



FIREYE Flame Safeguard System R9107A Controller C9701A, C9707A Flame Scanners

SYSTEM APPLICATION

FIREYE burner management systems provide recognition and continuous monitoring of fossil fuel flames in semiautomatically controlled boilers and furnaces. The R9107A Controller monitors signals from one flame scanner, and provides relay switching in response to flame loss. In conjunction with a burner management system and the appropriate interlock and limit sensing devices, the R9107A Controller prevents burner startup unless required conditions have been verified, and initiates immediate shutdown if limit conditions are exceeded during burner operation.

Flame scanners available for use with the R9107A Controller:

The C9701A Ultraviolet Flame Scanner responds to ultraviolet (UV) radiation wavelengths between 1850 and 2650 angstroms, which is emitted by gaseous and liquid fuel flames.

The C9707A All Fuel Scanner uses sensors that respond to radiation in the range of 1850 to 10,000 angstroms, making it suitable for monitoring the flames of natural gas, No. 2 oil, No. 6 oil, pulverized coal and bark.

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FEATURES

- Adjustable flame threshold.
- Redundant flame relays to ensure response to flame failure.
- Selectable flame on delay time - 1 or 2 seconds.
- Selectable flame off delay time - 3.2 or 6.5 seconds (3.2 second delay time only for FM approved model).
- External output for remote flame signal voltmeter (0 to 10 vdc).
- Optional 4 to 20 milliampere flame signal output for connection to remote device.
- Self-checking light chopper simulates flame loss every 10 seconds to thoroughly test scanner for proper operation.
- Fault relay energizes if response to simulated flame loss is improper.
- Operation of Fault relay may be used to de-energize Flame relays (optional).
- Two separate user-adjustable gain settings provide enhanced discrimination in multi-burner application.
- Front panel analog voltmeter and select switch allow indication of the flame threshold of the controller or the flame signal monitored by the scanner.
- Controller to scanner power is fused for system protection.

DESCRIPTION

The R9107A Controller processes the signal from one flame scanner and energizes the Flame relays in response to flame conditions. The R9107A includes a self-checking feature that tests response to a loss of flame once every 10 seconds. This test is accomplished by mechanically blocking light from the flame, then checking the controller for the appropriate response. In the event of a failure, the Fault relay will energize and the FAULT LED will illuminate. Optionally, the Flame Failure relays may also de-energize. The faceplate indicators, consisting of four LED status outputs and one analog flame signal meter, allow remote monitoring while the self-checking feature ensures constant system reliability. The following list summarizes the front panel controls and indicators. Refer to Figure 1 for the R9107A faceplate.

CHECK LED - illuminated during the scanner test.

AUX. FLAME AND FLAME ON LEDs - illuminated when the flame signal exceeds the flame-on setpoint and the Flame relays are energized.

FAULT LED - illuminated when the system is not responding to self-test properly and the Fault relay is energized.

METER SELECT SWITCH - allows monitoring of either the user-adjusted flame threshold (SET-POINT) on the controller or the flame intensity monitored by the scanner (METER).

Three potentiometers are located on the faceplate of the R9107A Controller. A description of their functions follows:

SETPOINT - adjusts the flame threshold setpoint.

GAIN 1 -adjusts the Channel 1 flame signal amplitude.

GAIN 2 -adjusts the Channel 2 flame signal amplitude.

***NOTE:** When two different Flames can be viewed by the scanner (for example a pilot and a main Flame), the gain controls can be set so that the controller responds appropriately to each flame. A signal from an external switch applied to the back plate of the controller determines which gain setting is used. Only one gain setting can be used at a time. Refer to the "Gain Adjustment" section of this manual for further information*

FIGURE 1. R9107 FACEPLATE



THEORY OF OPERATION

The FIREYE R9107A Controller monitors signals from a flame scanner and generates relay output switching in response to changes in flame status. Burner flame discrimination is accomplished by incorporating an adjustable flame threshold to compensate for background radiation and adjacent burner interference. Two gain channels allow the controller to respond appropriately to the selected flame. An input from an external switch determines which channel will be used. The flame response circuitry monitors the signal from the flame scanner and energizes the Flame relay when the scanner signal exceeds the flame setpoint. At ten second intervals, a mechanical light chopper in the scanner blocks the signal from the flame to simulate a flame loss. If response to the simulated flame loss is improper, the Fault relay is energized. Referring to Figure 2:

