DET TRONICS

SERVICE MEMO

Precautions for Handling Electrostatic Sensitive Devices

With the trend toward increasingly widespread use of microprocessors and a wide variety of other electrostatic sensitive semiconductor devices, the need for careful handling of equipment containing these devices deserves more attention than it has received in the past.

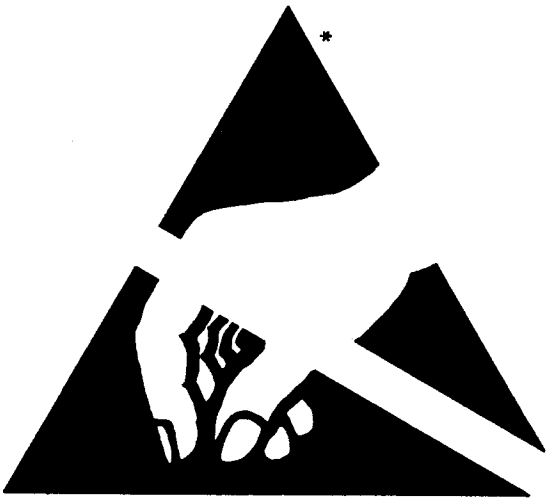
Electrostatic damage can occur in several ways. The most familiar is by physical contact. Touching an object causes a discharge of electrostatic energy that has built up on the skin. If the charge is of sufficient magnitude, a spark will also be visible. This voltage is often more than enough to damage some electronic components. Some devices can be damaged without any physical contact. Exposure to an electric field can cause damage if the electric field exceeds the dielectric breakdown voltage of the capacitive elements within the device.

In some cases, permanent damage is instantaneous and an immediate malfunction is realized. Often, however, the symptoms are not immediately observed. Performance may be marginal or even seemingly normal for an indefinite period of time, followed by a sudden and mysterious failure.

Damage caused by electrostatic discharge can be virtually eliminated if the equipment is handled only in a static safeguarded work area and if it is transported in a package or container that will render the necessary protection against static electricity.

Det-Tronics modules that might be damaged by static electricity are carefully wrapped in a static protective material before being packaged. Foam packaging blocks are also treated with an antistatic agent.

If it should ever become necessary to return the module, it is highly recommended that it be carefully packaged in the original carton **and static protective wrapping**.



Since a static safeguarded work area is usually impractical in most field installations, caution should be exercised to handle the module by its metal shields, taking care not to touch electronic components or terminals.

In general, always exercise all of the accepted and proven precautions that are normally observed when handling electrostatic sensitive devices.

A warning label is placed on the packaging, identifying those units that use electrostatic sensitive semiconductor devices.

*Published in accordance with EIA Standard 471

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DET TRONICS

INSTRUCTIONS

Combustible Gas Controller

R8471A

Section I
General Information

DESCRIPTION

The R8471A Combustible Gas Controller monitors a 4 to 20 milliampere (ma) dc signal generated by a Det-Tronics combustible gas sensor/transmitter assembly. The single channel system operates in the range of 0 to 100% LFL (lower flammable limit). Controller response includes actuation of solid state or optional relay outputs for direct control of field response devices, a full array of faceplate indicators, as well as an optional 4 to 20 ma output for transmitting system information to other monitoring devices.

FEATURES

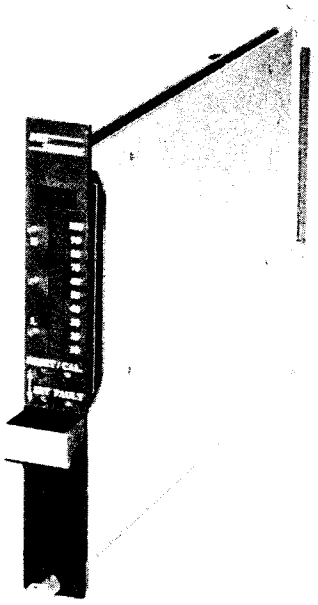
- Controller accepts a 4 to 20 ma input, ensuring compatibility with a variety of transmitters.
- Digital display, bar graph display, and high intensity LEDs indicate important system status information.
- AutoCal feature ensures easy and accurate calibration.
- Microprocessor based controller is easily field programmable to meet the needs of a specific application.
- Base model is furnished with solid state alarm and fault outputs.
- Premium model is furnished with relay outputs and a 4 to 20 ma dc output.
- Current output is selectable for isolated/non-isolated operation.
- Rack compatible with Det-Tronics R7400 series flame controllers.
- Variety of racks available in 4U or 3U height configuration.

SPECIFICATIONS

CONTROLLER

OPERATING VOLTAGE—
24 vdc. Can operate in the range of 18 to 32 vdc.

MAXIMUM RIPPLE—
Ripple should not exceed 5 volts peak-to-peak. The sum of dc plus ripple must be ≥18 vdc and ≤ 32 vdc.



POWER CONSUMPTION (controller only)—
Base model: 0.7 watt nominal, 1.3 watts maximum (25 ma nominal, 50 ma maximum at 24 vdc.)
Premium model: 1.2 watts nominal, 3.5 watts maximum (50 ma nominal, 145 ma maximum at 24 vdc.)

TEMPERATURE RANGE—
Operating: +32°F to +140°F (0°C to +60°C)
Storage: –49°F to +185°F (–45°C to +85°C).

OPERATING RANGE—0 to 100% LFL.

SOLID STATE OUTPUTS (Base model only)—
The outputs are open collector transistors with a 100K resistor from the collector to emitter with the emitter grounded, rated 100 ma at 32 volts dc maximum.

RELAY CONTACTS (Premium model only)—
Selectable normally open/normally closed contacts rated 5 amperes at 30 vdc/250 vac. See Table 1 for selectable relay options.

CURRENT OUTPUT (Premium model only)—
4 to 20 ma dc current, with a maximum loop resistance of 600 ohms at 20 to 32 vdc.

DIMENSIONS—
See Figure 1.

SHIPPING WEIGHT (approximate)—
2.0 pounds (0.9 kilogram).

K SERIES TRANSMITTER

INPUT VOLTAGE—
24 vdc (10 to 28 vdc range).

POWER CONSUMPTION—
1.5 watts with sensor.

OUTPUT CURRENT—
Linear 4 to 20 ma.

ZERO SHIFT WITH TEMPERATURE—
0.02% LFL/°C at maximum gain.

GAIN SHIFT WITH TEMPERATURE—
0.01% LFL/°C at maximum gain.

TEMPERATURE RANGE—
Operating: 0°F to +167°F (–40°C to +75°C).
Storage: –49°F to +185°F (–45°C to +85°C).

SENSOR

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.

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).

REPEATABILITY—
±5 percent, full scale.

ZERO DRIFT—
Less than 1% LFL per month.

OXYGEN EFFECTS—
The sensor will operate normally with the oxygen level in the atmosphere at or above 10 percent concentration. Under oxygen enriched conditions the sensor will respond normally, but the user should beware of an increase in the explosive hazard. Contact the factory for information regarding use of the sensor in oxygen deficient atmospheres.

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

Table 1—Selectable Relay Options

Relay	Selectable Normally Open/Closed	Selectable Normally Energized/ De-Energized	Selectable Latch/ Non-Latch
Low	Y	Y	Y
High	Y	Y	N[1]
Auxiliary	Y	Y	Y
Fault	Y	N[2]	N[3]

Y = Yes N = No [1]Latching only
[2]Normally energized [3]No latching option

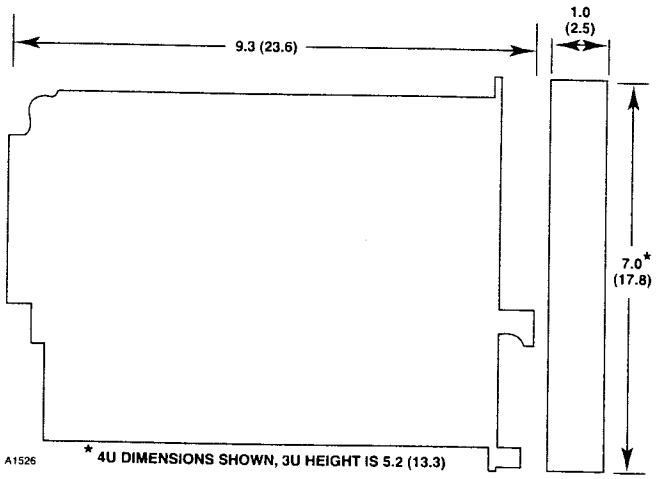


Figure 1—Controller Dimensions in Inches (Centimeters)

SYSTEM OPERATION

SENSOR

Det-Tronics combustible gas sensors use a catalytic type sensing element and operate in the range of 0 to 100% LFL. Sensors are available in aluminum or stainless steel housings, with a choice of three sensing elements - standard, poison resistant, and high temperature. With proper calibration, the sensor can be used to detect a wide variety of combustible gases. Contact Detector Electronics for assistance in adapting the sensor to a specific application.

TRANSMITTER

The transmitter functions as the interface between the sensor and the controller. It regulates operating power to the sensor and generates a linear 4 to 20 ma output signal proportional to 0 to 100% LFL combustible gas concentration.

A transmitter output signal of less than 4 ma is displayed as a negative reading by the controller.

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.

Detector Electronics offers a variety of transmitter models that operate in the 0 to 100% LFL range and are compatible with the R8471 Controller. Refer to the "Ordering Information" section for more information.

CONTROLLER

Faceplate Description

The faceplate of the controller provides LEDs for identifying status conditions, a digital display and bar graph display for indicating the sensor input, and pushbuttons for programming, calibrating and resetting the system. See Figure 2 for the location of indicators and pushbuttons.

