DET
TRONICS

INSTRUCTIONS

Combustible Gas Detection System

Model 400

10/90 Form 95-8336-01

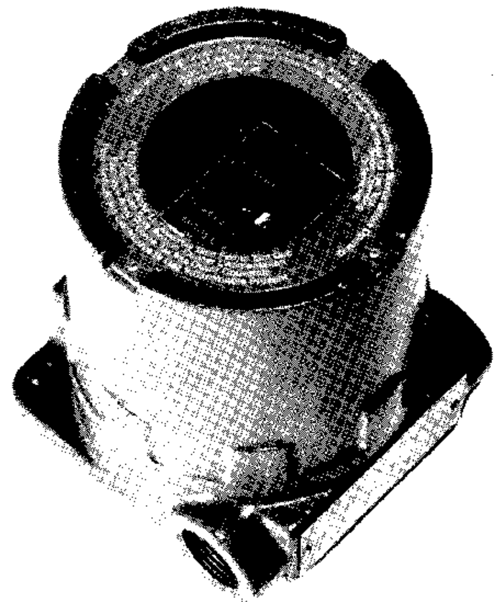
Table of Contents

DET TRONICS

INSTRUCTIONS

Combustible Gas Detection System

Model 400



APPLICATION

This manual contains information pertaining to the installation and operation of the Model 400 Combustible Gas Detection Transmitter. Figure 1 is a schematic of a typical system.

LOWER FLAMMABLE LIMIT

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 combustible gas-free atmosphere and 100% LFL being an atmosphere in which the gas mix is at its lower flammable limit. The relationship between % LFL and percent by volume differs from gas to gas. The following data is from NFPA 5th Edition 325M.

Hydrogen (H2), 100% LFL = 4.0% by volume in air

Methane (CH4), 100% LFL = 5.0% by volume in air

Ethane (C2H6), 100% LFL = 3.0% by volume in air

Ethylene (C2H4), 100% LFL = 2.7% by volume in air

Pentane (C5H12), 100% LFL = 1.5% by volume in air

Propane (C2H8), 100% LFL = 2.2% by volume in air

For data on other gases, refer to NFPA 5th Edition 325M. Typical settings for the alarm circuits are 20% for the low alarm and 40% 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, but at approximately one atmosphere, 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.

SYSTEM DESCRIPTION

SENSOR

The Det-Tronics combustible gas sensor and poison resistant combustible gas sensor contain essentially two matched resistors. One of the resistors is a catalytic element, which changes resistance in the presence of combustible gas. The other resistor is used as a reference element. Both resistors operate at a high temperature and are enclosed by a sintered-metal cover that acts as a flame arrestor.

SENSOR CONDUIT BOX

An explosion-proof (NEMA 7) and water resistant conduit box houses both the sensor and transmitter. The sensor is calibrated without removing the cover.

TRANSMITTER

The transmitter generates a linear (4 to 20 milliampere) signal which is proportional to the

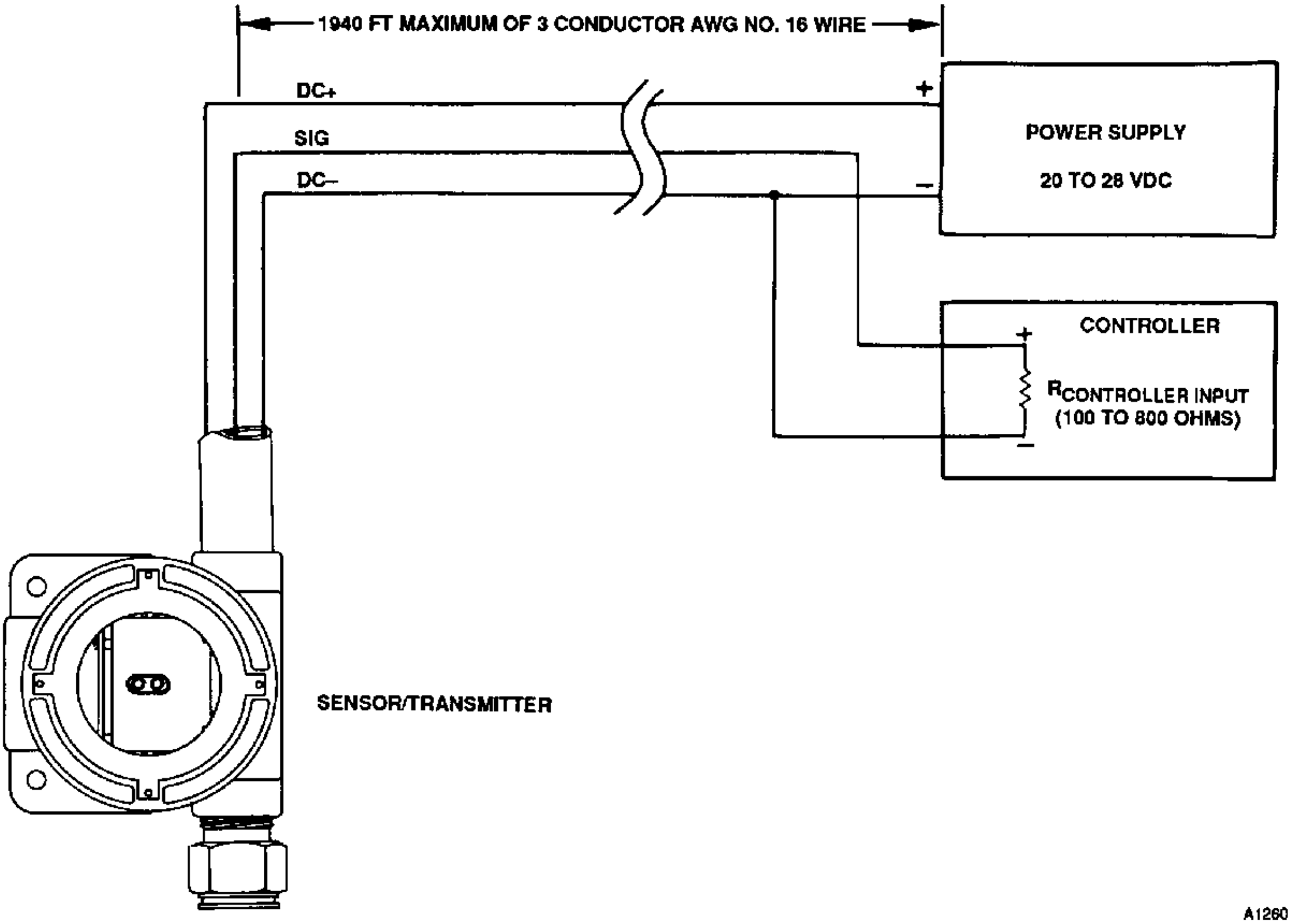


Figure 1—Example of a Typical System

amount of flammable gas at the sensor. It is calibrated so that a 4 milliampere signal is sent when the % LFL is zero, and a 20 milliampere signal is sent when the sensor detects 100% LFL. The maximum output of the transmitter is 26 milliamperes. A signal below 4 milliamperes from the transmitter indicates a trouble condition. Should any of the three wires from the controller to the transmitter and to the sensor become disconnected or break, the signal current will be 0 milliampere.

CONTROLLER

The controller receives the signal output from the transmitter. A typical controller has a trouble, a low alarm and a high alarm indicator as well as a % LFL display for each transmitter that is connected. Alarm lights, sirens and fire prevention equipment are usually connected to the controller to complete the system.

The operation, troubleshooting, and calibration sections of this manual assume certain minimum controller functions:

1. A "% LFL" display which displays the output signal of the transmitter as a percentage of the lower flammable limit of the gas at the sensor, and has a range of -25 to 100% LFL. The equation shown below may be used to convert the signal current to a % LFL reading, and vice-versa.

$$\%\,LFL = [6.25 \times I_{Signal}(mA)] - 25$$
$$= 6.25 \times I_{Signal}(mA) - 4\ mA$$

$$I_{Signal}(mA) = (\%\,LFL \times 0.16) + 4\ mA$$
$$= (\%\,LFL + 25) \times 0.16$$

   The ability to display negative % LFL readings is useful in troubleshooting and monitoring sensor zero drift.

2. A Trouble detection and alarm circuit to direct attention to the fact that part of the system is not functioning properly.

3. A low and high gas level alarm. These alarms typically are set to go off when the combustible gas at the sensor exceeds twenty and forty

percent of its lower flammable limit (20 and 40% LFL). Usually these alarms must be manually acknowledged, and cannot be reset until the % LFL at the sensor drops below the alarm level.

The Model 400 transmitter is designed for use with Det-Tronics controllers: Model 1000 Single Channel, Model 2000 Dual Channel and Model 8000 Eight Channel. The Model 400 Transmitter may also be used with other controllers provided that system installation guidelines are followed.

POWER SUPPLY

Det-Tronics Model 1000, 2000 and 8000 Controllers contain a monitored power supply for the transmitters. If controllers other than Det-Tronics models are used, the power source for the transmitter must be supplied and must be within specifications.

REMOTE CALIBRATION METER

The remote calibration meter allows one person to calibrate the system. When the calibration meter is plugged into the transmitter, the signal to the controller is limited to a maximum of –2% LFL (3.68 milliamperes) to prevent unwanted alarms. This level is adjustable.

The sensor response to the calibration gas mixture is shown on the calibration meter display.

SPECIFICATIONS

MODEL 400 TRANSMITTER

STORAGE TEMPERATURE RANGE –
–67°F to +212°F (–55°C to +100°C).

OPERATING TEMPERATURE RANGE–
–40°F to +185°F (–40°C to +85°C).

OPERATING VOLTAGE RANGE—
10 to 30 vdc (24 vdc nominal).

NOMINAL POWER CONSUMPTION (with Sensor)—
3.6 watts.

CURRENT DRAW—
75 milliamperes (350 milliamperes on power-up).

OUTPUT CURRENT—
Range: 0 to 26 milliamperes
Nominal: 4 to 20 milliamperes (equal to 0 to 100% LFL).

LOAD RESISTANCE OF SIGNAL OUTPUT—
100 to 500 ohms.

OUTPUT SIGNAL DURING CALIBRATION—
–3% LFL.

TROUBLE OUTPUT SIGNAL—
≤1 milliampere

RELAY BOARD—
Two SPDT relays, 2 amperes, 24 vdc.

SENSOR

NOTE
Specifications apply over full operating temperature range.

STORAGE TEMPERATURE—
–67°F to +257°F (–55°C to +125°C).

OPERATING TEMPERATURE RANGE—
–40°F to +185°F (–40°C to +85°C).

HUMIDITY—
0 to 100% relative humidity.

RESPONSE TIME—
Less than 20 seconds to reach 90% of full scale reading with methane.

RECOVERY TIME—
Less than 30 seconds after exposure to pure methane.

ZERO DRIFT—
Typically less than 1% LFL per month.

SENSOR LIFE—
2 to 3 years expected.

CALIBRATION CYCLE—
60 to 90 days.

LINEARITY—
±5% (0 to 100% LFL).

TRANSMITTER/SENSOR ENCLOSURE

ENCLOSURE RATINGS—
NEMA 7; NEC Class I, Groups B, C, D.
NEMA 4 (water resistant).

DIMENSIONS—
Figure 2 shows dimensions of the transmitter/sensor conduit box and recommended clearances for easy servicing.

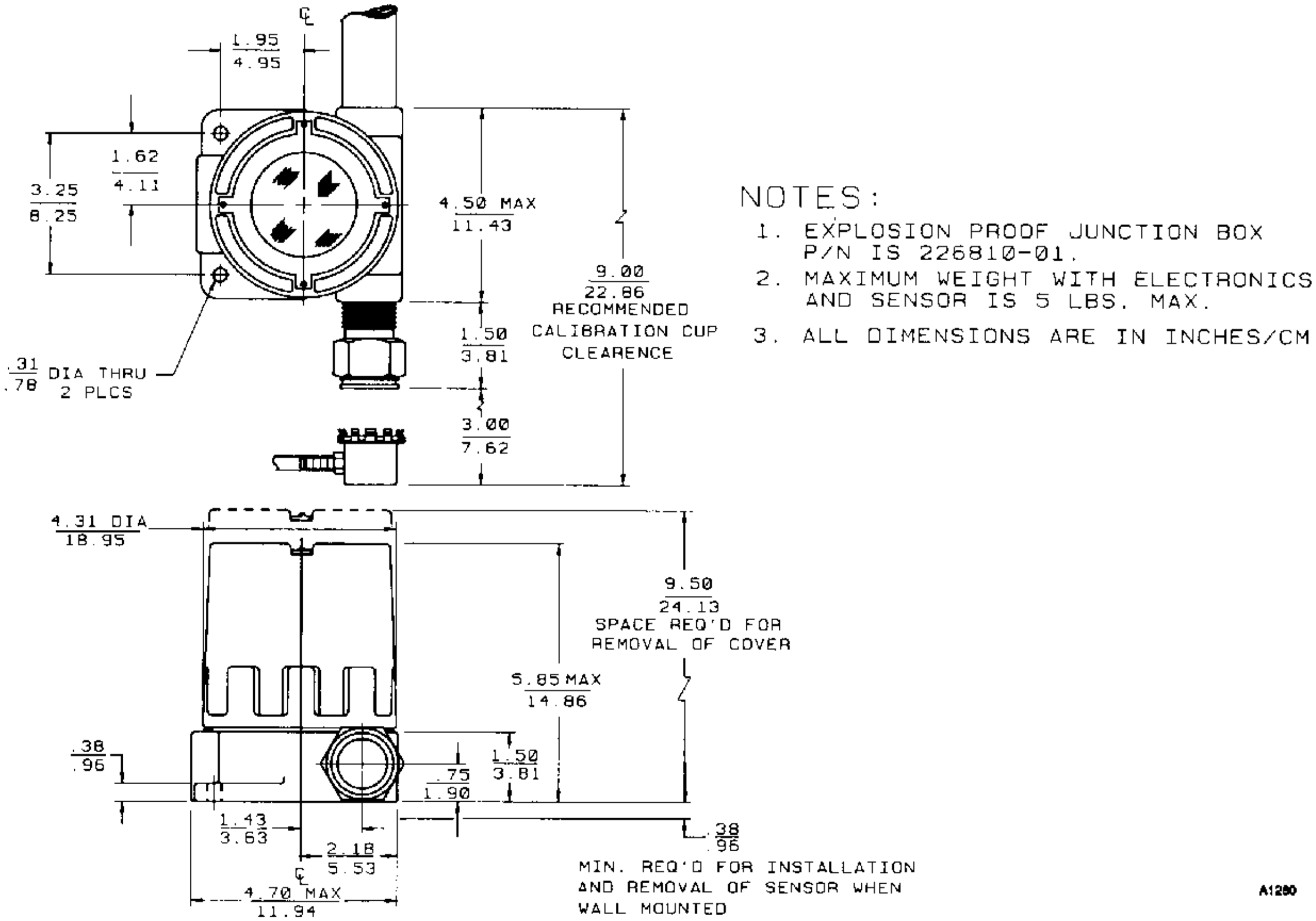


Figure 2—Transmitter Dimensions

OPTICAL CALIBRATION METER

STORAGE TEMPERATURE—
–40°F to 130°F (–40°C to +55°C).

OPERATING TEMPERATURE—
–4°F to +130°F (–20°C to +55°C).

