WINDOW 141

Flame Scanning System

User's Manual

WARNING

DO NOT INSTALL, MAINTAIN OR OPERATE THIS EQUIPMENT WITHOUT FIRST READING, UNDERSTANDING, AND FOLLOWING INSTRUCTIONS IN THIS MANUAL. FAILURE TO FOLLOW INSTRUCTIONS AND HEED CAUTION INFORMATION IN THE MANUAL MAY RESULT IN PROPERTY DAMAGE, SEVERE PERSONAL INJURY. OR DEATH.

PIA

INDUSTRIAL FLAME SCANNERS

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PIA WINDOW 141

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PROCÉDÉ INDUSTRIEL AUTOMATISÉ

WINDOW 141 Flame Scanning System

INTRODUCTION

PIA WINDOW 141 was created to overcome flame scanner field adjustment difficulties, to make sure that the scanner head is sighting the best optimum location at all time at any load and conditions. Visual sighting of the flame through the scanner head gives an extra dimension to the flame scanning and combustion monitoring. Dual IR/UV system with independent control and outputs helps the fuel control in the burner management system.

SYSTEM OVERVIEW

The **PIA WINDOW 141** system consists:

1. Flame Viewing Scanner head

The heads are characterized to respond to either or both (UV) ultra violet emissions at 220nm peak and (IR) infrared flicker frequencies at 1550nm peak emissions. They are both blind to the visible section of the radiation spectrum. Three versions are available: dual UV/IR detection, UV only and IR only. The UV digital output signal is directly proportional to the UV radiation strength. The IR digital output signal represents the IR flicker frequency independent of the brightness of the flame. An automatic gain control takes care of the IR emission strength from very low to very high. No manual amplifying or aperture discs are necessary. The visible brightness has no effect on the detection. On the other hand the visible section of the spectrum is available for direct human observation through the integral WINDOW. **This WINDOW allows the operator to adjust the line of sight for the best positioning of the detector.** It allows also checking any time the status of the flame, the proper operation of the mechanical shutter and the cleanliness of the quartz lens.

2. Flame viewing head mounting

The head is equipped with a 1-inch NPT female connection which can be mounted through a heat barrier to a ball swivel connector to allow for correct alignment of the scanner sight. The head is also equipped with a 3/8" inch NPT female connection for the cooling air. Electrically, it has an 8 pins MIL-spec grounded quick male connector.

3. Head cable

The head cable is available up to a length of 500 feet. The cable is a high temperature 9 conductor cable, Teflon covered, 100% shielded with both foil and braid shields. At one end it is connected to an 8 pin MIL-spec quick female connector.

4. Microcontroller rack

From 1 to 8, 6U Eurocard microcontroller modules can be inserted in a properly sized aluminum wall mounted rack.

5. Microcontroller module

The microcontroller module interprets the UV, IR signals and the scanner head operation, it computes, makes decisions and creates output to the Burner Management System (BMS). It also creates visible outputs to the module front on the actual status of the system such as:

a) UV frequency proportional to the UV strength (digital)
b) UV relative level (bar graphs)
c) IR absolute flicker frequency (digital)
d) IR relative level (bar graphs)
e) Status of UV output relay
f) Status of IR output relay
g) Internal fault indication

All the accumulated non-fatal faults are recorded in the module and can be looked up and cancelled through the Hand Held Terminal Unit which can be connected at any time to the front of the module.

6. Hand Held Data Terminal Unit (DT)

The hand held Data Terminal unit can be connected at any time to the module and will not interfere with the operation of the system. Through this terminal the operator can check, program and cancel the following:

a) Non-fatal faults since the last resetting of the faults.
b) The existing and the highest recorded temperature of the head and module.
c) The IR and UV adjustment levels which can be reprogrammed.
d) Independently the IR and UV flame failure response time (FFRT) can be reprogrammed from 0.5 to 3.5 (± 0.5) seconds.
e) Independently the percentage of leakage during shutter closure for IR and UV from which it is easy to determine the status of the shutter (with the complementary help of the visual observation through the scanner head window), the UV tube and the IR sensor.
f) Also in some special installations when opposite or adjacent flames are creating discrimination problems a UV and IR AND function can be established by programming the system for this purpose.
g) Some other information: the unit is equipped with 4 keys and an illuminated crystal display.

FEATURES AND BENEFITS

- ✓ Independent UV and IR detection, each with its own output flame relay and displays.
- ✓ A complete watchdog and safety system (verified every second).
- ✓ The output relays are safe and dynamically operated.
- ✓ On the module front, both the relative and absolute values for both IR and UV are continuously displayed.
- ✓ Mechanical shutter for self-check continuously monitored.
- ✓ 0 or 4 (selectable) to 20mA analog flame level output.
- ✓ Individual adjustable FFRT from 0.5 to 3.5sec (± 0.5) for both IR and UV.
- ✓ No adjusting potentiometers which anybody could alter.
- ✓ WINDOW type scanner head for sight adjustment and visual monitoring of the sighted flame (to improve discrimination).
- ✓ Proven discrimination techniques for opposing and adjacent flames.
- ✓ Easy commissioning and adjusting procedures through Data Terminal.
- ✓ Cooling air connection on scanner head.
- ✓ Suitable for oil, gas, coal and non-standard fuel scanning.
- ✓ Multilayer, surface mount technology with flash memory microcontroller.
- ✓ No back up battery required.
- ✓ No aperture disks necessary.