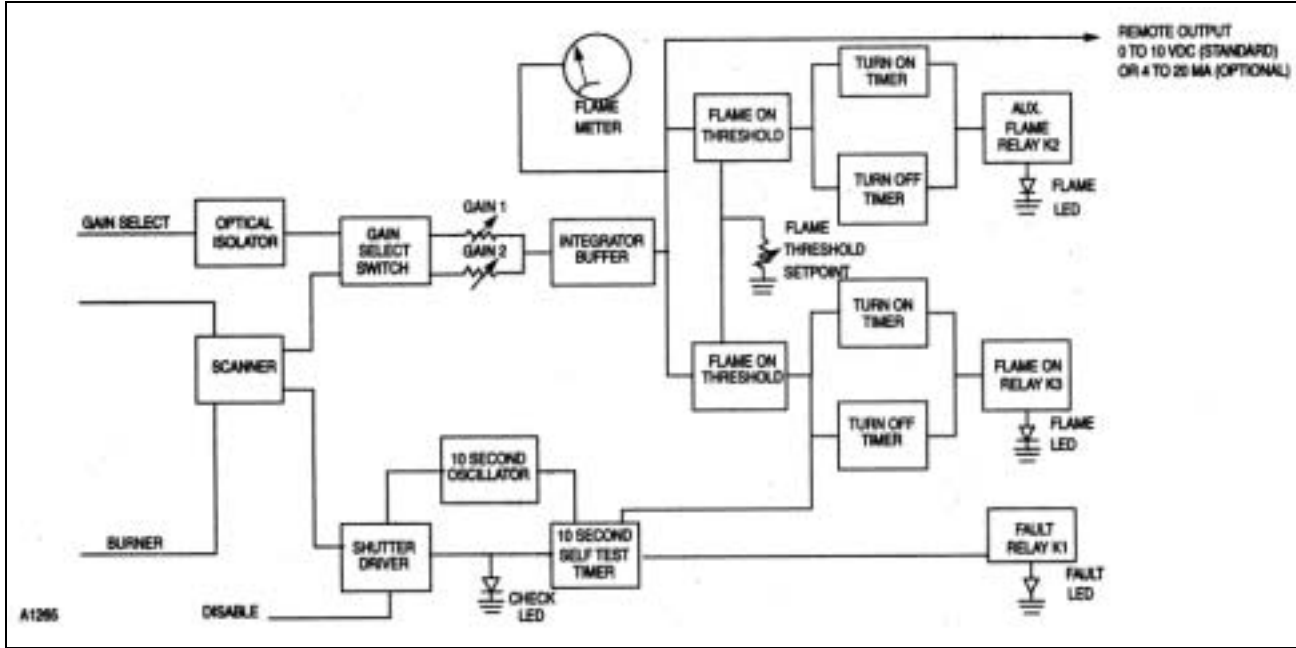
- Scanner signal pulses, periodically interrupted by the self-test, are transmitted through the selected gain channel to the integrator buffer circuit.
 - The flame signal is sent to the flame meter and to terminals for connection to a remote meter.
- NOTE: The R9107A can have either a voltage or current output, but not both.*
- The flame signal is sent to the flame-on threshold circuit.
 - If the flame signal exceeds the user-adjusted flame-on threshold setpoint, the signal initiates the turn on timer (selectable between 1 or 2 seconds).
 - If the flame signal remains above the threshold setpoint for the selected amount of time, the AUX. FLAME and FLAME LEDs are turned on and the Flame relays (K2 and K3) are energized.
 - If the flame signal falls below the flame on threshold setpoint, the flame detector initiates the turnoff timers (3.2 or 6.5 seconds). If the flame signal remains below the setpoint for the selected amount of time, the turn off timers "time out" causing the Flame relays (K2 and K3) to deenergize and the AUX. FLAME and FLAME LEDs to turn off.
 - When the flame signal exceeds the flame on threshold setpoint, the signal is passed to the self-test timer.
 - If the flame signal does not drop below the flame on threshold setpoint (in response to a successful scanner self-test) on any two successive check cycles, the fault test timer will "time out" causing relay K1 to energize and the FAULT LED to illuminate.

NOTE: Since the Flame relays and the FLAME LEDs are controlled by a timer that is set at 3.2 seconds, they are unaffected by the 1.0 second check period in which the flame is blocked during the scanner self-test.

- Front panel indicators reflect normal system operation in the following manner:
 - When the Meter Select switch is set in the METER position, the front panel displays flame signal. (If a remote meter is connected, it will display flame signal regardless of Meter Select switch position).
 - When the Meter Select switch is in the OFF position, no signal is displayed.
 - When the Meter Select switch is set in the ALARM SETPOINT position, the user adjusted Flame On threshold setpoint is displayed.
 - The green CHECK LED is illuminated for 1 out of every 10 seconds by the selfcheck circuitry.
 - The red FLAME ON and AUX. FLAME LEDs are illuminated, indicating that the flame on threshold has been exceeded, and K2 and K3 are energized.
 - The amber FAULT LED is normally not illuminated. When the LED is on, it indicates improper response during self-test and that relay K1 is energized.