BATTERY LIFE—
200 hours (approximately 2000 calibrations).

OPTIONAL RELAY BOARD

OPERATING TEMPERATURE—
–40°F to +176°F (–40°C to +80°C).

CONTACT RATINGS (Resistive)—
20 vdc: 0.01 ampere, minimum; 2.0 amperes, maximum.
120 vac: 0.01 ampere, minimum; 0.5 ampere, maximum.

POWER CONSUMPTION—
2.9 watts.

OPTION STANDARD SETTINGS (FACTORY SETTINGS)

RELAY 1 (P1)—
Set at and above 20% LFL, Reset below 15% LFL.
Mode: Automatic reset below reset level; external switch input disabled (AD).

RELAY 2 (P2)—
Set at and above 40% LFL, Reset below 35% LFL.
Mode: Automatic reset below reset level; external switch input disabled (AD).

SIGNAL OUTPUT LEVEL (P4)—
During calibration: –2% LFL.
Signal flash: off.

COMBUSTIBLE GAS INPUT RANGE (P5)—
100% LFL full scale (20 milliamperes) output.

SYSTEM INSTALLATION

SENSOR/TRANSMITTER LOCATION

Among many factors that determine where each sensor should be located are two important considerations: the expected flow pattern of the gases (which is a function of molecular weights of the gases and the ventilation system or wind), and the most probable location of the gas leakage. If the gas is heavier than air (e.g., benzene, butane, butylene, propane, hexane, pentane), then the sensor head should be placed below the probable leak source. Although not required, it is preferable to shield the transmitter from intense sunlight to reduce solar heating of the transmitter. Minimizing temperature and thermal cycling will increase the life of any electronics circuit.

The sensor should be installed into the 3/4-inch NPT opening on the bottom side of the conduit box and the conduit should be installed into the 3/4-inch opening on the top of the box. Seal the conduit to prevent rain, spray or conduit condensation from entering the transmitter enclosure. Use conduit and fittings suitable for use in hazardous locations. The conduit box may be mounted to a wall or post or it may be suspended by the conduit. For proper operation, the sensor must be oriented with the sintered metal opening face down. Coating the sensor threads with an appropriate grease will ease sensor installation and replacement.

The sensor conduit box should be electrically connected to an earth ground. Observe all local electrical codes when installing the conduit and box.

It is preferable to have the sensor mounted in the same conduit box as the transmitter. However, if this is not possible, a Transmitter/Sensor Separation Kit, part number 226365-03, is available from Det-Tronics. This kit contains the components necessary to separate the sensor from the transmitter. See Figure 3.

When installing and operating the system, avoid the use of chemicals such as silicon rubber, which may degrade the sensor response. See the "Troubleshooting" section for more details on poor sensor environments.

SPECIAL APPLICATIONS

If the probable leak source is in an environment which is hostile to the system, then a sample draw system may be used to bring a sample of the gas to the sensor.

For outdoor locations, a sensor splash shield is often used to prevent the sensor flame arrestor from becoming plugged or wet.

A clip-on dust cover is available for use in dusty locations.

See the "Parts and Accessories" section for a complete listing of these and other available items.

SYSTEM WIRING

TYPICAL SYSTEMS

Figures 4 and 5 show typical power and signal wire circuits. For the transmitter to operate properly, the resistance of the power wires, signal wires and controller input must be within the limits specified.

NOTE

If a Model 1000, 2000 or 8000 Controller will be used, the transmitter/sensor power supply is contained within the controller.

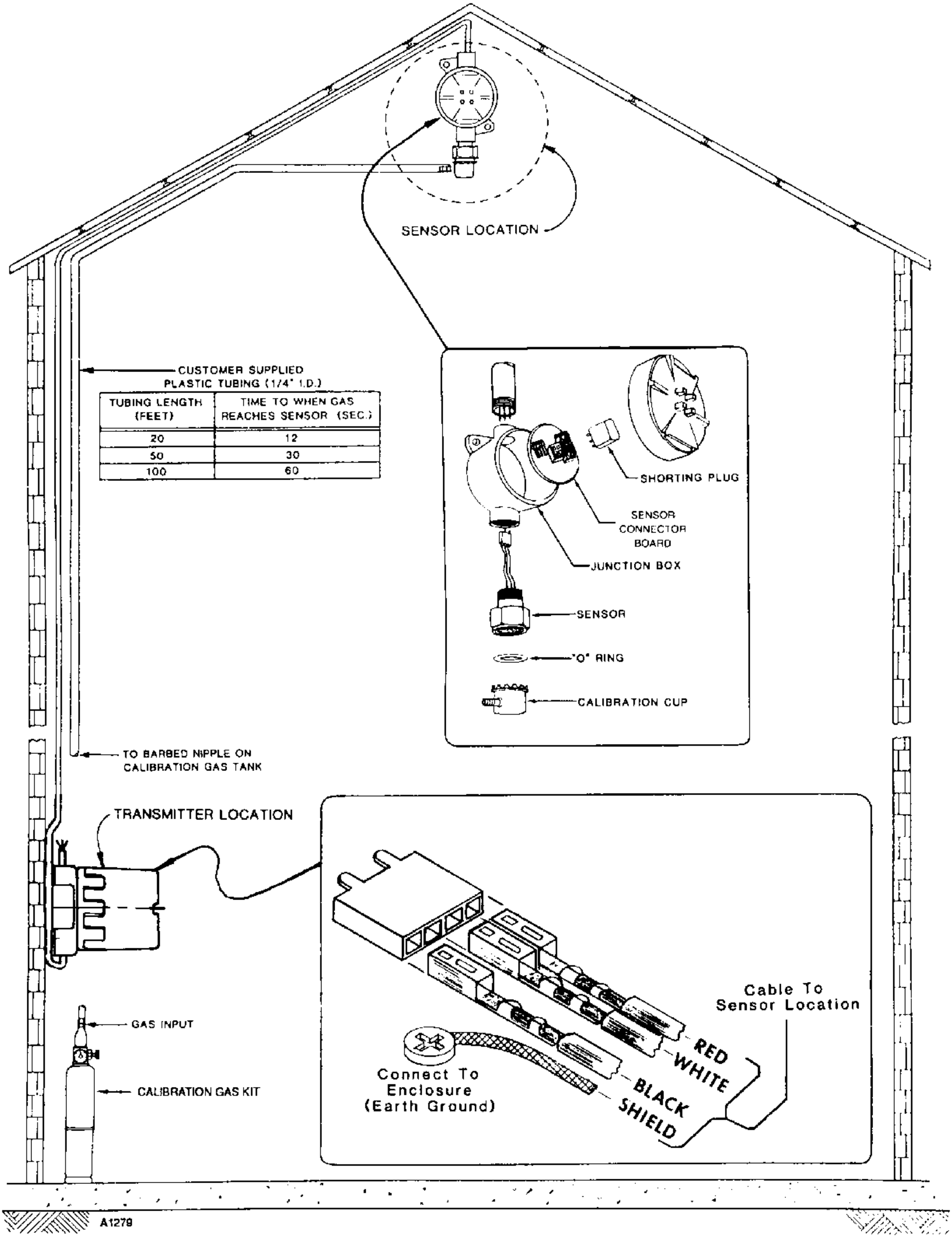
POWER WIRE LENGTH

Figure 6 shows the maximum power wire loop resistance for a given minimum power supply voltage. Loop resistance is defined here as the sum of the resistance of the positive and negative power supply wires (Figures 4 and 5). The minimum power supply voltage is the lowest voltage, measured at the power supply, at which the transmitter is guaranteed to receive sufficient power to operate.

Figure 7 shows the maximum distance between a transmitter and the power supply for a given wire size and minimum power supply voltage. The graphs are for standard annealed copper wire, and are valid over a wire temperature range of –40 to +85°C.

SIGNAL OUTPUT LOOP RESISTANCE

The maximum allowable load resistance between the transmitter output terminal (sig connection) and the transmitter common terminal (DC–) is called the maximum signal loop resistance, and it is proportional to the power supply voltage at the transmitter (DC+ to DC–). The signal loop resistance is the sum of the resistance of the wires leading to the controller and the controller input resistance. This is shown in Figures 4 and 5.



TUBING LENGTH (FEET)	TIME TO WHEN GAS REACHES SENSOR (SEC.)
20	12
50	30
100	60

Figure 3—Pictorial Drawing of Sensor - Transmitter Separation

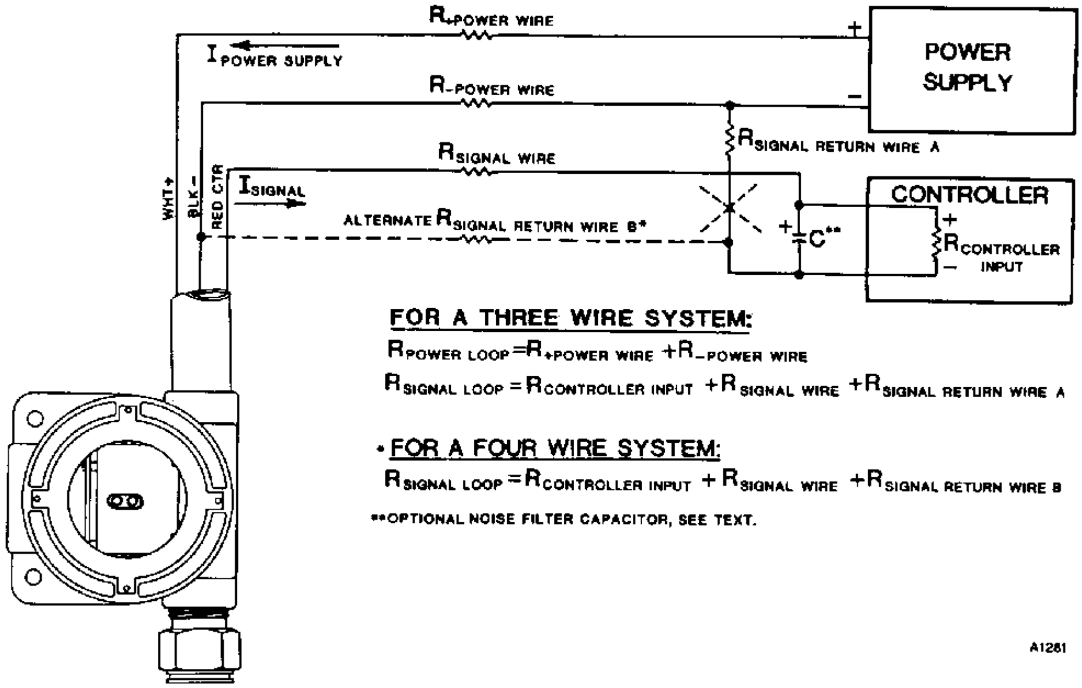


Figure 4—Model 400 Single Unit System Wiring

$R_{POWER\ LOOP} = (R_{+BUSS} \times N) + R_{+POWER\ WIRE} + R_{-POWER\ WIRE} + (R_{-BUSS} \times N)$

$R_{SIGNAL\ LOOP} = R_{SIGNAL\ WIRE} + R_{CONTROLLER\ INPUT} + (R_{SIGNAL\ COMMON\ RETURN\ WIRE} \times N) - (2 \times R_{-POWER\ WIRE})$

WHERE "N" IS THE NUMBER OF TRANSMITTERS.