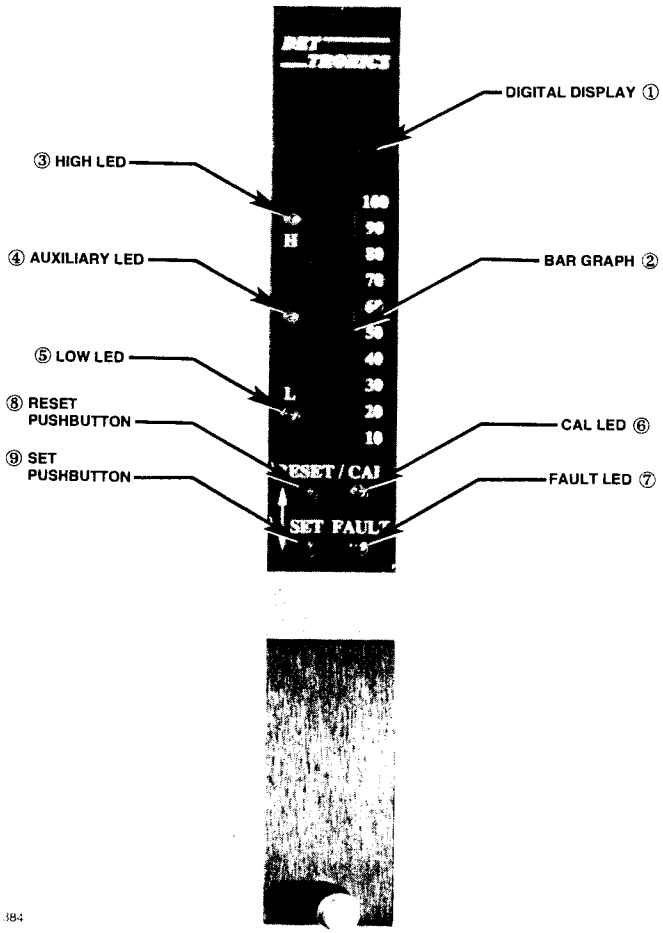


Figure 2—Controller Front Panel

1. Digital Display—The digital display continuously provides a % LFL reading of the sensor input in both the Normal and Calibrate modes. In the event of a fault, it identifies the nature of the fault using an alpha-numeric code. In other operating modes it shows the alarm setpoints and programmed calibration gas concentration. A negative zero drift condition is indicated by a minus (–) sign in the left hand digit. If an over-range condition occurs, the display flashes and the highest reading latches on. Since this display is always on, it also functions as a power indicator.

2. Bar Graph Display—The 20 segment bar graph display provides a reading of sensor input in 5% LFL increments.

3. High Alarm LED—Flashes in response to a sensor signal that exceeds the high setpoint.

4. Auxiliary Alarm LED—Flashes in response to a sensor signal that exceeds the auxiliary setpoint.

5. Low Alarm LED—Flashes in response to a sensor signal that exceeds the low setpoint.

NOTE

The alarm LEDs flash when the setpoint is exceeded and are on steady (until reset) when the gas level drops below the setpoint, whether the corresponding alarm output is latching or non-latching.

6. Cal LED—Illuminated while the controller is in the calibrate mode.

NOTE

In the Setpoint Display or Setpoint Adjust mode, a flashing alarm LED identifies the particular setpoint currently being indicated on the digital display. A flashing Cal LED indicates that the programmed calibration gas concentration in % LFL is currently being shown on the digital display.

7. Fault LED—Flashes upon detection of a system fault and is on steady during the power-up time delay.

8. Reset Pushbutton—Used for various system programming and calibration functions as well as for resetting the controller.

9. Set Pushbutton—Used for various system programming and calibration functions.

Setpoints

The R8471 Controller has independent Low, High, and Auxiliary alarm setpoints, with corresponding outputs.
The programmed calibration gas concentration in % LFL is also displayed and adjusted with the alarm setpoints. This value must be equal to the % LFL concentration of the calibration mixture that is used for the span adjustment.

The adjustment range is:

Low alarm	5 to 50% LFL
High alarm	10 to 60% LFL
Auxiliary alarm	5 to 90% LFL
Calibration gas	30 to 99% LFL.

The alarm setpoints and calibration gas concentration can be checked by pressing the Reset pushbutton located on the front panel of the controller. See "Setpoint Adjustment" and "Calibration" sections.

Outputs

The R8471 Controller is available in a Base version and a Premium version. The differences between the two models are the output configuration and programming options.

Base Model—The base controller is furnished with open collector transistor outputs (rated 100 ma at 32 volts dc) for the Low alarm, High alarm, Auxiliary alarm, and Fault circuits. The normally de-energized alarm outputs are energized when their corresponding setpoints are exceeded. The fault output is normally energized and becomes de-energized upon detection of a system fault.

Premium Model—The premium model is furnished with a set of four relays in place of the four solid state outputs. The relays have SPST contacts rated 5 amperes at 30 vdc or 250 vac.

This model also includes a selectable isolated/non-isolated 4 to 20 ma dc current output for transmitting system information to other monitoring devices. The linear 4 to 20 ma output corresponds to levels from 0 to 100% LFL. If a system fault is detected, the output drops to less than 1.0 ma. The current output can be calibrated in the field to ensure maximum accuracy. (Refer to the "Calibration" section for details.)

Programming Options (Premium model only)—Each of the four relays is field selectable for either normally open or normally closed contacts using jumper plugs located on the printed circuit board inside the controller. (See Table 1.)

The alarm relays are also switch programmable for either normally energized or normally de-energized operation. The fault relay is normally energized.

The low and auxiliary alarm relays are programmable for either latching or non-latching operation. The high alarm relay is always latching and the Fault relay is non-latching. Latching relays are reset using either the Reset pushbutton on the front panel of the controller or an external reset switch.

The 4 to 20 ma circuit is selectable for isolated or non-isolated operation.

Automatic Diagnostics and Fault Identification

The microprocessor based controller features self-testing circuitry that continuously checks for faulty sensor or open sensor wiring, low or high input voltage, and other problems that could prevent proper system response. When power is applied, the microprocessor automatically tests memory. In the Normal operating mode, it continuously monitors the input signal from the transmitter to ensure proper functioning. In addition, a "watchdog" timer is maintained to ensure that the program is running correctly. If a fault should occur:

- The Fault LED flashes.
- The digital display identifies the nature of the fault using an alpha-numeric code. Refer to Table 2.
- The normally energized Fault output is de-energized.
- The dc current output drops to less than 1 ma.

NOTE

The fault code will be shown for about 2 seconds out of every 5 seconds. The gas concentration at the sensor will be displayed during the remaining time. If more than one fault should occur, the highest priority fault will be displayed. (Table 2 lists the faults in order of priority.)

An alarm condition will normally over-ride a fault condition unless the fault condition occurred first (except F10, F2X). However, faults that affect the actual function of the controller (F50, F60, F70, F9X) can impair the ability of the controller to maintain an alarm output.

All faults automatically reset except the F9X, F20, and F10 faults. After the fault condition has been corrected, the fault output automatically switches to the normal (energized) state, the dc current output returns to normal, and the Fault LED turns off. Clearing F9X faults requires removing operating power from the controller for approximately one second.

CAUTION

The fault detection circuitry does not monitor the operation of external response equipment or the external wiring to these devices. It is important that these devices be checked periodically to ensure that they are operational.

Table 2—System Status Codes

Status	Condition
F9X	Initialization failure. (Subcodes are as follows.)
F91	EPROM sumcheck failure.
F92	Sensor failure during startup - current too high or too low.
F93	Watchdog timer failure.
F94	RAM failure.
F95	Internal 5 volt power supply failure during startup.
F96	External 24 volt power supply failure during startup.
F97	Controller type invalid. Error in data from RAM.
F98	Watchdog timer reset the controller.
F70	External reset button has been activated for 15 seconds or longer. Self clearing when button is released.
F60	External 24 vdc power input is not in the 18 to 32 vdc range.
F50	Internal 5 volt power supply is not in the 4.75 to 5.25 volt range.
F40	Sensor fault (after startup). Input is above 35 ma or below 2 ma.
F30	Negative zero drift. Sensor input is –9% full scale or lower.
F2X	Calibration error. (Subcodes are as follows.)
F20	General calibration fault, or calibration aborted due to a higher priority fault.
F21	Time ran out while waiting for calibration gas to be applied to the sensor.
F22	Sensor input is too low. The sensor cannot generate enough offset to get an accurate calibration. Replace sensor.
F23	Sensor is too sensitive for the controller to read 100% full scale. Replace sensor.
F24	Zero gas level too high, or sensor zero input over limit.
F10	Sensor reaching end of life. Consider replacing the sensor within the next two calibration periods.

Operating Modes

NOTE

The following section is intended to acquaint the operator with the basic operation of the controller. For complete step-by-step programming and calibration procedures, refer to the corresponding sections in this manual.

The controller can operate in any of the following modes. Operating modes other than Normal are selected by pressing the appropriate pushbutton(s) located on the controller front panel. See Figure 3.

NORMAL

In the Normal operating mode with no alarm condition:

— Digital display is on and indicates the sensor input in % LFL.
— Bar graph display reads the same as the digital display.
— All LEDs are off.
— Alarm outputs are in their normal state (energized or de-energized as programmed).
— DC current output signal level corresponds to sensor input.
— Fault output is energized.

In the Normal operating mode with a low and/or auxiliary alarm condition occurring:

— Digital display and bar graph display indicate the sensor input in % LFL.
— Low and/or Auxiliary LED flashes.
— Low and/or Auxiliary alarm output changes state.
— Dc current output signal level corresponds to sensor input.
— Fault output energized and LED off.

When the signal decreases below the low or auxiliary setpoint:

— Digital display, bar graph display, and 4 to 20 ma output continue to track the sensor input.
— With latching operation programmed: No change to alarm outputs.
— With non-latching operation programmed: Alarm outputs return to their normal state.
— Low and Auxiliary LEDs are on steady until reset.

In the Normal operating mode and a high alarm condition occurring:

— Same as low or auxiliary alarm, but High LED is on and high alarm output is actuated.

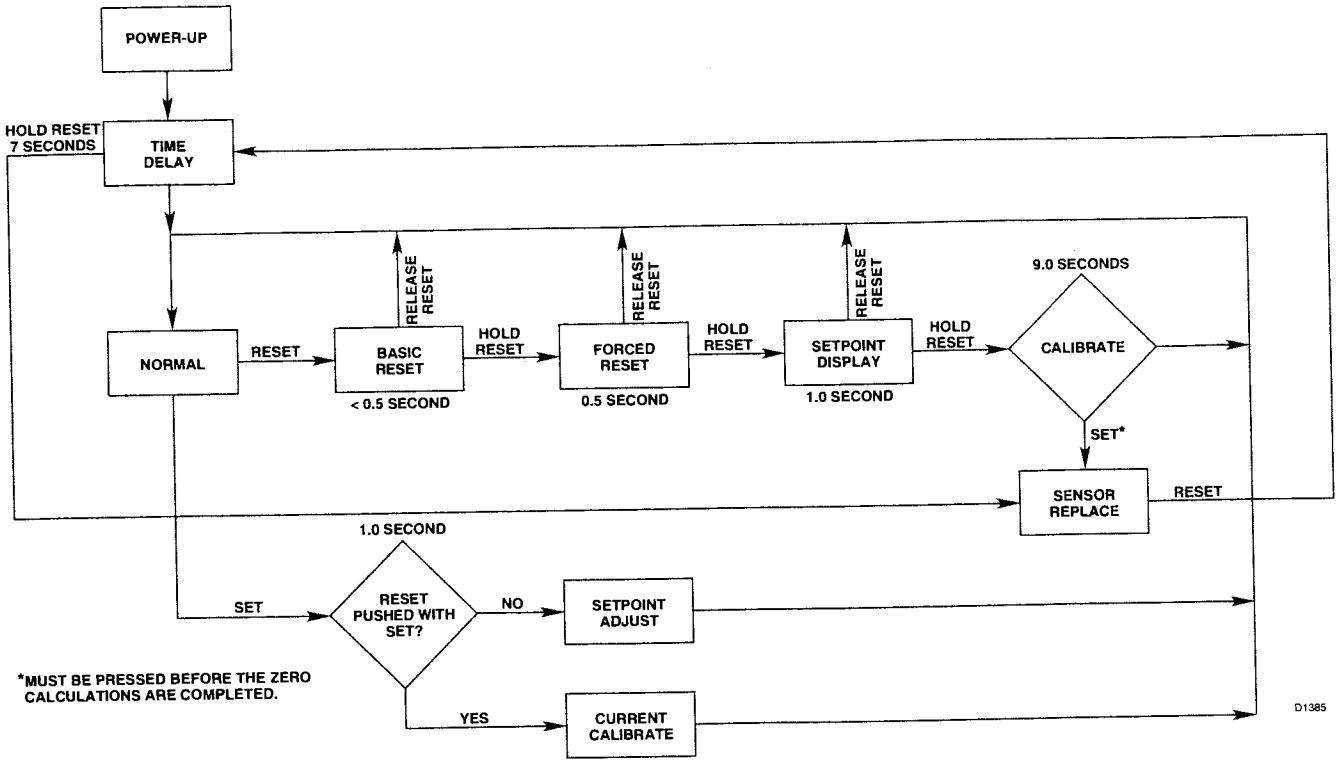


Figure 3—R8471 Controller Flow Chart

When the signal decreases below the high alarm setpoint:

— The high alarm is always latching and unaffected by the latching/non-latching programming for the low and auxiliary alarms. High LED is on steady until reset.

