Reuter-Stokes

Flame Tracker Dry 325

Hazardous area - Class I, Division 1, Zone 0

Operation and Maintenance Manual

Applicable to part numbers:

RS-FS-9010-03

RS-FS-9010-03-25X

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Revision: M
August 2025

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

IMPORTANT INFORMATION

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If this equipment is used in a manner not specified by the manufacturer, the protection provided by the design of this equipment may be impaired.

This instrument contains no operator serviceable parts and should be serviced by qualified personnel only.

WARNINGS AND CAUTIONS

Information and Safety Paragraphs

Note: These paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.

WARNING: THESE PARAGRAPHS INDICATE A RISK OF POTENTIAL SERIOUS PERSONAL INJURY, UNLESS THESE INSTRUCTIONS ARE FOLLOWED CAREFULLY.

CAUTION: THESE PARAGRAPHS INDICATE A RISK OF POTENTIAL MINOR PERSONAL INJURY AND/OR SEVERE DAMAGE TO THE EQUIPMENT, UNLESS THESE INSTRUCTIONS ARE FOLLOWED CAREFULLY.

IMPORTANT: *THESE PARAGRAPHS PROVIDE INFORMATION THAT EMPHASIZES INSTRUCTIONS THAT ARE ESSENTIAL TO PROPER SETUP OF THE EQUIPMENT. FAILURE TO FOLLOW THESE INSTRUCTIONS CAREFULLY MAY CAUSE UNRELIABLE PERFORMANCE.*

General Safety Issues

The user must make sure to operate all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

WARNING: 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.

CAUTION: THE **FLAME TRACKER DRY** IS DESIGNED TO OPERATE AT EXTREME TEMPERATURES. DO NOT ATTEMPT TO WORK ON THE **FLAME TRACKER DRY** UNTIL IT HAS REACHED A SAFE HANDLING TEMPERATURE.

AVERTISSMENT! RISQUE D'EXPLOSION. NE PAS BRANCHER NI DEBRANCHER SOUS TENSION.

OVERVIEW

The information contained in this document is applicable to all models of the Flame Tracker Dry 325 (FTD325) listed on the title page. There are small differences between these models as shown in Table 1.

Model	Gain	Nominal Cable Length
RS-FS-9010-03	Standard	30 feet (9.1 m)
RS-FS-9010-03-25X	Increased Low Gain (ILG)(*)	30 feet (9.1 m)

Table 1: Sensor Differences

(*) Gain is increased by roughly 2.5X for a given flame input signal until the output reaches between 11 and 12 mA, at which time the output is the same for all models.

General Description

The Flame Tracker Dry 325 (FTD 325) is an ultraviolet (UV) light sensor used to measure the intensity of UV radiation emitted by the flame in a combustion chamber. When used in combination with appropriate threshold values, the sensor indicates if the flame is on or off. It is a key sensor for safe operation. RS flame sensors use a silicon carbide photodiode that is tuned to the 310 nm peak that is prominent in hydrocarbon and hydrogen flames. This results in high sensitivity and excellent detection of a wide range of fuels. UV sensors are inherently fast. Unlike IR sensors, they do not respond to black body radiation. RS flame sensors do not need to use flame flicker analysis and are thus faster than IR sensors. In addition, the RS flame sensors operate at low power, nominal 24 VDC and 4-20 mA, which enables safe and easy installation in hazardous areas.

SPECIFICATIONS

Mechanical

External Material:	300 series stainless steel
Mechanical Interface Hot End:	3/4" NPT female, 2-1/4" union nut
Mechanical Interface – Cool End:	2-1/2" pipe clamp for 1-5/8" strut channel
Cool End Connector:	MIL-C-38999 Series III size 15 (5 pin)
Sensing Element:	Silicon Carbide photodiode
Sensor Window:	Sapphire

Operating

Sensitivity:	>5 mA @ $1x10^{10}$ photons/in^2/sec. @ 310 nm for RS-FS-9009-03
	>6.25 mA @ $1x10^{10}$ photons/in^2/sec. @ 310 nm for RS-FS-9009-03-25X and RS-FS-9009-03-173
Output:	Operating: 4 - 20 mA dc, Max < 21 mA
Response time	<175 milliseconds
Power Requirements:	12 - 30 VDC @ > 100 mA, nominal 24 VDC
	Max voltage 300 Vrms
Cool end temperature (ambient):	-51°C to 140°C (-60°F to 284°F)
Hot end temperature (ambient):	-51°C to 325°C (-60°F to 617°F)
Relative Humidity	100%
Process Pressure	400 psig (2.8 Mpa)

INTERCONNECTING CABLE

The recommended cable to attach the flame sensor to the junction box is the RS-E2-0285PXXX. A right-angle cable version is shown in Figure 1. Dimensions shown are in inches (mm) and are reference only.

