number
20	2,000	8772
18	3,000	8770
16	4,000	8618
14	5,000	83753
12	9,000	83803

Table 1
Wire Gauge and Length

To install the monitor follow the steps listed below.

1. Remove the transmitter electronics from the main housing by unscrewing the two mounting screws. Lift the board out of the housing and unplug the sensor cable harness from the board (J1 a 4 position brown connector).

2. Connect the three wires from the *Sensys* controller to the terminal block marked "P" "S" "G" on the transmitter electronics. See Table 2 for connector labeling and for recommended wire colors.

<i>Sensys</i> Label	Monitor Label	Wire Color
+ EXC	P	White
+ CH#	S	Black
GND	G	Green

Table 2
Connector Labeling and Wire Colors

3. Connect an earth ground wire to the ground screw provided in the main housing.
4. Reconnect the sensor cable harness to the transmitter electronics (Connector J1) and replace the electronics board into the enclosure insuring that a sufficient service loop stores into the enclosure.
5. Complete any required terminations of the cables to the *Sensys* controller (see *Sensys* instructions).

2.3 Start-up Procedure

After all the wiring has been installed apply power to the sensor module(s) by providing power to the *Sensys* controller. Wait 30 seconds and check that the status LED on the gas monitor is ON. If the status LED is not on, follow trouble shooting guidelines (Section 4.2).

Note that typical *Sensys* operation provides a five minute warm-up period, after power up, before signals from the monitor are processed for alarm decision purposes.

3.0 Calibration

3.1 Frequency of Calibration

Sierra Monitor recommends that model 4100 series gas monitors be calibrated every ninety days. Monitors should be on power for at least 24 hours continuously before calibration adjustments are made.

3.2 Procedure

There are two alternative procedures for calibration of Model 4100 monitors connected to *Sensys* controllers. The following procedure adjusts the monitor output to a precise 4-20 mA output. The alternate procedure is described in *Sensys* instructions and allows the monitor output to remain unadjusted while the *Sensys* controller concentration processor is adjusted to compensate for drift of the monitor output signal.

3.2.1 To calibrate the monitor output:

Equipment required:

- Digital Volt Meter (DVM) 3 1/2 digits
- Calibration gas of a concentration equal to the full scale value of the monitor as follows:

Model 4100-30:

5,000 ppm Methane (CH_3)

Model 4100-31:

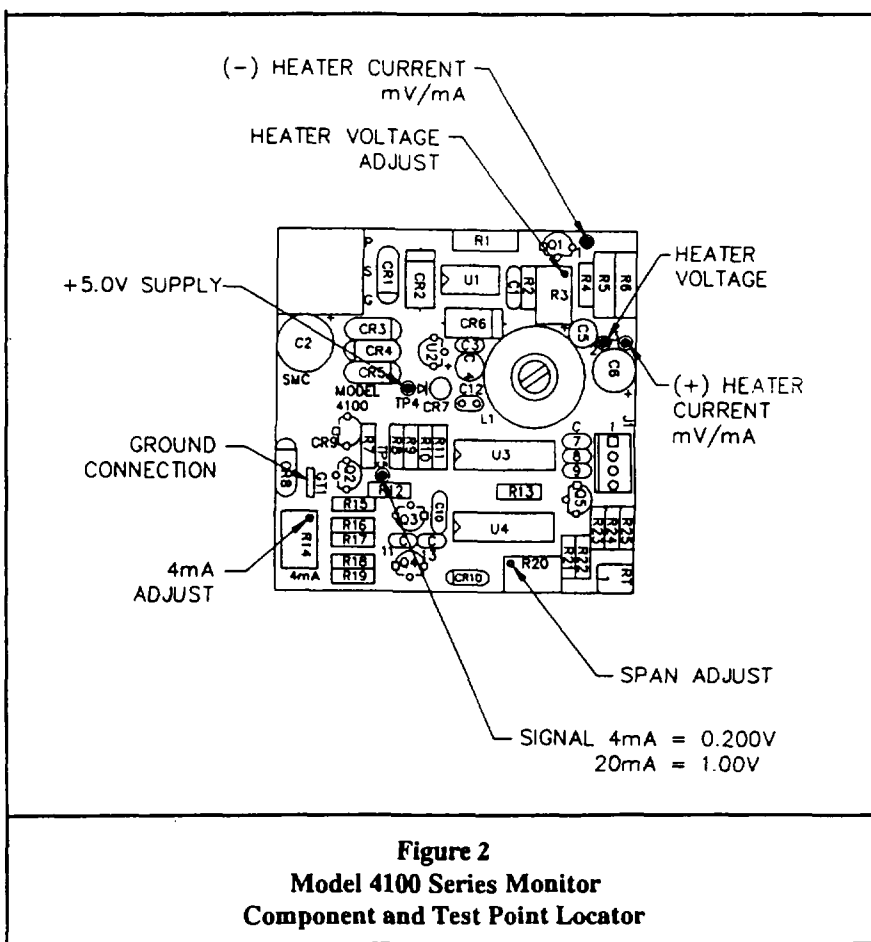
500 ppm Carbon Monoxide (CO)

Model 4100-32:

1,000 ppm Ammonia (NH_3)

3.2.2 Procedure (refer to Figure 2):

1. Remove the enclosure lid by turning counterclockwise.
2. Verify that the status LED is ON. If the status LED is out, do not attempt calibration and refer to trouble shooting guidelines (Section 4.2).
3. Connect DVM across TP2 (heater voltage) and GT1 (ground connection) and verify that heater voltage is 5.0 VDC $\pm 0.05\text{V}$ if not adjust using potentiometer R3 (heater voltage adjust).
4. Connect DVM across TP5 (signal) and GT1 (ground connection).



With no span gas applied the voltage at TP5 should be approximately 0.20VDC $\pm$ 0.025V. If not adjust using potentiometer R14 (4 mA adjust).

5. Apply Span gas at a flow rate of 100 ml/min. Allow 3 to 5 minutes before making any adjustments.
6. Adjust Span Pot R20 (span adjust) so that voltage at TP5 (signal) is 1.00 VDC $\pm$ 0.005V. Verify that the **Sensys** Controller is displaying the correct concentration, if not adjust potentiometer R20 accordingly.
7. Remove span gas, wait 5 minutes and verify that the concentration on the **Sensys** Controller goes to 0 ppm or DVM attached to TP5 goes to 0.20VDC $\pm$ 0.025V. If not adjust via potentiometer R14 (4 mA adjust).

4.0 Service

4.1 Sensor Replacement

The sensor should be replaced when either of the following conditions occur:

1. It is no longer possible to obtain the correct value on the **Sensys** Controller or the correct voltage level at TP5 on the electronics board using R20 (span adjust) and R14 (4mA adjust). (At 4mA the voltage at TP5 should be 0.200V $\pm$ 0.025V and at 20mA the voltage at TP5 should be 1.00V $\pm$ 0.005V)
2. When the signal at TP5 becomes noisy causing erroneous or fluctuating concentration readings.

To remove the Sensor, remove the electronics board from the main housing and unplug the sensor connector harness from the electronics.. Unscrew the old sensor from the main housing and install the new sensor in the reverse order.

After replacement a coarse calibration adjustment may be performed. Precision calibration is required after twenty four hours of stabilization.

4.2. Troubleshooting

If the Status LED is OFF check the following.

1. Power is available at the 4100-30. There should be 14 VDC to 30 VDC at TB1 (the channel wiring connector) between "P" (power) and "G" (ground). If not, verify that wiring from **Sensys** Controller to the 4100-30 is correct and that the channel fuse in the **Sensys** is not blown.
2. Verify that Sensor cable is plugged in all the way and is correctly oriented.