NOTE: If the option that interlocks the Fault relay and the Flame relays is used, when the amber FAULT LED comes on, the red FLAME ON and AUX. FLAME LEDs will go off.

FIGURE 2. FLAME RESPONSE CIRCUITRY BLOCK DIAGRAM



SPECIFICATIONS

CONTROLLER

GAIN SELECT (from external switch): No voltage applied selects Channel 1 gain setting. Line voltage (see OPERATING VOLTAGE specifications) applied selects Channel 2 gain setting.

OUTPUTS: Relay contact ratings - Fault relay K1, Aux. Flame relay K2 and Flame On relay K3: (Form C) 4 amperes at 125 vac or 240 vac; 3 amperes at 30 vdc or 1/20 HP at 125 or 250 vac.

FLAME SIGNAL OUTPUT: 0 to 10 vdc, 4 to 20 milliamperes (optional).

NOTE: The R9107A can have either a 0 to 10 vdc output or a 4 to 20 milliampere output, but not both.

OPERATING VOLTAGE: 120 vac, 50/60 Hz (15 vac, -18 vac), standard. 240 vac, 50/60 Hz (+30 vac, -36 vac), selectable by jumpers.

POWER CONSUMPTION: 12 watts typical.

TEMPERATURE RANGE: Operating: -40°F to +167°F (-40°C to +75°C).

Storage: -40°F to +220°F (-40°C to +105°C).

HUMIDITY: 5 to 95% relative (non-condensing).

SHIPPING WEIGHT: (Approximately 2.0 pounds (0.9 kilogram).

FLAME FAILURE RESPONSE TIME: 3.2 seconds (FM approved models) and 6.5 seconds (FM approval is void with W2 installed).

FAULT RECOGNITION TIME: 10 to 20 seconds.

SELF-CHECK PERIOD: 10 seconds (9 seconds viewing, 1 second blocked).

FLAME-ON THRESHOLD: User-adjustable, 2 to 6 volts relative meter reading.

FLAME RECOGNITION TIME: User-selectable - 1 or 2 seconds.

DIMENSIONS: See Figure 3 for the R9107A dimensions.

MOUNTING: The R9107A is rack mounted (see Form 65-8062, Q9801C Rack Assembly, for details).

FLAME SCANNERS

ELECTRICAL: Standard military connector with various cable lengths available. Five conductor, non-shielded, 600 vdc breakdown. Refer to "Accessories" section.

MECHANICAL: 1 inch NPT to sight pipe, 3/4 inch NPT purge air.

TEMPERATURE RANGE: -4°F to +160°F (-20°C to +71°C)

SHIPPING WEIGHT: 7 pounds (3.18 kilograms).

RESPONSE RANGE: C9701A UV Flame Scanner: 1850 to 2650 angstroms.

C9707A All Fuel Scanner: 1850 to 10,000 angstroms.

DIMENSION: See Figure 3.

