DET TRONICS

INSTRUCTIONS

Combustible Gas Transmitter

Model 405B

Section I
General Information

DESCRIPTION

The Model 405B Combustible Gas Transmitter is designed to interface directly with a computer, programmable controller, or various other monitoring devices such as a Det-Tronics Controller. The transmitter uses microprocessor based circuitry to monitor the output of a catalytic combustible gas sensor. The output is a linear 4 to 20 milliampere dc current signal that corresponds to gas levels from 0 to 100% LFL (lower flammable limit). An optional relay board is available to enable the Model 405B to function as an independent single channel detection system. All electronic circuitry of both the sensor and transmitter is housed in explosion-proof metal enclosures. The sensor can be mounted either directly to the transmitter enclosure, or separately using the Det-Tronics Sensor Separation Kit.

FEATURES

- Linear 4 to 20 ma output corresponds to gas concentration of 0 to 100% LFL. Output can be field calibrated to ensure accuracy.
- Sensor can be calibrated to detect a wide variety of combustible gases.
- Calibration can be performed by one person without opening the transmitter enclosure.
- Digital display on calibration meter provides important calibration, diagnostic and test information.
- Non-volatile memory retains calibration and setpoint data during loss of input power.
- Optional relay board provides two SPDT relays.

SPECIFICATIONS

TRANSMITTER

OPERATING VOLTAGE—
24 vdc nominal, total range 10 to 30 vdc, measured at the transmitter.

POWER CONSUMPTION—
Without Relay Board: 3.3 watts (135 ma at 24 vdc).
With Relay Board: 3.3 watts nominal, (135 ma at 24 vdc), 5.5 watts maximum, (230 ma at 24 vdc).

OPERATING RANGE—
0 to 100% LFL.

TEMPERATURE RANGE—
Operating: –40°F to +167°F (–40°C to +75°C).
Storage: –49°F to +185°F (–45°C to +85°C).

RELAY BOARD TEMPERATURE RANGE—
Operating: –40°F to +167°F (–40°C to +75°C).

CURRENT LOOP OUTPUT—
4 to 20 milliamperes dc nominal, 0 to 26 milliamperes total range, capable of driving a 600 ohm load at 20 vdc input voltage.

Table of Contents

Section I - General Information

Section II - System Installation

Section III - System Startup

Section IV - System Maintenance

List of Illustrations

List of Tables

RELAY CONTACTS (Optional)—
Two SPDT relays rated 2.0 amperes at 24 vdc (ac loads not recommended).

RATINGS—
CSA certified for Class I, Division 1, Groups B, C and D.

DIMENSIONS—
See Figure 1.

SHIPPING WEIGHT (Approximate)—
6.0 pounds (2.7 kilograms).

SENSOR

OPERATING RANGE—
0 to 100% LFL.

TEMPERATURE RANGE (Standard Model)—
Operating: –40°F to +167°F (–40°C to +75°C).
Storage: –67°F to +257°F (–55°C to +125°C).

REPEATABILITY—
±5 percent, full scale.

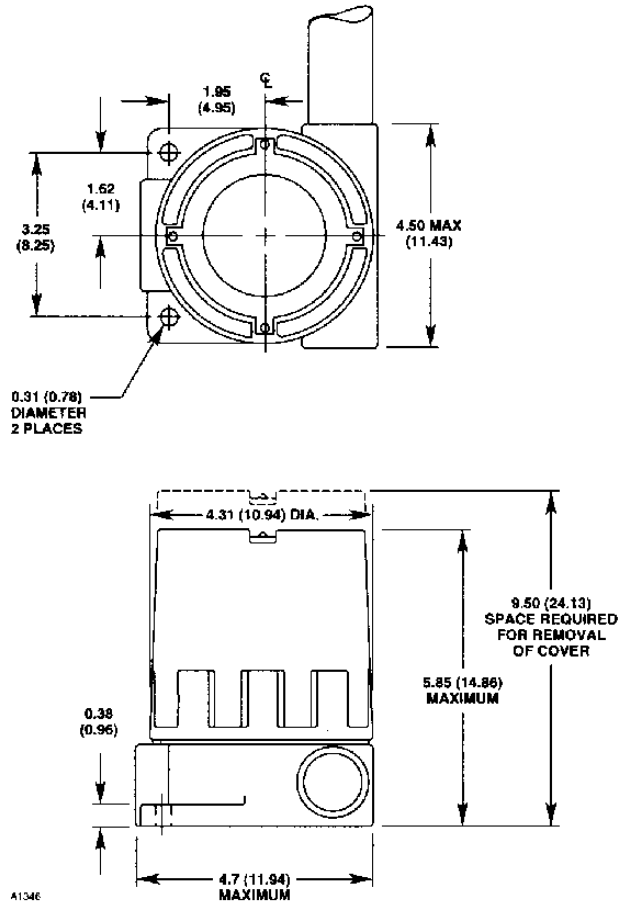

Figure 1—Transmitter Dimensions in Inches (Centimeters)

ACCURACY—
±3 percent full scale up to 2.5 percent methane gas by volume in air (50% LFL), ±5 percent full scale up to 5 percent methane gas by volume in air (100% LFL).

RESPONSE TIME (with full scale gas applied)—
10 seconds to reach 50 percent of value of applied gas, and 30 seconds to reach 90 percent of value of applied gas.

ZERO DRIFT—
Less than 1% per month.

HUMIDITY EFFECT—
Less than ±5 percent full scale deviation at 10% to 90% RH.

RATINGS—
Standard sensor is FM approved and CSA certified for Class I, Division 1, Groups A, B, C and D. Poison resistant sensor is CSA certified for Class I, Division 1, Groups A, B, C and D.

DIMENSIONS—
See Figure 2.

SHIPPING WEIGHT (Approximate)—
Aluminum: 0.5 pound (0.2 kilogram).
Stainless steel: 1.0 pound (0.4 kilogram).

CALIBRATION METER

TEMPERATURE RANGE—
Operating: –4°F to +130°F (–20°C to +55°C).
Storage: –40°F to +130°F (–40°C to +55°C).

CALIBRATION METER BATTERY—
Eveready no. 522. Approximate life: 200 hours or 2000 calibrations.

RATINGS—
CSA certified intrinsically safe for Class I, Division 1, Groups A, B, C and D.

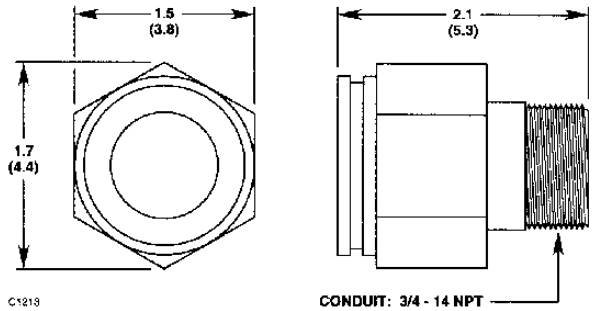

Figure 2—Sensor Dimensions in Inches (Centimeters)

GENERAL APPLICATION INFORMATION

A combustible gas is one that will burn when mixed with air (or oxygen) and ignited.

The lower explosive limit (LEL) or lower flammable limit (LFL) of a combustible gas is defined as the smallest amount of the gas that will support a self-propagating flame when mixed with air (or oxygen) and ignited. In gas detection systems, the amount of gas present is specified in terms of % LFL, 0% LFL being a gas-free atmosphere and 100% LFL being an atmosphere in which the gas concentration is at its lower flammable limit. The relationship between % LFL and % by volume differs from gas to gas.

Hydrogen (H_2), 100% LFL = 4.0% by volume in air
Methane (CH_4), 100% LFL = 5.0% by volume in air
Ethane (C_2H_6), 100% LFL = 3.0% by volume in air
Ethylene (C_2H_4), 100% LFL = 2.7% by volume in air
Pentane (C_5H_{12}), 100% LFL = 1.5% by volume in air
Propane (C_3H_8), 100% LFL = 2.2% by volume in air

For data on other gases, refer to NFPA 325M. Typical settings for the alarm setpoints are 20% LFL for the low alarm and 40% LFL for the high alarm.

The LFL of a gas is affected by temperature and pressure. As the temperature increases, the LFL decreases and hence the explosion hazard increases. The relationship between LFL and pressure is fairly complex, however, a pressure increase usually lowers the LFL. The LFL of a gas is not significantly affected by the humidity fluctuations normally encountered in the operation of a gas detection system.

OPERATION

The transmitter functions as the interface between the sensor and a monitoring device such as a computer, programmable controller, or Det-Tronics controller. The sensor detects the presence of combustible gas. The transmitter monitors the output from the sensor and generates a linear 4 to 20 milliampere dc signal that is proportional to gas concentrations from 0 to 100% LFL. An optional relay board is available, providing two alarm relays with SPDT contacts.

SENSOR

The sensing element used in the Det-Tronics Combustible Gas Sensor consists of a pair of elements, which are matched to have the same electrical resistance. One is an active catalytic sensing element, and the other is inactive and functions as a temperature compensating reference element. The active element has a catalytic coating applied to its surface, however, the reference element is glazed so that it does not react to the presence of a combustible gas/air mixture.

In the presence of a combustible gas/air mixture, the resistance of the active sensing element increases in proportion to the concentration of the gas at the sensor. The change in resistance of the active element, relative to that of the reference element, is used by the transmitter in determining the LFL percentage of the gas at the sensor. This process is also reversible, causing the output to return to its normal value when the level of gas returns to 0% LFL.

Both elements operate at a high temperature and are enclosed by a porous stainless steel filter, which functions as a flame arrester. See Figure 3. This filter allows the diffusion of gas to and from the sensing element, but prevents the ignition of the atmosphere outside the sensor should the combustible gas concentration exceed its LFL.

A barrier is placed between the element pair to prevent thermal interaction and to prevent the transfer of catalytic material from the active element to the surface of the reference element.

Figure 4 shows the response of a typical sensor to various levels of combustible gas. Note that a reading of 40% LFL will be given at 2% methane and also at 80% methane, well above the upper flammable limit of methane. Although gas levels above the upper flammable limit will not propagate a flame, it stands to reason that somewhere between the leak and clear air there will be a flammable mixture.

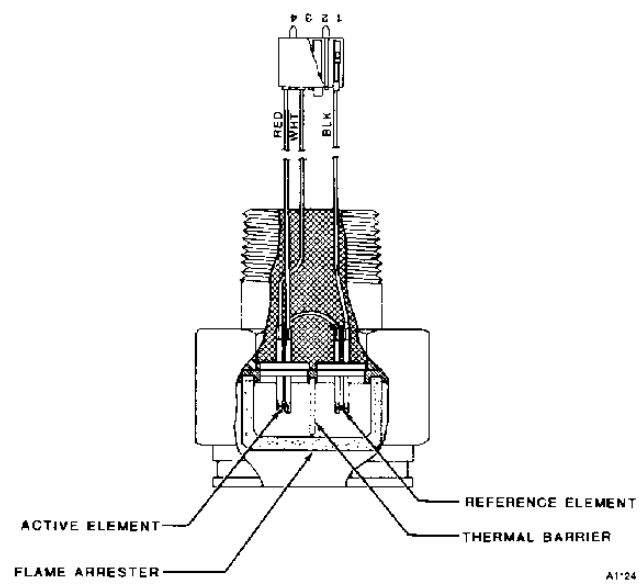

Figure 3—Cutaway View of Det-Tronics Sensor

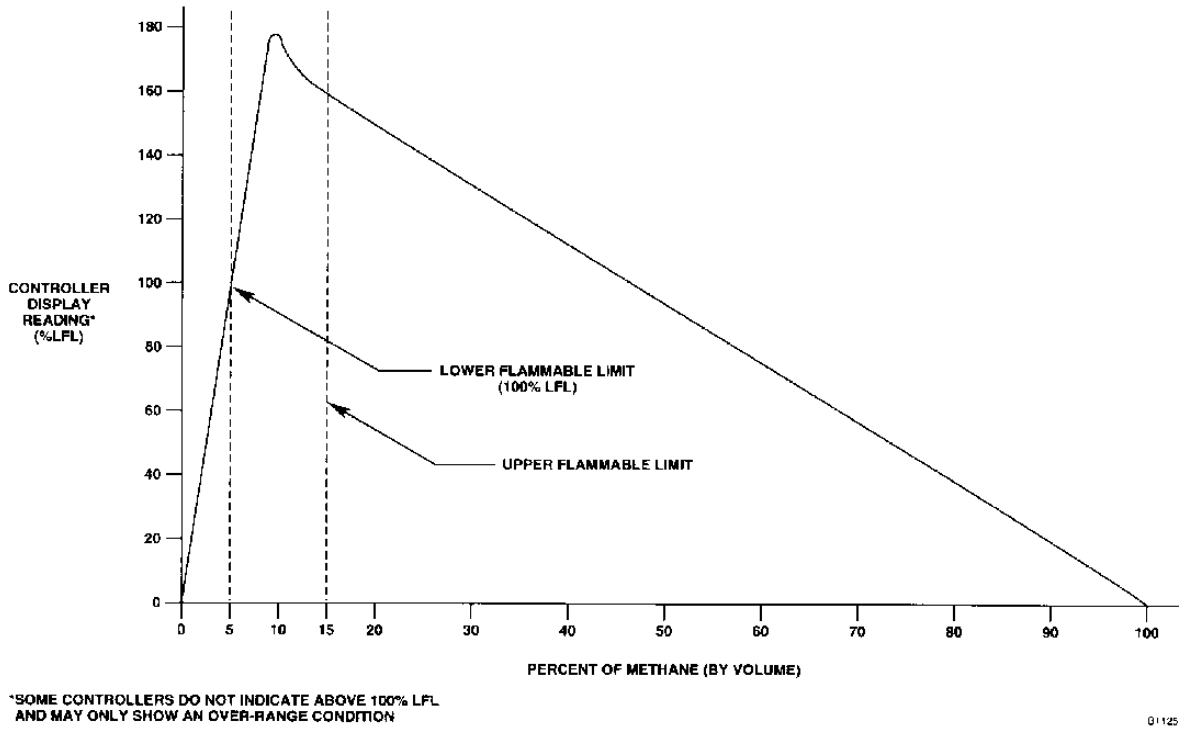

Figure 4—Response of a Typical Sensor to all Possible Mixtures of Methane and Air

CAUTION

It is possible for the display to drop to a low % LFL reading after going into high alarm and still have an unsafe level of combustible gas present. Therefore, precautions should be taken to ensure that the combustible gas has been cleared before classifying the area as safe.

All catalytic type sensors require oxygen to detect combustible gases. The sensor response will decrease if enough combustible gas displaces the normal oxygen present in air. Figure 5 shows the effect of oxygen enriched and oxygen deficient atmospheres on the response of a typical combustible gas sensor. The sensor should not be used where the oxygen level is less than 10%.

The sensing element is mounted inside an aluminum (316 stainless steel optional) housing that is designed to meet most national and international standards relating to use in hazardous areas.

A choice of three sensing elements is offered - standard, poison resistant, and high temperature. The poison resistant sensor has many times the service life of standard catalytic bead sensors in atmospheres containing silicones, halogenated hydrocarbons, and organometallics. Due to its rugged construction and high performance, it holds up under punishing conditions.

With proper calibration, the sensor can be used to detect a wide variety of combustible gases. Contact the Field Support Group at Detector Electronics for assistance in adapting the sensor to a specific application.

TRANSMITTER

The microprocessor based Model 405B Transmitter generates a linear 4 to 20 milliampere dc output signal, which is proportional to the level of combustible gas at the sensor. This current output is calibrated so that the output is 4 ma when no gas is detected and 20 ma when 100% LFL gas is present. The maximum output of the transmitter is 26 ma.

A dc current output level below 4 ma indicates a negative zero drift condition (up to -9% LFL) or calibrate mode (the actual current output during calibration is user selectable). A transmitter output signal of less than 4 ma is displayed as a negative % LFL reading by the calibration meter and also by a control device such as a Det-Tronics controller. If any of the connecting wires should break or become disconnected, the current output signal will be 0 ma.

The sensor is normally threaded directly to the transmitter enclosure. However, the sensor and transmitter can be mounted separately using a Sensor Separation Kit available from Detector Electronics.

The sensor, transmitter and separation kit are designed for use in hazardous areas, and when properly installed will provide an explosion-proof installation.

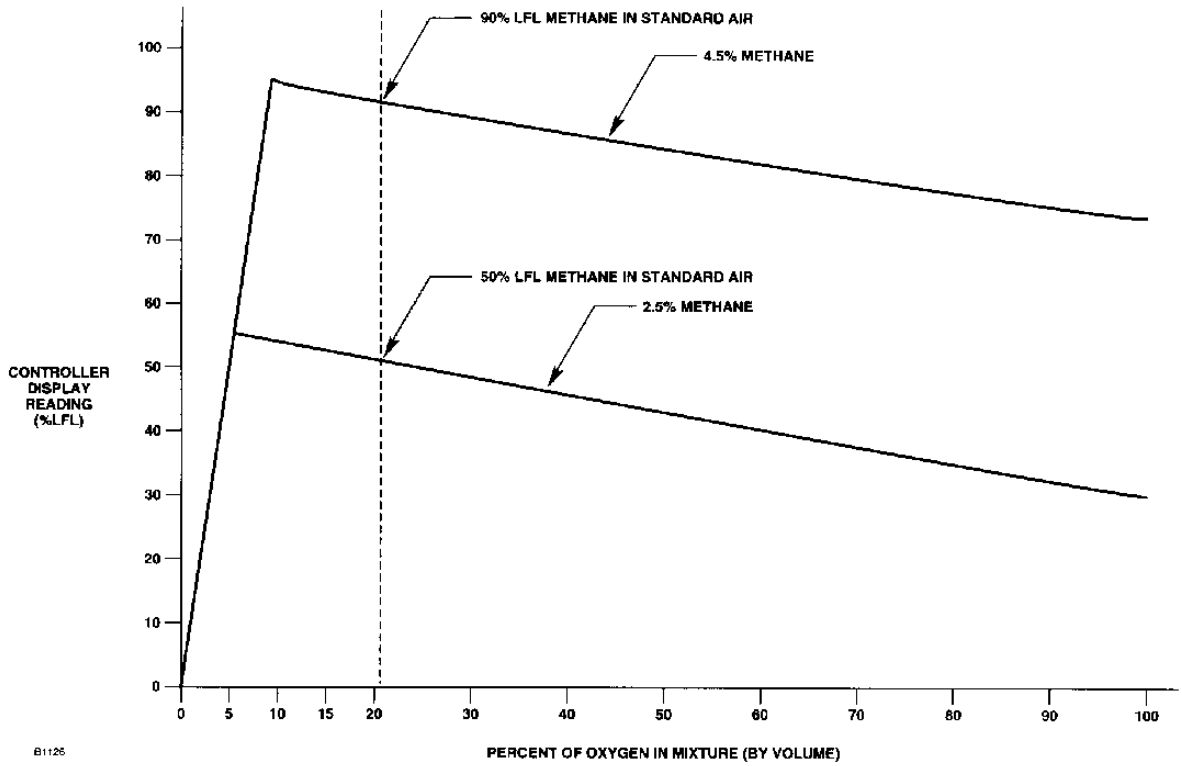

Figure 5—Effect of Oxygen Enriched and Deficient Atmospheres

Relay Board (Optional)

If the application requires that external response equipment be controlled directly by the transmitter, a Relay Board with two alarm relays can be added to the transmitter. Two relay status LEDs, which are visible through the window on the transmitter cover, signal actuation of their corresponding relay.