In the event of a system fault:

— The normally energized Fault output is de-energized and the Fault LED is illuminated.

RESET

The Reset mode is the first mode that is entered by pressing the Reset button located on the front panel of the controller. (See Figure 3.) When the Reset button is **momentarily depressed**, all LEDs turn off and all outputs return to their normal condition if no alarms or faults are occurring (basic reset). When the Reset button is **held for 0.5 second**, the LEDs turn off and the outputs return to their normal condition even if an alarm or fault condition still exists (forced reset). Remote reset capability is also provided. (Remote reset performs a forced reset.)

NOTE

The remote reset performs a reset function only. It cannot be used for entering other controller operating modes.

SETPOINT DISPLAY MODE

If the Reset button is held for approximately one second, the digital display sequentially shows the programmed alarm setpoints and calibration gas concentration. Each value is displayed for approximately 2 seconds. After completing the sequence, the controller automatically returns to the Normal operating mode if the Reset button is no longer being depressed.

This mode is used only for displaying the setpoints. Use the "Setpoint Adjust" mode for changing setpoint and calibration gas values.

CALIBRATE

The R8471 Controller uses a fully automatic calibration procedure that requires no adjustments to be made by the operator. The Calibrate mode is entered by pressing and holding the Reset button until completion of the "Setpoint Display" sequence described above (approximately 9 seconds). The controller performs the Zero adjustments, then signals the operator when to apply and also when to remove the calibration gas. Upon completion of a successful calibration, the controller automatically returns to the Normal operating mode.

If the operator fails to complete the calibration procedure, if an error in calibrating occurs, or if a success-

ful calibration cannot be completed, the microprocessor will automatically return to the Normal mode (after 10 minutes) and continue to use the previous calibration data. A fault indication ("F2X" status) will be displayed until a reset occurs. If the microprocessor determines that the sensing element is approaching the end of its useful life, "F10" will be indicated on the digital display. Refer the "Calibration" section for complete information regarding calibration.

While in the Calibrate mode, all controller outputs are inhibited, the CAL LED is illuminated, and the dc current output goes to a preset level (adjustable from 0 to 20 ma).

SENSOR REPLACEMENT

This mode inhibits all controller outputs to allow sensor replacement without removing power from the controller. In addition, this mode automatically sets the factory default values for sensor calibration. Other programmed setpoint values are not affected.

CAUTION

Upon entering the Sensor Replacement mode, all previously entered sensor calibration information is lost. ***Sensor calibration must be performed,*** *even if the sensor was not replaced.*

To enter the Sensor Replacement mode, first enter the Calibrate mode as described above, then press the Set button. To exit this mode, press the Reset button.

SETPOINT ADJUST

The Setpoint Adjust mode is entered by depressing the Set button for approximately one second. In this mode the alarm setpoints and calibration gas level are sequentially displayed on the digital display for approximately five seconds and the corresponding LED flashes. To change the setpoint, depress the Reset button to increase the displayed value or the Set button to decrease the value. If no changes are made for 5 seconds, the microprocessor automatically advances to the next setpoint. At the end of the sequence, the microprocessor automatically returns to the Normal operating mode.

DC CURRENT OUTPUT CALIBRATION

This mode is used to calibrate the 4 to 20 ma dc output. To enter this mode, hold the Set button, then press Reset. First the 0% LFL value (4 ma) is generated for approximately 7 seconds while the Low LED flashes. Then the 100% LFL value (20 ma) is generated while the High LED flashes. Finally the current output during calibration is generated while the CAL LED flashes. The microprocessor automatically returns to the normal operating mode at the end of the sequence. Adjustments to the current output level are made by pressing the Reset (increase) or Set (decrease) button. This procedure requires a dc current meter to monitor the actual controller dc milliampere output.

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 an anticipated source.

3. Ventilation characteristics of the immediate area must also be considered. Movement of air can 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 consider 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. The use of the 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 premature 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

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.

In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment.

The use of shielded cable is recommended for connecting the transmitter to the controller. If a sensor separation kit is used, shielded cable **must** be used between the sensor and the transmitter.

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 become 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 watertight 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 device as possible. In no case should this seal be located more than 18 inches (46 cm) from the device. When an explosion-proof installation is required, an additional seal may be needed at any point where the conduit enters a non-hazardous area. Always observe the requirements of local codes.

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 can 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 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.

Three wire cable is used for connecting the sensor/transmitter assembly to the controller. Three conductor cable with a foil shield is recommended. The shield of the cable should be open at the transmitter junction box and connected to earth ground at the controller.

The maximum distance between the transmitter and controller is limited by the resistance of the connecting wiring, which is a function of the gauge of the wire being used. Table 3 shows the maximum wiring distance allowed for a given wire size when using K Series Transmitters. **For other transmitter models, refer to the transmitter manual for specific instructions.**

SENSOR SEPARATION

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

NOTE

*The illustrations in the following section show the sensor separation kit used with a **K Series***

Table 3—Maximum Wiring Distances – Controller to K Series Transmitter

Wire Size		Maximum Controller to Transmitter Distance	
AWG No.	Diameter (millimeters)	(feet)	(meters)
18	1.024	1,800	550
16	1.291	2,900	900
14	1.628	4,600	1,400
12	2.053	7,300	2,200

Transmitter. *Although the basic wiring scheme is similar for other transmitter models, factors such as wiring distances and wire gauge will be different in each case. Refer to the transmitter manual for information specific to that model.*

Kit Description

The sensor separation kit consists of the following:

— Junction box with connector board
— Shorting plug
— Calibration cup
— Separation kits used with Model 400/405 Transmitters also include a plug-in connector kit.

NOTE

When using a sensor separation kit with K Series Transmitters, a transmitter extender plug is required for adjusting sensor voltage. The extender plug is not included in the separation kit. Refer to the "Ordering Information" section for part number.

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 the terminals for connecting the sensor and external wiring.

See Figure 4 for an illustration of a typical system using the Sensor Separation Kit.

The shorting plug, which attaches to the connector board, must be in place at all times that the sensor is operating.

The calibration cup can remain on the sensor after calibration without interfering with normal operation. By connecting a length of tubing 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 during routine calibration. If the filter becomes dirty and cannot be properly cleaned, the calibration cup must be replaced.*

Sensor Installation

For proper operation, the sensor must be oriented with the filter pointing down. Install the sensor in the lower 3/4 inch NPT opening on the junction box. Connect the conduit to the upper opening.

The sensor junction box can be mounted to a wall or post, or it can be suspended by the conduit. The junction boxes should be electrically connected to earth ground.

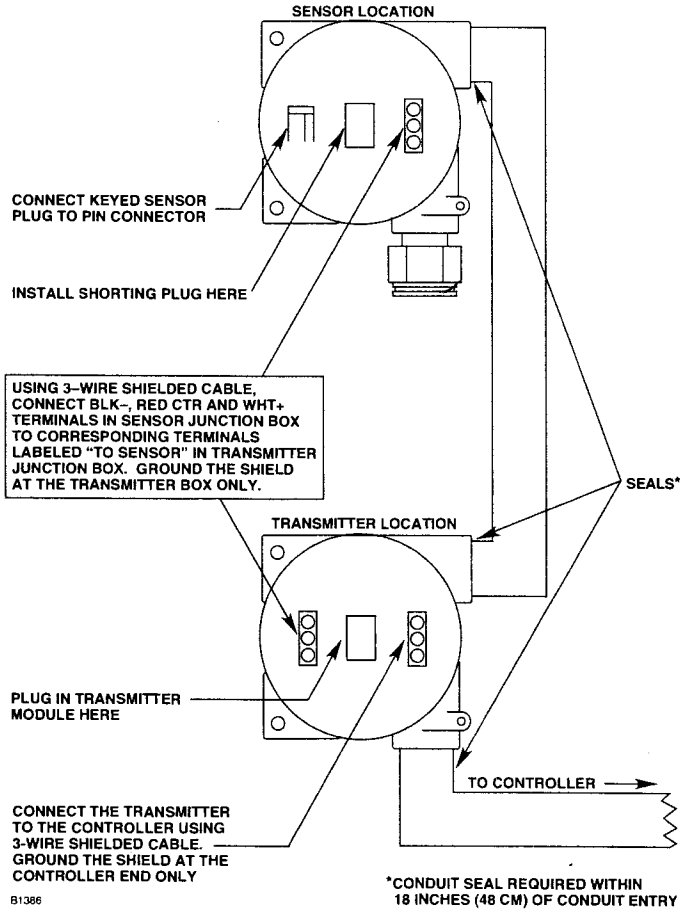


Figure 4—Typical Installation Using Sensor Separation Kit with K Series Transmitter

Wiring Requirements

Three wire cable is used for connecting the sensor to the transmitter and also for connecting the transmitter to the controller. The use of shielded cable is required for connecting the sensor and transmitter, and is highly recommended for connecting the transmitter and controller. Three conductor 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. Note that maximum wiring distances also vary with the specific transmitter model being used. Table 4 shows the maximum separation distance allowed for a given wire size when using K Series Transmitters. For other transmitter models, refer to the transmitter manual for specific instructions.

Sensor Voltage Adjustment (K Series Transmitters only)

When using a sensor separation kit with a K Series Transmitter, an adjustment to the sensor voltage is required to assure proper operation. This adjustment should be performed at the time of system startup, **before calibration is performed**.

