



E110 with ED510 Display Module

# E110 FIREYE FLAME-MONITOR™

**BURNER MANAGEMENT CONTROL  
FOR USE WITH THE  
MICROPROCESSOR-BASED  
EP AND EPD STYLE  
PROGRAMMER MODULES**



## DESCRIPTION

The Fireeye® E110 FLAME-MONITOR™ System is a microprocessor based burner management control system designed to provide the proper burner sequencing, ignition and flame monitoring protection on automatically ignited oil, gas, and combination fuel burners. In conjunction with limit and operating controls, it programs the burner/blower motor, ignition and fuel valves to provide for proper and safe burner operation. The control also provides current operating status and lockout information in the event of a safety shutdown. The manner in which this information is displayed is dependent on the type of programmer (EP or EPD) and display module (ED510 or ED500).<sup>\*</sup> Refer to Flame-Monitor PROGRAMMER SELECTION later in this document for the various combinations of programmer and display modules.

The E110 consists of the EB700 chassis, dust cover, and shortened mounting screw (P/N 48-1836). The display module (ED510), if required, must be ordered separately. Interchangeable programmer and flame amplifier modules allow for complete versatility in selection of control function, timing, and flame scanning means. Functions such as pre-purge, recycling interlocks, high fire proving interlock, and trial for ignition timing of the pilot and main flame are determined by the programmer module. The E110 Flame-Monitor can be used with ultra-violet, auto-check infrared, flame rod, or self-check ultraviolet flame scanners by choosing the proper amplifier module.

The eighteen (18) terminal wiring base allows for many functional circuits including motors, valves, and ignition transformers as well as multiple interlocks such as high purge, low purge, fuel valve and running interlock circuits. The E110 uses the same wiring base as the Fireeye E100 Flame-Monitor control, D Series and C Series Controls and is directly interchangeable with most models without rewiring.

Additional functions of the Flame-Monitor system include:

- A non-volatile memory which allows the control to remember its history and present position even when power is interrupted.
- A constant flame signal read-out via display module or 0-10 VDC output (EPD programmers only).
- Read-out of main fuel operational hours and complete cycles via display module.
- Modbus communications via RS485 multi-drop link.
- Dipswitches located on the EP programmer to allow selectable purge time.
- A run/check switch which allows the operator to stop the program sequence in any of three different positions (Purge, PTFI, or Auto).
- Remote Display Capability.
- Annunciate 16 additional interlocks using E300 Expansion Module.

<sup>\*</sup> The ED500 display was the predecessor of the ED510 display and uses an older design. It does not have the latest features of the ED510 display module.



**CAUTION:** While programmers are mechanically interchangeable in that they mate with a common wiring base, you should select the correct model for your application. Inappropriate application of a control could result in an unsafe condition hazardous to life and property. Selection of a control for a particular application should be made by a competent professional, such as a boiler/burner service technician licensed by a state or other government agency.

## FLAME-MONITOR SPECIFICATIONS

### Supply Voltage:

**E110:** 120 VAC (+10%, -15%) 50/60 Hz

**E120:** 220 VAC (+10%, -15%) 50/60 Hz

### Power Consumption: 25 VA

**Shipping Weight:** (E110 Approx.) 5 lbs. (2.3kg)

### OPERATING TEMPERATURE LIMITS

CONTROL	MAXIMUM		MINIMUM	
	°F	°C	°F	°C
E110, E120, EB700, EB701	140°F	60°C	- 40°F	- 40°C
EP, EPD Programmers	140°F	60°C	- 40°F	- 40°C
All Amplifiers	140°F	60°C	- 40°F	- 40°C
ED510 Display	140°F	60°C	32°F	0°C
Scanner UV1A, UV2, UV8A, 45UV3, UV90	200°F	93°C	- 40°F	- 40°C
45UV5-1007, 45UV5-1009	200°F	93°C	- 40°F	- 40°C
Flame Rod (Tip 2460 F)	1500°F	816°C	- 40°F	- 40°C
48PT2	140°F	60°C	- 40°F	- 40°C
Humidity: 85% R.H. (Non-condensing)				

### LOAD RATINGS

TERMINAL	TYPICAL LOAD	A. Maximum Rating @120V-50/60Hz	B. Alternate Rating @120-50/60Hz
5, 6 Individually or Combined	Pilot Valve(s) and Ignition Transformer(s)	50VA Pilot Duty (Solenoid Valves) plus 500VA (Transformer)	125VA Pilot Duty Solenoid Valves plus 250VA (Transformer)
7	Main Fuel Valve(s)	250VA Pilot Duty (Solenoid Valve)	1250 VA Opening 500 VA Holding (Motorized Valve) plus 65 VA Pilot Duty (Solenoid Valve)
M	Burner/Blower Motor	9.8 F.L.A. * 58.8 L.R.A.	240 VA Pilot Duty (Motor Starter Coil)
10-11-12-X	Modulator	125 VA Pilot Duty	
A	Alarm	50 VA Pilot Duty	
Terminal ratings may be selected from either column A or B: (select the rating from the column for each terminal which best applies to the connected load on that terminal).			
* F.L.A. = full load amps L.R.A. = locked rotor amps			

**Maximum Simultaneous Connected Load: 2000 VA**

## ELECTRICAL RATINGS

VA ratings (not specified as pilot duty) permit the connection of transformers and similar devices whose inrush current is approximately the same as their running current.

VA *Pilot Duty* ratings permit the connection of relays, solenoid valves, lamps, etc. whose total operating load does not exceed the published rating and whose total inrush current does not exceed 10 times the rating.

*Running and locked rotor* ratings are intended for motors. VA and VA Pilot Duty loads may be added to a motor load provided the total load does not exceed the published rating.



**WARNING: This equipment is a Class B digital apparatus which complies with the Radio Interference Regulations, CRC c.1374.**



**CAUTION: Published load ratings assume that no contact be required to handle inrush current more often than once in 15 seconds. The use of control switches, solenoid, relays, etc. which chatter will lead to premature failure. It is important to run through a test operation (with fuel shut off) following the tripping of a circuit breaker, a blown fuse, or any known instance of chattering of any external current consuming devices.**

## APPROVALS

### Underwriters Laboratories Inc.:

MCCZ File MP 1537

Controls, Primary Safety - Listed

MCCZ2 File MP1537

Controls, Primary Safety - Component

MCCZ7 File MP1537

Controls, Primary Safety Certified for Canada

MCCZ8 file MP1537

Controls, Primary Safety Certified for Canada - Component

**Acceptable by:** Industrial Risk Insurers (I.R.I.)

Factory Mutual Approved

*Note: E120 is FM approved only.*



**WARNING: This equipment generates and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures which may be required to correct the interference.**



## APPLICABLE BULLETINS

E120, Flame-Monitor Chassis, 220 VAC Operation, FM approved	E-1201
Programmers, Non-Recycle Operation	EP-1601, EPD-1601
Programmers, Recycle Operation	EP-2601, EPD-2601
Programmers, Non-Modulating	EP-3801, EPD-3801
Amplifiers	EAMP1
Display, ED510	ED-5101
Expansion Module	E-3001

All bulletins are available in .pdf format at [www.fireye.com](http://www.fireye.com).

## FLAME AMPLIFIER SELECTION

FIREYE P/N	DESCRIPTION	USE WITH SCANNER
EUV1	Standard UV Amplifier	UV1A, UV8A 45UV3, UV2
E1R1	Autocheck Infrared Amplifier	48PT2
E1R2	Autocheck Infrared Amplifier (For special applications - high sensitivity—consult factory)	48PT2
E1R3	Autocheck Infrared Amplifier. (Without oil fog rejection spray circuitry.)	48PT2
ERT1	Rectification Amplifier	69ND1
EUVS4	Self-Check UV Amplifier	45UV5-1007/1008/1009

## SCANNER SELECTION

FIREYE P/N	DESCRIPTION	USE WITH SCANNER	BULLETIN
48PT2-1003 48PT2-9003 48PT2-1007 48PT2-9007 4-263-1	Infrared 1/2" straight mount 96" TC-ER Infrared 1/2" 90° angle mount 96" TC-ER Infrared 1/2" straight mount 48" TC-ER Infrared 1/2" 90° angle mount 48" TC-ER Replacement photo detector	E1R1, E1R2, or E1R3	SC-103
UV1A3 UV1A6 UV8A UV2 UV2A6 45UV3-1050 UV90-3 UV90-6 UV90-9	UV 1/2" straight 36" TC-ER cable UV 1/2" straight 72" TC-ER cable UV 1/2" 90° head 72" unshielded leads UV 3/8" straight 36" TC-ER cable UV 3/8" straight 72" TC-ER cable UV 3/4" cast aluminum housing 8" cable UV 90° lateral view with 36" flex conduit UV 90° lateral view with 72" flex conduit UV 90° lateral view with 108" flex conduit	EUV1	SC-102
69ND1-1000K4 69ND1-1000K6 69ND1-1000K8	Flame rod 12", 1/2" N.P.T. mount Flame rod 18", 1/2" N.P.T. mount Flame rod 24", 1/2" N.P.T. mount	ERT1	SC-103
45UV5-1007 45UV5-1008 45UV5-1009 4-314-1	Self-check UV 1" British thread mounts, 230V Self-check UV 1" British thread mounts, 120V Self-check UV 1" N.P.T. threads, 120V Replacement UV tube	EUVS4	SC-101



## FIREYE® FLAME-MONITOR™ Selection Guide

1. **SELECT CHASSIS**  
 E110 FLAME-MONITOR, 120 VAC operation  
 E120 FLAME-MONITOR, 220 VAC operation
  
2. **SELECT PROGRAMMER**  
 EP Programmers provide selectable operation (e.g. extended purge time)  
 EPD programmers have integral LED indicator display.

NON-RECYCLE OPERATION		RECYCLE OPERATION		DESCRIPTION	NON-MODULATION		DESCRIPTION
EP160	EPD160	EP260	EPD260	10 and 15 sec. TFI	EP380, EP387, EPD380		30 sec. purge
EP161	EPD161	EPD261		Extended MTFI	EP381	EPD381	15 sec. purge
EP165				Pilot stabilization	EP382	EPD382	1 sec. purge
EP166				Pilot stabilization			
EP170	EPD170	EP270	EPD270	Early spark termination	EP390	EP390	90 sec. purge
NOTE: The EP programmers listed above are available in both Spanish and French languages. Consult factory or your local Fireye distributor for ordering information.							

3. **SELECT DISPLAY**  
 Required for EP Programmers, Optional for EPD programmers  
 ED510 2 line x 16 character LCD display.
  
4. **SELECT AMPLIFIER**  
 Requires appropriate flame scanner.

	DESCRIPTION	USE WITH SCANNER
EUV1	Standard ultra-violet amplifier	UV1A, UV2, UV8A, 45UV3, UV90
EUVS4	Self-check ultra-violet amplifier	45UV5-1007, 1008, 1009
E1R1	Autocheck infra-red amplifier	48PT2
E1R2	Autocheck infrared amplifier (with high sensitivity circuitry)	48PT2
E1R3	Autocheck infrared amplifier (without oil fog rejection circuitry)	48PT2
ERT1	Flame rectification amplifier	69ND1

5. **SELECT WIRING BASE**  
 60-1386-2                      Surface mount  
 60-1466-2                      Panel mount
  
6. **SELECT ACCESSORIES**  
 (on following page).



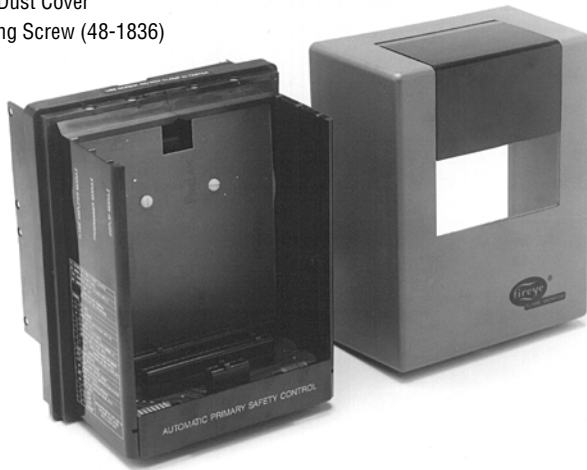
<b>FIREYE P/N</b>	<b>DESCRIPTION</b>	<b>BULLETIN</b>
ED510	Display Module (2 line x 16 characters LCD Display)	ED-5101
129-145-1, -2, -3	Remote Display Mounting Kit (for ED510) with 4', 8' or 2' cable respectively	E-8002
E350-3, -6	Expansion Module cables in 3' and 6' lengths	E-3001
ED150-3, -6, -15, -25	Remote Reset cables in 3', 6', 15' and 25' lengths	E-8001
ED600	Multi-port Cable Adapter	E-8001
ED610	Multi-port Adapter (for ED510 and RS485 communications)	E-8002
E500-3	Communication Interface (up to 6 Flame-Monitor controls)	E-5001
EC485	RS232 to RS485 converter for direct connect	EC-4851
ED512-2, -4, -8	Communications interface cables in 2', 4' and 8' lengths	E-8002
ED580-2, -4, -8	Remote display cables in 2', 4' and 8' lengths	E-8002
IT1000	Wireless communication monitor system for up to 10 Flame-Monitor Controls	INT-1000



## FLAME-MONITOR Ordering Information

### E110 Flame-Monitor (One required)

E110 consists of:  
 EB700 Chassis  
 EC600 Dust Cover  
 Mounting Screw (48-1836)



### ED510 Display Module

Required with EP Programmers  
 Optional with EPD Programmers



EP programmers must have an Eng. code of 28 or later (e.g. 9414-28). EPD Programmers must have an Eng. code of 02 or later.

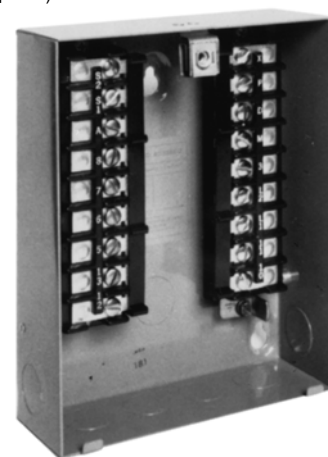
### Amplifier Module (One Required)

- E1R1
- E1R2
- E1R3
- EUV1
- EUVS4
- ERT1



### Wiring Base (One Required)

60-1386-2  
 Surface Mount  
 (shown)

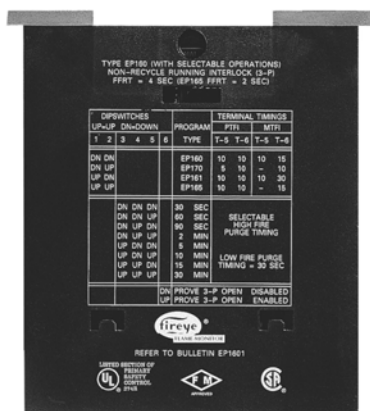


60-1466-2  
 Cabinet Mount

## Programmer Module (One Required)

### EP Programmer

- EP160
- EP161
- EP165
- EP166
- EP170
- EP260
- EP265
- EP270
- EP380
- EP381
- EP382
- EP387
- EP390

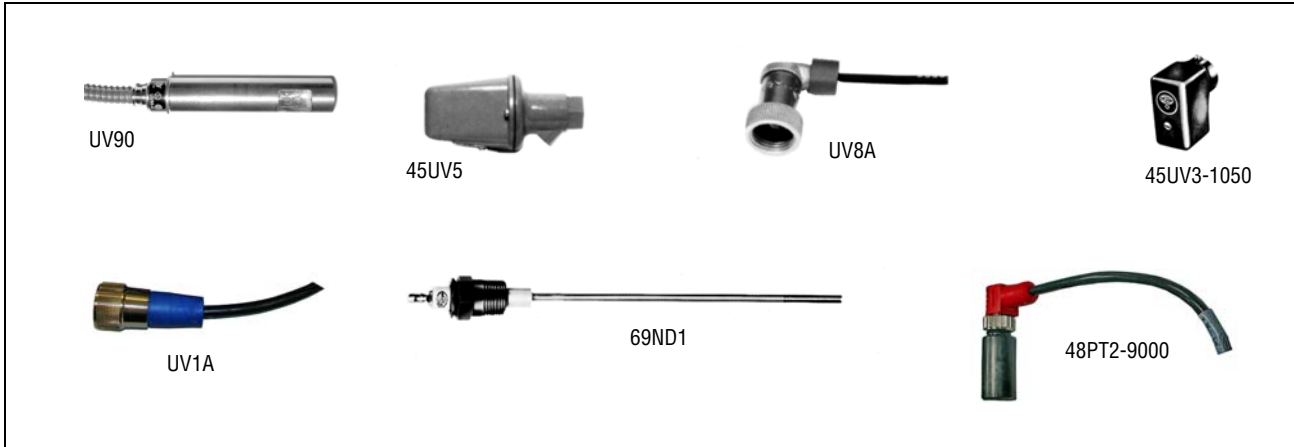


### or EPD Programmer

- EPD160
- EPD161
- EPD167
- EPD170
- EPD260
- EPD261
- EPD270
- EPD380
- EPD381
- EPD382
- EPD390



## FLAME SCANNERS



**CAUTION:** The UV1, UV2, UV8A, UV90 and 45UV3 ultra-violet flame scanners and associated amplifier modules are non-self checking UV systems and should be applied only to burners that cycle often (e.g.: a minimum of once per 12 hours) in order for the safety checking circuit to be exercised. If component checking is required during burner operation for constantly fired burners, utilize the self-checking ultra-violet flame scanners (45UV5) with associated amplifier module (EUVS4), or the infrared flame scanner (48PT2) with associated Auto Check amplifier (E1R1, E1R2, E1R3).