SPECIFICATIONS

1. Flame viewing head

Construction	Aluminum case
Size	65mm x 55mm x 120mm
Weight	500g
Mounting	1 inch NPT female, usually through adjustable ball joint.
Cooling air	3/8" NPT female connection for 5 SCFM purge instrument air at less than 105°F (40°C). 5" WC above wind box pressure.
Environment	-13 to 185F (-25°C to 85°C)
Humidity	95% non-condensing
Detection	- UV at 220nm peak - IR at 1550nm peak
Window	Look through visible sight of the detection area.
Display	Red LED for IR detection. Blue LED for UV detection.
Self-checking	Mechanical
Connector	8 pin MIL-spec quick disconnect male connector

2. Cables and connectors

1.1 Scanner head connector

Quick-disconnect 8 pin MIL-spec environmentally sealed.

1.2 Cable high temperature 9 conductor cable

Teflon covered. 100% shielded with both foil and braid shields.

1.3 Radiation immunity

SAMA standard PMC 33.1 1978 with cable attached to scanner head and microcontroller mounted in a sealed NEMAIR enclosure.

3. Microcontroller module

Module size	6U Eurocard with plastic front panel 11" x 6.7" x 2"
Weight	1kg
Environment	-4 to 158°F (-20 to 70°C)
Humidity	95% non-condensing
Fuses	2 required : T63mAL, 250V, Wickmann model 3720063041
Supply voltage	120 or 240VAC -15% to +10% 60Hz, 12VA max.
Signal input	IR & UV signals from scanner head
Flame on response	1sec max.
Flame failure response (FFRT)	0.5 to 3.5 seconds ± 0.5sec adjustable with 0.5sec increments
Display	- Two digital displays, one for IR flicker frequency and one for UV intensity proportional frequency. - Two multicolor LED bar graphs, one for IR relative strength and one for UV relative intensity. - System status LEDs.
Output contact	Individual UV, IR flame (NO) relay and system fault (NC) relay. Relay contact ratings: **Max. switching power: 60W/125VA** **Max. switching voltage: 220VDC/250VAC** **Max. switching current: 2A** **Max. carrying current : 2A**
Output, analog	0 or 4 to 20mA representing the highest IR or UV bar graph level for maximum 500Ω load resistance (between output and -12VDC).
Output communication	Plug on module front for Hand Held Terminal for adjusting and verifying the system.
False signal rejection	Any constant (for 8 sec. or more) IR and/or UV signal which does not represent a real flame (like incandescent light, interference, defective UV tube, etc.) will be rejected and the system fault relay will be energized.

FLAME SCANNER HEAD

A module can accommodate a dual UV/IR scanning head or independent UV and IR heads.

When only one scanner head is needed for both igniter and main flame, a dual UV/IR head is recommended. When the sight path of the igniter flame is not the same as those of the main flame, two scanners can be used with the same module: one for UV, sighting the igniter; the other for IR, sighting the main flame.

However, when both sight paths of the main flame and igniter are the same, a single dual UV/IR scanner head can be used for both flames, depending on the type of fuel and user's preferences.

A) Dual UV/IR Scanner Head

- The WINDOW compact UV and IR scanning head contains a recognized gas-filled detector tube to sense a narrow band of ultraviolet radiation with a peak at 220nm mainly for gas firing detection. It is non-sensitive to visual light and to radiation emitted from hot refractory. The IR detector is a very high speed and very reliable photodiode operating in the IR region with a peak at 1550nm excellent for oil, different quality of coals, etc. The detection is based on the modulated flicker frequencies. It is again non sensitive to visual light. No adjustment or aperture discs are required. An auto-gain control will monitor the IR radiation level from very low to very high and will not alter the flicker frequency.
- The scanner head can be mounted in any position without affecting the operation of the system.
- Two LEDs indicate the flame detection. One red for IR and one blue for UV. Both are inside the scanner head and can be seen through the WINDOW.
- A mechanical shutter, the only moving part on the system, periodically blocks the scanner head input to be sure that signals detected are coming only from the flame being viewed. Each detector UV and IR are checked alternatively. If both signals are present, the shutter does operate every 4.25sec for 0.25sec. If only one signal is detected, the period is 8.5sec.
- Two small multilayer surface mount electronic PC boards are assembled in the housing of the scanner head visible through the WINDOW. One of the PC boards has an opening for the visual inspection of the flame.
- A quartz lens is installed between the detector and the flame, allowing the transparency for UV, visual and IR radiations.
- One filter lens is installed at the back of the scanner head backed up with a standard glass lens to protect the filter lens and a wire mesh. The filter lens will block the UV and the IR radiations to penetrate from the boiler room to the UV tube and to IR photocell. The wire mesh will protect the detector against any RF activity in the surrounding. The only radiation which will pass through the lens is the visible band of the spectrum. The visible band of the radiations emitted by the flame would only be visible by human eye and not the detectors.
- Through the WINDOW it is possible to see the LEDs, the inside of the scanner head, the shutter operation, the cleanliness of the quartz lens and the most important: the targeted flame.
- An 8 pin MIL-spec male connector to connect the head to the module.
- A 3/8" NPT female connection for cooling air.

B) UV Only Scanner Head

Description is the same as for the dual scanner head, except that all references to IR do not apply.

C) IR Only Scanner Head

Description is the same as for the dual scanner head, except that all references to UV do not apply.

MICROCONTROLLER MODULE

Each scanner head is connected to a dedicated microcontroller module that can be programmed to process only the flame characteristics of the fuel or fuels (2) being used.

Each module is composed of two multilayer surface mount PC boards:

a) The main board containing the transformers, fuses, relays, power supply and the flash memory microcontroller based electronics to control the whole system. It also includes a plug for the Data Terminal Unit.

b) The front LED PC board contains the electronics to display both digital UV and IR signals, both relative bar graphs for UV and IR and the status LEDs.

The back of the module is equipped with two 64 pins male PC board connectors for the outside connections.