The combustible gas sensor is designed to operate at 3.3 volts dc. Greater voltages will shorten sensor life and lower voltages will reduce sensitivity to certain gases. The sensor supply voltage is factory adjusted. However, re-adjustment is necessary if the sensor and transmitter are separated.

Table 4—Maximum Separation Distances – Sensor to K Series Transmitter

Shielded Wire Size (AWG)	Recommended Maximum Transmitter to Sensor Distance*	
	Feet	Meters
18	50	15
16	75	23
14	125	38

*Sensor voltage adjustment is required.

CAUTION

Sensor voltage adjustment requires the removal of the junction box cover at both the sensor and transmitter locations. The area must be de-classified when removing the junction box cover with power applied to the system.

To adjust sensor voltage, connect a digital voltmeter across +WHT and -BLK on the connector board inside the **sensor junction box** (see Figure 5). Install the transmitter extender plug between the transmitter module and the connector board in the **transmitter junction box** to allow access to potentiometer R18 on the transmitter module. Adjust R18 to obtain a reading of 3.3 volts on the voltmeter.

SENSOR/TRANSMITTER WIRING (without Sensor Separation)

The following section describes the installation and wiring procedure for **K Series Transmitters.** When using other transmitter models, mount and wire the sensor and transmitter as described in the transmitter manual.

1. Locate the sensors in positions that are best suited for covering the area to be protected, following the previously discussed guidelines. Whenever practical, they should be placed where they are easily accessible for calibration.

NOTE

Do not apply power to the system with the junction box cover removed unless the area has been de-classified.

2. Remove the cover from the transmitter junction box.

NOTE

The transmitter and controller contain 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.

3. Remove the transmitter module from the junction box.

4. The junction box can be mounted to a wall or post, or it can be suspended by the conduit. The junction box should be electrically connected to earth ground.

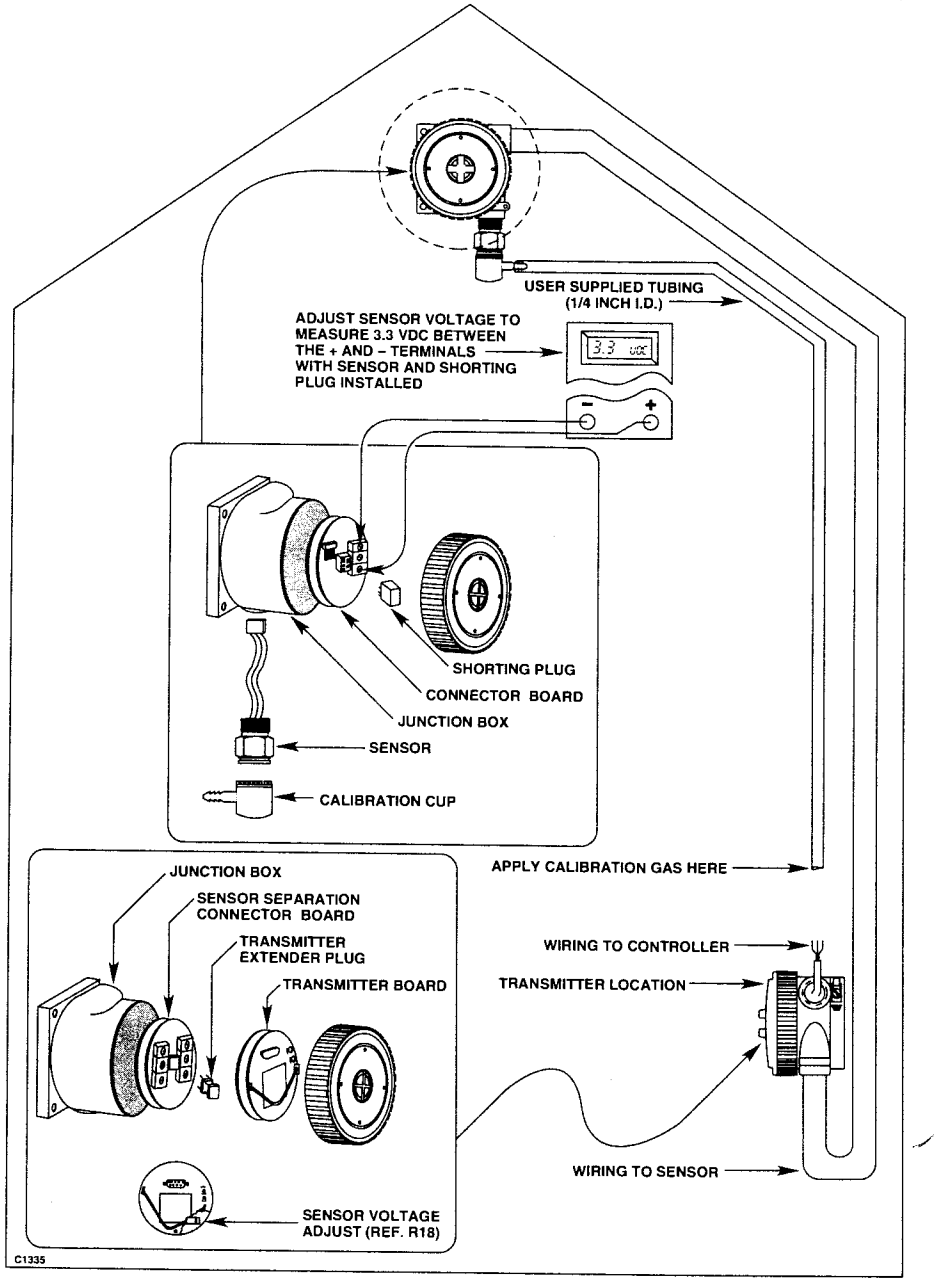


Figure 5—Sensor Separation with K Series Transmitter

For proper operation, the sensor must be oriented with the filter pointing down. Install the sensor in the lower 3/4 inch NPT opening on the junction box. Connect the conduit to the upper opening.

5. Attach the sensor to the junction box. The sensor should be tight to ensure an explosion-proof installation, however, do **not** overtighten. Attach the wiring plug at the appropriate terminal location. (See Figure 6.)

CAUTION

The sensor threads can be coated with an appropriate grease to ease both the initial installation and future replacement of the sensor. Also lubricate the cover threads. The recommended lubricant is a silicone free polyalphaolefin grease, part number 005003-001, available from Detector Electronics. 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.*

6. Connect the power and current output leadwires to the appropriate screw terminals inside the junction box. When using shielded cable, the shield should be connected to earth ground at the controller end only.

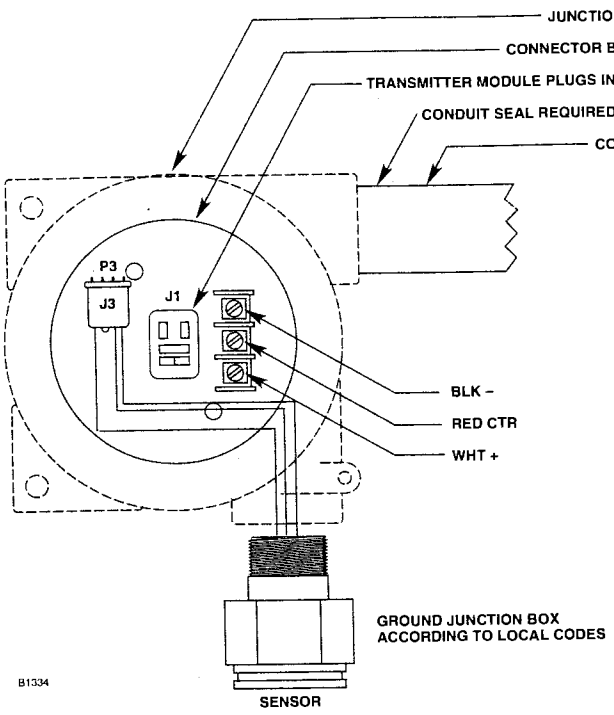


Figure 6—Transmitter Wiring

The wiring code is:
BLK – = Power supply negative (–)
RED CTR = Signal
WHT + = Power supply positive (+).

7. Check all field wiring to ensure that the proper connections have been made, then pour the conduit seals and allow them to dry (if conduit is being used).

8. Install the transmitter module inside the junction box.

9. Place the cover back on the junction box.

CONTROLLER WIRING

Field Wiring Connector

The controller is furnished with a field wiring connector backplate that incorporates pressure type screw terminals for connecting the external wiring and a circuit board edge connector for attaching to the controller. The use of a mounting rack is recommended for mounting the controller. The backplate is attached to the back of the rack to allow easy removal of the controller without disturbing the wiring. See Figures 7 and 8.

The controller is designed for installation in a non-hazardous area.

Figure 9 shows the terminal configuration for the R8471 Combustible Gas Controller.

Terminals 1 and 2— 4 to 20 ma dc output.

Non-Isolated Current Output – If the 4 to 20 ma current loop is to be non-isolated, wire the system as shown in Figure 10. Note that terminal 2 is not used with a non-isolated current loop. Program the unit for a non-isolated current loop as described in the "Controller Programming" section.

Isolated Current Output – If an isolated current loop is desired, wire the system as shown in Figure 11 and program the unit for an isolated current loop as described in the "Controller Programming" section. Note that this wiring scheme requires an external power source for the isolated current output.

Terminal 3— Chassis ground. Ground the cable shield at this terminal.

NOTE

If local wiring codes permit and if a ground fault monitoring system is not being used, the minus side of the dc power source can be connected to chassis (earth) ground. Alternatively, a 0.47 microfarad, 100 volt capacitor can be installed (terminal 5 to ground) for best immunity against electromagnetic interference.

Terminal 4— Connect to the positive (+) side of the 18 to 32 vdc power source.

Terminal 5— Connect to the negative (–) side of the dc power source.

Terminal 6— Make no connections to this terminal.

Terminal 7— 4 to 20 ma dc signal input from transmitter/sensor assembly.

Terminal 8— A normally open momentary closure switch can be connected between this terminal and the negative (–) side of the power source for remote reset.

Terminals 9 and 10— High Alarm Output.

