



CU-125  
February 29, 2024



## VFS-2000 TURBINE FLAME SENSOR



SIL3

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### DESCRIPTION

This document describes the Fireeye Turbine Flame Sensor for turbine flame monitoring applications, its installation and setup. The Turbine Flame Sensor responds to Ultraviolet optical energy from the flame (200-400 nanometers) and has a loop powered 4-20mA output representing flame brightness from a very low level. It is not sensitive to visible and IR emissions from hot walls. The Fireeye design basis is a total separation of the optical sensing device from the turbine without the need for expensive water or pressurized air cooling systems.

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### APPLICATION

The Fireeye Turbine Sensor is designed to sense flame in extreme high pressure and hot environments such as those found on turbine generators in power generation facilities. Similar challenging environments can be found near steam boilers, waste incinerators, down-fired reformer furnaces, ground flares, rotary kiln systems, ovens and dryers in power generation facilities, oil refineries, petrochemical, ammonia plants, paper and pulp industries.

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### OPERATION

At the hot end is a sapphire glass window to protect the lens and fiber optic bundle from extreme pressure and temperature. The fiber optic bundle transmits the UV light to the electronic assembly on the cool end, which amplifies the signal and converts it to a 4-20mA output. The sensor is a loop powered 4-20mA device. The sensor monitoring electronics needs to provide a voltage between 18 and 30 VDC and the sensor will vary the current between 4 and 20mA depending upon the turbine optical signal. Nominal voltage is 24 VDC. With no optical signal from the flame output will be 4mA as a minimum. Because of variation in fuel, sighting, turbine styles, etc. the output level for a FLAME ON is a site decision. Fireeye recommends that at least 5 mA be used as a threshold level to detect FLAME ON. The cable has multiple conductors and uses white for +24 VDC and black for the return of the 4-20mA signal.





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# WARNING



The equipment described in this manual is capable of causing property damage, severe injury, or death. It is the responsibility of the owner or operator to ensure that the equipment described is installed, operated and commissioned in compliance with the manufacturer's instructions and all applicable codes and regulations.

When this equipment is fitted to an appliance, due regard must also be given to the requirements of that appliance.

Before attempting to install, commission, or operate this equipment, all relevant sections of this document must be read and fully understood. If in doubt about any requirements consult your supplier.

Installation, commissioning or adjustment of this product **MUST** be carried out by suitably trained engineers or personnel qualified by training and experience.

The manufacturer of this equipment accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation, commissioning or adjustment of operating parameters of the equipment. There are no user serviceable parts.

Before attempting any work on this equipment or any equipment controlled by or connected to this equipment, all related electrical supplies **MUST** be isolated.

Safety interlocks **MUST NOT** be removed or overridden. Any faults once detected must be corrected before the control is operated.

**DO NOT** disconnect the sensor while the circuit is energized (live), unless the area is known to be non-hazardous and free of explosive gases.

These paragraphs indicate a risk of potential serious personal injury, unless these instructions are followed carefully.

Failure to properly install or operate the equipment in this manual could result in significant property damage, severe injury, or death. It is the responsibility of the owner or user to ensure that the equipment described is installed and operated in compliance with this manual and other system component manuals, as well with all applicable national and local codes.

The flame sensor seals high pressures within the turbine. The union nut must be tightened to the specified torque. Insufficient torque could result in combustion gases being released into the turbine compartment. The window holds pressure. The union is only for mechanical attachment.

The Turbine Sensor and its accessories are designed to operate at extreme temperatures. Do not attempt to work on this device until it has reached a safe handling temperature.

The fiber optic cable cannot be bent to a radius less than 6 inches or 15 cm.

Do not install a flame sensor that has a cracked window, damaged threads, or one that has been disassembled.

Explosion hazard. Do not connect or disconnect when energized.

