GENERAL MONITORS

Protection for life.

MODEL S216

Hydrogen Sulfide Gas
Enhanced Smart Sensor with Relay
(Single Point Calibration)

INSTRUCTION MANUAL 07/94

Part No. MANS216
Revision C/07-94

GENERAL MONITORS
Model S216

Warranty

General Monitors warrants the *Model S216* to be free from defects in workmanship or material under normal use and service within two (2) years from the date of shipment. General Monitors will repair or replace without charge any such defective equipment to be found defective during the warranty period. Full determination of the nature of, and responsibility for, defective or damaged equipment will be made by General Monitors' personnel. Defective or damaged equipment must be shipped prepaid to General Monitors' plant or representative from which shipment was made. In all cases this warranty is limited to the cost of the equipment supplied by General Monitors. The customer will assume all liability for the misuse of this equipment by its employees or other personnel.

All warranties 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 General Monitors' approval or which have been subjected to neglect, accident, improper installation or application, or on which the original identification marks have been removed or altered. Except for the express warranty stated above, General Monitors disclaims all warranties with regard to the products sold, 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 General Monitors for damages including, but not limited to, consequential damages arising out of/or in connection with the use or performance of the product.

WARNING

HYDROGEN SULFIDE GAS IS AN EXTREMELY TOXIC GAS, AND EXPOSURE MAY RESULT IN A LOSS OF CONSCIOUSNESS OR DEATH.

CAUTION

THE MODEL S216 HYDROGEN SULFIDE GAS ENHANCED SMART SENSOR ASSEMBLY CONTAINS COMPONENTS WHICH CAN BE DAMAGED BY STATIC ELECTRICITY. SPECIAL CARE MUST BE TAKEN WHEN WIRING THE SYSTEM TO ENSURE THAT ONLY THE CONNECTION POINTS ARE TOUCHED.

GENERAL MONITORS

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06 February, 1995

To All Model S106/S216 Users:

The Model S106 (revision E/07-94) and the Model S216 (revision C/07-94) Instruction Manuals do not adequately reflect the current revision of these units. These manuals are in the process of being updated, and in order to continue servicing you on these products, please make note of the following changes:

The fault relay option is not available on the Models S106 & S216. The table below lists the pages where the Instruction Manual indicates a fault or a malfunction relay.

Model S106	**Model S216**
Introduction, Page 1	Introduction, Page 1
Installation, Page 10	Installation, Page 10
Operation, Page 15	Operation, Page 18
Appendix, Page 34	Appendix, Page 33
Configuration Code S106-335-XXX-20X is not valid	Configuration Code S216-335-XXX-X0X is not valid

If you have any questions, please contact your General Monitors' Sales Representative or the factory direct. Thank you.

Respectfully,

Charles Simek
Technical Writer
General Monitors, Inc.

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1.0 Introduction

1.1 General Description

The Model S216 is an Enhanced Smart Sensor assembly that can be used for detecting Hydrogen Sulfide gas. The microprocessor-based electronics are contained within an explosion-proof housing and can process information at the sensor site. A digital display provides gas concentration levels and fault codes that can be viewed through a window in the cover. Relay contacts and an analog signal (4-20mA) provide remote and/or discrete indications of the sensor's operation. The Model S216 Enhanced Smart Sensor Assembly is rated explosion proof for use in Class I, Division 1, Group B, C, and D hazardous areas.

1.2 Features and Benefits

Microprocessor-Based Electronics: monitors eight individual fault conditions, processes input signals from the sensor and provides outputs in the form of display code, relay contact activation, and an analog signal.

One Person, Single Point Calibration: initiate the calibration sequence with a magnet, apply the gas, and wait for the display to indicate that the unit has completed the calibration. No tools or adjustments are required.

2 Digit Display: indicates gas concentrations, fault codes, calibration cues, and is used for selecting relay options.

4 to 20 mA Output: transmits fault, over range, calibration, and gas concentration levels to a remote display, computer or other readout device.

Relay Contacts (SPDT): provides a discrete connection for an Alarm or a Fault indication to activate hazard prevention or safety control devices (such as fans, vacuum pumps, ventilation equipment, etc.).

1.3 Applications

This is a partial listing of applications.

- Refineries
- Drilling Platforms and Rigs
- Gas and Oil Production Platforms
- Mud-Logging Operations
- Desulfurization Facilities
- Heavy Water Nuclear Facilities
- Wastewater Treatment Plants
- Chemical and Petrochemical Plants
- Well Head Sites
- Oil Recovery/Reinjection

2.0 Sensor Assembly

2.1 Sensor Signal Processing

General Monitors uses a proprietary Metal Oxide Semiconductor (MOS) film on the sensor for detecting hydrogen sulfide (H_2S) gas. The MOS film is deposited onto a substrate between two electrodes (figure 1). With no gas present, the measured resistance between these two electrodes is very high (in the mega-ohms). As H_2S adsorbs onto the film, the resistance between the two electrodes decreases (to kilo-ohms). This decrease in resistance is logarithmically proportional to the concentration of H_2S that is present.

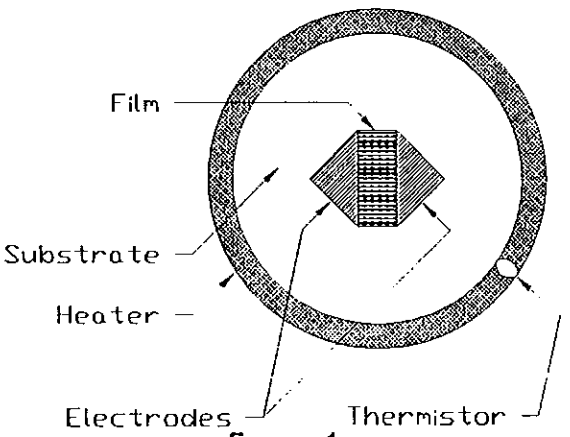

figure 1

The change in resistance is converted to a change in voltage and amplified by the input circuit (figure 2). This amplified signal is fed to an Analog to Digital (A/D) Converter, converted to a digital signal and sent to the microprocessor to be processed. The process of H_2S adsorbing onto the MOS film is most effective at an elevated temperature. On the outer edge of the substrate is a heater ring. The temperature of this heater ring is measured with a thermistor and kept constant by a circuit located inside the body of the sensor. As H_2S adsorbs onto the film, electrons move more freely from one electrode to the other (figure 3).

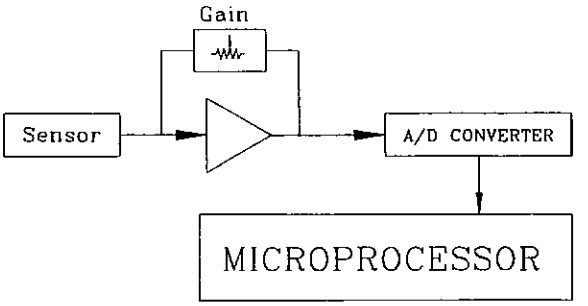

figure 2

This is represented as a decrease in resistance. The process of H_2S adsorbing onto the MOS film is completely reversible. As the concentration of H_2S decreases (H_2S desorbs), the resistance between the electrodes will increase.

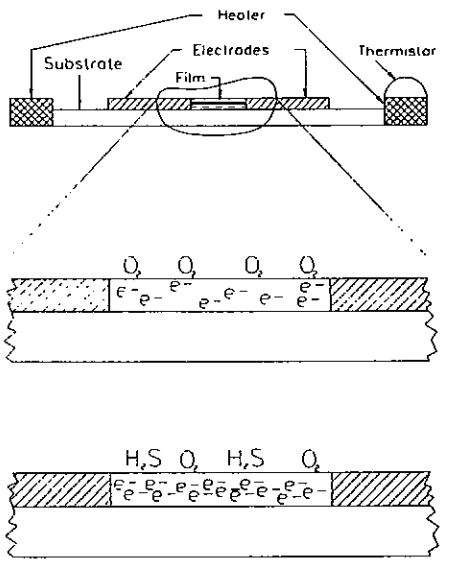

figure 3

2.2 Power Supply

The Model S216 operates from a +24VDC (nominal) input. This unregulated source is fed to a converter board that produces regulated voltages (see figure 4). These voltages are the source for operating all of the circuitry on the control and the display boards, and supplying the sensor with power.

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Sensor Assembly

Power Supply (*continued*)

Terminal connections inside of the housing have been provided for accepting the input power.

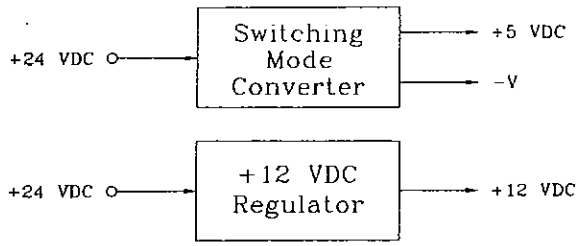

figure 4

2.3 Control Electronics

The control electronics are centered around an eight bit microprocessor (figure 5). The Sensor Signal, the CAL Switch, the Non-Volatile Memory (NOVRAM), and certain Fault conditions are monitored as inputs. By processing these inputs, the following outputs are generated: 4-20mA Output Signal, Relay Contact States, Digital Display Indications, and Calibration Values (NOVRAM).

As the microprocessor (MPU) receives and processes the inputs, it determines what value is output to the display, the 4-20mA current generator, and the state of the relay contacts. When the CAL Switch is activated, the MPU allows the user to choose between the Calibration, Test Gas, or the Alarm Set Point and Relay Option Selection Modes. While the unit is in the Test Gas Mode, the MPU will fix the 4-20mA output signal to 1.5mA. The optional 0mA output signal is for the calibration mode only.

Calibration Mode: When the unit is placed in this mode, the MPU will look at the signal from the sensor and determine when to accept the calibration value. This value is stored in the NOVRAM and is used in adjusting with the digital potentiometers associated with the Input Amplifier. During calibration the microprocessor will output a 1.5mA analog signal (0mA is optional).

Test Gas Mode: In this mode, the MPU will output the gas concentration to the display. When the gas concentration drops below 5% of full scale, the unit will return to normal operation. The purpose of this mode is to check the response of the unit to a known level of gas and determine if calibration is necessary, while the output current remains at 1.5mA.