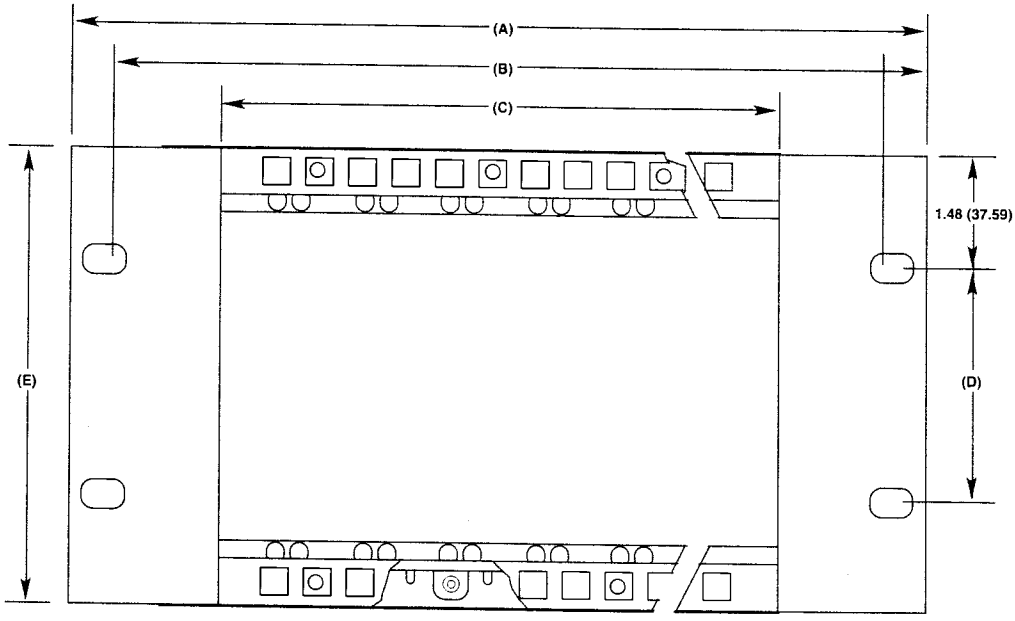
Terminals 11 and 12— Auxiliary Alarm Output.

Terminals 13 and 14— Low Alarm Output.

Terminals 15 and 16— Fault Output.

PREMIUM CONTROLLER – The relay outputs (terminals 9 to 16) are programmed for the desired operation using the procedure described in the "Controller Programming" section.

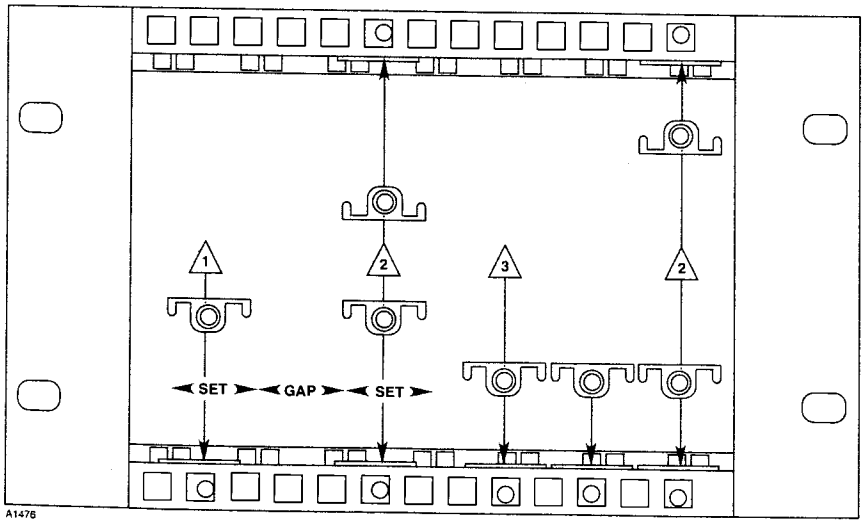
CONTROLLER POSITIONS FOR:		HT:	DIM. (A)		DIM. (B)		DIM. (C)		DIM. (D)		DIM. (E)	
FIRE	GAS		INCH	MM	INCH	MM	INCH	MM	INCH	MM	INCH	MM
8	16	4U	19.00	482.6	18.30	464.8	17.36	440.9	4.00	101.6	6.97	177.1
6	12	4U	15.06	382.6	14.36	364.7	13.42	340.9				
4	8	4U	11.13	282.6	10.43	264.9	9.49	241.1				
3	6	4U	9.16	232.7	8.46	214.9	7.52	191.0				
2	4	4U	7.19	182.7	6.49	164.9	5.55	141.0				
1	2	4U	5.22	132.6	4.52	114.8	3.58	90.9				
	16	3U	19.00	482.6	18.30	464.8	17.36	440.9	2.25	57.15	5.22	132.6
	12	3U	15.06	382.6	14.36	364.7	13.42	340.9				
	8	3U	11.13	282.6	10.43	264.9	9.49	241.1				
	6	3U	9.16	232.7	8.46	214.9	7.52	191.0				
	4	3U	7.19	182.7	6.49	164.9	5.55	141.0				
	2	3U	5.22	132.6	4.52	114.8	3.58	90.9				



ALL CONTROLLER CAGES REQUIRE A MINIMUM OF 10.12 INCHES (257.1 MM) DEPTH CLEARANCE

Figure 7—Dimensions of the Mounting Rack

THE Q4004 CONTROLLER CAGE HAS BEEN MODIFIED TO ACCOMMODATE EITHER FIRE OR GAS CONTROLLERS OR ANY COMBINATION OF THE TWO. BY FOLLOWING THE INSTRUCTIONS BELOW, THE CAGE CAN BE SET UP TO ANY CONFIGURATION.



1. FIRE CONTROLLERS ARE APPROX. TWO INCHES WIDE AND REQUIRE TWO GUIDE RAILS FOR INSERTION. PLACE THE RETAINING CLIP BETWEEN RAILS TO FORM SETS, LEAVE A GAP BETWEEN SETS.

2. TO INSERT A BLANK PANEL, PLACE A CLIP IN THE TOP BRACKET IN LINE WITH THE CLIP IN THE BOTTOM BRACKET.

3. GAS CONTROLLERS ARE APPROX. ONE INCH WIDE AND REQUIRE ONE RAIL FOR INSERTION. PLACE CLIPS IN LINE WITH GUIDE RAILS, CAGES WILL ACCEPT AS MANY GAS CONTROLLERS AS RAILS PROVIDED.

Figure 8—Clip Positioning for Mounting Racks

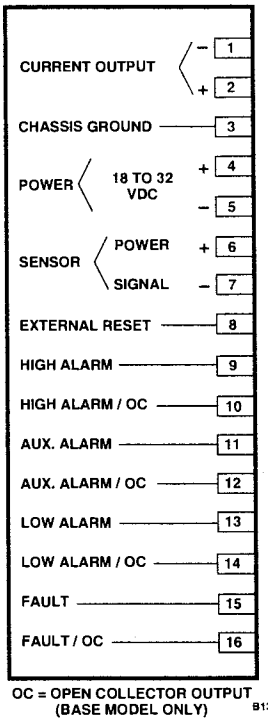


Figure 9—Terminal Configuration for R8471 Combustible Gas Controller

BASE CONTROLLER – Connections to open collector transistor outputs are made at terminals 10, 12, 14, and 16. Terminals 9, 11, 13, and 15 are not used. See Figure 12 for an example of a typical connection to an open collector transistor output.

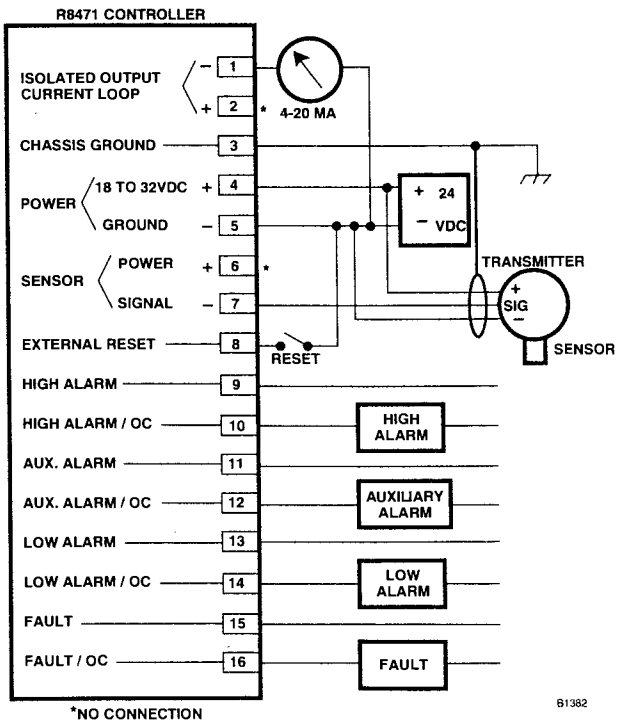


Figure 10—A Typical System with Relay Outputs and Non-Isolated Current Output

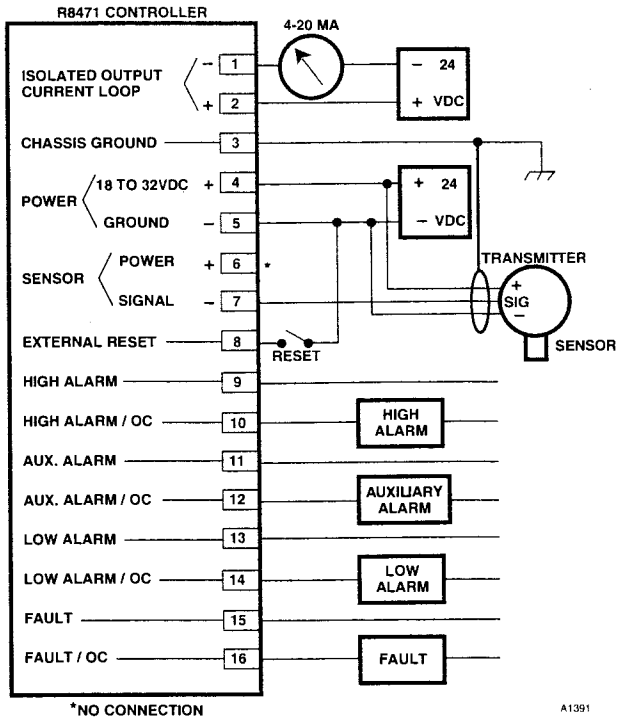


Figure 11—A Typical System with Relay Outputs and Isolated Current Output

NOTE

External equipment that can generate transients when switching (such as relays) ***must have a transient suppression device*** *(diode) properly connected across the coil at the time of installation. This will safeguard the output transistors of the controller against possible damage. Figure 12 illustrates an inductive load with a diode used for transient suppression.*

CONTROLLER PROGRAMMING

Refer to Figure 13 to determine the location of programming jumpers and switches. Table 1 shows the selectable options for each relay.

NOTE

All of the controller jumper plugs must be installed. The controller outputs will not function properly if a jumper plug is missing.