4.1 Specifications

SENSOR

TYPE: Solid State Metal Oxide Semiconductor
RANGE: 4100-30: 50 - 5,000 ppm Methane
(See Appendix A for cross reference to other gases).
4100-31: 50-500ppm CO
4100-32: 20-500ppm Ammonia (NH₃)
RESPONSE: 90% of concentration in less than 30 seconds.
TYPICAL LIFE Five years in Normal Service.

DETECTABLE GASES AND VAPORS

Acetone, Acetylene, Benzene, Butane, Carbon Monoxide, Dioxane, Ethane, Ethyl Ether, Ethylene Oxide, Freon, Gasoline, Hydrogen, Isopropanol, Jet Fuels, Kerosene, Methane, Methanol, Methyl Ethyl Ketone, Natural Gas, Propane, Toluene, Xylene

CALIBRATION

ADJUSTMENTS: For manual calibration: 4mA loop, Span, Heater Voltage
No manual adjustments when calibrated with *Scany* Controller.
STATUS LED: OFF indicates that either the heater or film is an open circuit.

ENVIRONMENTAL

OPERATING: Temperature -10°C to +40°C
Humidity 5% to 95% non condensing
STORAGE: Temperature -55°C to +85°C

ELECTRICAL DATA

WIRING: 3 wire non isolated
INPUT
VOLTAGE: 14 - 30 VDC
CURRENT: 70mA @ 4mA loop Current; 90mA @ 20mA loop Current at 24VDC.
POWER: 2.1 Watts
OUTPUT
RANGE: 4-20mA
LOOP RES.: 800 ohms at 28VDC

MECHANICAL

PHYSICAL: Nominal Dimensions (HxWxD)
6.75" x 4" x 3.5"
MATERIAL: Cast Aluminum epoxy painted
WEIGHT: 2 pounds
CLASSIFICATION: Class I Division I Groups C,D
MOUNTING: Connects to a vertical 3/4" electrical conduit

5.1 Limited Warranty

SIERRA MONITOR CORPORATION warrants its products to be free from defects in workmanship or material under normal use and service for one year after date of shipment. SMC will repair or replace without charge any equipment found to be defective during the warranty period. Final determination of the nature and responsibility for defective or damaged equipment will be made by SMC personnel.

All warranties hereunder are contingent upon proper use in the application for which the product was intended and do not cover products which have been modified or repaired without SMC approval or which have been subjected to accident, improper maintenance, installation or application, or on which original identification marks have been removed or altered. This Limited Warranty also will not apply to interconnecting cables or wires, consumables (ie. calibration gases, batteries), nor to any damage resulting from battery leakage.

In all cases SMC's responsibility and liability under this warranty shall be limited to the cost of the equipment. The purchaser must obtain shipping instructions for the prepaid return of any item under this warranty provision and compliance with such instruction shall be a condition of this warranty.

Except for the express warranty stated above, SMC disclaims all warranties with regard to the products sold hereunder including all implied warranties of merchantability and fitness and the express warranties stated herein are in lieu of all obligations or liabilities on the part of SMC for damages including but not limited to consequential damages arising out of or in connection with the use or performance of the product.

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APPENDIX A

The model 4100 series gas monitors source a non-linear 4-20 mA output that require *Sensys* curve fitting for signal linearization. Each module, -30,-31,-32, has been curve fitted for a specific gas over a specified concentration range. Other gases can be detected with the modules and some gases may be detected by more than one module. When selecting or matching a module to a gas, it is imperative to remember that the range must remain the same. For example; model 4100-31 has been characterized using 0-500 ppm carbon monoxide. If this module is the desired choice to detect acetylene, the range must be 0-500 ppm. The following is a cross reference list, ordered by model number.

Model 4100-30

Sensys Configuration:
Full scale range: 5,000 ppm CH4
Curve fit function G02cc, Scaling Factor 4.28.
[All cross calibrations tested using 1000 ppm methane at the listed module voltage and gas concentration.]

EXAMPLE:
To detect acetylene: Use the listed *Sensys* range, function code and scaling factor. From the cross reference list enter a calibration span value of 4000 ppm (from list). Apply 1000 ppm methane to the sensor and adjust the module output to 1.90 volts (19.0 mA).

GAS DETECTED	MODULE VOLTAGE	CONCENTRATION (PPM)
Methane	2.00	5,000
acetic acid	1.26	700
acetonitrile	1.37	1,000
acrylonitrile	1.37	1,000
acetone	1.07	350
acetylene	1.90	4,000
n-butane	1.30	800
i-butane	1.30	800
1-butanol	1.26	700
2-butanol	1.37	1,000
i-butanol	1.37	1,000
t-butanol	1.61	2,000
butene	1.61	2,000
cyclopentane	1.26	700
cyclohexane	1.43	1,200
diethylketone	1.26	700
dipropylether	1.11	400
ethane	1.04	300
ethanol	1.04	300
ethylene	1.22	600
Freon 113	0.70	55
n-heptane	1.51	1,500
n-hexane	1.40	1,100
1-hexanol	1.51	1,500
methanol	1.11	400
methyl bromide	0.88	150
methyl chloride	0.88	150
methyl ethyl ketone	1.17	500
methyl propyl ketone	1.17	500
nitroethane	1.37	1,000
nitromethane	1.61	2,000
1-pentanol	1.43	1,200
propanal	1.17	500
n-propanol	1.04	300
i-propanol	1.30	800
propylene	1.61	2,000

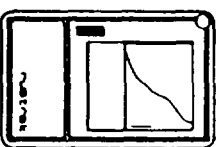
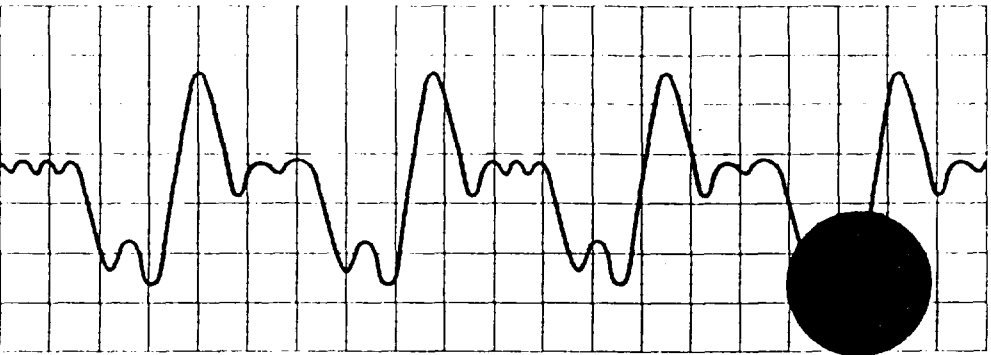
Model 4100-31

Sensys Configuration:
Full scale range: 500 ppm CO
Curve fit function G03cc, Scaling Factor 3.51
[All cross calibrations tested using 500 ppm carbon monoxide at the listed module voltage and gas concentration.]