## DIMENSIONS

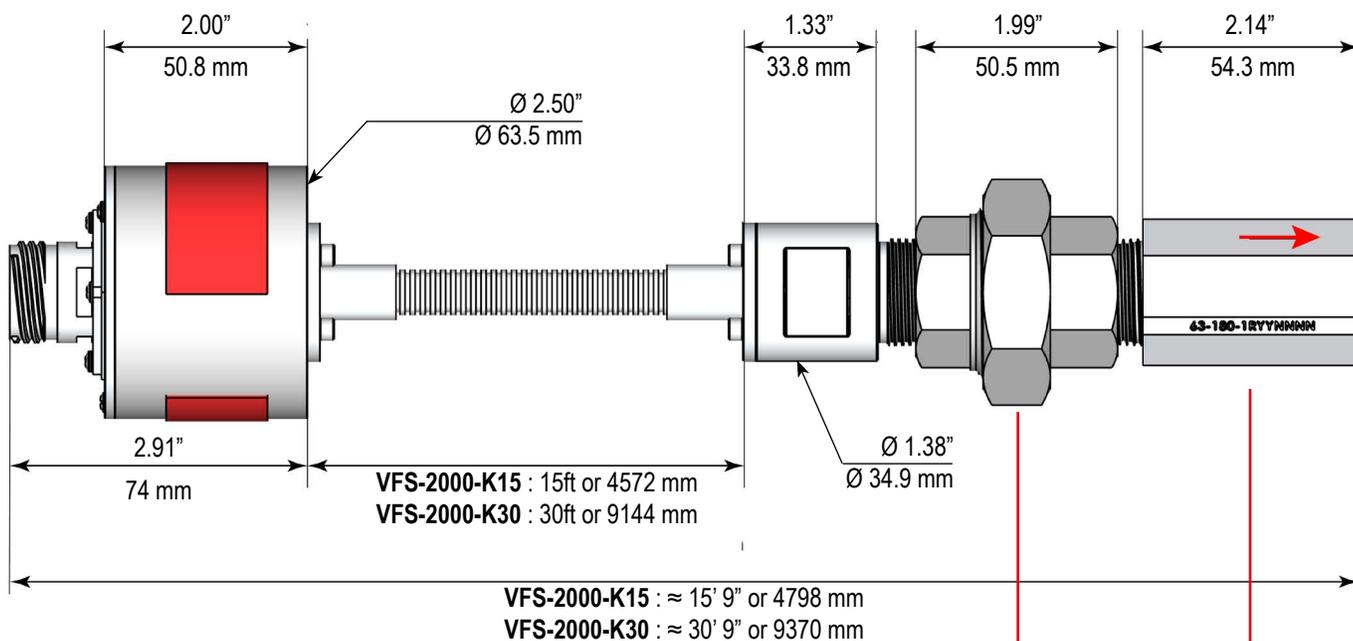
### VFS-2000-Kxx : Turbine flame sensor kit includes

- Turbine flame sensor head & amp - Electronics assembly
- High pressure, high temperature window
- Stainless steel high temperature union
- UV Enhanced quartz fiber optic (fully sheathed) assembly, hot & cold end connections

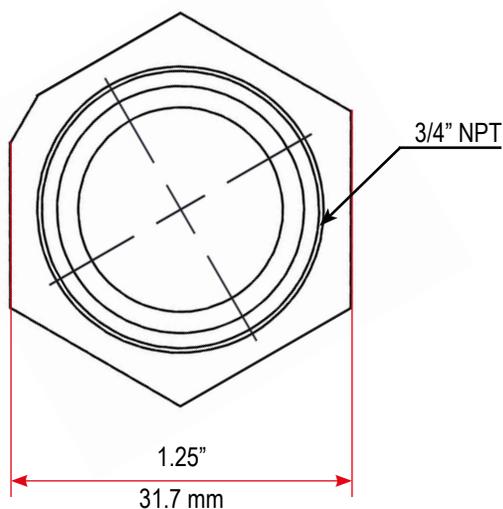
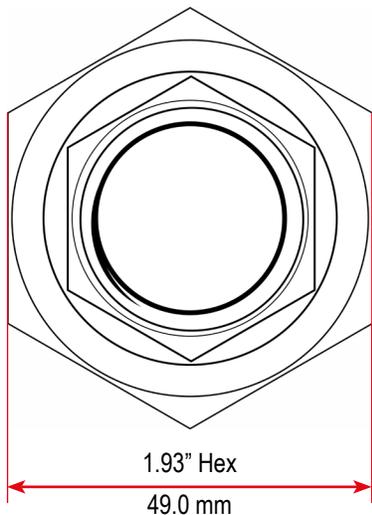
### Fiber optic length :

**VFS-2000-K15 : 15 feet or 4.6 meter**

**VFS-2000-K30 : 30 feet or 9.1 meter**



**STAINLESS STEEL, HIGH TEMPERATURE UNION**



**HIGH PRESSURE, HIGH TEMPERATURE WINDOW**

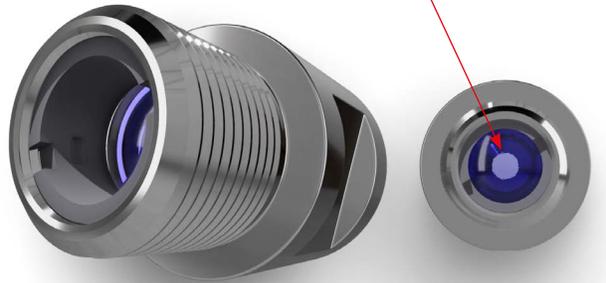
### The Cool End...