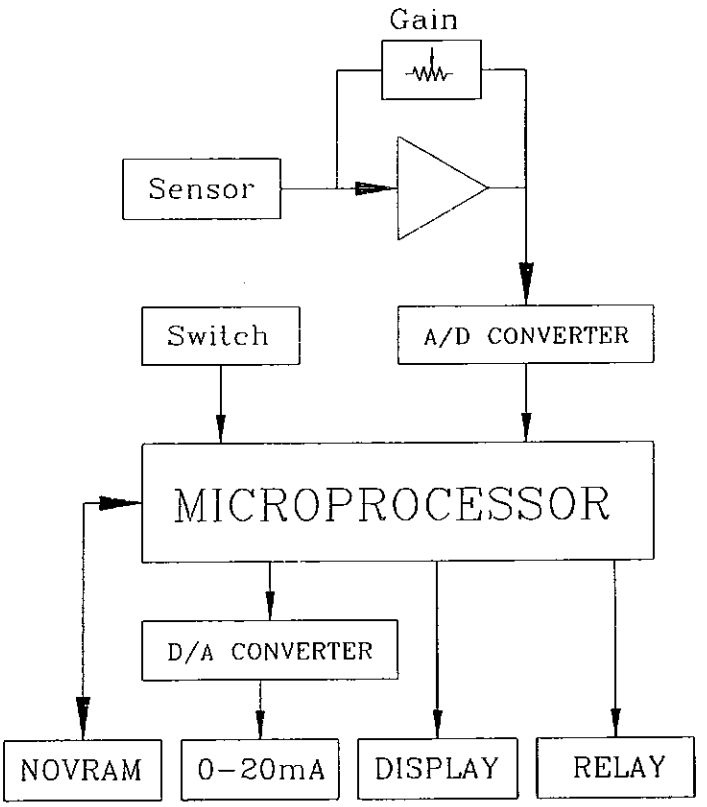

figure 5

Sensor Assembly

Control Electronics (*continued*)

Alarm Relay Options Selection Mode: This mode is offered only if the Model S216 was ordered with an Alarm relay, not a Fault relay. The two Relay Options that are available are Energized/De-Energized and Latching/Non-Latching. The Alarm Set Point is the next selection to make. The Alarm Set Point can be selected in increments of 5 parts per million for 0 to 100ppm and 0 to 50ppm ranged sensors and in increments of 1 part per million for 0 to 20ppm ranged sensors. Once the Alarm Set Point and Relay Options have been selected, the unit will revert to the calibration sequence, and must be calibrated.

3.0 Installation

3.1 Receipt of Equipment

All equipment shipped by General Monitors is prepackaged in shock absorbing containers which provides considerable protection against physical damage. The contents should be carefully removed and checked against the packing slip. If any damage has occurred or if there is any discrepancy in the order, notify General Monitors as soon as possible. All subsequent correspondence with General Monitors must specify the equipment part and serial numbers.

Each Model S216 is completely checked by the factory. However, a complete check-out is necessary upon initial installation and start up to ensure system integrity.

3.2 Sensor Location Considerations

There are no standard rules for sensor placement since the optimum sensor location is different for each application. The customer must evaluate conditions at the facility to make this determination. Generally, the Model S216 Smart Sensor should be easily accessible for calibration checks. The sensor assembly should be mounted pointing down to prevent water build-up on the sensor head. The sensor assembly should not be placed where it may be coated by contaminating substances. Although the Model S216 is RFI resistant, it should not be mounted in close proximity to radio transmitters or similar equipment. Other considerations when placing sensors should include:

- Locate the Model S216 where prevailing air currents contain the maximum concentration of gas.
- Locate the Model S216 near possible sources of gas leaks.
- Observe the Model S216's temperature specification and locate the unit away from concentrated sources of heat.
- Sensor Assemblies should be mounted in an area that is as free from wind, dust, water, shock, and vibration as possible. See Appendix, section 5.2.4 for the environmental specifications of the unit.

Sensors may be adversely affected by prolonged exposure to certain materials. Loss of sensitivity or corrosion may be gradual if such materials are present in low concentrations, or it may be rapid at high concentrations. The more important materials adversely affecting sensors are:

- Silicones (often contained in greases and aerosols). Silicones do not chemically attack the sensor, they coat it and reduce or inhibit its response to H_2S gas.
- Halides . . . compounds containing flourine, chlorine, brommine, or iodine.
- Caustic and acidic liquids and vapors.

The presence of poisons and contaminants in an area does not necessarily preclude the use of a Model S216 Enhanced Smart Sensor. The feasibility of using a sensor in such areas must be determined by an analysis of the specific factors in each application and General Monitors should be consulted before attempting any such installation.

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Installation

Sensor Location Considerations (*continued*)

Sensors used in these areas usually require more frequent calibration checks than normal, and typically have a shorter life. In many such applications the normal two year warranty would not apply.

CAUTION: General Monitors discourages the painting of sensor assemblies. If the sensor head is painted over, the gas will not be able to diffuse into the sensor. If the assembly cover is painted over, the digital display cannot be read.

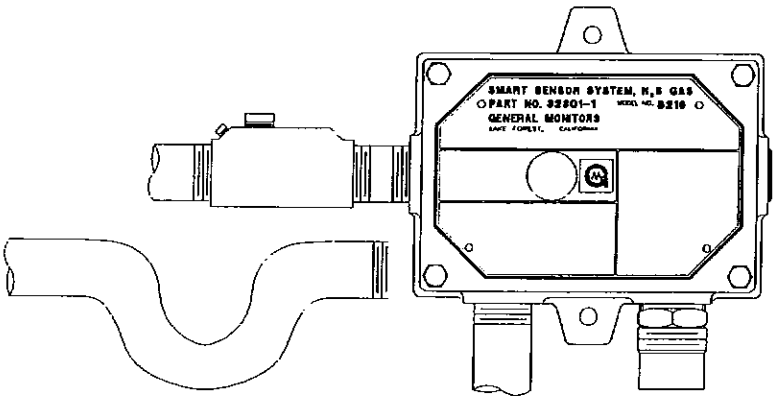

figure 7

3.3 Installation Instructions

The overall and mounting dimensions for the Model S216 (figure 6 & 27) should be used when making installation determinations. A complete list of the mechanical specifications can be found in section 5.2.2.

To prevent possible corrosion due to moisture or condensation, it is recommended that the conduit connected to the Model S216 housing, be sealed or contain a drain loop (figure 7).

Each conduit run from a hazardous location to a non-hazardous location should be sealed so that gases, vapors, and/or flames can not pass beyond the seal. The purpose of seals in a Class I hazardous location is to prevent the passage of gases, vapors, or flames from one electrical installation to another through the conduit system. It is not necessary to seal the Model S216 housing to maintain its explosion proof integrity, however, conduit runs containing wires attached to the Model S216's relay contacts must be sealed (see section 5.5). Information on Class I location seals can be found in the NEC handbook, Article 501-5.

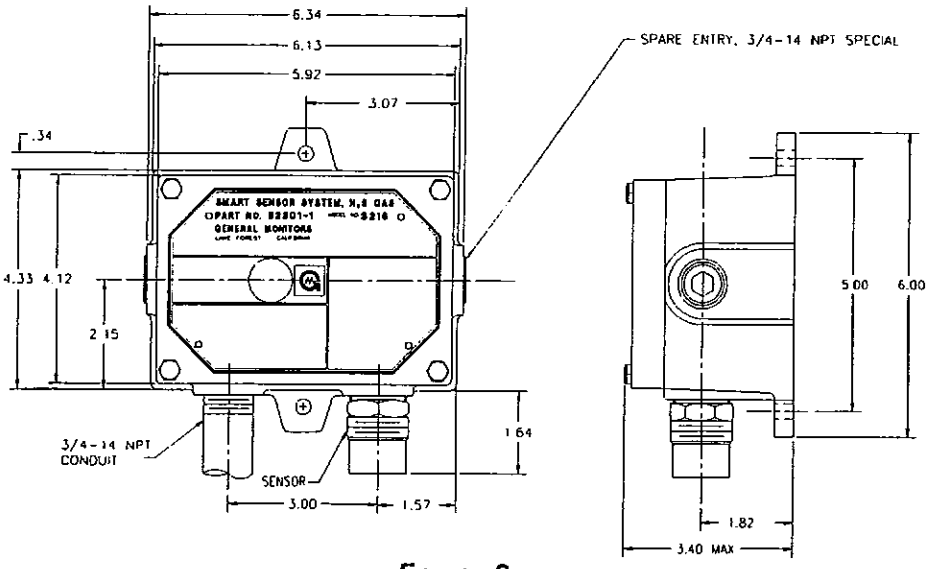

figure 6

Installation

Installation Instructions (*continued*)

NOTE: Acetic acid will cause damage to metal components, metal hardware, ceramic IC's, etc. If damage results from the use of a sealant that outgases acetic acid (RTV silicone), the warranty will be void.

Once correctly installed, the Model S216 requires little or no maintenance other than periodic calibration checks to ensure system integrity. General Monitors recommends that a schedule be established and adhered to.

NOTE: The system's full two year warranty will be voided if customer personnel or third parties damage the system during repair attempts.

Sensor heads exposed to the elements may require the accessory mounting threads to be lubricated. Grease **must not** be used. As an alternate, PTFE (teflon) tape may be used on threads that **do not** contact the sensor housing.

The removal of particulate matter from sensor accessories may be done through the use of an appropriate halogen-free solvent. Water or ethanol are examples of suitable solvents. The accessories should be thoroughly dried, with compressed air if necessary, before refitting to the sensor body.

General Monitors recommends that the complete system, including all alarm circuitry, be tested at least annually. Some typical items to check during maintenance examinations are:

- The sensor mounting, to see it is secure.
- The sensor screen, to see it is clear of oil, water, dust or paint which might clog it.
- The cable connections for tightness and possible damage.
- All sensor placements are up to date with the layout of the plant (e.g. modifications to the plant).
- The complete system, to see it has a back up supply for the full prescribed time.

3.4 Terminal Connections

The terminal blocks (TB) are located inside of the housing and can by accessed by removing the cover (figure 8). TB2 contains the four sensor connections, White (W), Green (G), Black (B), and Red (R). TB1 contains the connections for Power, Relay Contact, Remote Functions, and Output Signal.

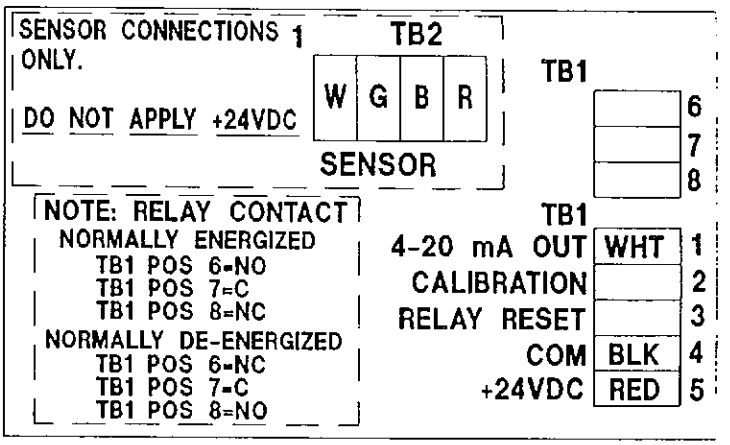

figure 8

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Installation

Terminal Connections (*continued*)

TB1 position	Function
1	4-20mA Output
2	Remote Calibration Switch
3	Relay Reset Switch
4	Common (Ground)
5	+24VDC Power

The function for the relay connection varies according to the normal state of the relay. Use the following as a guide for determining which connection is the Normally Open (NO) and the Normally Closed (NC) contact:

Normally Energized:

TB1 position	Relay Contact
6	Normally Open
7	Common
8	Normally Closed

Normally De-Energized:

TB1 position	Relay Contact
6	Normally Closed
7	Common
8	Normally Open

NOTE: If the Model S216 has been ordered with a Malfunction Relay, there is no relay option. Use the Relay Contacts that appear under Normally Energized.