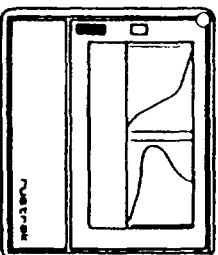
GAS DETECTED	MODULE VOLTAGE	CONCENTRATION (PPM)
Carbon Monoxide	2.00	500
acetic acid	1.59	120
acetonitrile	1.20	30
acrylonitrile	1.32	50
acetone	1.08	20
acetylene	1.74	200
benzene	1.20	30
n-butane	1.44	70
i-butane	1.54	100
1-butanol	1.20	30
2-butanol	1.20	30
i-butanol	1.32	50
t-butanol	1.32	50
butene	1.28	40
chloroform	1.74	200
cyclopentane	1.54	100
cyclohexane	1.48	80
diethylketone	1.08	20
dipropylether	1.20	30
ethane	1.94	400
ethanol	1.20	30
ethylene	1.40	60
Freon 113	1.48	80
n-heptane	1.44	70
n-hexane	1.40	60
1-hexanol	1.20	30
hydrogen	1.32	50
methanol	1.20	30
methylene chloride	1.54	100
methyl bromide	1.74	200
methyl chloride	1.74	200
methyl ethyl ketone	1.20	30
methyl propyl ketone	1.20	30
nitroethane	1.00	15
nitromethane	1.48	80
1-pentanol	1.08	20
propane	1.66	150
n-propanol	1.08	20
i-propanol	1.15	25
propylene	1.28	40
toluene	1.40	60
xylene	1.28	40

Model 4100-32

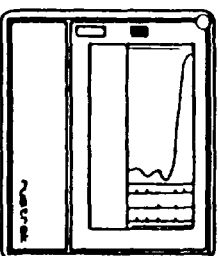
Sensys Configuration:
Full scale range: 1,000 ppm NH₃
Curve fit function G03cc, Scaling Factor 5.57



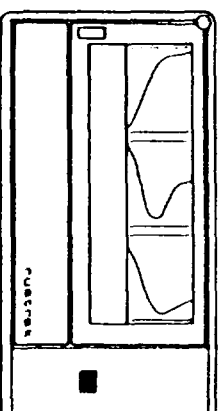
200 Series



300 Series



7000 Series



4000 Series

rusttrak[®]

D.C. SIGNAL RECORDER INSTRUCTION MANUAL

THIS MANUAL COVERS:

MODELS - 288, 388, 4288, 7288, 291, 391, 4291, 288 E1, 388 E1, 4288 E1, 7288 E1-E3

FEATURES: F217W, F217N, F205, F137, F437

gulion

IT IS SUGGESTED THAT THIS MANUAL BE READ IN ITS ENTIRETY BEFORE SETTING UP OR OPERATING YOUR RUSTRAK RECORDER.

WARRANTY

GRAPHIC INSTRUMENTS DIVISION, GULTON INDUSTRIES INCORPORATED warrants RUSTRAK products described in this manual to be free of defects in material and workmanship under normal usage and service for a period of one year from the date of its initial purchase from the factory or an authorized GRAPHIC INSTRUMENTS DIVISION distributor. The company's obligation under this warranty is limited to repairing or replacing any instrument or component which, upon examination by factory personnel, is found not to conform to the foregoing warranty. The instrument must be returned to the factory; transportation prepaid. We shall not be liable for any damages, consequential or otherwise.

The foregoing warranty is exclusive and in lieu of all other warranties whether expressed or implied.

This warranty does not apply to galvanometer stylus damage or damages resulting from transportation, alteration or misuse.

GRAPHIC INSTRUMENTS DIVISION, GULTON INDUSTRIES INCORPORATED reserves the right to discontinue any model or change specifications or design without notice and without incurring any obligation.

RECEIVING

Each carton contains a recorder, one or more manuals to cover the models and features, and one roll of chart paper. In addition, Series 200 recorders are supplied with hardware kit A-6464. The kit contains hardware needed for bench or panel mounting. If items are missing, obtain them from your local distributor.

Shipping damage must be reported to your carrier immediately. Do not destroy packing material or containers, even if they appear undamaged, until your agent has examined them.

Under U.S. shipping regulations, damage must be claimed and collected by the consignee. Do not return merchandise damaged in shipping until your claim is examined and documented.

APPLICATIONS ASSISTANCE

Rustrak is prepared to offer almost any kind of help or suggestions you may need to get the most efficient use from your Rustrak recorder. Your local distributor can probably answer your questions; engineers at our East Greenwich facility will also be pleased to assist you in any way.

GEAR TRAINS

Various ratio gear trains are available to alter any Rustrak recorder to run at chart speeds other than those originally chosen. High speed gear trains are available for 60 and 100 rpm motors.

MOTORS

A variety of motor speeds, voltages and frequencies are available. Please consult your distributor or the Rustrak sales department in East Greenwich, RI for galvanometer limitations.

CAUTION — EXTERNAL TRANSFORMERS, SHUNTS, SIGNAL CONDITIONERS AND SENSORS

Many Rustrak systems are not complete without the use of an external device. Failure to use the proper device can create an error or a HAZARDOUS SITUATION. The part numbers of the approved devices are usually printed on the recorder scale.

Please also refer to SAFETY CONSIDERATIONS on page 2 of this manual.

INTRODUCTION

This manual describes standard RUSTRAK Series 200, 300, 4000, 7000 and optional features with which they may be equipped. All recorders described are for measuring DC voltage or current.

Information given for Series 200 single channel recorders is typical for Series 300 dual channel and Series 4000 three channel recorders. Each channel's function can be determined by the recorder's model number suffix. Your recorder's model number is on serial plate along with primary power information. Use your model number suffix to determine which sections of this manual pertain to your instrument. Refer to other manuals for channels not contained in this booklet.

EXAMPLE: MODEL 388/3107
REFER TO: 288 SECTION OF THIS MANUAL
2107 SECTION OF THE A.C. RECORDER
MANUAL

The Series 700 single channel recorder is a 4" (100mm) version of the Series 200 single channel recorder. In some cases an intermediate amplifier is used in conjunction with transducer circuitry. Refer to the recorder's serial plate for the model number. Use the manual section determined by the model number suffix for operation.

SAFETY CONSIDERATIONS

All Rustrak recorders provide some method for grounding the metal case. Use this provision. Do not assume that the recorder is grounded because it is plugged into a 3 prong outlet. Make certain your power system ground is not faulty. *FAILURE TO PROPERLY GROUND AN ELECTRICAL DEVICE CAN BE FATAL.* This applies to battery operated recorders as well because the signal itself could be a lethal voltage.

Recorders using sensitive signal conditioners may not operate properly without a case ground.

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RECORDER GENERAL DESCRIPTION

The RUSTRAK galvanometric recorder consists of several basic elements: galvanometer, spring loaded striker, backup bar (writing edge), chart drive motor and cam, and pressure sensitive paper.

A rotating cam lifts the striker away from the galvanometer pointer allowing free movement of the pointer. The cam allows the striker to fall against the pointer pressing it against the pressure sensitive paper. The force is absorbed by the backup bar located behind the paper. This action removes the white top coating on the paper and exposes the black base material at the point where the pointer and backup bar cross. Each strike makes one dot.

When chart speed, and cam RPM are chosen properly, the succession of dots has the appearance of a continuous line.

The motor which rotates the cam also provides the motion to move the chart paper through the recorder.

MODEL 288 RECORDER SPECIFICATIONS

Single channel analog chart recorder for measuring DC voltage and DC current. Use of different galvanometers and multipliers produces voltage sensitivity from 10 mV to 500 V and current sensitivity from 10 uA to 1 mA and higher using shunts.

Accuracy	± 2% (current recorder w/o shunt)
Response Time	1 second maximum
Usable Chart Width	2 5/16"
Chart Length	63 feet
Chart Speed	1/48"/hr to 480"/hr with std. motors and gear trains
Chart Motor Voltage	115 or 230 V, 50 or 60 Hz 6, 12, 24, 48 VDC unregulated or inverter motors
Striking Rate	1 per 12 sec. to 4 per sec.
Dimensions	3 5/8"W x 5 5/8"H x 4 5/16"D
Weight	3 3/4 pounds

MODEL 291 RECORDER SPECIFICATIONS

Two analog channels in a Model 288 case and chart drive configuration. Use of different galvanometers and multipliers gives voltage sensitivity from 57 mV to 500 V and current sensitivity from 10 uA to 1 mA and higher using shunts.

Usable Chart Width Two one inch analog channels
Refer to Model 288 specifications at left for all other specifications.

MODEL 288EI (FORMERLY 2146) RECORDER SPECIFICATIONS

One analog channel and one event channel in a Model 288 case and chart drive configuration. Use of different galvanometers and multipliers gives voltage sensitivity from 57 mV to 500 V and current sensitivity from 10 uA to 1 mA and higher using shunts.