DATA TERMINAL UNIT (DT)

The data hand held adjusting terminal allows users to easily adjust, program and verify data in the microcontroller module. The terminal is enclosed in a protective case and features a membrane type keypad with 4 keys, which protects the unit from the outside environment. It comes complete with a 6 feet cable equipped with 2 male 4 pin plug (one at each end) for quick connection to the microcontroller module front. Inside a multilayer surface mount PC board containing the necessary electronics for a flash memory microcontroller which controls the unit. It also contains an illuminated 4 lines, 20 characters liquid crystal display.

On the keypad, the four control keys are: [C], [E], [▲], and [▼]

Each one has several functions which are indicated for each case on the liquid crystal display. [ ] represents a terminal key on the keypad and # is for a numerical value.

Each parameter modification is used immediately by the module but it is only temporary. It can be cleared with a "clear" action or will be cleared automatically if the terminal connection is removed. Any parameter in order to be permanent has to be entered before the removal of the terminal. When values or displays are blank, the terminal waits for the module instructions.

Operation of the terminal

Once the terminal is connected to the module front, the following message will be displayed for page 1/3:

```
->.IR Level Adjustment
  .UV Level Adjustment
  .Recorded Fault(s)
  .Fault(s)       p1/3
```

With the key [▼], the cursor will move to the next line (in this case to "UV Level Adjustment") and so forth every time to key is depressed the cursor will move to next line through page 2/3:

```
->.IR FFRT Adjustment
  .UV FFRT Adjustment
  .Temperatures
  .Leakages       p2/3
```

Then, page 3/3:

```
->.Min UV to keep IR
  .Hardware
  .About...
                    p3/3
```

Then, back to page 1/3.

With key [▲], a reverse action is obtained.

The operation of the terminal can be divided into 6 sections:

1. Flame level (Threshold) adjustment

a) **For IR**, select with key [E] (Enter) the first line on page 1/3 of the general menu. The following page will appear:

```
 IR BAR GRAPH:   ###%
Min: ###%  Max:  ###%
Use [▲] [▼] to adjust
IR Bar Graph.    p1/1
```

To adjust the bar graph to the desired value for the specific flame it is scanning at that moment use key [▲] or [▼]. Use [E] to enter the data into the flash memory. "Modification saved" data will appear. Use [C] (clear) to return to the main menu and clear the temporary modifications. 100% or more will illuminate 10 bar graphs. Three reading will be displayed temporarily as long as the page is displayed (the actual, the minimum and maximum recorded) to ease the adjustments.

With key [▼], the maximum recorded value is reset or with key [▲] the minimum to the actual bar graph value, the other value remains unchanged. Any other action will clear both values. The maximum bar graph adjustment is normally 220%. Nevertheless after adjustment, if the flicker increases drastically the bar graph reading could go over 220% up to 1000%.

b) **For UV**, select with a key [E] the second line on page 1/3 of the general menu. The following page will appear:

```
 UV BAR GRAPH:  ###%
Min: ###% Max:  ###%
Use [▲] [▼] to adjust
UV Bar Graph.   p1/1
```

Adjustments are identical to the IR adjustments.

2. Flame Failure Response Time (FFRT) adjustment

a) **For IR**, select the first line on page 2/3 of the general menu. The following page will appear:

```
  IR Flame Failure
Response time (FFRT)
  #.#sec ± 0.5sec
Use [▲] [▼]     p1/1
```

The FFRT can be adjusted from 0.5 to 3.5 seconds (± 0.5) by increment of 0.5sec.

To increase or decrease the value use keys [▲] or [▼] followed by [E] to enter and save the parameters into the flash memory.

Use key [C] to return to the main memory and clear the non-saved modifications.

b) **For UV**, select the second line on page 2/3 of the general menu. The following page will appear:

```
  UV Flame Failure
Response time (FFRT)
  #.#sec ± 0.5sec
Use [▲] [▼]     p1/1
```

Adjustments are identical to the IR adjustments.

3. Special AND function

In special cases where, for example, opposing flames exist in a combustion chamber and the opposing flame IR signal is also detected, the special AND function can be activated by the DT to discriminate the right flame. Normally, the UV signal emitted by the root of the opposing flame is filtered and absorbed by the outskirt of the flame. On the other hand, the front flame which is scanned has to contain some UV from its root. This is why our flame has to contain more UV than the minimum programmed in order to recognize the IR signal. This special function is cancelled if the min. UV is set to 0 (zero). When burner light-on is initiated, a minimum of five bar graphs reading has to be established before IR is recognized. Once the IR is recognized, the UV has to be maintained at the min. of bar graph setting.

For the minimum UV adjustment of the special AND function, select the first line on page 3/3 of the general menu. The following page will appear:

```
MINIMUM of UV Bar to
KEEP IR Response: ##
 Use [▲] [▼]
 to adjust.      p1/1
```

Select the required value from 0 to 10 bar graphs with key [▲] or [▼]. Use key [E] to record it to the flash memory or [C] to clear and/or return to main menu.

4. Fatal and non-fatal faults display and cancellations

A fatal fault could only occur if internal software or a major hardware problem and/or MCU failure occur. These fatal faults are not indicated by the Data Terminal and cannot be indicated by the fault relay (**inoperative**) due to their complexity. Under normal operation, it is very unlikely to happen and the system is well protected. For more details, see "**Module Safety Measures**". Non-fatal faults are handled by the Data Terminal.

a) When the Fault relay is activated, two types of situation can occur:

   i. An operational fault (leakage or bad flame detection) for which the UV and IR flame relays are de-energized.

   ii. A preventive warning to indicate a marginal flame signal or increasing operational temperature. The operator has to take preventive actions before losing the burner. Flame relays are not affected.