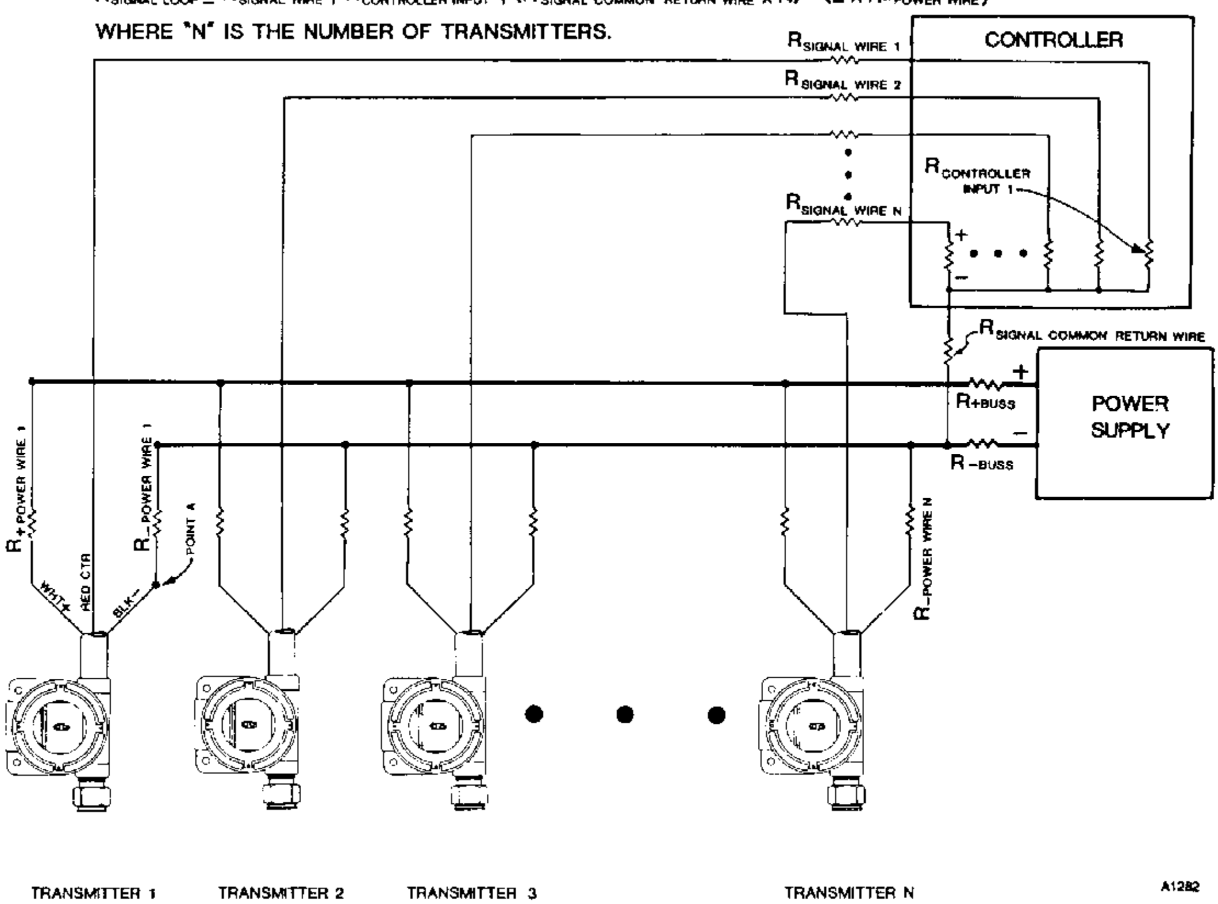


Figure 5—Model 400 System Schematic with Multiple Transmitter/Sensors

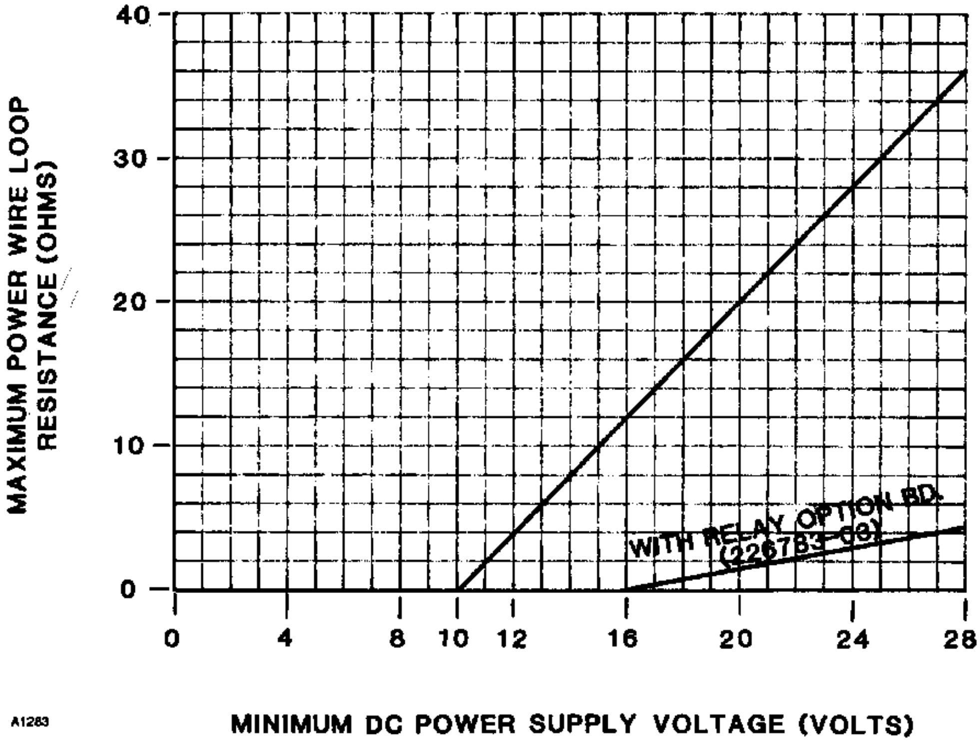


Figure 6—Power Wire Loop Resistance

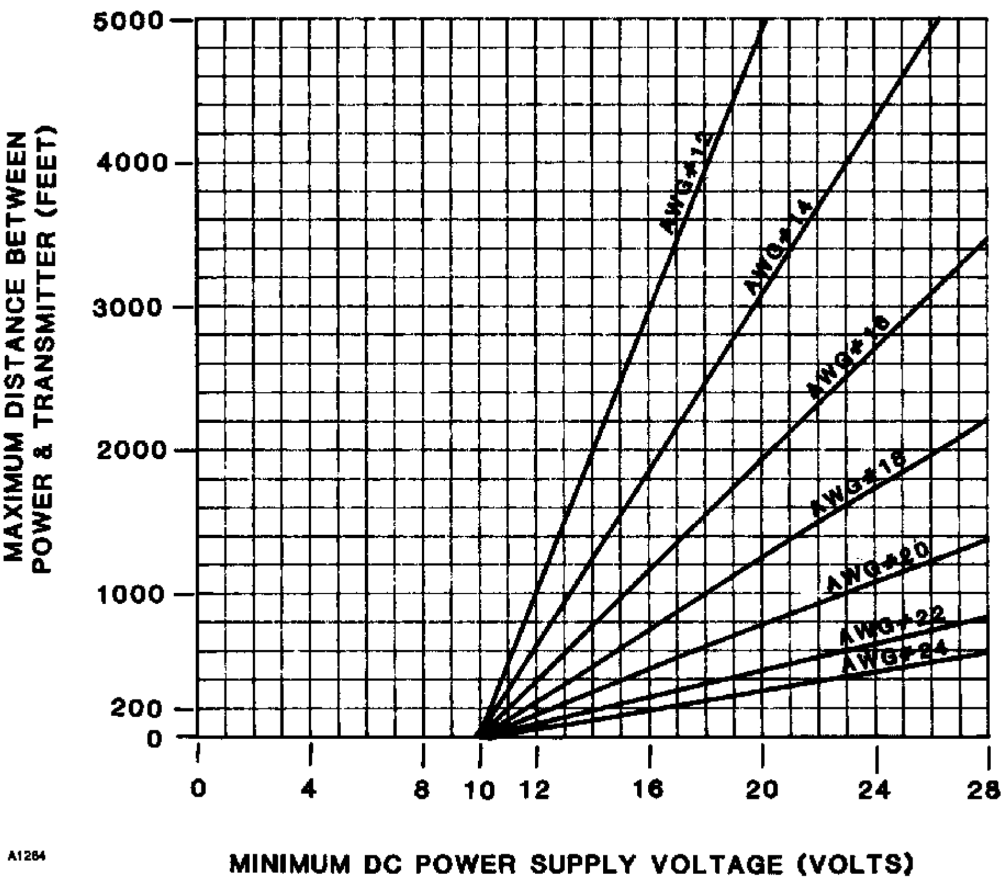


Figure 7—Transmitter to Power Supply Wire Length

Figure 8 shows the maximum signal loop resistance for a given minimum power supply voltage. These curves are for the worst case (maximum power wire resistance, maximum temperature, etc.). Typically, the load resistance may be several hundred ohms greater and still receive a full 20 milliampere signal. There is no minimum resistance requirement, a direct connection from output to DC– is acceptable.

TRANSMITTER TO SENSOR WIRING

For cases where the sensor is not in the same box as the transmitter, Table 1 gives a recommended maximum distance between the sensor and the transmitter conduit boxes.

The resistance of pure annealed copper wire changes with temperature. The wire size table takes this into consideration. The maximum distances between a transmitter and its sensor for a given wire size are valid over the entire operating temperature range of the system (–40°C to +85°C). The system has been designed so that changes in the resistance of the copper wire will have no significant effect on the system's operation.

Table 1—Maximum Transmitter to Sensor Distance

Wire Size (AWG)	Maximum Transmitter to Sensor Distance* (Feet)	(Meters)
20	56	17
18	89	27
16	140	42
14	225	68
12	357	108

*R_{Loop} = 1.45 ohms at 85°C

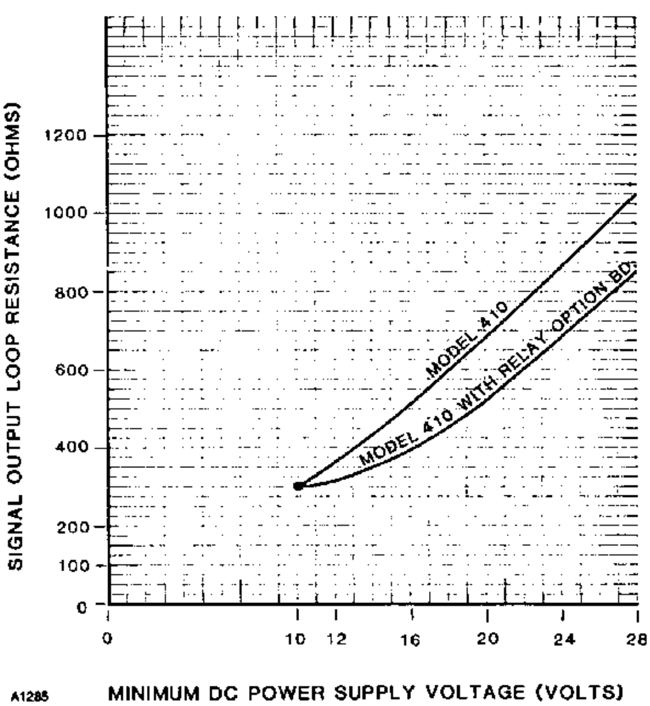


Figure 8—Signal Loop Resistance

WIRING THE TRANSMITTER

Figure 9 shows the transmitter wire routing. Unplug the screw connectors from the transmitter and relay board when attaching the wires.

EXAMPLES OF MODEL 400 SYSTEM WIRING

Three Wire System

For a three wire system with a 20 to 28 volt power supply and a 1500 foot distance between the power supply and controller:

- What wire size should be used?
- Can a controller with a 500 ohm input be used?

From Figure 7, at 1500 feet and 20 volts 18 awg wire is too small, so 16 AWG wire should be used for the power wires. With 16 AWG wires the transmitter will operate at power supply voltages above 18 volts.

The signal loop resistance (Figure 8) can be up to 680 ohms for a 20 volt power supply. If the signal wire is 16 AWG also, then its resistance at 85°C can be found from standard wire tables to be: (1300 feet) (5.138 ohms/1000 feet) = 6.7 ohms. If there is a signal plus signal return wire resistance of less than 680 –6.7 –500 = 173 ohms between the controller and power supply, a controller with a 500 ohm input can be used.

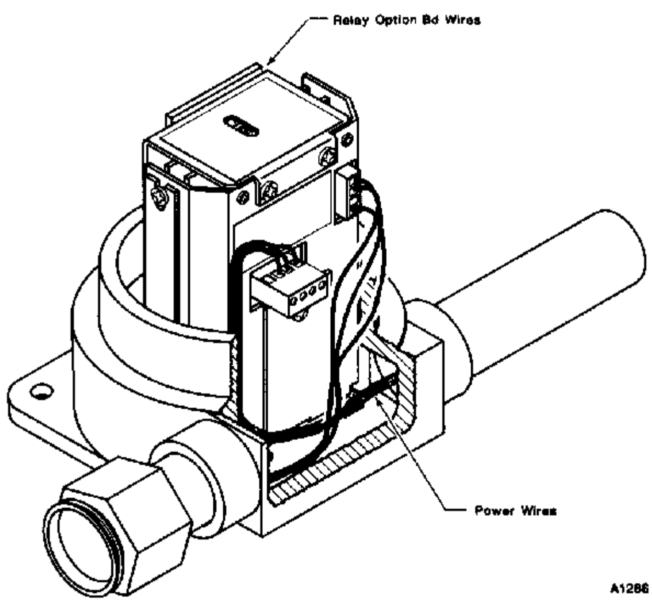


Figure 9—Transmitter Wire Routing

Example of a Four Wire System

If a customer supplied power supply (20 to 28 vdc) was used to power a transmitter 1200 feet away; and a Model 1000 controller, 8800 feet away, was used to display the signal and provide alarm outputs:

- What gauge power wires should be used?
- What gauge signal wires should be used?

Figure 4 illustrates this type of system.

From Figure 7, 18 awg should be used for the power wires.

Controller models 1000, 2000 and 8000 all have 100 ohm inputs. From Figure 8, the maximum signal loop resistance for a 20 volt power supply is 680 ohms. This allows a wire resistance of up to 680–100 = 580 ohms. The wire resistance must be less than 580 ohms/(8800 feet x 2 lengths) = 33.0 ohms per 1000 feet. Standard wire tables show that 24 AWG at 85°C, or less, will work.

SYSTEM OPERATION

TERMINOLOGY

User Operation - is defined to be any operation that uses the optical calibration meter to communicate with the transmitter.

Normal Operation - is defined to be the sensing of gas at the sensor and the output of the appropriate signal level. Also, relays are set and reset by the gas level.

Trouble Mode - is automatically entered when the system is unable to operate properly. This can be caused by lack of power, or a disconnected or bad sensor. The transmitter output signal will drop to 0 milliampere.

CATALYTIC COMBUSTIBLE GAS SENSOR

The combustible gas sensor is made up of two elements, an active or catalytic element and an inactive or reference element, both of which are exposed to the test atmosphere. These elements are composed of a platinum alloy wire coil encased in ceramic. The active element has a catalytic coating applied to its surface. This coating is formulated to have a rather large surface area which is loaded with fine particles of platinum. The reference element is glazed so that it does not provide a surface on which a combustible gas/air mixture will react. The active/reference element pair is matched, in air at their operating voltage, to have the same electrical resistance.

The active/reference element pair is matched, in air at their operating voltage, to have the same electrical resistance.

The active/reference element pair is enclosed in a porous stainless steel cup. This cup, called a flame arrestor, allows the diffusion of gas to and from the element pair, but prevents the ignition of the test atmosphere outside the sensor should the combustible gas concentration exceed its LFL. See Figure 10.

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.

The sensor is connected into the electrical circuit of the gas detection system with the matched element pair completing a Wheatstone Bridge arrangement. When a combustible gas diffuses into the sensor it absorbs on the active element's catalytic surface reacting with absorbed oxygen. This oxidizing reaction heats the ceramic encasing the resistance coil, resulting in an increase in the electrical resistance of the coil. This increase in resistance unbalances the bridge in direct proportion to the concentration of the combustible gas, and is registered on the controller display. The purpose of exposing the reference element to the test atmosphere is to compensate for second order effects such as temperature, humidity, pressure, etc.

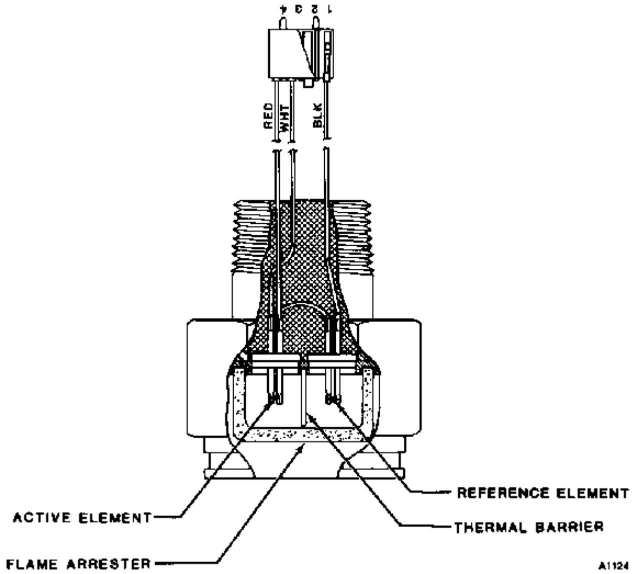


Figure 10—Catalytic Combustible Gas Sensor

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 the air. Figure 11 shows a typical sensor response to various levels of combustible gas. Note that a reading of 40% LFL will be given at 2.0% methane (40% LFL), and also at 80.0% 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.

CAUTION

It is possible for a 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 assure the combustible gas has been cleared before classifying the area as safe.

Figure 12 shows the effect of oxygen enriched and oxygen deficient atmosphere on the response of a typical standard combustible gas sensor. Note that the percent oxygen axis shown is volume percent of oxygen in the total mix of methane, oxygen and nitrogen. The dashed line indicates normal sensor responses when methane is mixed with standard (20.0% oxygen) air.

TRANSMITTER

Transmitter Circuitry

The transmitter is the connection between the controller and the sensor. It converts a voltage change at the sensor to a linear output signal.

The transmitter consists of four main sections: the signal circuits, the power supply, the calibration meter communication circuits and the trouble detection circuits.

The signal circuitry consists of an analog-to-digital converter (A/D), a computer, and a digital to current converter. The analog-to-digital converter measures the sensor resistance approximately seven times per second and converts it to a digital number. From this number, the computer calculates the % LFL of the gas at the sensor using the calibration data stored in its memory. The computer then sends the digital value of the % LFL to the digital-to-current converter, which converts the % LFL value to a current signal. This signal is the output of the transmitter. The computer uses a special memory that saves all vital data even when power to the transmitter is removed.