The relays have SPDT contacts that are rated 2 amperes at 24 vdc and can be programmed for either normally energized or normally de-energized operation. Each relay has separate set and reset setpoints, which are adjustable in 1% LFL increments. The relays are automatically reset when power is first applied to the transmitter and when a trouble signal is being generated. Latching and reset options for the alarm relays are programmed at the time of installation using the calibration meter. See the "Transmitter Programming" section of this manual for details.

CALIBRATION METER

The Det-Tronics Optical Calibration Meter uses a liquid crystal display (LCD) to allow the user to see the actual response of the sensor to the calibration gas mixture. In addition to routine calibration of the sensor, the calibration meter can also be used to select various options and to aid in identifying system problems. See Figure 6.

Refer to the "Operating the Calibration Meter", "Calibration" and "Transmitter Programming" sections of this manual for complete information regarding the use of the calibration meter.

Calibration

Calibration is performed with the calibration meter attached to the glass window on the transmitter housing. The transmitter and calibration meter exchange information through an optical coupling arrangement. The LCD on the calibration meter displays essential information to enable the operator to make zero and span adjustments. In addition, it enables the operator to determine remaining sensor life.

This method of calibration is easily performed by one person without removing the enclosure cover or declassifying a hazardous location.

Upon entering the calibrate mode, the calibration meter automatically inhibits the output signal of the transmitter under calibration. While in the calibrate mode, a special "calibrate signal" is sent to the controller (actual output value is determined by the user). This prevents an unwanted alarm and indicates to the control device that the transmitter is in the calibrate mode. During this time the remainder of the detection system continues to function normally.

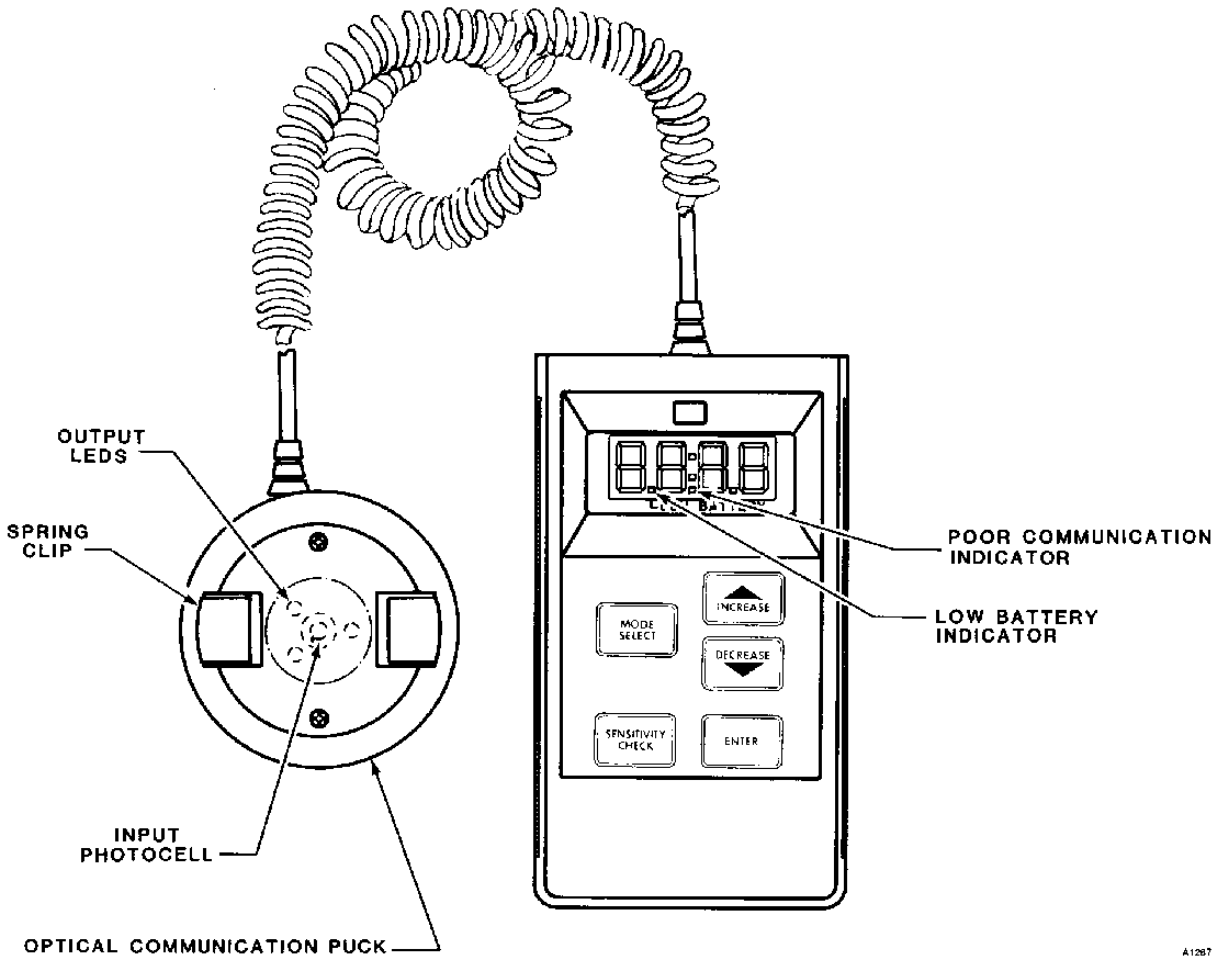

Figure 6—Optical Calibration Meter

Section II
System Installation

INSTALLATION

SENSOR LOCATION

It is essential that the sensor be properly located to enable it to provide maximum protection. The formula for determining the most effective number and placement of sensors varies depending on the conditions at the job site. The individual performing the installation must rely on experience and common sense to determine the quantity of sensors and the best sensor locations to adequately protect the area.

For additional information on determining quantity and placement for sensors in a specific application, refer to Instrument Society of America (ISA) Transaction Volume 20, Number 2, titled "The Use of Combustible Detectors in Protecting Facilities from Flammable Hazards".

The following factors should be considered for every installation:

1. What kind of gas is to be detected? If it is lighter than air (acetylene, hydrogen, methane, etc.), place the sensor above the potential gas leak. Place the sensor close to the floor for gases that are heavier than air (benzene, butane, butylene, propane, hexane, pentane, etc.) or for vapors resulting from flammable liquid spills. However, note that air currents can cause a gas that is heavier than air to rise. In addition, if the gas is hotter than ambient air, it could also rise.
2. How rapidly will the gas diffuse into the air? Select a location for the sensor as close as practical to the anticipated source of a gas leak.
3. Ventilation characteristics of the immediate area must also be considered. Movement of air will cause gas to accumulate more heavily in one area than another. The sensor should be placed in the area where the most concentrated accumulation of gas is anticipated. Also take into consideration the fact that many ventilation systems do not operate continuously.
4. The sensor should be pointed down to prevent the buildup of moisture or contaminants on the filter and to ensure proper operation.

5. The sensor must be accessible for testing and calibration. A Sensor Separation Kit will be required in some installations.

6. The sensor should be located in an area where it is safe from potential sources of contamination that can poison the sensing element.

7. Exposure to excessive heat or vibration can result in pre-mature failure of any electronic device and should be avoided if possible. Shielding the device from intense sunlight will reduce solar heating and can increase the life of the unit.

Remember, the finest gas detector is of little value if the gas cannot readily come into contact with it.

GENERAL WIRING REQUIREMENTS

The use of shielded cable is required to protect against interference caused by extraneous electrical "noise." In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment. To assure proper operation of the transmitter, the resistance of the connecting wire must be within the specified limits. The maximum distance between the transmitter and power source (controller) is determined by the minimum supply voltage and wire size. See Figure 7 to determine the proper wire size and maximum wiring distance allowed.

Since moisture can be detrimental to electronic devices, it is important that moisture not be allowed to come in contact with the electrical connections of the system. Moisture in the air can be trapped within sections of conduit, therefore the use of conduit seals is required to prevent damage to electrical connections caused by condensation within the conduit.

These seals must be water-tight and explosion-proof and are to be installed even if they are not required by local wiring codes. A seal must be located as close to the transmitter enclosure as possible. In no case should this seal be located more than 18 inches (46 cm) from the transmitter. When an explosion-proof installation is required, an additional seal should also be installed at any point where the conduit enters a non-hazardous area.

When pouring a seal, the use of a fiberdam is required to assure proper formation of the seal. The seals should never be poured in temperatures that are below freezing, since the water in the sealing compound will freeze and the compound will not dry properly. Contamination problems can then result when temperatures rise above the freezing point and the compound thaws.

The shielding of the cable should be stripped back to permit the seal to form around the individual leads, rather than around the outside of the shield. This will prevent any siphoning action that might occur through the inside of the shield.

It is recommended that conduit breathers also be used. In some applications, alternate changes in temperature and barometric pressure can cause "breathing," which allows the entry and circulation of moist air throughout the conduit. Joints in the conduit system and its components are seldom tight enough

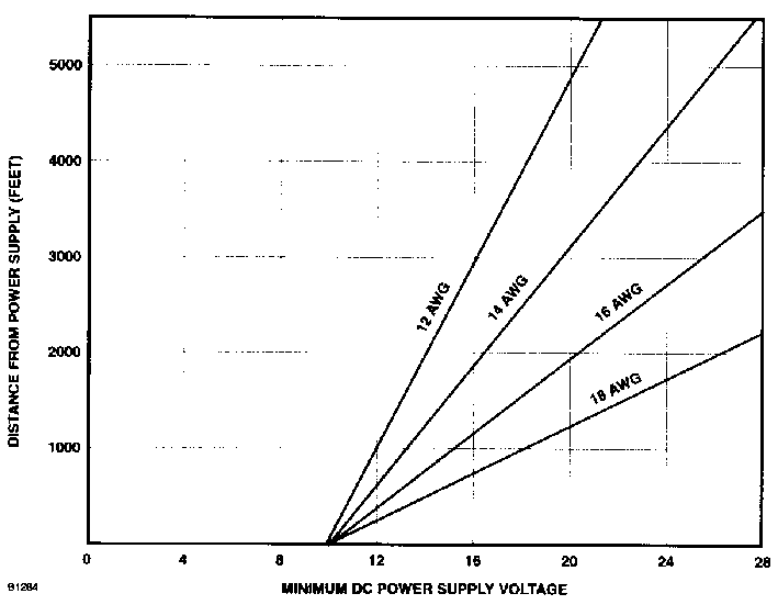

Figure 7—Transmitter Wiring Requirements

to prevent this "breathing." Moisture in the air can condense at the base of vertical conduit runs and equipment enclosures, and can build up over a period of time. This can be detrimental to electronic devices. To eliminate this condition, explosion-proof drains and breathers should be installed to automatically bleed off accumulated water.

SENSOR SEPARATION (Optional)

The Sensor Separation Kit is designed for use in applications where the sensor and transmitter are installed in different locations.

Kit Description

The sensor separation kit consists of the following:

—Junction box with connector board
—Calibration cup
—Plug-in connector kit.

The aluminum junction box is designed for use in hazardous areas, and when properly installed will provide an explosion-proof installation. The connector board assembly, mounted inside the junction box, contains a plug-in terminal for connecting the sensor and a screw type terminal block for connecting external wiring.

See Figure 8 for an illustration of a typical system using the Sensor Separation Kit.

The kit also includes a special calibration cup that can remain on the sensor after calibration without interfering with normal operation. By connecting a length of tubing (1/4 inch I.D.) from the calibration cup back to the transmitter location, the operator can make calibration adjustments and also control the flow of calibration gas from the same location.

IMPORTANT

The operator must frequently inspect the filter on the calibration cup. This filter ***must*** *be kept clean. If the filter should become clogged by environmental contaminants such as dirt, oil, paint, etc., the flow of gas to the sensing element will be restricted. This can significantly reduce the sensitivity and response time of the sensor, thereby impairing the ability of the system to respond to a hazardous condition. Problems of this nature will not be detected by the system's diagnostic circuitry or by routine calibration. If the filter becomes dirty and cannot be properly cleaned, the calibration cup must be replaced.*

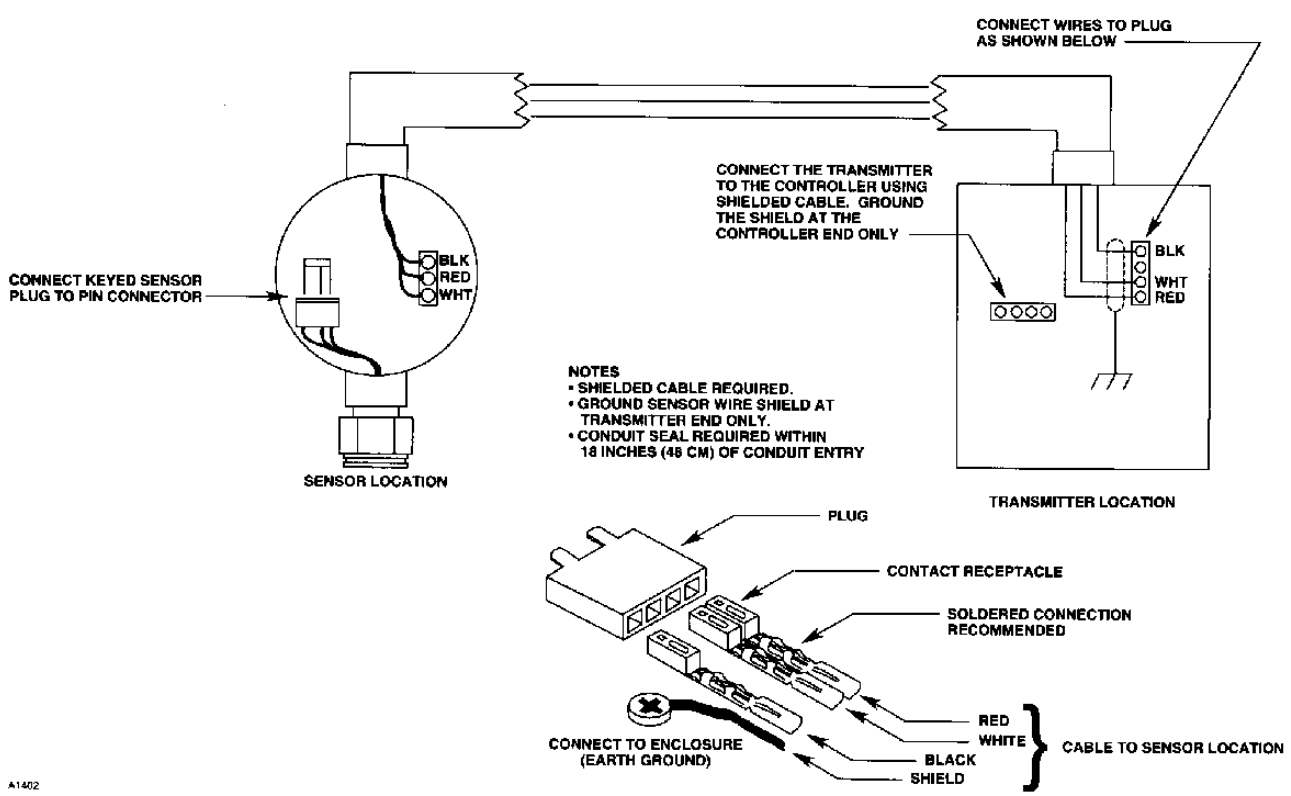

Figure 8—Sensor Separation with Model 405B Transmitter

Wiring Requirements

Three wire cable is used for connecting the sensor to the transmitter. The use of **shielded cable is required** for connecting the sensor and transmitter, and is highly recommended for connecting the transmitter and controller. Cable with a foil shield is recommended. The shield of the cable connecting the sensor and transmitter should be open at the sensor junction box and connected to earth ground at the transmitter junction box. The shield of the cable connecting the transmitter and controller should be open at the transmitter junction box and connected to earth ground at the controller.

The maximum distance between the sensor and transmitter is limited by the resistance of the connecting wiring, which is a function of the gauge of the wire being used. Refer to Table 1 to determine the maximum separation distance for a given wire size.

Sensor Installation

The sensor junction box can be mounted to a wall or post, or it can be suspended by the conduit. A spacer (1/4 to 1/2 inch) may be needed between the junction box and the mounting surface to allow adequate room for the sensor and calibration cup. The junction box should be electrically connected to earth ground. For proper operation, the sensor must be oriented with the filter pointing down.

Lubricate the sensor threads with the appropriate grease, then install the sensor in the conduit entry of the separation kit junction box. It should be tight to ensure an explosion-proof installation, however, do **not** overtighten. Connect the plug to the sensor terminal on the connector board located inside the junction box.