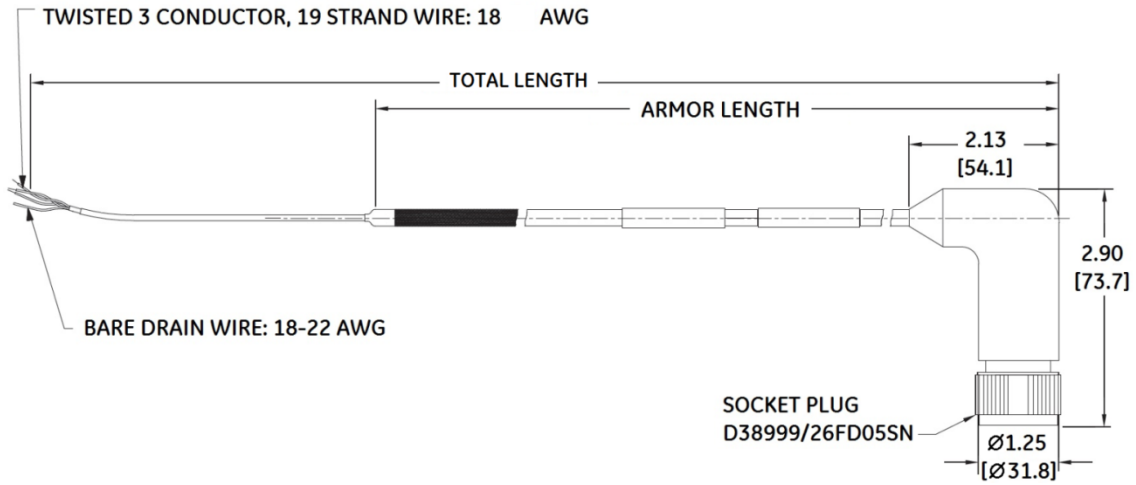

Figure 1: 4-20 mA Interconnect Cable

Connector: MIL-DTL-38999 series III, shell size 15, 5 #16 pins

Voltage (max): 300 VRMS

Temperature (max): 250°C (482°F)

The available cable part numbers are listed in Table 2: Available Interconnect Cables

.

Interconnecting Cable Part Number	Total Length ft [m]	Armor Length in [cm]	Connector Type
RS-E2-0285P001	60-62 [18.3-18.9]	36 [91.4]	Right Angle
RS-E2-0285P003	60-62 [18.3-18.9]	75 [190.5]	Right Angle
RS-E2-0285P004	120-123 [36.6-37.2]	36 [91.4]	Right Angle
RS-E2-0285P021	15-17 [11.9-12.50]	36 [91.4]	Right Angle
RS-E2-0285P011	60-62 [18.3-18.9]	36 [91.4]	Straight
RS-E2-0285P012	120-122 [36.6-37.2]	36 [91.4]	Straight
RS-E2-0285P013	60-62 [18.3-18.9]	96 [243.8]	Straight
RS-E2-0285P010	60-62 [18.3-18.9]	120 [304.8]	Straight