The power supply converts the power input voltage (10 to 28 vdc) into two voltage outputs to power the

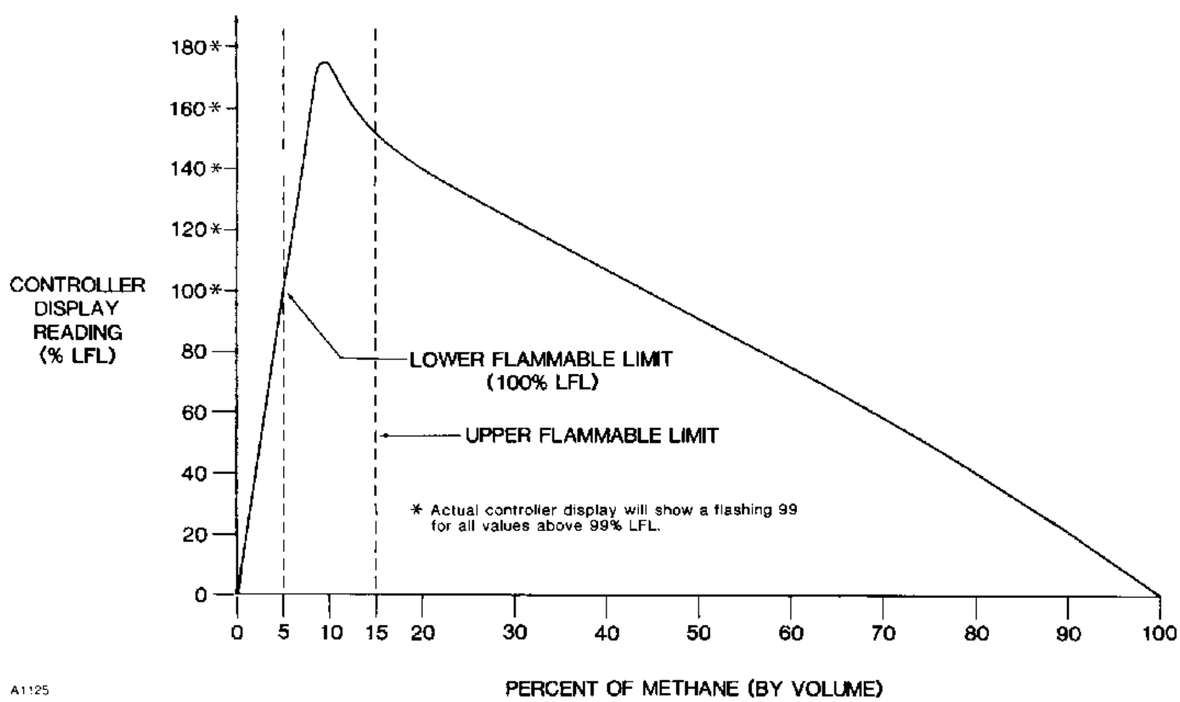


Figure 11—Typical Sensor Response to All Possible Mixtures of Methane and Air

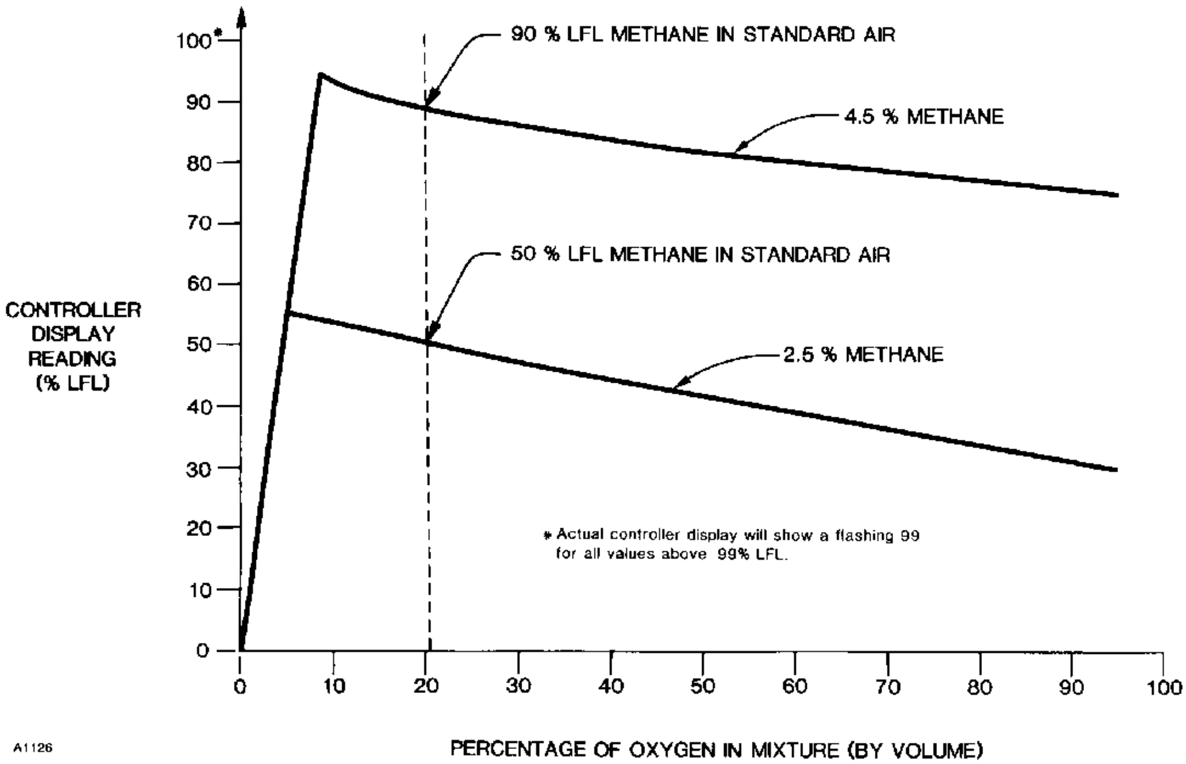


Figure 12—Effect of Oxygen Enriched and Deficient Atmosphere

computer and signal circuitry (+5 and −8 vdc), and one precision current output to power the sensor. The sensor output is adjusted by VR1 to 340 milliamperes at the factory, and does not require user adjustment.

The communications circuits consist of an LED to send a coded light signal to the calibration meter, and a photo pickup, amplifier and demodulator to receive signals from the calibration meter.

The trouble detection circuits monitor the power supply voltage, the sensor current, and the computer operation. If the power supply voltage is too low, if the sensor is unplugged, or if the computer "latches up," the signal output will be set to 0 milliampere, the communication LED will light, and the computer will be reset.

Transmitter Calibration

The transmitter has two calibration points: sensor zero and sensor span. They are called C0 and C1 in the calibration routine.

With no combustible gas present at the sensor, the zero is entered into the computer. If the sensor zero is out of range, the calibration meter will display the message "bad." At this point the sensor should be replaced; however, the computer will adjust as close to zero as possible, which may allow the sensor to be used a little longer until a replacement can be installed. Press ENTER to clear the message.

To set the span, an accurate % LFL calibration gas (typically 50% LFL) is applied to the sensor, and then the computer span data is adjusted to get the correct reading on the calibration meter display. The actual sensor response level to the calibration gas can be read by pressing the sensitivity check button during calibration.

Transmitter Output

Figure 13 shows the nominal transmitter output current versus the % LFL of the gas present at the sensor. Note that with some combustible gases, the response curve will not be as linear as shown, but it will usually fall within five percent of the ideal curve. Also, linearity can vary slightly from sensor to sensor. For more specific information, contact the factory.

Note that the Model 400 signal output is limited to less than 26 milliamperes.

During calibration and other user operations that do not affect the output signal, the standard output is −2% LFL (3.68 milliamperes). This is to prevent

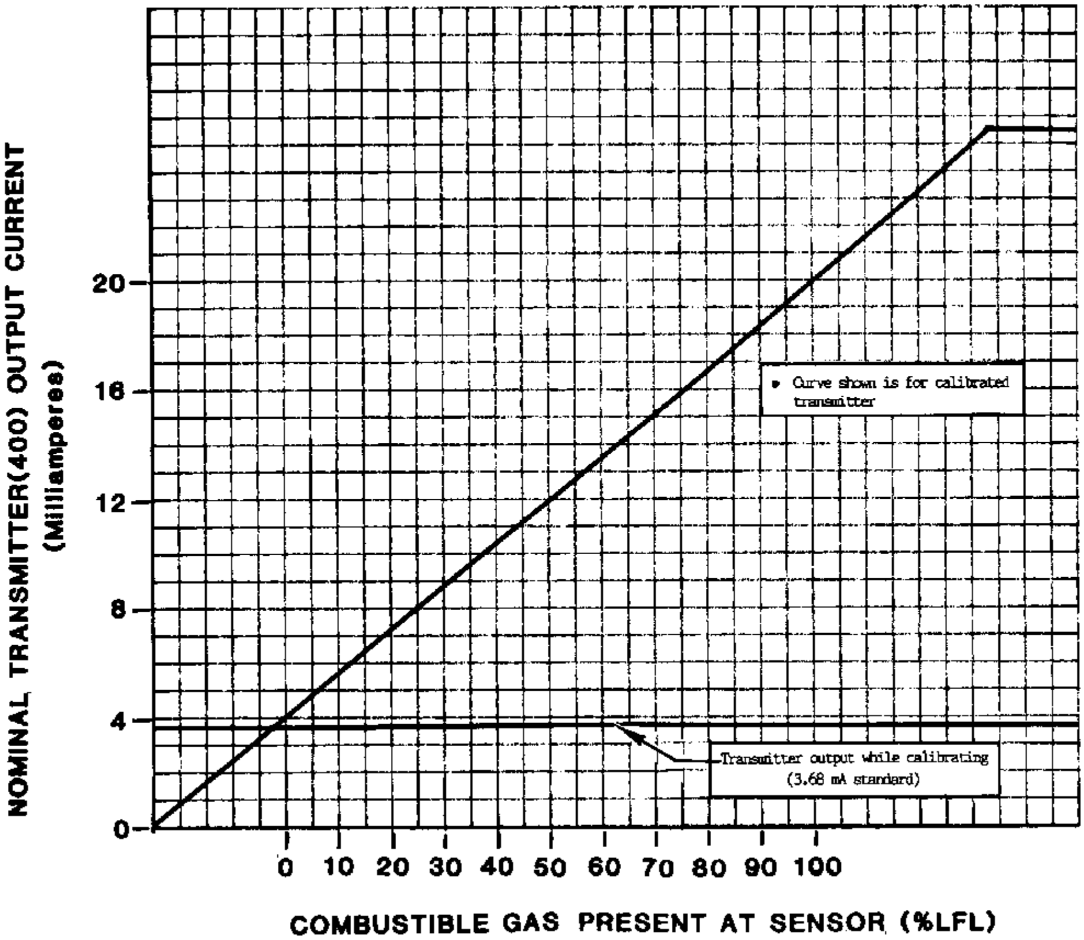


Figure 13—Transmitter Output Current

trouble, low, or high alarms at the controller. If it is desired to have a special output level to signify that a transmitter is being calibrated, a level such as –15% LFL (1.6 milliamperes) is recommended since it is extremely unlikely that the sensor zero will drift this far. To adjust this level see "User Operations, Prog P4."

A transmitter output signal of less than 4 milliamperes is displayed as a negative % LFL reading by the controller and by the calibration meter. A signal of less than 4 milliamperes indicates that the transmitter needs calibration or that trouble has been detected.

The transmitter contains circuitry to detect and send a trouble signal (0 milliampere) if any of the wires connecting it to the sensor or controller are disconnected, or if a sensor element is broken.

Electrical Noise

The transmitter is designed to operate normally in moderately noisy environments. Should the transmitter output be affected by noise, additional filtering or shielding may be required. When the transmitter is exposed to excessive RF signal levels, the usual effect is that the signal output will drop to 0 milliampere.

A good way to reduce the effect of transient noise on the signal at the controller A/D (if used), is to use an integrating A/D converter with about a half second or less conversion cycle. Another simple method is to place one or more capacitors across the controller input as shown in Figure 4 (a 0.01 microfarad ceramic in parallel with a 10 to 1000 microfarad electrolytic should prove effective).

OPTICAL REMOTE CALIBRATION METER

The remote calibration meter allows one person to accurately calibrate the transmitter to the sensor without setting off any alarms at the controller. Its secondary function is to indicate the rate of sensor sensitivity loss and to indicate when sensor replacement is recommended. A third function of the remote calibration meter is to aid in troubleshooting sensor and transmitter problems.

The calibration meter is simply a display and entry unit. All information shown on the display and all responses to its buttons come from the computer in the transmitter. The same calibration meter may be used with any model transmitter in the 400 series.

A flashing nine on the display means a number larger than nine. For Example, a flashing "99" means a number of 100 or greater.

Display information is sent from the transmitter through the enclosure window to the calibration meter by the red LED in the transmitter. In return, the switch on/off information is sent from the calibration meter to the transmitter by the LEDs in the "puck" (see Figure 14). Both the calibration meter and transmitter contain a photo pickup to receive the "light" signal along with a circuit to amplify and decode the signal.

If the light signal from the transmitter is weak or blocked, the calibration meter display will flicker or become unusable. If the data returned to the transmitter is weak or contains detectable errors, the transmitter will turn on the center decimal point located below the colon on the display. This can be demonstrated by holding the puck away from the transmitter and moving a finger through the light paths.

The light signal is specially coded so that the sun, electric lights, shadows or reflections off vibrating machinery do not cause false signals.

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

The calibration meter begins the communication sequence. When its power is turned on, it puts out a long pulse of coded light. The transmitter detects this signal and takes about one second to verify that there is a calibration meter present and that the two-way communication is free from errors.

If there is a poor signal or a noise source triggered the transmitter, it will return to normal operation and the next time valid communication is established, the error indicator "ER:2" will be displayed. If the calibration meter display does not show "CAL" when power is turned on, clean the enclosure window or adjust the puck position, wait for the meter to turn off and then press ENTER again.