Inductive loads (bells, buzzers, relays, etc.) on dry relay contacts must be clamped down (figures 9 and 10). Unclamped inductive loads can generate voltage spikes in excess of 1000 volts. Spikes of this magnitude may cause false alarms and contact damage.

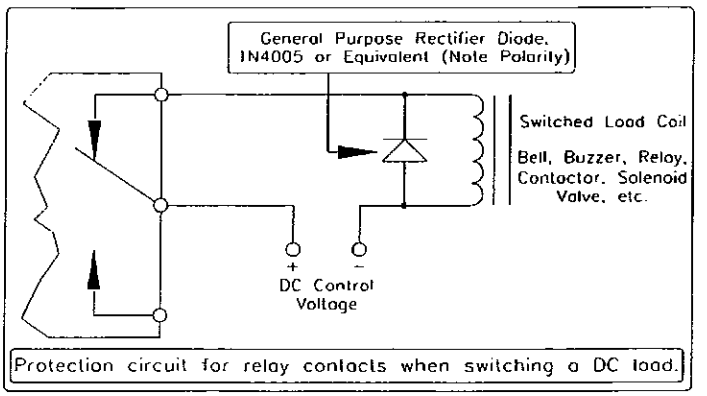


figure 9

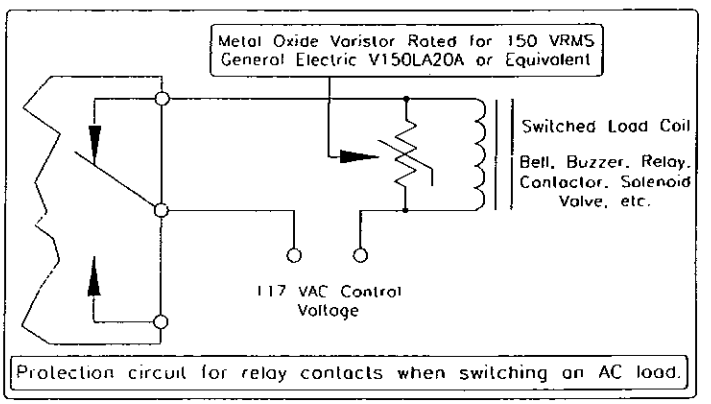


figure 10

NOTE: Contact with PCB components should be avoided to prevent damage by static electricity. All wire connections are made to the Terminal Blocks.

It is recommended that a three wire (red, black, white) shielded cable be used for making power and output signal connections on the Model S216. See Appendix, section 5.5.

Installation

Terminal Connections (*continued*)

The terminal block accepts 16 AWG to 22 AWG stranded or solid wire. Each wire should be stripped before wiring the Model S216 Enhanced Smart Sensor.

To connect wiring to the terminal block, insert a screw driver into the orange tab and press down (figure 11), opening the terminal. Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal.

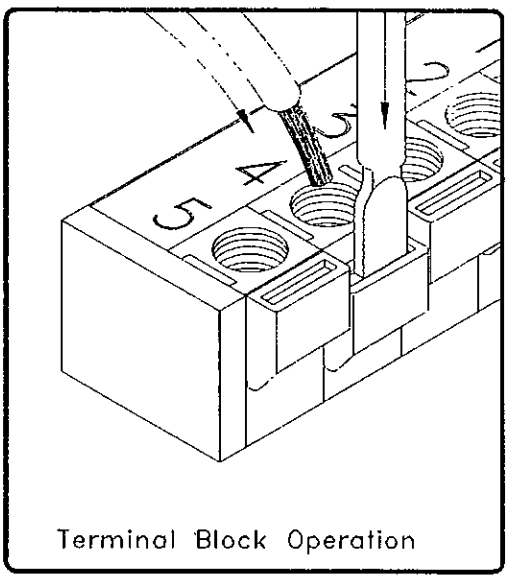
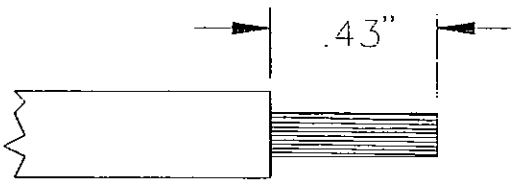


figure 11

Check the connection by GENTLY tugging the wire to ensure it is locked in. **NOTE:** 14 AWG wire can be used if it is carefully stripped (see figure 12).



Strip Length
figure 12

A 4 to 20mA output signal is provided by the Model S216 Hydrogen Sulfide Gas Enhanced Smart Sensor and can be sent up to 9000 feet (2740 meters) to a General Monitors readout/relay display module, industrial analog to digital converter, computer based monitor, PLC, DCS, etc. See the Appendix (section 5.2.3) for cable length specifications. The 4 to 20mA signal provides for control room or other locations remote to the Model S216 to display indications of operation and alarm conditions.

To connect the 4 to 20mA output signal with another unit, connect the white wire to TB1, position 1, labeled 4-20 mA OUT. For making output signal connections to display devices, refer to the specific manual for that device (figure 13).

FROM	TO				
MODEL S216	MODEL DT200	MODEL DT210	MODEL DT220	MODEL DT230	MODEL TA202
TB1 PIN 1 4-20 mA OUT	REAR PIN 3 ANALOG IN	REAR CH 1-8 4-20mA	REAR TB 1 PIN 8 or 9	REAR PIN 2 or 5 ANALOG IN	REAR PIN 26d,z

4-20mA Output Signal Connection

figure 13

If a device other than a General Monitors readout/relay display module is being used, the commons, COM, of both systems must be connected together.

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Installation

Terminal Connections (*continued*)

The Model S216 Hydrogen Sulfide Gas Enhanced Smart Sensor operates from a nominal supply of +24 VDC. Primary DC power must be provided by the customer unless one of the following General Monitors Modules is being used with the Model S216:

- DT210 Readout/Relay Display Module with Power Supply & Relay Module
- DT230 Readout/Relay Display Module
- TA202 Trip Amplifier Module with a PS002

The following General Monitors Modules provide power connections for the Model S216, but need a customer supplied DC source:

- DT210 Readout/Relay Display Module without Power Supply & Relay Module
- TA202 Trip Amplifier Module without a PS002

Since the Model S216 is designed to operate continuously, a power switch is not included, in order to prevent accidental system shutdown. **NOTE:** Power must remain disconnected until all other wiring connections have been made.

The maximum distance between the Model S216 and the power supply is 4500 feet (1372 meters). See the Appendix (section 5.2.3) for cable length specifications. The cable run should be as short as possible.

To connect +24VDC to the Model S216, connect the red wire to TB1, position 5, labeled +24VDC. Connect the black wire to TB1, position 4, labeled COM (figure 14).

	FROM	TO			
COMMON	MODEL S216	MODEL DT200	MODEL DT210	MODEL DT230	MODEL TA202
	TB1 PIN 4 "COM"	REAR TERMINAL BLOCK PIN 5 "ANALOG COM"	REAR COMMON (8X)	REAR PIN 3 or 6 "COM"	REAR PIN 30d,z

	FROM	TO			
+24 VDC	MODEL S216	MODEL DT200	MODEL DT210	MODEL DT230	MODEL TA202
	TB1 PIN 5 "+24VDC"	REAR TERMINAL BLOCK PIN 4 "DC OUT"	REAR CH1-8 24V	REAR PIN 4 or 7 "DC OUT"	REAR PIN 28d,z

Power Connections

figure 14

3.5 Applying Power

Before applying power to the system for the first time, all wiring connections should be checked for correctness and the housing cover replaced. Upon first power-up the sensor may take up to fifteen minutes to stabilize.

At the initial application of power, or after a fault condition has been corrected, the unit will indicate "**SU**" (Start-Up) before entering the normal mode of operation.

General Monitors recommends that the Model S216 be calibrated within the first hour of operation after the the initial application of power and that a second calibration be performed 24 hours after this initial calibration. These two calibration sequences should be performed with new units and units that have been off of power for more than a week. See Calibration, section 4.1 for more details..

Installation

3.6 Maintaining the X/P Integrity

The Model S216 is rated explosion proof for Class I, Division 1, Group B, C & D hazardous locations. The acceptable limits for explosion proof housings being used in Class I hazardous locations are defined in CSA Standard C22.2 No.30-M1986.

Anytime the cover of the smart sensor housing is removed or the cover bolts are loosened, the flame path between the lid and the housing is effected. If power is left on when removing or loosening the cover bolts on the Model S216 it will be necessary to de-classify the area. When replacing the cover, the gap between the lid and the housing should be less than .0015 inch (.038mm). This can be verified by tightening the cover bolts to a torque setting of 50 inch-pounds or by using a feeler gauge to ensure the gap between the cover and the housing is less than .0015 inch (.038mm).

There are four entry holes on the Model S216 housing. These holes are dedicated to the sensor, reset switch and conduit. Each hole is tapped for 3/4 NPT threads. If a particular entry hole is not used it must be plugged during operation in the field. The factory installs aluminum housing plugs in the unused entry holes, except one. A plastic cap plug is placed into this hole and must be removed before conduit can be attached to the housing.

Each Model S216 will have the following items placed in the remaining three entry holes:

- A sensor, if present (if not, a plastic plug)
- A reset switch
- An aluminum housing plug

The sensor, reset switch and aluminum housing plug have seven threads. Each of these components is screwed into the housing using five to seven turns. If it becomes necessary to replace one of these components, the user must use five to seven turns to ensure the explosion proof integrity of the housing is maintained.

4.0 Operation

4.1 Calibration

Activating the Calibration Switch will automatically disable the alarm circuits by sending a 1.5mA (0mA optional) analog output current. This will prevent activation of the relay contacts when using a General Monitors' display module or sending incorrect gas concentration information during the calibration process.

General Monitors recommends that the Model S216 Hydrogen Sulfide (H_2S) Gas Enhanced Smart Sensor be calibrated one hour and twenty four hours after initial start-up, and that calibration be checked at least every ninety days to ensure system integrity.

General Monitors is not implying that the customer should expect problems with sensor life or stability but "frequent" calibration checks merely ensure the integrity of the life protecting equipment.

The above statement is not intended to discourage the customer from checking calibration more frequently. Frequent calibration checks are recommended for problem environments (i.e. mud collecting on the sensor head, sensors accidentally being painted over, etc, see Appendix 5.5).

NOTE: A calibration check consists of applying a 50% of full scale concentration of gas to the sensor and observing the reading on the Model S216.

General Monitors recommends that a calibration schedule be established and a log book should be kept showing calibration dates and dates of sensor replacement.