FIGURE 3. R9107 DIMENSIONS

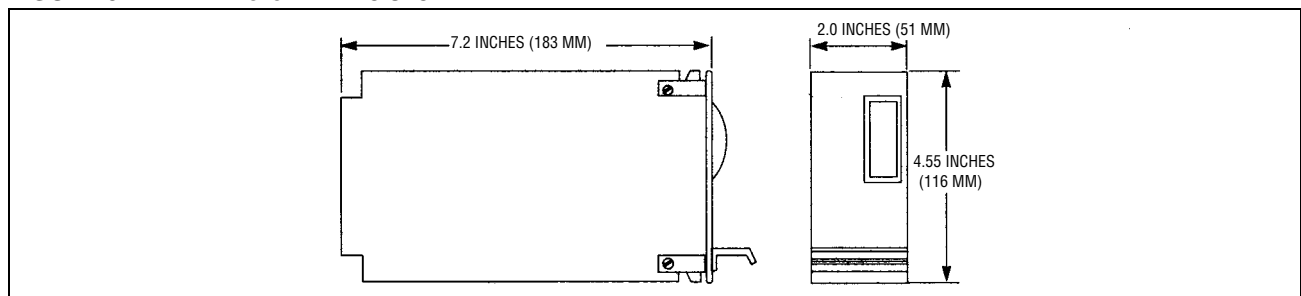
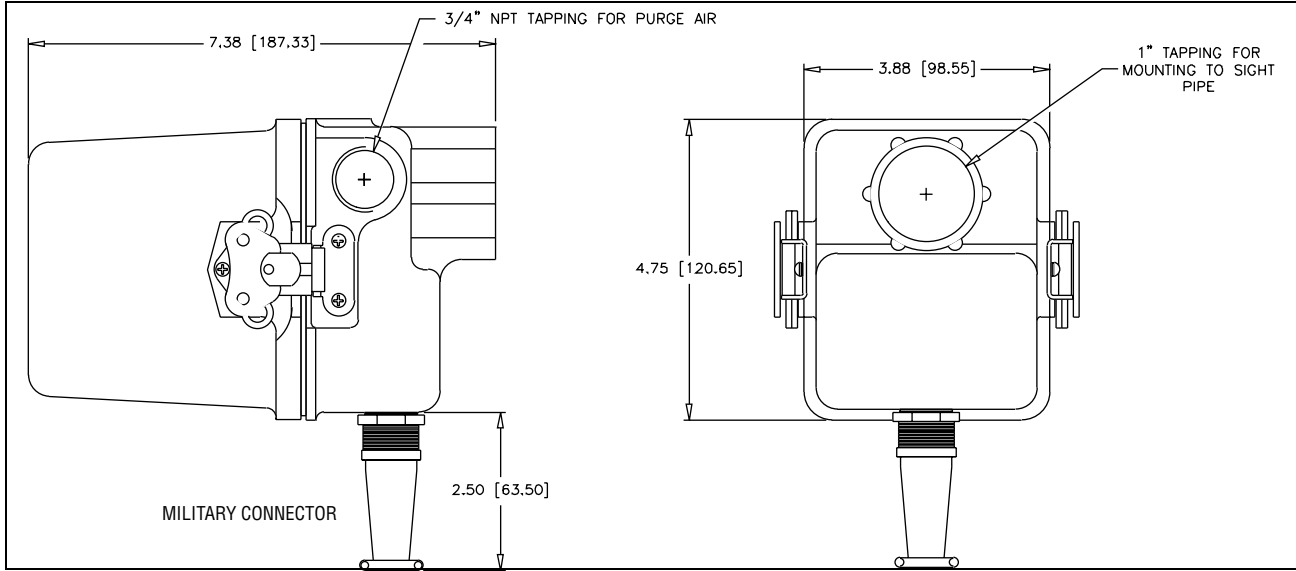


FIGURE 4. C9701/C9707 DIMENSIONS



INSTALLATION

JUMPER SETTINGS

The R9107A has jumpers on the circuit board that must be set (and should be checked) for proper operation. Table 1 lists the settings. The circuit board is readily accessible (see Figure 5). Refer to Table 1 for the correct jumper settings and Figure 5 for jumper locations.



WARNING: Use of the 6.5 second Flame Off delay time voids FM approval. If not used, it is suggested that jumper W2 pins be clipped to avoid inadvertent use.

Table 1:

FEATURE		JUMPER NO. W												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Power Input	120 VAC 240 VAC									X O	X	X O		
Gain Select	120 VAC 240 VAC			X O					X X					
Disable Input	120 VAC 240 VAC							X O	X X					
Use with C9707						X								
Output Signal	0 - 10 VDC 4 - 20 mA				X O		O X		X O					
Flame On Delay	1.0 sec. 2.0 sec.	O X												
K2, K3 independent of K1 K2, K3 interlocked with K1													O X	X O
Flame Off Delay (See note 1)	3.2 sec. 6.5 sec.		O X											
Note 1: This jumper cannot be used on FM approved models. Note 2: Jumpers W1, W3, W4, W6, W7, W9, W11 and W13 are factory installed. X = Installed O = Omitted														



WARNING: Incorrect installation of jumpers can impair operation and cause damage to the unit. Contact the factory for assistance with questions or problems.

