

INSTALLATION AND OPERATION MANUAL

FOR

The Flame Intensity Monitor



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1.0 INTRODUCTION

1.1 PURPOSE OF THE MANUAL

This manual provides a description of the installation and operation of a PRO Flame Intensity Monitor, including:

- ❑ sensor specifications
- ❑ sensor options and accessories
- ❑ installation and operating procedures
- ❑ maintenance and calibration procedures

1.2 OVERVIEW

Williamson Flame Intensity Monitors (FI) are the single-wavelength sensors of choice for a variety of flare applications where the more sophisticated dual-wavelength flare products are not appropriate or are not required.

The Williamson Flame Intensity Monitor utilizes single-wavelength technology and thoughtful wavelength selection to sense the presence and intensity of flames of all types. The FI class sensors are ideal when viewing hydrogen, ammonia, CO and other flames. This lower-cost technology is also commonly used as a pilot flame detector for ground flares and landfill flares where the viewing distance is less than about 300 feet or 100 meters.

- Thoughtful wavelength selection for maximum sensitivity
- Model FI2 is recommended for Hydrogen and Ammonia, Model FI5 is recommended for CO Flames
- Ideal as a Pilot Monitor for Ground Flares and Landfill Flares

- Increased sensitivity compared to UV flame detectors
- Adjustable Sensitivity for Optimum Performance

The standard housing is rated NEMA4X / IP65. An explosion-proof housing for use in areas designated as hazardous is optional. The FI may be installed as a stand-alone transmitter or with an optional Interface Module. An optional Power Supply is available for the stand-alone configuration. The FI is supplied with a Swivel Mounting Bracket and through-the-lens Visual Aiming .

The FI provides a continuous mA output and a Relay Alarm Output. The optional Interface Module (IM) includes two mA outputs two Relay Alarm Outputs, a TTL alarm and RS232 and RS485 digital communications. The FI indicates a dimensionless value between 0 and 1000 proportional to the size and intensity of the viewed flame for the primary control signal. Flame intensity and internal sensor temperature parameters are also available.

The Williamson sensor is configured as a temperature sensor, and so this control parameter is reported by the sensor as a temperature value, but it is not a temperature value and no units are displayed. However, for the purpose of the displayed parameter and the output and alarm parameters, this value is called the “Filtered Temperature” and the “Unfiltered Temperature” value. The Filtered Temperature value has signal conditioning applied in the form of time average and peak hold. The Unfiltered Temperature value is the raw signal without any time average or peak hold applied.

Configuration and Operation

The Williamson Flame Intensity Monitor (FI) is a single-wavelength optical device that senses the infrared energy emitted by a flame or hot metal objects in its field of view

Environmental Configuration:

The Flame Monitor (FI) is available in a weather-proof configuration, designated “N4” and rated NEMA4X and IP65, or in an explosion-proof / flame-proof / weather-proof configuration, designated “EXP” and rated NEMA7/4X and IECEx type “D”, Ex D IIB+H2 IEC 60079-0, IEC 60079-1. The N4 version is suitable for areas classified as non-hazardous. The EXP version is suitable for use in most areas designated as hazardous.

Interface Module Configuration:

Each FI may be configured as a stand-alone transmitter or with an optional remote Interface Module, model IM. The IM provides an improved human interface, the ability to monitor multiple measured parameters and the ability to interact with the FI from a remote location.

Power Supply Accessories:

When the IM is used, the FI is powered by the power supply built into the IM. Otherwise, the FI operates on 24 Vdc, 300 mA. For plants that do not have 24 Vdc available, Williamson offers several power accessories as listed in the Section 2.2.

Operation:

The measured parameter value is unsteady, and so a peak hold feature is enabled. The default configuration for the sensor is a Peak Hold Delay of 200 seconds. This is used for pilot monitoring applications. For flame intensity monitoring, this can be changed to a Peak Hold Decay Rate. The recommended setting is 10°/sec.

| Optical Configuration | |
|--|--|
| D/35,D/40, D/100, D/200 | Standard Optical Resolution |
| Environmental Configuration | |
| N4 EXP | Non-Hazardous Area Classification Hazardous Area Classification |
| Interface Configuration | |
| Six-Wire Analog Transmitter | <ul style="list-style-type: none"> • One Analog Signal • One Relay Alarm |
| Four-Wire Analog Transmitter | <ul style="list-style-type: none"> • One Analog Signal or Relay Alarm |
| Six-Wire Digital Transmitter | <ul style="list-style-type: none"> • Four Measured Parameters via RS485 Digital Communications |
| Six-Wire Configuration with Interface Module, Model IM | <ul style="list-style-type: none"> • Two Analog Signals • Two Relay Alarms • One TTL Alarm • Four Measured Parameters via RS232 & RS485 Digital Communications |

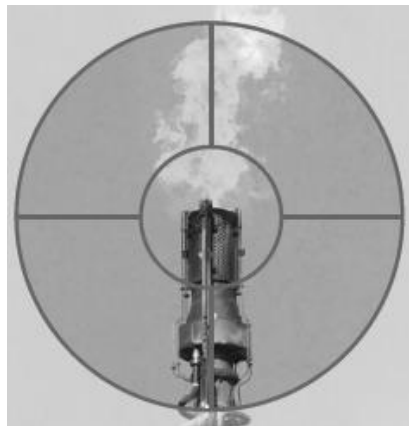
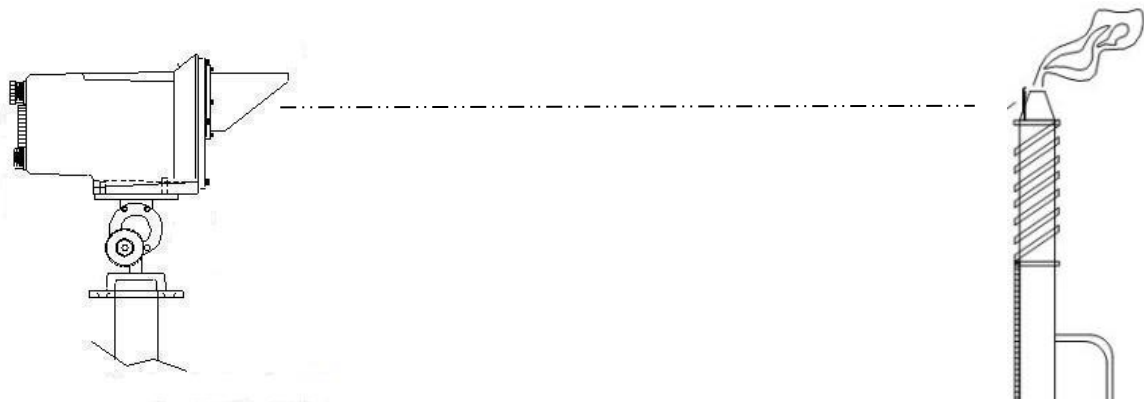