Connect the cable leadwires to the appropriate screw terminals inside the sensor junction box. **Do not** ground the shield at the sensor junction box. Ground the sensor wire shield at the transmitter end only.

Check the connections inside the sensor separation kit junction box, then install the shorting plug on the connector board and place the cover on the junction box.

A four position plug-in connector is supplied with the sensor separation kit for connecting the external sensor wiring to the transmitter. To connect the wire ends to the plug, remove approximately 1/4 inch of insulation from each of the three wires. Connect a metal contact receptacle to each of the three wires. A soldered connection is recommended to ensure reliability.

Table 1—Maximum Sensor Separation Distances

Wire Size (AWG)	Maximum Transmitter to Sensor Distance	
	Feet	Meters
18	500	152
16	795	242
14	1270	387
12	2010	612

Three-wire shielded cable is required.

Insert the contact receptacles into the plug as shown in Figure 8. (Proper sensor wire positions can also be determined by referring to the label on the side of the transmitter module adjacent to the plug location.)

Install the plug on the transmitter and ground the cable shield. Check to ensure correct wiring. Improper wiring can result in damage to the detector.

WIRING PROCEDURE

The following procedure should be used for mounting and wiring the Model 405B Transmitter.

NOTE

Do not remove the enclosure cover if power is applied.

1. The unit should be installed in a location that is best suited for covering the area to be protected, following the previously discussed guidelines. Whenever practical, it should be placed where it is easily accessible for calibration. For proper operation, the sensor should be pointing down. See Figure 1 for mounting dimensions.

NOTE

A spacer (1/4 to 1/2 inch) may be needed between the enclosure and the mounting surface to allow adequate room for the sensor and calibration cup.

2. Remove the cover from the enclosure.

3. Connect the enclosure to the conduit. The enclosure should be electrically connected to earth ground.

NOTE

The transmitter contains semiconductor devices that are susceptible to damage by electrostatic discharge. An electrostatic charge can build up on the skin and discharge when an object is touched. Therefore, use caution when handling, taking care not to touch the terminals or electronic components. For more information on proper

handling, refer to Service Memo form 75-1005, which is included with this manual.

4. If the optional relay board is used, plug the ribbon cable on the relay board into terminal J2 on the transmitter module. Attach the relay board to the side of the transmitter module using the screws provided. See Figure 9.

5. Loosen the three mounting screws on the transmitter module, then install the module in the mounting bracket inside the enclosure and tighten the screws. See Figure 10.

6. Attach the sensor to the conduit entry on the transmitter enclosure as shown in Figure 10. The sensor should be tight to ensure an explosion-proof installation, however, do **not** overtighten. Route the wires as shown. Attach the sensor plug to the transmitter module at the appropriate terminal location. See Figures 10 and 11. If a sensor separation kit is being used, refer to the appropriate section in this manual for installation details.

CAUTION

The sensor threads should be coated with an appropriate grease to ease both the initial installation and future replacement of the sensor. Also lubricate the cover threads. Detector Electronics offers a silicone free polyalphaolefin grease that is especially suited for use with catalytic type combustible gas sensors (part number 005003-001). The use of other lubricants is not recommended, since some materials can cause irreversible damage to the sensing element. Silicone based lubricants or compounds must never be used.

7. Connect the power and current output leadwires to the screw terminals on the plug that is provided. Proper wire locations are indicated on the sideplate of the transmitter and also in Figure 11. See Figure 10 for proper wire length and routing. Connect the shield to earth ground at the power supply. Under normal conditions, the other end of the shield should **not** be grounded at the transmitter unless such a connection is required by local wiring codes.

8. If an optional relay board is being used, continue with steps 9 to 11. If a relay board is not used, go to step 12.

9. See Figure 12 for connecting external loads to the relay outputs.

NOTE

Direct connection of 120/240 vac to the relay terminals inside the transmitter enclosure is not recommended, since switching relay contacts can induce electrical noise into the electronic circuitry, possibly resulting in a false alarm or other

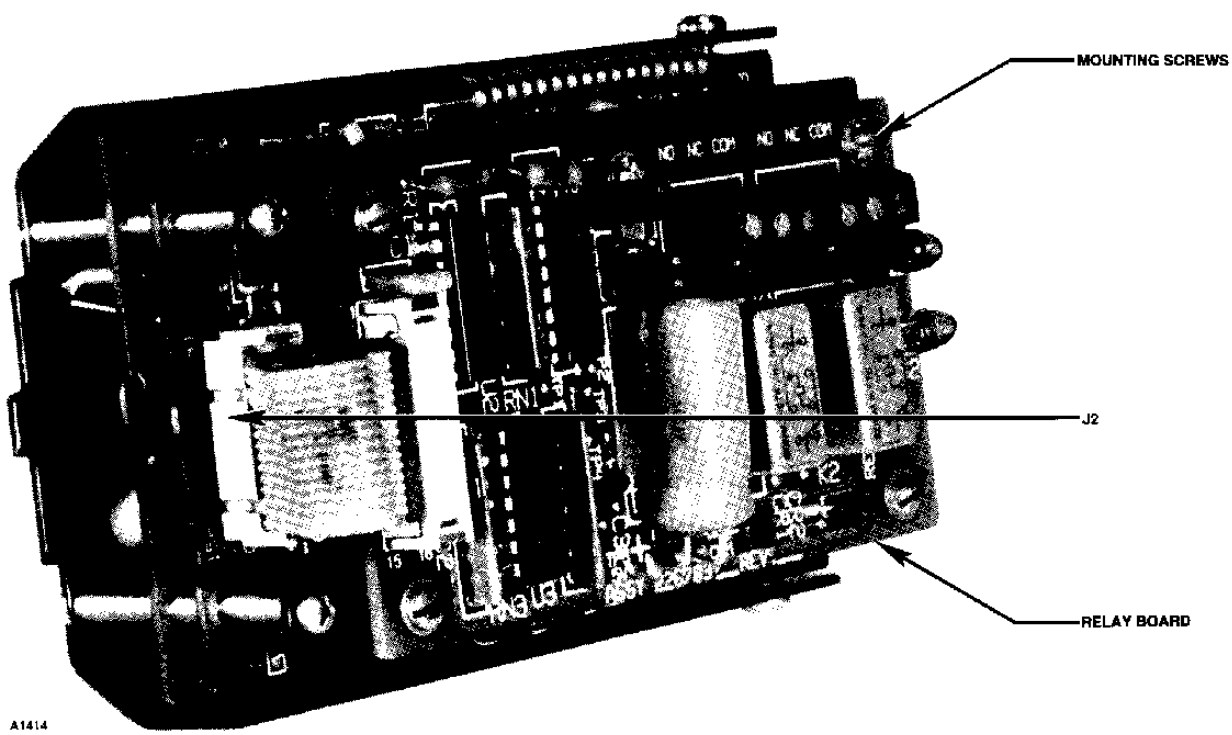

Figure 9—Optional Relay Board

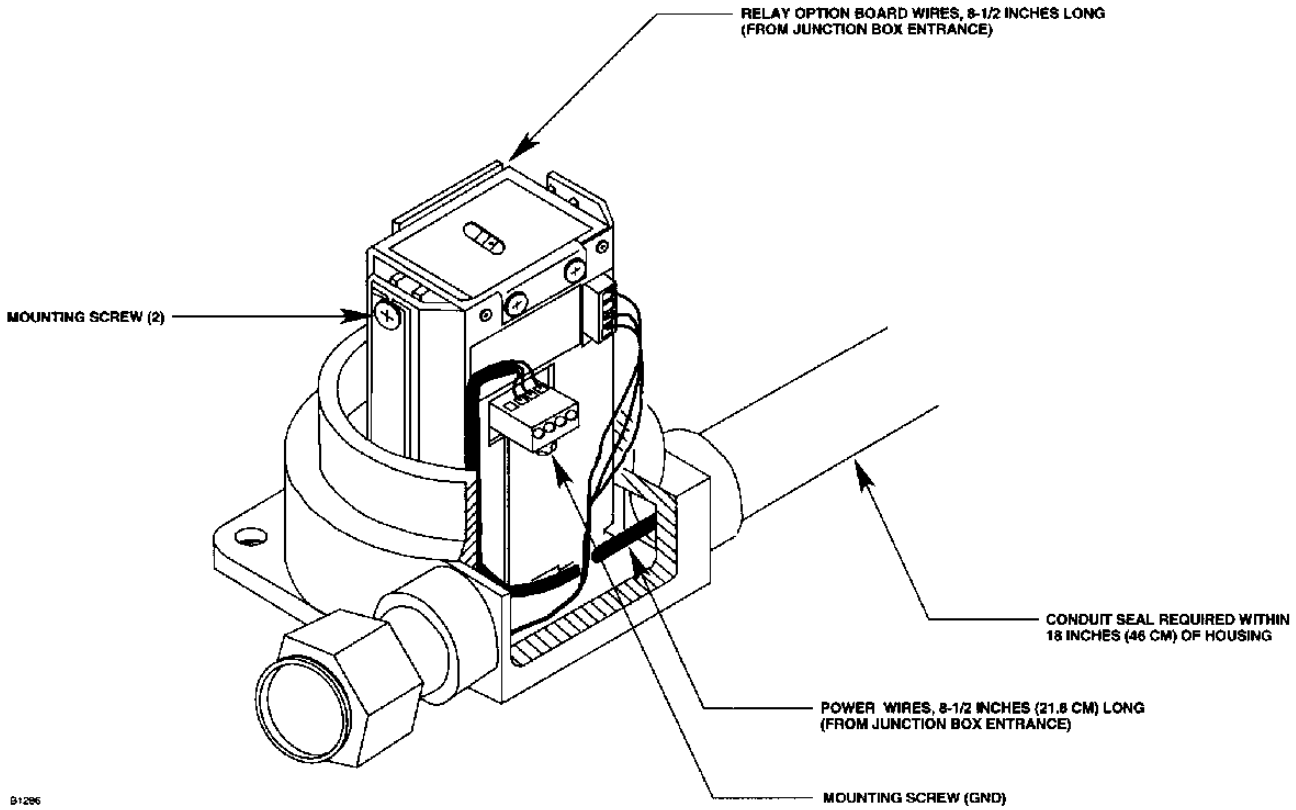

Figure 10—Transmitter Module Installation

system malfunction. If the application requires that ac powered equipment be controlled by the Model 405B Transmitter, the use of externally located relays is recommended.

External relays, solenoids, motors, or other devices that can cause inductive transients should be transient suppressed. Place a MOV across the coil for ac devices. Place a diode across the coil for dc devices. See Figure 13.

10. If the optional relay board is installed, a remotely located relay reset switch can be wired as shown in Figure 11. (The relays can also be reset using the calibration meter.) The use of shielded wire is recommended for wiring the switch. The switch must be held for approximately one second before the transmitter resets the relays.

Table 2—Jumper Positions on the Optional Relay Board

Function	Relay 1	Relay 2
Normally De-energized	W1, Pins 1 & 2	W2, Pins 1 & 2
Normally Energized	W1, Pins 2 & 3	W2, Pins 2 & 3

11. The relays are programmed for normally energized or de-energized operation by placing jumper plugs on the appropriate pins at locations W1 and W2 on the relay board. See Table 2. W1 controls Relay No. 1 and W2 controls Relay No. 2. For normally de-energized operation, place the jumper across pins 1 and 2. For normally energized operation, place the jumper across pins 2 and 3. See Figure 12 for jumper locations.

12. Check all field wiring to ensure that the proper connections have been made, then install explo-

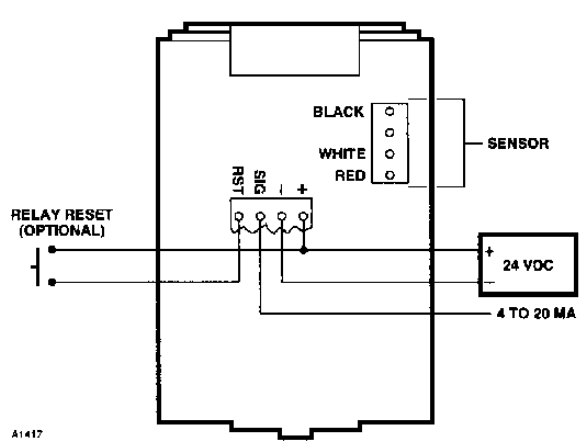

Figure 11—Transmitter Wiring

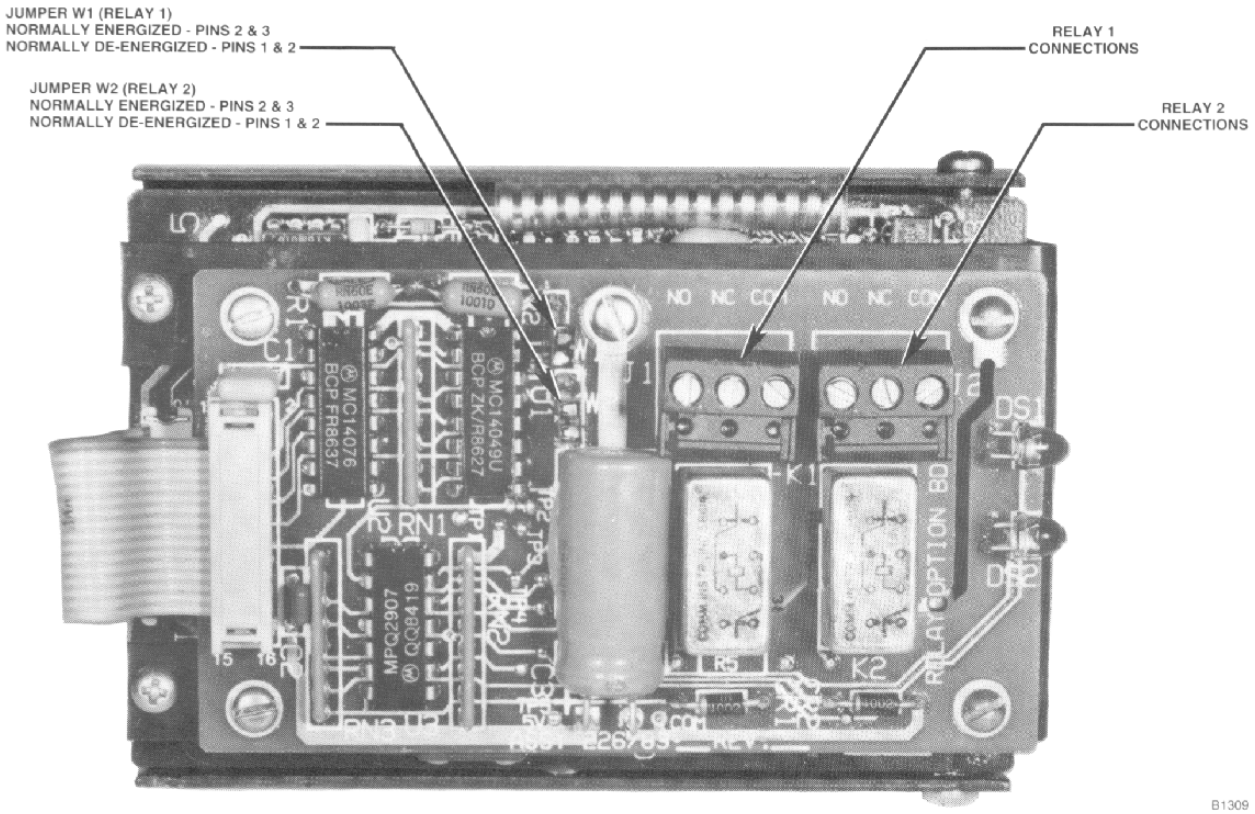

Figure 12—Relay Wiring Terminals and Programming Jumpers

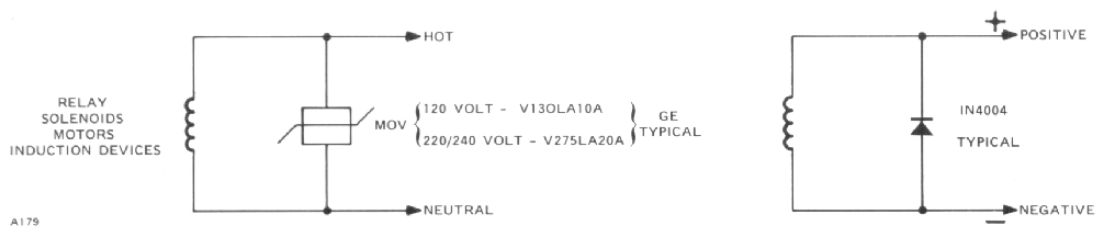

Figure 13—Transient Suppression for Inductive Loads

sion-proof conduit seals at the conduit entries of all junction boxes.

13. Place the cover back on the transmitter enclosure.

NOTE

The wiring procedures in this manual are intended to ensure proper functioning of the device under normal conditions. However, because of the many variations in wiring codes and regulations, total compliance to these ordinances cannot be guaranteed. Be certain that all wiring complies with applicable regulations that relate to the installation of electrical equipment in a hazardous area. If in doubt, consult a qualified official before wiring the system.

TYPICAL APPLICATIONS

Various alarm indicators and response devices can be connected to the optional alarm relays. Recorders, computers, programmable controllers, etc. are typically connected to the 4 to 20 ma current output. Figure 14 shows an example of typical user connections.

Refer to Figure 15 for an illustration of a typical system using a Model 405B Transmitter with either a Model 1000 or 2000 Controller. In this example, the controller is powered by a 24 volt dc supply. The Model 405B receives power by direct connection to the controller.