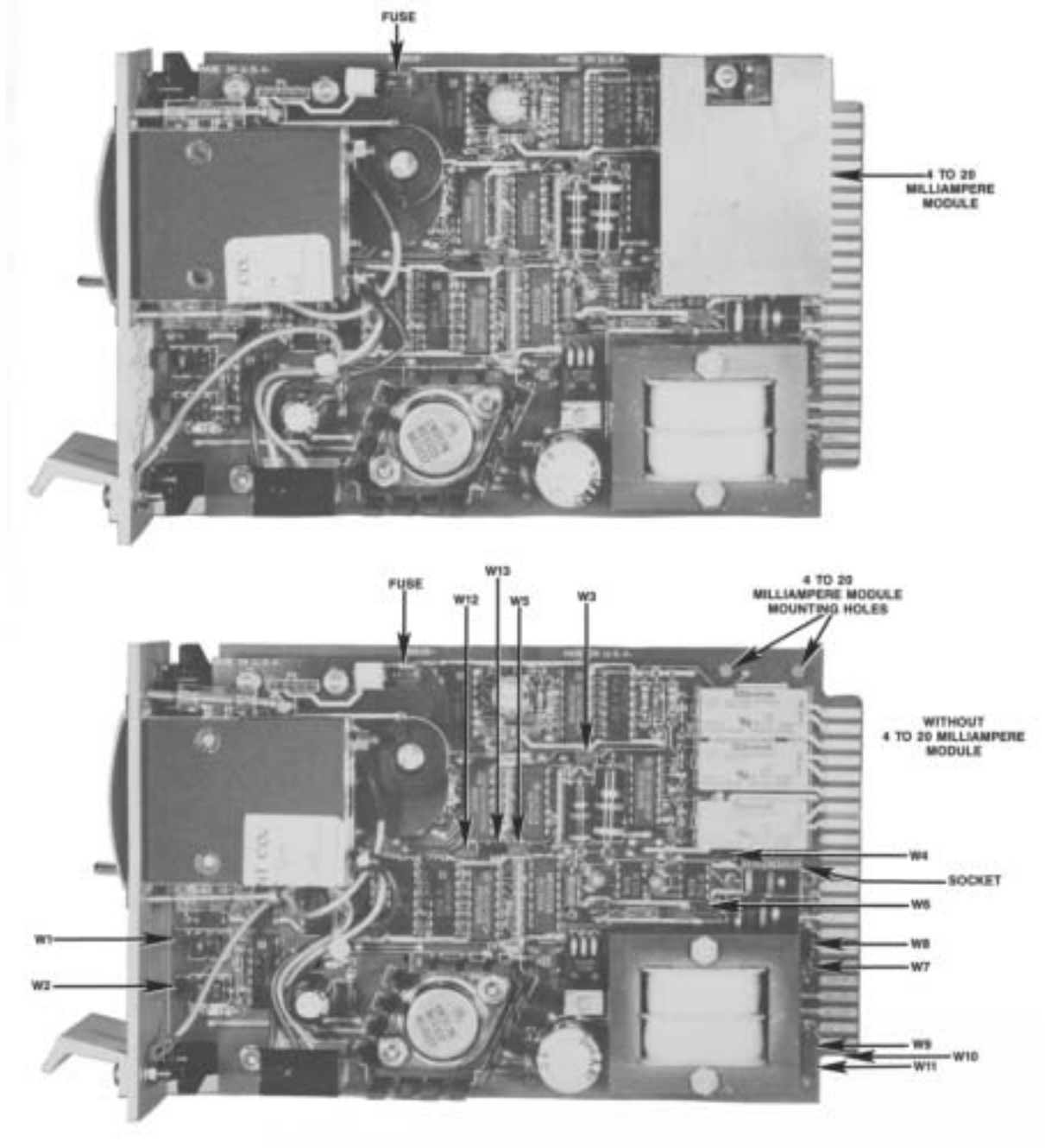
Power Input

The R9107A is set for 120 vac operation when shipped (Jumpers W9 and W11 installed). To convert the R9107A to 240 vac operation, remove Jumpers W9 and W11, and install Jumper W10.

Gain Select Input

The R9107A is set for a 120 vac Gain Select Input when shipped (Jumper W3 installed). To use the R9107A with a 240 vac Gain Select Input, remove Jumper W3. Note: Use the same ac source as the power input.

FIGURE 5. R9107 JUMPER LOCATIONS



Disable Input

The R9107A is set for a 120 vac Disable Input when shipped (Jumper W7 installed). To use the R9107A with a 240 vac Disable Input, remove Jumper W7. Note: Use the same ac source as the power input. Note:

Use With the C9707A All Fuels Scanner

If the R9107A is to be used with the C9707A All Fuels Scanner, install Jumper W5.

Flame On Delay

The R9107A is set for a 2.0 second Flame On Delay when shipped (Jumper W1 installed). To set the R9107A for a 1.0 second time delay, remove Jumper W 1.

Flame Off Delay

The R9107A is set for a 3.2 second Flame Off Delay when shipped. To set the Flame Off Delay for 6.5 seconds, install Jumper W2. (The 6.5 second delay is available on all models but voids approval on FM models.)

Output Signal

The R9107A is set for a 0 to 10 vdc output when shipped (Jumpers W4 and W8 installed). If the 4 to 20 Milliampere Module is installed, remove Jumpers W4 and W8 and install Jumper W6.

Operation of Flame Failure Relays K2 and K3

For normal operation (K2 and K3 de-energize only on flame failure), W12 is not installed and W13 is installed.