Figure 1 - Typical Flame Intensity Monitor Installation

2.0 SYSTEM SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS AND FUNCTIONS

| STAND-ALONE FLAME INTENSITY MONITOR DEFAULT SPECIFICATIONS | | | | | |
|--|---|-------------|--------------|--|---|
| Intensity Output | 0 to 1000 (dimensionless) | | | | |
| Type of Sighting | Visual Aiming | | | | |
| Field of View | D/35, D/40, D/100 or D/200 Optical Resolution | | | | |
| Working Distance | 0 to 300ft (90m) Pilot Monitoring, 0-1200 feet (365 m) Flame Intensity Monitoring | | | | |
| CE Certification | EMI / RFI for heavy industry, LVD (Low Voltage Directive) | | | | |
| Ambient Temperature Limits | Flame Intensity Monitor: -40 to 140°F (-40 to 60°C) | | | | |
| Input Power | 24Vdc (300mA) stand-alone configuration | | | | |
| Input and Output Signals | <p>Stand Alone Configuration: an internal jumper is used to select the analog or digital mode.</p> <table border="1"> <thead> <tr> <th>Analog Mode</th> <th>Digital Mode</th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output: Filtered Temperature (Note this is a dimensionless ratio value, not a temperature value) • Relay Alarm: Can be assigned to Sensor Internal Temperature or Filtered Temperature • Relay Type: SPST Alarm (rating 2A at 120 or 250 Vac) </td> <td> <ul style="list-style-type: none"> • Bi-directional RS485 communications • RS232 w/ a converter </td> </tr> </tbody> </table> | Analog Mode | Digital Mode | <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output: Filtered Temperature (Note this is a dimensionless ratio value, not a temperature value) • Relay Alarm: Can be assigned to Sensor Internal Temperature or Filtered Temperature • Relay Type: SPST Alarm (rating 2A at 120 or 250 Vac) | <ul style="list-style-type: none"> • Bi-directional RS485 communications • RS232 w/ a converter |
| Analog Mode | Digital Mode | | | | |
| <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output: Filtered Temperature (Note this is a dimensionless ratio value, not a temperature value) • Relay Alarm: Can be assigned to Sensor Internal Temperature or Filtered Temperature • Relay Type: SPST Alarm (rating 2A at 120 or 250 Vac) | <ul style="list-style-type: none"> • Bi-directional RS485 communications • RS232 w/ a converter | | | | |
| Mounting | Swivel Mounting Bracket with 1-1/2 inch pipe thread or a four bolt mount (see figure 2) | | | | |
| Housing Rating | NEMA4X, IP65 (part number = N4) or Explosion Proof (DATA SHEET CUT/PASTE) IECEx Type “D”, Ex D IIB +H2, IEC 60079-0, IEC 60079-1 (part number = EXP) (IECEx Equipment Certification is Pending) Corrosion Resistant Casting | | | | |
| Dimensions | Flame Intensity Monitor N4: 8.50in x 5.25in x 6.00in (216mm x 133 mm x 152 mm) Flame Intensity Monitor -EXP: 5.4in diameter x 10.7in (137mm diameter x 271mm) | | | | |
| Nominal Weight | Flame Intensity Monitor N4: 8 lbs. (3.6 kg) Flame Intensity Monitor -EXP: 11.8 lbs (5.4 kg) | | | | |

Table 1 – Stand-Alone Flame Intensity Monitor Specifications

| FLAME INTENSITY MONITOR WITH INTERFACE MODULE DEFAULT SPECIFICATIONS | | | | | | | | | |
|--|--|---------------------------|---------------------------------|--|---|--------------------------------------|--------------------------|---|--|
| Intensity Output | 0 to 1000 (dimensionless) | | | | | | | | |
| Type of Sighting | Visual Aiming | | | | | | | | |
| Field of View | D/35, D/40, D/100, D/200 Optical Resolution | | | | | | | | |
| Working Distance | 0 to 300ft (90m) Pilot Monitoring, 0-1200 feet (365 m) Flame Intensity Monitoring | | | | | | | | |
| CE Certification | EMI / RFI for heavy industry, LVD (Low Voltage Directive) | | | | | | | | |
| Ambient Temperature Limits | Flame Intensity Monitor: -40 to 140°F (-40 to 60°C) , Interface Module: 120°F (50°C) max. | | | | | | | | |
| Input Power | 90-260Vac | | | | | | | | |
| Input and Output Signals | <p>System Configuration with Interface Module</p> <table border="1"> <thead> <tr> <th>2 Programmable mA Outputs</th> <th>Programmable Relay Alarm Output</th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output 1: Filtered Temperature • Output 2: Internal Sensor Temperature </td> <td> <ul style="list-style-type: none"> • Alarm 1: Filtered Temperature • Alarm 2: Internal Sensor Temperature </td> </tr> <tr> <th>Bi-directional Serial Communications</th> <th>1 Programmable TTL Alarm</th> </tr> <tr> <td> <ul style="list-style-type: none"> • RS232 and RS485 </td> <td> <ul style="list-style-type: none"> • Relay Type: SPDT (2A at 120 or 250Vac) • TTL rating is 5 ma at 5Vdc • Select alarm parameter and set point </td> </tr> </tbody> </table> | 2 Programmable mA Outputs | Programmable Relay Alarm Output | <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output 1: Filtered Temperature • Output 2: Internal Sensor Temperature | <ul style="list-style-type: none"> • Alarm 1: Filtered Temperature • Alarm 2: Internal Sensor Temperature | Bi-directional Serial Communications | 1 Programmable TTL Alarm | <ul style="list-style-type: none"> • RS232 and RS485 | <ul style="list-style-type: none"> • Relay Type: SPDT (2A at 120 or 250Vac) • TTL rating is 5 ma at 5Vdc • Select alarm parameter and set point |
| 2 Programmable mA Outputs | Programmable Relay Alarm Output | | | | | | | | |
| <ul style="list-style-type: none"> • 4-20mA or 0-20mA (1000ohm max. impedance) • Output 1: Filtered Temperature • Output 2: Internal Sensor Temperature | <ul style="list-style-type: none"> • Alarm 1: Filtered Temperature • Alarm 2: Internal Sensor Temperature | | | | | | | | |
| Bi-directional Serial Communications | 1 Programmable TTL Alarm | | | | | | | | |
| <ul style="list-style-type: none"> • RS232 and RS485 | <ul style="list-style-type: none"> • Relay Type: SPDT (2A at 120 or 250Vac) • TTL rating is 5 ma at 5Vdc • Select alarm parameter and set point | | | | | | | | |
| Mounting | Swivel Mounting Bracket with 1-1/2 inch pipe thread or a four bolt mount (see figure 2) | | | | | | | | |
| Housing Rating | Sensor: NEMA4X, IP65 or Explosionproof IECEx Type “D”, Ex D IIB +H2, IEC 60079-0, IEC 60079-1DATA SHEET CUT/PASTE (IECEx Equipment Certification is Pending), Corrosion Resistant Casting Interface Module: NEMA 12, IP52 front panel – Anodized Aluminum Housing | | | | | | | | |
| Dimensions | Flame Intensity Monitor N4: 8.50in x 5.25in x 6.00in (216mm x 133 mm x 152 mm) Flame Intensity Monitor -EXP: 5.4in diameter x 10.7in (137mm diameter x 271mm) Interface Module-IM: 7.0in x 3.78in x 3.78in (177.8 mm x 96 mm x 96 mm) | | | | | | | | |
| Nominal Weight | Flame Intensity Monitor N4: 8 lbs. (3.6 kg) Interface Module-IM: 2.2 lbs. (1kg) Flame Intensity Monitor -EXP: 11.8 lbs. (5.4 kg) | | | | | | | | |

Table 2 – Flame Intensity Monitor with Interface Module Specifications

2.2 FLAME INTENSITY MONITOR OPTIONS & ACCESSORIES

| FLAME INTENSITY MONITOR OPTIONS AND ACCESSORIES | |
|--|--|
| Code | Description |
| IM | Remote ¼ DIN Programmable Interface Module <input type="checkbox"/> Dual Displays <input type="checkbox"/> Human Interface <input type="checkbox"/> Universal Power Supply: 90-260Vac 50-60Hz <input type="checkbox"/> Programmable Analog Outputs: Output 1 and Output 2, each 4-20mA or 0-20mA <input type="checkbox"/> Bi-directional Digital Outputs: RS232 and RS485 <input type="checkbox"/> Programmable Alarms, two SPDT relays and one TTL, Rated 2 A at 250 V ac <input type="checkbox"/> NEMA 12 Front Panel Refer to sections 3.2.4 for additional details. |
| PSD | DIN Rail Power Supply for Stand Alone Sensors: <input type="checkbox"/> Output: 24Vdc (600mA) <input type="checkbox"/> Input: 85-264Vac, 50-60HZ |
| PSN4 | Power Supply in a weather-proof enclosure for Stand Alone Sensors <input type="checkbox"/> Output: 24Vdc (600mA) Input: 85-264Vac, 50-60HZ |
| PSEXP | Power Supply in an explosion-proof / flame-proof enclosure for Stand Alone Sensors: <input type="checkbox"/> Output: 24Vdc (600mA) Input: 85-264Vac, 50-60HZ NEMA7 Class I, Groups B, C & D; Class II, Groups E, F & G, Class III, Type 4X, CSA Certified and UL Classified, FM Approved. Atex ExII 2G Eex d IIB+H2 |
| CFn (CMn) | Interconnecting electrical cable (six-conductor, shielded with copper braid, and a Teflon jacket) n = length in feet (CFn) or meters (CMn). Maximum length = 4000 feet / 1220 meters. |
| EXP | NEMA7 Class I, Groups B, C & D; Class II, Groups E, F & G, Class III, Type 4X, CSA Certified and UL Classified, FM Approved. IECEx ExII 2G Eex d IIB+H2) IECEx Equipment Certification pending) |