Figure 16 shows a typical system using four Model 405B Transmitters connected to a Model 8000 Controller. (A Model 8000 Controller can accommo-

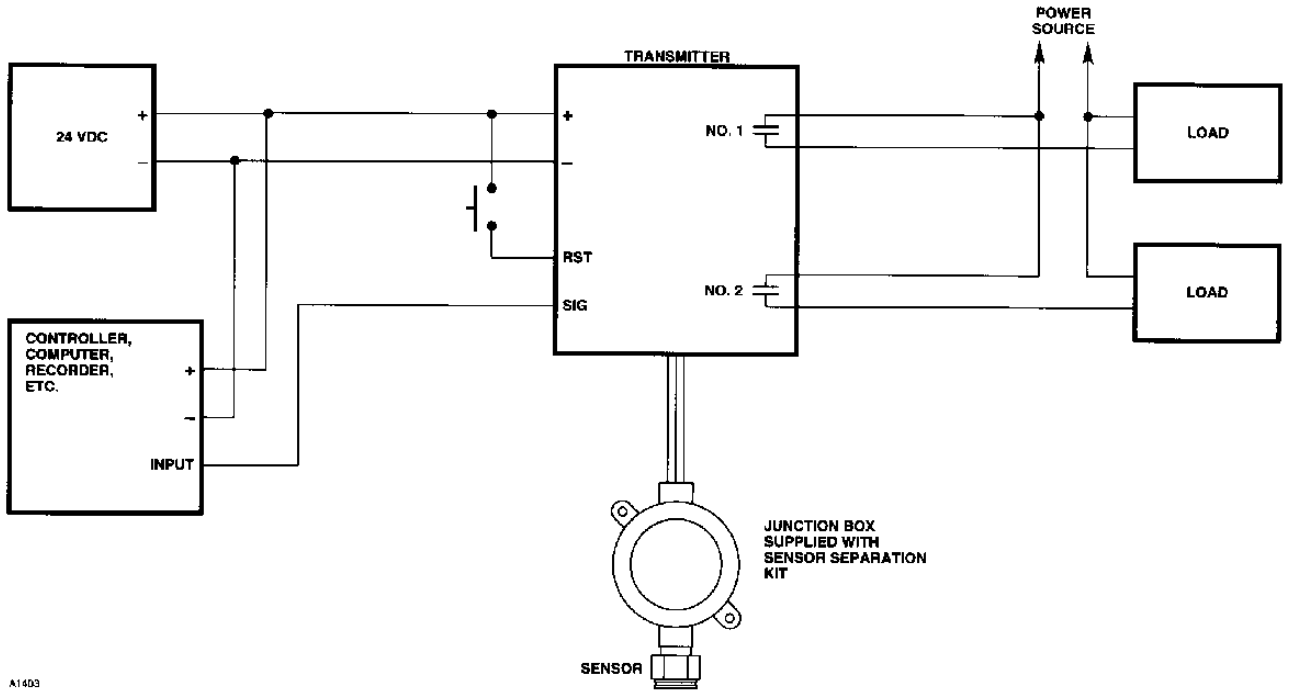

Figure 14—A Typical System Showing Transmitter Equipped with Optional Relays and Sensor Separation

date up to eight transmitters.) The controller is powered by an external ac input source. The transmitters are powered by connection to the controller.

For assistance in adapting a system to your individual requirements, contact the Field Support Group at Detector Electronics.

INSTALLATION CHECKLIST

The following checklist is provided as a means of checking the system to be sure that all phases of system installation are complete and have been performed correctly.

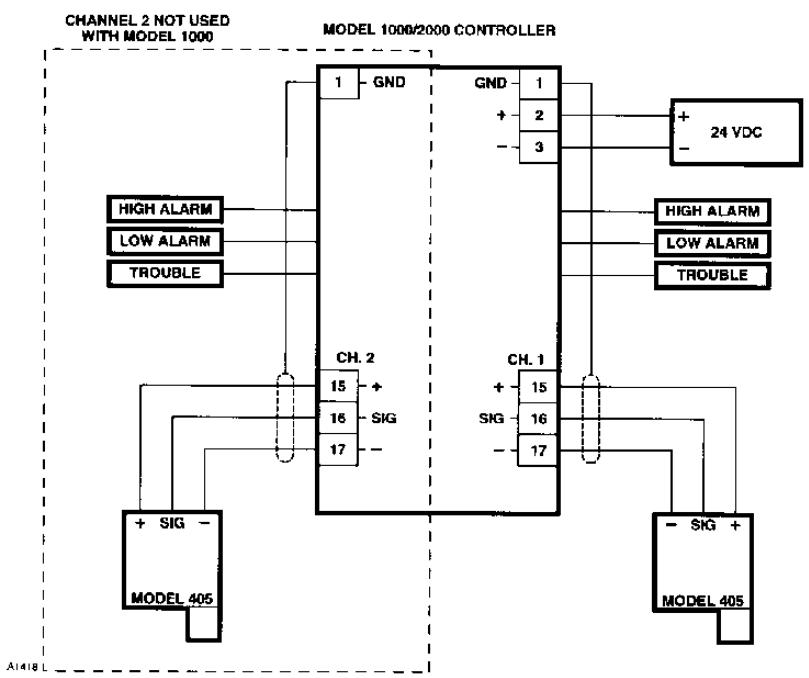

Figure 15—Model 405B with Model 1000/2000 Controller

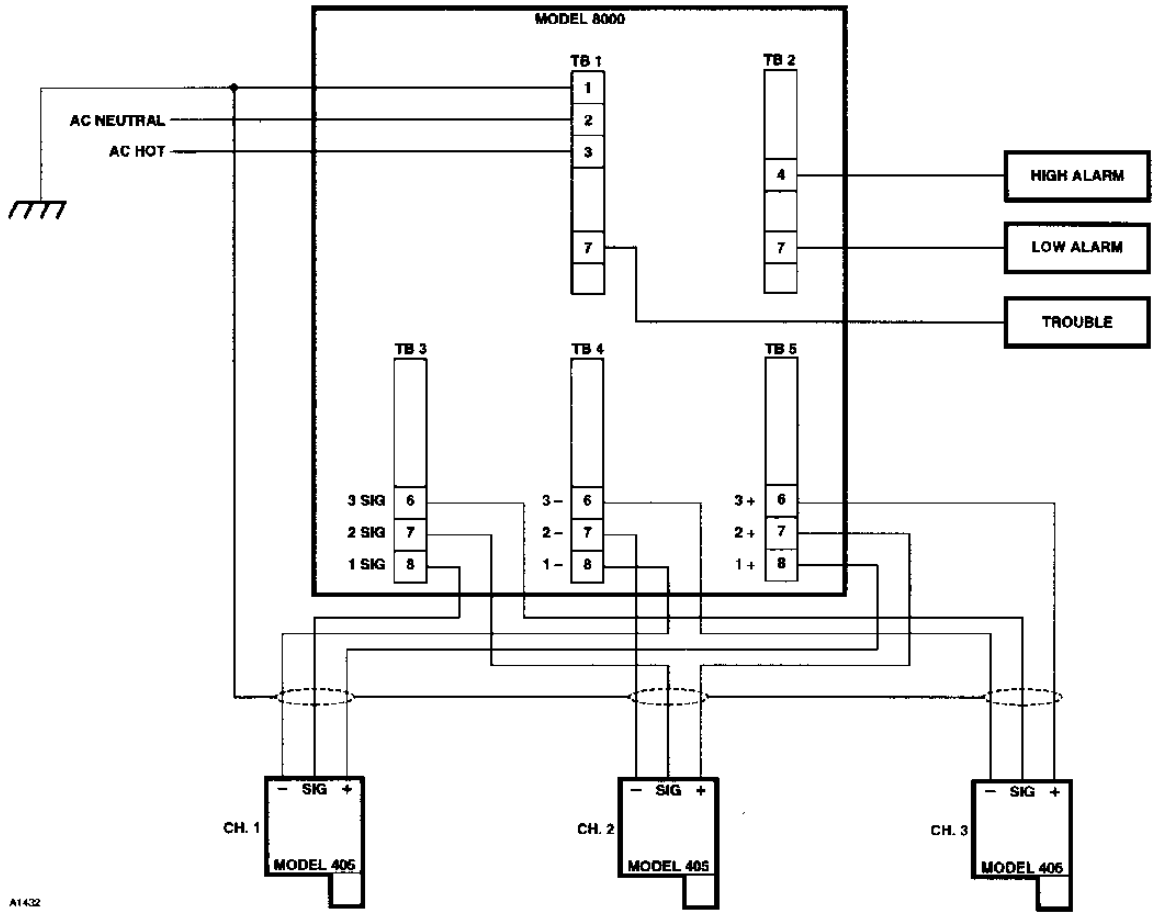

Figure 16—Model 405B with a Standard Model 8000 Controller

1. Enclosure is securely mounted and sensor is pointing down.
2. Explosion-proof conduit seals have been installed at all junction box entries.
3. Power wiring is installed and power source is operational.
4. Wiring to external loads and/or monitoring devices is properly connected.
5. If a sensor separation kit is used, interconnecting wiring is correct.
6. All cable shields are properly grounded.
7. Device is programmed as desired. Record this information for future reference.
8. Optional sensor accessories (dust/splash guards, sample draw devices, etc.) are installed, clean, and in good condition.
9. Electronic transmitter module is properly installed.
10. Cover is tightly installed and gasket is in good condition.
11. Monitoring devices and/or response equipment is operational.

Proceed to System Startup and Calibration.

Section III
System Startup

STARTUP PROCEDURE

1. Since the transmitter has not been calibrated, it is possible for a controller or other output device that is connected to it to generate an alarm output when power is applied. Therefore, output loads that are normally actuated by the system should be secured (remove power from all output devices) to prevent undesired activation of these devices.
2. Check to be sure that all external wiring has been installed properly and that the sensor has been

connected properly. Be sure that the transmitter module has been properly mounted inside the enclosure.

3. Apply power. The LED on the transmitter will flash as the transmitter performs its initialization procedure. After a 100 second time delay, the transmitter will begin normal operation.

4. Allow the sensor to operate for about an hour, then perform the calibration procedure. Refer to the "Calibration" section of this manual for a recommended calibration schedule.

5. If the optional relay board is being used, the desired relay operation must be programmed into the transmitter using the procedure described in the "Transmitter Programming" section of this manual.

NOTE

The operator can use the calibration meter to test the transmitter output signal and/or the optional relay board and reset switch functions by performing tests T4 and T2, respectively. The relays are unsupervised and should be tested periodically to ensure proper operation. Refer to the "Transmitter Programming" section of this manual for details regarding these tests.

6. Remove mechanical blocking devices (if used) and restore power to the output loads.

OPERATING THE CALIBRATION METER

The calibration meter allows the operator to calibrate and program the transmitter without opening the transmitter enclosure or triggering an alarm at the controller. It can also indicate the relative sensitivity of the sensor, enabling the operator to determine when replacement of the sensor is needed. In addition, the calibration meter can be used to aid in troubleshooting sensor and transmitter problems.

The calibration meter and transmitter communicate with each other by sending and receiving a coded light signal. Message signals are generated by LEDs that are located on the "puck" of the calibration meter and on the faceplate of the transmitter. The messages are received and interpreted using photocells, along with amplifying and decoding circuitry.

The calibration meter is turned on by pressing the MODE SELECT button. It automatically turns off approximately six seconds after it stops receiving data from the transmitter.

NOTE

When pressing the buttons on the calibration meter, press and hold the button momentarily until the proper response is observed.

If the light signal is weak or is blocked by dirt or other contamination on the transmitter window, the display on the calibration meter will flicker or become difficult to read. The "Poor Communication" indicator (center decimal point located below the colon on the display) will be illuminated.

The decimal point on the left side of the digital display flashes when the battery in the calibration meter needs to be replaced. The meter will continue to operate until the output of the LED is too low for the transmitter to detect.

NOTE

The battery must never be replaced in a hazardous area.

Various operating modes are available for testing and programming the transmitter using the calibration meter. See Flow Chart, Figure 17. Once a mode has been entered, a number of routines can be performed before exiting that mode. The INCREASE and DECREASE buttons are used to alter the operation of the transmitter. If these buttons are not pressed, the operator can step through all the routines (except P3, F3, F4 and CAL) without affecting the operation of the system. (The P3, F3 and F4 routines reset the unit to the factory programmed settings. Pressing ENTER in any of these modes automatically executes the function.) The ENTER button is used to end a routine and return the unit to normal operation.

All data changes are stored in permanent memory as each routine is completed. If power is interrupted before a routine is completed, the new data is lost and the old data is retained. If the calibration meter is removed before the ENTER button is pressed for the final time to exit the last routine, the transmitter will automatically restore the old data and return to normal operation (after a 10 minute waiting period).

MODE DISABLE SWITCHES

A set of four switches is provided to prevent accidental alarms or changes to the programmable features. These switches are located on the printed circuit board **inside the calibration meter**, which is illustrated in Figure 18. All switches are set in the "off" position and must be switched on to enable the desired function.

S1-1 is not used and should remain off.

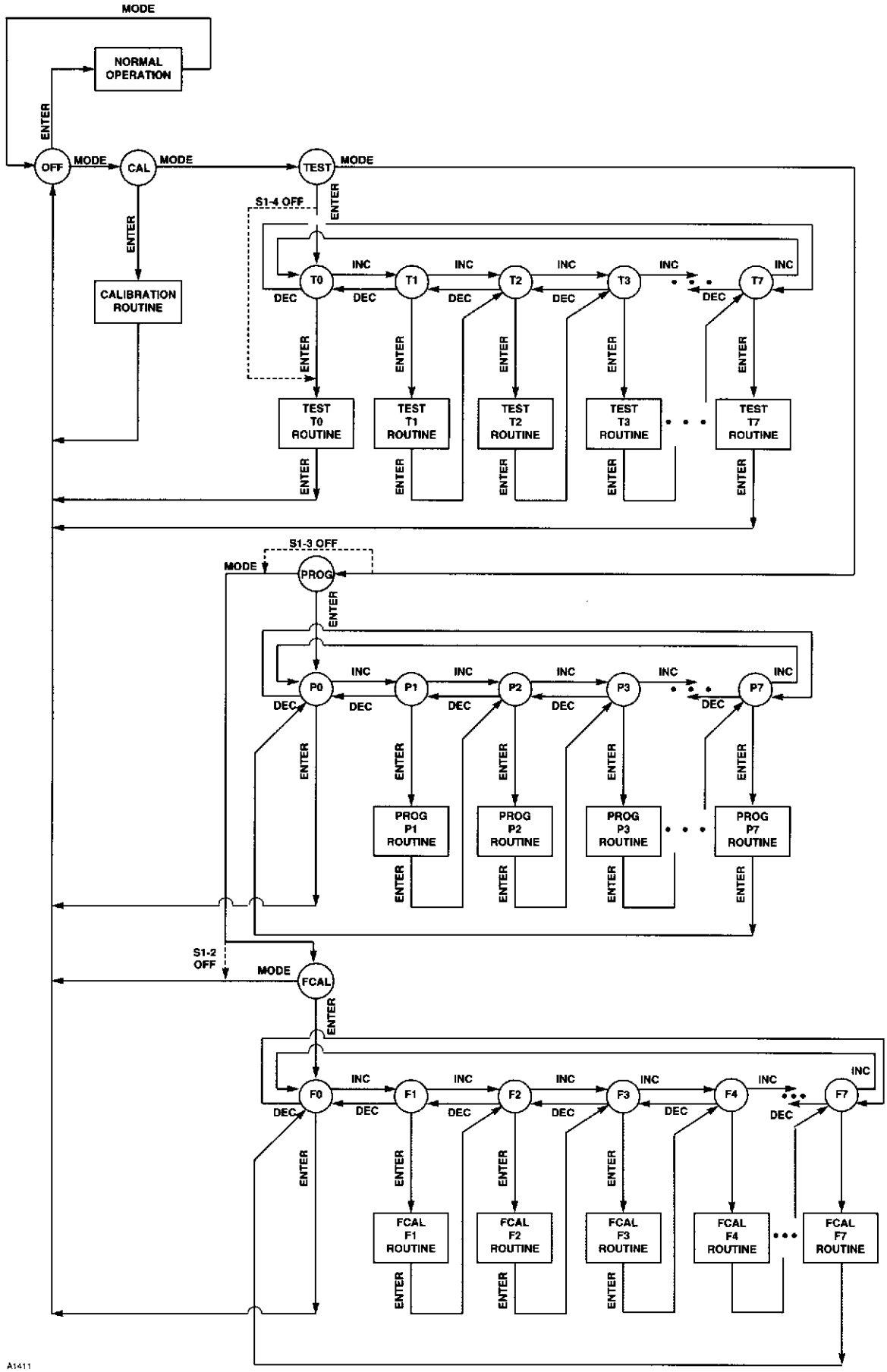

Figure 17—Calibration Meter Flow Chart

S1-2 must be on to calibrate the 4 to 20 ma output (FCAL routines).
S1-3 must be on to allow adjustments to the relay setpoints or other user programmable options.
S1-4 must be on to enable various system tests.

ERROR MESSAGES

Error codes are displayed on the calibration meter to identify various system problems. See Table 3.

Press ENTER or MODE SELECT to clear the error message and resume normal operations. All error messages except "ER:0" will be lost if power is removed.

CALIBRATION

Various factors affect the time interval between periodic calibrations. Since each application is different, the length of time between regularly scheduled calibrations can vary from one installation to the next. Calibration is typically performed at 30, 60, or 90 day intervals, depending on the conditions. Initially, it is recommended that calibration be performed at least every 30 days, until a longer interval is proven acceptable. In general, the more frequently a system is checked, the greater the reliability.

Calibration **must** be performed:

— Before a new system is initially put into service
— When the sensor is replaced
— If the transmitter module is replaced
— If the sensor is exposed to a high level of combustible gas.

CAUTION

Exposure to a high level of gas can have an adverse effect on the sensitivity of the sensing element. If the level of gas at the sensor should reach 100% LFL, it is important that it be tested and recalibrated if required. In some cases, it may be necessary to replace the sensor.

The user must exercise caution if an over-range reading is indicated, since a highly explosive condition could exist. The hazardous area should be checked with a portable detection instrument to determine the actual level of combustible gas present.

For best calibration results, allow a **new** sensor to operate for several hours to ensure a stable output before performing calibration. For the highest degree of accuracy, perform a second calibration after 24 hours.

When a sensor is exposed to a different or new environment, calibration should be checked frequently to determine the proper interval between periodic calibrations.