## FLAME-MONITOR PROGRAMMER SELECTION

All programmers for the Flame-Monitor Series are designated with the prefix "EP" or "EPD." The functional operation, flame failure response time, purge timings, firing rate motor circuit, trial for ignition timings, recycling function and display messages are determined by the programmer.

Following is a chart of the most common programmers. Refer to the appropriate product bulletin for a detailed description of the operation of each programmer.

Take note of the programming sequence chart for each programming module for the proper explanation of pre-purge timings.



**WARNING: THE INAPPROPRIATE SELECTION OR APPLICATION OF A PROGRAMMER MODULE COULD RESULT IN AN UNSAFE CONDITION HAZARDOUS TO LIFE AND PROPERTY.** The various programmer modules (EP(D)160, EP(D)260 and EP(D)380) are interchangeable because they plug into a common chassis. Changing the dipswitches modifies the operation of each programmer module. Care should be taken to insure the proper dipswitch settings. Refer to the appropriate programmer bulletin for dipswitch settings. Selection of the programmer module and setting the dipswitches for a particular application should be made by a competent professional, such as a Boiler/Burner technician licensed by a state or government agency, engineering personnel of the burner, boiler or furnace manufacturer (OEM) or in the performance of duties based on the information from the OEM.





FIREYE PART NUMBER	Pre-purge programming (Seconds)	Proven High Fire Purge Interlock (D/8 Ckt)	Proven Low Fire Start Interlock (M/D Ckt)	Intermittent Ignition/ Pilot	Interrupted Ignition/ Pilot	Early Spark Termination	Pilot Trial-for-Ignition		Main Trial-for-Ignition		Running Interlock (3/P CKT)	Firing Rate Motor Circuit
							Term 5	Term 6	Term 5	Term 6		
EPD/EP <sup>2</sup> PROGRAMMERS												
EPD160 EP160 EPD167 <sup>8</sup>	30 <sup>1</sup> Supervised	Yes	Yes	No	Yes	No	10 10	10 15	Non Recycle	Yes		
EPD161 EP161	30 <sup>1</sup> Supervised	Yes	Yes	No	Yes	No	10 10	10 30	Non Recycle	Yes		
EP165 <sup>7</sup>	30 <sup>1</sup> Supervised	Yes	Yes	No	Yes	No	10 10	— 10 <sup>6</sup>	Non Recycle	Yes		
EP166 <sup>7</sup>	30 <sup>1</sup> Supervised	Yes	Yes	No	Yes	No	10 10	— 15 <sup>6</sup>	Non Recycle	Yes		
EPD170 EP170	30 <sup>1</sup> Supervised	Yes	Yes	No	Yes	Yes	5 10	— 10	Non Recycle	Yes		
EPD260 EP260	30 <sup>1</sup>	No	Yes	No	Yes	No	10 10	10 15	Recycle	Yes		
EPD261	30 <sup>1</sup>	No	Yes	No	Yes	No	10 10	10 30	Recycle	Yes		
EPD270 EP270	30 <sup>1</sup>	No	Yes	No	Yes	Yes	5 10	— 10	Recycle	Yes		
EPD380 EP380 EP387 <sup>8</sup>	30	No	Yes	Yes <sup>3</sup>	Yes	Yes <sup>4</sup>	10 10	10 Intermittent <sup>3</sup>	Recycle <sup>5</sup>	None		
EPD381 EP381	15	No	Yes	Yes <sup>3</sup>	Yes	Yes <sup>4</sup>	10 10	10 Intermittent <sup>3</sup>	Recycle <sup>5</sup>	None		
EPD382 EP382	0	No	Yes	Yes <sup>3</sup>	Yes	Yes <sup>4</sup>	10 10	10 Intermittent <sup>3</sup>	Recycle <sup>5</sup>	None		
EPD390 EP390	90	No	Yes	Yes <sup>3</sup>	Yes	Yes <sup>4</sup>	10 10	10 Intermittent <sup>3</sup>	Recycle <sup>5</sup>	None		

All programmers have a maximum 4 second Flame Failure Response Time (FFRT) with the exception of the EP165 and EP166 (2 sec. FFRT).

All EPD Programmers and EP Programmers have selectable 3-P Proven Open to Start feature via dipswitch.

<sup>1</sup> These programmers add a 30 second waiting period to the prepurge while the firing rate motor is driven to the low fire position.

<sup>2</sup> Purge timings can be extended via dipswitches of EP style programmers.

<sup>3</sup> Selectable intermittent or interrupted (15 sec. MTFI) operation of terminal 6 via dipswitch (EP models only).

<sup>4</sup> These programmers can use terminal "X" for spark termination. This requires jumpering terminals 5 and 10 on the wiring base. PTFI timing is 5 seconds on terminal "X."

<sup>5</sup> Selectable Recycle or Non-Recycle Operation via dipswitch.

<sup>6</sup> During MTFI terminal 6 is energized for 5 seconds (pilot stabilization) before energizing terminal 7 for 10 seconds for EP165 and 15 seconds for EP166 only.

<sup>7</sup> EP165 will lockout on power interruption.

<sup>8</sup> The EPD167 and EP387 wait indefinitely for the low fire start switch (M-D) to close.

## PROGRAMMER AND DISPLAY MODULE COMPATIBILITY

All programmers for the Flame-Monitor Series are designated with the prefix "EP" or "EPD." The ED510 is a 2 line by 16 character LCD display with keypad to provide both current and historical information pertaining to the operation of the control. Refer to Bulletin ED-5101 for a complete description of the features and capabilities of the ED510 display module. The ED500 is an eight character LED display, was the predecessor to the ED510 and does not have the latest features of the ED510 display module. EP style programmers with an Engineering code of 28 or later (e.g. 9414-28) are compatible with both the ED510 and ED500 display module. EP style programmers with an Engineering code before 28 are only compatible with the ED500 display. The EPD style programmers (with an Engineering code 02 or later) are compatible with the ED510 display module as well.

**Note:** The EPD style programmers do not require a display module to function.



For a complete system, choose one of each of the following:

- Chassis
- Flame Detector
- Programmer Module
- Wiring Base
- Amplifier Module



**WARNING: Installer must be trained and qualified. Follow the burner manufacturers instructions, if supplied. Otherwise, proceed as follows:**

## INSTALLATION OF CONTROL

### Wiring Base

Mount the wiring base on the burner or on a panel. The location should be free from excessive vibration and within the specified ambient temperature rating. The base may be mounted in any angular position.

All wiring should comply with applicable electrical codes, regulations and local ordinances. Use moisture resistant wire suitable for at least 90 degrees C. Good electrical wiring practice should be followed to ensure an adequate ground system. Refer to Fireeye Service Note 100 separately and General Grounding Rules, later in this document, for recommended grounding methods

A good ground system should be provided to minimize the effects of AC quality problems. A properly designed ground system meeting all the safety requirements will ensure that any AC voltage quality problems, such as spikes, surges and impulses have a low impedance path to ground. A low impedance path to ground is required to ensure that large currents involved with any surge voltages will follow the desired path in preference to alternative paths, where extensive damage may occur to equipment.

Refer to suggested Wiring Diagram on page 32.



**WARNING: Controls require safety limits utilizing isolated mechanical contacts. Electronic limit switches may cause erratic operation and should be avoided.**

## BEFORE INSTALLING THE CONTROL



**CAUTION: Ensure that electric power is turned off. Refer to SN-100 for recommended grounding techniques.**

**Be aware that power to some interlocks (operating controls, air flow switches, modulating circuits, etc.) may be derived from sources other than what is controlling the Flame-Monitor.**

If either a ground or a short circuit is detected, it must be eliminated before the control is plugged into the wiring base and power turned on.

Test the electrical field wiring for short circuits and grounds. The recommended method requires the use of an ohmmeter set on its lowest resistance scale.

*Note: When using ultra-violet or infrared scanning, be sure to remove any jumpers on the wiring base which ground the S2 terminal.*

1. Touch the meter probes together and calibrate accurately to ensure a reliable test.
2. Disconnect the neutral wire (L2) from the control system at the power source. Clip one meter test lead to the grounded green terminal on the lower right side of the wiring base and with the other probe touch each other terminal. At no time should the meters show continuity or read 0 ohms.

3. Reconnect the neutral wire (L2) at the power source. Remove the test probe from the grounded terminal and reconnect it to Terminal L2 in the wiring base. With the other probe, touch each other terminal. It is normal to obtain a resistance reading on the meter at some terminals during this test as there are resistive loads (coils, transformers, lamps, etc.) connected whose normal DC resistance may be less than 5 ohms. However, at no time should the test meter read zero ohms.



**CAUTION: Restore power for the following test.**

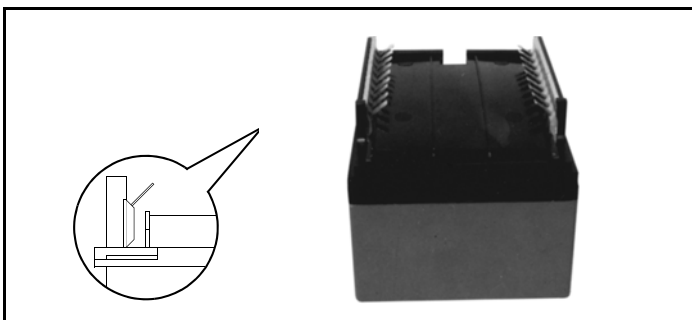
4. With Flame-Monitor removed, measure voltage from L2 to all other terminals. Reading should be zero on all terminals except L1.

## INSTALLING THE CONTROL



**CAUTION: Electric power must be turned off during installation.**

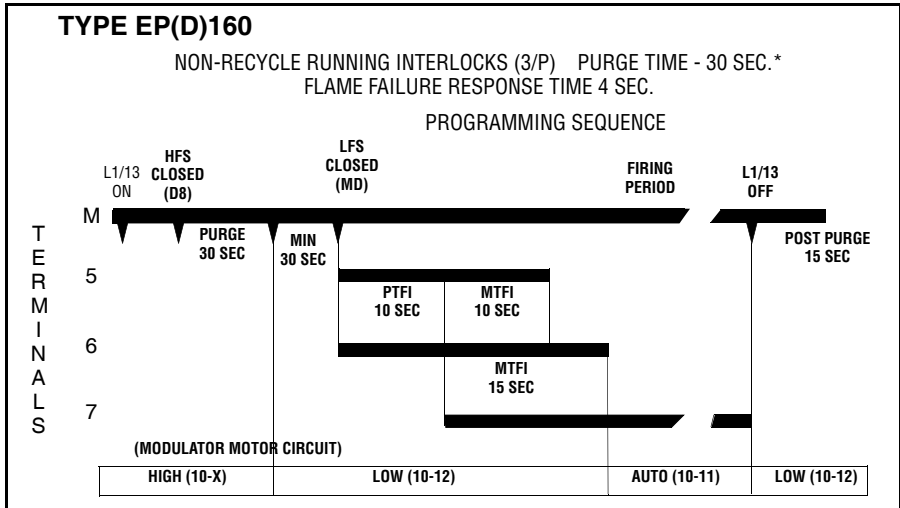
1. Check the electrical tabs on the bottom of the chassis—if they are bent out of position, reposition them with your fingers so that they are in line as shown here.



2. Select the appropriate programmer and amplifier modules for your application. Remove the dust cover from the chassis. Insert the amplifier module into the slot marked Flame Amplifier Module and gently push the module into position. Insert the programmer module into the slot marked Programmer Module and gently push the module into position. Attach the display to the program module and plug ED580-1 into RJ45 connections.
3. Slide the slots at the bottom of the assembled control over the tabs on the wiring base. Push the control into position. Insert a screwdriver through the hole in the top of the control and tighten the retaining screw.
4. Electric power may now be turned on.

## OPERATION

The programmer module determines the functional operation of the E110 control (e.g. purge timing, trial for ignition timings, recycle or non-recycle operation, etc.). For purposes of illustration, we will be looking at the EP160/EPD160 Programmer functions and messages associated with the ED510 display module in this bulletin. **Because the messages change depending upon which EP style programmer is being used, it is necessary to check the bulletin covering the specific programmer for exact details.** Refer to the suggestions shown in this bulletin before proceeding to power the Fireye E110 Flame-Monitor system. Items such as scanner installation, short circuit tests and safety information should be reviewed.



**DIPSWITCH SETTINGS**

1	2	3	4	5	6
INACTIVE		Down	Down	Down	Down

Refer to appropriate programmer bulletin for a complete description of the dipswitch functions.

**CAUTION: On initial power-up and on restarts following a power failure, the control will perform self-test diagnostics for 15 seconds.**

**Start-Up (Normal Cycle)**

*Note: For direct spark ignited oil burners, substitute the words Main-Oil Valve for Pilot Valve.*

1. Constant 120 VAC should be available to the L1-L2 terminals only on the wiring base.
2. The operating control circuits (L1-13) will close, signaling the burner to start its firing sequence.
3. If the fuel valve end switch (13-3) is closed, the burner/blower motor (terminal M) circuit is energized. The running interlock (limit) circuit (3-P) will close (e.g. all limits, interlocks, etc. are proven).
4. The firing rate motor (Modulator Motor) is driven toward the high purge open damper position (10-X circuit made).
5. When the firing rate motor reaches its open damper position, the Hi Purge switch closes (D-8) and the prepurge interval of 30\* seconds is initiated. The ED510 will display:

**PURGE 0:05  
 HIGH FIRE PURGE**

If the D-8 circuit does not close, the program will hold in this position for ten minutes waiting for it to close. If it does not, the control will lockout.

6. When the prepurge is completed, the firing rate motor is driven toward the low purge damper position (10-12 ckt. made). The ED510 will display:

**PURGE 0:35  
 LOW FIRE PURGE**

7. Following the minimum 30 second delay (to permit the firing rate motor to get to the low fire position), the control will wait for the low fire switch (M-D) to close. When it closes, the trial for ignition sequence will start. If after ten minutes, the M-D circuit is not closed, the control will lockout. The EPD167 will wait indefinitely for the M-D circuit to close.

\* Prepurge timing is selectable via dipswitches.



8. The trial for ignition period begins with Terminal 5 and 6 being energized simultaneously. This is known as PTFI (Pilot Trial for Ignition). The ED510 will display:

**PTFI 0:02**  
**IGNITION TIMING**

This period is ten seconds in duration. If no flame is detected after ten seconds, the control will de-energize Terminals 5 and 6 and lockout. When flame is detected during this 10 second period, the ED510 will display

**PTFI 20**  
**FLAME SIGNAL**

<b>FLAME SIGNAL</b>	
0-9	NOT ACCEPTABLE
10	MINIMUM ACCEPTABLE
20-80	NORMAL

9. With flame proven at the end of PTFI, the main flame trial for ignition (MTFI) period begins. Terminal 7 is energized. The ED510 will display:

**MTFI 35**  
**FLAME SIGNAL**

Terminal 5 is de-energized 10 seconds later and Terminal 6 is de-energized after another 5 seconds.

10. The firing rate motor is now sent to the auto position (10-11 ckt made) and is under the command of the proportional controller. The ED510 will display:

**AUTO 40**  
**FLAME SIGNAL**

*NOTE: Trial-for-Ignition timings depend on the programmer selected. The timing chart on page 9 points out the differences in the EP(D)160, EP161, EP165, and EP(D)170.*

### **Normal Shutdown**

1. When the operating control circuit (L1-13) opens, the main fuel valve is de-energized. The firing rate motor is driven to the low purge position (10-12 ckt made).
2. Following a 15 second post purge, the burner/blower motor is de-energized.
3. The burner is now off and the ED510 will display

**STANDBY**  
**L1-13 OPEN**

Burner history can be displayed by using ED510 keypad. See bulletin ED-5101.

---

## **BACKLIT DISPLAY**

The ED510 display has a two (2) line by sixteen (16) character backlit LCD display. The backlit function is energized when power is applied to the FLAME MONITOR.