Table 3 – Flame Intensity Monitor Options and Accessories

3.0 INSTALLATION PROCEDURES

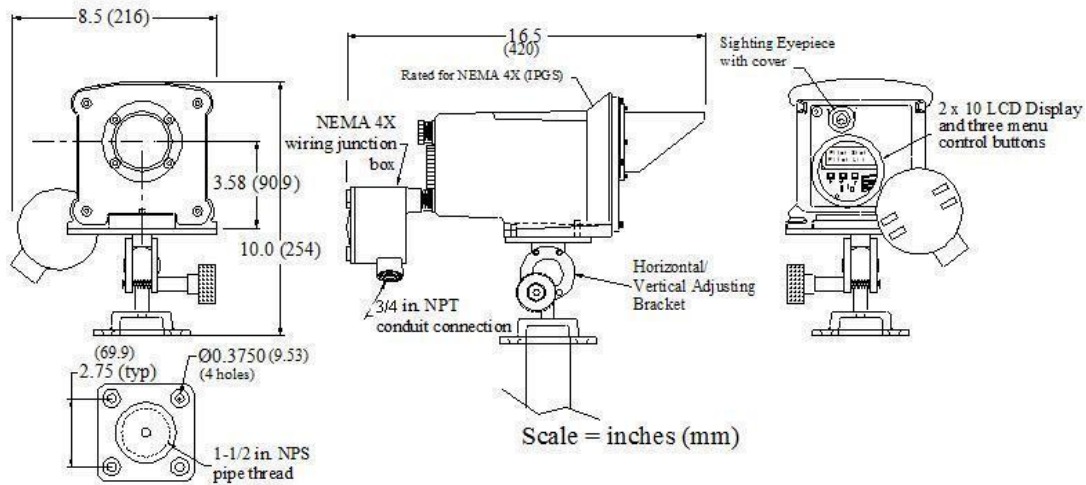
3.1 PLANNING THE SENSOR INSTALLATION

Mounting and Site Selection

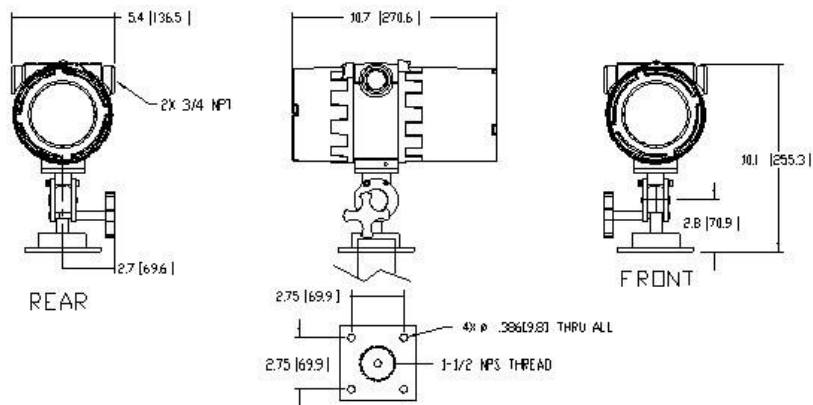
The Swivel Mounting Bracket is typically mounted to a 1-1/2" pipe, or, using U-bolts, to a hand rail, or to a base plate located at or near ground level allowing for convenient access. The dimensions are shown in Figure 2. Some recommended guidelines for mounting the Flame Intensity Monitor are as follows:

- ❑ The sensor must be mounted such that it has a clear view of the Flare Flame for Flame Intensity measurements or the Pilot Flame for Pilot Monitoring applications
- ❑ The closer the sensor is mounted to the flame, the higher the sensor sensitivity.
- ❑ The optimal mounting distance is 0-300 feet (90m) from the pilot flame for Pilot Monitoring or 0-1200 feet (365m) meters from the flame for Flame Intensity Monitoring.
- ❑ Avoid viewing the sun. For installations in the northern hemisphere, mount the sensor at any point south of the east-west line passing through the base of the flare. For installations in the southern hemisphere, mount the sensor at any point north of the east-west line passing through the base of the flare. For installations within the tropics, a direct eastern or a direct western view should be avoided. See Figure 3.
- ❑ The Williamson model FI will operate correctly so long as some portion of the flame is viewed. However, when the wind knocks the flame down on the far side of the stack so that no part of the flame is visible to the Williamson sensor, then the reading will be lost. For this reason, it is recommended that the Williamson model FI sensor not be mounted directly upwind from the prevailing wind direction. For best results, the sensor should be mounted down-wind from the prevailing wind direction or, if upwind, at an angle of more than 45 degrees from the prevailing wind direction. If it is necessary to assure that a reading is continuously produced regardless of wind direction, then two Williamson model FI sensors should be installed with an angle of 60 degrees or more of separation around the stack.
- ❑ To minimize the likelihood of damage due to lightning strikes, the Flame Intensity Monitor should be electrically isolated from surrounding metal structures (including electrical conduit).