For interlocked operation (K2 and K3 de-energize if there is a flame failure or if the Fault relay is energized), W12 is installed and W13 is not installed.

Optional 4 to 20 Milliampere Module Assembly

The DE4643-001 includes the 4 to 20 Milliampere Module and mounting hardware. Refer to Figure 5 and the instructions below to install the DE4643-001.

1. Ensure that Jumpers W4 and W8 are removed, and that Jumper W6 is installed.
2. If standoffs are used for mounting, screw them to the control board through the mounting holes.
3. Plug the 4 to 20 Milliampere Module into the socket on the R9107A.
4. If spacers are used for mounting, place the spacers between the two board mounting holes and the top of the 4 to 20 Milliampere Module.
5. Install the screw through the mounting holes of the control board and the spacer.
6. Tighten the nuts on the top of the 4 to 20 Milliampere Module.
7. Before installing the R9107A - If the Gain Select input (terminals 13, 14 and 15, 16) is being used, ensure that the hot side of the ac input is connected to terminals 15, 16 as shown in Figure 7.

Specifications (4 to 20 Milliampere Module)

Output Type: Isolated two-wire current loop.

Power Source: External dc power supply with an supply voltage between 12.1 and 40 vdc is required.

Loop Resistance: The maximum loop resistance which can be driven is a function of the power supply output voltage and can be calculated with the following formula:

$$R_{\max} = \frac{V_{ps} - 12.1}{0.02}$$

R_{\max} = maximum loop resistance

V_{ps} = supply output voltage

R9107A CONTROLLER MOUNTING

The R9107A Controller is designed to be mounted in the Q9801C Rack. There are two models of the Q9801C Rack available:

- Q9801C-1124 with 44 pin connections
- Q9801C-1126 with 22 pin connections and jumpers
 - Common ground circuit
 - Common neutral circuit
 - Jumpers to reduce field wiring



Rack Jumper 5 (connects ac power supply neutral input to the controller Gain Select neutral). Remove this jumper when the 4 to 20 milliampere module is used.

Rack Jumper 29 (connects ac power supply hot input to K3 relay common).. Remove this jumper when relay K3 is powered externally or when a dry circuit is required.

Rack Jumper 35 (connects ac power supply hot input to K2 relay common). Remove this jumper when relay K2 is powered externally or when a dry circuit is required.

Rack Jumper 41 (connects ac power supply hot input to K1 relay common). Remove this jumper when relay K1 is powered externally or when a dry circuit is required.

1. If the rack has a locking mechanism, pull the lock tab that releases the lock bar on the card rack.
2. Insert the controller, making certain that the edge of the circuit board aligns with the guide track. Slide the controller firmly into place (edge connector is keyed between positions 30 and 32) and push the locking tab back in



CAUTION: If controller does not fit, check alignment. Do not force controller into connectors.

R9107A Controller Wiring

1. The electrical connections of the R9107A Controller are shown in Figures 6 and 7.
2. The controller is inserted in a card edge connector with attached screw terminals (located on rear of rack), which are designed for a maximum of two 18 AWG leadwires. Controller terminal numbers are marked on the backplane circuit board (do not use terminal block numbers).
3. Wire in accordance with the National Electrical Code and local code requirements