**Contrast Control:** The contrast for the LCD display is factory set. If the contrast must be adjusted for any reason (e.g.: remote mounting), a potentiometer is provided on the back of the ED510 display board. Refer to bulletin ED-5101 for detailed information.



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## LOCKOUTS

When a safety shutdown occurs, the control will display a message indicating LOCKOUT and the reason for the lockout. The alarm circuit (Terminal “A”) will be energized. The non-volatile memory will remember the status of the control even if a power failure occurs. By momentarily depressing the reset button on the display, the control can be reset. The button must be held down for one second and then released. Very little force is required to do this. Do not press hard.

### Safety Shutdown

1. If the running interlock circuit does not close, the control will lockout and the blower motor will be de-energized. If the interlock circuit opens during a start-up or firing period, all fuel valves will be de-energized and the control will lockout.
2. If the proven high fire circuit (D-8) has not closed after a ten (10) minute “Hold” period at the start of prepurge, the control will lockout.
3. If the low fire start circuit (M-D) has not closed after a ten (10) minute “Hold” period at the end of prepurge, the control will lockout.
4. If dipswitch 6 is in the “Up” position (3-P prove open to start-enabled), and the 3-P circuit is closed at the start of the operating cycle, the control will hold for one (1) minute waiting for the 3-P circuit to open. If, after one (1) minute, the 3-P circuit does not open, the control will lockout.
5. If pilot flame is not detected during the 10 second trial for ignition period, the pilot valve and ignition transformer will be de-energized and the control will lockout on safety.
6. If main flame is not detected at the end of the main flame trial for ignition period, all fuel valves will be de-energized and the control will lockout on safety.
7. If the main flame fails during a firing cycle, all fuel valves will be de-energized within 4 seconds maximum, after loss of flame signal and the control will lockout on safety.
8. The EP165 and EP166 programmers will lockout on a power interruption.
9. If flame is detected when the operating control (L1-13) is open, the control will wait sixty (60) seconds and then lockout if flame is still present. If the operating control closes and flame is detected during purge, the blower motor (term M) remains energized and the purge sequence is put on hold. If the flame signal goes away within sixty (60) seconds, the control will proceed with a normal start-up. If flame signal is still present after sixty (60) seconds, the control will lockout.

*NOTE: Manual Reset is required following any safety shutdown.*

*NOTE: Depressing and releasing the reset button during a cycle will cause the control to shut the burner down and recycle.*

---

## DESCRIPTION OF FUNCTIONS OF OPERATING CONTROLS

1. **Operating Controls:** Generally pressure or temperature activated, the operating control closes, causing the burner start-up sequence to begin. When the operating control opens, the burner shuts off. The operating control is connected in the L1-13 circuit on the wiring base.
2. **Limit Switches:** These are generally pressure, water level or temperature activated
  - a. Recycle —when it is desired to stop the burner when the limit switch opens and restart it when the limit switch reclosed, they are connected between Terminals L1 and 13.
  - b. Non-Recycle —when it is necessary to stop the burner when the limit switch opens and prevent it from starting until both the limit switch recloses and the manual reset is activated, they are connected between terminals 3 and P.\*

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\* Refer to programmer selection on page 9 to determine which programmers offer non-recycle operation of the running interlock circuit (ckt. 3-P).



3. **Fuel Valve End Switch Interlock:** This is generally an integral switch mounted on the main fuel valve and activated by the valve stem. It is connected between Terminal 3 & 13. The fuel valve end switch interlock prevents a burner start-up if the valve stem is not in the “valve closed” position.
4. **Purge Interlock:** Generally a firing rate motor linkage position switch or a differential air-pressure switch, that proves a maximum purge air flow rate. It is connected between Terminals D and 8. The purge interlock proves that the purge air flow rate is at maximum during the purge.
5. **Running Interlocks:** These generally are air flow switches, high and low fuel pressure switches, oil temperature switches, atomizing media pressure switches, and excess smoke density controls. These interlocks prove proper conditions for normal operation of the burner. They are wired in series and connected between Terminals 3 and P.
6. **Low Fire Start Interlock:** Generally a firing rate motor linkage position switch or a damper position switch, will prove both the linkage and dampers are in their proper positions to begin burner light off. This switch is connected between Terminals M and D.

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## IMPORTANT INFORMATION — PLEASE READ CAREFULLY

### DETECTING AIR FLOW SWITCH (3-P) CLOSED AFTER START

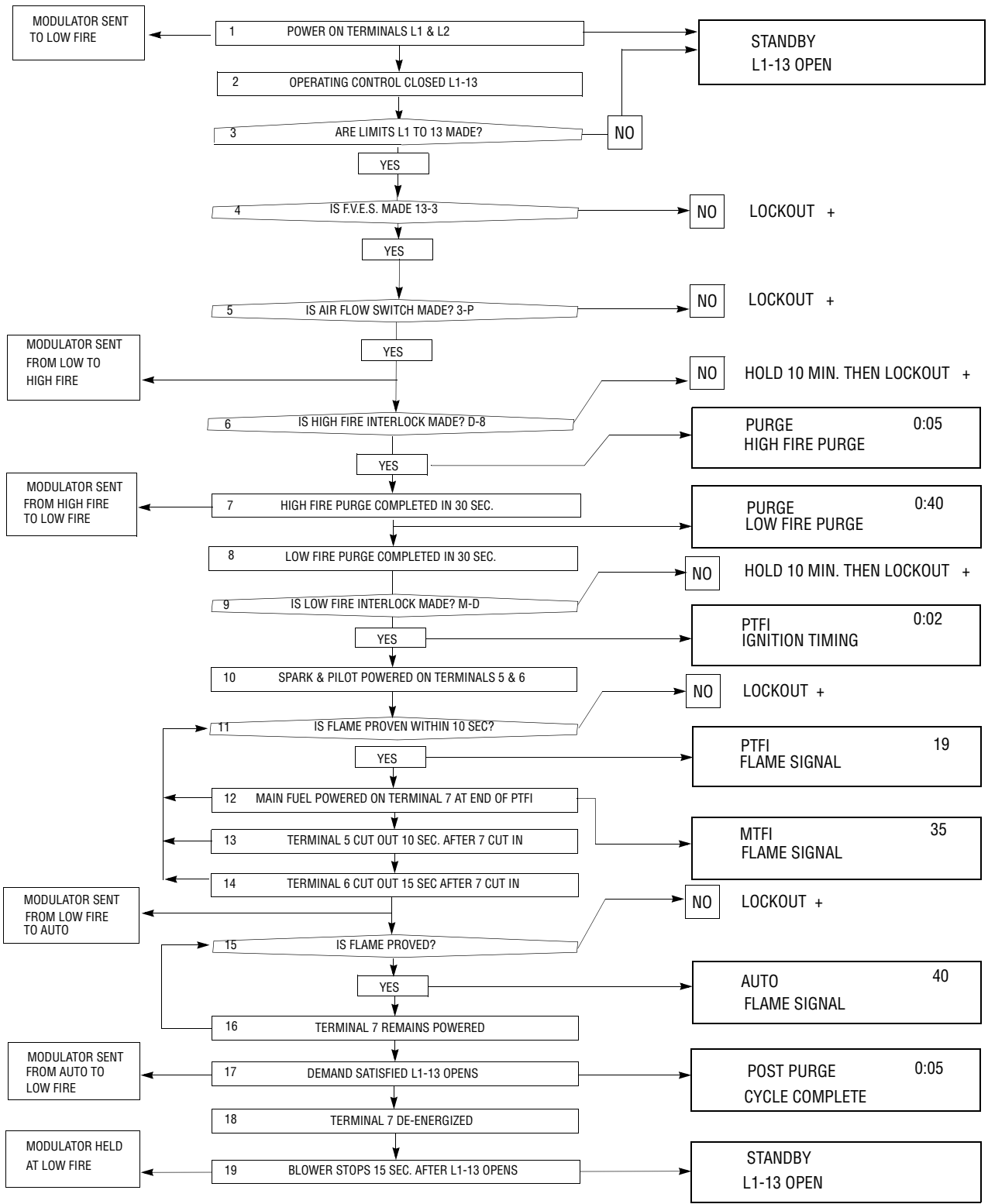
In code 39 programmers and above, the method used to detect the air flow switch closed at the beginning of a cycle has been changed to avoid any nuisance lockouts. Currently, after the operating control closes, the programmer waits 10 seconds for the air flow switch to close and if not closed will go into lockout. The EP programmers utilize the open damper switch interlock, D-8, to determine the wait time for the air flow switch to close. If, at the start of a cycle after a blower turns on, the D-8 interlock is detected as closed, most likely indicating a jumped high fire switch, the programmer allows 20 seconds for the air flow switch to close. Alternatively, at startup, if the D-8 interlock is open, indicating the firing rate motor is at the low fire position and the damper is closed, the programmer will not check for the air flow switch closed until 10 seconds after the open damper switch has closed and the purge period has begun. This means the programmer will send the mod motor to the high fire position, forcing the high fire damper switch to close, and will then begin its 10 second timer to check for the air flow switch to close.

### EP160 - DIP SWITCH 1

When used in conjunction with Nexus PPC5000, dip switch 1 in the UP position provides a 3 second delay between burner cycles. This time period is used to de-energize the blower motor, terminal M. This allows sufficient time for the PPC5000 to realize a new cycle is beginning and it can reset its operating parameters accordingly.

Refer to the specific programming bulletin for additional information regarding dip switch settings.

# EP(D)160 LOGIC FLOW DIAGRAM NORMAL CYCLE



+ LOCKOUT AND HOLD MESSAGES ARE EXPLAINED IN THE FOLLOWING PAGES.





## ED510 MESSAGES

### RUN MESSAGES

STANDBY L1-13 OPEN		The operating control of the FLAME-MONITOR (terminals L1-13) is open.
PURGE HIGH FIRE PURGE	0:05	Firing rate motor sent to high fire (term. 10-X made), purge timing displayed upper right hand corner.
PURGE LOW FIRE PURGE	0:35	Firing rate motor sent to low fire (term. 10-12 made), purge timing displayed in upper right hand corner.
PTFI IGNITION TIMING	0:02	PTFI timing started. Pilot not proven yet. PTFI timing displayed in upper right hand corner.
PTFI FLAME SIGNAL	19	Pilot flame proven during PTFI. Flame signal strength displayed in upper right hand corner.
MTFI FLAME SIGNAL	25	Main flame proven during MTFI. Flame signal strength displayed in upper right hand corner.
AUTO FLAME SIGNAL	40	Modulator motor sent to auto position (term 10-11 made). Flame signal strength displayed in upper right hand corner.
POST PURGE CYCLE COMPLETE	0:05	Demand satisfied. L1-13 open. Blower motor de-energized 15 seconds after L1-13 opens.

### HOLD MESSAGES

HOLD STANDBY 3-P INTLK CLOSED	0:23	Dipswitch #6 (3-P Proven Open to Start) is set in the Up position (Enabled). At the start of the cycle, the 3-P circuit was closed. It will hold in this position for 60 seconds and then lockout if the 3-P circuit does not open.
HOLD PURGE D-8 LIMIT OPEN	0:00	The control has driven the firing rate motor to high purge (term. 10-X made) and is waiting for the high fire switch (term. D-8) to close. It will hold this position for ten (10) minutes and then lockout if the D-8 circuit does not close. <b>Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers.</b>
HOLD PURGE D-8 LIMIT CLOSED	0:00	Dipswitch #6 (3-P Proven Open to Start) is set in the Up position (Enabled). At the start of a cycle the D-8 circuit was closed. It will hold in this position for 30 seconds and then lockout if the D-8 circuit does not open. Possible solution is to remove jumper from D-8 circuit or properly set the firing rate motor and switches. <b>Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers</b>
HOLD PURGE M-D LIMIT CLOSED	0:30	Dipswitch #6 (3-P Proven Open to Start) is set in the Up position (Enabled). At the end of high fire purge and beginning of low fire start, the M-D circuit is closed. It will hold in this position for 30 seconds and then lockout if the M-D circuit does not open. The solution is to remove jumper from the M-D circuit or properly set the firing rate motor and switches. <b>Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers</b>



HOLD PURGE  
M-D LIMIT OPEN 0:00

The control has finished purge and the firing rate motor is driving to the low fire position (term. 10-12 made) waiting for the low fire start switch (term. M-D) to close. It will hold this position for ten (10) minutes and then lockout if the M-D circuit does not close, excluding the EPD167.

HOLD PURGE  
3-P INTLK OPEN 0:10

The running interlock circuit (3/P) has not closed within the first ten (10) seconds of purge. The control will hold for ten (10) minutes and then lockout. **Applies to recycle programmers only.**

HOLD STANDBY  
FALSE FLAME 25

Flame has been sensed during the burner off time (term. L1-13 open) or during the purge period. This message will hold for sixty (60) seconds and then lockout if flame is still present. Flame signal strength is displayed in the upper right hand corner.

### LOCKOUT MESSAGES

LOCKOUT STANDBY  
3-P INTLK CLOSED

Dipswitch #6 (3-P Proven Open to Start) is set in the Up position (Enabled). At the start of the cycle, the 3-P circuit was closed, and the control has waited 60 seconds for the 3-P circuit to open.

LOCKOUT PURGE  
D-8 LIMIT OPEN

The control has held for more than 10 minutes waiting for the high fire switch (D-8) to close. **Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers.**

LOCKOUT PURGE  
D-8 LIMIT CLOSED

Dipswitch #6 (3-P proven open to start) is set in the Up position (Enabled). The D-8 circuit has been closed for 30 seconds at the start of cycle. **Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers**

LOCKOUT PURGE  
M-D LIMIT CLOSED

Dipswitch #6 (3-P proven open to start) is set in the Up position (Enabled). The M-D circuit has been closed for 30 seconds at the end of high purge or at the beginning of low fire start. **Applies to EP(D)160, EP(D)161, EP165, EP166, EPD167 and EP(D)170 programmers**

LOCKOUT PURGE  
3-P INTLK OPEN

The running interlock circuit (3-P) has opened during the purge period or failed to close within the first 10 seconds of purge on non-recycle programmers or has not closed within 10 minutes on recycle programmers.

LOCKOUT STANDBY  
13-3 FUEL VALVE END SWITCH

The fuel valve end switch wired between terminals 13 and 3 opened during purge or at start up.

LOCKOUT PURGE  
M-D LIMIT OPEN

The control has held for more than 10 minutes waiting for the low fire switch (M-D) to close. This does not apply to the EPD167 or EP387.

LOCKOUT PTFI  
3-P INTLK OPEN

The running interlock circuit (3-P) has opened during the pilot trial for ignition period. **Applies to non-recycle programmers only.**

LOCKOUT MTFI  
3-P INTLK OPEN

The running interlock circuit (3-P) has opened during the main trial for ignition period. **Applies to non-recycle programmers only.**

LOCKOUT AUTO  
3-P INTLK OPEN

The running interlock circuit (3-P) has opened during the main burner on period. **Applies to non-recycle programmers only.**



LOCKOUT STANDBY FALSE FLAME	Flame has been sensed during the burner off time (term. L1-13 open) or during the purge period for sixty (60) seconds.
LOCKOUT PTFI FLAME FAIL	A flame failure occurred during the pilot trial for ignition period.
LOCKOUT MTFI FLAME FAIL	A flame failure occurred during the main trial for ignition period.
LOCKOUT AUTO FLAME FAIL	A flame failure occurred during the main burner on period.
LOCKOUT PTFI SCANNER NOISE	This message appears because of ignition cable noise. Reroute scanner wires away from high voltage ignition cables. Check for proper spark gap or cracked porcelain. Check for proper grounding of wiring base and power supply. Replace worn ignition cable and/or faulty connections.
LOCKOUT PURGE SHORT CIRCUIT TERM 5,6,7	Excessive current or short circuit detected on terminals 5, 6, or 7 during PTFI, MTFI, or Auto. The control will lockout upon sensing this condition on two consecutive cycles.
LOCKOUT PTFI FUEL VALVE STATE CHANGE	During pilot trial for ignition period, voltage sensed on terminal 7 is different from the previous cycle. (e.g.: jumper added or removed between term. 7 and 5 or 6).
LOCKOUT AUTO LINE FREQUENCY NOISE DETECTED	Electrical noise detected on terminals L1 and L2.
LOCKOUT AC POWER FAIL	A power interruption to terminals L1 and L2 has caused the control to lockout. <b>Applies to EP165 and EP166 programmers only.</b>

### CHECK MESSAGES

CHECK PURGE D-8 HI LIMIT	0:15	The "Run-Check" switch has been placed in the Check position during purge and will hold indefinitely. The firing rate motor is being driven to the high purge position.
CHECK PURGE M-D LOW LIMIT	0:45	The "Run-Check" switch has been placed in the Check position after high fire purge and will hold indefinitely. The firing rate motor is being driven to the low fire position.
CHECK PTFI FLAME SIGNAL	19	The "Run-Check" switch has been placed in the Check position during the pilot trial for ignition period. Flame signal strength is displayed in the upper right hand position. The control will lockout on safety only when no flame signal is sensed for a continuous 30 seconds while the control is in the Check position.
CHECK AUTO LOW FIRE SIGNAL	25	The "Run-Check" switch has been placed in the Check position during the main burner on period. and the firing rate motor is driven to the low fire position. Flame signal strength is displayed in the upper right hand corner.