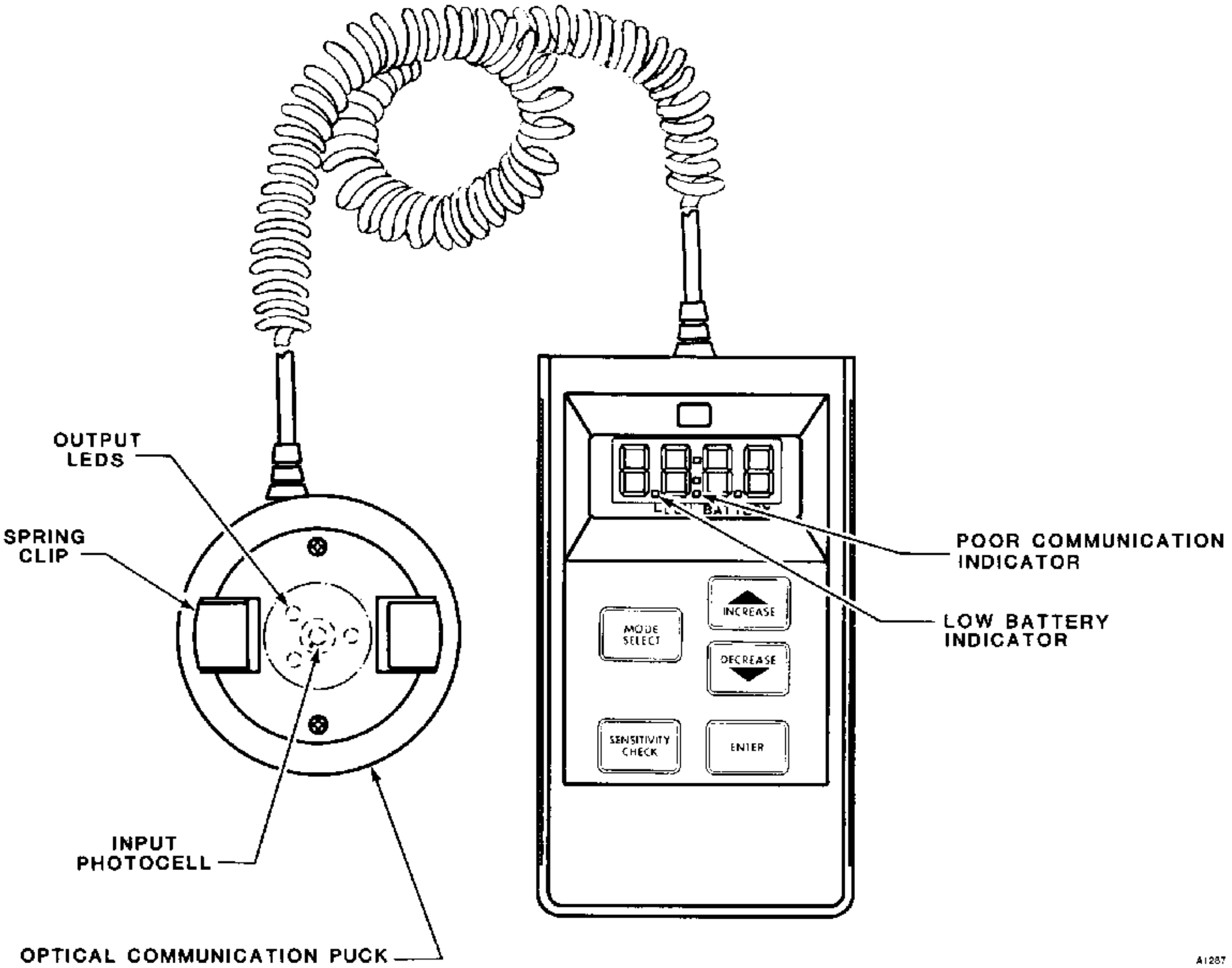


Figure 14—Optical Calibration Meter

Mode Disable Switches

To prevent accidental alarms or changes to the programmable features, there is a set of "mode disable" switches inside the calibration meter. These switches are located under the touch panel cable as shown in Figure 15. Switch S1-3 must be in the "ON" position to access or adjust the relay setpoints or other user programmable options. Switch S1-4 must be in the "ON" position to access tests other than Test T0. (Test T0 shows the position of these switches.) Switch S1-2 allows access to the factory calibration routines and should be left in the "OFF" position. Switch S1-1 keeps the calibration meter turned on, and should be left in the "OFF" position. All switches are put in the "OFF" position at the factory.

NOTE

The tests may be run without turning the switch on, see "User Operations, Test T1."

Low Battery Indicator

The decimal point on the left side of the display will flash when the calibration meter battery needs replacement. The meter will continue to operate until its output light level is too low for the transmitter to detect.

WARNING

To prevent ignition of a hazardous atmosphere, battery must only be charged in an area known to be non-hazardous.

Error Messages

ER:0 – If the sensor is unplugged, power to the transmitter is interrupted, or the "watchdog" circuit resets the computer, the error indicating message "ER:0" will be displayed the next time the calibration meter is used.

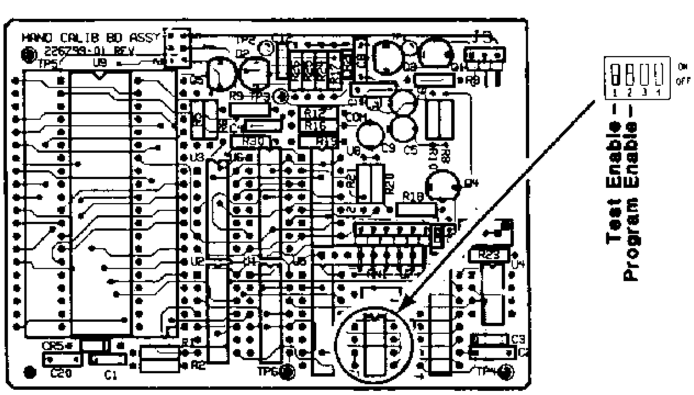


Figure 15—Mode Disable Switch Locations

ER:1 – If the calibration meter is removed without completing an operation (such as calibration), the transmitter will attempt to contact the calibration meter for about five minutes. If no response is received, the transmitter will return to normal operation and the data from the previous calibration will be used. Also, the next time a calibration meter is used "ER:1" will be displayed to indicate that an error has occurred.

ER:2 – If the calibration meter or a strong noise source triggers the transmitter to look for a calibration meter, but the transmitter does not get a valid return signal, then the next time a calibration meter establishes communication, "ER"2" will be displayed.

ER:3 – This error indicates that a component malfunction or an extremely strong noise source (i.e., a near hit by lightning) caused the computer to lose its place in the program, but special software allowed the computer to recover from this fault.

ER:4 – The transmitter contains a special data memory device (EEPROM) that stores data even when power is removed from the transmitter. The calibration data relay setpoints, selected options data, etc., are stored in this device. Each time data is saved, this device is tested; if it malfunctions, "ER:4" will be displayed.

ER:5 to ER:7 are not used.

When an error message is displayed, press ENTER or MODE to clear the message from the memory and resume user operations. All error messages except "ER:0" will be lost when the sensor is unplugged or power is removed.

USER OPERATIONS

This section shows all the operations that can be performed with the optical remote calibration meter. Each step of every operation is shown in full, starting with turning the calibration meter on, and ending with turning it off. Once a mode has been selected and entered, such as programming, a number of routines can be performed before exiting from that mode. For example: one may program the setpoint for relay 1 (P1) and then program the setpoint for relay 2 (P2) before exiting the program mode (P0).

The INCREASE and DECREASE buttons are used to alter the values displayed. As long as these buttons are not pressed one may step through all the routines, except CAL and P3, without permanently affecting the operation of the unit. The calibration routine automatically resets all options to the factory standard settings when used. The user programs are arranged such that, if ENTER is pressed and held, the computer will eventually return to normal operation.

All data changes are stored in permanent memory when the last enter of each routine, such as P1, is pressed. Should power be interrupted before that occurs, the new data will be lost and the old data will be retained. If the calibration meter is removed before the last ENTER is pressed, the transmitter will automatically restore the old data and return to normal operating mode after fifteen minutes.

Figure 16 is a flow diagram, which shows the test routine and program routine selection process.

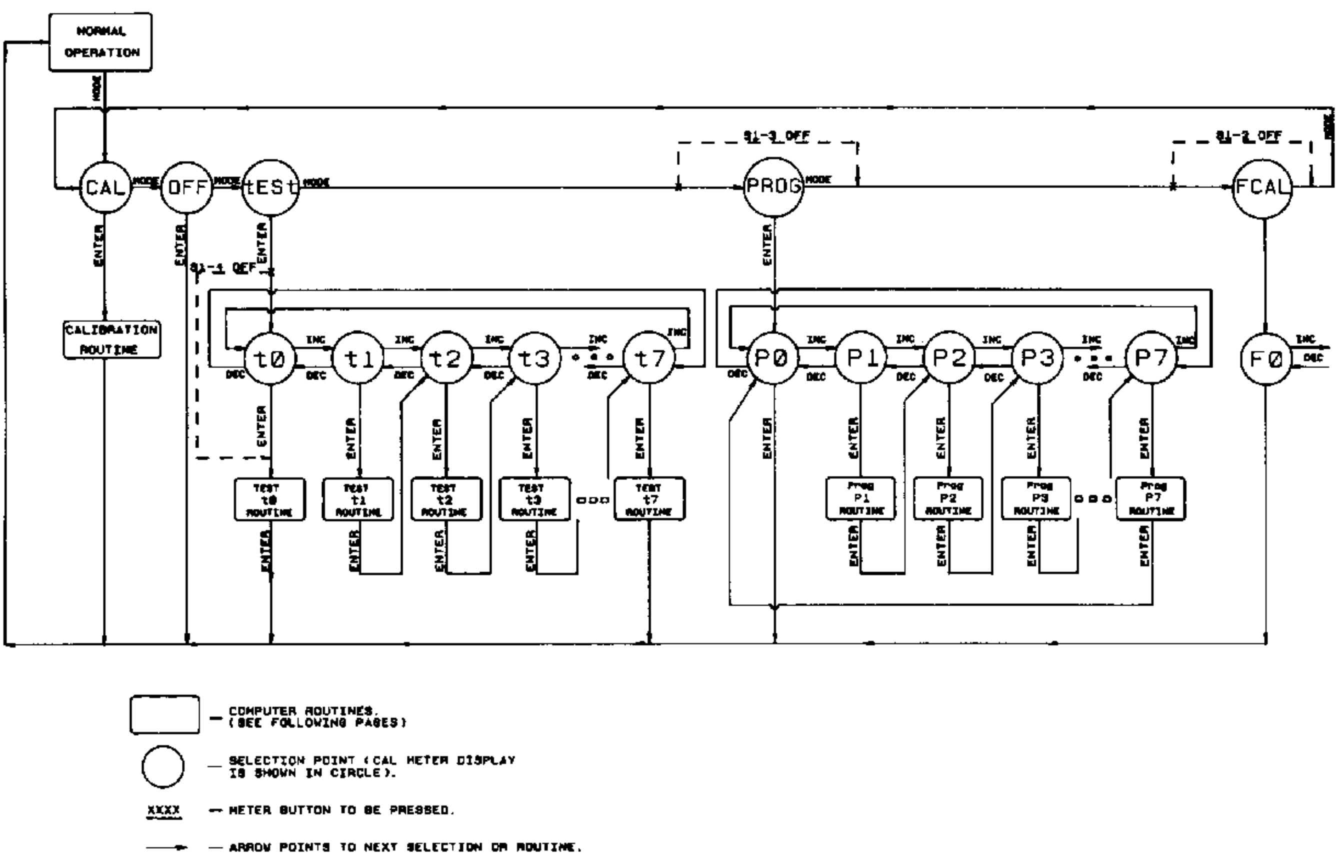


Figure 16—Test and Program Routine Flow Diagram

Calibration and Off Modes

CAL – Calibration Mode
Function: Transmitter/Sensor Calibration (see Figure 17).

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	o With calibration meter clipped to window of the Model 400 junction box, press mode select to turn meter on and start communications
ENTER	LO SEn	o Press ENTER.
	Entr o.LFL	o The LOW SENSITIVITY message may be briefly displayed to indicate that the sensor was near the end of its life during the last calibration.
	C0:XX	o XX shows the current % LFL reading.
ENTER	SEt SPAn	o Make sure there is no combustible gas present at sensor and press ENTER to set the sensor to zero.
	C1:XX	o Apply calibration gas (typically 50% LFL). When reading is stable check sensor sensitivity by pressing the SENSITIVITY CHECK button. If sensitivity is low, replace sensor.
SENSITIVITY CHECK	SE:XX	
INCREASE / DECREASE	C1:50	o Adjust span by pressing INCREASE or DECREASE, to get the appropriate % LFL reading.
ENTER	SE:XX	o Press ENTER. Sensitivity is briefly displayed.
	GAS	
	:XX	o Display will show % LFL gas reading.
		o Remove calibration gas immediately to complete calibration.
	End OF CAL	o When the sensor reading drops below 3% LFL, the transmitter will leave the calibration mode and return to normal operation.

Figure 17—Calibration Mode

OFF
Function: Used to exit user functions and return to normal operation without performing a calibration (see Figure 18).

Testing Modes

Test T0 – Switch Test and Test Exit
Function: Test T0 is used to test and display the position of the switches on and inside the optical calibration meter (see Figure 19).

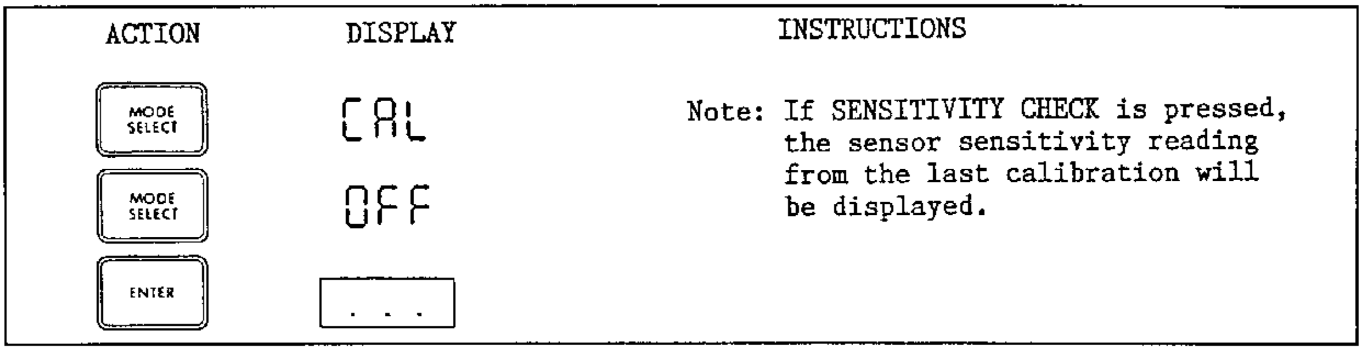


Figure 18—Off Mode

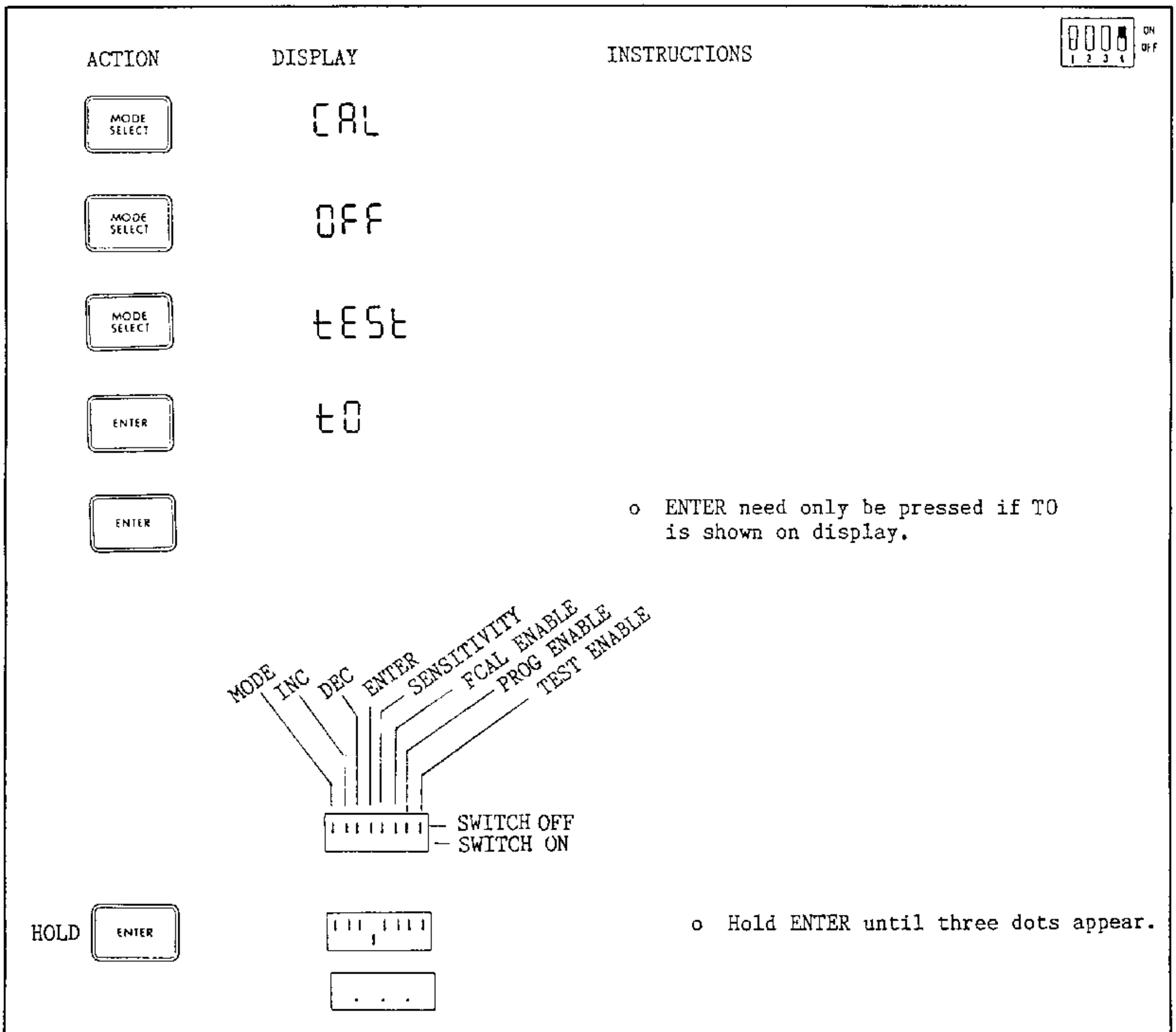


Figure 19—Test T0

Test T1 – Normal Operation with Display

Function: Test T1 mimics normal transmitter operation, and at the same time gives a % LFL display. This is useful for verifying the operation of a full system from the sensor to the controller display and alarm operations (see Figure 20).