NOTE

Loss of sensitivity can be caused by various factors. A common cause is by clogging of the sin-

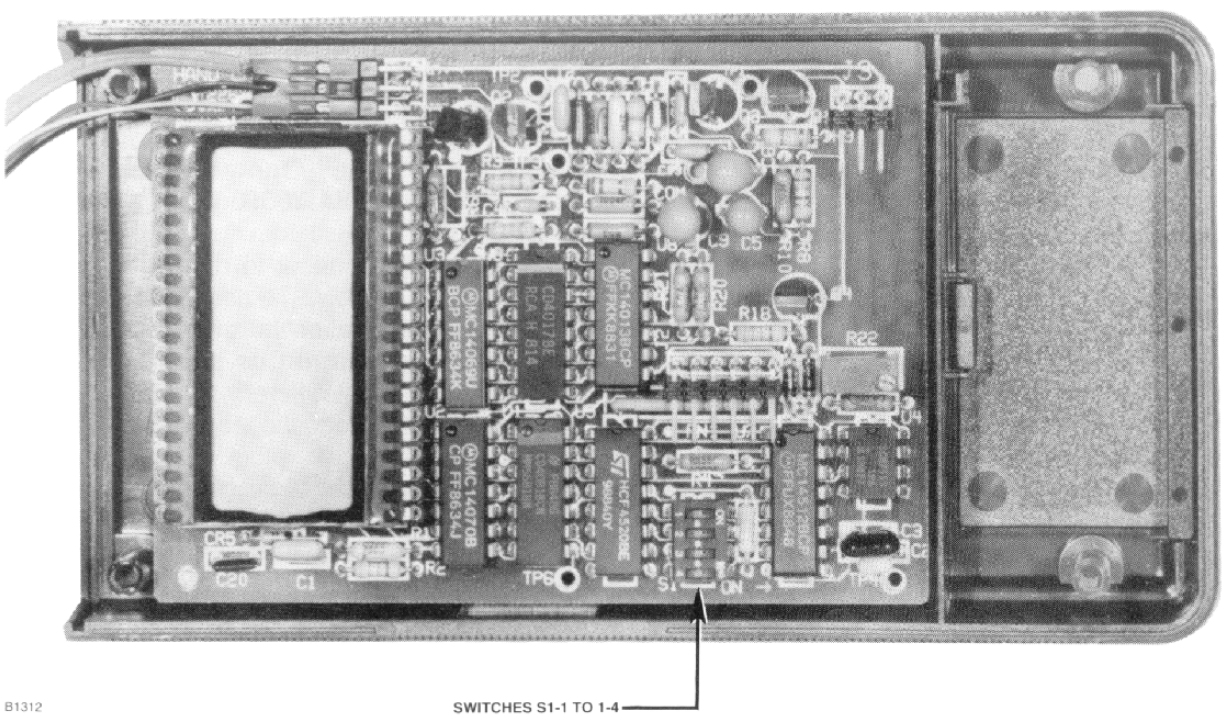

Figure 18—Mode Disable Switches

Table 3—Error Codes

Display	Possible Cause	Corrective Action
ER:0	Power is interrupted.	Press ENTER or MODE SELECT
ER:1	Calibration was attempted and not completed. (The transmitter will return to normal operation using the previous calibration data after 10 minutes.)	Press ENTER or MODE SELECT to clear, then calibrate.
	Puck removed without exiting.	Press ENTER or MODE SELECT to clear.
ER:2	Noise interference problem.	Press ENTER or MODE SELECT. Locate and remove source of noise, use shielded cable.
	Communication problem between the transmitter and calibration meter.	Clean window on detector cover and adjust the position of the puck on the window.
ER:3	Component or software failure.	Press ENTER or MODE SELECT.
ER:4	EEPROM failure	Simultaneously press ENTER and MODE SELECT. If normal operation is restored, the transmitter must be recalibrated and all programming options must be checked.
ER:5	Non-recoverable PROM/RAM failure.	Remove power and try a restart. If the failure persists, the unit must be returned to the factory for repair.
ER:6	Sensor zero drift exceeds –10% LFL or sensor is unplugged.	Recalibrate. Replace sensor, then recalibrate. Check sensor wiring.

tered metal filter by water, dirt, oil, paint, etc. Problems of this nature are capable of totally incapacitating the sensor. To ensure adequate protection, the gas detection system must be calibrated on a regular basis. Relay operation as well as current output signal should also be tested on a regular basis to ensure proper operation.

Before performing calibration, the operator should examine the sintered metal filter of the sensor (flame arrestor) to be sure that it is not missing or damaged. If the filter is defective or missing, the sensor **must not** be operated, since the exposed sensing element can act as an ignition source. It should also be noted that a dirty filter can significantly reduce the sensitivity of the sensor.

If a dust cover or splash shield is used, it should be checked to ensure that it is not dirty or plugged. A plugged dust cover can restrict the flow of gas to the sensing element, seriously reducing its effectiveness. For optimum performance, sensor covers/filters should be replaced at each calibration to ensure that they have not been degraded or plugged. To ensure accuracy, calibration should be performed with filters in place wherever possible.

CONVERSION (K) FACTOR

The output of the sensor to different types of gases can vary considerably. To ensure accuracy, it is recommended that calibration be performed using a gas/air mixture of the gas that is intended to be detected. If several different combustible gases can be present, calibrate to the least detectable gas.

If a calibration mixture of the gas to be detected is not available, the detector can be calibrated with a standard calibration gas using an appropriate "K" factor. The "K" factor is used to calculate the span value that is entered into the microprocessor in place of the standard calibration gas % LFL concentration. The "K" factor represents the relationship between the gas to be detected and the gas type to be used for cali-

bration. A "K" factor value of "1" is optimum.
To calculate the span value that will be programmed into the microprocessor, use the following formula.

$$S = C \times K$$

S = Calibration gas setting
C = LFL percentage of gas being used
K = Conversion factor

For example, assume that 50% LFL methane will be used for calibrating a detector that will detect a gas with a "K" factor of 1.2. Using the above formula, 50% (C) is multiplied by 1.2 (K) to arrive at a calibration gas setting of 60% (S). The value "60" must then be used when entering the span value into the microprocessor.

IMPORTANT

Accurate calibration depends on the use of the correct K factor. The process of determining the correct K factor involves considering the type and LFL percentage of the calibration gas being used, as well as the type of gas to be detected. In addition, since K factors can vary from one sensor model to the next, the type of sensor must also be considered. Contact Detector Electronics to determine or verify the correct K factor to be used. If a K factor for a specific compound is not available, a K factor can be established using a sample of the material to be detected. Contact the factory for details.

CALIBRATION PROCEDURE

Calibrate the system using the following procedure.

NOTE

If the sensor is being replaced, refer to the "Sensor Replacement" section (under "Maintenance") in this manual for information regarding both sensor replacement and calibration.

1. Verify that the area is safe for entry (no dangerous levels of either toxic or combustible gas are present).

2. Hold the calibration meter puck by the spring clip and squeeze to compress the spring. Place the puck on the window of the transmitter and release the spring clip. It should grip the cover behind the red label.

3. Turn the calibration meter on by pressing the MODE SELECT button. See Figure 19. The display should show OFF. (If the display shows "Er:X" press ENTER to clear it. See Table 3 for an interpretation of error codes. If a proper display does not appear, try cleaning the window or adjusting the position of the puck.)

4. Press the MODE SELECT button. The display will show CAL.

5. Press the ENTER button. The meter will show "SET LO, C0:XX." "XX" is the present sensor reading.

6. Be sure that only clean air (0% LFL) is present at the sensor.

NOTE

If background gas is present, it may be necessary to purge the sensor with clean air to assure accurate calibration. The practice of placing your hand over the sensor during the zero portion of the calibration procedure is not recommended. If the level of background gas exceeds 5% LFL or if the sensor output drifts to greater than 5% LFL, the transmitter will not accept the sensor output for the zero value. The calibration meter will indicate "bad" and the calibration procedure will automatically be ended.

When a stable reading is displayed, press ENTER. The display should now show "SET SPAn C1:XX."

7. Apply the calibration gas mixture.

8. When the reading on the calibration meter stabilizes (typically within 2 to 3 minutes), press the INCREASE or DECREASE button to adjust the reading on the display to match the level of the applied calibration gas.

NOTE

The calibration meter will indicate "Lo Sen" (low sensor sensitivity) when the sensor is approaching the end of its useful life.

9. Press ENTER to save the calibration data and end the calibration procedure. The sensor sensitivity will be displayed briefly, then the meter will alternately display "GAS" and the level of the gas present at the sensor. If the display should indicate "bad", the sensor must be replaced and the calibration procedure must be repeated. If the display shows "bad" or "Lo Sen," press and hold ENTER to exit.

NOTE

Sensor sensitivity is displayed as a two-digit

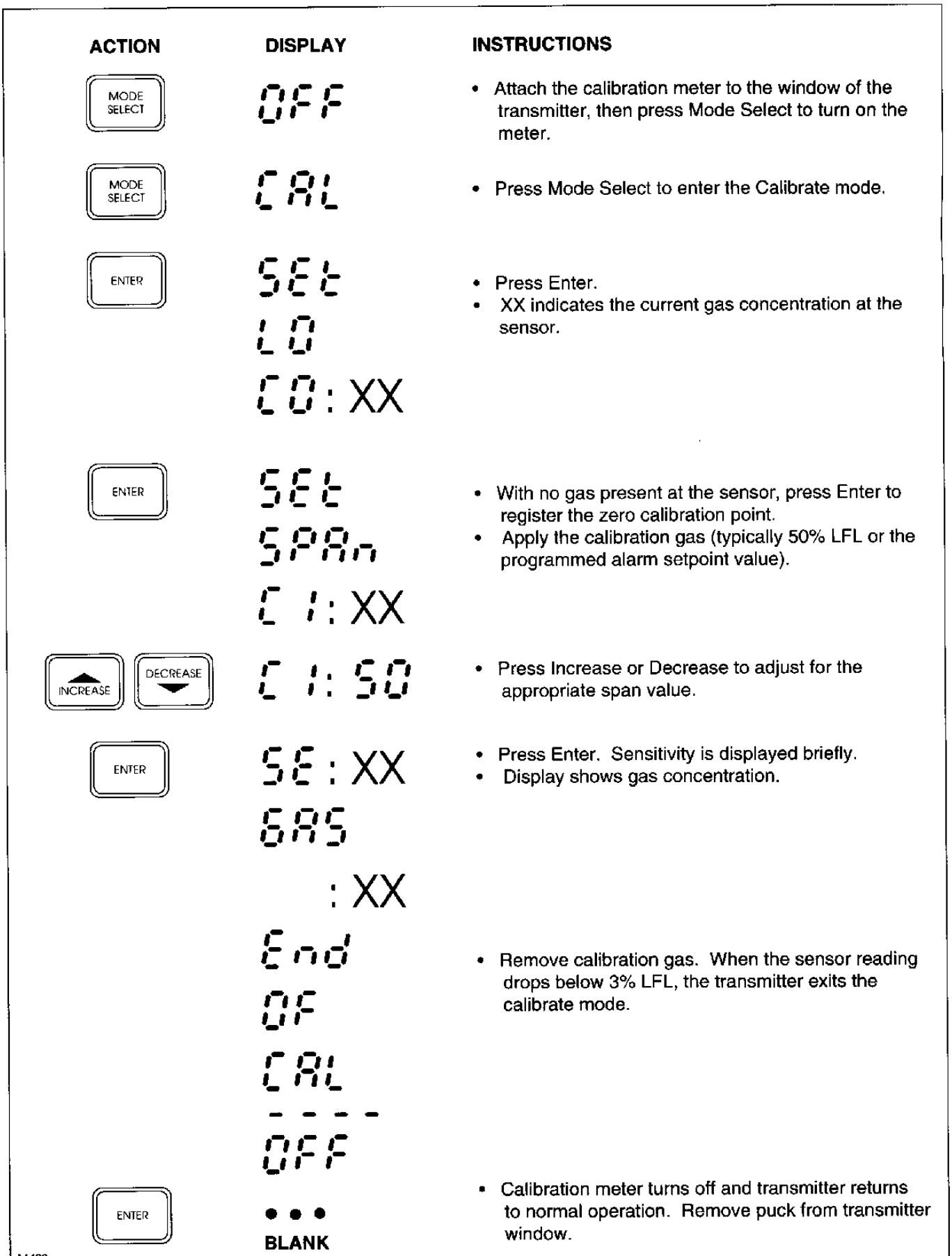

Figure 19—Transmitter Calibration

number (0 to 99). The larger this number, the greater the sensitivity of the sensor. Some sensors with a sensitivity reading near 0 can still provide reliable service and in some cases can still be successfully calibrated. In general, a sensitivity reading below 10 indicates that the sensor is approaching the end of its useful life. Sensor replacement may be needed at the next scheduled calibration.

10. Shut off the gas flow and remove the calibration cup from the sensor. The "GAS" message will continue until the gas level drops below 3% LFL or 90 seconds go by.

NOTE

If power was interrupted during the calibration procedure, the transmitter will automatically return to the normal mode 90 seconds after the "GAS" message appears. If the gas level at the sensor is above an alarm setpoint at this time, an alarm output will be generated.

11. The meter will display "END OF CAL" followed by "OFF." Press ENTER to turn off the calibration meter and return the transmitter to normal operation.

12. Remove the calibration meter from the transmitter.

NOTE

If the calibration meter is removed prematurely, the transmitter will automatically return to the normal operating mode after a ten minute period.

NOTE

If power to the transmitter is interrupted during the calibration procedure, the transmitter will automatically return to the beginning of the calibration procedure when power is restored and the calibration meter is connected.

NOTE

To safely exit the calibration mode at any point without affecting calibration (no gas can be present at the sensor and the calibration meter must read 0% LFL), press ENTER (one or more times, depending on the point in the procedure) until the display shows OFF. Disregard any response messages from the calibration meter. Press ENTER once more to turn off the meter. The transmitter will return to the normal operating mode and use the previous calibration data.

TRANSMITTER PROGRAMMING

If the transmitter is equipped with the optional relay board, it must be programmed before being placed in service. Each relay must be programmed for the gas concentration at which it will set (change state upon reaching the alarm setpoint level) and reset (return to its non-alarm state). In addition, four different operating modes are available for each relay to provide the set/reset characteristics required for the specific installation. The following operating modes are available:

1. **Non-Latching, Remote Reset Switch Disabled—** The relay is set when the gas concentration at the sensor reaches the alarm setpoint level and automatically resets when the gas concentration drops below the programmed reset level. The remote reset switch has no effect on relay operation in this mode.

2. **Latching, Switch Reset *Below* Reset Level—** The relay is set when the gas concentration at the sensor reaches the alarm setpoint level. The relay can be reset using the external reset switch when the level of gas goes *below* the programmed reset level.

3. **Latching, Switch Reset at *Any* Level—** The relay is set when the gas concentration at the sensor reaches the alarm setpoint level. The relay is reset using the external reset switch at any time, even if the gas level is above the reset level. However, after the relay is reset, it cannot be set again until the gas concentration at the sensor drops below the reset level and then rises to the programmed set level.

4. **Latching, Calibration Meter Reset—** The relay is set when the gas concentration at the sensor reaches the alarm setpoint level and must be reset using the calibration meter.

CALIBRATION METER RESET

When resetting the relays with the calibration meter, the gas concentration at the sensor must be below the programmed reset level for the relays to remain reset. If the gas concentration is above the reset level, the relay will return to the alarm condition when the calibration meter is removed. To reset the relays, attach the calibration meter to the transmitter enclosure and turn on the meter by pressing the MODE SELECT button. The relays will reset. The meter can be turned off by pressing MODE SELECT until "OFF" is displayed, and then pressing ENTER.

FACTORY SETTINGS

The factory settings for the transmitter are as follows. (To return the transmitter to the factory settings, perform routine P3 or F3.)

Relay 1 Set level = 20% LFL
Reset level = 15% LFL
Operating mode = Auto Reset with Reset switch input disabled
(Use routine P1 for changes.)

Relay 2 Set level = 40% LFL
Reset level = 35% LFL
Operating mode = Auto Reset with Reset switch input disabled
(Use routine P2 for changes.)

Signal Output During Calibration = –2% LFL (3.68 ma)

Alternating Signal Feature = Off
(Use routine P4 for changes.)

MODE SELECTION

The calibration meter operates in any of the following modes.

Calibrate— Used to calibrate the system.

Off— Used to terminate communication between the calibration meter and the transmitter.

Test— Used to perform various system tests (switch S1-4 must be on to enable this mode.)

Program— Used to select setpoints, relay reset options, and various other system options. (Switch S1-3 must be on to enable this mode.)

FCAL— Used to calibrate the 4 to 20 ma output. (Switch S1-2 must be on to enable this mode.)

To turn the calibration meter on, press the MODE SELECT button. See Figure 17. The meter displays "OFF." To exit and return to the normal operating mode press "ENTER." To enter one of the other modes, press the MODE SELECT button until the desired mode is indicated on the display, then press "ENTER" to enter that mode.

After exiting a mode, the unit will return to the "OFF" mode. The operator can then select and enter another mode, or **turn the calibration meter off** by pressing ENTER.

NOTE

If the calibration meter is removed before selecting "OFF," the transmitter will automatically return to the normal operating mode after a 10 minute waiting period.

PROGRAMMING PROCEDURES

Programming changes are made to the Model 405B Transmitter by performing the following routines using the Program mode. (Switch S1-3 inside the calibration meter must be on.)

P0

The P0 routine is used to exit the Program mode. With "P0" displayed on the calibration meter, press ENTER. The meter will show "OFF." Press MODE SELECT to select a different mode, or press ENTER to turn the calibration meter off.

P1

The P1 routine allows the operator to program the set and reset levels for relay number 1, and also determines the method of resetting the relay.