Usable Analog Chart Width	two inches
Event Channel	one 5/16 inch
Event Indication	1/16 inch rectangular trace with on-off signal
Event Response Time	10 Events per second
Event Voltage	6, 12, 24, 48 VDC and 6, 12, 24, 48, 115, 230 V 50/60 Hz +20 -15%
Event Power	2 Watts Nominal

SERIES 300 RECORDER SPECIFICATIONS

The Series 300 is a dual width recorder in which Models 288, 291, 2146, four or eight events or other combinations are available.

Dimensions	6 5/8"W x 5 5/8"H x 8 1/4"D
Weight	6 pounds

SERIES 4000 RECORDER SPECIFICATIONS

The Series 4000 is a triple width recorder in which Models 288, 291, 2146, four to sixteen events or other combinations are available.

All 4000 Series recorders have two speed chart motors (2 and 8 RPM) which are push button controlled from the right hand panel.

Dimensions 11"W x 5 5/8"H x 8 1/4"D
Weight 8 pounds

SERIES 7000 RECORDER SPECIFICATIONS

Single 100 mm wide analog channel with up to three events in a Series 300 case and chart drive configuration. Basic sensitivity is 5mA at 140 ohms. Other voltage and current sensitivities are obtained with amplifiers, multipliers, or shunts.

Accuracy	±2% (current recorder w/o shunt)
Response Time	1 second maximum
Analog Chart Width	100mm
Event Channels	Up to three 5/16" spacing
Event Indication	1/16 inch rectangular trace
Event Response Time	10 Events per second
Event Voltage	6, 12, 24, 48 VDC and 6, 12, 24, 48, 115, 230 V
	50/60 Hz +20 -15%
Event Power	2 Watts Nominal
Chart Length	63 feet
Chart Speed	1/48"/hr to 480"/hr using all std. motors and gear trains
Chart Motor Voltage	115 or 230 V, 50 or 60 Hz
	6, 12, 24, 48 VDC unregulated or inverter motors
Striking Rate	1 per 12 sec. to 4 per sec.
Dimensions	6 5/8"W x 5 5/8"H x 8 1/4"D
Weight	6 pounds

AMPLIFIER FEATURE 217 SPECIFICATION

DC preamplifiers may be added to the basic Models 288, 291, 2146 as well as any analog channel in a Series 300, 4000 or 7000. Standard spans are from 10 mV to 100 mV with input resistance of 50,000Ω

Accuracy ±2% (voltage or current)
Ambient Temperature 0 to 50°C
Recorder Dimensions Series 300, 4000 see recorder specifications
Series 200
3 5/8"W x 5 5/8"H x 6"D

Span Any Span Between 10 & 100 mV
Offset & Suppression Up to ± 1x Span
Model 2194 is a fixed gain version of the 217 Feature with 10,000Ω input resistance, and a span of 10 mV (1 μA)

AMPLIFIER FEATURE 217N SPECIFICATION

Specifications for 217 apply except:

Span Any Span between 1 and 9.9 mV
Offset & Suppression Up to ± 5x Span

CONTROLLER FEATURE 205 SPECIFICATION

Controller feature may be added to any analog channel of Series 200, 300, 4000 or 7000. The maximum number of setpoints is two per channel.

Type of Output	2 Amp Relay
Number of Setpoints	one or two
Type of Setpoint	High (A) or Low (B)
Input Sensitivity	Same as recorder sensitivity
Dead Band	.2% to 5% adjustable
Indication	Red LED indicates when relay energizes

EXTERNAL WIRING, SERIES 200

All recorders have a label inside showing all terminal and pin numbers regardless of whether or not they have been supplied pre-wired. The serial plate gives all voltage, frequency, model and serial information for the particular recorder.

The table below shows standard connection for Series 200 AC powered recorders.

CONNECTOR	PIN #	MODEL 288	MODEL 291	MODEL 288E1
1		+ galvo	+ galvo LH	+ galvo
2		- galvo	- galvo LH	- galvo
3		high line	high line	high line
4		low line	low line	low line
5		case	+ galvo RH	event
6		NC	- galvo RH	event
lug		not used	case	case

When the above models are supplied with attached line cord, pins 3 and 4 are not used. (Includes CSA approved models)

When the above models are supplied with DC motor, pin 3 is positive and pin 4 is negative.

When a 217 feature is installed, the recorder has attached line cord, and the signal input is to the red (positive) and black (negative) binding posts.

EXTERNAL WIRING, SERIES 300, 4000, 7000

These models are supplied with attached line cord as standard. All other inputs and outputs are via rear barrier strip or binding posts. The inside label identifies all connections.

INSTALLATION, SERIES 200, FEATURES 217, 217N, 205

These recorders are furnished with A-6484 hardware kit for bench or panel mounting. Instructions are in the kit. A template for panel cutout dimensions is available.

INSTALLATION, SERIES 300, 4300

These recorders are shipped with all hardware installed as a bench mount. A modification kit is available for panel mounting.

PRIMARY POWER

Rustrak recorders may be supplied A.C. or D.C. powered. Check your recorder's serial plate for the proper voltage and frequency. Your recorder is rated at $\pm 10\%$ primary voltage. Out of tolerance primary voltage may cause limiting of measurement errors. Observe D.C. polarity before connecting your recorder. Reversed polarity could cause mechanical and/or electrical failure.

CALIBRATION PROCEDURE, SERIES 200, 300, 4000, 7000

All recorders without signal conditioners are calibrated by zeroing the galvanometer. The zero adjustment is located behind the front nameplate. Remove by inserting a small flat screwdriver into the left hand slot and prying.

Recorders are normally supplied as zero left, center, or right. Variations may place the zero some other place on or off scale.

ZERO ON SCALE

With signal disconnected, rotate the zero adjustment to give recording on the appropriate line of the paper. To check accuracy, apply a known voltage or current equivalent to full scale. The maximum error should be less than $\pm 2\%$ of span. There is no adjustment for span.

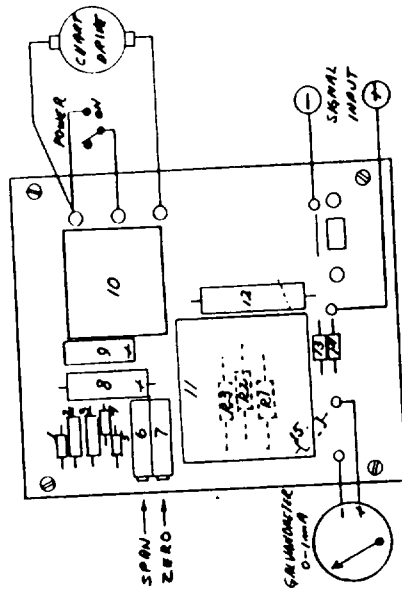
ZERO OFF SCALE

Apply a known voltage or current equivalent to low end scale and adjust the mechanical zero adjustment to give recording on the most left hand line of the chart paper. Check full scale by applying a known full scale signal. The maximum error should be less than $\pm 2\%$ of full scale value.

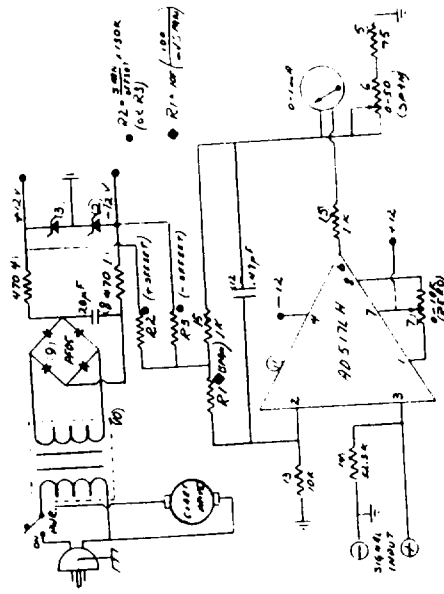
CALIBRATION PROCEDURE, FEATURE 217, MODEL 2194

Recorders equipped with DC amplifiers always have a 1 mA, zero left galvanometer.