5 PIN MALE MIL-DTL-38999



### The Lens Housing...

LENS



### Hazardous area requirements:

The plastic "Loc Fast" retainers (supplied) must be installed over the electrical connector.



High temperature electrical cable & backshell with exterior cable braid



### Det-Tronics portable turbine sensor UV test lamp

Specifically designed, intrinsically safe and portable, battery operated source of ultraviolet radiation, emitting a wide band of UV radiation corresponding to the response of the turbine sensor.





## SPECIFICATIONS

VFS-2000-Kxx	
Service	FLAME SENSOR
Manufacturer	Fireye Inc
Hazardous area classification	Class I, Div 2 - Groups A,B,C & D, (North America). Ex II 3G Ex ec IIC T3 Gc (ATEX/IECEX)
Housing material	Stainless Steel 18-8 (304)
Mounting connection	3/4" male NPT
Min. operating temperature	32°F/0°C
Min. storage temperature	-40°F/-40°C
Max. operating temperature hot end	617°F/325°C
Max. operating temperature cool end	284°F/140°C
Humidity	100%
Vibration	Per IEC 60068-2-64, Stationary Installation, Category 3
Detection principle	Ultraviolet solid state sensor
Sensor	Silicon Carbide Diode
Sensitivity	1nW/cm <sup>2</sup> @310nm
Output	4-20mA DC, current loop
Flame Present Detection Time	175ms (typical < 75ms)
Flame Failure Detection Time	175ms (typical < 75ms)
Power supply	18-30 VDC
Reverse polarity protected	YES
Electrical connection	5-pin male MIL-DTL-38999 shell, size 15 series III hermetic, scoop proof
SIL Rating	SIL 3
SIL Certificate	EN61508
UL Certificate	UL 353, 5th Ed., Issue Date: 1994-09-23, Revision Date: 2011-11-08
CSA Certificate	C22.2 NO. 24-15, 9th Ed. Issue Date: 2015-01-01
CE Certificate	EUROPEAN COMMUNITY COUNCIL DIRECTIVE 2014/30/EU
Emissions	FCC Part 15, Subpart B, Class A (30MHz to 1GHz)
Expected lifecycle	36,000 hours
Warranty standard	18 Months

<b>63-180</b>	
Service	WINDOW
Housing material	Stainless Steel 316
Window	Sapphire glass
Mounting connection	3/4" female NPT
High pressure window, differential pressure	27ATM/400PSI/27.5 bar

<b>35-410</b>	
Service	UNION COUPLING
Housing material	Stainless Steel 316
Mounting connection	3/4" female NPT thread on both sides

	<b>59-606-40</b>	<b>59-606-60</b>	<b>59-606-80</b>	<b>59-606-100</b>
Service	CABLE & CONNECTOR			
Shield	YES			
Voltage	18-30 VDC			
Temperature range	-40°F/-40°C - 284°F/140°C			
Cable length	40 feet / 12.1 meter	60 feet / 18.1 meter	80 feet / 24.3 meter	100 feet / 30.4 meter

	<b>59-621-40</b>	<b>59-621-60</b>	<b>59-621-80</b>	<b>59-621-100</b>
Service	CABLE & CONNECTOR			
Shield	ARMORED			
Voltage	18-30 VDC			
Temperature range	-40°F/-40°C - 284°F/140°C			
Cable length	40 feet / 12.1 meter	60 feet / 18.1 meter	80 feet / 24.3 meter	100 feet / 30.4 meter



## PART NUMBERS

REFERENCE	DESCRIPTION
VFS-2000-K15	Turbine flame sensor with fiber optic length 15 feet / 4.6 meter, Incl. high pressure, high temperature window & union
VFS-2000-K30	Turbine flame sensor with fiber optic length 30 feet / 9.1 meter, Incl. high pressure, high temperature window & union
59-606-40	High temperature electrical cable & prefabricated molded connector 40 feet / 12.1 meter
59-606-60	High temperature electrical cable & prefabricated molded connector 60 feet / 18.1 meter
59-606-80	High temperature electrical cable & prefabricated molded connector 80 feet / 24.3 meter
59-606-100	High temperature electrical cable & prefabricated molded connector 100 feet / 30.4 meter
59-621-40	High temperature electrical cable & backshell with exterior cable braid. 40 feet / 12.1 meter, EU
59-621-60	High temperature electrical cable & backshell with exterior cable braid. 60 feet / 18.1 meter, EU
59-621-80	High temperature electrical cable & backshell with exterior cable braid. 80 feet / 24.3 meter, EU
59-621-100	High temperature electrical cable & backshell with exterior cable braid. 100 feet / 30.4 meter, EU

Contact your reseller to inquire about other lengths.