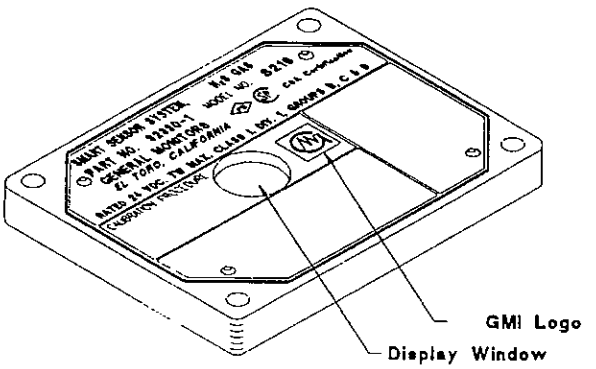

figure 15

Calibration Procedure:

- If it is suspected that hydrogen sulfide gas is present, it will be necessary to purge the sensor with clean air.
- Place the magnet over the GMI logo on the cover of the unit and hold it there (about ten seconds) until "**AC**" appears in the display window.
- Apply a concentration of H_2S gas, equivalent to 50% of full scale, to the sensor. The display will change from "**AC**" to "**CP**" indicating that the sensor is responding to the gas.
- After three to five minutes the display will change from "**CP**" to "**CC**" indicating that the calibration is complete. Remove the calibration gas and allow the sensor to see clean air. The display will change from "**CC**" to indicate a few parts per million (ppm) and then drop to " **0**".
- The unit is now calibrated and the new values have been stored in the NOVRAM (non-volatile memory).

Operation

Calibration (*continued*)

General Monitors recommends that the Model S216 be calibrated within the first hour of operation after the the initial application of power and that a second calibration be performed 24 hours after this initial calibration. These two calibration sequences should be performed with new units and units that have been off of power for more than a week. Use the calibration procedure listed on page 13.

Figure 16 shows a flow diagram of the codes that will appear in the display window during the calibration procedure.

The Model S216 can be returned to normal operation if the magnet is re-applied after ninety seconds of initiating the calibration sequence. If the Model S216 is placed in the calibration mode and no gas is applied for twelve minutes, the unit will revert to a fault condition. Placing the magnet over the GMI Logo again will return the unit to the calibration mode.

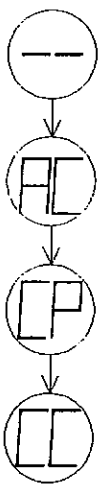

figure 16

Re-applying the magnet after ninety seconds will return the Model S216 to normal operation using the previous set of calibration values.

If there is a problem and the Model S216 Smart Sensor cannot complete the calibration sequence, the unit will display a fault code and the output will drop to zero.

The Model S216 will indicate an "F1" if the sensor is too responsive, an "F3" if the sensor is not sensitive enough, an "F2" if the total calibration interval has been exceeded, or an "F7" if the calibration values were not properly stored in the NOVRAM. These and other fault codes are explained in section 4.6 Fault Codes and Their Remedies.

NOTE: If the unit fails to calibrate an "F" code will be displayed. The calibration gas should be removed from the sensor and the sensor must "see" clean air for at least five minutes before a second calibration is attempted by re-applying the magnet. The possible reasons for an unsucessful calibration are covered in section 4.6 Fault Codes and Trouble Shooting.

4.2 Calibration Equipment

General Monitors offers Breaker Bottles and Ampoules as the method of introducing calibration or test gas to the Model S216. It will be necessary to place the ampoule inside a breaker bottle (see figure 17 on page 15). The Ampoule should be 50% of full scale. Place the breaker bottle over the sensor and follow the calibration procedure listed on page 13 of this Instruction Manual.

When the display indicates "**AC**" break the 50% of full scale ampoule. The display will change to "**CP**" indicating that the sensor is seeing the gas. When the display indicates "**CC**", remove the breaker bottle and allow the sensor to see clean air.

Operation

Calibration Equipment (*continued*)

Use the table below to determine 50% of full scale for the different sensors.

Sensor Range	50% of Full Scale
0 to 100 ppm	50 ppm
0 to 50 ppm	25 ppm
0 to 20 ppm	10 ppm

(values given in parts per million)

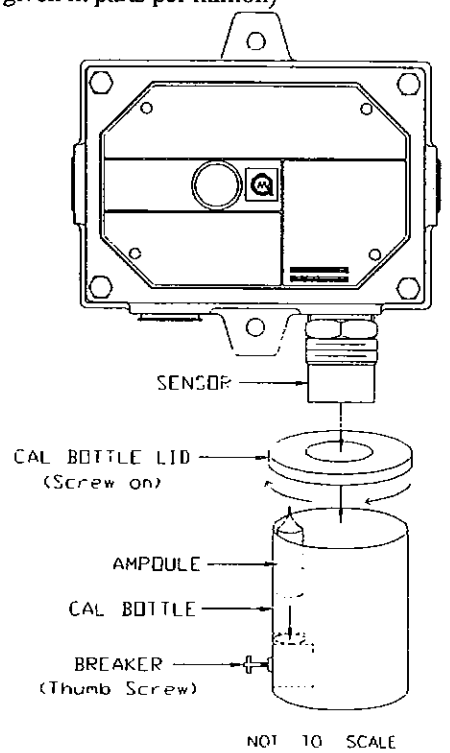

figure 17

4.3 Test Gas Mode

If it is desired to check the sensor for its response without sending a gas concentration signal to a remote display device, this can be accomplished by placing the Model S216 into the "Test Gas" mode. The 4-20mA output signal will be held at 1.5mA during the "Test Gas" mode.

The procedure for checking the calibration is:

- Place the magnet over the GMI Logo on the cover of the Model S216. Remove the magnet when a flashing pair of bars, "- -" (figure 18), appears on the display.
- Apply the test gas to the sensor and the value of the gas concentration will be indicated by the flashing display in about two or three minutes.
- When the reading has stabilized and the test is complete, remove the gas and the unit will return to normal operation when the concentration drops below 5% of full scale.

The test gas concentration must be at least 10% of full scale before the unit will complete the test sequence.

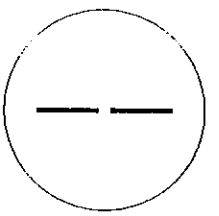

figure 18

If the Model S216 is placed in the test gas mode and no gas is applied for twelve minutes, the unit will revert to a fault condition (see section 4.6 Fault Codes and Their Remedies). Re-applying the magnet over the GMI logo will return the unit to normal operation. During a calibration check, if the "test Gas" reading has stabilized and is out of tolerance, the unit can immediately be placed in the "calibration" mode by applying the magnet to the General Monitors' Logo on the lid of the Model S216.

Operation

4.4 Setting the Options

There are three options that can be set on the Model S216. They are:

- Energized/De-Energized Alarm Relay
- Latching/Non-Latching Alarm Relay
- Alarm Set Point

The Alarm options are available only if the Model S216 has been ordered with an Alarm Relay.

Model S216 with Fault Relay
There are only three modes available on the Model S216 with a Fault Relay. They are:

- Normal Mode (when the unit is in normal operation)
- Calibration Mode (for calibrating the unit)
- Test Gas Mode (for checking the unit's response to a 50% of full scale concentration of gas)

Model S216 with Alarm Relay
In addition to the modes listed above the Model S216 (with alarm relay) will enter the Relay Option Mode if the magnet is held over the GMI logo for about 15 seconds ("**AL**" will appear in the display window). After the Relay Options have been selected, the unit will revert to the Calibration Mode and the unit must be calibrated or the Relay Options selections will not be valid. If the Relay Option Mode or the calibration sequence, after the Relay Option Mode, are aborted, the Model S216 will use the previous calibration values and Relay Options selections.

Relay Options Mode
The type of relay that is provided with the Model S216 must be specified when the unit is ordered. The two types of relays that are available are a Fault Relay or an Alarm Relay. The physical characteristics and contact ratings of these two relays are identical. Each relay has one Normally Open and one Normally Closed contact. The main difference between them is what causes the relay to activate.

For the Fault Relay, any Fault or Malfunction condition that is monitored by the microprocessor will cause the relay to activate. When the Fault or Malfunction condition is corrected, the relay will return to its normal state. **There are no Relay Options that are associated with a Fault Relay.** The standard configuration for this relay is Normally Energized and Non-Latching.

For the Alarm Relay, when the gas concentration reaches the user selectable Alarm Set Point, the relay will activate. Whether or not the relay returns to its normal state when the gas concentration drops below this level depends on one of the user selectable options.

The Latching/Non-Latching option specifies if the relay contacts need to be manually reset or if they reset automatically. Another user selectable option is the Energized/De-Energized state. This specifies if the relay is to have power applied normally (energized) or if the relay is normally at mechanical rest (de-energized).

Operation

Setting the Options (*continued*)

The last option that is user selectable is the Alarm Set Point. This is the level of gas concentration at which the relay will activate.

- Follow the procedure for entering the Relay Options Mode (page 16).

- After the magnet is removed, the display will indicate "**En**", BLANK, "**dE**", BLANK. The display will repeat this sequence until a selection is made. Apply and remove the magnet when the desired option appears on the display. "**En**" stands for Energized and "**dE**" stands for De-Energized. When this selection has been made, the next option will appear.

- Next, the display will indicate "**LA**", BLANK, "**nL**", BLANK. The display will repeat this sequence. Apply and remove the magnet when the desired option appears on the display. "**LA**" stands for Latching and "**nL**" stands for Non-Latching. When this selection has been made, the next option will appear.

- Next, the display will sequence through the Alarm Set Point Levels. The levels that are available will depend on the scale of the sensor being used.

  0 to 100ppm ("-1")
  "5", "10", "15", "20", "25", "30", "35", "40", "45", "50", "55", "60", "65", "70", "75", "80", "85", "90", "95"

  0 to 50ppm ("-5")
  "5", "10", "15", "20", "25", "30", "35", "40", "45"

  0 to 20ppm ("-9")
  "1", "2", "3", "4", "5", "6", "7", "8", "9", "10", "11", "12", "13", "14", "15", "16", "17", "18", "19"

The display will repeat this sequence until a selection is made. Apply and remove the magnet when the desired option appears on the display. After the Relay Options have been selected, the Model S216 will revert to the calibration mode. The unit must be calibrated.

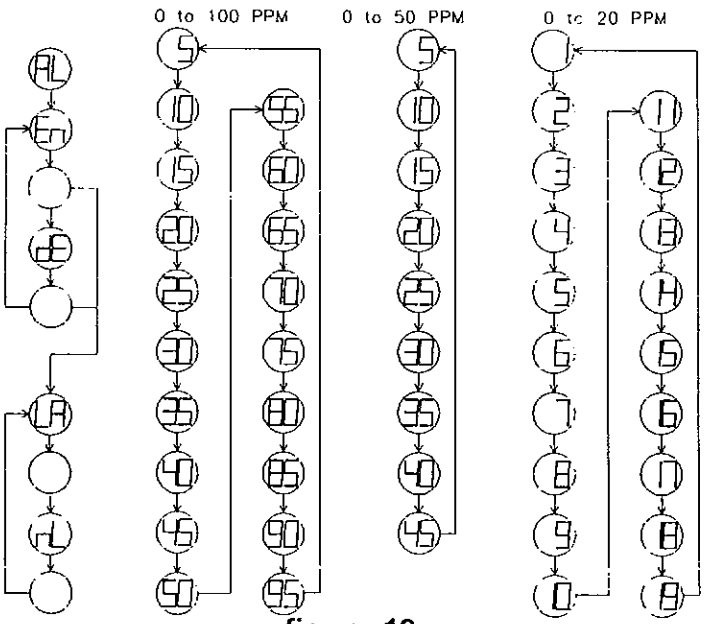

figure 19

Operation

4.5 Digital Display Codes

The following codes will appear on the display when the unit is placed in a mode other than the normal operating mode.