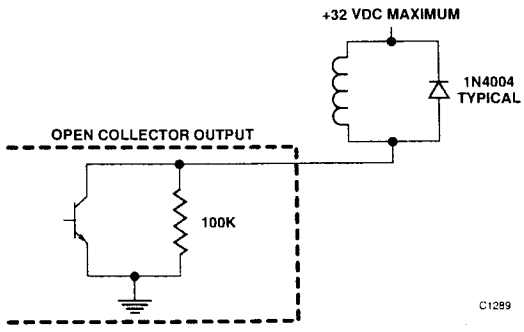


Figure 12—Open Collector Output with Inductive Load and Transient Suppression Device

Normally Open/Closed Relays

The four relays are individually programmed for either normally open or normally closed contacts. This is accomplished by placing a jumper plug on the appropriate pair of pins. Each relay has a set of three pins. For normally open operation, place the plug on the NO and center pins. For normally closed operation, place it on the NC and center pins. The pin groups are identified as follows:

J2 – High Alarm
J3 – Auxiliary Alarm
J4 – Low Alarm
J5 – Fault

The controller is programmed at the factory for normally open relay contacts.

Latching/Non-Latching Relays

The Low and Auxiliary alarm relays are programmable for latching or non-latching operation. The High alarm relay is always latching. Latching relay operation is programmed using rocker switch 1 at SW1 (SW1-1). For latching operation, place the switch in the closed position. For non-latching operation, place it in the open position. This switch is set at the factory for non-latching relay operation.

Normally Energized/De-Energized Relays

The three alarm relays are also programmable for normally energized (fail-safe) or normally de-energized operation. This is accomplished by setting rocker switch 2 at SW1 (SW1-2). For normally energized alarm relays, place the switch in the closed position. For normally de-energized operation, place it in the open position. This switch is set at the factory for normally de-energized operation.

The Fault relay is always normally energized, regardless of the setting of SW1-2.

4 to 20 Ma Output

Isolated or non-isolated operation of the 4 to 20 ma output can be selected using a jumper plug at J1. For non-isolated operation, as illustrated in Figure 10, place the jumper plug in the INT (**int**ernal power source) position. Place the plug in the EXT position for an isolated circuit, as illustrated in Figure 11. The jumper is set at the factory for non-isolated operation.

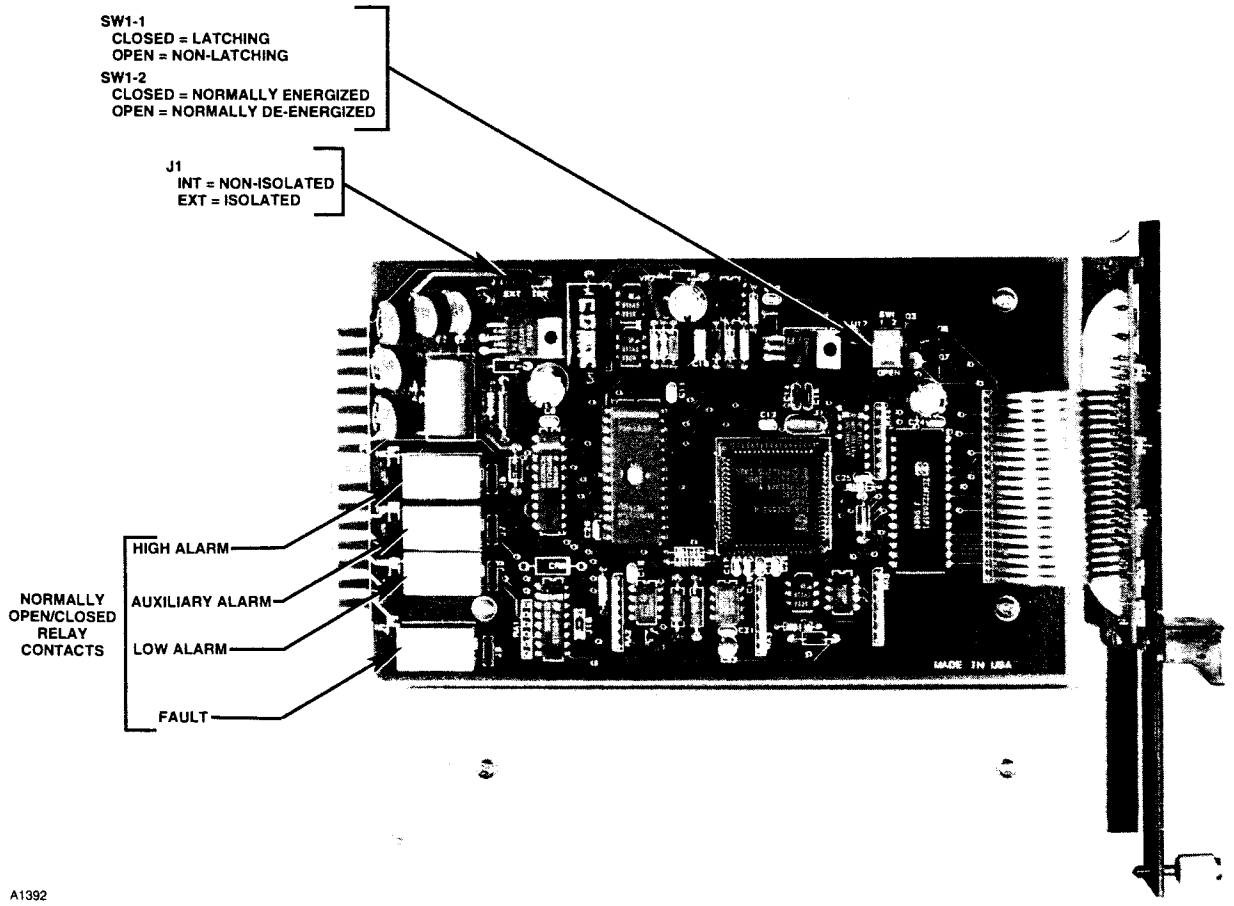


Figure 13—Programming Jumper Plugs and Switches

INSTALLATION CHECKLIST

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

1. Sensors are pointing down and junction boxes are securely mounted.

2. Optional sensor accessories (dust/splash guards, sample draw devices, etc.) are installed, clean, and in good condition.

3. If a sensor separation kit is used, interconnecting wiring is correct and shorting plug is installed.

4. All cable shields are properly grounded.

5. Conduit seals have been installed at all junction box entries (if conduit is being used).

6. All transmitter modules are properly installed in their junction boxes.

7. All junction box covers are tightly installed.

8. Transmitter to controller wiring is correct.

9. Power wiring to the controller is installed and power source is operational.

10. External loads are properly connected to the controller.

11. Controller is programmed as desired. Record this information for future reference.

12. Controllers are properly installed in the mounting enclosure.

13. Proper ventilation is provided to prevent overheating of the controller.

Proceed to System Startup, Setpoint Adjustment and Calibration.

Section III
System Startup

STARTUP PROCEDURE

1. Output loads that are normally actuated by the gas detection system should be secured (remove power from all output devices) to prevent undesired activation.

2. Check all external wiring for proper connection. Be sure that the sensor has been connected properly and that the transmitter module has been installed properly.

3. Before installing the controller in the mounting rack, inspect it to verify that it has not been physically damaged in shipment. Check the jumper plugs and rocker switches on the controller for proper programming, then slide the controller fully into the mounting enclosure.

4. Apply power to the system.

NOTE

When power is applied to the controller, it enters a time delay mode to allow the sensor output to stabilize before beginning normal operation. During this time the outputs are inhibited, the FAULT LED is illuminated, and the current output indicates a fault condition. This time delay can last up to five minutes, but will end earlier if the sensor output no longer exceeds any alarm setpoints.

5. If a sensor separation kit and K Series Transmitters are being used, adjust the sensor voltage to 3.3 vdc, following the procedure described in the "Sensor Separation" section.

6. If desired, controller operation can be tested by manipulating the transmitter output to a level that exceeds the alarm thresholds. With K Series Transmitters, this is done by adjusting the Zero potentiometer. [The transmitter Span adjustment may have to be increased (clockwise) to obtain a full scale reading on the controller.] The output of Model 400/405 Transmitters can be adjusted over the entire operating range of the transmitter using the optical calibration meter. Refer to the transmitter manual for details. Note that this test will actuate the controller outputs.

7. Put the controller in the Setpoint Display mode to determine the present alarm setpoints and calibration gas concentration. If changes are required, perform the Setpoint Adjustment procedure.

8. Perform the calibration procedure.

9. Check the 4 to 20 ma current loop for proper calibration and adjust as required.

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

SETPOINT ADJUSTMENT

The adjustment range for the alarm setpoints and calibration gas concentration is as follows:

Low alarm	5 to 40% LFL
High alarm	10 to 60% LFL
Auxiliary alarm	5 to 99% LFL
Calibration gas	30 to 99% LFL

The factory settings are:

Low alarm	20% LFL
High alarm	40% LFL
Auxiliary alarm	40% LFL
Calibration gas	50% LFL

To **check** the present levels, use the "Setpoint Display Mode" described below. To **change** the values, use the "Setpoint Adjustment Procedure".

SETPOINT DISPLAY MODE

1. To enter the Setpoint Display mode, press and hold the Reset button until the Low LED begins to blink (approximately one second). Release the Reset button. The low alarm setpoint will be shown for two seconds on the digital display.

NOTE

The Reset button should be released as soon as the controller has entered the Setpoint Display mode (after one second). If the button is still depressed at the end of the Setpoint Display mode (9 seconds), the controller will automatically enter the Calibrate mode. If the operator is not prepared to perform a calibration, a calibration fault will occur. Recycle power to the controller to exit the calibrate mode without affecting the calibration settings.

2. At the end of the two second interval, the Low LED goes out, the High LED begins to blink, and the digital display shows the high alarm setpoint.

3. Two seconds later the High LED goes out and the Auxiliary LED blinks. The digital display now shows the programmed auxiliary alarm setpoint.

4. Two seconds later the Auxiliary LED goes out and the CAL LED blinks. The digital display now shows the programmed calibration gas concentration.

5. After displaying the calibration gas concentration for two seconds, the controller automatically leaves the Setpoint Display mode and returns to the Normal operating mode.

6. If adjustments to the setpoints are required, perform the Setpoint Adjustment procedure. When the setpoint levels are acceptable, record this information for future reference and perform the Calibration procedure.

SETPOINT ADJUSTMENT PROCEDURE

1. Determine the required alarm setpoint levels and calibration gas concentration. If the system will be used to detect a gas other than the type being used for calibration, a conversion ("K") factor **must** be used to determine the correct value to be programmed into the microprocessor in step 5 below. Refer to the "Calibration " section.

2. Press and hold the Set button for one second. The digital display indicates the present low alarm setpoint and the Low LED blinks. Press the Reset button to increase the reading or the Set button to decrease the reading. (Holding the button will cause the reading to change rapidly.)

3. When no changes to the setpoint level have been made for 5 seconds, the Low LED goes out, the High LED blinks, and the digital display shows the high alarm setpoint. Press the appropriate button (detailed in step 2 above) to obtain the desired reading on the digital display.

4. When no changes to the setpoint level have been made for 5 seconds, the High LED goes out, the Auxiliary LED blinks, and the digital display shows the auxiliary alarm setpoint. Press the appropriate button to obtain the desired reading on the digital display.