1. Press the MODE SELECT button to show "prog" on the display. See Figure 20.
2. Press ENTER. The display shows "P0."
3. Press INCREASE to advance to "P1."
4. Press ENTER. The display shows "relay.1," "St:XX." "XX" is the present alarm setpoint. Press INCREASE or DECREASE to display the desired relay set level.
5. Press ENTER. The display shows "rt:XX." "XX" is the relay reset point.
6. Press INCREASE or DECREASE to display the desired relay reset level.
7. Press ENTER. The display shows "r1:XX."
8. Program the relay operating mode by pressing INCREASE or DECREASE to achieve the desired reading. (See Figure 20.)
9. Press ENTER. The display shows four dashes and then "P2."
10. To continue with routine P2, press ENTER (step 4 below). To exit, press DECREASE to show "P0" on the display. (The display must show "P0" to exit this operating mode.) Press ENTER. The display shows "OFF." Press ENTER to return to normal operation. (See "Mode Selection" section for

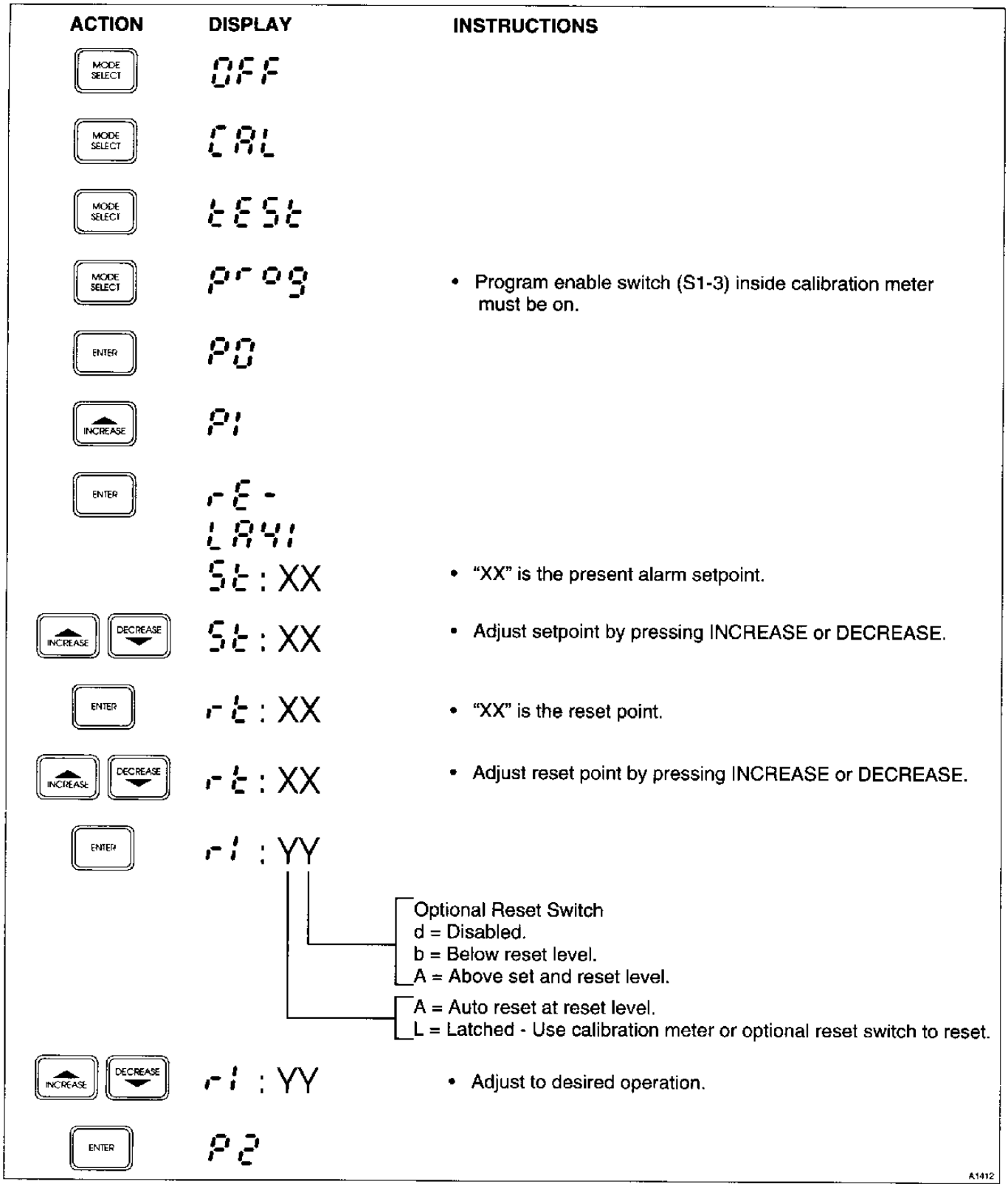

Figure 20—P1 Routine

information regarding selection of a different operating mode or turning off the calibration meter.)

P2

The P2 routine allows the operator to program the set and reset levels for relay number 2, and also determines the method of resetting the relay.

1. Press the MODE SELECT button to show "prog" on the display. See Figure 21.
2. Press ENTER. The display shows "P0."
3. Press INCREASE to advance to "P2."
4. Press ENTER. The display shows "relay.2," "St:XX." "XX" is the present alarm setpoint. Press INCREASE or DECREASE to display the desired relay set level.
5. Press ENTER. The display shows "rt:XX." "XX" is the relay reset point.
6. Press INCREASE or DECREASE to display the desired relay reset level.
7. Press ENTER. The display shows "r2:XX."
8. Program the relay operating mode by pressing INCREASE or DECREASE to achieve the desired reading. See Figure 21.
9. Press ENTER. The display shows four dashes and then "P3."
10. To continue with P3, press ENTER (step 4 below). To exit, press DECREASE to show "P0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

P3

The P3 routine is used to program the transmitter to the factory settings.

CAUTION

Pressing ENTER while P3 is displayed on the meter will restore the factory default settings for the alarm relays.

1. Press the MODE SELECT button to show "Prog" on the display. See Figure 22.
2. Press ENTER. The display shows "P0."
3. Press INCREASE to advance to "P3."
4. Press ENTER. The display shows four dashes followed by "Std OPt SEt," followed by "P4."
5. To continue with P4, press ENTER (step 4 below). To exit press DECREASE to show "P0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

P4

The P4 routine allows the operator to program the current output level that will be generated while the transmitter is in the calibrate mode. Two different adjustments are possible:

— Output amplitude. The adjustment range is from –25 to 100% LFL (0 to 20 milliamperes).

— Flashing option. The transmitter offers the option of alternating this signal level with 4.0 milliamperes (0% LFL) to achieve a unique "flashing" signal during calibration.

1. Press the MODE SELECT button to show "prog" on the display. See Figure 23.
2. Press ENTER. The display shows "P0."
3. Press INCREASE to show "P4" on the display.
4. Press ENTER. The display shows "P4:XX." "XX" is the calibration output signal level in % LFL. Note that the signal output changes as this value is adjusted.
5. Press INCREASE or DECREASE to select the desired level.
6. Press ENTER. The display shows "F:OFF." Press INCREASE or DECREASE to switch the flashing feature on or off.

   OFF— Transmitter generates a steady signal (amplitude selected in step 4 above) during calibration.

   ON— Two different signal levels (4 ma and the value programmed in step 4 above) are alternately generated during calibration.

7. Press ENTER. The display shows four dashes followed by "P5." To exit press DECREASE to show "P0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

P5, P6 and P7

Do not use.

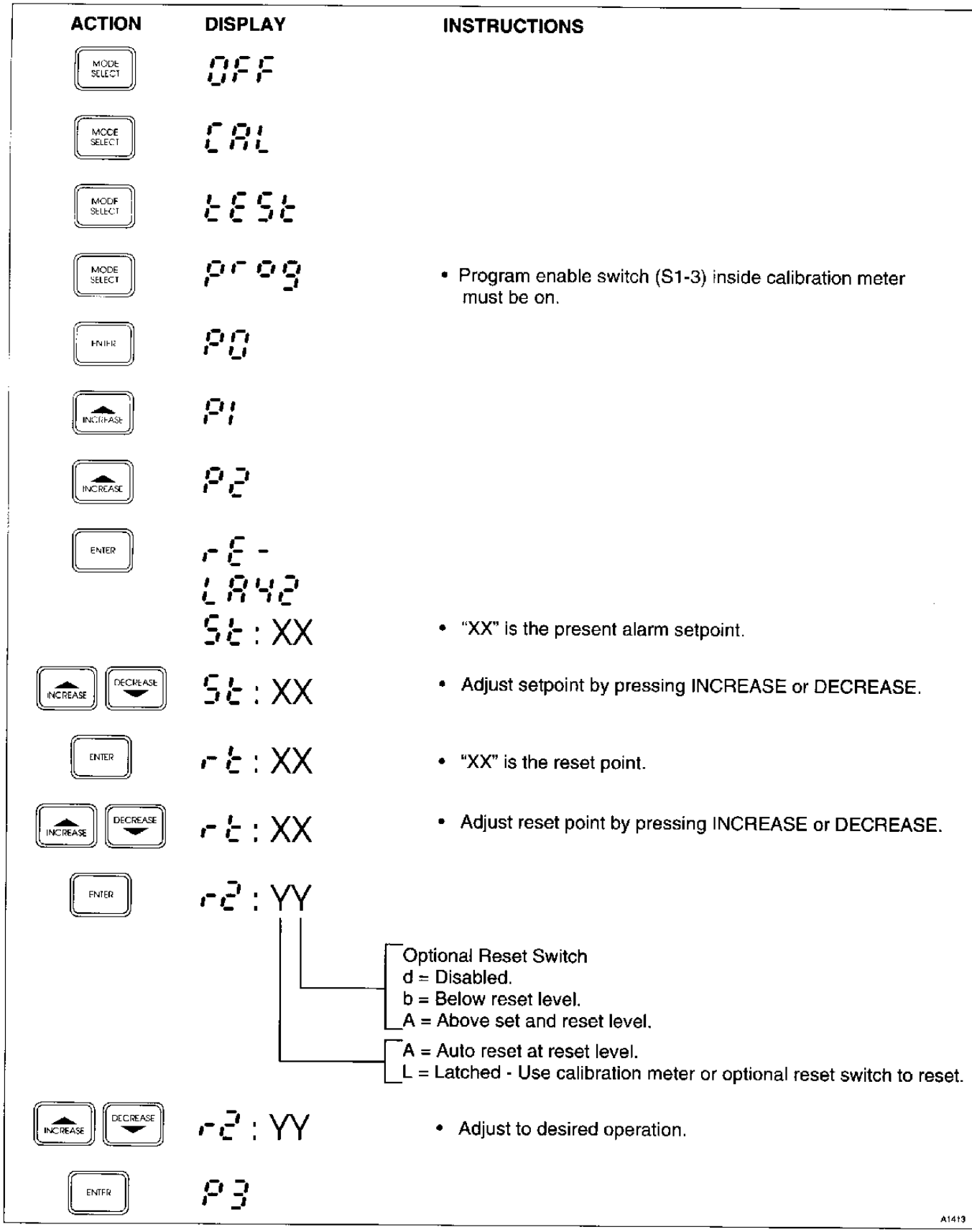

Figure 21—P2 Routine

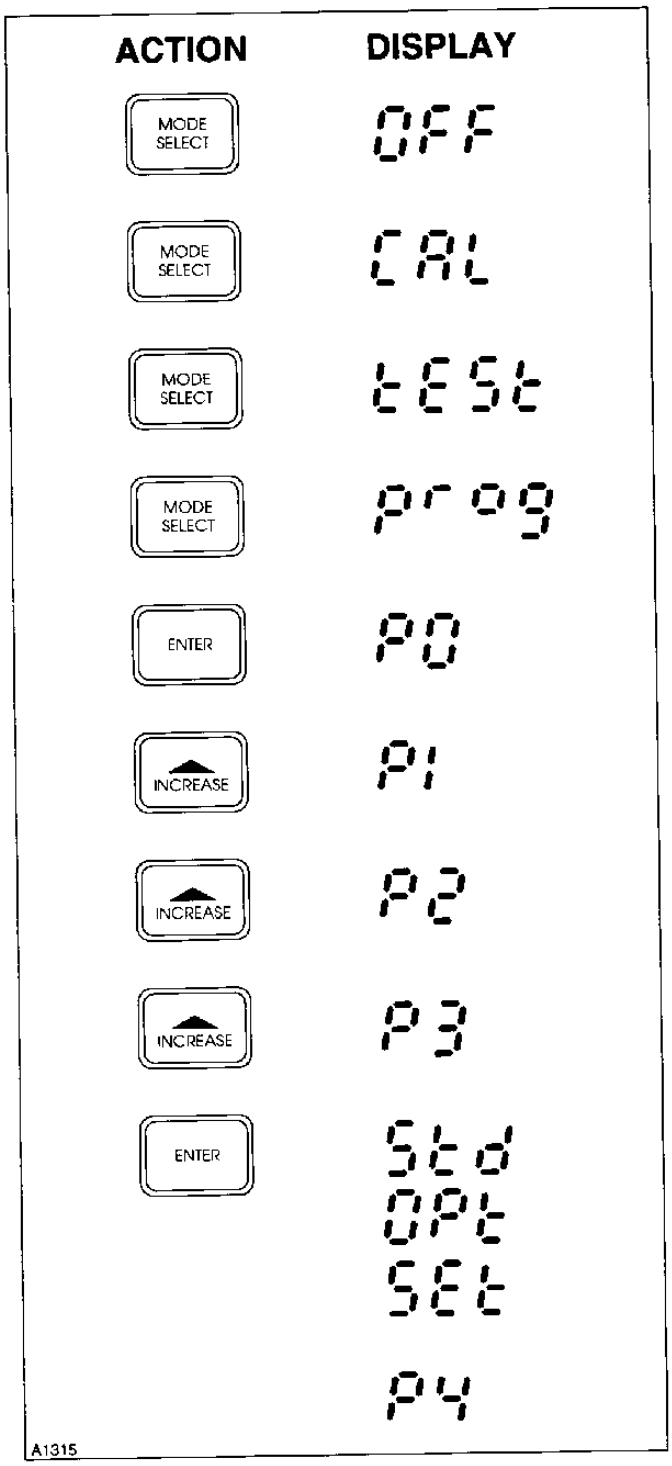

Figure 22—P3 Routine

FCAL

FCAL is a mode that is used to calibrate the 4 to 20 milliampere output signal. (Switch S1-2 inside the calibration meter must be on.)

F0

The F0 routine is used to exit the FCAL mode. With "F0" displayed on the calibration meter, press ENTER. The meter will show "OFF." Press MODE SELECT to select a different mode, or press ENTER to turn off the calibration meter.

F1

The F1 routine allows the operator to fine tune the transmitter output signal for precisely 4.0 ma with 0% LFL at the sensor.

NOTE

If an alarm setpoint of a monitoring device is exceeded, an alarm output will be generated. It should also be noted that an adjustment to the current output can affect the calibration current level (refer to routine P4).

1. Press the MODE SELECT button to show "FCAL" on the display.
2. Press ENTER. The display shows "F0."
3. Press INCREASE to advance to "F1."
4. Press ENTER. While monitoring the current output, press INCREASE or DECREASE to adjust the output to 4.0 ma, ±0.02 ma. (The display will show an increasing or decreasing reference number.)

NOTE

Holding the INCREASE or DECREASE button for 3 seconds will cause the output to change at a rapid rate.

5. Press ENTER. The display shows four dashes followed by "F2."
6. To continue with the F2 routine, press ENTER (step 4 below). To exit, press DECREASE to show "F0" on the display. (The display must show "F0" to exit this operating mode.) Press ENTER. The display shows "OFF." Press ENTER to return to normal operation. (See "Mode Selection" section for information regarding selection of a different operating mode or turning off the calibration meter.)

F2

The F2 routine allows the operator to fine tune the transmitter output signal for precisely 20.0 ma with 100% LFL at the sensor.

NOTE

If an alarm setpoint of a monitoring device is exceeded, an alarm output will be generated. It

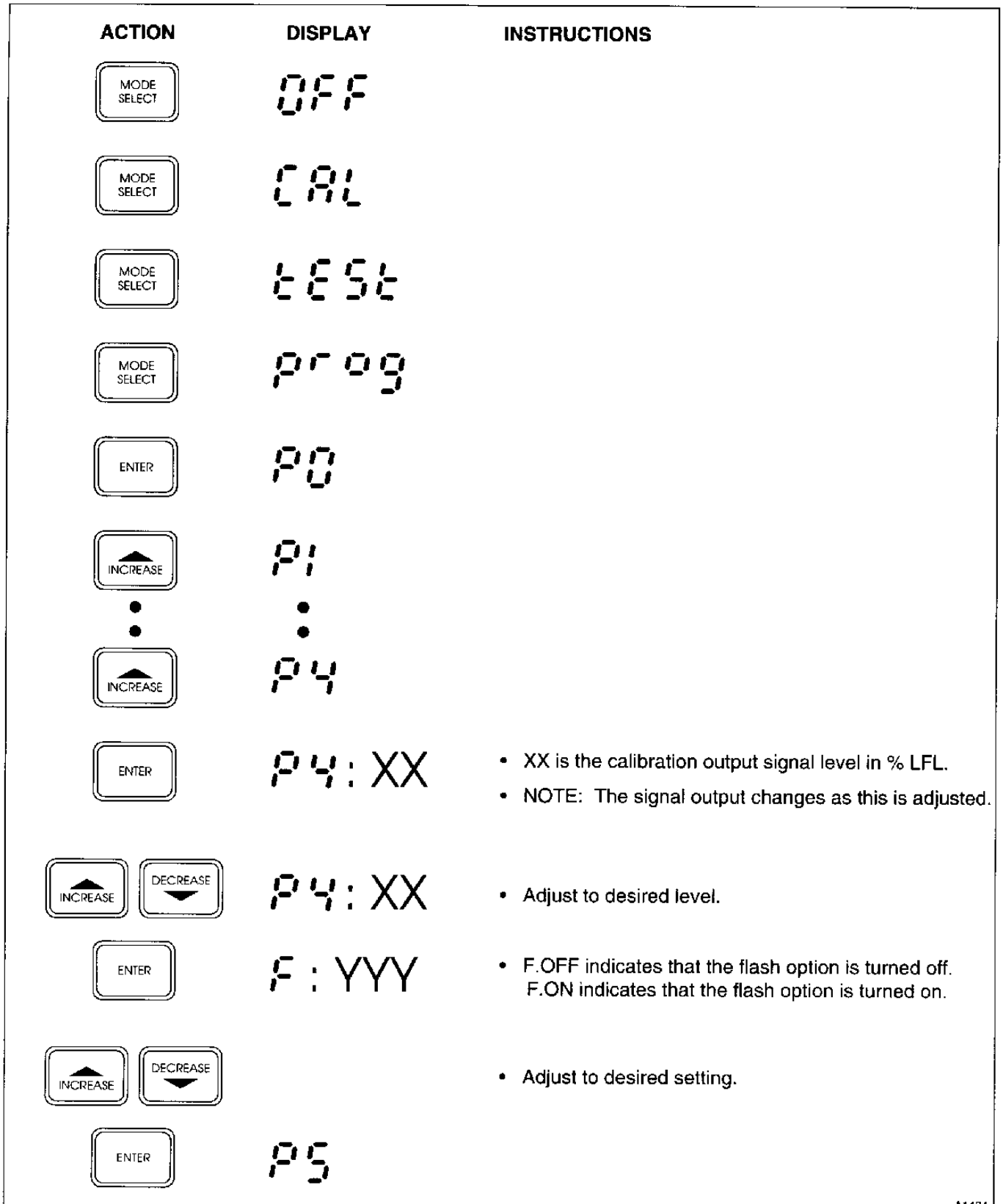

Figure 23—P4 Routine

should also be noted that an adjustment to the current output can affect the calibration current level (refer to routine P4).