CHECK STANDBY  
UNIT ADDRESS 00

The “Check-Run” switch has been placed in the Check position with the operating control circuit (L1-13) open. Every time the Reset button is depressed and held for one second will increment the Unit Address by one. Refer to programmer bulletin for additional information on Unit Address.

### DIAGNOSTIC MESSAGES

LOCKOUT AUTO  
CHECK AMPLIFIER

#### POSSIBLE CAUSE

- High electrical noise
- Defective field wiring.
- Defective amplifier.
- Defective IR scanner.

#### SOLUTION

- Check for proper ground on power supply.
- Install noise suppressor on power supply.
- Make sure line phase on interlock circuit is the same as found on L1/L2 power supply to E110.
- Replace amplifier.
- Replace IR cell.

LOCKOUT PTFI  
CHECK CHASSIS

- Voltage on terminal 7 at improper time.
- Defective Chassis.
- Defective Programmer.

- Check wiring to terminal 7.
- Replace Chassis (EB700).
- Replace Programmer.

LOCKOUT PURGE  
CHECK PROGRAMMER

- Voltage on terminal 5 or 6 at improper time.
- High Electrical Noise.
- Failed Programmer.
- Worn Chassis.

- Check wiring to terminals 5 and 6.
- Install noise suppressor on power supply
- Re-route scanner wires away from high voltage wiring.
- Replace Programmer.
- Replace Chassis.

LOCKOUT AUTO  
CHECK SCANNER

- Flame signal detected during shutter close time on 45UV5 scanner.

- Stuck scanner shutter. Replace 45UV5 scanner.

LOCKOUT AUTO  
CHECK EXPANSION MODULE

- The E300 Expansion Module has a defective optocoupler.

- Replace E300 Expansion Module.

LOCKOUT AUTO  
AUTO CHECK AMPLIFIER FAIL

- Amplifier has failed diagnostic checks.

- Replace amplifier.

FIREYE ED510  
SYSTEM ERROR

- Defective programmer.

- Replace programmer.



## HISTORICAL INFORMATION /SYSTEM SUB-MENUS

At any time the control is powered, the SCRL key will scroll through and display the total number of burner cycles, burner lockouts, and system hours on the bottom line of the ED510 display. The top line will continue to show the current run mode of the control (e.g. PURGE, AUTO, etc.). Following the historical information, the SCRL key will display four (4) System Sub-menus providing the following information and/or functions:

- Lockout History (with burner cycle and burner hour time stamp).
- E300 Message Select (to program messages associated with the E300 Expansion Module).
- Program Setup (to display programmer type, purge timing, FFRT timing, etc.).
- System Information (status of M-D circuit, average pilot flame signal, etc.).

The system sub-menus require the MODE key to gain access to the information associated with each sub-menu. An arrow is displayed in the lower right hand corner of the display to indicate a system sub-menu. Every time the SCRL key is pressed the information is displayed as follows:

AUTO	40
BNR HOURS	823

Number of hours Terminal 7 (main fuel) is energized.\*

AUTO	40
BNR CYCLES	385

Number of burner operating cycles. (L1-13 closed).\*

AUTO	40
BNR LOCKOUTS	21

Number of burner lockouts.\*

AUTO	40
SYS HOURS	1233

Number of hours the control has been powered.\*

AUTO	40
LOCKOUT HISTORY	→

Sub-menu to display the cause of the last 6 lockouts. The MODE key is required to display the actual lockouts.

AUTO	40
E300 MSG SELECT	→

Sub-menu to program the messages associated with the operation of the E300 Expansion Module. The MODE key is required to enter the sub-menu.

AUTO	40
PROGRAM SETUP	→

Sub-menu to display various operating parameters of the programmer and amplifier. The MODE key is required to enter the sub-menu.

AUTO	40
SYSTEM INFO	→

Sub-menu to display information pertaining to the operation of the control. The MODE key is required to enter the sub-menu.

\* Refer to SYSTEM INFO to reset value to zero.



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## LOCKOUT HISTORY

The sub-menu "LOCKOUT HISTORY" will display the last six (6) lockouts, along with the burner cycle and burner hour when the lockout occurred. When the MODE key is pressed, the screen will display the most recent lockout condition and the number of that lockout (e.g. LO #127 represents the 127th lockout of that control). The SCRL key will display the Burner Hour, followed by the Burner Cycle when the lockout occurred. The SCRL key will advance to the next lockout, and repeat the sequence listed above. The MODE key will exit the sub-menu.

PRESS	SCREEN DISPLAYS	DESCRIPTION
SCRL	AUTO 45 LOCKOUT HISTORY >	Scrolling through the historical information. Control has released to auto modulation, flame signal strength = 45.
MODE	LO #158 PURGE D-8 LIMIT OPEN	The last (most recent) lockout condition. This is the 158th lockout of the control.
SCRL	LO #158 PURGE @ BNR HOURS 136	The last lockout occurred after 136 hours of burner operation.
SCRL	LO #158 PURGE @ BNR CYCLE 744	The last lockout occurred on the 744 burner cycle.
SCRL	LO #157 AUTO 3-P INTLK OPEN	The next to last lockout condition. This is the 157th lockout of the control.
MODE	AUTO 45 FLAME SIGNAL	Screen has returned to the run message. Control has released to auto modulation, flame signal strength = 45.

---

## E300 MESSAGE SELECT

The sub-menu "E300 MSG SELECT" will allow the user to modify the lockout alarm messages associated with the operation of the E300 Expansion Module. The various safety limits had to be wired in the exact order that was shown in the E-3001 Product Bulletin for the E300. For example, the low water cutoff had to be wired between terminals 23 and 24 of the 60-1950 wiring base of the E300. With the EP style programmers (Engineering code 28 or later), the user will now be able to select which message applies to the individual terminals. The messages associated with the E300 are divided into four (4) groups: Recycle, Non-recycle, Gas Select, and Oil Select.

The **Recycle** group pertains to the limits that are connected between terminals L1 and 13 of the E110 Flame-Monitor. These are terminals 20-21, 21-22, and 22-13. Note: Refer to Bulletin E-3001 for a wiring diagram of the E300 terminals.

The **Non-Recycle** group pertains to limits connected between terminals 3 and P of the E110 FLAME-MONITOR. These are terminals 3-23, 23-24, 30-31, 31-32, 32-33, 33-34, 34-35, and 35-P.

The **Gas Select** group pertains to the terminals associated with the gas interlocks of the E300. These are terminals 25-27, 27-30.

The **Oil Select** group pertains to the terminals associated with the oil interlocks of the E300. These are terminals 26-28, 28-29, and 29-30.

The lockout messages associated with the above terminals can be modified via the ED510 Display. The selection of available messages are dependent on each group. For example, the message "Low Oil Pressure" is a selection only for the Oil Select group. The default message for a particular interlock is the standard message for those terminals as indicated in the E-3001 bulletin. For example, the default message for terminals 20-21 is "L1-13 AUX #1 OPEN."



## TO MODIFY THE E300 MESSAGES

All three keys: Mode, Reset and Scroll, are used to modify the E300 messages. The Mode key is used to enter or exit the sub-menu associated with the E300 messages. The Scroll key is used to advance through the various terminals or selectable messages. The Reset key is used to modify a terminal message and select a new message. To modify the E300 messages:

Press the Scroll key until the ED510 displays

**E300 MSG SELECT.**

Press the Mode key and the screen displays:

**E300 TERM #20-21**

**L1-13 AUX#1 OPEN** or programmed message.

Press the Scroll key and the screen displays:

**E300 TERM #21-22**

**L1-13 AUX#2 OPEN** or programmed message.

To change the message, press and hold the Reset key for one (1) second. When the Reset key is released, the screen displays:

**MDFY TERM #21-22**

**L1-13 AUX#2 OPEN**

Press the Scroll key to display the available messages for the particular group being modified. See attached List of available messages for each group.

When the messages displayed is appropriate for the terminals, press and hold the Reset key for one (1) second. When the Reset key is released, the screen displays:

**E300 TERM #21-22**

**LOW WATER** or programmed message.

Press the Mode key to exit the E300 Message Sub-menu.

---

## AVAILABLE E300 MESSAGES

The following messages are available for each of the four E300 terminal groups:

### GROUP 1 — RECYCLE

E340 OP CNTL OPEN

HIGH WATER

CONTROL PANEL SWITCH OPEN

DAMPER POSITION END SWITCH  
OPEN

BLOWER MOTOR INTLK

HIGH GAS PRESSURE

COMBUSTION AIR END SWITCH OPEN  
LOW WATER

HIGH STACK TEMPERATURE

LOW GAS PRESSURE

### GROUP 2 — OIL SELECT

LOW OIL PRESSURE

LOW OIL TEMPERATURE

LOW ATOMIZING MEDIA

HIGH OIL PRESSURE

HIGH OIL TEMPERATURE

### GROUP 3 — GAS SELECT

HIGH GAS PRESSURE

LOW GAS PRESSURE

### GROUP 4 — NON-RECYCLE

E340 SAFETY INTLK OPEN

HIGH TEMPERATURE

BLOWER MOTOR INTLK

HIGH WATER

AIR FLOW OPEN

I.D. FAN INTLK

LOW WATER

OIL GUN END SWITCH OPEN

F.D. FAN INTLK

HIGH PRESSURE

HIGH STACK TEMPERATURE



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## USER PROGRAMMED E300 MESSAGES

In addition to selecting the lockout alarm messages for the E300 Expansion Module from a menu selection via the ED510 display, the user can also program any message (up to 40 characters in length) for the individual terminals of the E300 using a dumb terminal (or PC with communication software) and the appropriate interface cables. Refer to bulletin E-3001 for complete details.

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## PROGRAM SETUP

The sub-menu “PROGRAM SETUP” allows the user to review the various operational settings of the programmer module (e.g. programmer type, purge timing, etc.). The MODE key is used to enter the “PROGRAM SETUP” sub-menu, and the SCRL key is used to advance through the sub-menu.

<b>Press</b>	<b>Screen Displays</b>	<b>Description</b>
SCRL	AUTO 45 PROGRAM SETUP >	SCRL key advances through the historical information until “Program Setup” is displayed. Control has released to auto modulation, flame signal strength = 45.
MODE	AUTO 45 PROGRAMMER EP(D)160	Programmer Type is an EP(D)160.
SCRL	AUTO 45 ENGR CODE NO. 28	Software Engineering code of the programmer module is code 28.
SCRL	AUTO 45 AMP = EUV1 OR ERT1	Amplifier module is an EUV1 or an ERT1.
SCRL	AUTO 45 PURGE TIME 0:30	Purge timing (selected by the dipswitches) is 30 seconds.
SCRL	AUTO 45 PROVE 3-P OPEN = N	Proven 3-P Open To Start is disabled (selected by dipswitches).
SCRL	AUTO 45 FLAME FAIL TIME 4s	Flame Failure Response Time (FFRT) = 4 seconds (maximum).
SCRL	AUTO 45 UNIT ADDRESS #00	Unit Address is 00. Refer to programmer bulletin to modify Unit Address.
MODE	AUTO 45 FLAME SIGNAL	MODE key returns to run message.



## SYSTEM INFO

The sub-menu “SYSTEM INFO” allows the user to review information pertaining to the operation of the control (e.g. average main flame signal strength, status of the high fire and low fire end switches, etc.). This information can be very helpful when setting the damper linkages on the firing rate motor. The MODE key is used to enter the “PROGRAM SETUP” sub-menu, and the SCRL key is used to advance through the sub-menu.

Press	Screen Displays	Description
SCRL	AUTO 45 SYSTEM INFO >	SCRL key advances through the historical information until “System Info” is displayed. Control has released to auto modulation, flame signal strength = 45.
MODE	AUTO 45 AVG. PILOT FLM 22	The average flame signal strength of the pilot flame = 22
SCRL	AUTO 45 AVG. MAIN FLM 40	The average flame signal strength of the main flame = 40.
SCRL	AUTO 45 SHORT CKTS. 0	The total number of short circuits (excessive current) detected on terminals 5, 6, and 7. The short circuit condition must be sensed twice consecutively to be considered a short circuit.
SCRL	AUTO 45 D-8 LIMIT CLOSED	The status of the high fire end switch (D-8) is closed.
SCRL	AUTO 45 M-D LIMIT CLOSED	The status of the low fire end switch (M-D) is closed.
SCRL	PRESS RESET TO CLEAR HISTORY	While the control is in STANDBY position (L1-13 OPEN) pressing and releasing the RESET key will clear current burner hours, cycles and lockout history.
MODE	AUTO 45	MODE key returns to run message.



**The EP(D) programmer updates the messages to the ED510 display at least once every 8 seconds. If the ED510 display does not receive information from the EP(D) programmer within 10 seconds the ED510 will display:**

**FIREYE ED510  
WAITING FOR DATA**

**This can be the result of a defective connection between the programmer and display, defective cable, defective drivers in the programmer or display, or an electrical noise transient causing the EP(D) programmer to cease communication.**

**Removing and restoring power should be executed to recover proper operation. Refer to bulletin SN-100 for recommended techniques for display installation.**



## COMMUNICATIONS

The protocol to be used is Modbus RTU. This is implemented by the master (PC, PLC, etc.) issuing a poll to the slave (Flame-Monitor) and the slave responding with the appropriate message.

A typical format of a poll request is as follows:

DST	FNC	ADR HI	ADR LO	DAT HI	DAT LO	CRC LO	CRC HI
-----	-----	-----------	-----------	-----------	-----------	-----------	-----------

DST refers to the logical address of the slave.

FNC is the function being requested. FNC 03 is a read request.

ADR is the message number or register number of the data being requested. In Modbus, register addresses begin at 40001 but is interpreted as address 00.

DAT is the number of words being requested. A word is an integer consisting of 2 bytes.

The normal response from a slave is as follows:

DST	FNC	DBC	DATA.... Hi/Lo	CRC LO	CRC HI
-----	-----	-----	-------------------	-----------	-----------

DBC is the data byte count being returned. It must be two times the DAT number from the poll request.

DATA is the data returned and is always a series of 2 byte integers. If 4 words were requested then DBC would be 8 and there would be 8 data bytes or 4 data words containing the requested data.

**The format of the data is 4800,N,8,1 meaning 4800 baud, no parity, and 1 stop bit.**

Below is a table of currently available messages provided by the Flame-Monitor programmers, followed by a description where necessary, EP engineering code 38 or greater and EPD engineering code 4 or greater.

MESSAGE ADDRESS	WORD REQUESTED	RESPONSE	VALUE
00	1-6	STATUS	83 (053H) = RUN; 202 (OCAH) = LOCKOUT
01	1	MSGN	Current message being displayed (see Table 1)
02	1	GSTAT	Defines Timer Type
03	1	TIMER	Time, Flame, Address
04	1	FLAME	Flame Signal
05	1-3	LOGSTAT	Current logic module, PURGE, PTFI, AUTO (See Table 2)
06	1	INPUTS	Input limits state
07	1	OUTPUTS	Output relays state
08	2	SYSMINS	System on minutes
10	2	BNRMINS	Burner on minutes
12	2	CYCLES	Completed Burner Cycles
14	1	LOCKOUT COUNT	Stored Lockout Count
15	1-6	LOCKOUT HISTORY	Last 6 Lockouts, first word is most current lockout
21	1-2	DEVTYP	Programmer device type, 5=EP, 6=EPD, 7=MicroM
22	1	AMPTYP	Amplifier Type; EUVS4=0C0H; EIR1=0A0H; ERT1, EUV1=090H;
23			
24	2	FLAME SIGNAL AVERAGES	PTFI and Auto Flame Signal Averages
35	6	Most Recent Lockout Data	Returns complete lockout description of stored lockout history. Includes lockout message, lockout module, @ burner hours, and @ burner cycles



41	6	2nd Most Recent Lockout Data	
47	6	3rd Most Recent Lockout Data	
53	6	4th Most Recent Lockout Data	
59	6	5th Most Recent Lockout Data	
65	6	6th Most Recent Lockout Data	
71	1-3	Input limits and Expansion Module registers	Returns input limits state and lower and upper expansion module (E300) registers. See Table 3
72	1-2	Expansion Module (E300) registers	Returns lower and upper Expansion Module registers
73	1		Return only upper Expansion Module register

**It is suggested that polling intervals not be less than 200 mSec per request. Requesting data such as burner minutes, system minutes and burner cycles should be kept at a minimum due to the amount of processing time required to gather that data.**

Messages 00, 05, 08, 10, 15, 21 and 26 are unique in that a limited number of successive registers can be combined with these requests. For example, a request to message 00 can contain up to 6 data words. The response to this would contain STATUS, MSGN, GSTAT, TIMER, FLAME and LOG-STAT. If the requested data word count (DAT) were to be 2 then the response would contain STATUS and MSGN only. Message 15, last 6 lockouts, can return data ranging from 1 to 6, with 1 referring to the most recent lockout.