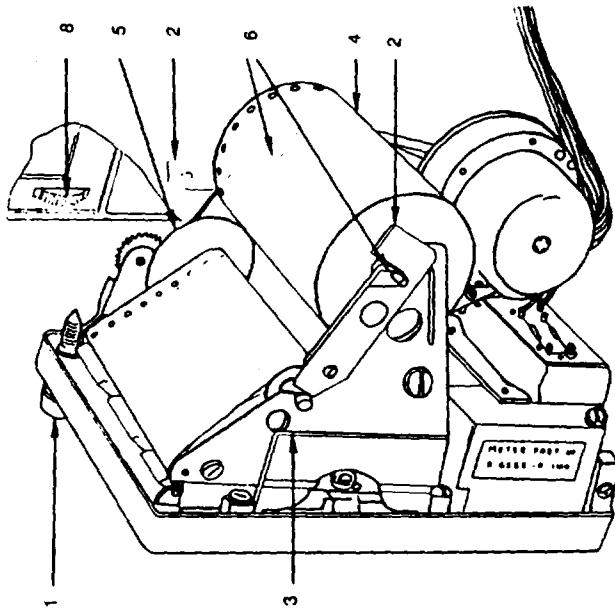
- 1) With power disconnected (Series 200) or power switched off (Series 300, 4000) zero the galvanometer according to the procedure above.
- 2) Connect a millivolt source to the input terminals observing polarity. Source resistance should be less than 100 Ω . Switch the source to zero mV and adjust the amplifier ZERO for a reading corresponding to zero on the scale.
- 2a) If zero is not on scale adjust the mV source for signal equivalent to left hand scale and adjust the amplifier ZERO for a reading on the most left hand line of the paper.
- 3) Apply a full scale signal and adjust the amplifier SPAN for a reading at full scale.
- 4) Repeat 2) and 3) as necessary.



217W, 217N, 2194, AMPLIFIER ASSEMBLY



217W, 217N, 2194 AMPLIFIER ASSEMBLY



SERIES 200 REROLL

CHART LOADING, RE-ROLL MODE

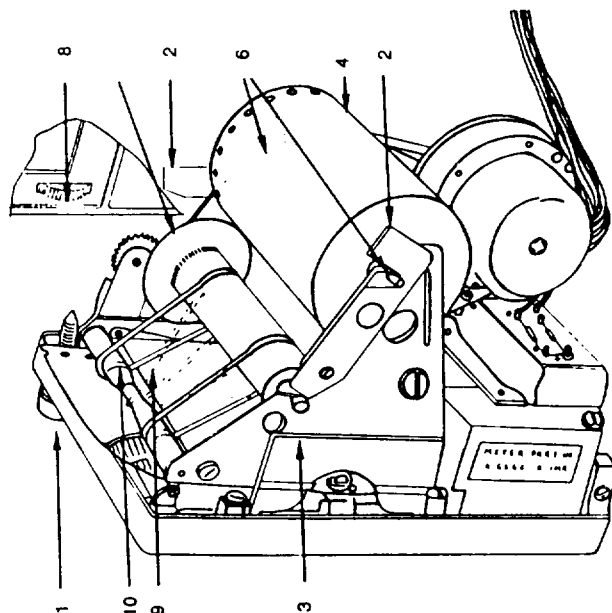
A warning to "RENEW CHART" appears on the last three feet of each roll of paper. Do not use partial rolls of paper in re-roll mode. Refer to diagram at left.

- 1) Turn power off before loading chart paper.
- 2) Open recorder by loosening thumbscrew (1).
- 3) Unlatch paper retaining clips (2).
- 4) Open panel to chassis latch (3) RH side plate.
- 5) Remove supply (4) and take up roller (5). If paper is still attached to supply roller, carefully slide the paper from between the front panel and chart drive. Do not pull the paper backwards through the recorder because of the danger of snagging the pointer.
- 6) Insert the supply roller into the new roll of chart paper. The perforated end of the paper is nearest to the roller shoulder.
- 7) Unroll about a foot of paper. Slide the paper between the panel and side plate, sprocket holes first. Keep paper taut and close to the drive drum to prevent snagging the pointer.
- 8) Engage the supply roller shaft in both seating notches (6) and check to be sure that the paper sprocket holes engage the time drum sprockets.
- 9) Slide cardboard sleeve all the way on the take up roller against the disc.
- 10) Butt paper against disc and tape the paper to the sleeve, printed side out. Wrap a few turns of the paper to be sure paper is started true.
- 11) Continue rolling paper and place roller shaft into notches. (Lower notch LH side).
- 12) Close clips (2), latch (3) and recorder front panel. Tighten thumbscrew (1).
- 13) Advance paper with the chart advance wheel (8), to assure that paper moves through the recorder. Set to time.

CHART LOADING, TEAR-OFF MODE

A warning to "RENEW CHART" appears on the last three feet of each roll of paper. Refer to the diagram at right.

- 1) Turn power off before loading chart paper.
- 2) Open recorder by loosening thumbscrew (1).
- 3) Unlatch paper retaining clips (2).
- 4) Open panel to chassis latch (3) RH side plate.
- 5) Slide drive belts (9) from chamfered grooves to center of top roller to release pressure on paper.
- 6) Remove supply roll (4). If paper is still attached to supply roll, carefully slide the paper from between the front panel and chart drive. Do not pull the paper backwards through the recorder because of the danger of snagging the pointer.
- 7) Insert the supply roller into the new roll of chart paper. The perforated end of the paper is nearest to the roller shoulder.
- 8) Unroll about a foot of paper. Slide the paper between the panel and side plate, sprocket holes first. Keep paper taut and close to the drive drum to prevent snagging the pointer.
- 9) Engage the supply roller shaft in both seating notches (6) and check to be sure that the paper sprocket holes engage the time drum sprockets.
- 10) Pull drive belts (9) back into the grooves (10).
- 11) Close clips (2), latch (3), and recorder front panel. Tighten thumbscrew (1).
- 12) Advance paper with the chart advance wheel (8), to assure that paper drives through the recorder. Set to time.



SERIES 200 TEAROFF

RECORDER STANDARD FEATURES, SERIES 200, 300, 4000, 7000

REROLL OR TEAROFF Chart drive mode may be quickly changed. Follow the instructions printed on the back of the nameplate.

NAMEPLATE Provides access for mechanical galvanometer zero adjustment.

CHART ADVANCE Push in and roll down thumbwheel to advance chart paper for time setting.

QUICK REVIEW Chart may be unrolled for analysis. Lift left retaining clip and set roller shaft in top notch. Snap the clip back in place. Unroll the paper as needed. Rewind the chart with the gear. Return the shaft to the bottom position by unlocking and relocking the retaining clip.

INTERCHANGEABLE GEAR TRAIN Gear trains affect chart speed. Fourteen different gears can provide up to 480/1 ratio of chart speeds. To change train, remove gear train spring. Move gear train in direction of arrow. Lift out from the top. Insert new gear bottom first and slide into place. Replace gear train spring. Test to be sure gear is engaged by noting zero clearance between top half round tab on side plate and gear train.