SU	Start-Up
- - (steady)	Magnetic Switch Activated
- - (flashing)	Test Gas Mode
AC	Automatic Calibration Mode
CP	Calibration in Progress
CC	Calibration is Complete
En	Energized Relay Option
dE	De-Energized Relay Option
LA	Latching Relay Option
nL	Non-Latching Relay Option
1,2,3,...etc.	Alarm Set Point
or	Over range
F1	High response during calibration
F2	Failed to complete the calibration
F3	Low response during calibration
F4	Sensor Heater is Open Circuited
F5	Sensor Heater is Short Circuited
F6	Low Supply Voltage
F7	EEPROM Verification Failure
F8	NOT USED
F9	Calibration check period exceeded

SU
This is displayed at start-up and after a Fault condition has been corrected.

- -
Appears on the display when the magnet has been properly positioned over the GMI Logo and when the the Test Gas Mode can be or has been entered.

AC, CP, CC
These codes appear on the display during the calibration process. For more information about these codes, refer to section 4.1, Calibration.

En/dE, LA/nL
These codes are used for selecting the Alarm Relay Options. For more information about these codes, refer to Section 4.2, Setting the Options.

5,10,...,95 5,10,...,45 1,2,...,19
These codes are used for selecting the Alarm Set Point. For more information about these codes, refer to Section 4.2, Setting the Options.

F1, F2, F3, F4, F5, F6, F7, F9
These codes will appear on the display if a Fault condition occurs. For more information about these codes, refer to Section 4.6 Fault Codes and Their Remedies.

"or" (flashing)
This indicates that the concentration of hydrogen sulfide gas exceeds the scale range of the display (over range).

When the unit is in the normal operating mode, the display will indicate the presence of hydrogen sulfide gas in parts per million (ppm). The ranges of detection are from 0 to 99ppm, 0 to 50ppm or 0 to 20ppm.

Operation

4.6 Fault Codes & Their Remedies

The Model S216 has self-diagnostics incorporated into the microprocessor's program. If a fault is detected, the output signal will drop to 0mA and a Fault code will be displayed. The output signal will inform a remote display module that the Model S216 is in the Fault Mode. The display will indicate a Fault code that can be viewed at the sensor site.

There are eight Fault conditions that are monitored by the microprocessor. When a calibration fault (F1, F2, F3) has occurred and has been corrected, the unit will automatically revert to the calibration process and the unit must be re-calibrated. If a fault other than a calibration fault occurs, and is corrected the unit will return to normal operation.

Fault Codes and their Remedies

F1 = High response during calibration

This fault may occur for one of the following reasons:

- Incorrect gas concentration - If the applied gas concentration is too high.
- Faulty sensor - A "-9" sensor is being used in a 0 to 100 ppm application.

Take the appropriate action:

- Make sure that the gas concentration is accurate.
- Use the correct sensor.

F2 = Failed to complete the calibration

This fault will occur if the unit is placed in the calibration mode and the sensor has not responded within twelve minutes.

F3 = Low response during calibration

This fault may occur for either of the following reasons:

- Incorrect gas concentration - If the applied gas is too low.
- Faulty sensor - The sensor may have suffered a loss of sensitivity due to contamination.

Take the appropriate action:

- Make sure that the gas concentration is accurate.
- Replace the sensor.

NOTE: If the unit fails to calibrate and an **F1, F2** or an **F3** code is displayed, the calibration gas must be removed from the sensor, and the sensor must see clean air for at least five minutes before a second calibration is attempted.

F4 = Sensor Heater is Open Circuited

This fault occurs if the sensor's heater circuit is open, or the sensor's black and/or white leads have become disconnected or broken.

Make sure the black and white sensor leads are properly connected to the Terminal Block, TB2. Replace the sensor, if necessary.

Operation

Fault Codes & Their Remedies (*continued*)

F5 = Sensor is Short Circuited

This fault occurs if the sensor heater switching transistor short circuits.

Replace the sensor.

F6 = Low Supply Voltage

This fault occurs if the supply voltage drops below +17VDC approximately.

Make sure that the supply voltage is at least +20VDC at the Model S216.

NOTE: With long supply leads, a considerable voltage drop may occur due to the electrical resistance of the leads.

The maximum cable resistance which the Model S216 can tolerate is dependent on the supply voltage (see Section 5.2.3 Electrical Specifications). A maximum of 10 ohms per conductor (20 ohms loop) at +24 VDC minimum.

F7 = EEPROM Verification Failure

This fault occurs during calibration when an attempt to verify the calibration parameter just written to the non-volatile memory fails. The usual cause of this is electrical interference corrupting the data (although on rare occasions it may indicate a problem within the electronics module).

Place the magnet over the GMI Logo and the microprocessor will attempt to re-write and verify the EEPROM.

F8 = NOT USED AT THIS TIME

F9 = Calibration Check Period Exceeded

If the Model S216 is left in the Test Gas Mode for more than twelve minutes without a test gas being applied, this fault will occur.

Place the magnet over the GMI Logo to return the unit to normal operation.

5.0 Appendix

5.1 Glossary of Terms

AC - Alternating Current.

Adsorb - To use the physical and chemical property of a solid surface to take and hold molecules of gas, not to be confused with Absorb.

Alarm Set Point - This is a fixed value that can be set by the user. When this value is exceeded, the microprocessor will activate the Alarm Relay.

Analog - Continuous, without steps.

Ambient Temperature - Surrounding or background temperature.

AWG - American Wire Gauge.

Calibration - Applying a known level of gas to a sensor and making adjustments so that the output signal matches the level of gas applied.

Canadian Standards Association - CSA is an approval agency. Testing laboratories will test Gas Detection Equipment to the standards that are set by approval agencies such as CSA. CSA certification is required for selling such equipment in Canada. CSA standards are recognized by many organizations outside of Canada.

Class I, Division 1, Groups B, C & D - This is a National Electric Code (NEC) classification dealing with hazardous locations, the degree with to which the hazard is present, and the type of hazard that is present. **Class I, Division 1** is defined as any location where ignitable concentrations of flammable gases or vapors may be present under normal operating conditions. **Groups B, C & D** refers to the type of gases or vapors.

Group B is atmospheres containing more than 30% Hydrogen or gases/vapors of equivalent hazard. **Group C** is atmospheres such as cyclopropane, ethyl ether, ethylene, or gases/vapors of equivalent hazard. **Group D** is atmospheres such as acetone, ammonia, benzene, butane, ethanol, gasoline, hexane, methanol, methane, natural gas, naphtha, propane, or gases/vapors of equivalent hazard.

COM - Common.

Conduit - Tubing, pipe or a protected trough for electrical wires.

DC - Direct Current.

DCS - Distributed Controls System.

De-Energized - A relay is de-energized when it is at mechanical rest. That is, the position of the contacts will not change until power is applied to the relay.

Desorb - To free from an adsorbed state, reverse the adsorption process.

Digital - Stepped in specific increments.

Diffusion - A process by which molecules or other particles intermingle as a result of random thermal motion.

Drain Loop - The purpose of a drain loop is to collect condensation so as to prevent moisture from entering the housing.

EEPROM - Electrically Erasable Programmable Read Only Memory (same as NOVRAM).

Energized - When a relay is energized, power is applied to the relay such that the contacts are held in a position for as long as the power is applied.

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Appendix

Glossary of Terms *(continued)*

FMRC - Factory Mutual Research Corporation.

H_2S - Hydrogen Sulfide.

Halogen-Free Solvent - Solvent that does not contain any of the following: astatine, bromine, chlorine, fluorine, or iodine.

Latching - To latch is to hold on to. A latching condition is a result of a condition occurring and going away, but the signal will be held by the electronics until manually reset.

mA - Milliampere, one thousandth (.001) of an amp.

Microprocessor Based Electronics - All of the input signal processing, fault monitoring, calibrating routines, and the outputs are controlled by a microprocessor.

MPU - Microprocessor Unit.

MOS - Metal Oxide Semiconductor.

Mounting Flanges - This is an area of metal on the housing, containing a screw hole, that extrudes in such a way that it facilitates mounting.

mV - Millivolt, one thousandth (.001) of a volt.

Non-Latching - A non-latching condition exists when the signal follows the condition (i.e. if a condition occurs a signal occurs; if the condition returns to normal, the signal returns to normal). The signal automatically resets.

NOVRAM - Non-volatile read and write memory (same as EEPROM).

PCB - Printed Circuit Board.

PLC - Programmable Logic Controller

Potentiometer - An adjustable resistor.

PPM - Parts per million.

RFI - Radio Frequency Interference.

Series Circuit - Components that are connected in series are connected continuously from one end to the other.

SPDT - Single Pole Double Throw. Each Pole is set of throws. Each Throw is a normally open or closed set of contacts. a double throw is one of each. So an SPDT relay has 1 open and 1 closed set of contacts.

T50 - This is the amount of time it takes a sensor to reach 50% of the applied gas concentration.

TB - Terminal Block.

5.2 Specifications

5.2.1 System Specifications

Sensor Type:
Diffusion, metal oxide semiconductor, adsorption type

Typical Life (sensing element):
3 to 5 years in normal service

Malfunctions Monitored:
Low DC supply voltage
Sensor heater open
Sensor heater shorted
Calibration out of range
EEPROM verification failure

Measuring Ranges:
0 to 100ppm
0 to 50ppm
0 to 20ppm

Approvals:
CSA Certifed and FMRC Approved

Appendix

Specifications (*contiued*)

Warranty:
Two years for the sensor & electronics

Accuracy:
±2ppm or ±10% of applied gas,
whichever is greater at reference ambient conditions *when the recommended initial power up calibration sequences are performed.*

Response Time:
T50 < 60 seconds with full scale concentration applied

Performance Standard:
General Monitors' Model S216 Smart Sensor meets the ISA S12.15 Part I
Performance Standard for Hydrogen Sulfide Gas Detection Instruments when the recommended initial power up calibration sequences are performed

5.2.2 Mechanical Specifications

Weight (approx.)	5.5 lbs.	2.5 kg
Length	6.34 "	161 mm
Height (w/bolts)	3.40 "	86 mm
Width at the base	4.10 "	104 mm
Between mounting holes centers	4.99 "	127 mm

5.2.3 Electrical Specifications

Input Power:
24 VDC nominal @ 0.25A max.
20 to 30 VDC range

Electrical Classification:
Class I, Division 1, Groups B, C & D

Relay Contact Rating (maximum):
SPDT - 4A 250 VAC, 3A 30 VDC, resistive.