The MSGN being transmitted is a numerical value and must be interpreted by the communicating device, which actually is an advantage since this can be made to be whatever message text the end user wants. In other words, it allows for programming custom messages without actually changing the message in the programmer. Refer to Table 1 for message information.

The Flame-Monitor stores its burner on time and system on time (L1 powered) in minutes. For display purposes, the programmer converts this to hours. The information being supplied by Modbus will be the actual time in minutes and it is up to the communicating device to do the conversion. Since the maximum value stored in the Flame-Monitor is 9,999,999 minutes, the maximum value in hex therefore is 98967FH and comprises two data words. The maximum cycle count is 999,999 decimal or F423FH, still two data words. As an example, the System on Minutes data is transmitted from the Flame-Monitor to the interface as high word / low word as shown below:

ADDRESS 8		ADDRESS 9	
HIGH WORD		LOW WORD	
HIGH BYTE	LOW BYTE	HIGH BYTE	LOW BYTE
0	98H	97H	FH

**Note:** Data from address 9 cannot be accessed directly.

All values are represented in a HEX or base 16 format.

GSTAT determines the type of value TIMER represents. TIMER can be a running timer such as is used in purge, a flame signal or meaningless. Only the lower nibble of GSTAT has any value. If this value is 0 then the TIMER value has no meaning. The value in TIMER is a background minute timer in the Flame-Monitor and should be ignored. If GSTAT is between 4 and 7, the TIMER represents the current value flame signal. If GSTAT is a 1, 2, or 3 then TIMER represents a running timer value.



The baud rate of the Flame-Monitor is fixed at 4800 bits per second. The format of the data is 8 data bits, no parity and 1 stop bit. Due to the RS485 format, the communication format is considered half-duplex. That is, only one user is permitted on the communication lines at a time.

The information contained in INPUTS and OUTPUTS represents the status of the interlocks and relays respectively. For the INPUTS, a 1 in the interlock position defines the interlock as being on or active where a 1 in any bit position in the OUTPUT register signifies the relay as being energized.

Refer to Fireeye bulletin E-3001 for terminal designations

**Table 3:**

**INPUTS**

Bit 7 Term P	Term 5/6	Term D		Term 8	Term 7	Term 3	bit 0 Term 13
Air Flow	Ignition	Low Fire	Ref	High Fire	Main Fuel	FVES or POC	Op Ctrl

A '1' in the opto-coupler position indicates the opto-coupler is on or interlock closed.

**EXPANSION MODULE (E300) LOWER - REFER TO BULLETIN E-3001**

Term 35	Term 34	Term 33	Term 32	Term 23	Term 22	Term 21	Term 20
Aux #6	Aux #5	Aux #4	High Temp	High Water	AUX #2	AUX #1	Op Ctrl

**EXPANSION MODULE (E300) UPPER - REFER TO BULLETIN E-3001**

Term 31	Term 30	Term 29	Term 28	Term 27	Term 26	Term 25	Term 24
High Pressure	Low Gas Pressure or Low Atomizing Media	Low Oil Temp.	Low Oil Pressure	High Gas Pressure	Oil Selected	Gas Selected	Low Water

**OUTPUTS**

Term 11	Term M	Term 6		Term 5	Term 7	Term A	Term X
Auto (RA1)	Blower (RB)	Ignition (RA2)	FVES (RV)	Pilot (RP)	Main Fuel (RF)	Alarm (RL)	High Fire (RH)

LOGSTAT is an indication of what logic module the control is currently in during its operating sequence and is used for diagnostic purposes only. The message displayed corresponds to the current logic module. The range of values are 4EH for Standby, 45H for PostIdle through 4DH for Shut down 2. Note that the above values are represented in hexadecimal format.

**Table 2:**

**EXPLANATION OF LOGSTAT**

LOGIC DISPATCHER			
VALUE		MODULE	FUNCTION
DEC	HEX		
69	45H	MPOSTIDLE	
70	46H	MPREPURGE1	Wait for air flow and/or high fire switch to close
71	47H	MPURGE	Open Damper Purge
72	48H	MPOST PURGE	Low Fire Purge
73	49H	MTFI	Pilot Trial
74	4AH	MTFMF	Main Trial
75	4BH	MAUTO	AUTO
76	4CH	MSHTDWN1	Post Purge
77	4DH	MSHTDWN2	Post Purge
78	4EH	MIDLE	Standby

Logstat represents the current software module the Flame-Monitor is currently executing. They are named as close to the logic module the actual burner sequence is in. For instance, in the Flame-Monitor, MPURGE represents High Fire Purge where MPOSTPURGE represents the low fire start period where the mod motor is sent to the low fire position in preparation for pilot light-off. MSHTDWN1 represents the post purge period after a complete cycle or the cool down period after a lockout.

MIDLE or STANDBY is the period of time where the operating control is open or the control is in lockout waiting for reset. On instances of false flame during the purge period, the control algorithm forces the control back to STANDBY until false flame ceases or lockout occurs.

MPREPURGE1 is the period of time prior to PURGE where the control checks the status of the air flow interlocks or the high fire proving switch (D-8). If either switch is found open, the control will remain in this state until the respective switch closes or lockout occurs.

MTFI represents the pilot trial for ignition stage of a burner sequence. MTFMF represents the main trial for main flame period where main fuel is introduced along with pilot and igniter.

MAUTO is the run period of the burner sequence.

MPOSTIDLE and MSHTDWN2 are small periods of time where certain internal tests are conducted and general cleanup before and after a cycle is performed.

The Flame-Monitor outputs the current displayed message as well as the historical lockout messages as numbers. The table that follows correlates the message number with the actual displayed test message.



**Table 1- Message Table**

DEC	HEX		<b>E110 FLAME-MONITOR MESSAGES</b>
1	1	R	L1-13 OPEN
2	2	H	HOLD FALSE FLAME- STANDBY
3	3	R	LOW FIRE PURGE
4	4	H	HOLD D-8 LIMIT OPEN- PURGE
5	5	H	HOLD 3-P AIR FLOW OPEN
6	6	L	LOCKOUT LINE FREQUENCY NOISE DETECTED
7	7	L	LOCKOUT FLAME FAIL - PTFI
8	8	C	CHECK UNIT ADDRESS
9	9	H	HOLD M-D LIMIT OPEN
10	A	R	IGNITION TIMING - PTFI
11	B		
12	C	R	FLAME SIGNAL - AUTO
13	D	R	CYCLE COMPLETE - POST PURGE
14	E	R	L1-13 OPEN (AFTER 2 MINUTES)
15	F	L	LOCKOUT AC POWER FAIL (EP165, EP166)
16	10	L	LOCKOUT SHORT CIRCUIT TERMINAL 5, 6 or 7
17	11	L	LOCKOUT D-8 LIMIT OPEN
18	12	L	LOCKOUT M-D LIMIT OPEN
19	13	L	LOCKOUT FLAME FAIL - MTFI
20	14	L	LOCKOUT FALSE FLAME
21	15	L	LOCKOUT 3-P INTLK OPEN (PURGE)
22	16	L	LOCKOUT 3-P INTLK CLOSED
23	17	H	HOLD 3-P INTLK CLOSED
24	18	H	HIGH FIRE PURGE
25	19	R	PLEASE WAIT (INITIALIZING)
26	1A	L	LOCKOUT 3-P INTLK OPEN -AUTO
27	1B	L	LOCKOUT 3-P INTLK OPEN (MTFI)
28	1C	L	LOCKOUT 3-P INTLK OPEN (PTFI)
29	1D	L	LOCKOUT 13-3 FVES OPEN
30	1E		
31	1F	C	CHECK FLAME SIGNAL - PTFI
32	20	C	CHECK D-8 HI LIMIT
33	21	C	CHECK M-D LOW LIMIT (CHECK)
34	22	R	FLAME SIGNAL- PTFI
35	23	C	CHECK LOW FIRE SIGNAL
36	24	R	FLAME SIGNAL - MTFI
37	25	L	LOCKOUT FLAME FAIL (AUTO)
38	26	H	HOLD 3-P INTLK OPEN - PURGE
39	27	L	LOCKOUT FUEL VALVE STATE CHANGE
<b>E300 EXPANSION MODULE LOCKOUT MESSAGES</b>			
40	28	L	3-P AIR FLOW OPEN
41	29	L	3-P HIGH WATER
42	2A	L	3-P LOW WATER
43	2B	L	3-P HIGH GAS PRESSURE
44	2C	L	3-P LOW GAS PRESSURE
45	2D	L	3-P LOW OIL PRESSURE
46	2E	L	3-P LOW OIL TEMPERATURE
47	2F	L	3-P LOW ATOMIZING MEDIA
48	30	L	3-P HIGH STEAM PRESSURE
49	31	L	3-P HIGH TEMPERATURE
50	32	L	3-P AUX #4 OPEN
51	33	L	3-P AUX #5 OPEN
52	34	L	3-P AUX #6 OPEN
53	35	L	3-P FUEL SELECT



SYSTEM DIAGNOSTIC MESSAGES			
54	36	L	LOCKOUT CHECK CHASSIS
55	37	L	LOCKOUT CHECK PROGRAMMER
56	38	L	LOCKOUT CHECK AMPLIFIER
57	39	L	LOCKOUT CHECK EXPANSION MODULE
58	3A	L	LOCKOUT AMPLIFIER AUTO CHECK FAIL
59	3B	L	LOCKOUT SCANNER NOISE
76	4C	L	LOCKOUT CHECK SCANNER
E300 EXPANSION MODULE HOLD MESSAGES			
60	3C	H	L1-13 AUX #1 OPEN (TERMINAL 20)
61	3D	H	L1-13 AUX #2 OPEN (TERMINAL 21)
62	3E	H	L1-13 AUX #3 OPEN (TERMINAL 22)
63	3F	H	3-P HIGH WATER (TERMINAL 23)
64	40	H	3-P LOW WATER (TERMINAL 24)
65	41	H	3-P HIGH GAS PRESSURE
66	42	H	3-P LOW GAS PRESSURE
67	43	H	3-P LOW OIL PRESSURE
68	44	H	3-P LOW OIL TEMPERATURE
69	45	H	3-P LOW ATOMIZING MEDIA
70	46	H	3-P HIGH PRESSURE (TERMINAL 31)
71	47	H	3-P HIGH TEMPERATURE (TERMINAL 32)
72	48	H	3-P AUX #4 OPEN (TERMINAL 33)
73	49	H	3-P AUX #5 OPEN (TERMINAL 34)
74	4A	H	3-P AUX #6 OPEN (TERMINAL 35)
75	4B	H	3-P FUEL SELECT
PURGE INTERLOCK RELATED MESSAGES			
76	4C	L	LOCKOUT CHECK SCANNER
77	4D	H	HOLD D-8 LIMIT CLOSED
78	4E	L	LOCKOUT D-8 LIMIT CLOSED
79	4F	H	HOLD M-D LIMIT CLOSED
80	50	L	LOCKOUT M-D LIMIT CLOSED
81	51	L	LOCKOUT 13-3 POC CLOSED (CB ONLY)
82	52	R	DYNAMIC CHECK (CB ONLY)

**R = Run**

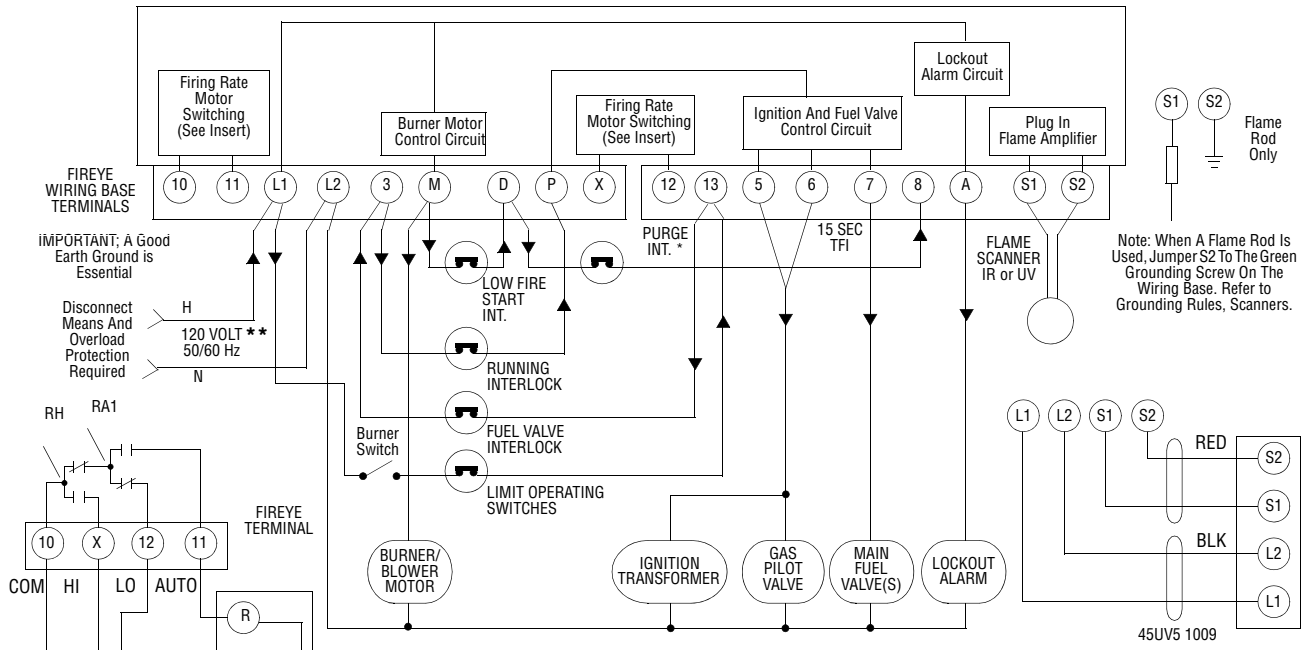
**H = Hold**

**C = Check**

**L = Lockout**

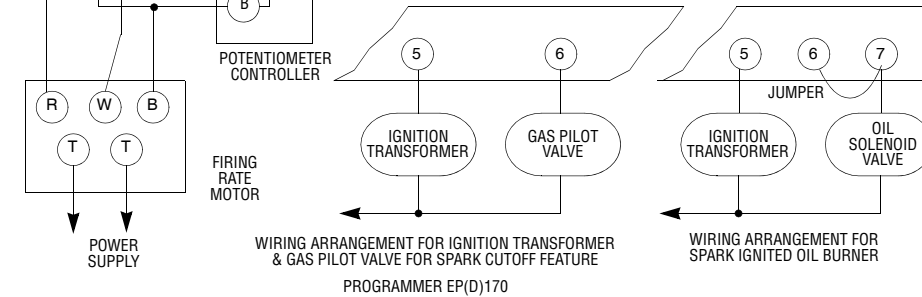


# SUGGESTED WIRING DIAGRAM FOR EP(D)160, EP161, AND EP(D)170 PROGRAMMERS



Note: When A Flame Rod Is Used, Jumper S2 To The Green Grounding Screw On The Wiring Base. Refer to Grounding Rules, Scanners.

## TYPICAL WIRING ARRANGEMENT FOR PILOT IGNITED BURNER



**Caution:** All safety limit switches should be approved as limit controls and should be wired directly in the circuit of the Flame Safeguard control.

The use of electronic switches to close interlock circuits may cause erratic operation.

Refer to Service Note 100 (SN-100) or Suggested Grounding Rules later in this document.