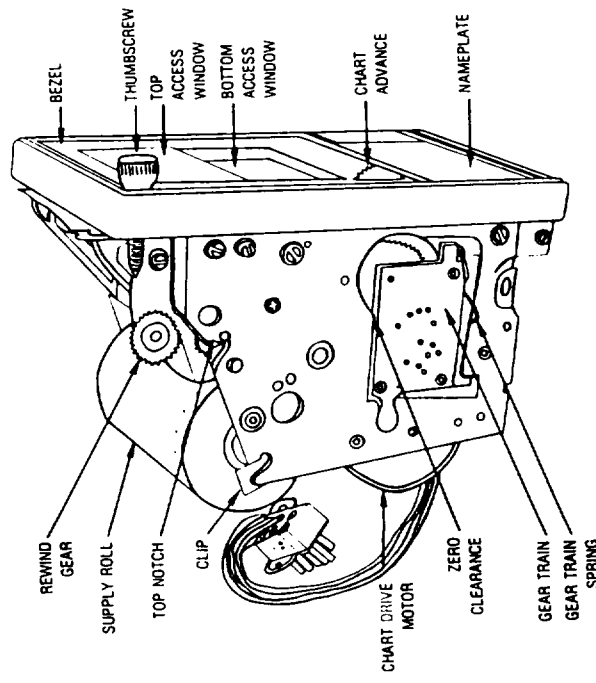
ACCESS WINDOW Slides down to provide access to chart for notes.

SCALE REPLACEMENT, SERIES 200, 300, 7000

- 1) Lower access window then grasp white plastic bezel at top center bending it to release both top tabs.
- 2) Lift out both windows noting their positions and lay to one side with the bezel.
- 3) Remove scale. Series 300 is held with tape.
- 4) Replace scale. Series 200 is self aligning. On 300 and 700 add double coated tape and line up the hash marks with the paper, press into place.
- 5) Replace the bottom window. Insert bottom two tabs of bezel.
- 6a) Series 200 replace top window then snap in left top tab then right.
- 6b) Series 300 and 7000 replace bezel as in 6a) then replace top window by putting it in one side then bending window so that it slides in on the other side.
- 7) Check access window to be sure of proper operation.

SCALE REPLACEMENT, SERIES 4000

Scale replacement on Series 4000 recorders requires partial disassembly of the recorder. Ask for Bulletin 9027 for a detailed procedure.



STANDARD MODEL 288 WITH CASE REMOVED

TWO POINT FEATURE OPERATION, (F137)

Series 200, 300, 4000 or 7000 may be equipped with two point feature in any or all channels.

A SPDT microswitch is activated by a cam with half the number of lobes as the striker cam. The microswitch activates a 4PDT relay which alternately connects the two channels to the galvanometer or if equipped with an amplifier feature to the amplifier input.

To identify channel 2 another cam geared to the time drum disconnects channel 2 every 1/2 inch of paper travel. See sample trace at right.

The signal sequence for each revolution of the chart drive motor is 1, 1, 2, 1, 2, 1, 2, 1, 2, 1, 2, 1, 2.

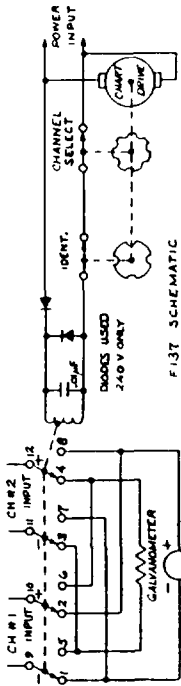
Some special DC powered recorders omit the 4PDT relay to conserve power. Both signals must have a common negative in this application.

FOUR POINT FEATURE OPERATION, (F437)

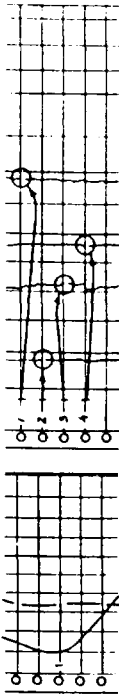
Series 7000 single channel, 100mm may be equipped with four point feature.

Refer to schematic at right. A leaf switch is actuated by the striker arm. The momentary closure triggers timer (15) which generates a 1.4 to 1.8 second pulse. This pulse is applied to the CLK1 input of JK flip flop (20). The two outputs from Q1 and Q2 provide the necessary coding to drive the multiplexer (19) whose four outputs are used to actuate DPDT relays used for signal switching.

Identification of the four recordings is accomplished by disconnecting each channel once each revolution of the time drum. This period is about 1/16" every 2.75 inches of paper. During the period that a channel is disconnected, a 1/16" trace is recorded. (See sample traces at right). The sampling sequence is channel 1, 2, 3, 4, 1, etc.

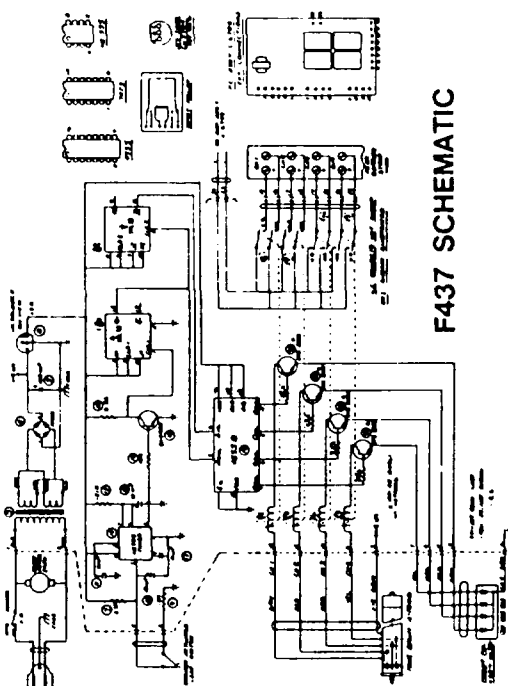


F137 SCHEMATIC



F137 IDENTIFY

F437 IDENTIFY



F437 SCHEMATIC

CONTROLLER FEATURE 205 OPERATION

Any analog channel can be equipped with one or two controller set points. Each set point can be type "A" (output relay energized below set point) or type "B" (output relay energized above set point).

Refer to schematic at right. The basic circuit is divided into a signal channel and a controller channel. The signal channel sets up the basic sensitivity and drives the galvanometer. The controller circuit which is completely isolated from the signal channel determines the type of control and the width of the dead band. The input resistance of the amplifier is determined by R2 and R3. Gain is determined by R4, R5, and R16. Rustrak drawing B-5919 lists the common configurations.

The signal is attenuated to 100 mV and applied to the controller channel which consists of operational amplifier (Q2) driving a DPDT power relay. Gain is variable from 500 to 20 to give a dead band of .2% to 5%.

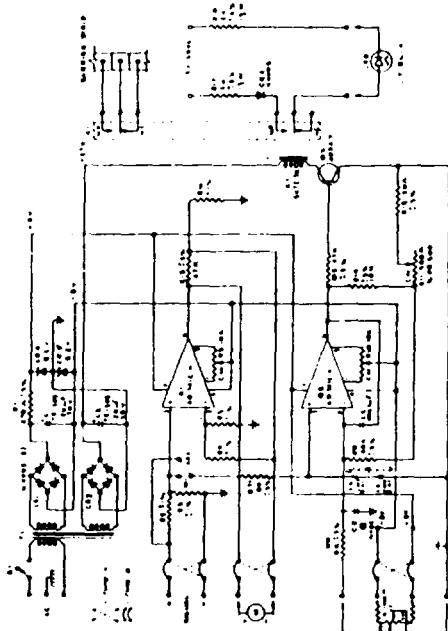
INTERNAL ADJUSTMENTS (See diagram at right).

R9 Electrical galvanometer zero adjustment.

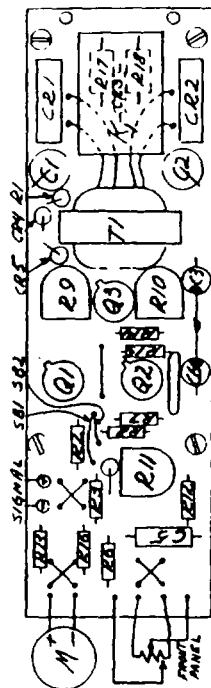
R10 Controller zero. Adjust to make front panel set point knob agree with scale.