FIGURE 6. R9107 Electrical Connections without 4 to 20 Milliampere Module

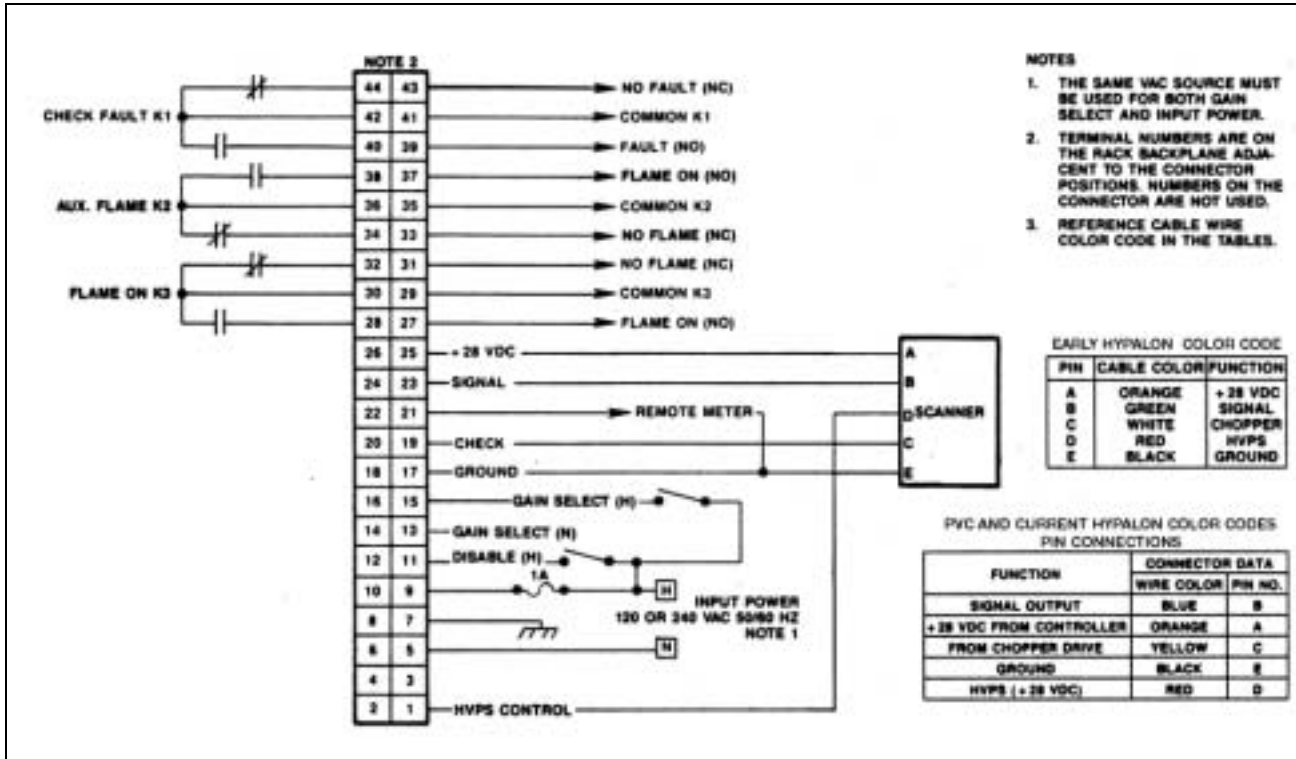
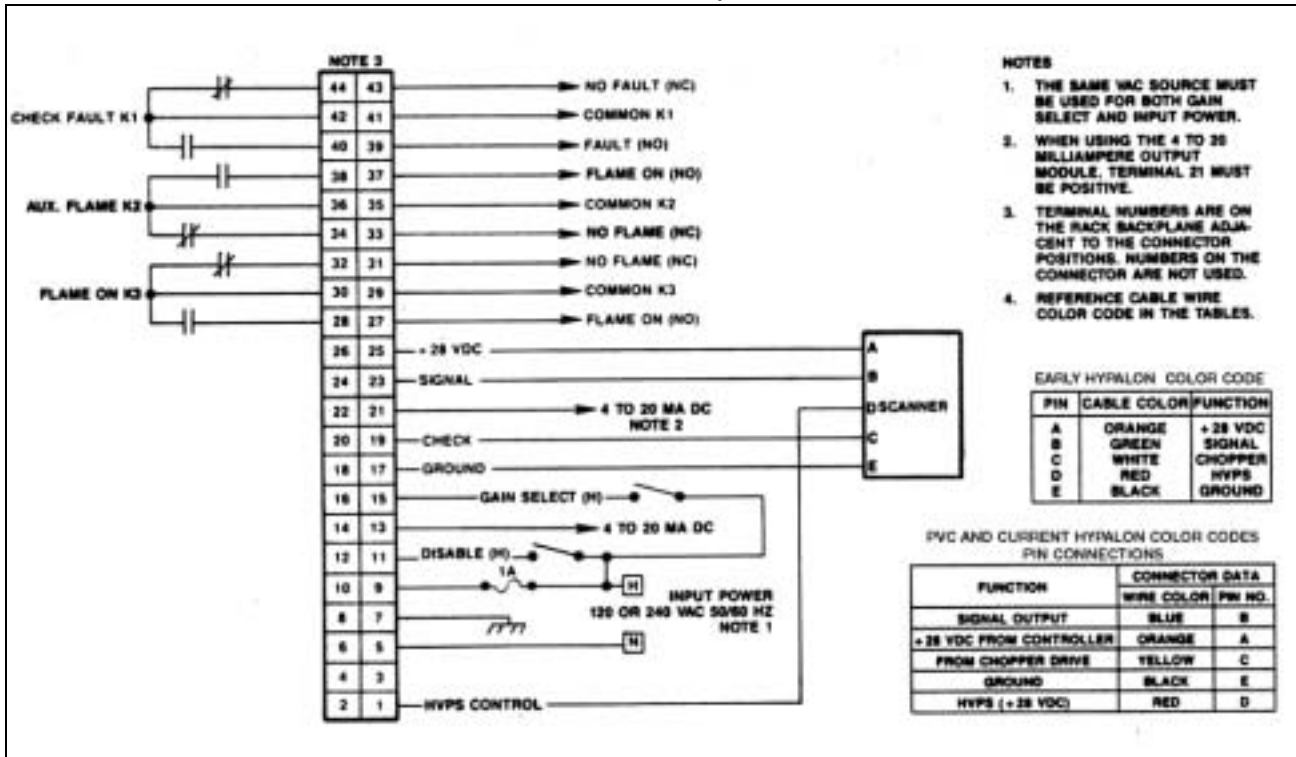