FIREYE PART NUMBER	Trial for Ignition/ Pilot (Seconds)		Trial for Ignition/ Main (Seconds)	
	Term 5	Term 6	Term 5	Term 6
EP(D)160	10	10	10	15
EPD167	10	10	10	30
EP(D)161	10	10	0	10
EP165*	10	10	0	15
EP166*	5	10	0	10
EP(D)170	5	10	0	10

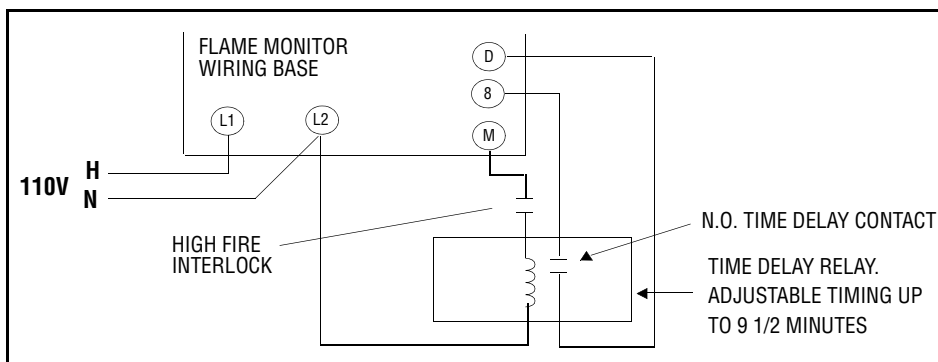
\* EP165 AND EP166 INCLUDE 5 SECOND PILOT STABILIZATION PERIOD.  
 \*\* ALL FLAME-MONITOR INTERLOCK INPUTS MUST BE THE SAME AC PHASE



## EXTENDED PREPURGE

With EPD programmers, it may be necessary to extend the pre-purge timing on the Flame Safeguard Control to greater than 30 seconds. This can be accomplished by adding a time delay relay in the L2/M and D/8 circuit and wired in the following manner:

The maximum extended purge time will be 10 minutes. The maximum time delay setting should be 9<sup>1</sup>/<sub>2</sub> minutes. If the time delay relay does not close the D-8 circuit within 10 minutes of the start, the Flame-Monitor control will LOCKOUT and the message will be LOCKOUT D-8 HI PURGE OPEN.



EP-style programmers provide this feature via dipswitches 3, 4, and 5.



### Auxiliary Device in M-D-8 Circuit at Flame Monitor Control

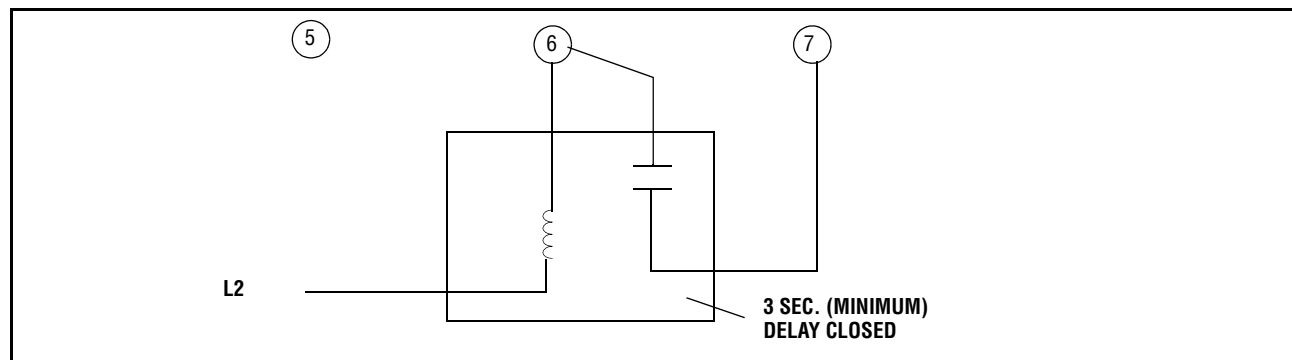
The function of the low fire start and high fire purge interlock circuits internally in a new Fireye Flame-Monitor unit is accomplished by highly reliable solid state electronic circuitry. This prohibits the connection of power consuming devices (i.e. lamps, annunciators, relays, timers, etc.) to the D or 8 terminals.

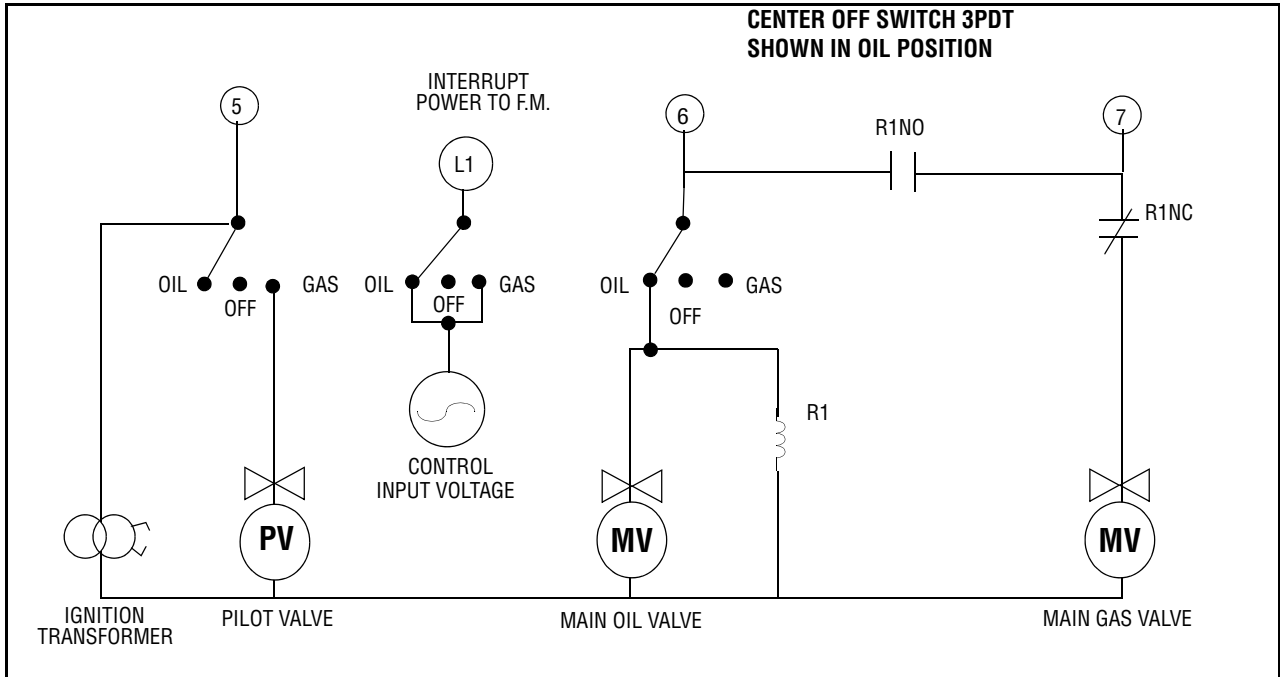
## COMBINATION FUEL BURNERS

*Note: An important safety feature of the FLAME-MONITOR system is the ability to monitor the proper timed operation of critical terminals; fuel valve terminals 5, 6 and 7 for instance. Jumpering of these terminals could therefore cause the control to sense an unusual condition and LOCKOUT.*

When changing fuels on combination fuel burners if DIRECT SPARK IGNITION is used, it is normal to jumper these terminals. To assure that burner operation is not interrupted in this situation, you must do one of the following:

1. Interrupt power to L1/L2 momentarily when changing fuels, before the initial burner cycle on the new fuel. Follow the diagram on page 34.  
*OR*
2. Install a time delay relay contact in the jumper circuit which is timed to close 3 seconds (minimum) after terminal 6 is energized. This method is only acceptable on programmers labeled "12" or higher (i.e. datecode 8710-12).





## INSTALLATION / TESTING

### Check-Run Switch

The Check-Run switch is located on the top of the EP Programmer Module and can be used to stop the control in its firing sequence at any time except during MTFI. If moved during the MTFI period, it is non-functional and automatic programming continues. It is designed to aid in set-up, start-up and check-out of the burner and its associated interlocks.

Following are the modes of operation:

1. When power is applied to the control (L1-L2) and the operating control circuit is closed (L1-13), the purge period begins and the firing rate motor is sent to the Hi Purge position. If the Check-Run Switch is moved to the Check position before the Hi Fire Switch (D-8) is made and the 30 second purge ends, the control will display:

CHECK PURGE	0:15
D-8 HI LIMIT	

The control will hold in this position indefinitely to allow the operator to make interlock switch and linkage adjustments. To continue in the cycle, move the Check-Run switch to Run to allow the control to advance.

2. If the Check-Run switch is moved to the Check position after the purge period reaches 30 seconds, but before 60 seconds, the control will display:

CHECK PURGE	0:45
M-D LOW LIMIT	

The control will hold in this position indefinitely to allow the operator to make interlock switch and linkage adjustments. To continue the cycle, moving the Check-Run Switch to Run will allow the control to advance.

3. After the PTFI period has begun, switching back to the Check position will stop the program in the PTFI period, allowing for pilot and/or scanner alignment adjustments to be made. The control will display:

CHECK PTFI	19
FLAME SIGNAL	

It will hold in this position indefinitely as long as the flame signal strength is above the threshold of 10. If it drops below 10 for thirty consecutive seconds, lockout will occur and the message on the display will read Flame Fail PTFI.

4. Switching from run to check during the burner on period will drive the modulator circuit to low fire (10-12 Closes). This allows for low fire fuel-air adjustments and holding the burner at low fire. Consult your boiler/burner instructions for low fire hold firing recommendations. The control will display:

CHECK AUTO	25
LOW FIRE SIGNAL	

As an aid adjusting the burner linkages, pilot, etc., a check-run selector is provided on each EP-and EPD Series Programmer Module.

## OPERATIONAL TEST



**WARNING: Before testing the control operation on the boiler, close the manual main shut-off fuel valve. Failure to do this may cause injury or property damage.**

1. Close the manual main shut-off fuel valve.
2. Recheck all limit circuit wiring for proper operation and correct connection.
3. Confirm that the automatic main fuel valves are wired to terminal "7."
4. Power the control and electronically check the proper sequence of operation according to the Operation section on page 11 of this bulletin.
5. After assuring yourself that all interlocks and valves are properly wired and that the sequence of operation is correct, open the manual main shut-off fuel valve and proceed cautiously through the boiler light off process. Check all safety interlocks for proper shut down of the boiler.

When the installation and all burner adjustments are completed, the entire burner control system should be tested in accordance with the burner manufacturer's instructions. The procedure should verify the correct operation of:

1. Each operating control (temperature, pressure, etc.).
2. Each limit switch (temperature, pressure, low water cutoff, etc.).
3. Each interlock switch (airflow switch, high and low fuel pressure or temperature switches, purge and low fire start switches, fuel valve proof of closure interlock, etc.).
4. Pilot flame failure response and lockout.
5. Main flame failure response and lockout.
6. Tight shut off of all fuel valves.



**CAUTION: LIVE VOLTAGE IS NECESSARY TO PERFORM THIS TEST.**

### Voltage Test

A Voltage Check is necessary to identify a potential problem with the supply to the control. This could be caused by an improperly sized or faulty transformer, faulty load coils or low entry voltage. Follow this procedure:

1. Using the Service Adapter (60-2107), monitor the L1-L2 supply throughout a complete burner cycle. The acceptable voltage range is 102V-132V. At no time during the cycle should the voltage dip below the minimum level.
2. Check other load terminal (M/L2, 5/L2, 6/L2, 7/L2) for voltage at improper times or improper values.

## TEST CHECKOUT PROCEDURES

### Normal Pilot Flame Test



**CAUTION: Before making a pilot flame test, manually shut off the fuel supply to the main burner.**

1. At the start of PTFI, place the Check-run switch in the check position.
2. Observe the pilot flame signal on the display. If the average signal is below the minimum of 10, readjust the pilot flame or realign the flame detector.
3. During the pilot flame test, if flame is not detected for a continuous 30 seconds, the control will lockout. To re-establish the pilot flame trial for ignition (PTFI), manual reset of the lockout switch is required, and a complete prepurge accomplished.
4. When UV flame detection is used, a test is required to verify that UV radiation from the ignition spark is not being detected. To accomplish this, manually shut off both pilot and main fuels. Initiate a normal start-up, and when the PTFI display comes on, observe the display which should read no signal more than 4. If more than 4 is observed, realign the UV scanner, and/or shield the spark from the scanner's view.
5. With all methods of flame detection, check pilot flame failure response by manually shutting off the pilot fuel and then initiate a normal start-up. With no pilot flame present, the control will de-energize the pilot assembly at the end of the trial for ignition interval, and the control will lockout. Also check to verify that the ignition spark does not "give" a flame signal on infrared or flame rod applications.

### Main Flame Test

**NOTE:** This test requires an interrupted pilot (a pilot that shuts off after main flame has been established).

1. Proceed through a normal startup. After the pilot flame is shut off, observe the reading on the display. If the signal reading is low, readjust main flame or realign detector.
2. Check main flame failure protection by manually shutting off the main fuel supply. Within 4 seconds after main flame goes out, the fuel valve will be de-energized. The alarm circuit will be energized following safety lockout.

### Minimum Pilot Test



**CAUTION: The minimum pilot test must be accomplished by a trained and qualified burner technician.**

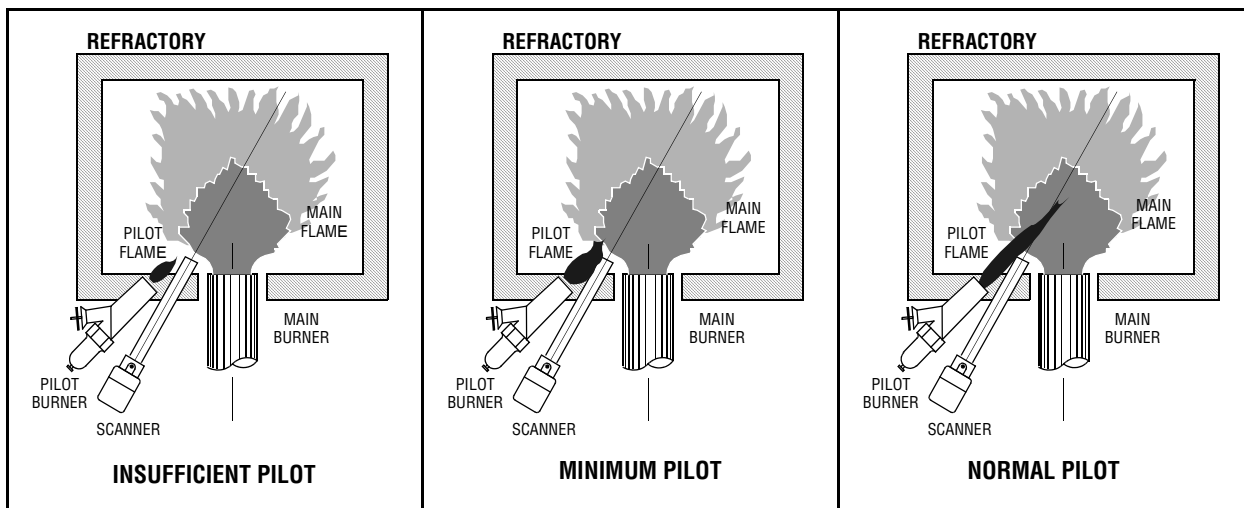
This test assures that the flame detector will not detect a pilot flame too small to reliably light off the main flame. The test should be made on every new installation and following any reapportioning of the flame detector. This procedure should not be used on a direct spark ignited burner.

1. Turn off the main fuel supply manually.
2. At the start of PTFI, place the Check-run switch in the check position.
3. Reduce the fuel supply to the pilot until the display reads below 10.
4. Slowly increase the fuel to the pilot until the display reads 10. This is minimum pilot flame that the flame detector will reliably detect.
5. Place the Check-run switch in the Run position. When the main fuel safety shut-off valve is energized, slowly open the manual main fuel valve.
6. Observe the light-off of the main flame. It must be smooth and normal.



**CAUTION: If the main flame does not ignite immediately, shut off the main fuel. Realign the detector to require larger minimum pilot flame.**

7. Repeat the test until a reliable and smooth light-off occurs with the minimum pilot.
8. After this test is completed, increase the fuel to the pilot to its normal setting.



### Scanner Wiring

Care should be taken to see that ignitor cables and scanner cables are routed away from one another on all installations. These cables, when crossed or run together, may interfere with the proper operation of the flame safeguard control.

If you are experiencing erratic operation or inappropriate characters on the display during the trial for ignition period, the cause is likely to be ignitor noise. Check for worn ignitor cable insulation, broken or cut insulation or loose connectors at the electrode and transformers.

## SUGGESTED GROUNDING RULES

The Flame-Monitor system, being microprocessor based, requires a ground system that provides a zero-voltage reference. The voltage measured from L2 to all other terminals except L1 should be 0 volts.

1. The most effective ground is to run the ground wire in the same raceway as the hot and neutral from the main distribution service panel (not intermediate sub-panels) to the burner control panel and insure that this ground wire is well bonded to the control panel.
2. The wiring base of the Flame-Monitor must have earth ground providing a connection between the sub-base and the control panel or the burner.
3. The earth ground wire must be capable of conducting the current to blow the 20A fuse in event of an internal short circuit. A number 14 AWG copper conductor is adequate, wide straps or brackets are preferred rather than lead wires.
4. The ground path needs to be low impedance (less than 1 ohm) to the equipment frame which in turn needs a low impedance to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors having maximum surface areas.
5. All connections should be free of nonconductive coatings and protected against rust.
6. Utilizing conduit as a means of providing a ground must be avoided.
7. Installing ground rods at the burner control panel defeats the purpose of a single point ground as described above and could also present a safety hazard.