Table 2: Available Interconnect Cables

MECHANICAL DIMENSIONS

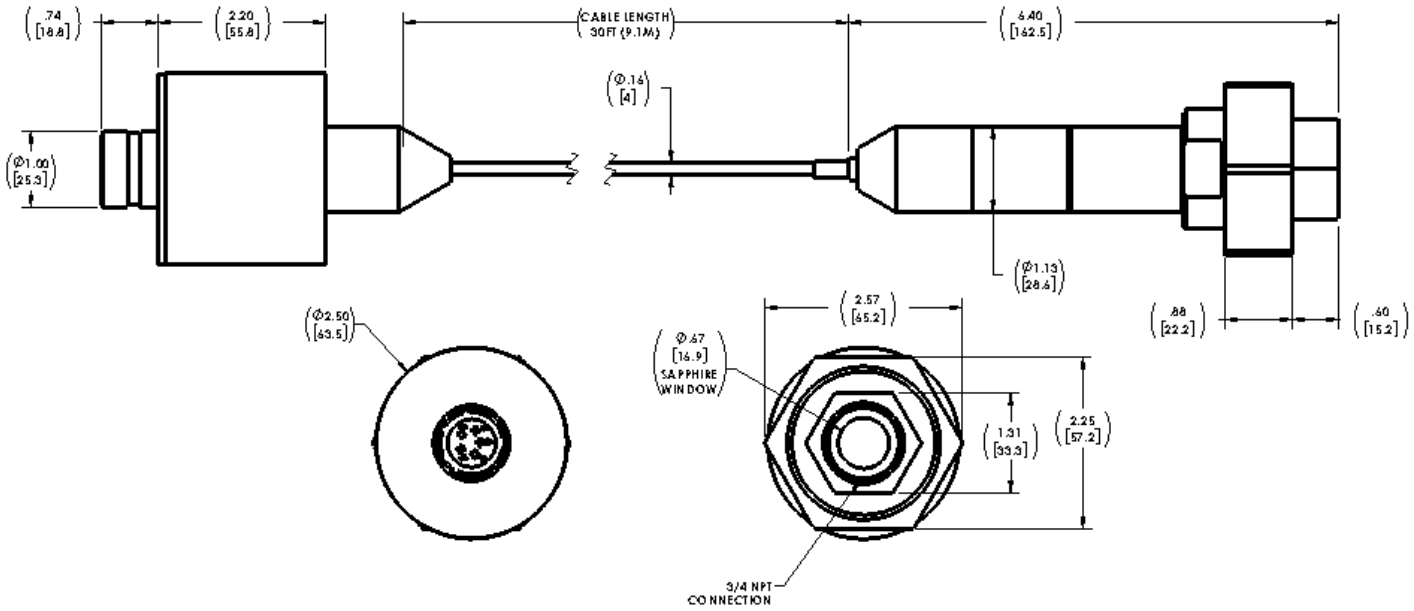

Figure 2: Mechanical Dimensions

Dimensions in inches [millimeters]

Dimensions are for reference only

CONNECTOR PINOUT

The pinout for the connector is shown in Table 3: Cool End Connector Pinout

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Pin	Signal	Wire Color for RS-E2-0285PXXX cable
A	-	Black
B	+	White
C	Ground	Green
D	Not used	n/a
E	Not used	n/a

Table 3: Cool End Connector Pinout

SENSOR

Figure 3 is a block diagram of the Flame Tracker Dry. Inside the *Hot End* assembly a lens focuses UV light from the combustion reaction onto a silicon carbide photodiode, which converts it into an electrical current in proportion to the intensity of the UV light. The photodiode is connected, via the *sensor cable*, to an amplifier in the *Cool End* assembly. The amplifier has a high initial gain, which automatically shifts to a lower gain to accommodate a wide range of input light levels without saturating. The sensor regulates the supply current in proportion to the intensity of the UV light. Both power and signal are transmitted on the same two wires on the output of the *Cool End*. The sensor can be powered from a DC voltage between 12 and 30 volts.