FIGURE 7. R9107 Electrical Connections with 4 to 20 Milliampere Module



Flame Scanner Mounting

Choose a sighting location where the scanner will have an unobstructed view of the flame under all firing conditions. Greatest ultraviolet radiation is produced near the base of the flame in the area immediately ahead of the burner. Greatest infrared radiation is produced in the later (cooler) stages of combustion, further out into the combustion chamber. A scanner monitoring a pilot flame and a main flame must be positioned so that it can sight both flames.

For further information refer to the applicable scanner operating manual (listed below).

C9701A - Publication 65-8058

C9707A - Publication 65-8065

Sighting the Scanner

Prior to making adjustments, set both GAIN potentiometers on the faceplate of the R9107A to maximum sensitivity (fifteen turns in a clockwise direction). Set the SETPOINT potentiometer to the lowest threshold setting (fifteen turns in a counter-clockwise direction). With the burner that is to be monitored by the controller off and any other burners in the boiler operating normally, place the toggle switch on the faceplate of the R9107A in the METER position. Observe the meter reading for the background radiation indication. If the meter reading is greater than 2.5 volts, the background radiation that the scanner is sighting is too high. Using the Q2625 Swivel assembly (if installed), reposition the scanner to decrease the amount of background radiation in its field of view.

Setpoint Adjustment

If the background radiation detected is between 2.5 and 5.5 volts, hold the faceplate toggle switch in the ALARM SETPOINT position and observe the meter reading. This is the flame relay threshold setpoint. Adjust the SETPOINT potentiometer (on the R9107A faceplate) to obtain a reading that is 1 volt higher than the background radiation observed in the previous step.

Gain Adjustment

The R9107A has one scanner input, however, this signal can be routed through one of two gain channels. Terminal 15 on the controller is used to select the gain channel (see Figure 6). With no voltage applied, Gain 1 is selected. With line voltage applied, Gain 2 is selected. The two gain channels can be independently adjusted using the following procedure.

1. Ensure that the desired Gain channel is selected (see above).
2. Ignite the burner that is to be monitored through the selected Gain channel.
3. Place the toggle switch on the R9107A faceplate to the METER position.
4. Adjust the GAIN potentiometer that corresponds to the gain channel selected to obtain a signal reading between 7 and 8 volts on the faceplate meter.
5. If the other gain channel is to be used, select it by applying the appropriate voltage to terminal 15 on the R9107A (see above).
6. Ignite the burner that is to be monitored through the selected Gain channel.
7. Place the toggle switch on the R9107A faceplate to the METER position.
8. Adjust the GAIN potentiometer that corresponds to the Gain channel selected to obtain a signal reading between 7 and 8 volts on the faceplate meter.



ORDERING INFORMATION

When ordering specify:

PART NUMBER	DESCRIPTION
R9107A1001	Controller
DE4643-001	4 to 20 Milliampere Module Assembly (Optional)
Q9801C1124	Mounting Rack, 8 position, 44-Pin Connections
Q9801C1126	Mounting Rack, 8 position, 22-Pin Connections & factory installed jumpers
101363-002	Replacement Fuse for R9107A

NOTICE

When Fireeye products are combined with equipment manufactured by others and/or integrated into systems designed or manufactured by others, the Fireeye warranty, as stated in its General Terms and Conditions of Sale, pertains only to the Fireeye products and not to any other equipment or to the combined system or its overall performance.

WARRANTIES

FIREEYE guarantees for *one year from the date of installation or 18 months from date of manufacture* of its products to replace, or, at its option, to repair any product or part thereof (except lamps, electronic tubes and photocells) which is found defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of its sales order. **THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES AND FIREEYE MAKES NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED.** Except as specifically stated in these general terms and conditions of sale, remedies with respect to any product or part number manufactured or sold by Fireeye shall be limited exclusively to the right to replace or repair as above provided. In no event shall Fireeye be liable for consequential or special damages of any nature that may arise in connection with such product or part.



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