FLAME INTENSITY MONITOR DIMENSIONS – “N4” HOUSING



FLAME INTENSITY MONITOR DIMENSIONS – “EXP” HOUSING



INTERFACE MODULE

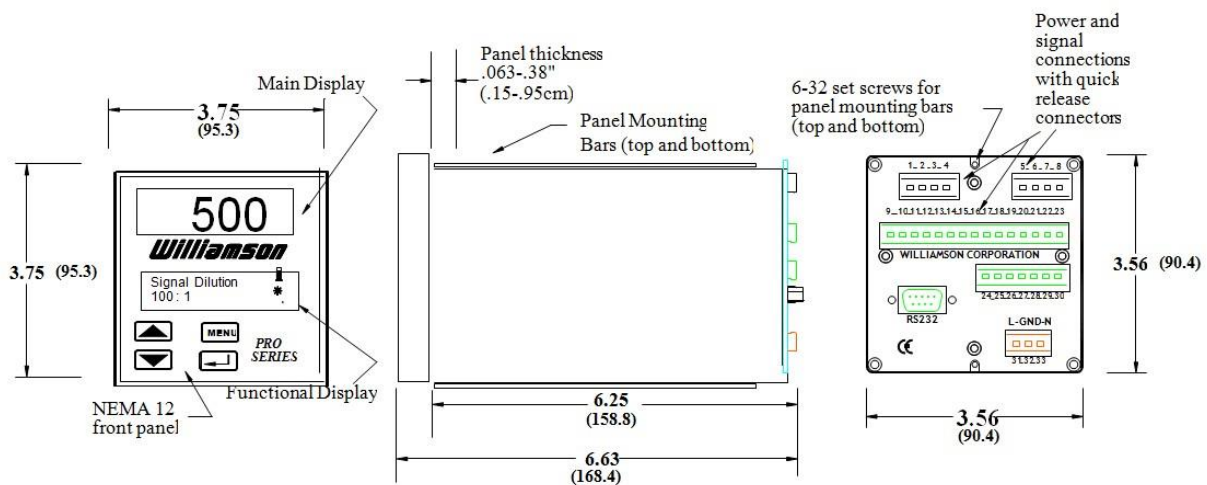


Figure 2 – Sensor and IM Dimensions

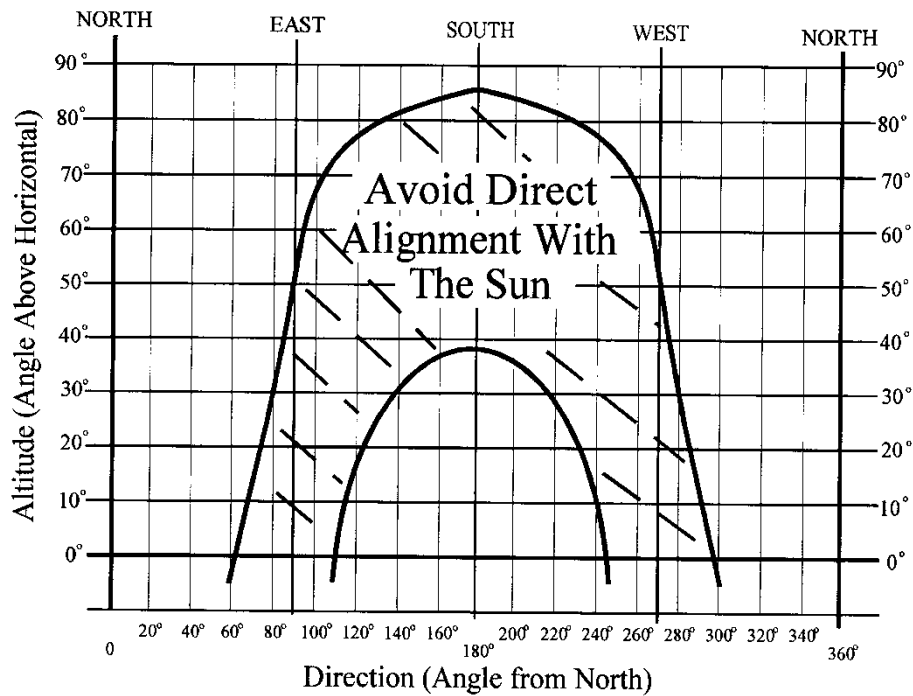


Figure 3 – Avoiding Interference from the Sun

Aiming the Sensor to the Target

To aim the sensor, remove the cover from the eyepiece on the rear of the sensor and adjust the Swivel Mounting Bracket so that a) for Pilot Monitoring the pilot is centered in the field of view or b) for Flame Intensity the top of the stack is centered in the target area with a clear line of sight. Replace the cover when not in use (Figure 1). The FI2 sensor is available with D/35, D/100 and D/200 optical resolution. The FI5 sensor is available with D/40 optical resolution. The target diameter, d, at any distance, D, equals the distance divided by the optical resolution. Using the model FI2-35-N4 with D/35 optical resolution as an example, the target diameter, d, is shown at varying distances, D, in Table 4 below.

Target Diameter at Working Distance for D/35

| Feet (d) at Feet (D) | | Meters (d) at Meters(D) | |
|----------------------|------|-------------------------|-----|
| 3 | 100 | 1 | 30 |
| 10 | 350 | 3 | 105 |
| 20 | 700 | 6 | 215 |
| 34 | 1200 | 10.5 | 365 |

Table 4 – Flame Intensity Monitor Field of View

3.1.3 Setting Parameter Values and Verifying Proper Operation

Once the system has been aimed as described above, the emissivity parameter must be adjusted to produce the desired sensitivity level. The required emissivity setting will vary depending upon the intended use (pilot monitor or flame intensity monitor), distance to the flame, the flame size and the flame composition. The lower the emissivity value, then the higher the sensor reading.

For Use As A Pilot Monitor

- Adjust the emissivity parameter value until the sensor reads a reasonably high value, typically in the range of 800 under normal operating conditions. If it is necessary to set the emissivity value lower than 0.010, then an internal jumper may be removed to further increase the sensitivity.

- ❑ Set the Peak Hold Parameter for Time Delay and the Peak Hold Time Delay to 200 seconds.
- ❑ Enable the Alarm. The factory default value for the alarm is 100. The alarm will trip if the signal level drops below 100. This parameter value may be adjusted if desired.

For Use As A Flame Intensity Monitor

- ❑ Adjust the emissivity parameter value until the sensor reads in the range of 500 under normal operating conditions. If the sensor reading is too high or too low as the flame intensity changes, then raising the emissivity parameter value will lower the reading and lowering the emissivity parameter value will raise the reading. If it is necessary to set the emissivity value lower than 0.010, then an internal jumper may be removed to further increase the sensitivity.

Set the Peak Hold Parameter for Rate of Change and the Decay Rate to 10 degrees per second. If a faster response to a smaller flame is desired, then increase the decay rate parameter value as desired.

Adjusting Parameter Values (Stand-Alone Configuration)

Press the two outside buttons simultaneously to enter the set up mode. The sensor will say “Signal Conditioning”. This is the “Main Menu” level. The left and right buttons may be used to scroll through the various Submenu Groups.

Press the Enter (Middle) button to enter the desired submenu group.

Press the Enter (Middle) button to unlock the parameter values.

Press the outside buttons to change parameter values.

Press the Enter (Middle) button to lock in the new parameter value.

To Exit a Submenu Group, scroll to the end of the parameter list until the sensor says “Return to Main Menu” or “Return to Display Mode” or press the two outside buttons simultaneously to return to the Main Menu level.

To Exit the Main Menu level, scroll to the end of the Submenu Group list until the sensor says “Return to Display Mode” or press the two outside buttons simultaneously to return to the Display Mode and to exit the Set Up Mode.

Please see Table 10 for a listing of sensor parameters within each submenu group.

Adjusting Parameter Values Using the Interface Module

Press the Menu button to enter the set up mode. The sensor will say “Signal Conditioning”. This is the “Main Menu” level. The up and down arrows may be used to scroll through the various Submenu Groups.

Press the Enter button to enter the desired submenu group.

Press the Enter button to unlock the parameter values.

Press the arrow buttons to change parameter values.

Press the Enter button to lock in the new parameter value.

To Exit a Submenu Group, scroll to the end of the parameter list until the sensor says “Return to Main Menu” or “Return to Display Mode” or press the Menu to return to the Main Menu level.

To Exit the Main Menu level, scroll to the end of the Submenu Group list until the sensor says “Return to Display Mode” or press Menu button to return to the Display Mode and to exit the Set Up Mode.

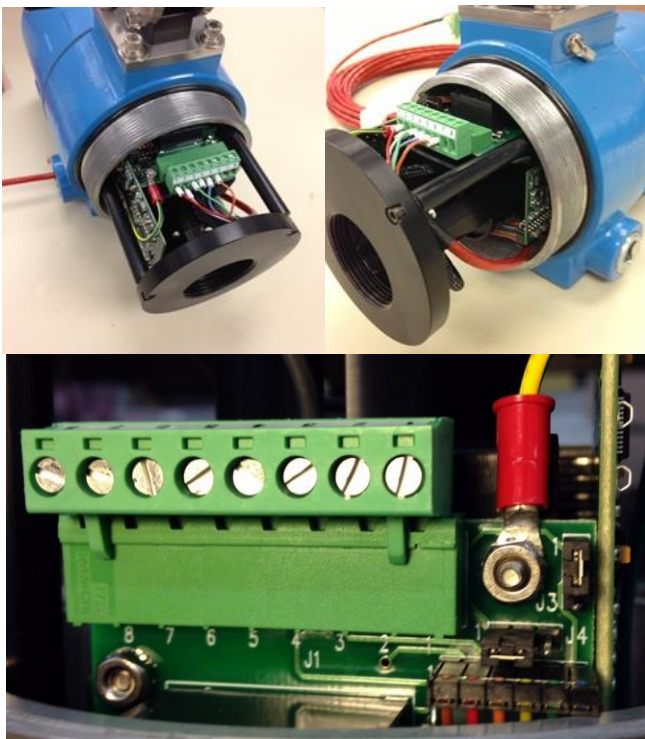
3.2 ELECTRICAL INSTALLATION

Each FI may be installed in one of three different configurations.

1. Stand Alone Analog Configuration (Table 5)
2. Stand Alone Digital Configuration (Table 5)
3. With the optional Interface Module (Table 6)

When power is properly applied to the FI or to the IM, the system displays will illuminate and go through the power up routine. The **stand-alone sensor** must be powered using 24Vdc (300mA). When using the IM, put the sensor in the Digital mode, connect the FI to the IM, and apply 90 to 260Vac power to the IM. Table 6 and Figure 7 provide complete details for making electrical connections to the IM's rear panel.

Converting between Analog and Digital Modes



J3 and J4 jumpers shown here in position 1 (pins 1&2) for Digital Mode. For Analog Mode with Relay Alarm Output, move both jumpers to position 2 (pins 2&3). For Analog Mode with Analog Input, J3 and J4 should remain in position 1

Figure 4 – EXP Housing Wiring & Connections

N4 Version Sensors are converted between analog and digital configurations using **two jumpers** as illustrated in Figures 5. The jumper in the junction box must be switched between the J3 (**A=Analog**) and J2 (**D=Digital**) positions, and the jumper inside the sensor hatch must be switched between the J5 (**A=Analog**) and J6 (**D=Digital**) positions. Both jumpers must be in the correct position for proper functionality.

EXP Version Sensors are converted between Analog and Digital using the jumpers J3 and J4 on the board as shown in Figure 4, as well as the **Mode** parameter, in the **Configure I/O** submenu group. The human interface on the rear of the sensor or on the IM is used to make this adjustment. If using a stand-alone sensor in digital mode, the conversion from digital to analog must be made via digital command; otherwise, the IM human interface may be used.