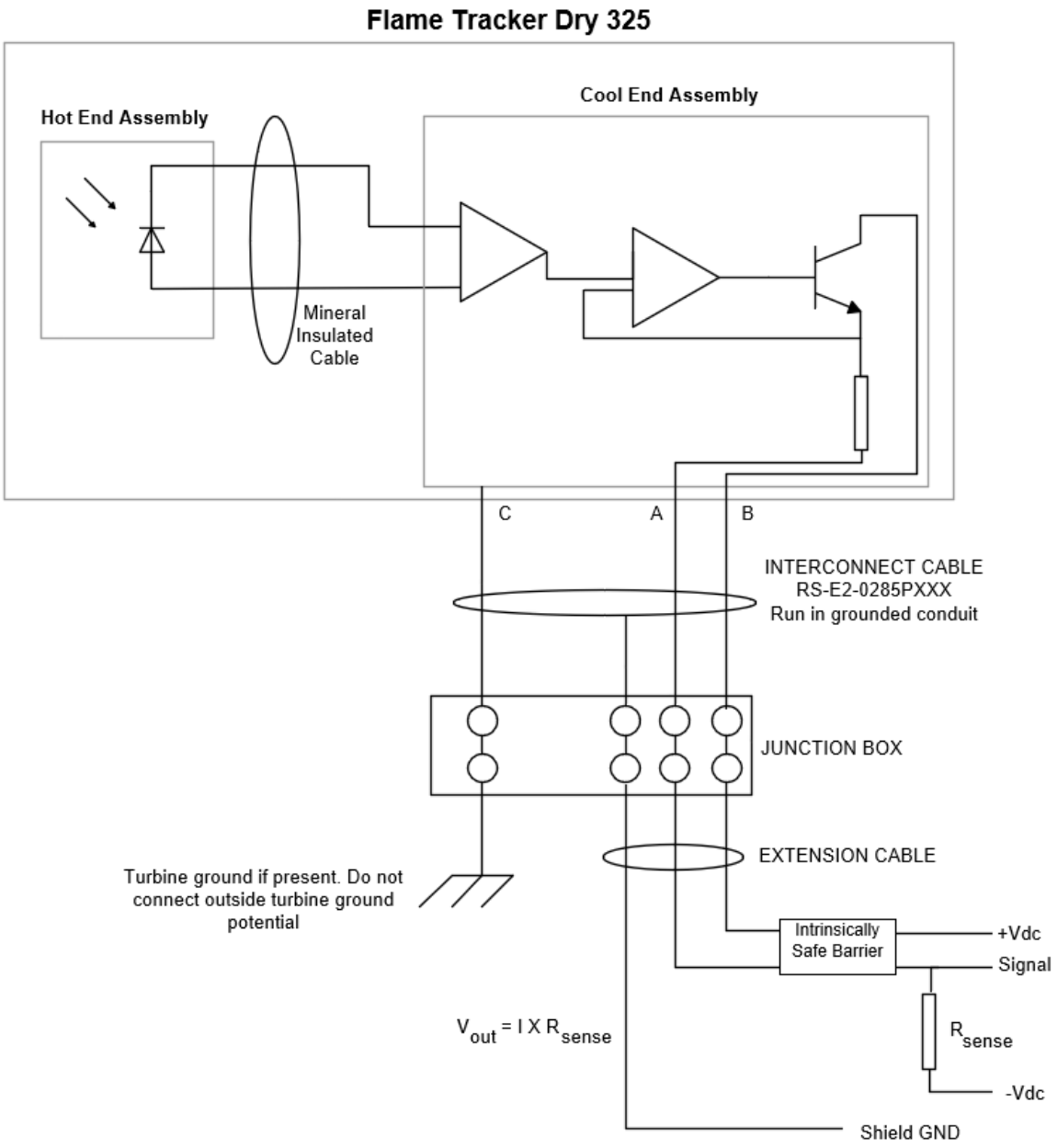


Figure 3: RS-FS-9010-03-XXX Block Diagram

INSTALLATION

WARNING: 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.

AVERTISSMENT! risque d'explosion. Ne pas brancher ni debrancher sous tension.

NOTE: DO NOT INSTALL A FLAME SENSOR THAT HAS A CRACKED WINDOW, DAMAGED THREADS, OR ONE THAT HAS BEEN DISASSEMBLED.

NOTE: MAINTAIN A MINIMUM BEND RADIUS OF 6 INCHES FOR ALL BENDS OF THE MI CABLE.

NOTE: STORE SENSORS IN SHIPPING CONTAINER PROVIDED. KEEP IN PLASTIC BAG WITH DESICCANT, THE DUST CAP IS TO REMAIN INSTALLED ON THE COOL END CONNECTOR UNTIL TIME OF INSTALLATION.