Report you to the recorded faults, select line 3 on page 1/3 of the general menu. One of the following pages will appear:

```
      NO FAULT
      RECORDED
[E] Exit
```

```
  # TYPE OF FAULT
     RECORDED
[▲] to see, [E] Exit
[C] to Clear all
```

```
  # DIFFERENT TYPES
  OF FAULT RECORDED
[▲] to see, [E] Exit
[C] to Clear all
```

To see and/or clear the faults, follow instructions described on the pages.
The different types of fault can be displayed as follows:

```
      NO FAULT
      RECORDED

[E] Exit
```

Normal operation of the system.

```
  IR LEAKAGE FAULT
     Total: ###
[C] to Clear
[E] Exit          p#/#
```

The scanner head shutter does not close properly.

UV LEAKAGE FAULT Total: ### [C] to Clear [E] Exit p#/#	*Either the shutter does not close properly or the UV tube is leaking.* *UV tube to be changed.*
IR MARGINAL FAULT Total: ### [C] to Clear [E] Exit p#/#	*Check the IR threshold.*
UV MARGINAL FAULT Total: ### [C] to Clear [E] Exit p#/#	*Check the UV threshold adjustment.*
BAD IR FLAME FAULT Total: ### [C] to Clear [E] Exit p#/#	*A non-flame artificial signal is detected (interference).*
BAD UV FLAME FAULT Total: ### [C] to Clear [E] Exit p#/#	*A non-flame artificial signal is detected (interference).*
HIGH TEMPERATURE MODULE FAULT: Total: ###, [E] Exit [C] to Clear p#/#	*Check module cooling (below 70°)*
HIGH TEMPERATURE HEAD FAULT: Total: ###, [E] Exit [C] to Clear p#/#	*Check head cooling. (below 85°)*

Note: The module is equipped with a thermal switch (NC contact) which will open between 80 to 85°C. The opening of the thermal switch will cause the power to the two UV/IR relays to be disconnected and will result in a UV/IR Flame Off condition to the BMS, even though they may be valid and displayed UV and/or IR signals. The module temperature has to be cooled below 70°C to reset the thermo-switch.

b) For the existing fault, select line 4 on page 1/3 of the general menu. The following page will appear:

	Relay status		
	Fault	UV	IR
NO FAULT	Off	NA	NA
IR LEAKAGE FAULT p#/#	On	Off	Off
UV LEAKAGE FAULT p#/#	On	Off	Off
IR MARGINAL FLAME FAULT p#/#	On	NA	NA
UV MARGINAL FLAME FAULT p#/#	On	NA	NA
BAD IR FLAME FAULT p#/#	On	Off	Off
BAD UV FLAME FAULT p#/#	On	Off	Off
HIGH TEMPERATURE MODULE FAULT p#/#	On	NA	NA
HIGH TEMPERATURE HEAD FAULT p#/#	On	NA	NA
IR and UV LEAKAGE FAULT p#/#	On	Off	Off

Only present faults are displayed.

P#/# means: the number of present faults.

Use [▲] or [▼] to see each present fault. [E] and [C] to exit.

NA = Not affected

5. Internal data reading

a) For existing and highest recorded temperature, select line 3 on page 2/3 of the general menu. The following can be displayed:

```
MODULE TEMPERATURE:

  ###°C ###°F
                  p1/4
```

```
HEAD TEMPERATURE:

  ###°C ###°F
                  p2/4
```

```
  MODULE TEMPERATURE,
  HIGH RECORDED:###°C
Non Clearable   ###°F
[E] Exit         p3/4
```

```
  HEAD TEMPERATURE,
  HIGH RECORDED:###°C
[C] to Clear    ###°F
[E] Exit         p4/4
```

Use [▲] or [▼] to see each temperature, [E] to Exit and [C] to clear "Head Temperature, High Recorded" only.

b) For the maximum IR and UV recorded leakages, select line 4 on page 2/3 of the general menu.

The following will appear:

```
   MAXIMUM RELATIVE
  UV LEAKAGE: ###%
 [C] to Clear
 [E] Exit        p1/2
```

```
   MAXIMUM RELATIVE
   IR LEAKAGE: ###%
 [C] to Clear
 [E] Exit        p2/2
```

Use [▲] or [▼] to see UV or IR Leakage. [E] to Exit, and [C] to Clear the Recorded Leakage.

c) To check some hardware data, select line 2 on page 3/3 of the general menu.

Use [▲] or [▼] to view hardware data. Recorded Min and Max values are Temporary for each page. [E] to Exit, except for p2/5. [C] to Exit.

The following data can be displayed:

UV TUBE VOLTAGE: Min: ###V Max: ###V p1/5	*Should be approximately:* *Min ≅170VDC* *Max ≅330VDC*
REMOTE OUTPUT SIGNAL: ###%, Offset: ## Use [E] to change Offset. p2/5	*This is to change the 0 to 20mA signal to 4 to 20mA or inverse.* *"NO" stands for 0,* *"YES" for 4.*
ANALOG VALUES OF IR INPUT: Min: ##.##V Max: ##.##V p3/5	
ANALOG VALUES OF UV INPUT: Min: ##.##V Max: ##.##V p4/5	
ANALOG VALUES OF IR SENSOR FEEDBACK: Max: ##.##V Min: ##.##V p5/5	

d) To display the software version and the serial number of the module, select line 3 (About) of the general menu. The following data will appear:

```
  W I N D O W  1 4 1
Version F3F
August 10 2007
S/N: Mxx-yy-zz
```

Use [E] to consult software version and serial number. To exit use any key.

F3F stands for PC board revision F and 3F for software issue, followed by date of version. S/N stands for serial number. M stands for module, followed by these numbers:

- xx: module number from 00 to 99
- yy: the week number in the year
- zz: the year from 20**07** to 20**99**, indicating when the module was issued

6. Other messages

a) Instant messages can appear when a New Fault is present, [E] will acknowledge, but not cancel, and will return to the same place it was before the Fault Message display.