Output Current: (300 ohms max. load)

Signal Range	0 to 22mA
Malfunction	0.0mA
Calibration	1.5mA (*0.0mA optional*)
Test Gas	1.5mA (*always*)
Relay Options	1.5mA (*always*)
0 to Full Scale	4 to 20mA
Over-Range:	20 to 22mA

Recommend Three Wire Shielded Cable:
Maximum distance between the Model S216 and the power source.

AWG	Feet	Meters
22	750	228
20	1100	335
18	1600	488
16	2250	685
14	4500	1372

For interfacing with 250 ohm input impedance devices, the following maximum cable lengths apply, with respect to the Analog Signal. The total loop resistance can be no greater than 300 ohms.

AWG	Feet	Meters
22	1600	488
20	2400	730
18	3800	1160
16	5200	1585
14	9000	2740

NOTE: Good design practices dictate cable lengths conservatively shorter than the maximum given values.

5.2.4 Environmental Specifications

Operating Temperature Range:
-40°F to 140°F (-40°C to 60°C)

Storage Temperature Range:
-31°F to 131°F (-35°C to 55°C)

Humidity Range:
15 to 90% Relative Humidity
non-condensing

Appendix

5.3 Engineering Documentation

5.3.1 Schematic Diagrams

Schematic - S216 Control Board

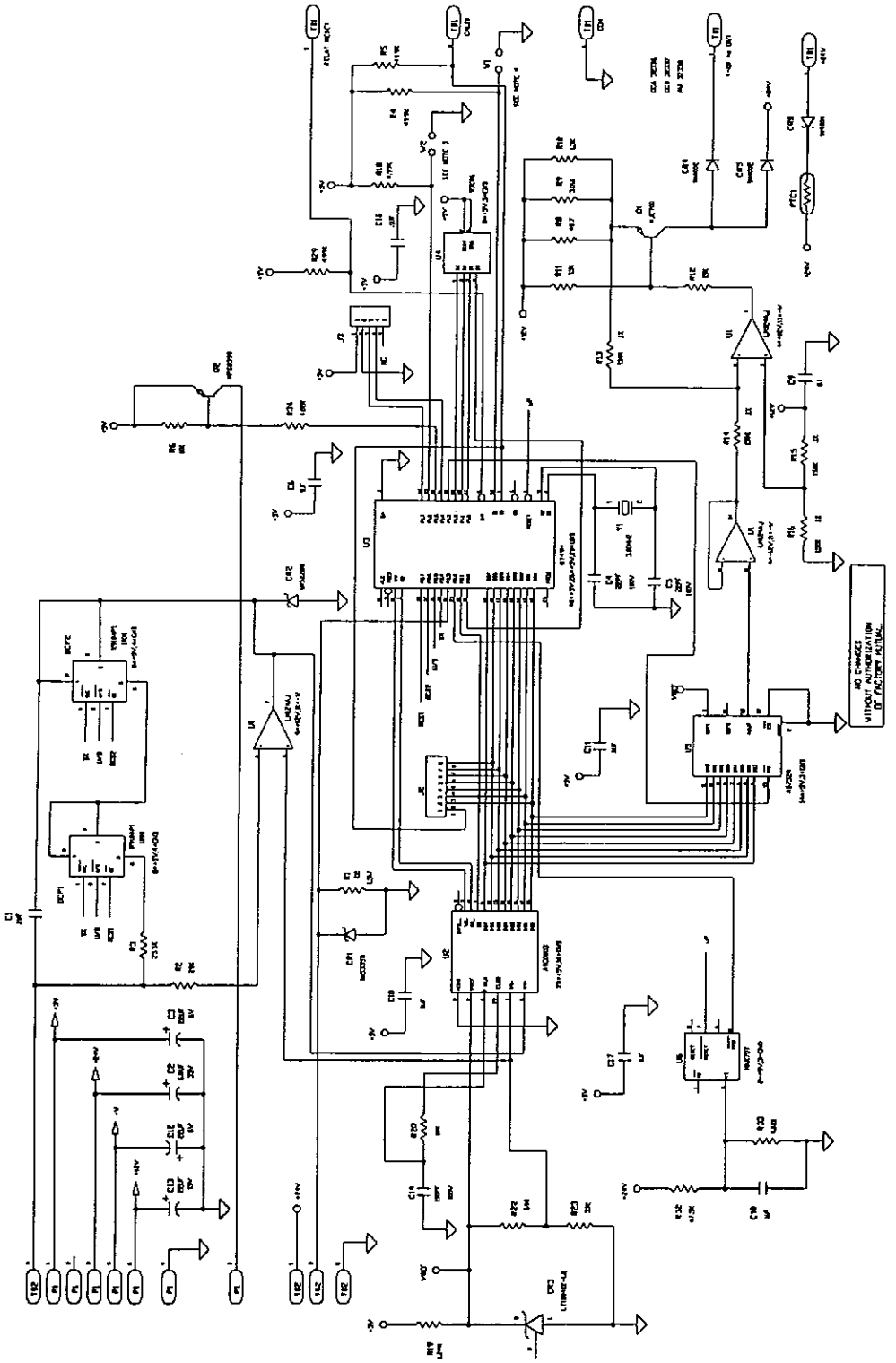

figure 20

Appendix

Schematic - S216 Converter Board

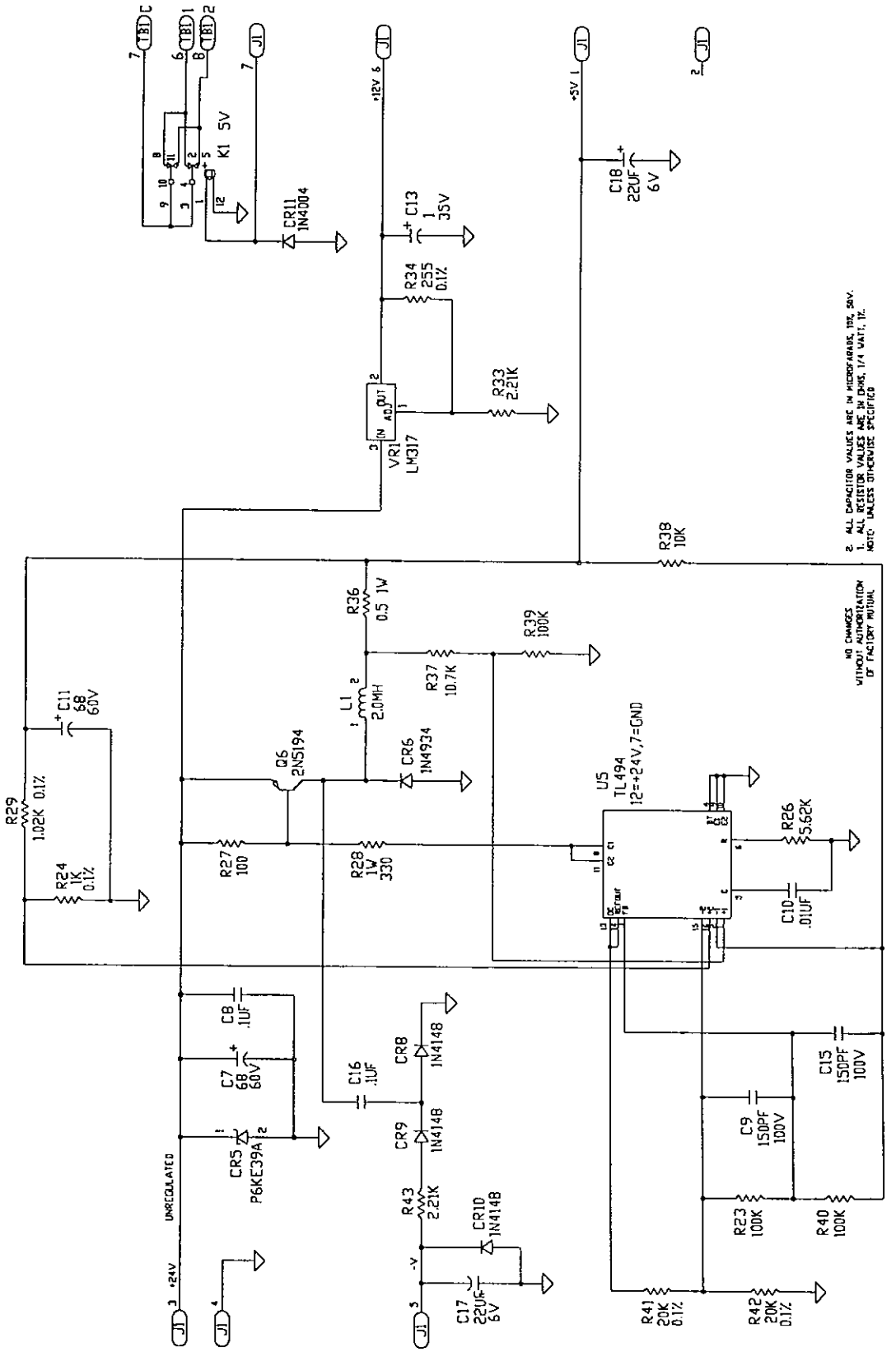

figure 21

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Appendix

Schematic - S216 Display Board

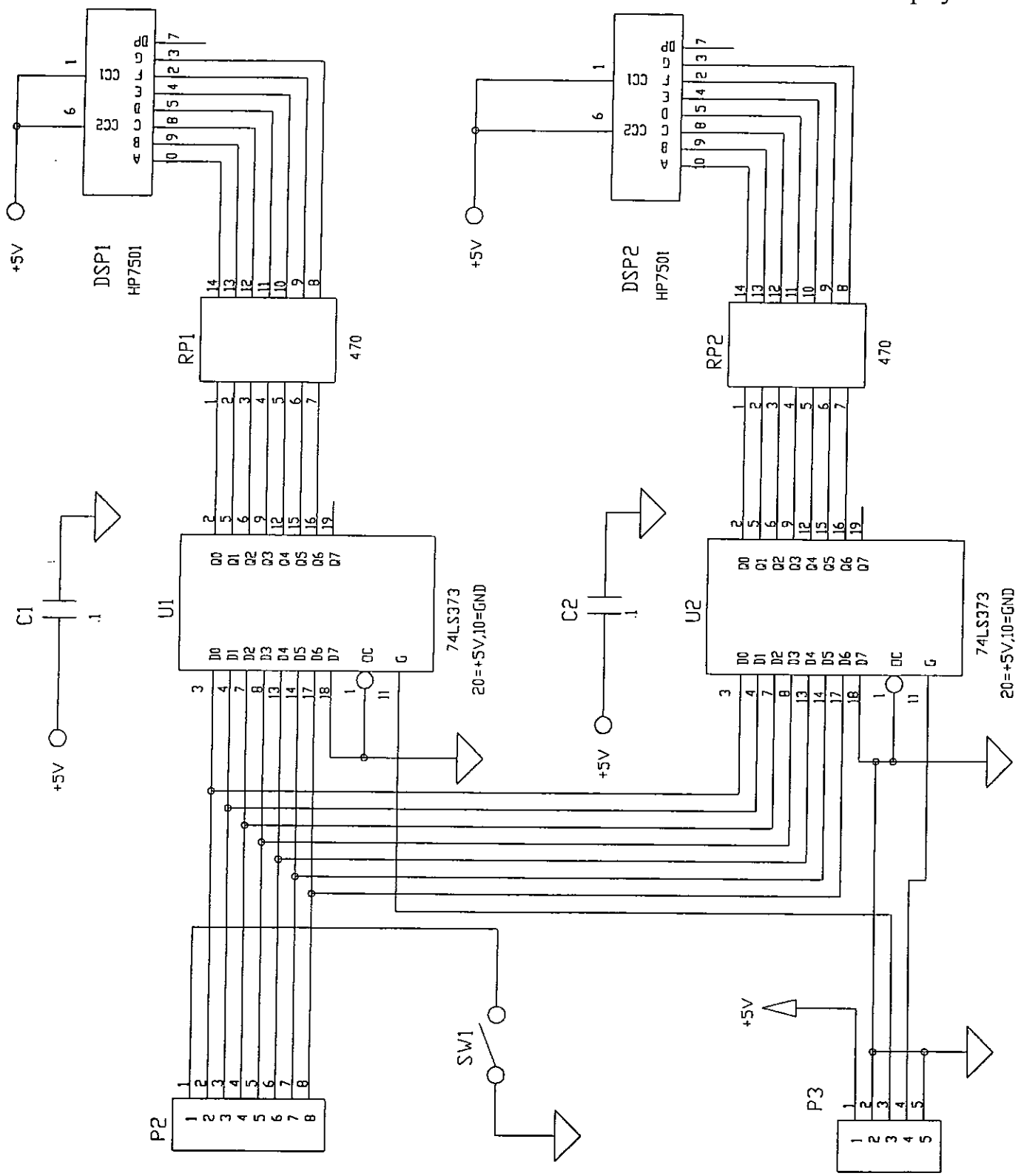

figure 22

Appendix

5.3.2 Circuit Board Assemblies

Circuit Card Assembly - S216 Control Board

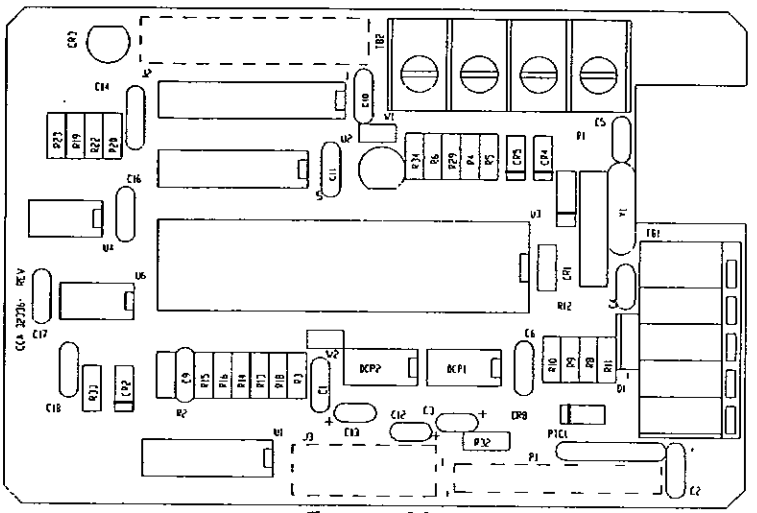

figure 23

Circuit Board Assy - S216 Display Board

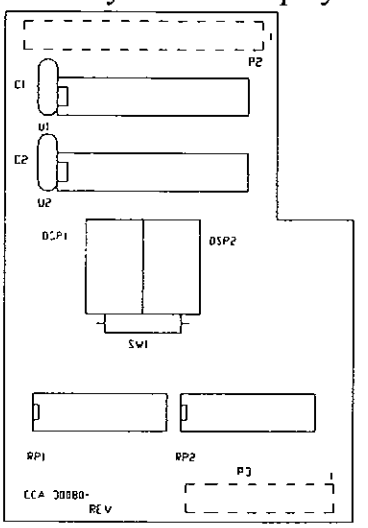

figure 25

Circuit Card Assy - S216 Converter Board

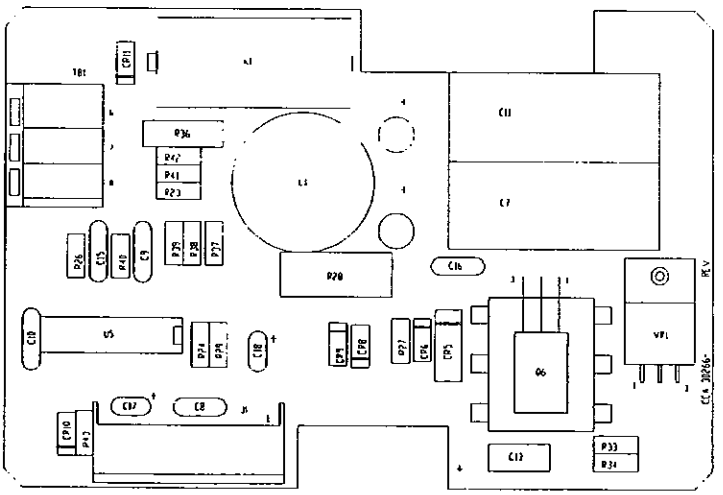

figure 24

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Appendix

5.3.3 Termination & Outline Drawings

Termination Drawing - S216

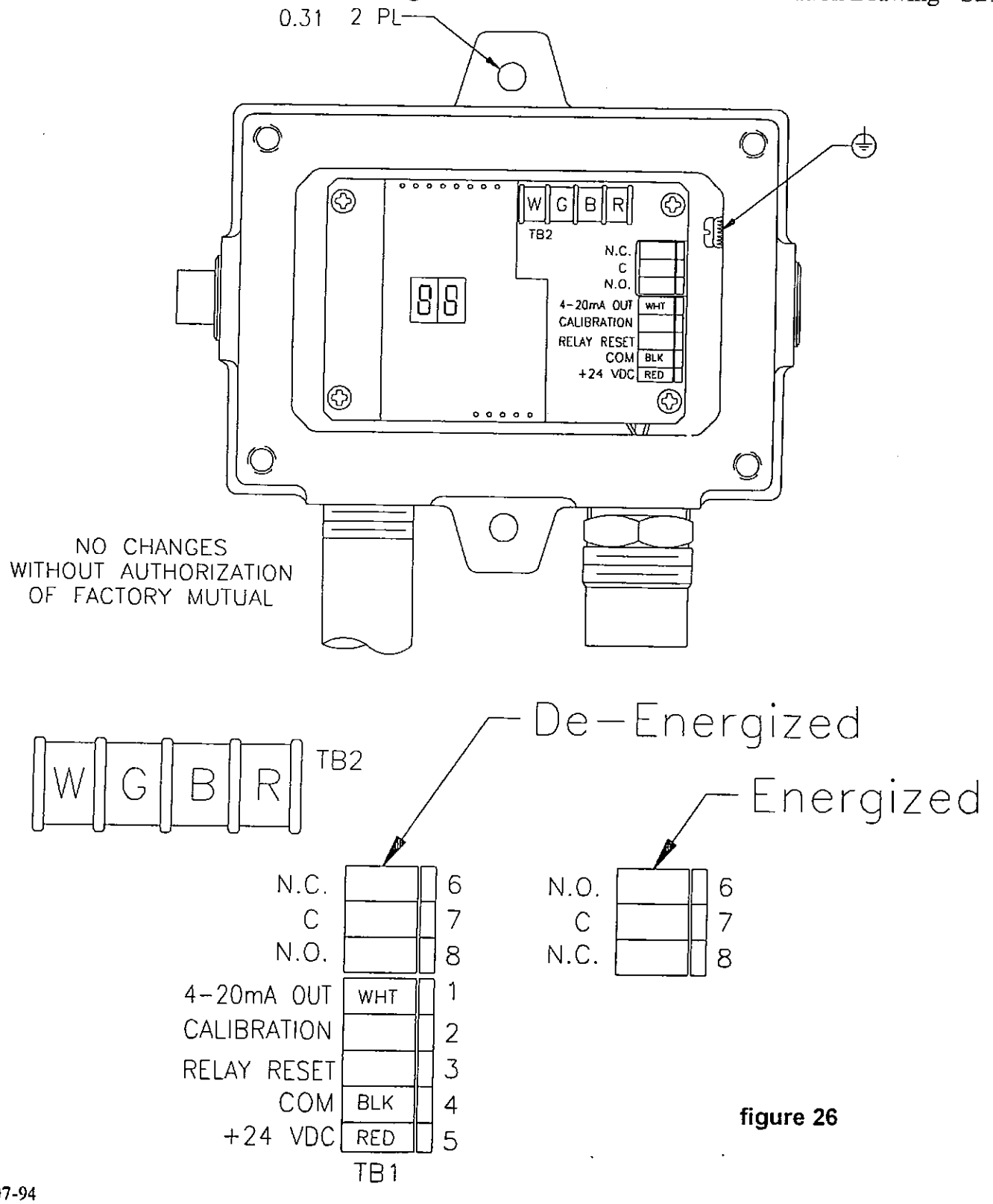
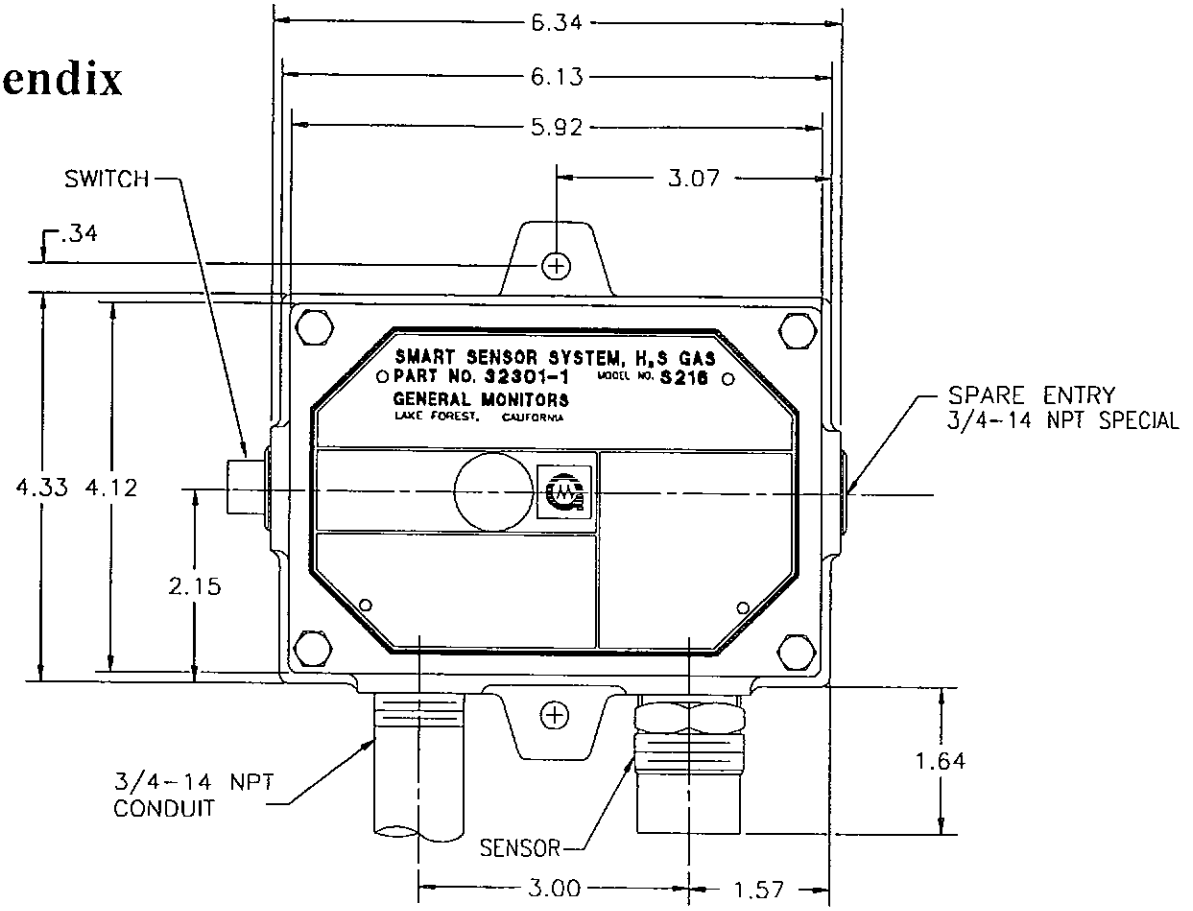
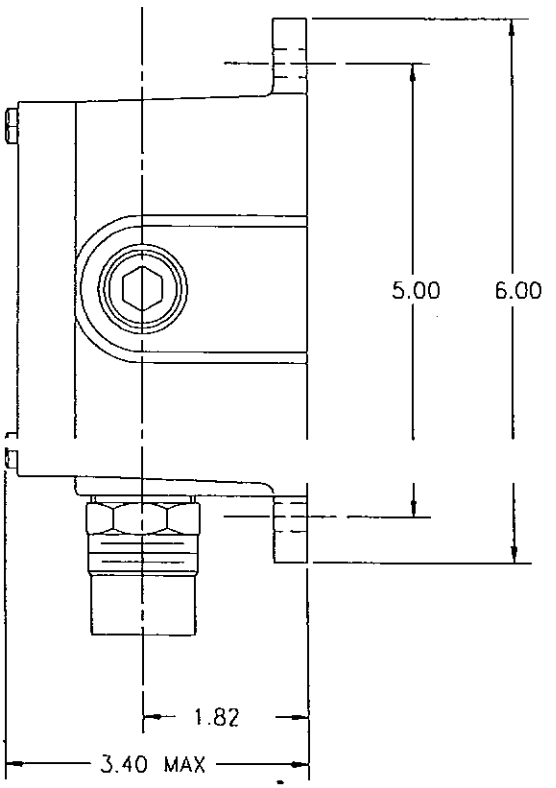