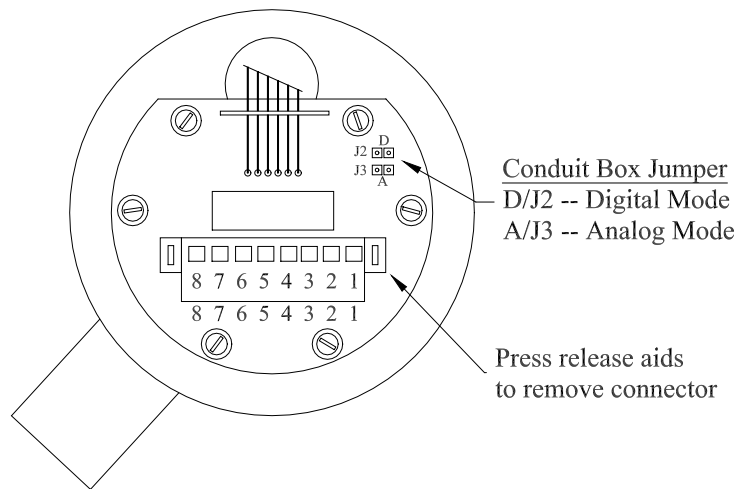


Figure 5 - Sensor Terminal Connections

| STAND ALONE FLAME INTENSITY MONITOR FUNCTIONS | |
|---|--|
| Measured Parameters | The measured parameters can be assigned to a mA or relay output. <ul style="list-style-type: none"> • Filtered Temperature (primary control signal with all signal conditioning filters applied) • Unfiltered Temperature (no signal conditioning filters applied – use for diagnostics) • Internal Sensor Temperature |
| Signal Conditioning | <ul style="list-style-type: none"> • Average Time • Peak Hold Delay (default) / Decay (available) • Alarm Setpoint |
| Diagnostics | <ul style="list-style-type: none"> • System Self-Test (enabled during each power up of the system) • Analog Output Test (force outputs to 4, 12 and/or 20mA for testing) • Relay Alarm Tests (change the state to verify the alarm functions) • Menu Access (for security, can lock access to the menu system) |

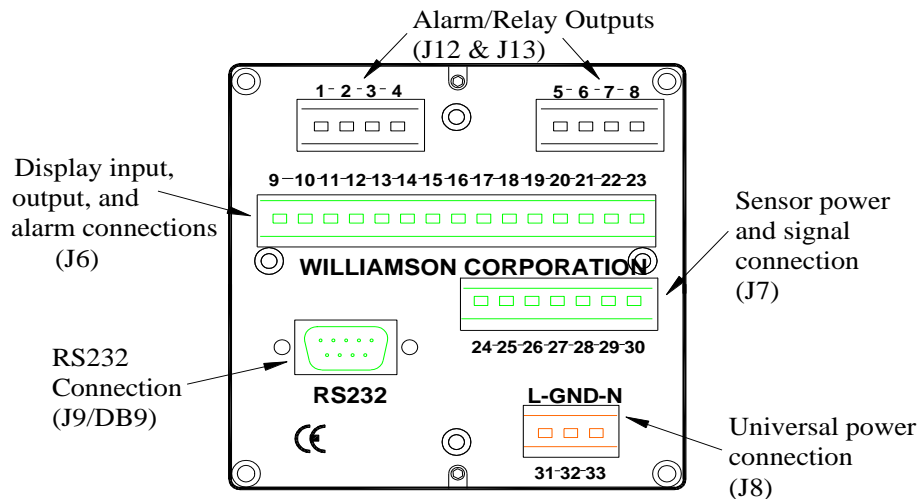
Table 5 – Standard Flame Intensity Monitor Functions

| Flame Intensity Monitor Wiring Diagram (EXP only) | | | |
|---|----------------------|---|--|
| Power Supply Terminal | Relay Board Terminal | Stand Alone Configuration With Analog Output and Alarm (JUMPER POSITIONS J3=2-3 & J4=2-3) | Stand Alone Configuration with a Digital Output, or System Configuration With The Interface Module (IM) (JUMPER POSITIONS J3=1-2 & J4=1-2) |
| 10 | 1 | +24Vdc / 300mA Max | +24Vdc (300mA) (Connect to Term. 30 on IM) |
| 9 | 2 | 24Vdc Return (Circuit Common) | 24Vdc Return (Circuit Common) (Connect to Term. 29 on IM) |
| 8 | 3 | mA Output + (0-20mA or 4-20mA) | RS485 Full Duplex Receive + (Connect to Term. 26 on IM) |
| 7 | 4 | mA Output Return | RS485 Full Duplex Receive - (Connect to Term. 25 on IM) |
| 6 | 5 | Not Used | RS485 Full Duplex Transmit + (Connect to Term. 28 on IM) |
| 5 | 6 | Not Used | RS485 Full Duplex Transmit - (Connect to Term. 27 on IM) |
| 4 | 7 | Relay Common (C) | Not Used |
| 3 | 8 | Relay Normally Open (N.O.) | Not Used |
| | | Earth Ground (Shield) | Earth Ground (Shield) (Not used when Earth Ground is made at the sensor) |

Note: Connect external ground lug (for EXP only) to local earth ground unless local electrical code prohibits it.

| Flame Intensity Wiring Diagram | | | | |
|--------------------------------|-----------------------------|-------------|--|--|
| Power Supply Terminal (1) | Sensor Connector Pin Letter | Cable Color | ANALOG MODE For Stand Alone Configuration or a sensor with a PID Controller | DIGITAL MODE For Stand Alone Digital Sensor or a System Configuration with a Remote Interface Module (IM) |
| 7 | 1 | Red | +24Vdc / 300mA Max | +24Vdc / 300mA Max (Connect to Terminal 30 on IM) |
| 6 | 2 | White | 24Vdc Return (Circuit Common) | 24Vdc Return (circuit common) (Connect to Terminal 29 on IM) |
| 5 | 3 | Green | Analog Output (0-20mA or 4-20mA) | RS485 Full Duplex Receive + (Connect to Terminal 26 on IM) |
| 4 | 4 | Black | Current Ground | RS485 Full Duplex Receive - (Connect to Terminal 25 on IM) |
| 3 | 5 | Blue | Relay Normally Open (NO) (2) | RS485 Full Duplex Transmit + (Connect to Terminal 28 on IM) |
| 2 | 6 | Orange | Relay Current (C) | RS485 Full Duplex Transmit - (Connect to Terminal 27 on IM) |
| 1 | Shield | Clear | Earth Ground | Earth Ground (Shield) (Connect to Terminal 24 on IM) |

Table 6 – Flame Intensity Monitor Wiring Diagram



Notes

- 20 to 16 AWG, shielded cable is recommended for the wiring the system.