The Hot End of the FTD 325 is mounted onto the sight tubes of the combustion chambers. The MI cable must be supported every three feet. The Cool End is mounted in a location where ambient temperature will not exceed the value shown in the specifications above. RS offers kits that include installation hardware for the hot end, MI cable, and cool end. See Figure 4 for an example installation on a Frame 7F turbine.

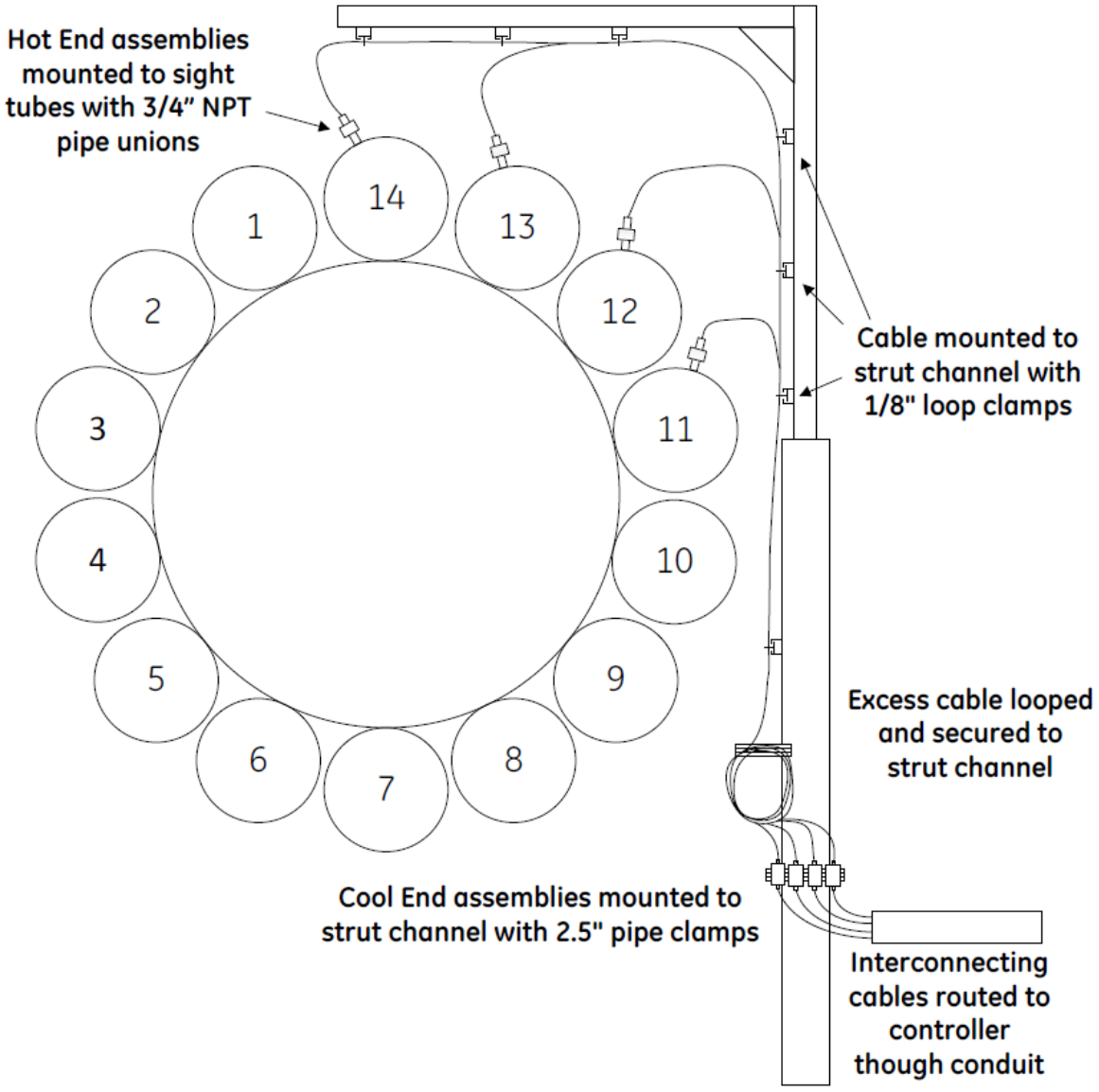


Figure 4: GE 7F Mounting Example

Note: Guide the Cool End down to the Cool End mounting location. Use care in handling the Cool End during the installation process to protect the electronics located inside the Cool End.