Test T2 – Local Relay Test

Function: Test T2 allows the user to independently turn the local relays on the auxiliary relay board on and off. It also indicates the reset signal from the OPTIONAL EXTERNAL RESET switch (if used). (See Figure 21.)

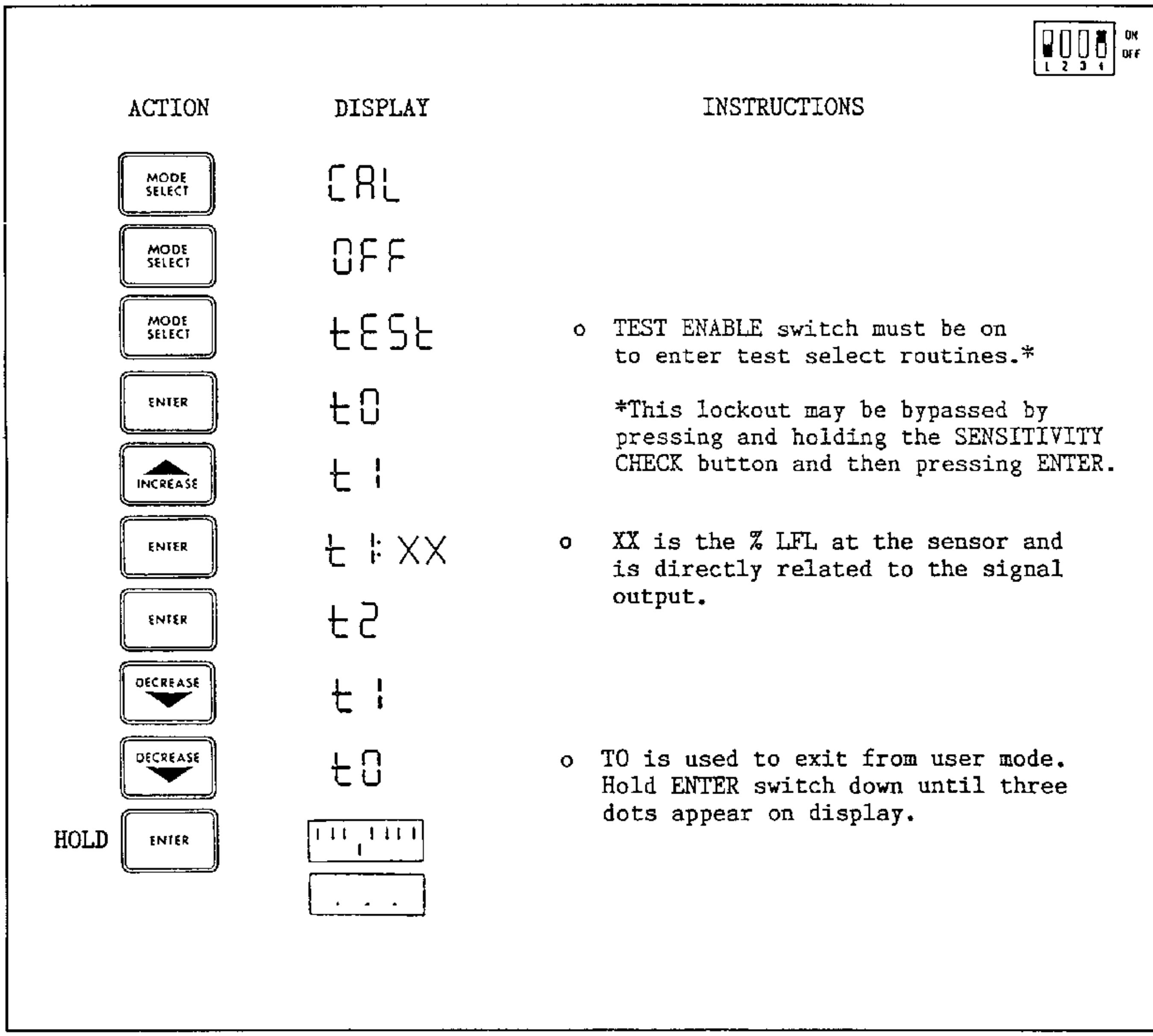


Figure 20—Test T1

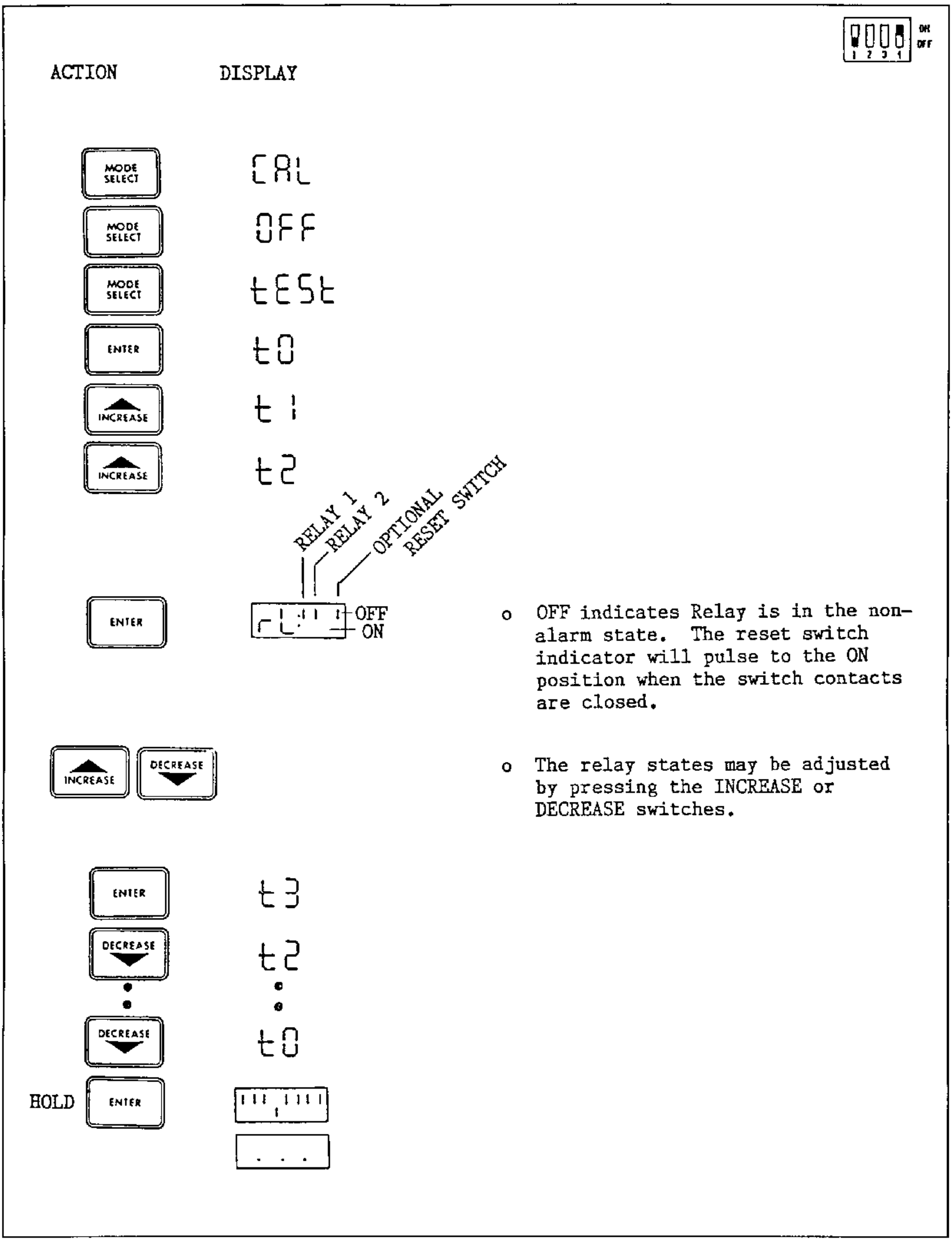


Figure 21—Test T2

Test T3 – A/D Test

Function: Test T3 displays the digital output of the analog to digital converter in hexadecimal code. A varying sensor signal will vary the displayed value. This is a production test (see Figure 22).

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
ENTER	t0	
INCREASE	t1	
INCREASE	t2	
INCREASE	t3	
ENTER	XXXX	o XXXX is output code.
ENTER	t4	
DECREASE	t3	
• • •	• • •	
DECREASE	t0	
HOLD ENTER		o Hold the ENTER button until the display changes.

Figure 22—Test T3

Test T4 – Controller Test (D/A Test)
Function: Test T4 allows the user to independently adjust the transmitter output signal. The signal in % LFL is displayed (see Figure 23).

Test T5 – Factory Test
Function: Displays computer RAM contents.

Test T6 – Not used.

Test T7 – Factory Test
Function: Tests operation of computer monitor circuit, causes system to go into power-up reset when entered.

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
ENTER	t0	
INCREASE	t1	
• • •	• • •	
INCREASE	t4	
ENTER	t4:XX	o XX is output signal in % LFL.
INCREASE / DECREASE	t4:XX	o Adjust signal to test controller displays and alarms.
ENTER	t5	
DECREASE	t4	
• • •	• • •	
DECREASE	t0	
HOLD ENTER	. . .	o Hold the ENTER button until the display changes.

Figure 23—Test T4

Programming Modes

PROG P0 – Programming Mode Exit
Function: To exit from the user option programming routines. When entered, computer returns to normal operation and calibration meter turns off (see Figure 24).

PROG P1 – Relay 1 Setpoints and Operation
Function: This operation allows the user to set the relay set and reset levels, and to select the method of resetting the relay (see Figure 25).

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
MODE SELECT	prog	o For program mode to be displayed or entered, switch S1-3 inside the calibration meter must be turned on.
ENTER	P0	
ENTER	. . .	

Figure 24—Program P0

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
MODE SELECT	prog	o Program enable switch (S1-3) inside calibration meter must be on.
ENTER	P0	
INCREASE	P1	
ENTER	rE- LAY.1 St:XX	
INCREASE DECREASE	St:XX	o Adjust set point by pressing INCREASE or DECREASE.
ENTER	rt:XX	
INCREASE DECREASE	rt:XX	o Adjust reset point by pressing INCREASE or DECREASE.

Figure 25—Program P1

ACTION	DISPLAY	INSTRUCTIONS
ENTER	rl:YY	Optional Reset Switch (second Y): d = Disabled. b = Below reset level. A = Above set and reset level. First Y: A = Auto reset at reset level. L = Latched - Use calibration meter or optional reset switch to reset.
INCREASE / DECREASE	rl:YY	o Adjust to desired operation.
ENTER	P2	
DECREASE	P1	
DECREASE	P0	
ENTER	. . .	

Figure 25—Program P1 (Continued)

PROG P2 – Relay 2 Setpoints and Operation

Function: This operation allows the user to set the relay set and reset levels, and to select the method of resetting the relay (see Figure 26).

ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
MODE SELECT	prog	Program enable switch (S1-3) inside calibration meter must be on.
ENTER	P0	
INCREASE	P1	
INCREASE	P2	
ENTER	rE- LAY.2 St:XX	
INCREASE / DECREASE	St:XX	o Adjust set point by pressing INCREASE or DECREASE.
ENTER	rt:XX	
INCREASE / DECREASE	rt:XX	o Adjust reset point by pressing INCREASE or DECREASE.

Figure 26—Program P2

ACTION	DISPLAY	INSTRUCTIONS
ENTER	r2: YY	First Y — Auto/latched reset: A = Auto reset at reset level. L = Latched - Use calibration meter or optional reset switch to reset. Second Y — Optional Reset Switch. d = Disabled. b = Below reset level. A = Above set and reset level.
INCREASE / DECREASE	r2: YY	o Adjust to desired operation.
ENTER	P3	
DECREASE	P2	
DECREASE	P 1	
DECREASE	P0	
ENTER	. . . .	

Figure 26—Program P2 (Continued)

PROG P3 – Standard Options Reset
Function: Entering P3 resets all user programmable options, such as relay setpoints, to the factory standard settings. See the "Specifications" section for factory standard settings (see Figure 27).

PROG P4 – User Mode Signal Level
Function: This operation allows the user to set the transmitter output signal level during calibration of the sensor. The adjustment range is 0 to 20 milliamperes. An option is also available to have the signal flash between the adjustable signal level and 4.0 milliamperes (0% LFL). This results in a unique signal output during calibration. (See Figure 28).