Figure 6 - Interface Module Connections

| ID | FUNCTION | NOTES | |
|------------|--|--|--|
| J12 | ALARM / RELAY OUTPUT 1 (Black Connector) | | |
| 1 | Normally Closed (N.C.) | Relays are rated 2 amps at 120 or 250Vac Relay Activation Time: 15 ms max Reset Time: 5 ms max Relay Default Setting: Filtered Temperature | |
| 2 | Common (C.) | | |
| 3 | Common (C.) | | |
| 4 | Normally Open (N.O.) | | |
| J13 | ALARM / RELAY OUTPUT 2 (Black Connector) | Select alarm parameter from Filtered Temperature (primary control parameter), Unfiltered Temperature, Signal Dilution, Internal Sensor Temperature, Out of Range, or Rate of Change. | |
| 5 | Normally Closed (N.C.) | | |
| 6 | Common (C.) | | |
| 7 | Common (C.) | | |
| 8 | Normally Open (N.O.) | | |
| J6 | OUTPUT, & ALARM FUNCTIONS (Green Connector) | | |
| 9 | Not Used | | |
| 10 | Circuit Common | Select output parameter from Filtered Temperature (primary control parameter), Unfiltered Temperature Signal, Signal Dilution, Internal Sensor Temperature, or Rate of Change. Select output scale of 4-20mA or 0-20mA. Generate a voltage output by using a shunt resistor (max 1000 ohms). | |
| 11 | Analog Output 2 | | |
| 12 | Circuit Common | | |
| 13 | Analog Output 1 | | |
| 14 | Circuit Common | | |
| 15 | TTL Alarm Output | TTL output rating is 5mA at 5Vdc | |
| 16 | Circuit Common | | |
| 17 | Not Used | | |
| 18 | Circuit Common | | |
| 19 | Not Used | | |
| 20 | RS485 Full Duplex Receive - | The RS485 connection offers full duplex (not multi-drop), bi-directional communication with a computer or a data logging system. The PRO Series sensors use an ASCII request-response type protocol for communication (see Section 4.5.3). The maximum distance limit is 4000 feet (1220m). | |
| 21 | RS485 Full Duplex Receive + | | |
| 22 | RS485 Full Duplex Transmit - | | |
| 23 | RS485 Full Duplex Transmit + | | |
| J7 | SENSOR CONNECTION (Green Connector) | | |
| 24 | Earth Ground (shield) | Shield | Isolated from circuit common |
| 25 | RS485 Full Duplex Receive - | 4 | Standard connection for all sensor communications. Maximum distance limit of 4000 feet (1220 meters) |
| 26 | RS485 Full Duplex Receive + | 3 | |
| 27 | RS485 Full Duplex Transmit - | 6 | |
| 28 | RS485 Full Duplex Transmit + | 5 | |
| 29 | 24Vdc Return (circuit common) | 2 | |
| 30 | +24Vdc | 1 | |
| J8 | AC POWER LINE IN (Green Connector) | | |
| 31 | AC IN Hot (L) | Input power 90-260Vac 50/60Hz (0.13Amps). | |
| 32 | AC IN Earth Ground | | |
| 33 | AC IN Neutral (N) | | |
| J9 | RS232 CONNECTION (DB9 Connector) | | |
| DB9 | N.C. | The RS232 connection offers bi directional communication with a computer or a data logging system. The PRO Series sensors use an ASCII request-response type protocol for communication (see Section 4.5.3). It requires a standard straight-through serial cable to connect to another device (wired as DTE). The maximum distance limit of the cable is 50 feet. | |
| | PC RS232 TX | | |
| | PC RS232 RX | | |
| | N.C. | | |
| | Circuit Common | | |
| | N.C. | | |
| | PC RS232 CTS | | |
| | PC RS232 RTS | | |
| N.C. | | | |

Table 7 - Interface Module Wiring Connections and Specifications

4.0 CONFIGURE AND OPERATE THE SYSTEM

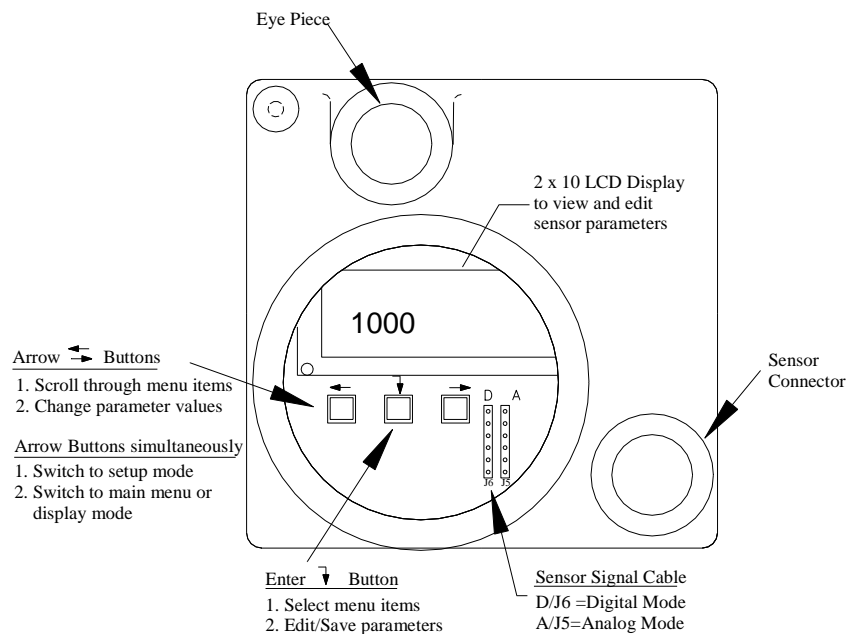
4.1 SENSOR MENU SYSTEM

Overview of the Menu System

Each Flame Intensity Monitor may be configured as a stand-alone transmitter or with the Interface Module. Figure 8 illustrates the operator interface that is provided with each of these options.

In the analog stand-alone configuration, the menu adjustments are made using the three buttons and the display inside the sensor's rear cover. When the sensor is setup in a system configuration, the operator can only change sensor settings from the Interface Module

STAND ALONE SENSOR



INTERFACE MODULE

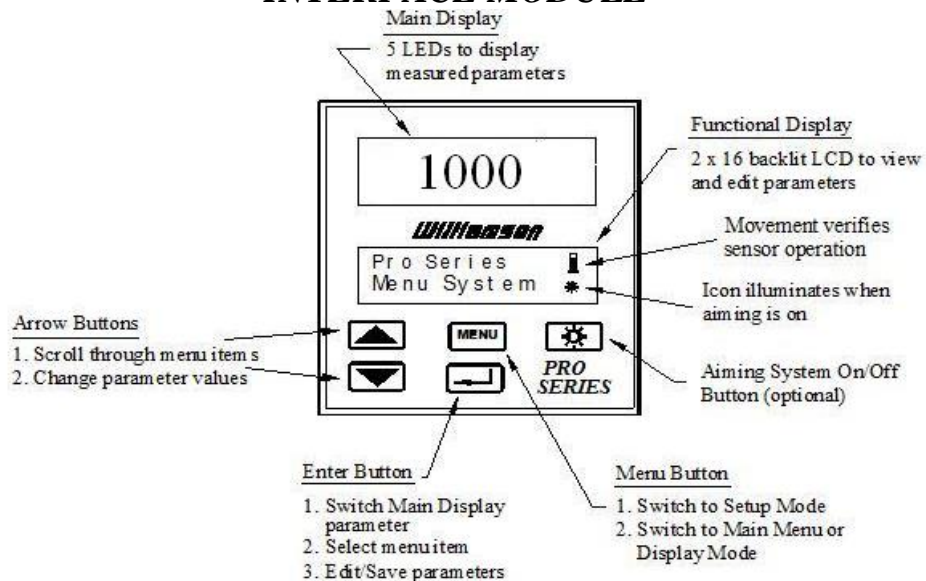


Figure 7 – Sensor and Interface Module Layout

Navigating the Menu System

Figure 7 shows the Sensor and Interface Module Layout and describes the function of each button. Table 8 describes how to edit parameters and Table 9 provides a summary of the functions provided by each type of menu item. Table 10 provides a description of the entire menu system organization.

Editing Parameters in the Setup Mode

Follow these steps to change/edit a sensor parameter:

| |
|--|
| 1. Press the menu button to enter into the setup mode from the display mode . To generate the menu button functions on the stand alone sensor, press the two outer arrow buttons simultaneously. |
| 2. Press the arrow buttons to scroll to the desired group menu. |
| 3. Press the enter button to access the group menu. |
| 4. Press the arrow buttons to scroll to the desired item in the group menu. An ‘E’ icon in the upper right hand corner of the functional display indicates that the displayed item may be edited. |
| 5. Press the enter button to enable the edit mode for the selected menu item. Upon pressing enter, the angled brackets ‘<>’ disappear, and the ‘E’ icon and parameter value blink. |
| 6. Press one of the arrow buttons to scroll through the pre-defined menu options or to increase or decrease the parameter value. Press and hold the arrow button to accelerate the rate of change. |
| 7. Once the final parameter value is selected, press the enter button to ‘save’ the selected value and end the editing process. Note that the output signal is not affected by the adjustment until the enter button has been pressed to save the new value. If the menu button is pressed before the change is entered, then the change is not saved and the original value is retained. |
| 8. Change other menu items by pressing the menu button once to return to the main menu. Or, return to the display mode from the group menu by pressing the menu button twice. |

Table 8 – Editing Parameters

| TYPE OF MENU ITEM | DISPLAY FORMAT |
|---|--|
| View Only Parameter: These items are a factory specification or a measured value by the sensor. | Description xxxxxxx |
| Adjustable Parameter: These are items that can be changed to configure the sensor or troubleshoot application issues. | Description E <xxxxxxx> ↵ |
| Reset Group Defaults: This function is included in each menu group to simplify editing procedures. When selected, the user is prompted, to select ‘yes’ to reset the default values of the respective group’s parameters, or ‘no’ if the user wants retain the current settings. | Reset Group Default Values |
| Menu Navigation Item: These items direct the system to another part of the menu. They are typically located at the end of each menu group. | RETURN TO MAIN MENU ↵ |