## PACKING

<b>Weight</b>	7 lbs	3.18 kg
<b>Length</b>	34.25"	870 mm
<b>Width</b>	34.25"	870 mm
<b>Height</b>	3.75"	95 mm



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## MECHANICAL INSTALLATION

### There are four components to the sensor installation:

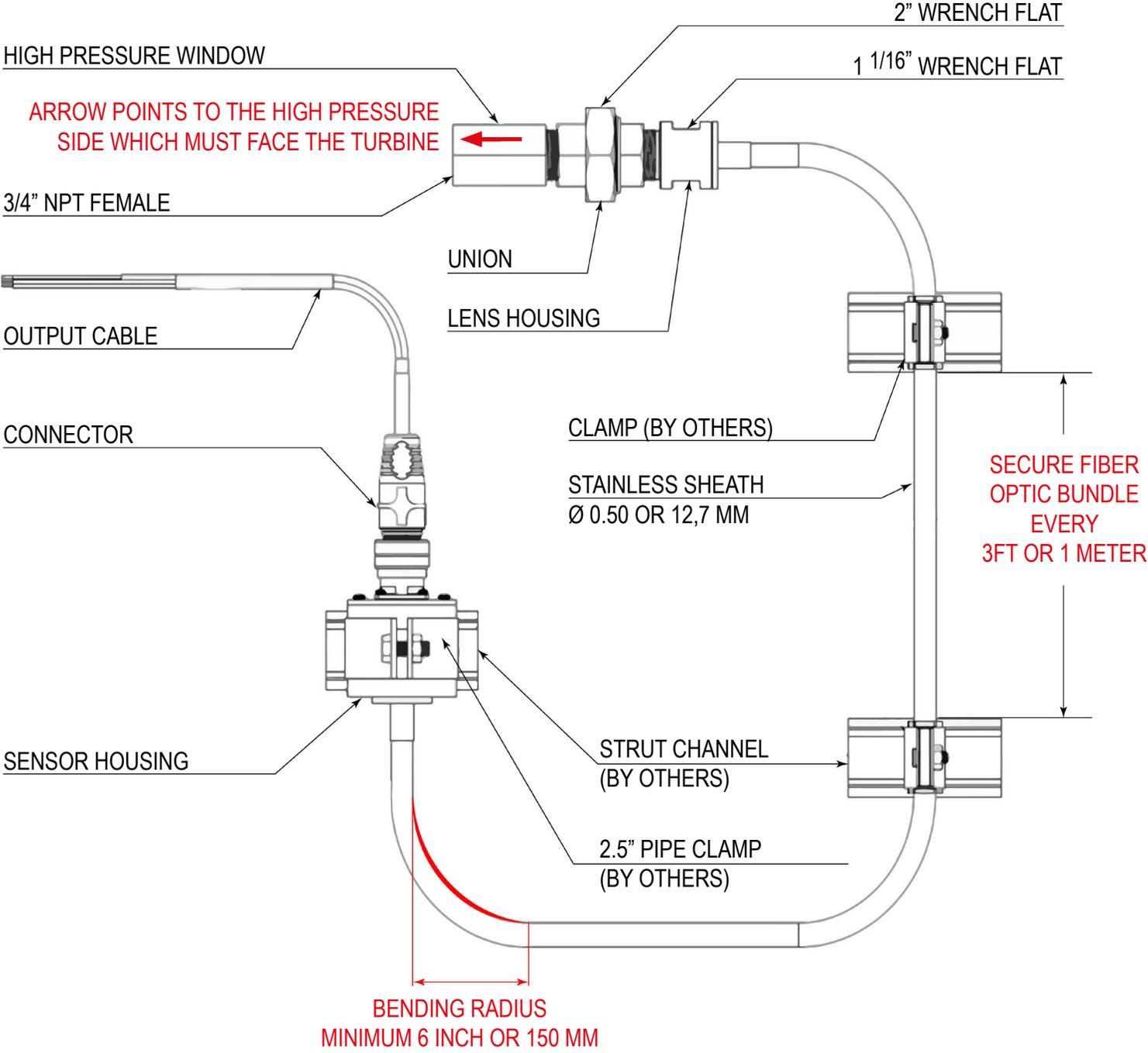
- Turbine Flame Sensor with integral optical fiber
- High pressure, high temperature window
- Stainless steel 3/4 inch high temperature union
- High temperature electrical cable