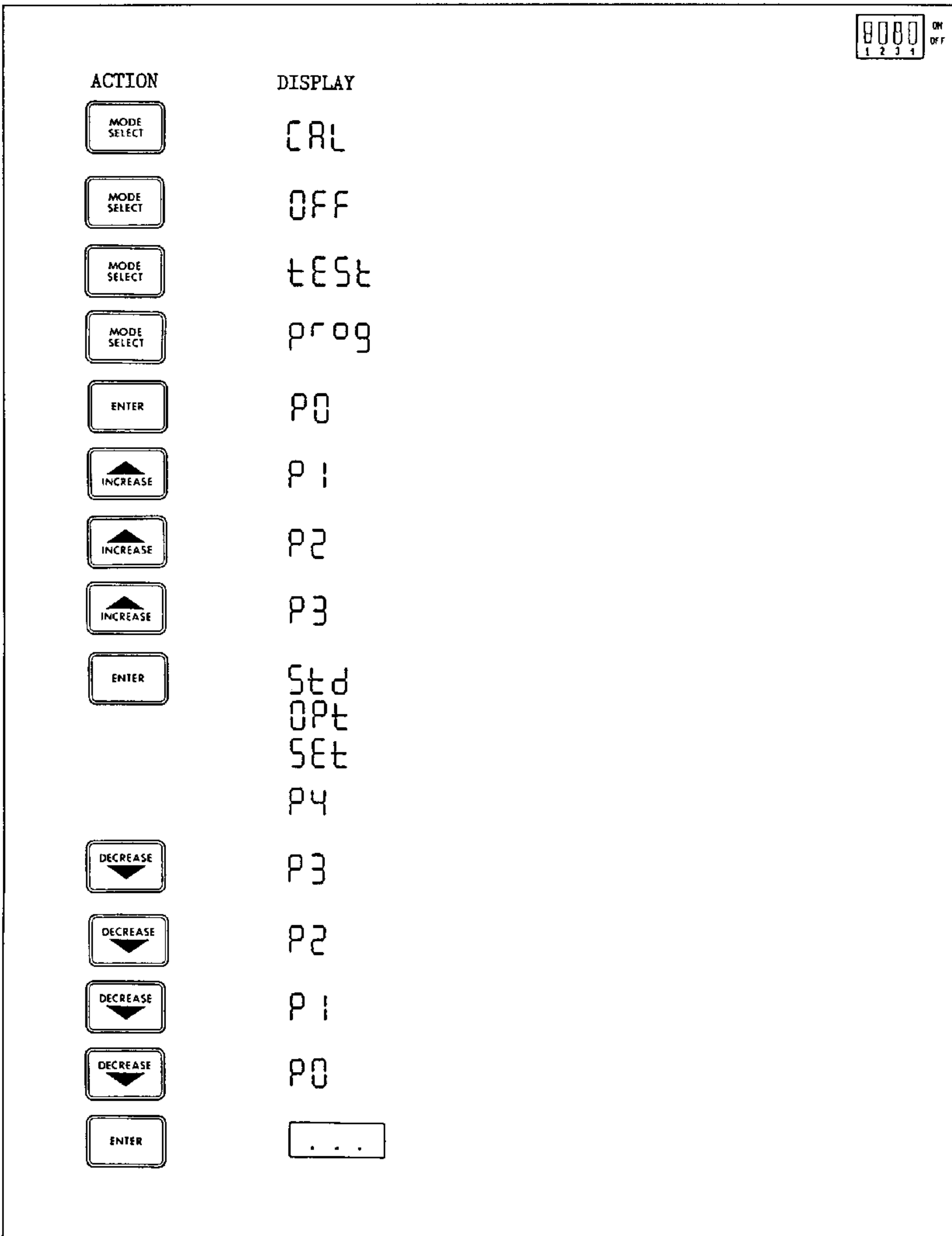


Figure 27—Program P3

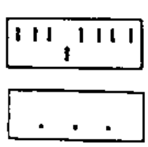
ACTION	DISPLAY	INSTRUCTIONS
MODE SELECT	CAL	
MODE SELECT	OFF	
MODE SELECT	tESt	
MODE SELECT	prog	
ENTER	P0	
INCREASE	P1	
•	•	
INCREASE	P4	
ENTER	P4:XX	o XX is the user mode output signal level in % LFL. o Note: the signal output changes as this is adjusted.
INCREASE / DECREASE	P4:XX	o Adjust to desired level.
ENTER	F:YYY	o F.OFF indicates that the flash option is turned off. F.ON indicates that the flash option is turned on.
INCREASE / DECREASE		o Adjust to desired setting.
ENTER	P5	
DECREASE	P4	
•	•	
DECREASE	P0	
HOLD ENTER		

Figure 28—Program P5

PROG P5 through P7 – Not used.

Factory Calibration

F0
Function: Used to exit factory calibration routines.

F1 – 4.00 milliampere Output Level Calibration
Function: Used to set 0% LFL gas signal output level.
Procedure: Enter F1, adjust output to 4.00 ± 0.02 milliamperes, enter adjusted level.

F2 – 20.00 milliampere Output Level Calibration
Function: Used to set the 100% LFL gas output level.
Procedure: Enter F2, adjust output to 20.00 ± 0.02 milliamperes, enter adjusted level.

F3 – Standard Option Set
Function: Used to set all options to the standard factory settings (same as P3). Refer to the "Specifications" section for the standard factory settings.
Procedure: Enter F3.

SYSTEM TESTING

Before installation of the transmitter into the enclosure, inspect the unit to verify that it has not been physically damaged in shipment. The rubber cover seal on the enclosure base should be intact.

Prior to connecting power:

1. Make sure the transmitter is properly mounted in the enclosure bracket.

2. Check for proper connections and for shorts between transmitter wires.

NOTE

The controller may give an alarm signal when power is connected if a transmitter is plugged in but not calibrated (see the "Sensor Calibration and Replacement" section).

CONNECTING POWER

1. Connect power to the transmitter. The red LED on the transmitter should flash slowly about 25 times, once per second, as the transmitter does a power-on time-delay countdown ("Pt: X" on the calibration meter, if attached). The LED should then flash rapidly several times as the transmitter checks to see if a calibration meter is attached.

NOTE

If the power to the transmitter was interrupted during the sensor calibration procedure the transmitter will automatically return to the beginning of the calibration procedure.

2. The signal wire loop to the controller and back to DC– can be tested using Test T4 (see the "User Operations" section), or by calibrating the transmitter and then applying gas to the sensor to simulate a hazardous condition.

3. The optional relay board and reset switch can be tested by using Test T2.

OPTIONAL TESTS

1. The entire system operation can be verified by calibrating the transmitter to the sensor, then using Test T1 to monitor the sensor response to gas. The optional relay board relays, the controller display and alarms, along with the sensor response, can all be tested by varying the % LFL at the sensor.

2. The transmitter and power wires may be tested under worst case conditions (maximum power drain) by reducing the power supply voltage to the minimum for the system, then energizing both relays (Test T2), and setting the signal current to maximum (Test T4).

TROUBLESHOOTING

TROUBLE DETECTION

The transmitter is designed so that its signal output will drop below a maximum of 1 milliampere (nominally to 0.0 milliampere) when:

1. Any of the three wires to the transmitter is broken or disconnected (or any of the four wires shown in Figure 4).

2. Any of the three wires between the transmitter and sensor is broken or disconnected, or should either element of the sensor open.

3. The transmitter is unplugged from power, or the sensor is unplugged from the transmitter. This will occur during calibration procedures if the sensor is to be replaced. Because of this, a means of inhibiting audible trouble alarms during routine calibration may be desired.

The signal level may also be between 0 and full output if the transmitter zero is not adjusted to the sensor.

If the sensor element is exposed to very high % LFL levels of some gases, the sensor zero may be affected. Also, during the life of the sensor the zero will drift slowly. Consequently, it is recommended that the controller should indicate trouble if the controller display level drops below –10% LFL (2.4 milliampere signal).

When power is applied to the transmitter and sensor, there is a short warmup period during which the transmitter output will be 0 milliampere. It is recommended that the controller indicate trouble if the controller display level drops below 10 PPM (2.4 milliampere signal).

SENSOR SIGNAL LOSS

When a catalytic type combustible gas sensor is observed to lose its sensitivity to a given flammable gas concentration, it is often concluded that the active element has been exposed to some airborne material that has poisoned its surface. This can be true. On the other hand, there are a number of other causes that can result in a similar decrease in signal. Interfering or contaminating gases or 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 flame arrestor, thereby reducing the gas diffusion rate into the sensor, are:

1. Dirt and Oil.
   a. A dust cover should be installed to protect the flame arrestor whenever these conditions exist.
   b. The dust cover can be cleaned as part of routine maintenance. Clean in an organic solvent using an ultrasonic bath.

2. Corrosion Products.
   a. This occurs when substances such as Cl (Chlorine) or HCl are present. A dust cover provides some protection.
   b. Replace the dust cover as part of routine maintenance.

3. Flame arrestor clogged during painting and housing cleaning.
   a. The sensor should be covered with a plastic bag when painting or cleaning takes place nearby. Remove the bag as soon as possible afterward.

4. Polymer formation in the flame arrestor.
   a. This sometimes occurs 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 sensor's active element.

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

Examples:

Lead Tetraethyl
Phosphine
Diborane
Silane
Trimethyl chlorsilane
Hydrogen fluoride
Phosphate esters
Silicone oils and greases
RTV silicone sealants

Longer sensor life can be obtained by using a poison-resistant sensor.

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

Some substances react with the catalytic metal, forming a volatile compound. This erodes the metal from the surface and, given sufficient exposure to these types of materials, all or most of the metal catalyst can be removed from the surface of the sensor's active element.

Halogens and halogen containing compounds are materials of this nature.

Examples:

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

A brief exposure to one of these materials can increase the sensitivity of the sensor. This is usually a temporary effect due to etching of the catalytic surface. This is sometimes used as a means to activate a sensor that has a degraded signal. This is a practice that is unreliable and may give a false sense of security.

Longer sensor life can be obtained by using a poison-resistant sensor.

D. Extended exposure to high concentrations of combustible gas and air.

1. Extended exposure of a detector element to high concentrations of combustible gases can introduce stress to the element that can seriously effect its performance. Therefore, recalibration should be carried out or the sensor replaced, or both, after an alarm due to a high concentration of combustible gas.

   The degree of damage to a sensor is a combination of the type of contaminant, its concentration in the ambient atmosphere, and the length of time the sensor is exposed.

   A large loss of sensitivity is sometimes discovered when the sensor is calibrated. If this occurs, first ascertain whether the calibration has been correctly carried out, the calibration system is functioning properly, and the correct gas mixture is being used. The calibration schedule should reflect the probable exposure of the sensor to known conditions that affect the quality of sensor signal.

   When it is known that the sensor has been exposed to high concentrations of a poison, extended exposure to high concentrations of combustible gas/air mixtures, or other unusual conditions, it should be recalibrated and checked a few days later for a significant shift in sensitivity.

Table 2 shows symptoms and possible causes for common wiring problems. For further assistance, contact the factory.

SENSOR CALIBRATION AND REPLACEMENT

CALIBRATION

Each transmitter must be adjusted to match the characteristics of the sensor to which it is connected. Whenever the sensor or transmitter is replaced, the system must be recalibrated. The system also requires periodic recalibration, typically every 60 to 90 days, depending on the environment and the sensor species.

When a sensor is exposed to a different or new environment, the transmitter calibration should be checked frequently (approximately twice in the first month) to determine the proper interval between periodic calibration. Read the "Troubleshooting" section for causes of signal loss.

The calibration routine Span Adjustment (C1) adjusts the % LFL reading to match the % LFL of the calibration gas. The span setting will vary for different combustible gases. Therefore, the calibration should always be the same as the one to be detected. If several combustible gases may be present, calibrate to the least detectable gas. Consult factory for more information. If calibrating with the gas to be detected is impractical, conversion factors for standard gases can be obtained from the factory.

CAUTION

Calibration and maintenance should not be performed if there is any indication of combustible gas at the sensor. A portable instrument should be used to ensure the area is clear of any combustible gases.

WARNING

A sintered-metal cover that acts as a flame arrestor is an integral part of the gas sensor (see Figure 10). Do not operate the system if the sintered metal is damaged or missing since the exposed element can act as an ignition source.

The following equipment is recommended for routine sensor calibration:

— Calibration Kit, part number 225130-XX.

— Optical Calibration Meter, part number 226906-01

Sensor Replacement

NOTE

When either the sensor or transmitter is unplugged, the controller will switch into the trouble mode.

WARNING

This location must be declassified as non-hazardous prior to service.

Table 2—Troubleshooting Guide

Symptom	Probable Cause	Recommended Action
Transmitter (XMTR) LED does not light briefly when power is applied to system.	• Low power, wrong polarity or no power at XMTR.	• Measure voltage at XMTR (dc + to dc –).
XMTR LED stays on (not flickering or flashing).	• Sensor unplugged.	• Plug sensor into XMTR.
	• Sensor power wire open (damaged sensor).	• Measure resistance of sensor white wire to sensor black wire. It should be about 5 ohms.
XMTR LED flickers very rapidly (and the calibration meter does not show a valid display).	• Low power to XMTR.	• Measure voltage at XMTR (dc + to dc –).
	• Excessive power wire resistance.	
	• Large ac ripple on power wires.	
XMTR LED flashes rapidly (calibration meter gives valid display).	• XMTR is trying to talk to calibration meter (Regular "User Mode" operation).	• Use calibration meter to exit "User Mode," or do nothing and transmitter will exit user mode after 15 minutes with no response from the calibration meter.
XMTR LED flashes rapidly for four pulses.	• A high level RF signal has triggered optic circuit to look for calibration meter. (ER:2 will be displayed when calibration meter is attached afterward.)	• Locate and reduce or eliminate noise source.
Calibration meter displays 8.8:8.8 when MODE button is pressed, or meter displays ER:2 and gives no response to pressed switches.	• Calibration meter not attached to a powered XMTR.	• Clean windows, rotate puck for best LED to XMTR photocell alignment. Try again.
	• Dirty window on XMTR or puck enclosure.	
	• Low calibration meter battery.	• Replace battery.
	• Poor LED to photocell alignment and combination of above causes.	
Calibration meter dispolay flickers or breaks up. Switch response is slow.	• Calibration meter not receiving clean signal from XMTR.	• See above.
Center decimal point on meter display turns on. Switch reponse is slow.	• XMTR not receiving clean return signal from calibration meter.	• See above.

Table 2 is continued on next page

Controller displays –25 ppm	• XMTR not plugged in. • No power at XMTR. • Sensor not plugged into XMTR or bad sensor. • Open signal or signal return wire from XMTR. • XMTR output wire (Sig.) shorted to DC– • XMTR waiting for calibration after power interruption during calibration. • XMTR not calibrated..	
Controller displays full scale reading.	• High level of combustible gas at sensor.	• Take appropriate safety measures. **Use extreme caution.**
	• XMTR not calibrated.	• Calibrate XMTR.
	• DC+ wire shorted to signal	• Remove power, test wires with ohmmeter.
Signal level at controller different than at XMTR.	• Shunt resistance between XMTR wires.	• Check wires with ohmmeter, check for water in conduit, etc.
NOTE: Any reversed or otherwise incorrect connection of power, signal, or reset switch to the transmitter should not damage transmitter.		

1. Begin the calibration procedure (see below) and stop when the display shows C0:XX or C1:XX.

2. Remove the transmitter enclosure cover, unplug the sensor, and unscrew it from the enclosure. About 2-1/2 inches from the plug, on the new sensor, bend the wires into a gentle right angle. This will help the plug slide past the wires and electronics in the transmitter enclosure. Slip the plug through the transmitter enclosure so that the plug sticks out. Screw the new sensor into the enclosure and plug it into the transmitter.

3. Replace the transmitter cover. Shortly after the sensor is plugged in, the transmitter will return to the calibration cycle. This will prevent false alarms at the controller.

4. The sensor may now be calibrated. Attach the calibration meter, turn it on, and clear the error message. Allow the sensor to warm up for five to ten minutes. To calibrate go to step 5 of the calibration procedure.