R11 Dead band adjustment. Maximum clockwise 5% ccw .2%. Jumpers are configured | | or x for type "B" or type "A" set point. Refer to schematic at right.

FRONT PANEL CONTROL knob moves the set point any place on scale. The panel lamp glows when the relay is energized.



F205 CONTROLLER SCHEMATIC



F205 CONTROLLER ASSEMBLY

TROUBLESHOOTING AND REPAIR (MECHANICAL)

Before returning an instrument to the factory or service center for repair, check the items mentioned in this section. Recorders returned to the factory for repair are subject to a minimum charge whether or not they are defective. All instruments returned to the factory are routinely recalibrated. If you know the problem or symptom be sure to include the information with the instrument. Be familiar with how the recorder operates. Refer to sections in this manual that pertain to the portion of the recorder that is malfunctioning.

If the recorder does not operate at all, check to see if instrument is properly connected to the correct power source as indicated on the serial plate. Be sure power switches, if any, are in the "on" position.

Following is a description of some common problems and possible solutions.

GALVANOMETER DOESN'T FOLLOW THE SIGNAL

With striker in its maximum open position the distance between the striker and paper should be $\frac{1}{8}$ ". The pointer should be midway. If the pointer is not centered, the galvanometer could have a bent pointer, broken taut band, cracked jewel. Defects not so visible such as open or shorted coil or debris in the air gap will cause the problem.

CHART SPEED FAST OR SLOW

All AC powered recorders use synchronous motors to drive the chart so a properly functioning recorder will not have timing errors. Recorders with unregulated motors can be expected to gain or lose several hours a day in the worst case. Recorders with inverter motors will keep time to within seven minutes a day. If chart speed is fast, the brake spring may be too weak or the clutch too tight. This is sometimes indicated by tears through the lower side of the sprocket holes. If chart speed is slow, the brake spring may be too tight or the clutch too loose. Slow chart can also be caused by a very soft or spongy roll of chart paper sometimes indicated by tears through the top side of the sprocket holes. Other causes of slow chart speed are such things as gear train slipping out of engagement because of a weak gear spring. An intermittent or low torque chart motor will cause slow speed.

TROUBLESHOOTING AND REPAIR (ELECTRICAL)

Instruments with amplifiers or other signal conditioning such as shunts or multipliers having functioning galvanometers may have developed one or more defective components. In general if checkouts are made in the order outlined below the defective part will be located.

- 1) Measure main power on the PC board
- 2) Measure AC voltage on all transformer secondaries
- 3) Measure DC voltage across power supply capacitors
- 4) Measure DC voltage across each zener and at the voltage pins of the operational amplifier
- 5) Apply a signal and measure to see that it gets to the input pin of the operational amplifier
- 6) All amplifier type signal conditioners have an output of 100 millivolts into a 100 load. Galvanometers are 1 milliamp, 100 Ω ; except series 7000 which are 5mA 140 Ω .
- 7) Visually inspect for broken connections, or defective components
- 8) Recorders with multipliers or shunts can be checked by making a resistance reading. DC voltmeters will measure 1000 times the full scale voltage (ie 100 VDC full scale resistance will be 100,000) DC current meters will have a resistance of 1 $\rightarrow$ full scale DC current (ie 10 mADC full scale will have a resistance of 10 Ω .)

TROUBLESHOOTING AND REPAIR (GENERAL)

In the process of troubleshooting, resist the temptation to change the galvanometer zero adjust or any electrical adjustments unless you have facilities for complete calibration of the instrument. You may adjust the galvanometer zero but first note where it was, and after moving it return the zero (with no signal applied) to where it belongs. If the galvanometer has suppression (zero off scale) don't adjust unless you have facilities for calibration.

Bulletins are available that explain in detail some of the adjustments, repairs, and checkouts that can be made in the field.

SERIES 200, 300, 4000
REPLACEABLE PARTS

- A-4553-P1 Tearoff Drive Belt (2 Reqd.)
- A-3280 Chart Advance Thumbwheel
- A-4216-P1 Thumbwheel Screw
- A-4219-G1 Thumbwheel Hinge Bracket
- A-4422-P1 Thumbscrew (Panel)
- A-4557-P1 Thumbscrew Retaining Ring
- specify Pt. No. Gear Train
- A-2354 Gear Train Spring
- A-4478-G Chart Review Arm & Gear
- A-5151-P1 Retaining Clip For Supply Roll
- A-4185-P2 Brake Spring
- A-2313-P2 Brake
- Note 1 Galvanometer
- C-4214-P2 Chassis Latch
- A-4551-P1 Pin For Chassis Latch (2 Reqd.)
- A-4252-P1 Chart Advance Ratchet
- A-4251-P1 Chart Advance Ratchet Stiffener
- Note1 Chart Drive Motor & Cam
- L-473-5 Parts Price List
- L-479 Exploded View Model 288

SERIES 200 REPLACEMENT PARTS

- B-4488-G1 Take Up Roller
- B-2316-P1 Supply Roller
- B-4550-G1 Time Drum
- A-2254-P1 Cardboard Spool
- Striker & Arm
- B-4117-P1 Top Front Panel Bezel
- B-4131-P1 Bottom Front Panel Bezel (Nameplate)

NOTE 1: When ordering replacement galvanometers specify the part number on the part.
When ordering chart drive motors specify voltage, frequency, R.P.M. and complete recorder model number.

SERIES 200 Replaceable Parts (continued)

- B-4178-P1 Top Window
- B-4179-P1 Bottom Window
- A-4558-P1 6 Pin Female Cable Connector
- L-479 Exploded View Model 288
- L-473-5 Parts Price List
- Note 1 Chart Drive Motor and Cam

SERIES 300 REPLACEMENT PARTS

- B-4953-G1 Take Up Roller
- B-4768-P1 Supply Roller
- B-4766-G1 Time Drum
- A-2254-P7 Cardboard Spool
- Striker & Arm
- C-6956 Top Front Panel Bezel
- A-4228-P9 Bottom Front Panel Bezel (Nameplate)
- B-4776-P1 Top Window
- B-4777-P1 Bottom Window
- MSS-22 Power Slide Switch
- Note 1 Chart Drive Motor & Cam
- L-473-5 Parts Price List

SERIES 4000 REPLACEABLE PARTS

- B-5866-G2 Take Up Roller
- B-5867-G2 Supply Roller
- B-5563-G1 Time Drum
- A-2254-P8 Cardboard Spool
- Striker & Arm
- B-5591-G2 Top Front Panel Bezel
- B-5543-P2 Bottom Front Panel Bezel (Nameplate)
- B-5557-P1 Top Window
- B-5554-P1 Bottom Window
- Note 1 1 or 2 Speed Chart Drive Motor & Cam
- L-473-5 Parts Price List

CHART PAPER

STANDARD CHART PAPER, 200 SERIES (SINGLE WIDTH)		
MINOR DIVISIONS	MAJOR DIVISIONS	STYLE/PT
20	4	G
30	6	I
40	8	H
50	10	A
60	12	K
65	13	C
75	15	B
80	16	F
15	312 channel	E
20	1012 channel	D

CHART PAPER FOR SPECIFIC MODELS, 200 SERIES		
DESCRIPTION	MODEL USED ON	STYLE/PT
50 Div ± 1 Event	288E1	N
4 or 8 Events	292.4 or 8	EE
25, 100, 300 Amps AC	230	Q
150, 300, 600 Volts AC	230	R
50 to 90 F, 10 to 90% RH	225	P
- 20 to + 80 F ± 1 Event	238	C-5873

STANDARD CHART PAPER, 300 SERIES (DOUBLE WIDTH)		
LEFT CHANNEL	RIGHT CHANNEL	STYLE/PT
G	G	WGG
I	I	WII
A	A	WAA
N	N	WNN
D	D	WDD
EE	EE	WDEE
EE	EE	WEE
EE	EE	W16E
A	P	C-6804
A	D	WAD
A	I	WAI

STANDARD CHART PAPER, 4000 SERIES (TRIPLE WIDTH)		
LEFT	MIDDLE	RIGHT
A	A	A
EE	EE	EE
D	D	D
N	N	N
A	A	EE
D	D	EE

STANDARD CHART PAPER, 7000 SERIES		
ANALOG DIV	EVENTS	STYLE/PT
50	3	A-100 mm
60	3	K-100 mm

SERVICE AND REPAIR

If the instrument should require repair which you are unable to perform, return it to your local distributor or to the manufacturer. If the instrument is in warranty, follow the instructions on Page 1 of this manual. Warranty repair must be performed at the factory unless special arrangements have been made.