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## INSTALLATION

Do not run high voltage ignition transformer wires in the same conduit with flame detection wiring.

Do not run scanner wires in a conduit with line voltage circuits.

Ensure the frame of the ignition transformer is securely connected to control panel frame or preferably the burner frame.

The Flame-Monitor chassis (EB700) contains a transient suppressing device connected internally across hot and neutral and then to the internal bracket. For this to be effective the chassis must be screwed securely into the wiring subbase.

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## REMOTE DISPLAY

When the ED510 is to be remotely mounted on the front of the control panel, the ED580 cable must contain a ferrite core, currently supplied by Fireeye with the cable. High frequency currents flow more to the surface of the conductor. The 60 Hz ground system, properly designed, has sufficient low-impedance at 60 Hz to maintain all metal surfaces at the same ground reference. But, this same system is unable to provide this at higher frequencies, because of the increased impedance caused by the 'skin effect'. The purpose of the ferrite core is to provide a low-impedance at these higher frequencies and absorb this unwanted energy.

Care must be taken not to route the ED580 cable in close proximity to any starter motor contactors located in the control panel or across any high voltage ignition wires. Refer to Fireeye bulletin E-8002 for proper installation.

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## COMMUNICATIONS

When interfacing Fireeye controls to a communication system, be it an E500, PLC or other microprocessor based device, ferrite cores should also be utilized. Proper twisted shielded pair cable must be utilized. In a multi-drop system, the shields should be tied together within a cabinet and not to any ground point. The shield at the source end of the cable of the multi-drop connection can then be terminated to ground. Source end is defined as the originating end of the communication system

Care must be taken not to route communication cables in close proximity to any starter motor contactors located in the control panel or across any high voltage ignition wires. Refer to Fireeye bulletin E-8002 for proper installation.

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## SCANNERS

The armored cable supplied with the Ultra-Violet and Infrared scanners should be connected to equipment by means of a good mechanical connection such as a conduit fitting. It may be necessary to utilize heat insulator (P/N 35-69) to isolate the sensing end of the scanner from boiler ground. Care must be taken not to route the scanner cable across the high voltage ignition cable. The high energy ignition cable should be checked periodically for cracking, connections and aging.

In applications using flame rod units and the ERT1 amplifier, it may be beneficial to route a separate return wire from the S2 terminal to the flame rod assembly. This will minimize the effects of transient currents flowing into the Flame-Monitor.

In all cases, scanner wires should be routed in separate conduit and not joined with any high voltage AC or ignition cables.

## MAINTENANCE

Periodically, the spark electrode should be inspected for proper gapping and cracked ceramics. At ignition time, the high energy from the ignition transformer will attempt to conduct to the point of least resistance and with an improper spark gap, where the conduction takes place will no longer be controlled.

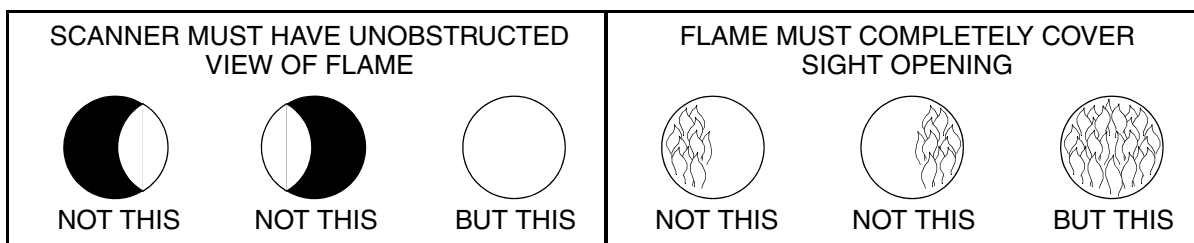
The VA rating of the control transformer must be sized to handle the inrush currents of the pilot solenoid and ignition transformer at PTFI and then the inrush currents of the main fuel valve assembly at MTFI time.

Inspect neatness of wiring in junction boxes and cabinets. It is best to have connections short and direct and also not having wires bunched up and tied off. Also, connections should be periodically inspected for tightness and corrosion.

## INSTALLATION - UV SCANNERS

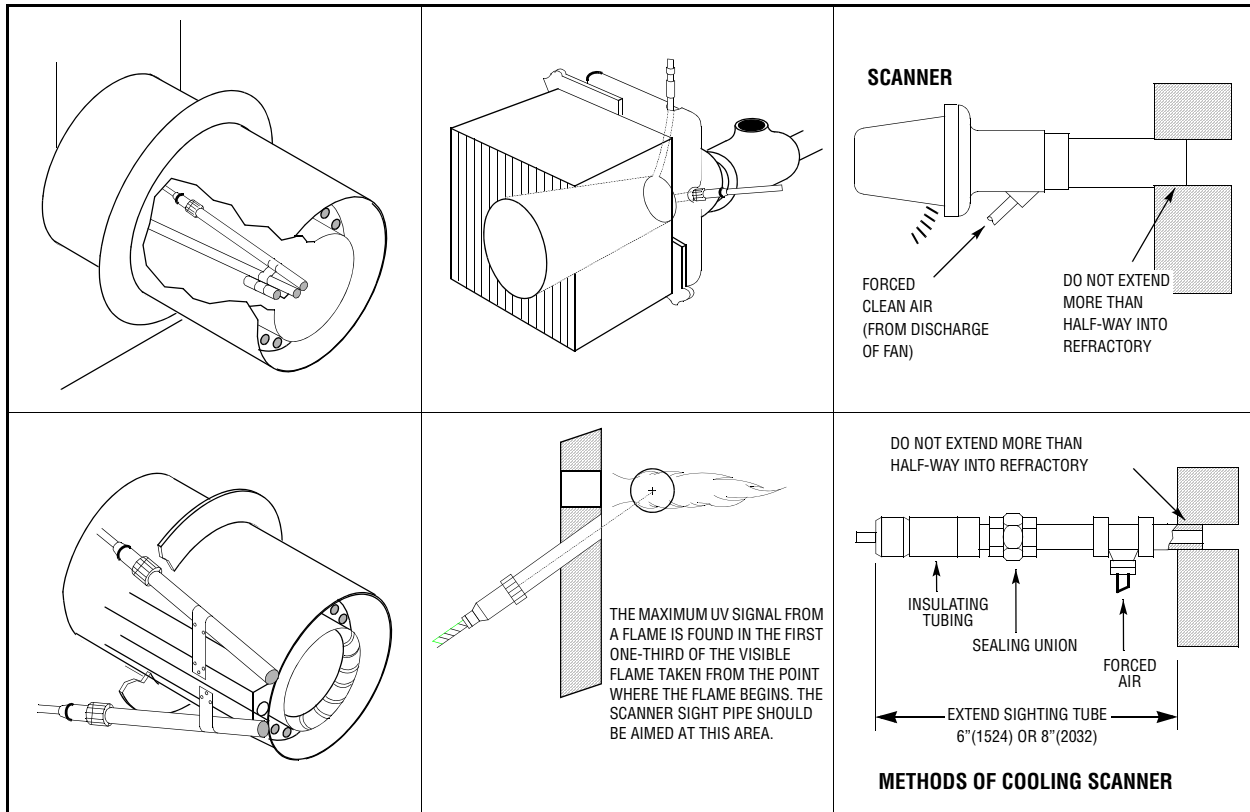
Where possible, obtain the burner manufacturer's instructions for mounting the scanner. This information is available for most standard burners. The scanner mounting should comply with the following general instructions:

1. Position the UV1, UV2 or UV90 Scanner within 30 inches of the flame to be monitored; the 45UV5 within 72 inches, closer if possible.
2. Select a scanner location that will remain within the ambient temperature limits of the UV Scanner. If cooling is required, use an insulating coupling (Fireye #35-69 for UV1, UV2 Scanners, #35-127-1 for 45UV5) to reduce conducted heat.
3. The UV1, UV2, 45UV5 Scanners are designed to seal off the sight pipe up to 1 PSI pressure. Higher furnace pressures should be sealed off. To seal off positive furnace pressure up to 100 PSI for UV1, UV2 Scanners, install a quartz window coupling (#60-1257) For 45UV5 Scanners, use #60-1199 coupling. Add cooling air to reduce the scanner sight pipe temperature.
4. Install the scanner on a standard NPT pipe (UV1: 1/2", UV2: 3/8", 45UV5: 1") whose position is rigidly fixed. If the scanner mounting pipe sights through the refractory, do not extend it more than halfway through. Swivel flanges are available if desired (#60-302 for UV1, UV2 Scanners, #60-1664-3 for 45UV5). The sight pipe must permit an unobstructed view of the pilot and/or main flame, and both pilot and main flames must completely cover the scanner field of view.



5. Smoke or unburned combustion gases absorb ultraviolet energy. On installations with negative pressure combustion chambers, a small hole drilled in the UV1, UV2 sight pipe will assist in keeping the pipe clean and free from smoke. For positive pressure furnaces, provide clean air to pressurize the sight pipe, if necessary.
6. Two UV1, UV2 or UV90 Scanners may be installed on the burner if it is necessary to view two areas to obtain reliable detection of the flame. They should be wired in parallel. Only one repetitive self-checking 45UV5 Scanner may be installed on a burner.
7. To increase scanner sensitivity with UV1, UV2 Scanners, a quartz lens permits location of the scanner at twice the normal distance. Use 1/2" x 1 1/2" pipe nipple between UV1 Scanner and the coupling. Use 3/8" pipe nipple and a 1/2" x 3/8" bushing on UV2 installations.
8. Request the assistance of any Fireye field office for recommendations of a proper scanner installation on a non-standard application.

## TYPICAL SCANNER INSTALLATIONS



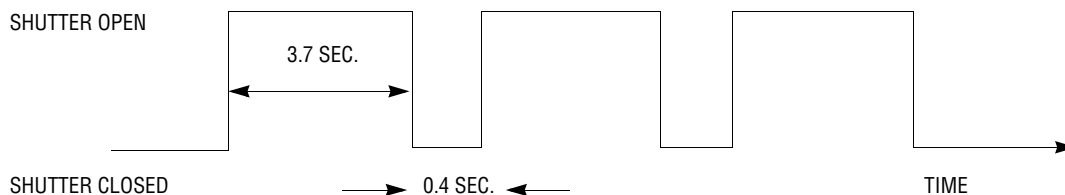
## OPERATION — 45UV5 SELF-CHECKING UV SCANNER

Self-checking ultraviolet scanners should be used in applications where burner firing operation is continuous or where the burner is on for long periods of time without recycling. In addition, ultraviolet self-checking systems are mandatory in some locations.

The operation of this type of system consists of maintaining the flame scanning capability at all times while also proving that the ultraviolet tube is firing properly. This is done periodically by mechanically closing off the sight of the UV tube and checking to make sure that the flame signal goes away. A shutter assembly in the 45UV5 scanner performs this function. The diagram below explains the process further.

If the shutter assembly in the scanner fails, the tube is faulty, or there is insufficient power to the scanner, the Flame-Monitor will LOCKOUT and display the following message LOCKOUT CHECK SCANNER. The ultraviolet tube is replaceable (P/N 4-314-1).

A lockout will result if a minimum signal is detected for three consecutive shutter closed periods.





## WIRING - UV SCANNERS

To connect the scanner to the control, the UV1 Scanner is supplied with 36" or 72" of flexible cable. The 45UV5 is supplied with four 72 lead wires. Install them in a suitable length of flexible armor cable and connect it to the control. A conduit connector is supplied with the scanner. Connect black wires (shutter) to terminals L1, L2; red wires (UV tube) to terminals S1, S2.

If it is necessary to extend the scanner wiring, the following instructions apply:

Scanner wires should be installed in a separate conduit. The wires from several scanners may be installed in a common conduit.

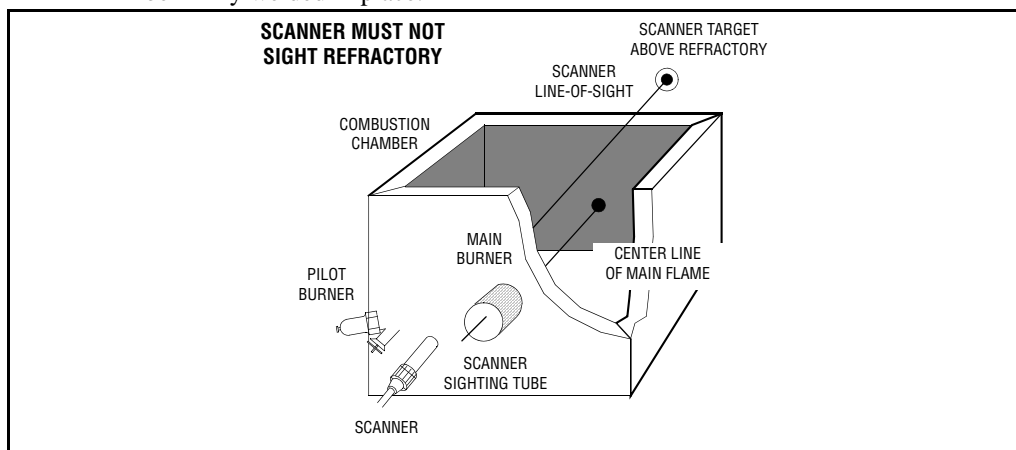
1. Selection of Wire
  - a. Wiring: For extended scanner wiring up to 500 feet, and for shorter lengths to reduce signal loss, use a shielded wire (Belden 8254-RG62 coaxial cable, or equal) for **each scanner wire** of UV1, UV2 and **each red wire** of the 45UV5. The ends of the shielding must be taped and not grounded.
  - b. Asbestos insulated wire should be avoided.
  - c. Multiconductor cable is not recommended without prior factory approval.
2. High voltage ignition wiring should not be installed in the same conduit with flame detector wires.
3. INSTALLATION—INFRARED SCANNER TYPE 48PT2

Where possible, obtain the burner manufacturer's instructions for mounting the scanner, otherwise proceed as follows:

A single scanner is used to detect both pilot and main flames. The sight pipe on which the scanner mounts must be aimed so that the scanner sights a point at the intersection of main and pilot flames.

Proper scanner positioning must assure the following:

1. Reliable pilot flame signal.
2. Reliable main flame signal.
3. A pilot flame too short or in the wrong position to ignite the main flame reliably, must not be detected.
4. Scanner must have an unobstructed view of flame being monitored.
5. Flame being monitored must completely cover the scanner field of view.
6. To avoid nuisance shutdowns, it is important to avoid sighting hot refractory and to keep scanner temperature low (below 125° F) (52°C).
7. When the proper position has been established, drill a hole through the furnace wall and install a 4" to 8" length of threaded  $\frac{1}{2}$ " black iron pipe on which to mount the 48PT2 scanner.
8. When satisfactory sighting position has been confirmed by operating tests, the sight tube should be firmly welded in place.



## Wiring

Attach the cable supplied with the scanner to a junction box. Splice the cable wires to a pair of wires not smaller than #18. Install the complete run in a separate conduit to the control. **Continuous conduit bonding between scanner and the control is mandatory!** Scanner may be located up to 100 feet from control. Do not pass scanner wiring through any junction box containing other wires. Do not run other wires through scanner conduit. Asbestos insulated wire should be avoided.

## Keeping the Scanner Cool

The Infrared Scanner (Temperature Limit 125° F) should never get too hot to grasp comfortably in the hand. Keep the scanner cool by one or more of the following methods.

1. Use 6" to 8" length of pipe between scanner and hot furnace front plate.
2. Use insulating tube (Part No. 35-69) on the end of the iron pipe.
3. Force air into sighting tube. Use Fireeye Sealing Union (Part No. 60-801).
4. Make sure sighting tube does not extend more than halfway into refractory wall.

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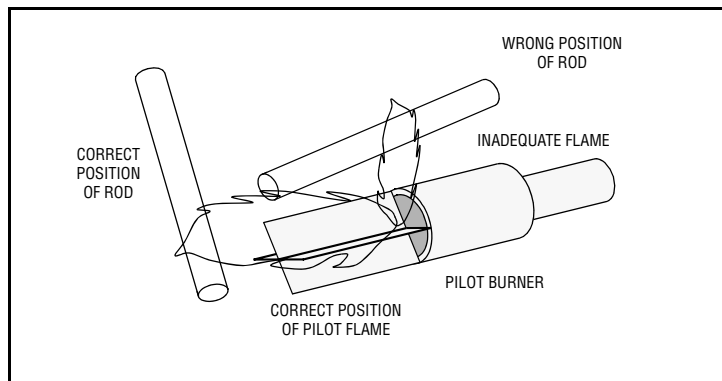
## INSTALLATION - 69NDI FLAME ROD

The 69NDI flame rod proves a gas pilot flame and/or main gas flame. It is a spark plug type unit consisting of  $\frac{1}{2}$ " "NPT" mount, a KANTHAL flame rod, a glazed porcelain insulating rod holder and a spark plug connector for making electrical connections. The 69ND1 is available in 12," 18" or 24" lengths.