CALIBRATION PROCEDURE

WARNING

This location must be declassified as non-hazardous prior to calibration.

1. Make sure the pressure gauge indicates that there is gas in the calibration gas tank.

2. Use a portable gas detector to verify that no combustible gas is present at sensor location.

3. Hold the calibration meter puck by the abrasive spring clip and squeeze to compress spring. Place puck on window of transmitter junction box. Release spring clip, it should grip junction box cover behind the red caution label. (See Figure 29).

4. Press the MODE button to turn the calibration meter power on and start communications with the transmitter. The display should flicker briefly and then display CAL or "Er:X." If "Er:X" is displayed, press ENTER to clear it. If a proper display does not appear, refer to the "Trouble-shooting" section.

5. Press the ENTER button to start the calibration routine. The meter will briefly display "ENTR 0.LFL, C0:XX." XX is the current 0% LFL reading from the sensor.

6. Make sure there is no background gas at the sensor (or apply zero air to sensor). Then press ENTER and the computer will set the sensor zero. The meter will briefly display "SET SPAN, C1:XX." XX is the current % LFL reading. "Lo Sen" may be displayed to indicate low sensor sensitivity during the last calibration.

7. If an optional dust cover or splash shield is used, remove and clean.

8. Check that the small hole on the side of the calibration adapter cup is not plugged and that the sintered-metal disc is in place. Snap the adapter cup onto the sensor. Do not plug the hole in the side of the adapter cup.

   Check the regulator to ensure that it is firmly secured on the tank. Start gas flow by turning the valve on the side of the tank one turn. Gas will flow at the proper rate for calibration (2 cubic feet per hour).

9. When the display on the calibration meter reaches a stable level, press the Sensitivity Check button. If display reads less than 15, sensor replacement is recommended. Release the Sensitivity Check button.

   If the sensor is to be replaced:

   a. Remove calibration gas
   b. Remove calibration meter
   c. Refer to the "Sensor Replacement" section.

10. Adjust the span setting (using the INCREASE and DECREASE buttons) until the meter displays the same % LFL as indicated on the calibration gas tank (typically 50% LFL).

    If the sensor separation kit is installed: after adjusting the span, remove the calibration gas and allow gas in the tube to the sensor to clear before proceeding. This will remove the possibility of a false alarm if the tube holds gas at the sensor for longer than 1-1/2 minutes. Note that the stored sensitivity data is sampled when ENTER is pressed and will not be correct.

11. Press ENTER to store the span setting and end the calibration sequence. The sensor sensitivity will be briefly displayed. Then the meter will alternate displaying "GAS" and the % LFL present at the sensor.

12. Remove the calibration adapter cup and shut off the gas flow. The calibration meter may now be removed.

13. The transmitter will continue to flash the gas message until the sensed gas level drops below 3% LFL, or 90 seconds go by. The transmitter will display "END OF CAL" and then return to normal operation.

14. Replace dust cover or splash shield as necessary.

DISPLAYING SENSOR SENSITIVITY

See the "System Operation" section under the "Sensor" heading for a discussion of sensitivity values.

To read the sensor sensitivity measurement taken during the last calibration:

1. Connect and turn on the calibration meter.

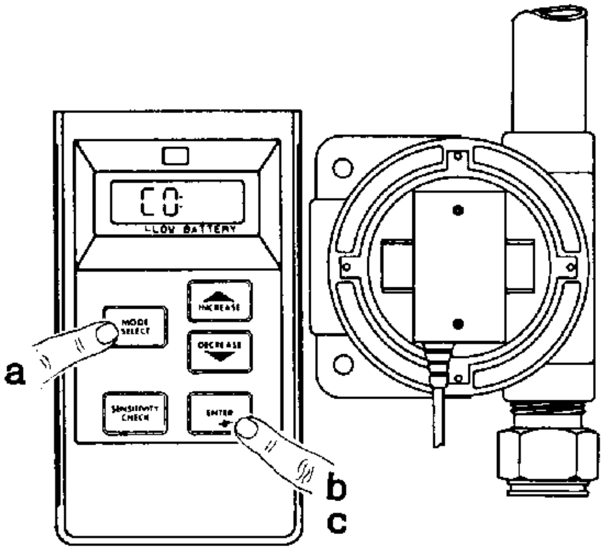
2. With the display showing "CAL" or "OFF" press the SENSITIVITY CHECK button.

3. To return the transmitter to normal operation press MODE until "OFF" is displayed, then press ENTER.

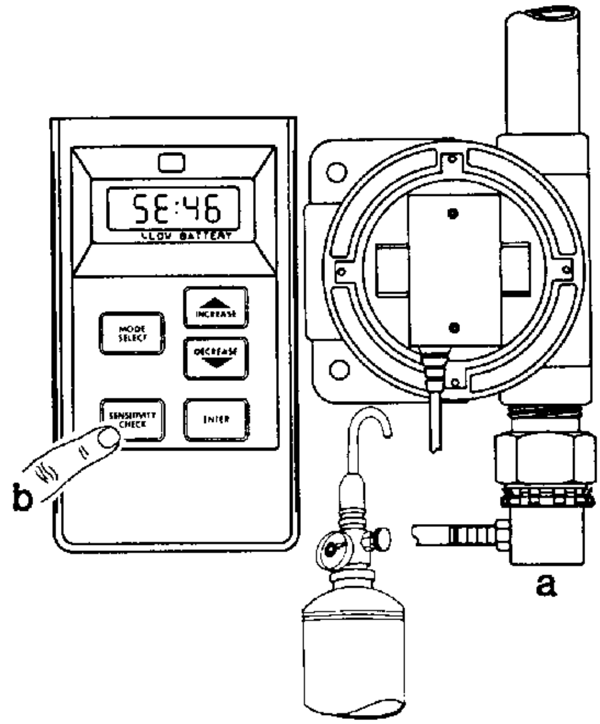
The sensitivity will be briefly displayed after the second calibration gas point is entered. It can also be viewed while the "GAS" message is flashing by pressing the SENSITIVITY CHECK button, but remember to remove the gas from the sensor within one minute of entering the C1 calibration point or the timeout could cause a false alarm at the controller.

RELAY OPTION BOARD

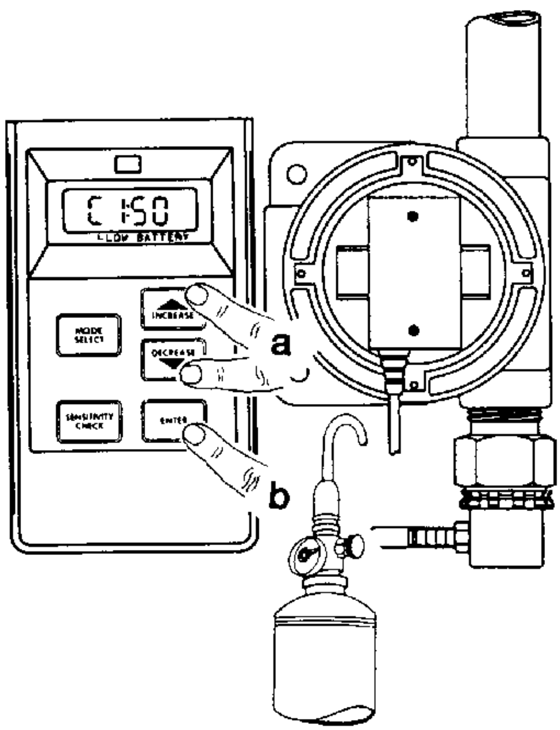
The relay option board (part number 226783) contains up to two hermetically sealed relays and relay status LEDs. Whenever a relay is energized, its corresponding LED will be lit. Each relay can be set to be normally de-energized (energize on alarm) or



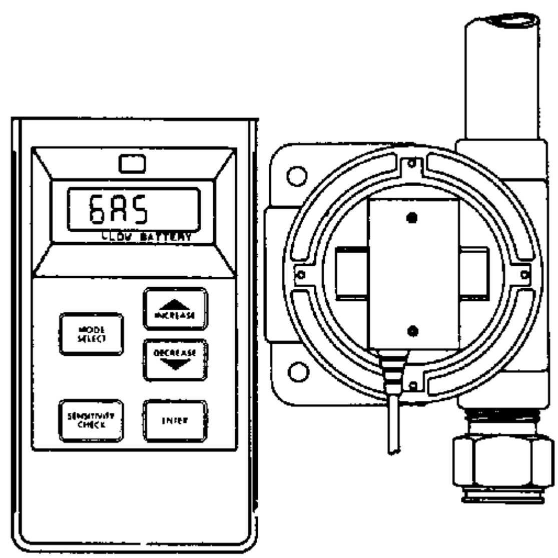
1. a) Turn on meter (or begin User Mode).
   b) ENTER CAL mode.
   c) ENTER sensor zero.



2. a) Apply calibration gas.
   b) Check Sensor Sensitivity.



3. a) Adjust sensor span.
   b) ENTER sensor span setting.



4. Remove calibration gas and meter.

Figure 29—Calibration Sequence

normally energized (de-energize on alarm or power failure). Each relay has separate set (switch to alarm state) and reset (switch back from alarm state) levels, which can be adjusted in 1% LFL steps. The relays will reset to the non-alarm state when power is applied to the transmitter and when the transmitter is giving a "Trouble" output (0.0 milliampere signal). Test T2 can be used to verify reset switch operation and to manually operate the relays (see the "User Operations" section).

RESET SWITCH

The transmitter has connections for a manual relay reset switch. However, the switch is not required since the optical calibration meter can be used to reset latched relays. If a switch is used it should have contacts suitable for low level switching and meet the hazardous environment specifications.

Figure 30 shows the wiring to the reset switch. The switch may be normally open or normally closed. The transmitter resets the relays when the switch changes from open to closed. This prevents problems due to a stuck switch. The switch must be held closed for about one second before the transmitter will reset the relays. This reduces the possibility of noise on the switch lines causing a reset.

RELAY MODES

The transmitter can be easily programmed by the user to operate each relay in one of several modes. These modes are: Auto-Reset/Reset Switch Input Disabled ("Ad"), Latched/Switch Reset Allowed Below the Reset Level ("Lb"), Latched/Reset Switch Disabled ("Ld"), and Latched/Switch Reset Allowed Above the Setpoint Level ("LA"). See "User Operations" Prog P1 and Prog P2 for information on programming the selected mode.

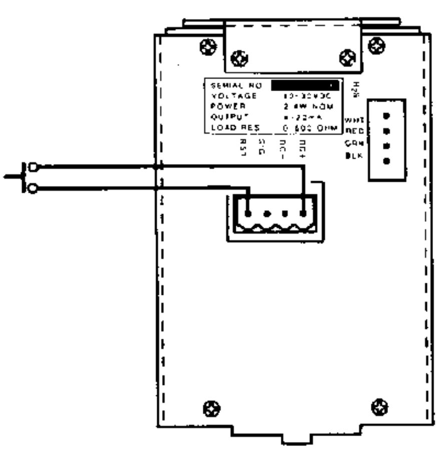


Figure 30—Optional External Reset Switch

When a relay is set for "Auto Reset/Reset Switch Disabled," the relay will set when the gas concentration at the sensor reaches the setpoint, and will automatically reset when the gas concentration drops below the reset level. The reset switch has no effect on relay operation. This is the standard mode.

With the "Latched Switch/Reset Below" option selected, the relay will set when the gas concentration at the sensor reaches the setpoint, but will not reset until the gas concentration drops below the reset level and the reset switch is pressed.

With the "Latched/Switch Reset Disabled" option, the relay will set when the gas concentration at the sensor reaches the setpoint, and will not reset until the optical calibration meter is attached and turned on.

With the "Latched/Switch Reset Above" option, the relay will set when the gas concentration at the sensor reaches the setpoint and may be reset, with the reset switch, at anytime thereafter, even with the gas concentration above the setpoint. After a reset the relay will not set again until the gas concentration at the sensor drops below the reset level, and then rises to the setpoint level.

Jumpers plugged onto headers W1 and W2 on the relay option board are used to select normally energized or de-energized operation for relays 1 and 2 respectively (see Figure 31). With a jumper plugged across pins one and two, the relay will be normally de-energized.

CALIBRATION METER RESET

When using the calibration meter to reset the relays, the gas concentration must be below the relay

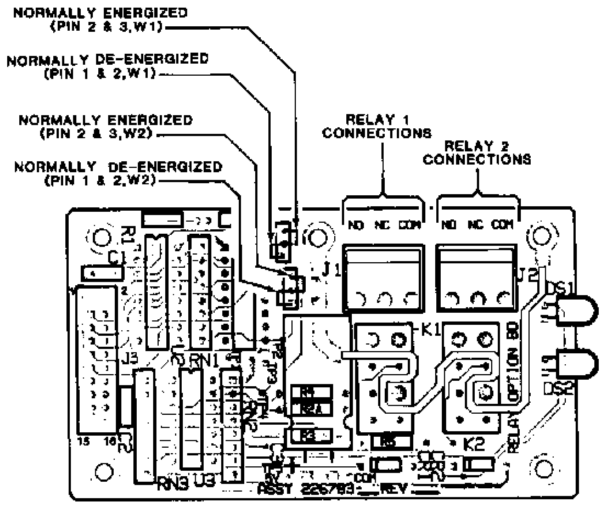


Figure 31—Relay/Jumper Connections

setpoint for the relays to stay reset. If the gas concentration is above the relay setpoints they will go back into alarm.

To reset the relays, attach the calibration meter to the transmitter enclosure and turn the meter on (press MODE). The relays will reset and the meter can then be turned off (press MODE until "OFF" is displayed, then press ENTER).

PARTS AND ACCESSORIES

RECOMMENDED SPARES

Item	Part number
Model 400 Remote Calibration Transmitter	226907-01
Optical Remote Calibration Meter	226906-01
Sensor (1 per 5 sensors)	See below
Dust Cover (1 per 5 sensors)	See below
Calibration Gas Tank	See below

SENSORS AND ACCESSORIES

Item	Part number
Combustible Sensor	225006-02
Combustible Sensor with Stainless Steel Housing	225957-01
Poison Resistant Sensor	226530-01
Poison Resistant Sensor with Stainless Steel Housing	226531-01
Transmitter Enclosure with Bracket	226905-01
Sensor Dust Cover (Stainless Steel)	225312-01
Sensor Dust Cover (Porex)	226190-01
Duct Mount and Calibration Assembly	226846-01
Sample Draw Assembly I	225775-01
Sample Draw Assembly II	226053-01
Sensor Rain Shield	226349-01
Sensor Splash Shield	226354-01
Transmitter/Sensor Separation Kit	226365-03

CALIBRATION EQUIPMENT

Item	Part Number
Optical Remote Calibration Meter	226906-01
Calibration Kit (2 bottles, regulator, hose and cup, carrying case)	
Methane	225130-01
Ethane	225130-02
Ethylene	225130-03
Propane	225130-04
Hydrogen	225130-05
Replacement Bottles (disposable)	
Methane	226166-01
Ethane	226166-02
Ethylene	226166-03
Propane	226166-04
Hydrogen	226166-05
Regulator	162552-01
Carrying Case	162553-01
Calibration Cup Adapter	225383-01

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.

Return all equipment transportation prepaid to the Minneapolis location.

Office Locations

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, MN 55438 USA
Telephone (612) 941-5665
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 (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