## INSTALLATION

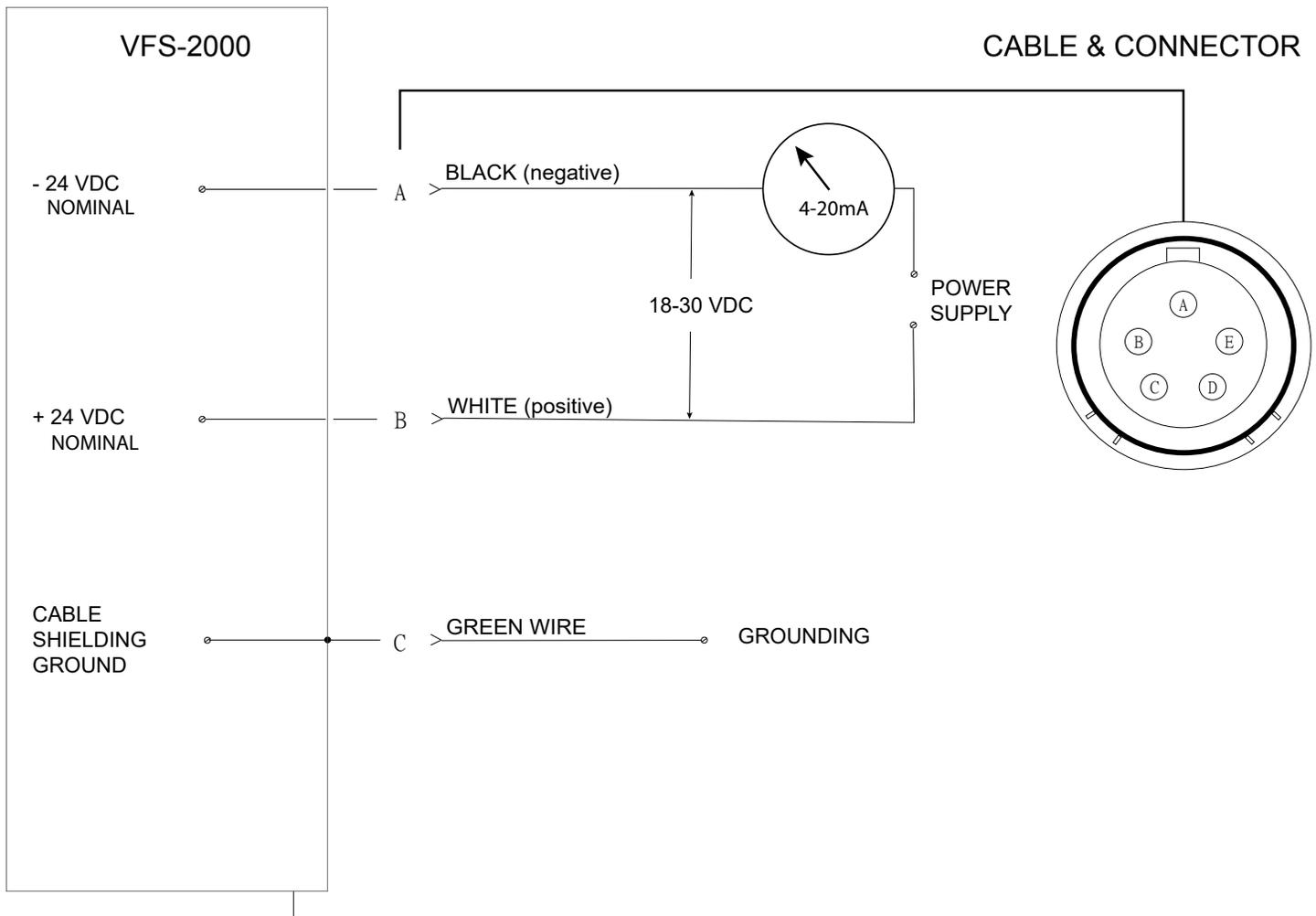
- First step: Check all items for possible damage and/or discrepancies. Do not install a flame sensor that has a cracked window, damaged threads, or one that has been disassembled.
- Inspect the turbine sensor connection. Make sure the thread is clean and undamaged.
- With respect to temperature, apply a small amount of high temperature lubricant to all threads before assembling. The use of hydrocarbon-based lubricant is not allowed.
- Before installing the HIGH PRESSURE WINDOW, make sure both sides of the window are clean and if necessary clean with isopropanol cotton swab. Make sure window is clean and completely dry before installing.
- The high temperature window on the hot end, rated to 325°C (617°F) and 27ATM/400 PSI (27.5 bar) has a 3/4 inch NPT thread on both sides and is marked to show the orientation to be installed on the turbine. Install the window on the turbine view port, hand-tight. Tighten with a 1<sup>1/4</sup> inch wrench or approximately 2.5 turns. STOP tightening when 125 ft-lbs of torque is reached.
- Separate the UNION and tighten one side to the HIGH PRESSURE WINDOW. Tighten with a 1<sup>1/4</sup> inch wrench for approximately 2.5 turns and STOP tightening when 125 ft-lbs of torque is reached.
- Install the other side of the UNION to the LENS HOUSING. Tighten with a 1<sup>1/4</sup> inch wrench, securing the LENS HOUSING with a 11/16 inch wrench for approximately 2.5 turns and STOP tightening when 125 ft-lbs of torque is reached.
- Mate the two union halves together. This will connect the LENS HOUSING with its integral fiber optic cable to the HIGH PRESSURE WINDOW. Tighten with a 2 inch wrench and a 1<sup>1/4</sup> inch wrench. DO NOT exceed 125 ft-lbs of torque. The union eliminates the need to rotate the fiber optic for installation.
- The FIBER OPTIC BUNDLE should not be routed with any radius less than 6 inches (15 cm). Fireye recommends P-clamps or similar be installed every 3 feet (1 meter) to support the fiber optic bundle and avoid damage caused by vibration.