NEW FAULT
NEW IR LEAKAGE FAULT [E] Exit
NEW UV LEAKAGE FAULT [E] Exit
NEW BAD IR FLAME FAULT [E] Exit
NEW BAD UV FLAME FAULT [E] Exit
NEW HIGH TEMPERATURE MODULE FAULT [E] Exit
NEW HIGH TEMPERATURE HEAD FAULT [E] Exit
NEW IR and UV LEAKAGE FAULT [E] Exit

Other messages as follow can appear:

i. This message appears if there is no communication with module:

NO COMMUNICATION between terminal and module

This message appears when temporary modifications are cleared:

```
MODIFICATIONS
C L E A R E D
```

ii. This message appears when modifications are entered in flash memories:

```
MODIFICATIONS
  S A V E D
```

OPERATING PRINCIPLES

With the module properly plugged in the chassis, the power can be applied to the system. **Never install or remove a module under power**.

A scanner head can be installed or removed at any time.

The scanner head will detect independently UV and IR and transmit the signals to the microcontroller module. In the microcontroller module, these signals are analyzed and treated according to the programmed operation.

Both IR and UV have independent threshold set points, digital and relative displays, FFRTs, output relays, leakage indications, associated fault displays, LED displays, etc.

Once both head and module are properly installed and powered, the system will operate according to predetermined set points with outputs to the Burner Management System and collecting extreme operational data in the module RAM which can be viewed with the Data Terminal Unit and reset.

SET-UP AND ADJUSTMENTS

At any time the system has to be installed or readjusted such as for:

1. Initial setup and start-up
2. Module exchange
3. Fuel exchange
4. Module failure which has to be reset due to software safety measures (for detail see "System Troubleshooting")

Proceed the following way:

Once head and module are installed, power up the system.

In order to adjust, it is necessary to have a flame at the targeted burner which **will not be fully protected by the scanner itself during set-up and a back-up protection should exist to supervise the flame either automatically or with the help of human intervention**.

It is the responsibility of the operator to make sure that proper adjustments are performed. (See Data Terminal bar graph adjustment)

Adjust the sighting of the scanner head to read the highest digital output either UV or IR or both and also with visual observation through the WINDOW to make sure that there are no obstruction between the targeted flame and the scanner sight or discrimination problems with other flames.

Once the head is properly lined-up, the readjustment can proceed. Plug in the Data Terminal Unit to the front of the module. For both IR and UV the adjustments are similar, here we are only describing for the IR.

Flame failure will occur after the bar graph display falls under the yellow LED for FFRT. If the bar graph is below the green LED's and remains in the yellow ones for more than 2 seconds, a marginal fault will appear.

Normally and theoretically, this minimum flame at low fire should be at bar graph level 8 (2 bottom green on). Then, when the flame is increased, the full 10 bar graphs can be on and even more but it is not indicated on the module front. In the terminal, the bar graphs are indicated in % which means that 8 bar graphs will show 80% but 10 on the module front can be anything from 100 to 1000% on the terminal. **A very high percentage in the data terminal bar graph adjustment display means that the system is not properly and safely programmed.**

Once the adjustments are completed, shut down the burner and keep all other burners of the boilers on at high fire. The bar graphs should read as low as possible in order not to detect any other adjacent or opposing flame.

The Flame Failure Response Time (FFRT) is adjusted independently for UV and IR. The adjustment is by increment of 0.5sec from 0.5 to 3.5sec (± 0.5). This ± 0.5sec is created by the fact that when the flame failure occurs, just before, during or after the shutter operation. So when the set point is 0.5sec the cut off can vary from 0 to 1sec. On the other hand, a flame failure can never overpass 3.5 + 0.5 = 4.0 seconds. Since both adjustments are independent, UV can be adjusted to 1.0sec and IR 3.0sec (this is just as an example).

If there is a flame failure with IR, the IR flame relay will shut down but it is not affecting the UV operation and the UV relay will remain on if the UV signal is properly detected.

There are three exceptions were two relays will drop out. One is for a 25% or more of any leakage. The second is for induced frequency detection on the IR or constant UV frequency due to defective UV tube. The third will be in a case of fatal failure. For this third case, see "**Module safety measures**" in "**System Troubleshooting**".

In a special case, when it is not possible to discriminate and eliminate the IR pick-up from adjacent or opposing flames and if the burner management does not allow the ignition of the burner, the following can be done. Through the terminal a minimum of UV detection can be adjusted to maintain the IR detection. Since in these cases the UV detection from adjacent or opposing flames is close to 0 but the IR is quite strong since we are looking on the opposite or adjacent flames contour where UV flame is not present, but IR yes.

On the other hand, on the targeted flame we are looking at the root where for ignition flame and main oil flames (as an example) there is always some UV. Before start-up, there is no UV detection and IR relay is not energized, allowing the Burner Management to proceed with start-up. Once ignition is established, UV is detected and the UV flame relay is energized. After this, the oil will energize the IR flame relay which, to be maintained in operation, needs a minimum UV which is present at the flame root. The flame relays can independently maintain operation of oil or gas. In the Burner Management System, the flame relays can be put in either "OR" or "AND" mode. Check the digital output signals for both UV and IR at different load, air flows, etc. It is possible that the scanner head sighting has to be readjusted; the WINDOW will give an extra input. Through the WINDOW, one can detect a poor combustion control adjustment which will affect the scanner efficiency as well as discrimination problems.

MICROCONTROLLER MOUNTING RACK

From 1 to 8 microcontroller modules open frame mounting rack can be supplied. There are equipped with rail guides, connectors for modules, terminal blocks, mounting brackets and grounding lug.

The microcontroller card slides into the mounting rack until the connectors at the rear of the card

mate with corresponding connectors in the rack. The microcontroller then is secured in place with four screws.