1. Press the MODE SELECT button to show "FCAL" on the display.
2. Press ENTER. The display shows "F0."
3. Press INCREASE to advance to "F2."
4. Press ENTER. While monitoring the current output, press INCREASE or DECREASE to adjust the output to 20.0 ma, ±0.02 ma. (The display will show an increasing or decreasing reference number.)

NOTE

Holding the INCREASE or DECREASE button for 3 seconds will cause the output to change at a rapid rate.

5. Press ENTER. The display shows four dashes followed by "F3."
6. To continue with F3 (F3 programs the transmitter to the factory settings), press ENTER (step 4 below). To exit, press DECREASE to show "F0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

F3

The F3 routine is used to reset the transmitter to the factory settings (same as P3).

1. Press the MODE SELECT button to show "FCAL" on the display.
2. Press ENTER. The display shows "F0."
3. Press INCREASE to advance to "F3."
4. Press ENTER. The display shows 4 dashes followed by "Std Opt Set," followed by F4. To exit press DECREASE to show "F0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

F4

The F4 routine (calibration options reset) is used to reset the 4 to 20 ma current loop and the sensor calibration values to the factory default settings.

CAUTION

Pressing ENTER with F4 displayed on the calibration meter restores the factory default calibration settings, which will invalidate any previous sensor and current loop calibrations.

1. Press the MODE SELECT button to show "FCAL" on the display.
2. Press ENTER. The display shows "F0."
3. Press INCREASE to advance to "F4."
4. Press ENTER. The calibration meter display reads "Cal Opt rset," followed by F5. To exit press DECREASE to show "F0" on the display. Press ENTER. The display shows "OFF." Press ENTER to return to normal operation.

F5 to F7

Not used.

SYSTEM TESTS

The following system tests are performed using the Test mode. (Switch S1-4 should be on at this time.)

T0

T0 is used to exit the Test mode. To exit, with T0 displayed, press and hold the ENTER button until the display shows four dashes. Release ENTER. The display shows "OFF." Press MODE SELECT to select a different operating mode or press ENTER to turn off the calibration meter.

T0 is also used to display the position of the calibration meter switches.

1. Press the MODE SELECT button to display "test" on the digital display. See Figure 24.
2. Press ENTER. The display shows "t0."
3. Press ENTER. The display shows the switch positions using the pattern illustrated in Figure 24.
4. To exit, press and hold ENTER until the display shows 4 dashes. Release ENTER; the display shows "OFF." Press ENTER to return to normal operation.

Test T1

Test T1 gives a direct % LFL reading on the calibration meter and is useful for verifying proper operation of the entire system from the sensor to the controller. The dc current output and the optional relays are **not** disabled during this test.

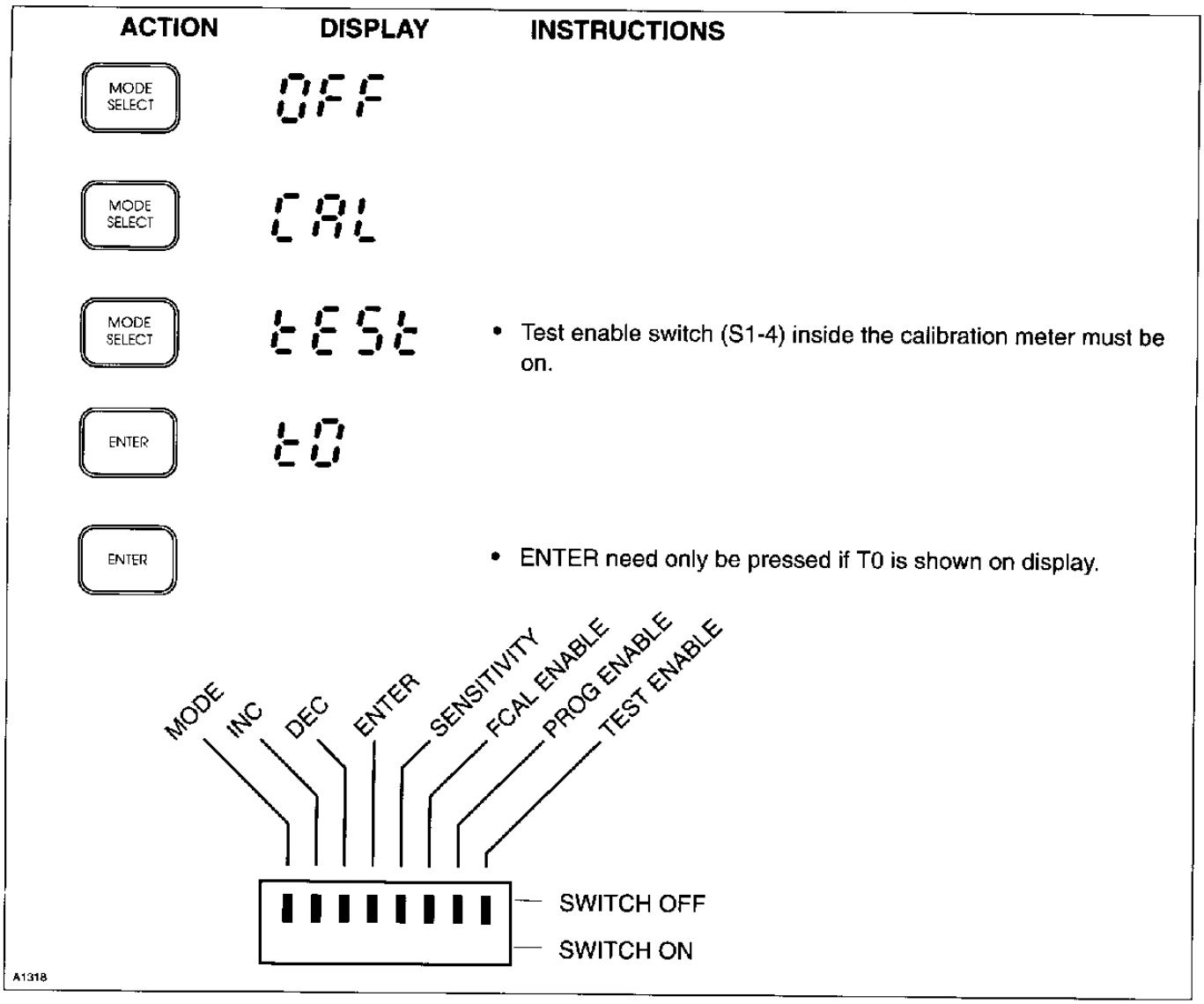

Figure 24—T0 Routine

1. Press the MODE SELECT button to display "test" on the digital display. See Figure 25.

2. Press ENTER. The display shows "t0."

3. Press INCREASE to advance to "t1."

4. Press ENTER. The display shows "t1:XX." "XX" is the LFL percentage of gas currently being detected at the sensor.

5. Press ENTER. The display shows "t2."

6. To continue with T2, press ENTER (step 4 below). To exit, press DECREASE to show "t0." (The display must show "t0" to exit the test mode.) Press and hold ENTER until the display shows 4 dashes. Release ENTER, the display shows "OFF." Press ENTER to return to normal operation. (See "Mode Selection" section for information regarding selection of a different operating mode or turning off the calibration meter.)

Test T2

Test T2 allows the operator to actuate the relays on the relay board. It also indicates a signal from the optional external reset switch. Since the relays are unsupervised, this test should be performed regularly to ensure proper system operation.

CAUTION

This routine causes actuation of the alarm relays. Response devices that are connected to the relays should be disabled to prevent unwanted activation.

1. Press the MODE SELECT button to show "test" on the digital display. See Figure 26.

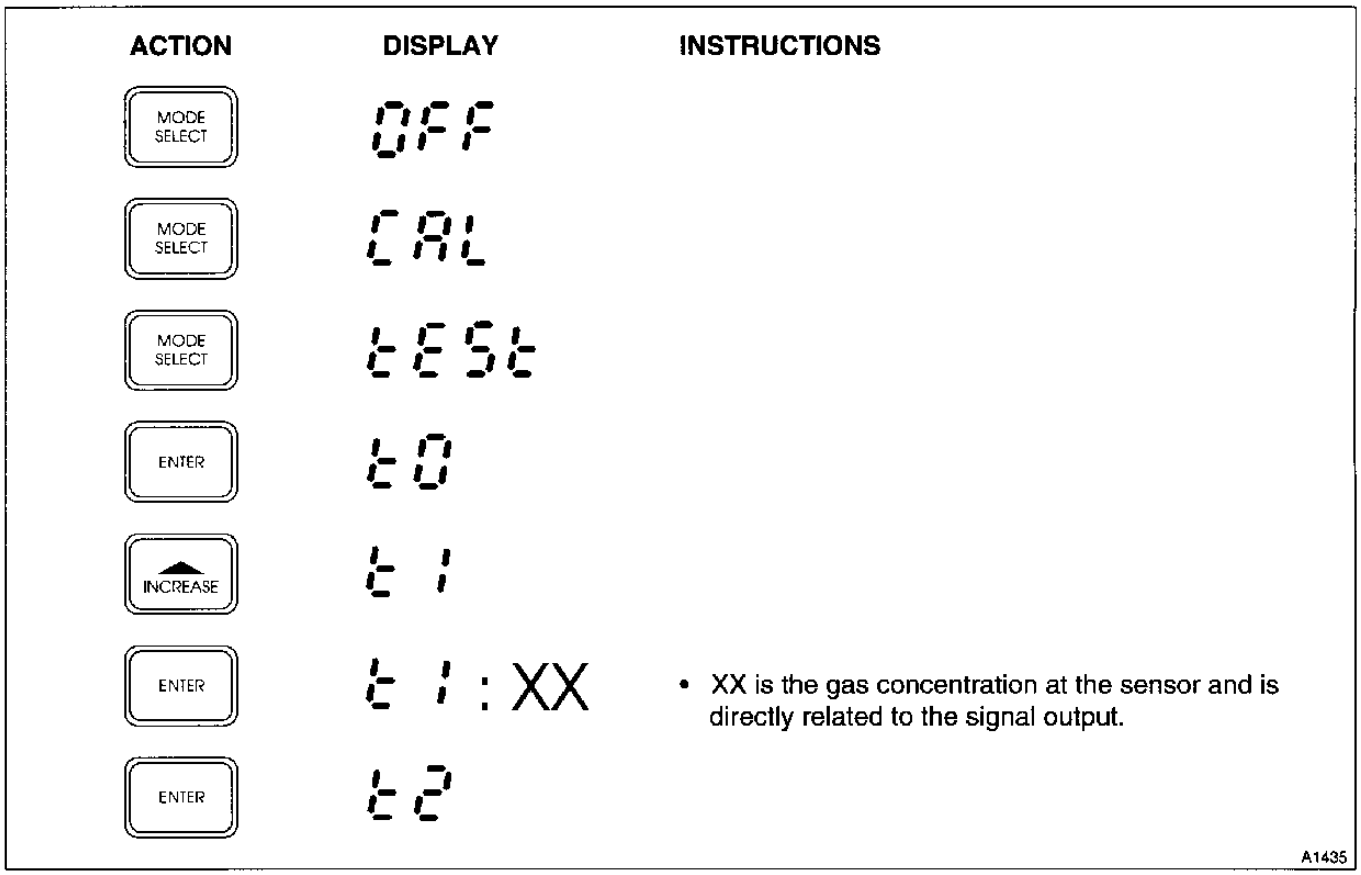

Figure 25—T1 Routine

2. Press ENTER. The display shows "t0."

3. Press INCREASE to advance to "t2."

4. Press ENTER. The display shows the pattern illustrated in Figure 26. An "on" indication means that the relay is in its alarm state. The reset switch indicator goes to the "on" position when the reset switch contacts are closed.

5. Press INCREASE or DECREASE to change the relay states.

6. Press ENTER. The display shows "t3."

7. To exit press DECREASE to show "t0." Press and hold ENTER until the display shows 4 dashes. Release ENTER, the display shows "OFF." Press ENTER to return to normal operation.

Test T3

A factory test. Do not use.

Test T4

Test T4 allows the operator to vary the output signal from the transmitter. The corresponding LFL percentage is shown on the digital display.

CAUTION

This routine causes an increase in the dc current output signal. Alarm response devices should be disabled to prevent unwanted actuation.

1. Press the MODE SELECT button to show "test." See Figure 27.

2. Press ENTER. The display shows "t0."

3. Press INCREASE to show "t4."

4. Press ENTER. The display shows "t4:XX." "XX" is the % LFL level of the output signal.

5. Press INCREASE or DECREASE to test controller response to the varying output signal from the transmitter.

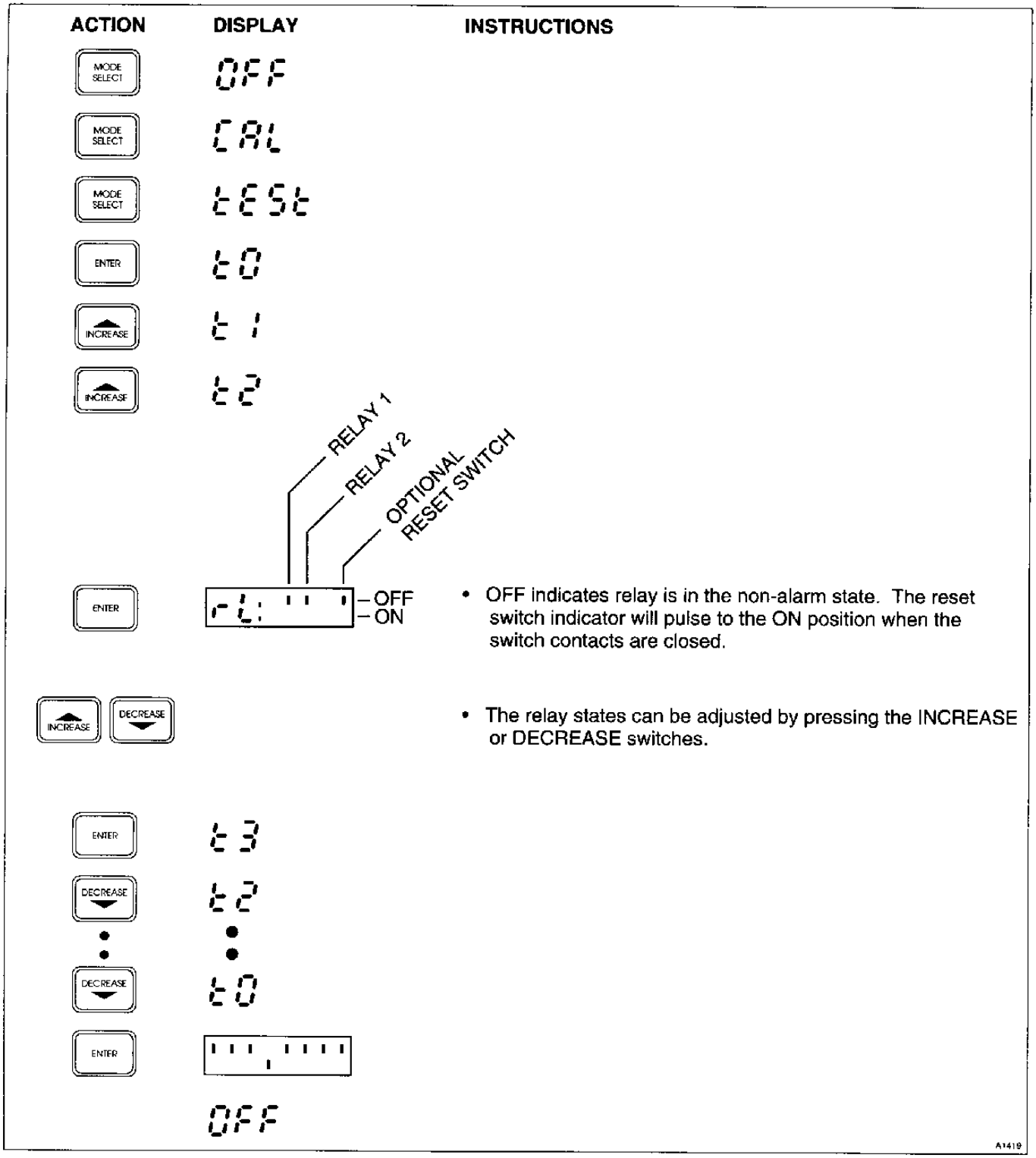

Figure 26—T2 Routine

6. Press ENTER. The display shows "t5."

7. To exit, press DECREASE to show "t0" on the display.

8. Press and hold ENTER until the display shows 4 dashes. Release ENTER, the display shows "OFF." Press ENTER to return to normal operation.