### CHECK

The SENSOR HOUSING temperature limit is 284°F/140°C. It is sealed against dust and fluids exposure & designed to be mounted with a 2.5 inch pipe clamp (not supplied).



## WIRING DIAGRAM



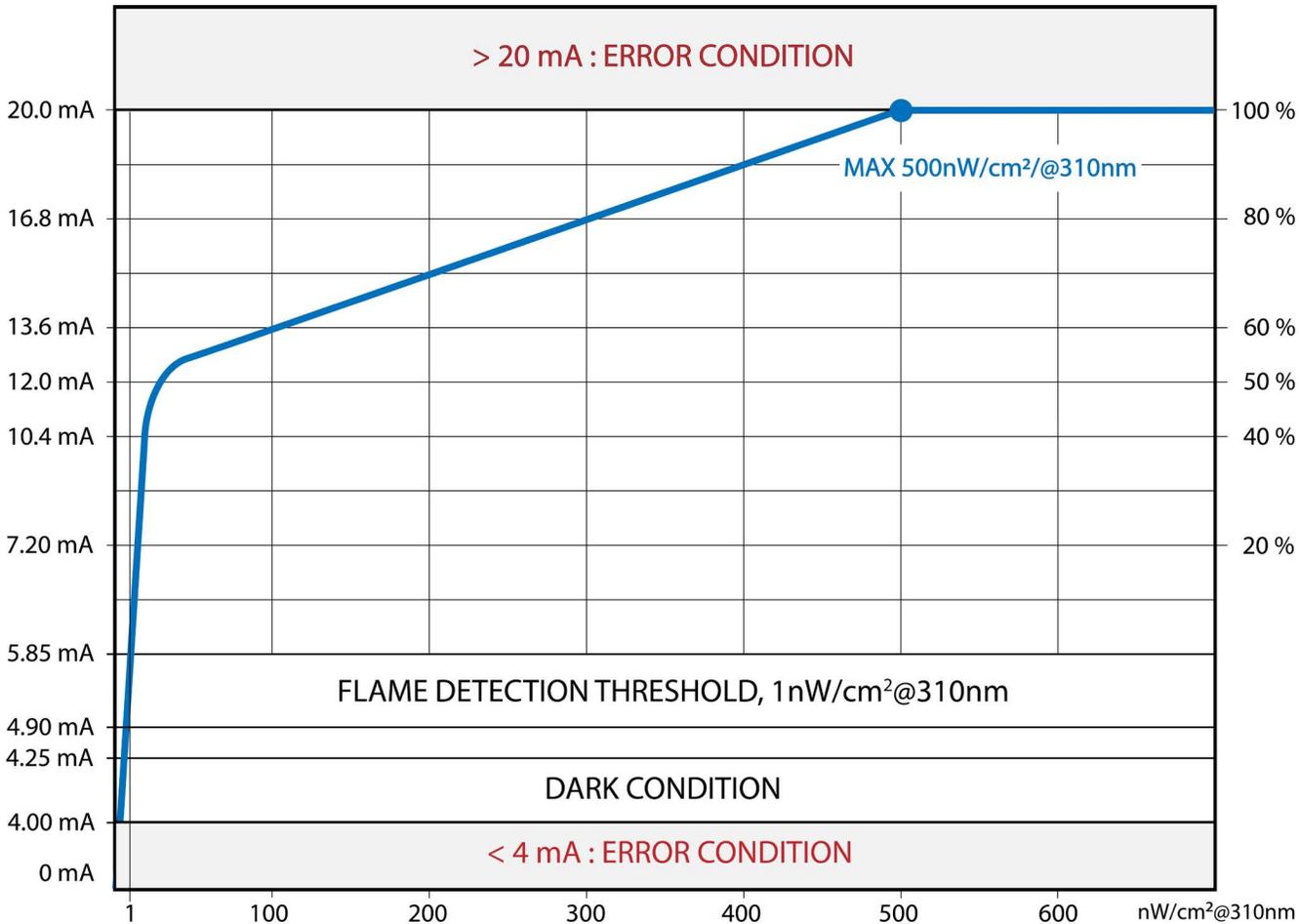
## ELECTRICAL INSTALLATION

- Before attempting any work on this equipment or any equipment controlled by or connected to this equipment, all related electrical supplies **MUST** be isolated off.
- Mount the OUTPUT CABLE along the strut channel around the turbine with sufficient length to handle the connector. The electrical cable must be routed in conduit and the conduit must be grounded.
- Do not use excessive torque when mating as connector damage may result.
- Wire the cable to the junction box.
  - BLACK: -24 VDC (negative) A
  - WHITE: +24 VDC (positive) B
  - GREEN WIRE: Grounding C

**CHECK**



# OUTPUT



CONDITION	BRIGHTNESS	ANALOG OUTPUT
FLAME OFF	DARK	< 4.25mA
FLAME ON	1nW/cm²@310nm	between 4.90mA & 5.85mA
Maximum flame	> 500nW/cm²	< 20mA

- A current less than 4mA or greater than 20mA are considered error conditions.
- The response time is less than 175ms. (Typically < 75ms)

## MAINTENANCE

No calendar/time-based preventive maintenance is required.

The feedback from the sensor however provides data that can be used for machine learning and to indicate the necessity for maintenance interaction. Monitoring the data will contribute in reducing reliability risks for operations.

### Following events may trigger a technical intervention :

- A value below 4mA or above 20mA indicates an error condition.  
*Check wiring, polarity and grounding*
- A significant signal drop during operation may indicate the presence of condensation or dirt.



## LAST MINUTE RISK ANALYSIS (LMRA)

Following items serve as a guideline to complete the LMRA in place and do not overrule any local regulations.

- Danger of hot surface**  