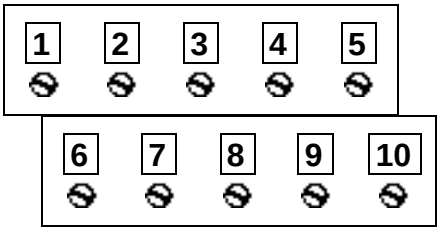
The mounting rack may be installed in various types of enclosures. The enclosures should be at least 10 inches deep and wide enough to accommodate the number of scanner microcontroller cards needed. It can be the same enclosures used for burner management equipment or a separate cabinet chosen to meet the environmental conditions required.

WIRING INFORMATION

Wiring to the mounting rack should be made with #20 AWG wire for signal wiring and #14 AWG wire for power wiring in accordance with N.E.C. and local codes. The following tables show the wiring connections for the upper and lower terminal blocks located on the mounting rack.

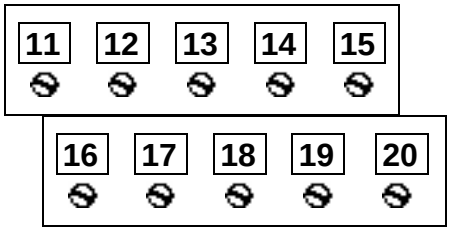
For 120 VAC supply, connect to Terminals 2 and 6; jumper Terminal 1 to 2 and 6 to 7.

For 240 VAC supply, connect to Terminals 2 and 6; jumper Terminal 1 to 7.



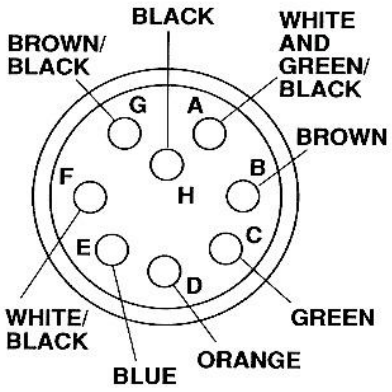
Upper Terminal Block	
No.	**Function**
1	120 VAC
2	120 VAC
3	Fault relay (Common)†
4	IR flame proven (N.O.)*†
5	UV flame proven (N.O.)*†
6	120 VAC (Neutral)
7	120 VAC (Neutral)
8	No connection
9	Fault relay (N.C.)**†
10	Flame proven return (Common)†

**Closed to common when flame is proven; **Closed when power is off or in normal operation, and is open on alarm; † Leakage; N.O. or N.C. to common: 10kΩ load, 0.14mA, 100kΩ load, 0.02mA.*



Lower Terminal Block Note: all terminals except 14 connect to scanner head cable		
No.	**Wire Color**	**Function**
11	Green	Shutter out/Temps in
12	Blue	IR frequency
13	Orange	UV signal
14	--	Flame signal (0 or 4 to 20mA)
15	Brown	UV operating voltage
16	White/Black	IR intensity
17	Black	-12 VDC (4- 20mA Common)
18	Brown/Black	+12 VDC
19	Green/Black	Flame signal (Common)
20	White	Temperature compensation

***Note:** In some cases, the brown and brown/black tracers are red and red/black, respectively.*



Scanner head cable connector terminals. Always route scanner head cable away from moving parts and hot steam lines. Never place close to other high voltage or high current cables which may induce harmful currents and cause malfunction.

***CAUTION:** The scanner head cable carries one wire (brown which connects to Terminal 15 conducting 335 VDC to the UV detector tube. Do not touch the end of this wire while it is under power.*

RELAY STATUS

Condition		IR relay (NO)	UV relay (NO)	Fault relay (NC)	Notes
IR signal	UV signal				
BG<5	**BG<5**	0	0	0 *	No Flame on.
BG<5	**BG>6**	0	1	0 *	Only UV on.
BG>6	**BG<5**	1	0	0 *	Only IR on.
BG>6	**BG>6**	1	1	0 *	Both UV and IR on.
BG>6	**4<BG<7**	1	1	1	IR on and marginal UV.
4<BG<7	**BG<5**	1	0	1	Marginal IR.
BG<5	**4<BG<7**	0	1	1	Marginal UV.
4<BG<7	**4<BG<7**	1	1	1	Marginal IR and UV.
4<BG<7	**BG>6**	1	1	1	Marginal IR and UV on.
Leakage or steady signal detection		0	0	1	Check scanner head shutter or possible induction around cable.
Module internal failure		0	0	0	System will reset while fault exists. Safety values imposed.
High temperature		NA	NA	1	Cool down the system before it fails.

Note: When fault relay becomes on, the fault is recorded and is readable by DT.

Safety values: FFRT = 0.5sec

Flame level = 0

For the safety of the scanner, in case of a fatal failure, the FFRT is set to the minimum setting which is 0.5sec and the flame output to 0%, which means that NO UV or IR flame on condition will be possible. In order to put back the system into operation, **new set points and start-up is required**.

Definitions for the relay status

0	-	Not energized
0 *	-	Not energized if no other fault exists
1	-	Energized
BG	-	Bar graphs (0 to 10 integers represent 0 to 100% variations. Each Integer = 10%)
NA	-	Not affected (Below 85°C for the module temperature. See "**Data terminal**" #4)

IR and UV output relay contacts have to be hooked up in the BMS in order to energize the UV and/or IR fuel valves when the relay contacts are closed. If they are open, the fuel valves should be closed.

Fault relay is a warning signal (status = 1) to indicate to the BMS that an operational fault exists (detection, temperature, adjustment or an unplugged module). A close contact indicates to the BMS that NO fault exists. An open contact indicates that an undefined operational fault exists. Verification has to be made with the Data Terminal.

SCANNER HEAD INSTALLATION

Select a location for the scanner head on the burner front that provides a clear, unobstructed view of the burner flame. Diffusers, louvers, vanes, or other burner parts should not be located between the scanner head and the portion of the flame to be viewed. Make sure that there is sufficient clearance around the scanner head so it may be swivelled to adjust for optimum flame viewing.