The flame rod may be located to monitor only the gas pilot flame or both the gas pilot and main gas flames. It is mounted on a  $\frac{1}{2}$ " "NPT" coupling.

The following instructions should be observed:

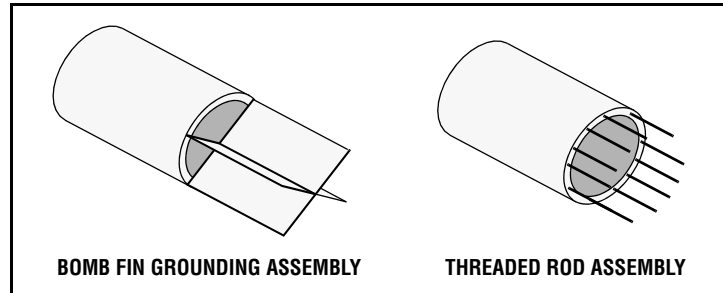
1. Keep flame rod as short as possible.
2. Keep flame rod at least  $\frac{1}{2}$ " from any refractory.
3. Flame rod should enter the pilot flame from the side so as to safely prove an adequate pilot flame under all draft conditions.
4. If the flame is nonluminous (air and gas mixed before burning), the electrode tip should extend at least  $\frac{1}{2}$ " into the flame, but not more than halfway through.



5. If the flame is partly luminous, the electrode tip should extend only to the edge of the flame. It is not necessary to maintain absolutely uninterrupted contact with the flame.
6. It is preferable to angle the rod downward to minimize the effect of sagging and to prevent it from coming in contact with any object.
7. An adequate grounding surface for the flame must be provided. The grounding surface in actual contact with the flame must be at least four times greater than the area of the portion of the flame rod in contact with the flame. It is essential to adjust the flame rod and ground area ratio to provide a maximum signal reading.

**NOTE:** Interference from the ignition spark can alter the true signal reading by adding to, or subtracting from it. This trend sometimes may be reversed by interchanging the primary wires (line voltage) to the ignition transformer. This interference can also be reduced by the addition of grounded shielding between the flame rod and ignition spark.

8. Proven types of flame grounding adapters, as shown below, may be used to provide adequate grounding surface. High temperature stainless steel should be used to minimized the effect of metal oxidation. This assembly may be welded directly over the pilot or main burner nozzle.





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## MAINTENANCE

### **Infrared and Ultraviolet Scanners**

The viewing area of the scanner must be kept clean. Even a small amount of contamination will reduce the flame signal reaching the detector by a measurable amount. Wipe the viewing area routinely using a soft cloth dampened with concentrated detergent.

- Type 48PT2 Scanners include a replaceable #4-263-1 Firetron cell.
- Type 45UV5 Scanners include a replaceable #4-314-1 UV tube.

### **Type 69ND1 Flame Rod**

The flame rod and its insulator should be kept clean by washing routinely with soap and water. Rods should be routinely replaced as they oxidize.

### **Flame Signal Strength**

Routine observation of the flame signal strength will forewarn any deterioration in the capability of the flame detector or its application.

### **Contacts**

There are no accessible contacts in the Flame-Monitor. Where contacts are used, their design assures long trouble-free life when the load circuits are maintained within the published load ratings.

### **Electrical Noise**

In areas of excessive electrical noise, the installation of an electrical noise suppressor to the power supply at the control circuit may be helpful.

### **Humidity**

In areas of high humidity, the control chassis should be removed and placed in a dry atmosphere when the system is expected to be out of service for an extended period.

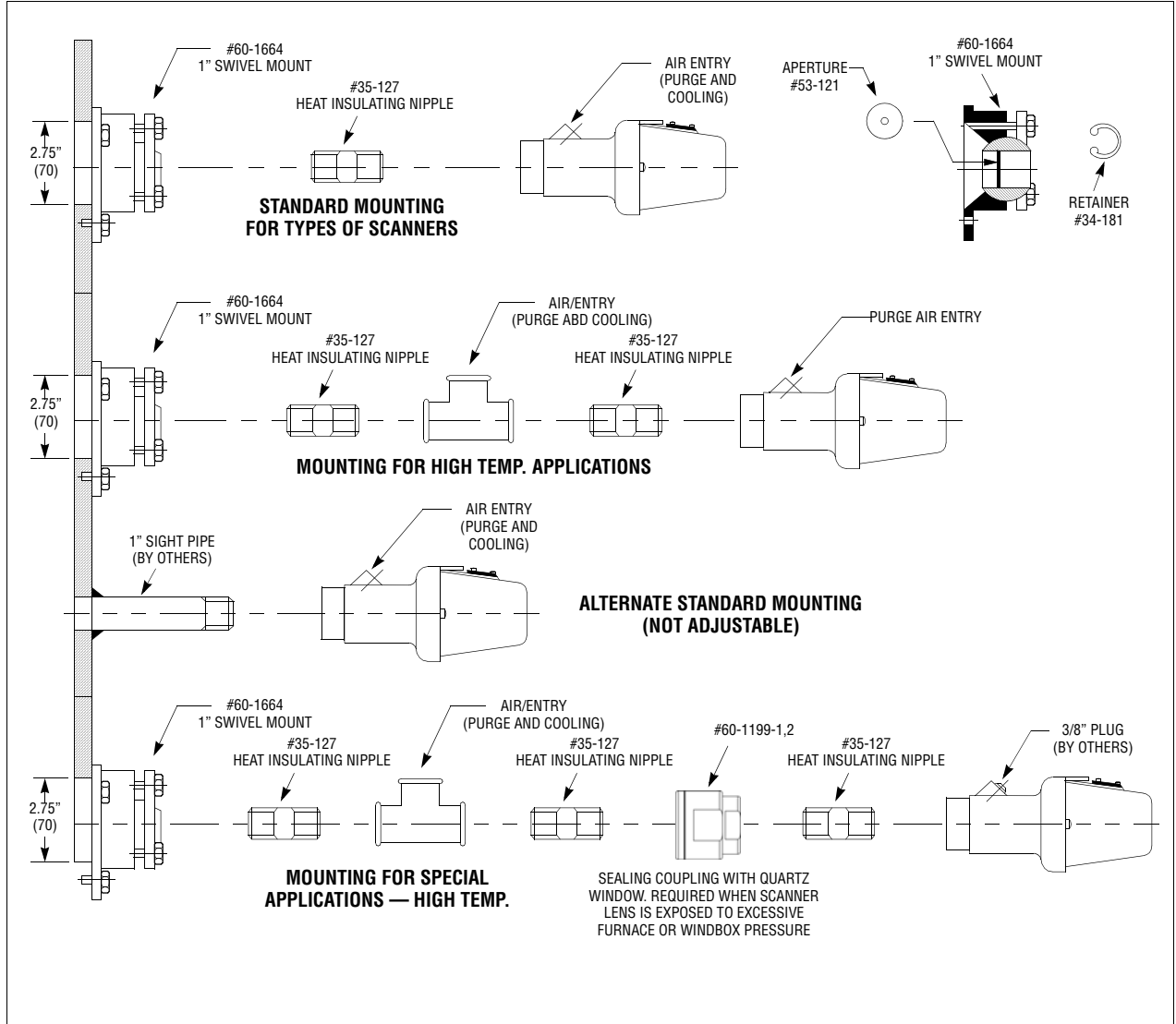
### **Periodic Safety Check**

It is recommended that a procedure be established to test the complete flame safeguard system at least once a month. This test should verify the proper operation of all limit switches and safety interlocks as well as flame failure protection and fuel safety shutoff valve tightness.

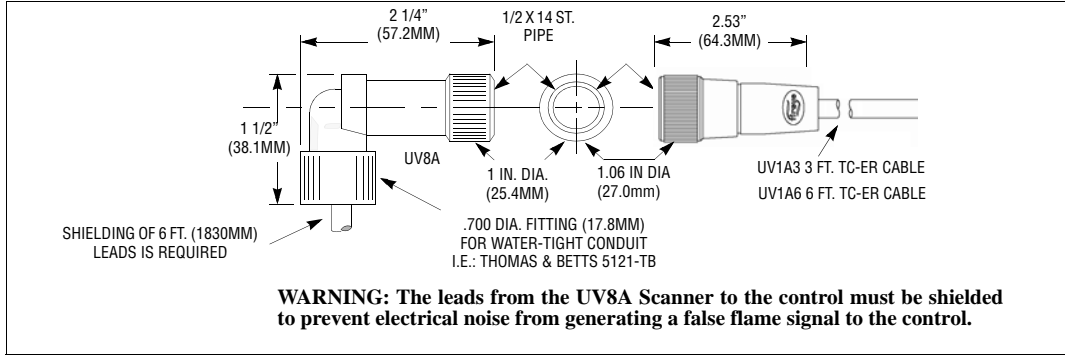
### **Rotation**

It is recommended that control and scanner units purchased as spares be installed periodically to ensure proper operation.

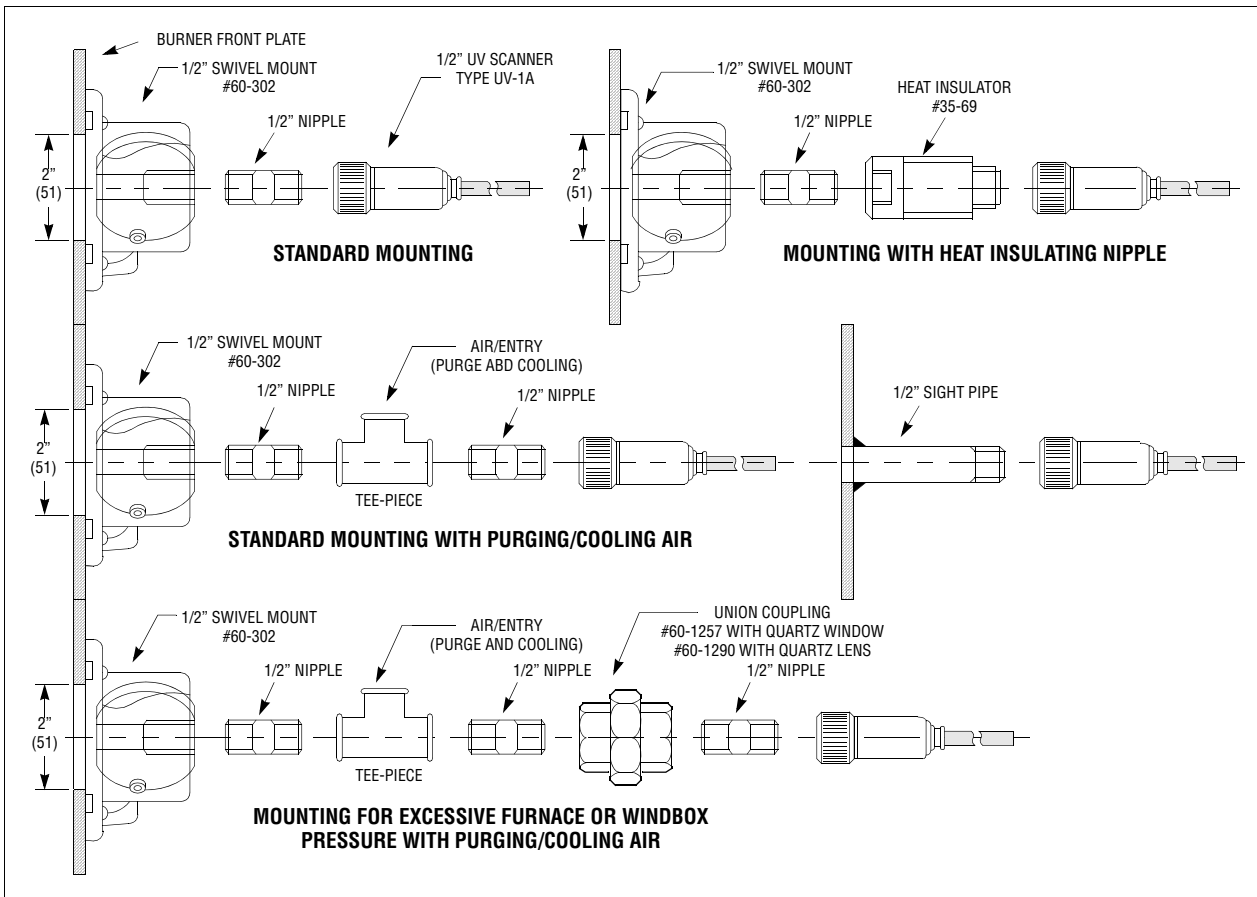
### Mounting 45UV5 Scanner

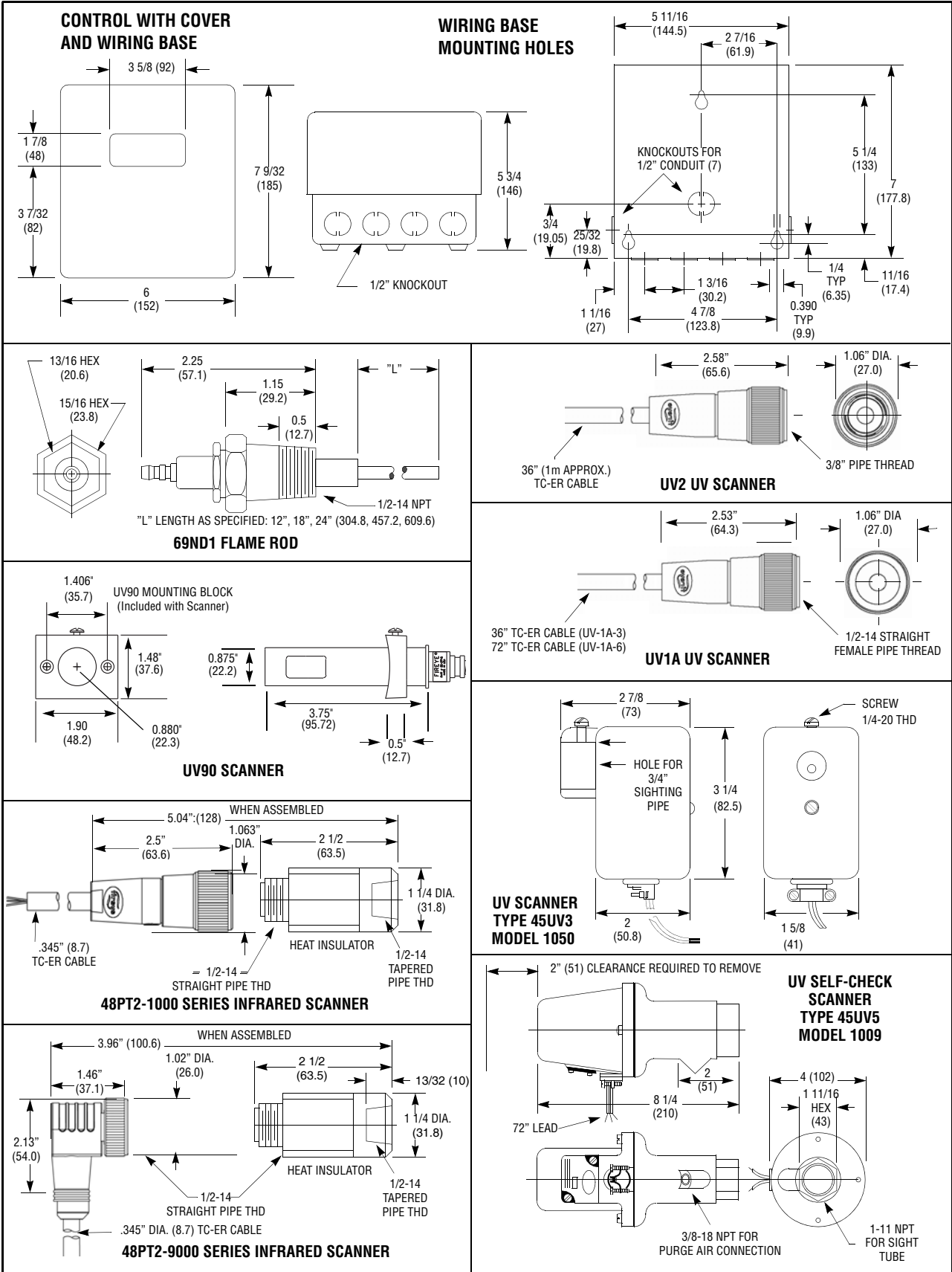


### UV8A Scanner



### Mounting UV1A Scanner





ALL DIMENSIONS IN INCHES (MILLIMETERS IN PARENTHESIS).



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## 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.

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## WARRANTIES

FIREYE 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 FIREYE 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 replacement 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.



FIREYE®  
3 Manchester Road  
Derry, New Hampshire 03038 USA  
[www.fireeye.com](http://www.fireeye.com)

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