figure 26

Appendix



NO CHANGES
WITHOUT AUTHORIZATION
OF FACTORY MUTUAL



Outline& Dimmensional Drawing - S216

figure 27

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Appendix

5.3.4 Final Assembly

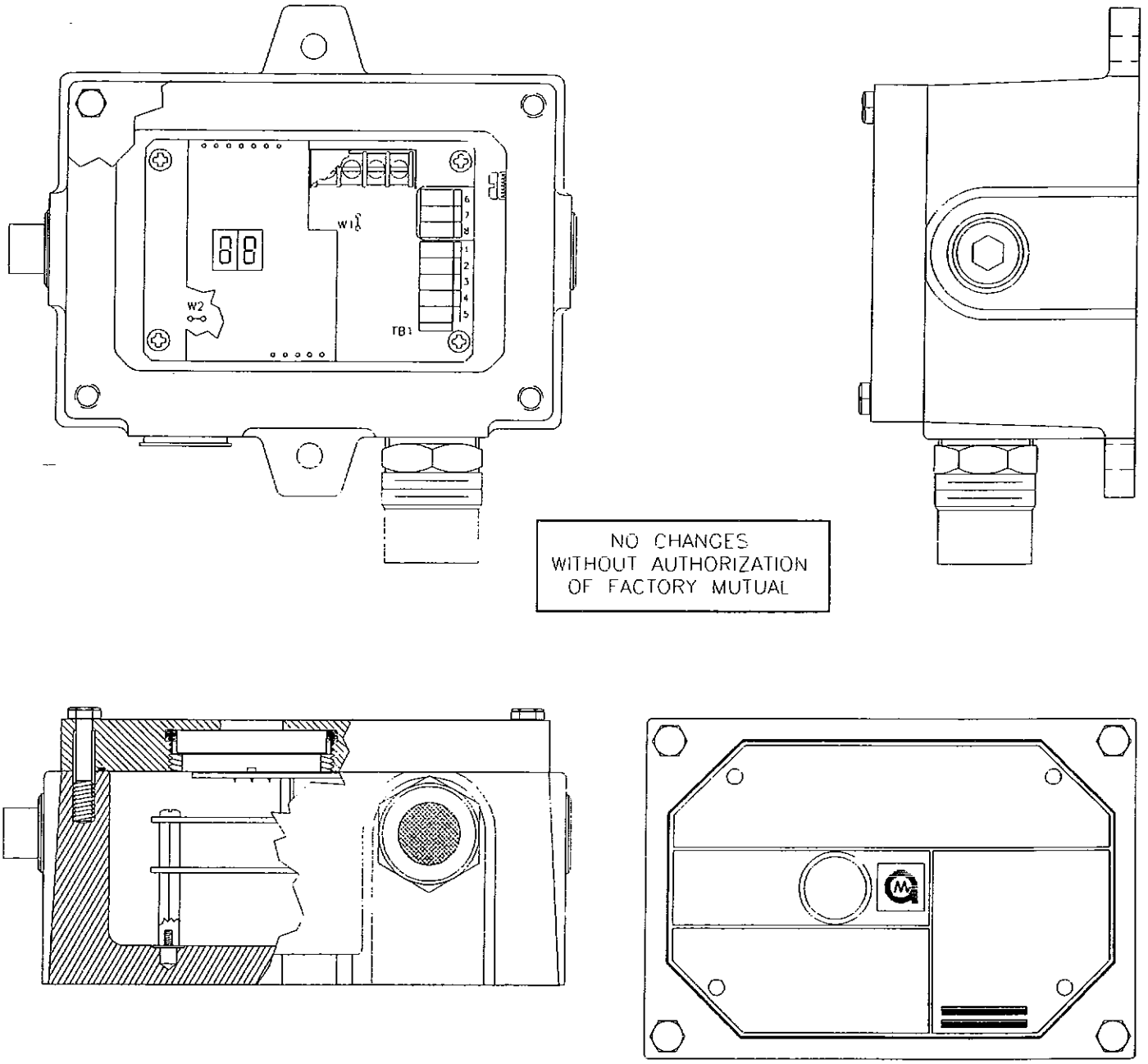

figure 28

Appendix

5.4 Ordering Information

S216 - 3 3 □ - □ □□ - □ 0 □

Calibration Signal:
- 1 = 1.5 mA Signal standard
- 2 = 0 mA Signal

H_2S Meter Scale:
- 1 = 99 ppm Scale.....standard
- 2 = 50 ppm Scale
- 3 = 20 ppm Scale

Hydrogen Sulfide Sensor:
- 00 = No Sensor
- 01 = 50445-1.....standard
- 02 = 50445-5
- 03 = 50445-9
- 04 = 50448-1
- 05 = 50448-5
- 06 = 50448-9
- 07 = 50454-1
- 08 = 50454-5
- 09 = 50454-9
- 10 = 50457-1
- 11 = 50457-5
- 12 = 50457-9
- 13 = Other, consult factory

Active Channels:
- 0 = Without Sensor
- 1 = With Sensor.....standard

Relay State:
- 1 = Latching Alarm, De-Energized
- 2 = Latching Alarm, Energized
- 3 = Non-Latching Alarm, De-Energized .... standard
- 4 = Non-Latching Alarm, Energized
- 5 = Non-Latching Fault, Energized

Appendix

5.5 FMRC Approval

Factory Mutual Research Corporation
1151 Boston-Providence Turnpike
Norwood, Massachusetts 02062

Approval of the transmitter does not include or imply approval of apparatus to which the transmitter may be connected and which process the electronic signal for the eventual end use. In order to maintain FMRC approved system, the control instrument, to which the subject instrument is connected, must also be FMRC approved.

The following sensors have been FMRC approved for use with the Model S216:

- 50445-1 Aluminum Body H_2S Gas Specific MOS Sensor, 0 to 100 ppm
- 50445-5 Aluminum Body H_2S Gas Specific MOS Sensor, 0 to 50 ppm
- 50445-9 Aluminum Body H_2S Gas Specific MOS Sensor, 0 to 20 ppm
- 50448-1 Stainless Steel Body H_2S Gas Specific MOS Sensor, 0 to 100 ppm
- 50448-5 Stainless Steel Body H_2S Gas Specific MOS Sensor, 0 to 50 ppm
- 50448-9 Stainless Steel Body H_2S Gas Specific MOS Sensor, 0 to 20 ppm

The following apparatus have been FMRC approved (although they have not been verified as part of a Model S216 system):

- Model DT210 Eight Channel Readout Relay Display Module
- Model DT220 Explosion Proof Dual Channel Readout Relay Display Module
- Model DT230 Dual Channel Readout Relay Display Module

Appendix

5.6 Calibration Schedule for Problem Environments

Sensor Serial Number:_____ Location:_____

1) Installation and preliminary calibration Record date after preliminary calibration is performed:
Date_____

2) 24 hour calibration Record date after 24 hour calibration is performed:
Date_____

3) 7 day calibration check (Record the date and reading of calibration check. Repeat after 7 days if reading deviates more than ±20% or 4ppm, whichever is greater. Otherwise go to step 4).

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

4) 14 day calibration check (Record the date and reading of calibration check. Repeat after 14 days if reading deviates more than ±20% or 4ppm, whichever is greater. Otherwise go to step 5).

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

5) 30 day calibration check (Record the date and reading of calibration check. Repeat after 30 days, if reading deviates more than ±20% or 4ppm, whichever is greater. (Otherwise go to step 6).

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

6) 60 day calibration check (Record the date and reading of calibration check. Repeat after 60 days, if reading deviates more than ±20% or 4ppm, whichever is greater. (Otherwise go to step 7).

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

7) 90 day calibration check:

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____