The selected location should be as close as possible to the centerline of the burner to allow sighting at the base of the flame. The visual sighting through the WINDOW will greatly ease this operation. This arrangement is preferred for flame viewing under varying loads and when more than one flame is present. For longest life, try to locate the scanner head in an area that is not subject to extreme temperatures or vibration.

Installation of a swivel–type ball joint on the burner front allows adjustment of the sighting. A 3/8" NPT female connection exists on the scanner head for the cooling/purging air.

The cooling/purging air supply piping must be flexible to allow adjustment of the scanner head. Air should be clean and dry with a maximum temperature of 105°F (40°C), a minimum flow of 5 SCFM, and a pressure greater than that in the wind box.

If it is necessary to avoid viewing other flames in the area being scanned it is sometimes helpful to install a sighting pipe extension from the scanner head to the flame being viewed. Sight pipes also help shield the line of sight from dust and unburned fuel, especially when firing coal. When a sight pipe is required, it should be threaded to the ball swivel so that it moves with the scanner head. Sight pipes less than 2 feet long usually are made from standard one-inch pipe. Longer pipes may require an increase in diameter to view a larger segment of the flame.

SHIELDING

It is essential that proper shielding procedures be followed.

Grounding of the scanner head cable shield is accomplished through the scanner head. Pipe connections between the scanner head and the burner front must be made with electrically conductive materials to ensure an adequate ground. If a nonconductive heat barrier is used in between the scanner head and the burner front, a conductive by-pass (cable) has to be installed.

If the scanner head cable has to be spliced or extended via a terminal box, the shielding has to be absolutely continuous; otherwise the proper shielding could be compromised. It is preferable to use a single non spliced cable.

If EMI/RFI is a problem, all wires and cable entries into the microcontroller enclosure are potential carriers of interference. In some cases, entering and exiting the enclosure with steel electrical conduit and extending it into an interference-free area will eliminate the problem.

AIMING THE SCANNER HEAD

With the scanner head and the microcontroller module properly installed and wired apply power to the system. The RUNNING LED will blink.

Ignite the burner (or igniter) whose flame is to be scanned following normal start-up procedure. Adjust burner to a low-fire condition. Be sure that cooling air purge is maintained. Through the observation WINDOW and with the help of the digital output signal the best position of the scanner head can be obtained. It should be at the root of the flame where the most intense energy is radiated.

Sighting along the flame, rather than across it, it helps for changing flame conditions, aids in discriminating the observed flame from other flames, and reduces the amount of particulate matter that is present along the scanner sight path.

To change the sight adjustment, loosen the swivel ball joint and adjust the scanner head to the best desired sight. Once the best maximum signal is obtained, tighten the ball swivel joint so that the setting will not accidentally change.

This completes the aiming process and the scanner head should not require further adjustment.

SET-UP AND OPERATION

Single burner and single fuel operation

With the scanner head properly aimed as described in the previous section and a single burner firing a single fuel at a low firing rate, operation of the system can proceed as follows:

1) Power-up the system. The RUNNING LED will blink. **Do not remove the microcontroller module while power is applied to the system.** This action could cause damage to the module. The scanner head can be installed and removed at any time without harm.
2) Plug-in the DT "Data Terminal Unit" to the front of the module. This connection can be made and broken without harm while the system is on.
3) For adjustment of the system, follow the instructions given in the Data Terminal Unit. At minimum firing rate it is recommended to have 8 bar graphs on for the required IR and/or UV. At high fire, there is no limit but only 10 bar graphs are displayed on the module front. On the Terminal, the excess can be observed.

4) Test the burner and system for all turn-downs, air flows and full power flame proven. The flame signal should consistently **remain in the 8 to 10 region of the bar graph for reliable operation for the detected IR and/or UV**. Shut down the burner and verify that both bar graphs and output relays are off.

The system is now prepared for operation with a single burner firing a single fuel.

Multi-burner operation

Multi-burner operation set-up proceeds exactly as described for a single burner. However, after programming is complete, the burner being scanned is shut down and the other adjacent and/or opposing burners are allowed to remain firing. Both IR and UV on LEDs should go out.

Multi-fuel operation

For single-burner multi-fuel operation, sighting and operating procedure previously described should be performed for each fuel to be fired. As an example: oil could be monitored with IR while natural gas with UV. Each fuel could have its own flame failure relay.

SYSTEM TROUBLESHOOTING

Normal operation

Under normal operation, the "RUNNING" LED should blink, the IR and/or UV displays should be on and FAULT LED off.

If the FAULT LED is on, check the system with the Hand Hold Terminal Unit to determine the cause of the fault. Then, proceed with the correcting actions.

Short

If connected and power is on the module check the two fuses. If they are blown, replace them and check the incoming primary current to the module.

1) For system connected on 60Hz, for 120V operation, the total current should be less than 100mA = 2 x 50 (for each fuse). For 240V operation, it should be less than 50mA. If it is more, there is a short in the system.
2) For system connected on 50Hz, for 120V operation, the total current should be less than 160mA = 2 x 80 (for each fuse). For 240V operation, it should be less than 80mA. If it is more, there is a short in the system.

In case of short, remove the associated head to check if the head has the short. If not, change the module. If the short still persists, it is on the base or most likely on the cable. If it is found that the short is coming from the scanner head or the module, **the defective unit has to be sent back to the manufacturer for repair or replacement**. The field cable should be checked and repaired according to our **"Wiring information"**.

Hand Held Data Terminal Unit

If the hand held Data Terminal Unit does not work on one unit, check it on another unit. The terminal unit is unlikely defective, more likely it could be the cable.