Tests T5 to T7

Factory tests. Do not use.

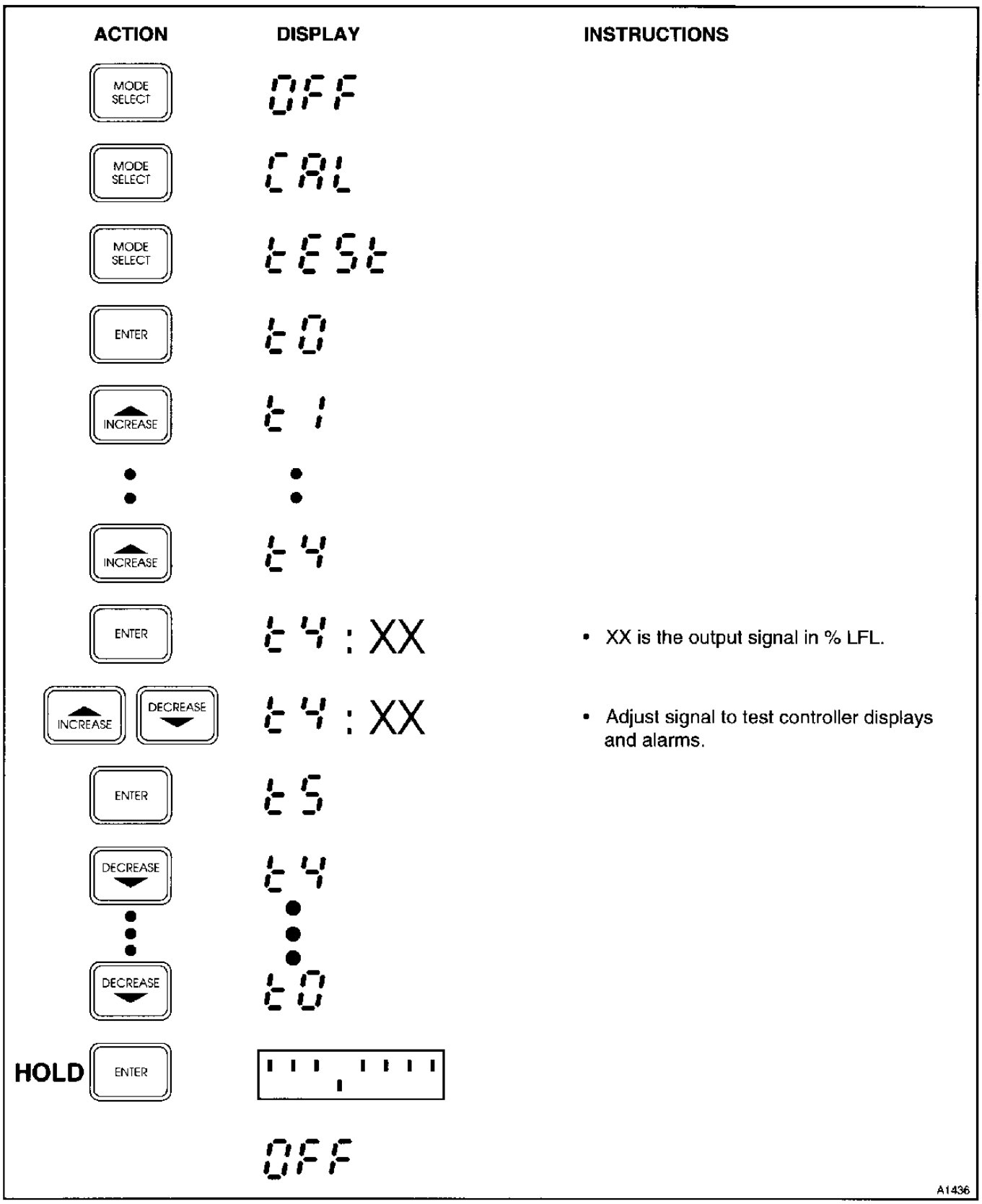

Figure 27—T4 Routine

Section IV
System Maintenance

ROUTINE MAINTENANCE

It is important to check and calibrate the gas detection system on a regularly scheduled basis to ensure that it will deliver reliable protection. The frequency of these checks is determined by the requirements of the particular installation.

VISUAL INSPECTION

The operator should frequently inspect the sintered metal filter on the front of the sensor housing. A dirty filter can significantly reduce the amount of gas that is able to reach the sensing element, thereby impairing the ability of the system to respond to a hazardous condition. If the filter becomes dirty and cannot be properly cleaned or if it is damaged, it must be replaced. DO NOT operate the detector if the filter is damaged or missing, since the sensor could act as an ignition source.

MANUAL CHECK OF OUTPUT DEVICES

Fault detection circuitry continuously monitors for various problems that could prevent proper response to a dangerous level of combustible gas, however, it does not monitor external equipment that is actuated by the detection system. It is important that these devices be checked initially when the system is installed, as well as periodically during the ongoing maintenance program.

CHECKOUT IN NORMAL MODE

The entire system should be checked periodically to ensure that the presence of gas at the sensor will result in the proper system response. Refer to the "Transmitter Programming" section for information regarding system tests using the calibration meter.

CAUTION

Be sure to secure all output devices that are controlled by the system to prevent unwanted actuation of this equipment, and remember to place these same output devices back into service when the checkout is complete.

SENSOR REPLACEMENT

NOTE

A dirty filter can adversely affect the response of the sensor by blocking the flow of gas to the sensing element. If the detector cannot be calibrated or responds slowly to the calibration gas, check the condition of the filter before replacing the sensor.

To replace the sensor:

1. De-classify the area prior to replacing the sensor.
2. Begin the normal calibration procedure as described in the "Calibration" section of this manual. Stop after completion of step 5 when the display shows C0:XX. (With the transmitter in the calibrate mode, the controller will not generate either a fault or an alarm output.)
3. Remove power from the transmitter. (When power is restored, the transmitter will return to the calibrate mode.)

NOTE

If power to the transmitter is interrupted during the calibration procedure, the transmitter will automatically return to the beginning of the calibration procedure when power is restored and the calibration meter is connected.

4. Remove the cover from the transmitter enclosure (or sensor separation kit junction box if one is being used).
5. Unplug the sensor and unscrew it from the conduit entry.
6. Coat the threads of the new sensor with the appropriate grease (part number 005003-001), then screw the sensor into the conduit entry and connect the plug at the appropriate location.
7. Place the cover back on the transmitter enclosure or sensor separation kit junction box.
8. Connect the calibration meter and re-apply power to the transmitter.
9. Press MODE SELECT to turn on the calibration meter and return to the calibrate mode. The display shows "Er: 0." Press ENTER. The display shows " Set LO C0:XX."
10. Be sure that no combustible gas is present at the sensor. When a stable reading is displayed, press ENTER. The display should now show "SET SPAn C1:XX."
11. Apply the calibration gas mixture.
12. When the reading on the calibration meter stabilizes (typically within 2 to 3 minutes), press the

INCREASE or DECREASE button to adjust the reading on the display to match the level of the applied calibration gas.

13. Press ENTER to save the calibration data and end the calibration procedure. The sensor sensitivity will be displayed briefly, then the meter will alternately display "GAS" and the LFL percentage of the gas present at the sensor. If the display should indicate "bad," the sensor is defective and must be replaced and the calibration procedure must be repeated. If the display shows "bad" or "Lo Sen," press and hold ENTER to exit.

14. Shut off the gas flow and remove the calibration cup from the sensor. The "GAS" message will continue until the gas level drops below 3% LFL or 90 seconds go by.

NOTE

If power was interrupted during the calibration procedure, the transmitter will automatically return to the normal mode 90 seconds after the "GAS" message appears. If the gas level at the sensor is above an alarm setpoint at this time, an alarm output will be generated.

15. The meter will display "END OF CAL" followed by "OFF." Press ENTER to turn off the calibration meter and return the transmitter to normal operation.

16. Remove the calibration meter from the transmitter

.17. If a dust cover or splash shield is used, it should be checked to ensure that it is not dirty or plugged. A plugged dust cover can restrict the flow of gas to the sensing element, seriously reducing its effectiveness. For optimum performance, sensor covers/filters should be replaced at each calibration to ensure that they have not been degraded or plugged.

Refer to the "Calibration" section of this manual for the recommended calibration schedule for a new sensor.

A test form is supplied at the rear of this manual for recording maintenance performed on the system.

An adequate supply of spare sensors should be kept on hand for field replacement. For maximum protection against contamination and deterioration, they should not be removed from the original protective packaging until the time of installation.

TROUBLESHOOTING

Table 4 is intended to serve as an aid in locating the cause of a system malfunction. If an error code is displayed on the calibration meter, refer to Table 3 in the "Operating the Calibration Meter" section of this manual.

NOTE

Record all faults on the Fault Record Sheet supplied in the back of this manual.

Table 4—Troubleshooting Chart

Symptom	Possible Cause
Calibration meter display blank	Meter not properly attached to transmitter.
Calibration meter or controller reads –25% LFL	Bad sensor or sensor not connected. No power to transmitter. Open or shorted transmitter wiring.
Transmitter LED does not light briefly when power is applied.	No power, low power, or wrong polarity.
Transmitter LED flashes rapidly and calibration meter does not show valid display.	Low power to transmitter. Excessive transmitter power wire resistance. Large ac ripple on power wires.
Calibration meter displays improper output or does not respond to pressed switches.	Dirty window on puck or transmitter. Poor alignment of LED and photocell.
Controller displays full scale reading.	High level of gas at sensor. Calibration error. Sensor wire shorted.

LOSS OF SENSOR SENSITIVITY

There are a variety of factors that can cause a decrease in the sensitivity of catalytic type combustible gas sensors. Interfering or contaminating substances that can adversely affect the response of the sensor to combustible gases are as follows:

A. Materials that can clog the pores of the sintered metal flame arrestor and reduce the gas diffusion rate to the sensor are:

1. Dirt and oil.

   A dust cover should be installed to protect the flame arrestor whenever these conditions exist.

   The dust cover can be cleaned as part of routine maintenance. This can be accomplished using an organic solvent and an ultrasonic bath.

2. Corrosive products.

   This occurs when substances such as Cl_2 (Chlorine) or HCl are present. A dust cover provides some protection. The dust cover should be replaced as part of routine maintenance.

3. Flame arrestor clogged as a result of painting or house cleaning.

   The routine maintenance procedure should include covering the sensor with a plastic bag when painting or cleaning. The bag should be removed as soon as possible when the procedure is complete.

4. Polymer formation in the flame arrestor.

   This can occur where monomer vapors such as 1-3 butadiene, styrene, isoprene, etc. are present.

B. Substances that cover or tie up the active sites on the catalytic surface of the active sensing element.

   This occurs in the presence of volatile metal organics, gases, or vapors of hydrides, and volatile compounds containing phosphorous, boron, silicone, etc.

   Examples: RTV silicone sealants
   Silicone oils and greases
   Tetraethyl lead
   Phosphine
   Diborane
   Silane
   Trimethyl chlorsilane
   Hydrogen fluoride
   Boron trifluoride
   Phosphate esters

   Significantly longer sensor life can be obtained by using the Det-Tronics poison resistant sensor.

C. Materials that remove the catalytic metals from the active element of the sensor.

   Some substances react with the catalytic metal forming a volatile compound. This erodes the metal from the surface. With sufficient exposure, most or all of the metal catalyst can be removed from the surface of the active element of the sensor.

   Halogens and compounds containing halogen are materials of this nature.

   Examples: Chlorine
   Bromine
   Iodine
   Hydrogen Chloride, Bromide or Iodide
   Organic halides:
   Trichloroethylene
   Dichlorobenzene
   Vinyl chloride
   Freons
   Halon 1301
   (Bromotrifluoromethane)

   A brief exposure to one of these materials can temporarily increase the sensitivity of the sensor. This results because the surface of the active element is increased due to etching. Prolonged exposure continues the etching process until the sensitivity of the sensor is degraded, resulting in shortened sensor life.

   Significantly longer sensor life can be obtained by using the Det-Tronics poison resistant sensor.

D. Exposure to high concentrations of combustible gases.

   Exposure of the sensor to high concentrations of combustible gases for extended periods of time can introduce stress to the sensing element and seriously affect its performance. After exposure to a high concentration of combustible gas, recal-

ibration should be performed and, if necessary, the sensor should be replaced.

The degree of damage to the sensor is determined by a combination of the type of contaminant, its concentration in the atmosphere, and the length of time the sensor is exposed. When a sensor has been exposed to a contaminant or a high level of combustible gas, it should be calibrated at the time, followed by an additional calibration a few days later to determine whether a significant shift in sensitivity has occurred.

REPLACEMENT PARTS

The Model 405B is not designed to be repaired by the customer in the field. If a problem should develop, first carefully check for proper wiring, programming, and calibration. If it is determined that the problem is caused by a defect within the transmitter module, it should be returned to the factory for repair.

NOTE

When replacing the transmitter module, be sure that the part number and programming jumpers of the replacement are the same as the original. Always remove power before removing or plugging in the module.

The sensing element is mounted in a sealed housing and is not intended to be repaired. When calibration can no longer be properly performed, the sensor must be replaced.

An adequate supply of spare sensors should be kept on hand for field replacement. For maximum protection against contamination and deterioration, the sensor should not be removed from the original protective packaging until the time of installation.

Always calibrate after replacing either the transmitter module or the sensor.

Refer to the "Ordering Information" section of this manual for a list of part numbers.

DEVICE REPAIR AND RETURN

Prior to returning devices or components, contact the nearest local Detector Electronics office so that an RMI (Return Material Identification) number can be assigned. A written statement describing the malfunction must accompany the returned device or component to expedite finding the cause of the failure, thereby reducing the time and cost of the repair to the customer.

Pack the unit or component properly. Use sufficient packing material in addition to an anti-static bag or aluminum-backed cardboard as protection from electrostatic discharge.

Return all equipment transportation prepaid to the Minneapolis location.

Office Locations

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, Minnesota 55438 USA
Telephone (612) 941-5665 or (800) 765-FIRE
Telex 6879043 DETEL UW
Cable DETRONICS
Facsimile (612) 829-8750

Detector Electronics Corporation
3000 Wilcrest
Suite 145
Houston, Texas 77042 USA
Telephone (713) 782-2172

Detector Electronics Corporation
466 Conchester Highway
Aston, Pennsylvania 19014 USA
Telephone (215) 497-5593
Facsimile (215) 485-2078

Detector Electronics (UK) Limited
Riverside Park, Poyle Road
Colnbrook
Slough, Berkshire
SL3 OHB
ENGLAND
Telephone 0753 683059
Telex 848124 GRAVIN G
Facsimile 0753 684540

Detronics Scandinavia AB
Box 81
S-260 83 Vejbystrand
SWEDEN
Telephone 431-53002/53240
Facsimile 431-52236

Det-Tronics Deutschland
Walter Kidde GmbH
Postfach 1457
Harkortstrasse 3
D-4030 Ratingen 1
GERMANY
Telephone 49 2102 4050
Direct 49 2102 405152
Facsimile 49 2102 405109
Telex 8589029

Detectomatic S.A.
AV17 Con Calle 72, No. 71-92
Apartado 10055
Maracaibo, Venezuela
Telephone 58-61-521274, -529154, -529749
Facsimile 58-61-529144
Telex 61331

Detector Electronics Corporation
C/O Walter Kidde Aerospace
The ADELPHI
No. 1 Coleman Street #05-02
SINGAPORE 0167
Telephone (65) 334-1255
Facsimile (65) 334-1607

ORDERING INFORMATION

The sensor must be ordered separately from the Model 405B Transmitter. When ordering please specify:

226907-005	Model 405B Transmitter Module*
226905-001	Junction Box with Mounting Bracket*
226906-001	Calibration Meter**
226783-001	Alarm Relay Board***
226365-003	Sensor Separation Kit***

*One required per transmitter assembly.
**One required per system.
***Optional.

SENSORS

Part Number	Description
225006-002	Standard sensor, aluminum housing
225957-001	Standard sensor, stainless steel housing
226530-001	Poison resistant sensor, aluminum housing
226531-001	Poison resistant sensor, stainless steel housing
226931-001	High temperature sensor, aluminum housing
226931-002	High temperature sensor, stainless steel housing

CALIBRATION EQUIPMENT

Calibration Kit includes regulator, hose, calibration cup, and two cylinders of calibration gas.

Part Number	Gas
225130-001	Methane (50% LEL)
225130-002	Ethane (50% LEL)
225130-003	Ethylene (50% LEL)
225130-004	Propane (50% LEL)
225130-005	Hydrogen (50% LEL)
225130-006	Methane (20% LEL)
225130-007	Methane (25% LEL)
225130-008	Methane (35% LEL)

Replacement Cylinders

Part Number	Gas
226166-001	Methane (50% LEL)
226166-002	Ethane (50% LEL)
226166-003	Ethylene (50% LEL)
226166-004	Propane (50% LEL)
226166-005	Hydrogen (50% LEL)
226166-006	Air (0% LEL)
226166-007	Methane (20% LEL)
226166-008	Methane (25% LEL)
226166-009	Methane (35% LEL)

ACCESSORIES

Part Number	Description
005003-001	Silicone Free Grease
226349-001	Sensor Rain Shield
225312-001	Sensor Dust Cover (Stainless Steel)
226190-001	Sensor Dust Cover (Porex)
225775-001	Sample Draw Assembly (1 "T" fitting)
226053-001	Sample Draw Assembly (2 "T" fittings)
226846-001	Duct Mount Assembly
000507-005	Open Frame Power Supply, 24 vdc at 3.6 amperes
000507-006	Open Frame Power Supply, 24 vdc at 12 amperes
005236-001	W4810 Power Supply (24 vdc) mounted in explosion-proof enclosure

For assistance in ordering a system to meet the needs of a specific application, please contact:

Detector Electronics Corporation
Field Support Group
6901 West 110th Street
Minneapolis, Minnesota 55438 USA
Telephone (612) 941-5665 or (800) 765-FIRE
Telex 6879043 DETEL UW
Cable Detronics
Facsimile (612) 829-8750