Table 9 – Types of Menu Items

| NAVIGATION FUNCTIONS | | | | DISPLAY MODE (2, 3) | | |
|----------------------|--|--|---|---------------------|--|---|
| Button | DISPLAY MODE (3) (View Only) | SETUP MODE (View and Edit) | | Main Display (LED) | Functional Display (Back-Lit LCD) | Status Messages |
| MENU (1) | (View Only) | Main Menu | Group Menus | | | |
| | Switch to the main menu in setup mode | Return to the display mode. | Return to the main menu in the setup mode. | | <ul style="list-style-type: none"> • Intensity | <ul style="list-style-type: none"> • |
| ▲ ▼ | Scroll through the sensor parameters on the LCD functional display. | Scroll through the main menu parameter groups. | Scroll through group parameters. During editing, changes parameter values. | | <ul style="list-style-type: none"> • Internal Temperature • Filtered Temperature • Unfiltered Temperature • Average Time • Peak Hold Delay • Emissivity (1λ) | <ul style="list-style-type: none"> • Alarm Set Points • Model Number • Sensor S/N • Spec. Bottom Temp • Spec. Top Temp • Field of View • Module Serial Number |
| ↵ | Press and hold the enter button to change the parameter shown on the main LED display. | Select the menu item. | If an 'E' icon is displayed, then the enter button activates the editing process and saves the new value. | | | <ul style="list-style-type: none"> • Out of Range • Internal Temperature Warning |
| | | | | | | <ul style="list-style-type: none"> • Check Sensor Cable • Lockout Enabled |

| MAIN MENU | | | | | | |
|-------------------|---|--|--|---|--|--|
| | SIGNAL CONDITIONING | CONFIGURE I/O (Inputs & Outputs) | CONFIGURE ALARMS | DIAGNOSTICS | SYSTEM SPECIFICATIONS | FACTORY OPTIONS |
| SETUP MODE | GROUP MENUS (2) | | | | | |
| | <ul style="list-style-type: none"> • Average Time • Out of Range • Peak Hold Delay • Peak Hold Time • Pk Hold Decay Rate • Advanced Signal Conditioning • Temp Scale (°F / °C) • Emissivity (1λ) or • Reset Group Defaults • Rtrn to Main Menu • Rtrn to Display Mode | <ul style="list-style-type: none"> • Input Parameter • Input Scale • Output 1 Parameter • Output 1 Scale • 0 / 4mA Temp (O1) • 20mA Temp (O1) • Output 2 Parameter • Output 2 Scale • 0 / 4mA Temp (O2) • 20mA Temp (O2) • PC Serial Port • Reset Group Defaults • Rtrn to Main Menu | <ul style="list-style-type: none"> • Alarm 1 Parameter • Alarm 1 Set Point • Alarm 2 Parameter • Alarm 2 Set Point • TTL Alarm Parameter • TTL Alarm Logic • TTL Alarm Set Point • Reset Group Defaults • Rtrn to Main Menu • Rtrn to Display Mode | <ul style="list-style-type: none"> • Output 1 Test • Output 2 Test • TTL Test • Alarm 1 Test • Alarm 2 Test • Menu Access • Reset Group Defaults • Rtrn to Main Menu • Rtrn to Display Mode | <ul style="list-style-type: none"> • Sensor Type • Model Number • Sensor S/N • Spec. Bottom Temp • Spec. Top Temp • Field of View • Manufactured Date • Last Calibration Date • Next Calibration Date • Warranty Exp. Date • Sensor Firmware • Module S/N • Module Firmware | <ul style="list-style-type: none"> • Field Calibration • BB Ref Bottom Temp • Measured Bottom Temp • BB Ref Top Temp • Measured Top Temp • Rtrn to Main Menu • Rtrn to Display Mode |

NOTES:

1. On the stand alone sensors, press the two outside arrow buttons simultaneously to generate the menu button functions.
2. The **bold items** are only available with an Interface Module. When an Interface Module is connected to a sensor, only the display mode is accessible from the back of the sensor.
3. The 'filling thermometer icon' in the upper right corner of the functional display indicates that the system is in the display mode (it disappears in the setup mode).
4. Contact Williamson for the commands required to access the field calibration functions in the Factory Options menu group. See section 5.1 for complete calibration instructions.
5. Stand-Alone sensors use a relay that is described in the menu system as a "TTL Alarm" because a TTL alarm inside the sensor drives the SPST Relay Alarm Output.

Table 10 – Menu System Summary

4.2 SYSTEM STATUS MESSAGES

The table below provides a list of the system status messages and their associated conditions.

| STATUS MESSAGES | | | | |
|------------------------------------|---|------------------------------|--------------------------------------|----------------------|
| Status | Condition | Main Display (5 LEDs) | Functional Display (2x16 LCD) | Analog Output |
| Ambient Warning | Sensor's measured internal temperature is above the sensor's limit. | No Change | Ambient Warning | No Change |
| Initializing | The Sensor does not respond to polling from the Interface Module. This message is also displayed as the initial communications are being established between the Sensor and the IM. | Dashes on LEDs | 'Initializing | 0 or 4mA |
| Establishing Communications | The Sensor does not respond to polling from the Interface Module. This message is also displayed as the initial communications are being established between the Sensor and the IM. | Dashes on LEDs | 'Establishing Communications | 0 or 4mA |
| Menu Lockout Enabled | This feature prevents inadvertent access to the sensor menu system, and it is enabled by using the menu access item in the diagnostics menu group. When this item is set to delay, the operator is required to press and hold the menu button for 7 seconds in order to get into the menu system. During the first 5 seconds of this 7-second delay the lockout message is displayed. | No Change | Menu Lockout Enabled | No Change |
| Filling Thermometer Icon | Sensor is in the display mode and operating correctly. This icon disappears when in the setup mode. | No Change | Appears in Display Mode only | No Change |

Table 11 – System Status Messages

4.3 SIGNAL CONDITIONING FUNCTIONS

Critical Default Parameter Settings

For most installations, the factory default settings are sufficient for out of the box ‘Aim and Read’ operation. If adjustments are required, the text-based menu provides easy access to the sensor settings and parameters.

| DEFAULT PARAMETER SETTINGS (STAND ALONE OR WITH INTERFACE MODULE) | | |
|---|--|--|
| Menu Item (w/ Default Value) | Parameter Range / Options | Notes |
| Average Time <2.0> sec | Enabled | A higher value will dampen sensor response. A lower value will quicken the response to a change. |
| Peak Hold <Delay> <200> sec | Available: <Delay Time> 0 to 360 seconds <Decay Rate> 0 to 300°F/sec | When used as a Pilot Monitor, the Delay Time mode is recommended with a setting of 200 seconds and not less than 90 seconds. When used as a Flame Intensity Monitor, the Decay Rate mode is recommended with a setting of 10 degrees per second. This value may be adjusted as desired. |
| Temperature Scale <Fahrenheit> | F or C | The 0-1000 output scale will change to -18 to 538 if this parameter is set to C. |
| Emissivity <0.200> | 0.010 to 2.000 | This parameter is used to adjust sensor sensitivity. A lower value will raise the measured signal. A higher value will lower the measured signal. An internal jumper may be removed if additional sensitivity is required. When used as a Pilot Monitor, the typical emissivity setting is 0.200 or lower. When used as a Flame Intensity Monitor, then the emissivity setting will vary depending upon the mounting distance, the flame size, and the flame composition. |
| Output 1 <Filtered Temperature> Note: The reported value is not actually a temperature value. | 0 to 1000 | Each installation will have a unique output level based on the target being viewed, its intensity and based on the amount of area the target fills the Field of View. |
| Alarm 1 <Enabled> | Filtered Temp, 100 | This alarm will indicate when Filtered Temp Value drops below 100. This can be adjusted for each installation. |
| Output 2 and Alarm 2 are only enabled when used with the Interface Module | | |
| Output 2 <Disabled> | Filtered Temp, Unfiltered Temp, Ambient Temp | The second output signal is available only with the optional Interface Module. |
| Alarm 2 <Disabled> | Filtered Temp, Unfiltered Temp, Ambient Temp | The second output signal is available only with the optional Interface Module. |