Fault LED on

If the Fault LED is on, check the system with the Hand Held Terminal Unit and make the appropriate correction to the system.

Module safety measures

The software and the hardware are continuously supervised to prevent undesirable reactions and unsafe situations in case of a fatal failure of the system, this as recommended by the latest prescription and regulation for Software in Programmable Components. If a failure, very unlikely, could occur in the MCU, all three UV, IR and fault output relays are de-energized, cutting the UV and IR "Flame On" signals and safety values are imposed for the set points to protect the system. The safety values which will be imposed are:

1) **UV FFRT = .5sec**
2) **IR FFRT = .5sec**
3) **UV flame level set to 0% (zero)**
4) **IR flame level set to 0%(zero)**

That means that no "Flame ON" relay outputs will be permissible. In order to reset the system, FFRT and flame level adjustments have to be reprogrammed through the hand held terminal unit (once a flame is detected on the digital display since the bar graphs will always indicate NO output even if the digital display indicates the presence of a flame) to the desired values. If the system cannot be reprogrammed (very unlikely), it would mean that a permanent failure occurred in the MCU. The module has to be replaced and sent back to the manufacturer for repair or replacement. No Fault relay indications would be possible.

No display on module

If there is no display on the module when fire exists, three things could happen:

1. Defective scanner head

Check visually the WINDOW head: it should sight the right flame, the IR and/or LED should indicate the presence of a flame, the shutter should operate and the quartz lens should be clean. If the hand held Data Terminal Unit indicates an IR and/or UV leakages, the shutter could be defective. If only UV leakage is detected, most likely the UV tube is leaking and should be replaced. If there is no UV output when there should be some, the UV tube could be dead and to be replaced.

If there is no action on the head, change the head and if the problem still persists, most likely the cable is defective. If it is the scanner head which is defective, it has to be sent back to the manufacturer for repair of replacement.

2. Defective interconnecting cable

If there is an interconnection problem between the module and the head, most likely the problem comes from the plug or from a broken or shorted wire.

3. Defective module

If there is no communication with the hand held Data Terminal Unit and/or no display on the module front but scanner head, cable and fuses are correct, change the module, which has **to be sent back to the manufacturer for repair or replacement**.

MAINTENANCE PROCEDURES

Other than normal cleaning, protection from spills and inspection for damage and frayed wire, there is little maintenance required with the WINDOW system. Common sense care should result in a long operating life for the components. Scheduled inspection of connectors and O-rings is suggested and a supply of replacement parts is highly recommended.

Proper detector head installation and clean burning fires will eliminate most detector cleaning chores. If the installation generated considerable soot, which will be visible through the WINDOW, a sliding quartz window should be installed, or frequent cleaning of the scanner head quartz would be necessary. Proper clean cooling air connected to the head could reduce drastically the soot deposit and keep the scanner head cool. Make sure that cabinets and housings are closed if the system is operated in a dirty environment.

Microcontroller module maintenance

There is no specific maintenance necessary for the module. Be sure it is operating in a clean and cool environment.

The two 63mA plug-in-fuses are serviceable when the card is removed. **Always disconnect power to the module before removing or reinstalling into the chassis, to avoid damage which could be caused to the module.**

The two output relays UV and IR contacts are rated for a maximum switching and carrying current of 2 Amp. An over-current could weld the output contacts ON, creating a false output signal. This line should be properly connected by the end user.

The module is specified to operate between -20 and 70°C. At 71°C, the fault relay and Data Terminal will indicate a module high temperature. There is a thermo-switch protection to open the UV and IR flame on relays to the burner management. The thermo-switch will open the circuit between 80 to 85°C. It has to be cold down to 70°C in order to re-enable the flame relays.

Scanner head maintenance

The scanner head will operate over long periods with a minimum amount of attention. The fail–safe shutter system has only one moving parts, **which if defective should be repaired or replaced by the manufacturer**.

Four items that may be serviced are the following:

1) The gas–filled UV detector tube
   It can either become continuously conductive (run away mode), creating a UV leakage fault or lose it sensitivity, giving a very weak or no output signal.
   To access the UV tube, first unplug the cable from the head, remove the four screws holding the back end section (WINDOW) and unplug the section from the rest of the head. The UV tube can be easily changed on the PC board. If a high sensitivity tube is used, make sure of the polarity. Re-plug the WINDOW section and make sure the O-ring is properly installed. Put back the four screws.
2) At the WINDOW end, one or both lenses can be broken. One is the IR/UV filter lens and the second is a regular glass protecting lens. They both can be replaced by removing the back end section the same way as for the UV tube. Once removed, remove the UV tube PC board and internal lens holding aluminum plate. Replace the broken lenses with the three O-rings:
   a. the black one between the clear lens and the back end section,
   b. the black flat one between the two lenses, then over the blue tinted lens put the shielding grid

c. the white O-ring is between the shielding grid and the lens holding plate

Then screw the lens holding aluminum plate and the PC board with the four internal screws. Finally put back the WINDOW section to the scanner as for the UV tube.

3) For the quartz lens at the scanner back, remove the back end from the scanner with four screws. Then, remove the shutter angle piece hold by four screws. Change the quartz lens and reinstall the angle piece. Make sure the O-ring is put back and that the shutter is not damaged. Reinstall the back end with the four screws.

4) The two main O-rings between the three scanner sections can be changed. They must be reinstalled, the same way as the O-rings for the lenses in order for the scanner to be waterproof. To install the O-rings for the front or back sections, remove and reinstall the sections as mentioned in #1 and #3.

Defective items

No guarantee or responsibility will cover a third party repair or replacement. Module and/or scanner head have to be sent back to the manufacturer for repair or exchange.

Manufacturer: **PIA Inc.**
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Tel: (514) 251-8169
Email: info@piacanada.ca

ANNEX 1

UV and IR detectors, flames and wall spectral curves