A hot surface can burn skin, either by contact or from radiated heat. The eyes are particularly sensitive to burning, especially from UV light radiation. Follow local Personal Protective Equipment (PPE) guidelines with fire-resistant garments and gloves, face masks and eye protection as a minimum.
- Danger of explosion**  
for manipulating an electrical connector in a hazardous area, where there is potential for an explosive atmosphere special precautions apply. Please verify local regulations. Wearing a gasdetector as a minimum requirement.
- Risk of high pressure & high**  
The turbine sensor is mounted on a high pressure, high temperature viewport. Ensure correct handling of the isolation valve prior to removing any of the turbine sensor components.

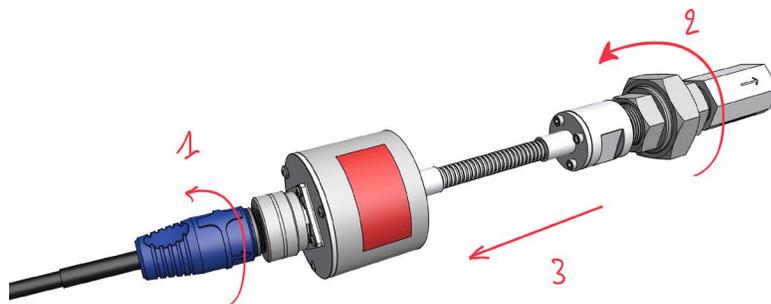
CHECK



## MAINTENANCE PROCEDURE

### STEP 1 : REMOVE THE SENSOR

- Disconnect the electrical connector to remove the power from the sensor.  
Caution : this may lead to an alarm in the control room.  
**HIGH TEMPERATURE, HIGH PRESSURE WARNING!**
- Open the 3-piece union coupling to disconnect the hot end from the turbine.
- Check all items for possible damages and/or discrepancies.
- Check the visibility of the flame by looking through the high pressure, high temperature window. **USE EYE PROTECTION!**
- Clean or replace the high pressure, high temperature window if necessary.

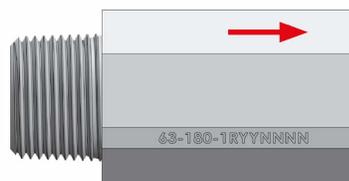


CHECK

### STEP 2 : IF NEEDED, CLEAN OR REPLACE HIGH TEMPERATURE, HIGH PRESSURE WINDOW

#### **HIGH TEMPERATURE/HIGH PRESSURE WARNING!**

- Close the block valve in front of the window completely.
- Remove the window.
- Check for possible damages and/or discrepancies.
- Replace in case of cracked window or damaged threads.
- Clean the window from both sides with an isopropanol cotton swab.
- Make sure window is clean and completely dry before re-installing.
- Install the window and tighten with a 1<sup>1/4</sup> inch wrench for another 2.5 turns, approximately.
- Make sure the arrow points towards the turbine.