Table 12 – Default Parameter Settings

4.4 OUTPUTS AND ALARMS

Output and Alarms Tables

| Measured Parameter | Default Range | Description |
|-------------------------------|--------------------------|--|
| Filtered Temperature | 0 to 1000 | The primary control parameter with signal-conditioning filters (time average and peak hold) applied. This signal is proportional to the intensity of infrared energy contained within the Field of View. Each installation will have a unique output level based on the target being viewed, its intensity and based on the amount of area the target fills the Field of View. |
| Unfiltered Temperature | 0 to 1000 | The same as the Filtered Temperature value, except with no signal-conditioning filters applied. It is intended for use during setup and troubleshooting and can be displayed simultaneously with the Filtered Temperature on the Interface Module. Because it is the raw signal reading, when the sensor is out of range, this output can provide a random value. |
| Ambient Temperature | 0 to 200°F (-17 to 93°C) | The ambient temperature measured inside the sensor enclosure. While the sensor can operate properly in temperatures as low as -40°F/C, this output can only measure as low as 0°F (-17°C). |
| Rate of Change | 0 to 1000 | A measure of the rate of rise of the filtered signal. If the ROC multiplier setting is 1, then this is the rate of change in degrees (points) per second. The default setting for the ROC multiplier is 0, so this feature is disabled when shipped from the factory. This feature requires the IM. |

Table 13 – Programmable Output and Alarm Parameters

| Alarm Parameter | Range Of Set Point | Condition (Default Value) | TTL Logic Normal | Interface Module Relay Alarms | |
|-------------------------------|------------------------|--|--------------------|-------------------------------|-----------------|
| | | | | Normally Open | Normally Closed |
| Power Off or Disabled | None | None | 0 Volts | Open | Closed |
| Filtered Temperature | 0 to 1000 | Measured Combustion Efficiency < Signal Set Point Measured Combustion Efficiency > Signal Set Point (Default Value for Alarm 1 is 100) | 0 Volts 5 Volts | Open Closed | Closed Open |
| Unfiltered Temperature | 0 to 1000 | Measured Combustion Efficiency < Signal Set Point Measured Combustion Efficiency > Signal Set Point | 0 Volts 5 Volts | Open Closed | Closed Open |
| Ambient Warning | 0 - 200°F (-17 - 93°C) | Measured Ambient Temp < Ambient Temp Set Point Measured Ambient Temp > Ambient Temp Set Point (Default value is 140°F) | 0 Volts 5 Volts | Open Closed | Closed Open |
| Rate of Change | 0-1000 | ROC > ROC Set Point ROC < ROC Set Point | 0 Volts 5 Volts | Open Closed | Closed Open |
| Out of Range | None | Reading in Range Reading Out of Range | 0 Volts 5 Volts | Open Closed | Closed Open |

Table 14 – Alarm Specifications

Using the Digital Outputs

The Flame Intensity Monitor sensors and Interface Module support full duplex / bi-directional communications via RS232 and RS485 for communication with a computer or a data logging system.

All measured parameter values and all sensor parameter settings may be accessed using digital communications. Please see a separate document for a complete description of the digital command set and instructions for communicating with the Flame Intensity Monitor digitally.

5.0 TROUBLESHOOTING AND MAINTENANCE

5.1 GENERAL MAINTENANCE

The FI is a precision electro-optic system. Once properly installed, the system should require no routine maintenance other than an occasional cleaning of the sensor's optical window with window cleaner or alcohol using a clean, soft cloth.

5.2 SYSTEM TROUBLESHOOTING

Adjacent Flares: Align the Flame Intensity Monitor so that the flame or pilot(s) from only one flare is viewed. If necessary, a mechanical obstruction may be fitted more than 14 inches (36cm) in front of the FI to prevent it from viewing an adjacent flame.

Internal Temperature Range: The Flame Intensity Monitor system is designed for continuous operation with internal temperatures from -40° to 140° F (-40° to 60° C). When the temperature exceeds 140° F, it will indicate an “Ambient Warning” and the system should be cooled. In some locations, a sun / radiation shield will be required.

Rain, Snow, Dew, Fog and Freezing Rain: Heavy rain, snow and fog will partially obstruct the sensor's view of the target. As the degree of optical obstruction increases, Intensity Level will gradually decrease. For installations where optical obstruction is a frequent concern, the sensor should be moved closer to the target to increase the measured energy level. In areas where snow accumulation is a frequent concern, the sensor should be mounted under a shield to prevent optical obstruction.

Lightning: In areas where lightning strikes are a concern, the Flame Intensity Monitor should be electrically isolated from metal structures, and an output signal isolator module should be used. Electrical conduit should include a nonconductive

section to minimize the likelihood of lightning damage.

Sun: Whenever possible, the sensor should be installed where it will not view a direct image of the sun (see Figure 3). Direct sunlight on the sensor or its lens system will not cause long-term damage, but it will cause the sensor to read higher than the true measured value. Direct sunlight upon the sensor's housing, may raise the internal temperature of the Flame Intensity Monitor enclosure(s) by as much as 15° F (8° C). In some cases a sun shield will be required to prevent overheating of the sensor.

Northern (Southern) Hemisphere Installations: If the sensor is aligned such that it is viewing in any northerly (southerly) direction [15 degrees or more North (South) of due East or West], then the sensor will never view the sun regardless of mounting angle above horizontal. [For installations within the 25th latitude from the equator, a northern (southern) component of as much as 25 degrees may be required.]

Wind: The Flame Intensity Monitor system is designed to operate effectively in heavy winds so long as a view of the flame is available every few seconds. The sensor will indicate a lower reading for a flame that is blown out of the sensor's view. Occasionally the wind may blow the Flare flame behind the stack and out of the sensor's field of view. The sensor is equipped with a peak hold feature to compensate for an intermittent loss of view of the flame. If wind conditions at the point of installation cause the flame to drop behind the stack and out of the sensor's view for more than a few seconds at a time, then the installation of a second sensor mounted to view the stack from a different angle is recommended. In this case, the second sensor should be mounted at least 60 degrees from the original sensor.

5.3 TROUBLESHOOTING GUIDELINES

| TROUBLESHOOTING GUIDELINES | |
|--|--|
| SYMPTOM | POSSIBLE CAUSE/RECOMMENDED ACTION |
| Verify Operation | Periodically check alignment and lens cleanliness. |
| Invalid Condition Occurs During a rainstorm, snowstorm, or heavy fog. | <ol style="list-style-type: none"> 1. Clean the sensor window. 2. Install a snow shield. 3. Move the sensor closer to the flare. 4. Increase the Peak Hold Delay Time or Decrease the Peak Hold Decay Rate |
| Invalid Condition Occurs during heavy winds, or when the sensor's view is blocked for a short time. | <ol style="list-style-type: none"> 1. Increase the Peak Hold Delay Time or Decrease the Peak Hold Decay Rate 2. Move the sensor closer to the flare. 3. Install a second sensor at a different viewing angle more than 60 degrees from the original sensor position. |
| Invalid Condition Occurs upon ambient temperature drop. | <ol style="list-style-type: none"> 1. Clear condensation from sensor window, or wait for condensation to evaporate. 2. Insulate the sensor. |
| No Signal from sensor. | <ol style="list-style-type: none"> 1. Verify the proper power is applied to the system (the displays should be lit). 2. Verify that the fuses in the interface module are not blown. 3. Verify that the analog/digital mode jumpers are in the proper position. 4. Verify that the sensor's lens/window is clean. 5. Verify the proper wiring connections for the power and the output signals. Use the Diagnostics submenu features. 6. Verify the cable connection of the sensor to the remote monitor (if included). 7. Verify the sensor is properly aligned to the measured target. 8. Verify that your current meter fuse is intact. |
| An Incorrect Signal is indicated. | <ol style="list-style-type: none"> 1. Verify that the Output Scale is set to Degrees Farenheight within the Signal Conditioning submenu group. 2. Verify that the output devices are properly calibrated to the sensor's linear output signal, and verify the configured output settings. Use the Diagnostics submenu features. 3. Verify the sensor is properly aligned to the measured target. 4. Verify that the sensor's lens/window is clean. 5. Verify that the sensor is not receiving input energy from reflections off the target surface or an image of the sun from behind the target. |
| Intermittent sensor operation . | Check for loose, intermittent electrical connections . |

Table 15 – Troubleshooting Guidelines