5. When no changes have been made for 5 seconds, the Auxiliary LED goes out, the CAL LED blinks, and the digital display indicates the calibration gas concentration. Press the appropriate button to change the calibration gas concentration as required.

6. When no changes have been made for 5 seconds, the controller automatically returns to the Normal operating mode.

7. Record the new values for future reference.

NOTE

The alarm setpoints, calibration gas concentration, and calibration data are stored in non-volatile memory and are retained in the event of a power loss. However, if power is interrupted while performing the Setpoint Adjustment or Calibration procedure, the entire procedure must be repeated when power is restored.

CALIBRATION

Various factors affect the time interval between periodic recalibrations. Exposure of the sensing element to contaminants in the air, exposure to a high concentration of combustible gas, or an extended period of normal operation can cause changes in sensitivity. Since each application is different, the length of time between regularly scheduled recalibrations can vary from one installation to the next. In general, the more frequently a system is checked, the greater the reliability. The sensor **must** be calibrated:

— Before a new system is initially put into service
— If the sensor is replaced
— If the transmitter is replaced
— If the controller 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.

If an over-range condition should occur, the digital display flashes and the highest reading latches on until reset. 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. One common cause is by clogging of the sensor filter by water, dirt, oil, paint, etc. Problems of this nature are capable of totally incapacitating the sensor, but it is only during calibration that the problem will be discovered. To assure the greatest level of reliability, calibration should be performed at regularly scheduled intervals.

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 cover can significantly reduce the sensitivity of the sensor.

CONVERSION (K) FACTOR

The output of the sensor to different types of gases can vary considerably. To assure calibration 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 system can be calibrated using a standard calibration gas and an appropriate "K" factor. The "K" factor is used to calculate the calibration gas setting that is entered into the controller in place of the standard (typically 50%) calibration gas % LFL concentration. The "K" factor represents the relationship between the gas to be detected and the best gas type to be used for calibration. A "K" factor value of "1" is optimum.

To calculate the calibration gas setting 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 system 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 programming the controller for the calibration gas.

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 estab-

lished using a sample of the material to be detected. Contact the factory for details.

CALIBRATION PROCEDURE

The combustible gas detection system can be calibrated using either of two methods:

1. TRANSMITTER CALIBRATION. This method of calibration can be performed by one person. All adjustments are made at the transmitter. Calibration of certain transmitter models requires removing the enclosure cover, therefore, the hazardous area must be de-classified.

2. CONTROLLER CALIBRATION. This method of calibration typically requires two people, one person at the controller and another at the sensor. All adjustments are made automatically by the controller. No adjustments are made to the transmitter.

NOTE

The most accurate calibration for a new sensor will be achieved if a transmitter calibration is performed initially, followed by a controller calibration (24 hours later for maximum accuracy). The controller calibration procedure can then be used for all subsequent calibrations.

Transmitter Calibration (All Transmitter Models)

The controller must be set for the factory default calibration values as follows:

1. Press and hold the RESET button for approximately 9 seconds until the digital display begins flashing **and** the CAL LED is illuminated. Release the Reset button.

2. Press the SET button. The FAULT LED comes on.

3. Press the RESET button. The controller returns to the normal operating mode after a time delay (up to five minutes).

4. The controller is now set for the factory default values. The above procedure does not need to be performed with each recalibration unless a controller calibration (described below) is performed.

Transmitter Calibration Procedure (K Series)

The K Series Transmitter can be calibrated using either of two procedures. The standard calibration procedure can be performed by one person using the plug-in calibration meter. In addition to calibrating the sensor, this procedure tests sensor sensitivity.

The alternate calibration procedure uses the digital display on the controller instead of the plug-in calibration meter to indicate sensor response. In most applications, two people are needed to perform this calibration. No sensor sensitivity test is possible.

For information regarding calibration of other transmitter models, refer to the appropiate instruction manual.

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

CAUTION

A portable instrument should be used to ensure that the area is clear of any combustible gases. If there is any indication of the presence of combustible gas at the sensor, calibration or maintenance should not be performed.

The location must be de-classified prior to calibration.

2. Remove the junction box cover and plug the calibration meter into the socket on the transmitter.

3. Adjust the Zero control with a screwdriver until the meter displays 0% LFL (Figure 14). If the possibility of background gases exists, purge the sensor with clean air to assure accurate calibration.

NOTE

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.

4. Apply the calibration gas to the sensor. (Be sure that the pressure gauge indicates that there is enough gas in the tank to complete the calibration.)

5. When the display shows a stable reading, adjust the Span control until the meter displays the same % LFL as indicated on the calibration tank (typically 50%).

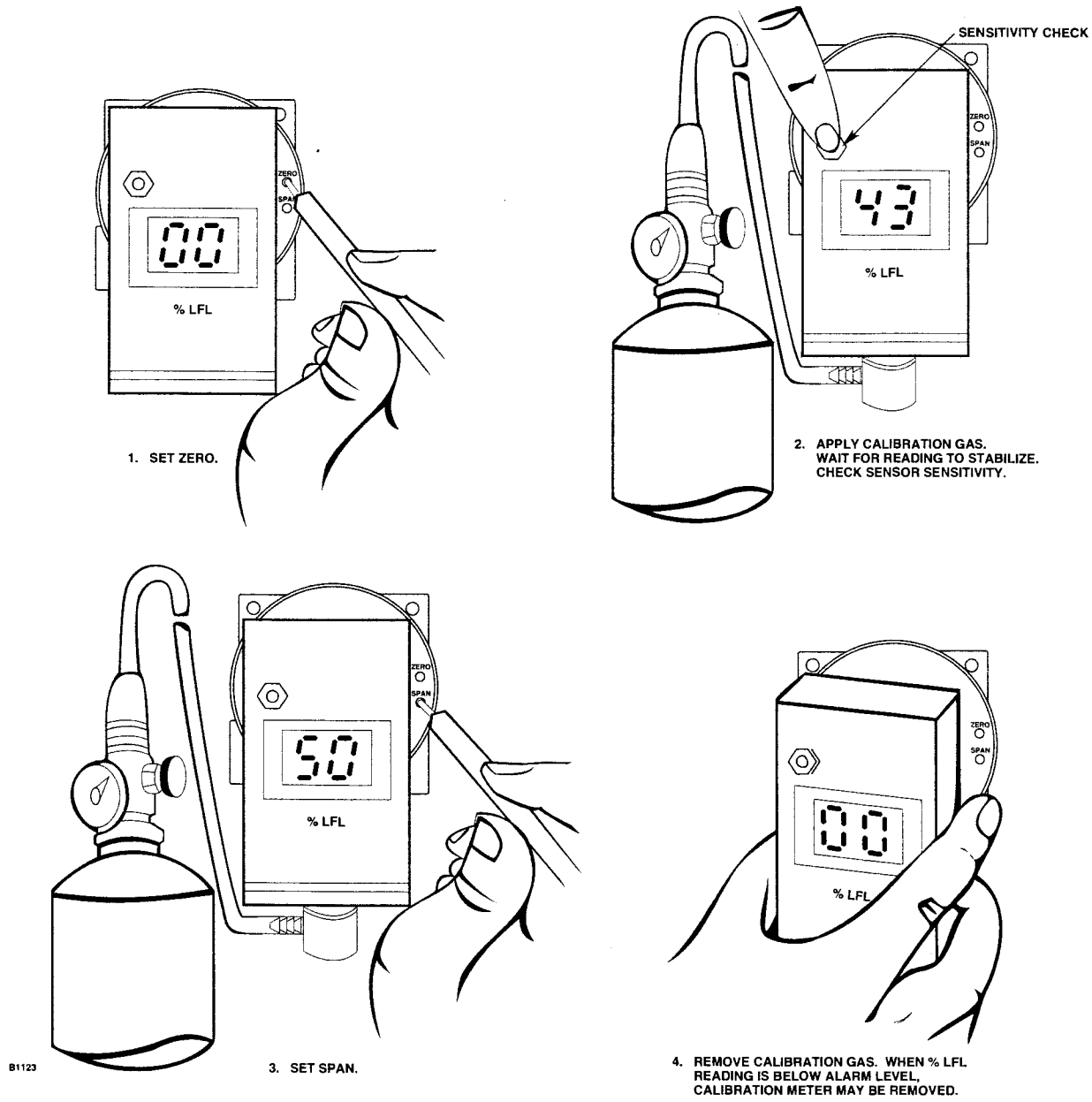


Figure 14—Calibration Sequence for K Series Transmitter

6. Press the sensitivity check button. If the display reads less than 15, check the sensor voltage (it should measure 3.3 vdc). If the sensor voltage is correct, sensor replacement is recommended. If the sensor must be replaced, refer to the "Sensor Replacement" section.

7. Remove the calibration gas from the sensor. DO NOT REMOVE THE CALIBRATION METER until the reading on the calibration meter returns below the low alarm setpoint level (or 5% LFL), or an alarm will be generated by the controller.

8. Unplug the calibration meter and replace the junction box cover.

Alternate Calibration Procedure for K Series Transmitters

This method of calibrating the K Series Transmitter uses the digital display on the controller for indicating sensor output, eliminating the need for the plug-in calibration meter. Two people are normally needed to perform the calibration.

1. The sensor location must be de-classified prior to calibration.

CAUTION

This calibration procedure involves placing the controller in the sensor replacement mode. Upon entering the sensor replacement mode, the

fault output will be de-energized. Be sure to secure any output devices connected to the fault output to prevent unwanted actuation of these devices.

2. Place the controller in the sensor replacement mode by pressing and holding the RESET button on the controller faceplate for approximately 9 seconds until the digital display begins flashing and the CAL LED is illuminated. Release the RESET button.

3. Press the SET button. The FAULT LED comes on. The controller is now in the sensor replacement mode.

CAUTION

Upon entering the sensor replacement mode, all previously entered sensor calibration information is lost. The calibration procedure cannot be aborted at this point. Sensor calibration must be performed.

4. Remove the sensor junction box cover.

5. Adjust the Zero control with a screwdriver until the controller display shows 0% LFL. If the possibility of background gases exists, purge the sensor with clean air to ensure accurate calibration.

6. Apply the calibration gas to the sensor.

7. When the controller display shows a stable reading, adjust the Span control until the display shows the same % LFL as indicated on the calibration gas tank (typically 50%).

8. Remove the calibration gas from the sensor.

9. When the reading on the digital display returns below the low alarm setpoint level, the controller can be returned to the normal operating mode by pressing the RESET pushbutton. The controller enters the normal operating mode after a time delay (up to 5 minutes).

CAUTION

All alarm outputs are inhibited when the controller is in the sensor replacement mode. The controller does not automatically return to normal operation, but remains in the sensor replacement mode until the RESET button is pressed or power to the controller is cycled. Be sure to press the RESET button at the end of the calibration procedure to return the controller to normal operation.