- Repeat the visibility check of the flame by looking through the high pressure, high temperature window. **USE EYE PROTECTION!**
- Repeat the cleaning procedure if necessary.

CHECK

### STEP 3 : TEST TURBINE SENSOR FUNCTIONALITY

- Place the turbine sensor in a comfortable position to prevent it from falling, within reach of the electrical connector
- Re-connect the electrical connector to power the turbine sensor.
- Be sure to wear proper **EYE PROTECTION**.
- Check all items for possible damages and/or discrepancies.
- Place the portable, Intrinsically safe UV test lamp in front of turbine sensor window as shown below to simulate a flame.
- A good functional test lamp, close and in front of a good functional turbine sensor returns a signal between 5mA and 20mA.  
We recommend to replace the turbine sensor for any value below 5mA or above 20mA.

**CHECK**



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## LABEL



**VFS-2000-K30**

Input Power: 24VDC, 1VA

YYWW-EC

DERRY, NH  
MADE IN U.S.A.

CE UK CA

FUNCTIONAL SAFETY

UL US LISTED

Intertek  
5010076

Conforms to UL 121201  
Certified to CSA STD C22.2 No. 213

CLASS I DIVISION 2, GROUPS A,B,C  
AND D. HAZARDOUS LOCATIONS,  
T3C 0°C TO +140°C

II 3G Ex ec IIC T3 Gc -40°C ≤ Ta ≤ 140°C  
ATEX - ITS-I ATEX38197X  
IECEX - IECEX ETL 23.0046X

Turbine Flame Sensor  
274R  
ALSO INVESTIGATED TO  
EN/IEC 61508, Parts 1 - 2 (2010) UP TO SIL 3  
See installation manual for safety functions

SEE **CU-125** INSTRUCTIONS BEFORE USE

UL US LISTED  
Turbine Flame Sensor  
16N8



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## CERTIFICATIONS

- SIL3 Certificate EN/IEC 61508
- UL Certificate UL 353, 5th Ed., Issue Date: 1994-09-23, Revision Date: 2011-11-08
- CSA Certificate C22.2 NO. 24-15, 9th Ed. Issue Date: 2015-01-01
- CE: EUROPEAN COMMUNITY COUNCIL DIRECTIVE 2014/30/EU
- UKCA
- ATEX: ITS-I ATEX38197X
- IECEX: IECEX ETL 23.0046X



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## NOTICE

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

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## WARRANTIES, EXCLUSIVE REMEDIES, AND LIMITATION OF DAMAGES

Fireye guarantees for one year from the date of installation or 18 months from the date of manufacture, whichever occurs first, to replace, or at its option, to repair any product or part thereof which Fireye, in its sole discretion, deems to be defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of its sales order. Fireye's obligations pursuant to this warranty do not extend to any products or parts thereof which Fireye determines to have been installed, operated, maintained, repaired, or altered improperly or otherwise than in conformity to Fireye's applicable instructions, or which have been subject to misuse, accident or neglect.

**THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, BOTH EXPRESS AND IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. EXCEPT AS SPECIFICALLY STATED IN THESE TERMS AND CONDITIONS OF SALE, REMEDIES WITH RESPECT TO ANY PRODUCT OR PART MANUFACTURED OR SOLD BY FIREYE, OR WITH RESPECT TO ANY BREACH OF OR DEFAULT UNDER THIS CONTRACT (INCLUDING ANY BREACH OF WARRANTY), SHALL BE LIMITED EXCLUSIVELY TO THE RIGHT TO REPLACEMENT OR REPAIR F.O.B. FIREYE MAIN WAREHOUSE LOCATION, AS ABOVE PROVIDED. IN NO EVENT SHALL FIREYE BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY NATURE WHICH MAY ARISE IN CONNECTION WITH SUCH PRODUCT OR PART OR ANY BREACH OF OR DEFAULT UNDER THIS CONTRACT. TO THE EXTENT PERMITTED BY LAW, THE AGGREGATE LIABILITY OF FIREYE HEREUNDER WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, WILL BE LIMITED TO ONE TIMES THE CONTRACT VALUE, PROVIDED HOWEVER THE FOREGOING LIMITATION DOES NOT LIMIT THE LIABILITY OF FIREYE FOR ANY INJURY TO, OR DEATH OF A PERSON, CAUSED BY THE GROSS NEGLIGENCE OF FIREYE**

Fireye, Inc.  
3 Manchester Road  
Derry, New Hampshire 03038 USA  
[www.fireye.com](http://www.fireye.com)

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