IT IS SUGGESTED THAT GENUINE RUSTRAK PAPER AND REPLACEMENT PARTS BE USED IN THIS RECORDER

RE-SHIPping THE EQUIPMENT

The equipment should be re-shipped in the original packing, if still intact. Do not pack the instrument in dirty materials such as popcorn, shredded newspaper or foam unless the recorder is sealed in a plastic bag. The company cannot be responsible for damage which is the result of poor packing.

NEVER ship a recorder with chart paper installed.

ALWAYS be sure that the striker is in the open position to allow free movement of the galvanometer pointer. If this is not observed the galvanometer will be damaged.

Observing these simple procedures will prevent unnecessary delays and expense to you.

Ship to:

GULTON INDUSTRIES INC.
GRAPHIC INSTRUMENTS DIVISION
Customer Service Department
Ammon Drive
Manchester, NH 03103
603-623-3593
FAX 603-622-5231 • Telex 710-220-1878

APPENDIX B

**Maintenance Form
Alarm Reporting Contacts**

MAINTENANCE REPORT

Address
Inspector

Date
Weather

Time

Is lid on tight?
Cement Seal
Are there signs of leakage?

Yes
Good
Yes

No
Damaged
No

Comment

Is there excess moisture?
Condition of electrical wires.
Is Sensor plugged or dirty?

Yes
Good
Yes

No
Damaged
No

Has it been Tampered with
Condition of wires
Instructions attached.

Yes
Good
Yes

No
Damaged
No

Has Strip Chart been functioning properly?
Are there any peaks over 100ppm?
If yes contact Mr. Jon Schock as soon as possible.

Yes
Yes

No
No

Comments

Calibration For 4100-30 Sensor

Time

Calibration Gas concentration

2478 ppm

1

Is LED On

Yes
No

Proceed
Refer to trouble shooting guides.

2

Connect DVM to TP2 and GT1 (ground)

3

Heater voltage should be 5.0 VDC. If not adjust R3.

Yes

4

Connect DVM to TP5 and GT1

5

Reading should be 0.02 VDC +/- 0.025v. If not adjust R14.

Yes

6

Apply Span gas at a flow rate of 100ml/min. Allow 4 minutes before proceeding.

7

Adjust Span Pot R20 to read 1.00 VDC +/- 0.005v

Yes

8

Record controller display value.

x 25

=

ppm

9

Remove Span gas. Wait 5 minutes and check controller. Should read 0.

If not adjust R14.

Yes

Calibration For 2001-10 Sensor

Time

Calibration Gas concentration

1000 ppm

Lamp Color (should be green)

Apply calibration Gas

Time To Red Lamp Color

If Red Light appears within one minute

OK

Time To Green Lamp Color

If green light appears within one minute of the removal of calibration Gas

OK

If lamp color is not green or either lamp time is not OK adjust according to attached instructions and repeat.

Have sensors been calibrated properly? Yes No

Comments

Emergency Numbers

Union Fire District	911
	(401) 783-2422
RI DEM	(401) 277-3070
EPA Region I	(617) 223-7265

Routine Numbers

Union Fire District	(401) 783-3321
Chief David Hall	(401) 789-8354

Mr. Jon Schock, Utilities Directory	(401) 789-9331
Town of South Kingstown	

Mr. Mark Dennen	(401) 277-2797
Department of Environmental Management	
Division of Air and Hazardous Material	

Mr. Dean Tagliaferro, OSC	(617) 860-4625
EPA Region I	

Mr. David Newton, RPM	(617) 573-9612
EPA Region I	

System Repairs**Gas Detection System**

Mr. Luke A. Fabbri	(508) 740-9915
Geological Field Services, Inc.	
203 Washington St., #132	
Salem, MA 01970	

APPENDIX C

Incident Response Sheet

INCIDENT RESPONSE SHEET

DATE _____
TIME _____ am pm
On Duty Officer _____

Name of Caller _____
Address of Alarm _____
Telephone # _____

Which Alarm Number has sounded, I or II or both? I II Both

What time did the alarm sound? _____ am pm

Was anybody home when the alarm first sounded? _____

How many people are currently in the building? _____

INSTRUCTIONS FOR RESIDENTS

ALARM I (Siren)

1. Instruct caller to have all persons evacuate the building, leaving the doors open behind them.
2. Once outside the building have caller open basement door to ventilate basement.
3. Instruct caller not to enter the basement in order to open the basement door if it is locked.
4. If basement door is locker from inside have caller wait for Fire Department assistance.

ALARM II (Red Light)

1. Instruct caller to reset alarm by pushing reset button #2 on control box.
2. Instruct caller to call back if alarm goes off again.
3. Fire Dpeartment will perform a combustibile gas survey of building within 24 Hours.

BOTH ALARMS

1. Follow Alarm I instructions.

FIRE DEPARTMENT

In the event that either Alarm I or Alarm II is reported the following actions should be taken.

ALARM I (Siren)

- 1. Respond to site as an emergency.
- 2. Treat site as a potentially combustable atmosphere.
- 3. Ventilate building then perform combustibale gas survey.

NOTIFY THE FOLLOWING IMMEDIATELY

		Date and Time of Contact
Rhode Island DEM	(401) 277-3070	_____
EPA Region I	(617) 223-7265	_____

Submit Incident Report and notify within 24 Hours.

Mr. Jon Schock	Town Hall, 180 High Street, Town of S. Kingstown, RI 02879
Mr. Mark Dennen	RI DEM, DA&HM, Providence RI 02903
Mr. Dean Tagliaferro	EPA Region I, 60 Westview Street, Lexington, MA 02173

Mr. Jon Schock	South Kingstown	(401) 789-9331	_____
Mr. Mark Dennen	Rhode Island DEM	(401) 277-2797	_____
Mr. Dean Tagliaferro	EPA Region I	(617) 860-4625	_____

ALARM II (Red Light)

Submit Incident Report and notify within 24 Hours.

Mr. Jon Schock	Town Hall, 180 High Street, Town of S. Kingstown, RI 02879
Mr. Mark Dennen	RI DEM, DA&HM, Providence RI 02903
Mr. Dean Tagliaferro	EPA Region I, 60 Westview Street, Lexington, MA 02173

Mr. Jon Schock	South Kingstown	(401) 789-9331	_____
Mr. Mark Dennen	Rhode Island DEM	(401) 277-2797	_____
Mr. Dean Tagliaferro	EPA Region I	(617) 860-4625	_____

ALARM INSTRUCTIONS

ALARM I (Siren)

1. Call the Union Fire Department and report alarm.
(DIAL 911)
2. Do not light any matches, turn off heat, and stove.
3. Do not go into basement area.
4. Have all people leave the building.
5. Leave door open for ventilation.
6. Open basement door from outside, do not go inside.
7. Wait for Fire Department to reset alarm and clear building.

ALARM II (Red Light)

1. Go into basement and push reset button #II on control box.
(DIAL 911)
2. Call the Union Fire Department and report alarm.
3. If alarm keeps going off call Mr. Jon Schock
Town of South Kingstown Utilities Department.
(DIAL 789-9331)

BOTH ALARMS

1. Follow Alarm I instructions.

The above direction will be laminated and given to each resident.