10. Replace the junction box cover.

Controller Calibration Procedure

1. Be certain that the controller is properly programmed for the gas/air mixture being used for calibration. (See "Setpoint Adjustment" section.) Reprogram the controller if required. Failure to do so will greatly impair system response.

2. Be sure that only clean air (0% LFL) is present at the sensor. (The microprocessor begins taking Zero readings immediately upon entering the Calibrate mode.) If the possibility of background gases exists, purge the sensor with clean air to assure accurate calibration.

NOTE

The practice of placing your hand over the sensor during the zero portion of the calibration procedure is not recommended.

3. Depress and hold the Reset button until the CAL LED is illuminated **and** the digital display starts to flash (approximately 9 seconds).

4. When the Zero calculations are complete (30 seconds minimum), the digital display stops flashing and reads "00".

5. Apply the calibration gas to the sensor. The digital display starts to flash, and the value indicated on the display rises. The bar graph display also indicates the level of gas at the sensor, but does not flash. (Be sure that the pressure gauge on the calibration gas bottle indicates that there is enough gas in the tank to complete the calibration.)

6. When the microprocessor has completed the Span adjustments (30 seconds minimum), the digital display stops flashing.

7. Remove the calibration gas. When the gas level falls below the lowest alarm setpoint, the controller automatically exits the Calibrate mode. All outputs and indicators return to normal operation.

If the operator fails to complete the calibration procedure or if the sensitivity of the sensor has deteriorated to the extent that calibration cannot be successfully completed, a calibration fault ("F2X" status) will be generated and the system will automatically revert back to the former calibration settings (after 10 minutes). If a successful calibration cannot be accomplished, replace the sensor and recalibrate.

If the microprocessor determines that the sensing element is approaching the end of its useful life, "F10" will be indicated on the digital display. This does not

indicate a system malfunction, but is intended simply to make the operator aware of this condition. A successful calibration can still be performed. Press Reset after completing calibration to clear this fault.

CURRENT OUTPUT CALIBRATION

The 4 to 20 ma output is calibrated at the factory to provide a degree of accuracy that is satisfactory for most applications. However, the highest level of accuracy can be obtained by performing the following procedure.

1. A dc current meter capable of measuring 4 to 20 ma must be connected to the current loop output. This can be accomplished by disconnecting all loads and connecting a dc ammeter between the two 4 to 20 ma terminals, by connecting a dc ammeter in series with the load, or by connecting a digital dc voltmeter across a known load resistance and calculating the current flow using the formula:

   I = voltage/load resistance.

2. Press and **hold** the SET button, then **immediately** press the RESET button. (The Reset button must be pressed within one second of pressing the SET button.) Release both buttons. The Low LED should flash slowly. The flashing Low LED indicates that the system is now generating a 4 ma output.

3. Press the RESET (increase) or SET (decrease) button to obtain a 4 ma reading on the meter. (Holding the button will cause the output to change rapidly.)

4. When no adjustments have been made for 7 seconds, the controller automatically switches to a 20 ma output. This is indicated by a flashing High LED. Press the appropriate button to obtain a 20 ma reading.

5. When no adjustments have been made for 7 seconds, the controller generates the current output level for the calibrate mode. This is indicated by a flashing CAL LED. Press the appropriate button to obtain the desired current output level for the calibrate mode.

6. When no changes have been made for 7 seconds, the system automatically returns to the Normal operating mode and saves the data in non-volatile memory.

7. Remove the meter from the system output.

Section IV
System Maintenance

ROUTINE MAINTENANCE

The gas detection system requires virtually no routine maintenance, except for periodic checks to assure proper system function and calibration. The frequency of these checks is determined by the requirements of the particular installation.

MANUAL CHECK OF OUTPUT DEVICES

Fault detection circuitry continuously monitors for an open sensing element, excessive negative zero drift, open sensor wiring, and various other problems that could prevent proper response to a dangerous level of gas. It does not monitor external response equipment or the wiring to these devices. 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 system must be checked periodically in the Normal mode to ensure that those items not checked by the controller diagnostic circuitry are functioning properly.

CAUTION

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

SENSOR REPLACEMENT

The area must be de-classified or power must be removed prior to replacing the sensor. To replace the sensor:

1. Press and hold the RESET button for approximately 9 seconds until the digital display begins flashing and the CAL LED is illuminated. Release the Reset button.

2. Press the SET button. The FAULT LED comes on. The controller is now in the Sensor Replacement mode.

NOTE

The remainder of this procedure assumes that K Series Transmitters are being used. Refer to the transmitter manual for information regarding sensor replacement for other transmitter models.

3. Remove the cover from the sensor junction box.

4. Remove the transmitter module. Unplug the sensor from the connector board and unscrew it from the junction box.

5. Coat the threads of the new sensor with the appropriate grease (part number 005003-001), then screw the sensor into the junction box and plug it into the connector board.

6. Plug the transmitter module into the connector board.

Controller Calibration

If the system is being calibrated using the "Controller Calibration" method, the most accurate calibration for a new sensor will be achieved if a transmitter calibration is performed first (as soon as the sensor output has stabilized). Then perform the "Controller Calibration" procedure described in the "Calibration" section (24 hours later for maximum accuracy). The controller calibration procedure can then be used for all subsequent calibrations.

Transmitter Calibration

1. Plug the calibration meter into the transmitter.

2. Allow the sensor output to stabilize (several hours for maximum calibration accuracy), then perform the Transmitter Calibration procedure described in the "Calibration" section.

3. When the calibration is complete, remove the calibration meter and place the cover back on the transmitter enclosure.

4. Press the controller RESET button. The controller returns to the normal operating mode (after a time delay).

For the highest degree of calibration accuracy, perform a second calibration after 24 hours.

A Recommended Test Form is supplied at the back of this manual for recording maintenance performed on the system.

TROUBLESHOOTING

Table 5 is intended to serve as an aid in locating the cause of a system malfunction.

NOTE

Record all faults on the Fault Record Sheet supplied with this manual.

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. Corrosion 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.

Table 5—Troubleshooting Guide

Problem	Possible Cause
No faceplate indicators illuminated.	1. Wiring to external power source. 2. Input power failure.
FAULT LED on, digital display blank.	1. Power-up time delay (up to 5 minutes). 2. If condition continues after 5 minutes, repeat power-up. If problem continues, replace controller.
F91 to F98 Status	1. Initialization failure. Repeat power-up. If successful, re-program and re-calibrate. If not, replace controller.
F92 Status	1. Sensor failure (during startup) - current is over 35 ma or below 2 ma.
F94 Status	1. RAM failure. Repeat power-up. If not successful, return to factory for repair. Do not press RESET button. If RESET is pressed, recalibrate and check setpoints.
F96 Status	1. Input power problem (should be18 to 32 volts). Check operation of power source and power wiring.
F97 Status	1. Controller type invalid. Error in data from RAM. Repeat power-up. If not successful, return to factory for repair. Do not press RESET button. If RESET is pressed, recalibrate and check setpoints.
F70 Status	1. External reset activated for over 15 seconds. Check external switch and wiring.
F60 Status	1. Input power out of tolerance. Check operation of power source and power wiring.
F50 Status	1. Internal power supply problem. Replace controller.
F40 Status	1. Sensor output (after startup) is over 35 ma or below 2 ma. Check sensor/ transmitter wiring and calibration. 2. Faulty sensor. Replace and calibrate. 3. Faulty transmitter. Replace and calibrate.
F30 Status	1. Negative zero drift. Calibrate sensor. 2. Faulty sensor. Replace and calibrate. 3. Faulty transmitter. Replace and calibrate.
F20, F21 Status	1. Calibration error. Re-calibrate.
F22, F23 Status	1. Sensor sensitivity out of tolerance. Calibrate transmitter.If problem continues, replace sensor and calibrate.
F24 Status	1. Wrong gas for zero calibration. 2. Background gas affecting the zero calibration. 3. Sensor zero input over limit, re-calibrate transmitter.
F10 Status	1. Sensor reaching end of life - no problem at present time. Be prepared to replace sensor at next calibration (calibration attempt may fail).

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, recalibration 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 R8471 Controller 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 in the controller's electronics, the device must be returned to the factory for repair.

NOTE

When replacing a controller, be sure that the jumper plugs and rocker switches of the replacement are the same as the original. Remove power before removing the device from the mounting cage or plugging in the replacement unit.

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. The frequency of replacement will be determined by the amount and type of contamination present at the particular installation.

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

Always calibrate after replacing the sensor.

Refer to the "Ordering Information" section for a list of parts.

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.

ORDERING INFORMATION

Sensors and transmitters must be ordered separately from the controller. When ordering please specify:

R8471A Combustible Gas Controller
Specify base or premium model, 3U or 4U height.

MOUNTING RACKS

A mounting rack is required for controller installation. 3U racks are used with gas controllers only. 4U racks can house gas or flame controllers in any combination. See Figures 7 and 8. Rack sizes are available to handle up to 8 flame controllers or up to 16 gas controllers.

TRANSMITTERS

Standard Transmitter and Accessories

K Series Transmitter module
Junction Box with Connector Board
Calibration Meter
Transmitter Extender Plug (for use with sensor separation kit)

Model 400/405B Transmitter and Accessories

Microprocessor based transmitters use optical calibration meter and offer relay option (two SPDT relays).
Junction box with bracket
Optional relay board
Optical calibration meter

U8700

Microprocessor based transmitter with pushbutton self-calibration, digital display, LED annunciation of alarm and fault conditions, self-diagnostics, optional relay contacts.

SENSORS

Specify standard, poison resistant, or high temperature sensor, in aluminum or stainless steel housing.

SENSOR SEPARATION KITS

Specify whether used with K Series, Model 400/405, or U8700 Transmitters.

ACCESSORIES

Silicone Free Grease
Rain Shield
Splash Guard
Dust Cover (Stainless Steel)
Dust Cover (Porex)
Sample Draw Assembly (one "T" fitting)
Sample Draw Assembly (two "T" fittings)
Open Frame Power Supply - 24 vdc at 3.6 amperes
Open Frame Power Supply - 24 vdc at 12 amperes
W4810 Power Supply (24 vdc) mounted in explosion-proof enclosure

CALIBRATION KITS

Calibration Kit includes regulator, hose, calibration cup, and two cylinders of calibration gas. Available gases are:

Methane - 20, 25, 35 and 50% LFL
Ethane - 50% LFL
Ethylene - 50% LFL
Propane - 50% LFL
Hydrogen - 50% LFL

Replacement Parts for Calibration Kit

Regulator
3 foot hose
Standard calibration cup
Modified calibration cup (for sensor separation)

Replacement Cylinders

Methane (20% LFL)
Methane (25% LFL)
Methane (35% LFL)
Methane (50% LFL)
Ethane (50% LFL)
Ethylene (50% LFL)
Propane (50% LFL)
Hydrogen (50% LFL)
Air (0% LFL)

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

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