Example 7EA Turbine Detector and Cable Routing

Figure 5 shows one possible installation on a 7EA turbine. Before installing the cool ends, the user must ensure that maximum ambient temperatures for the cool ends do not exceed those listed in the Specifications.

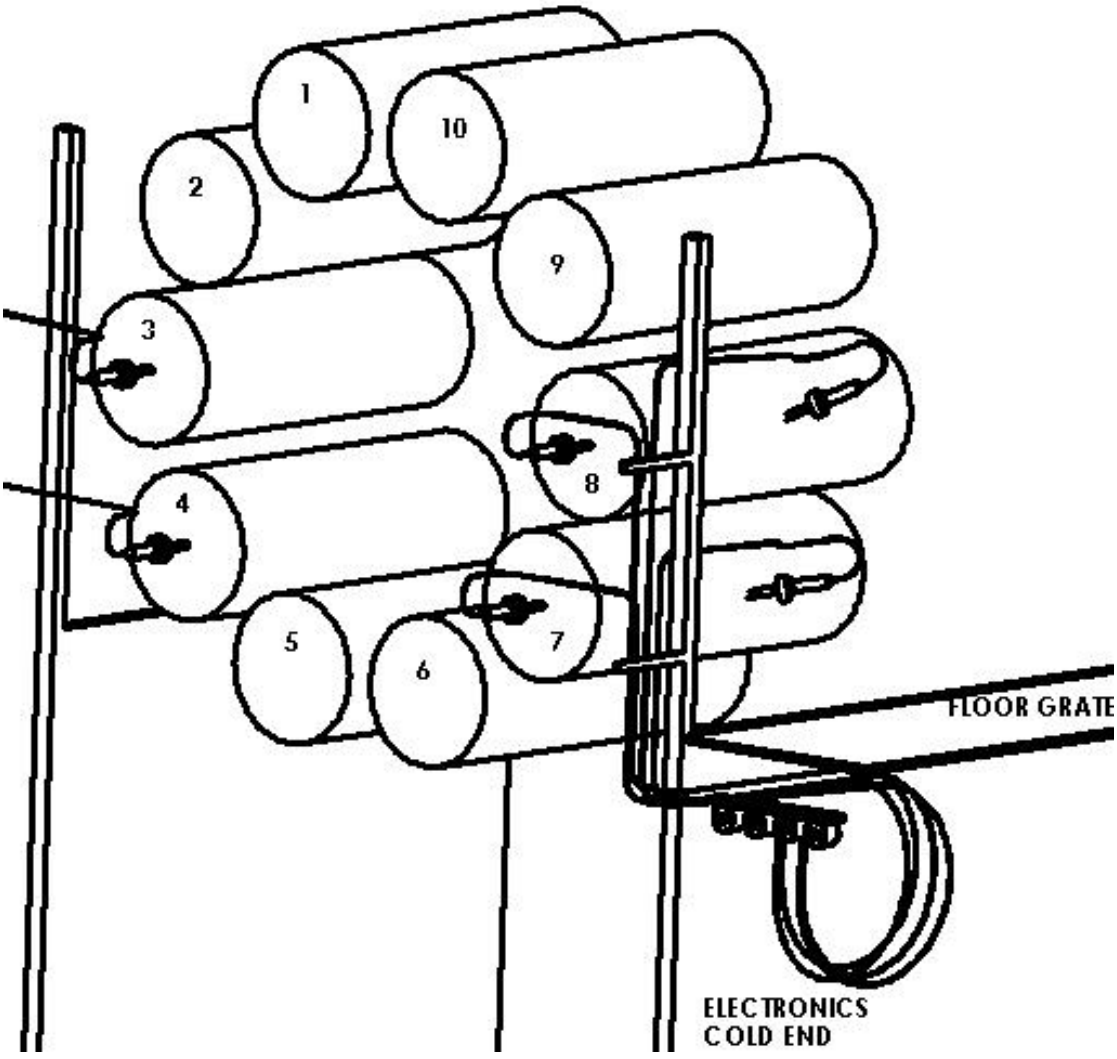


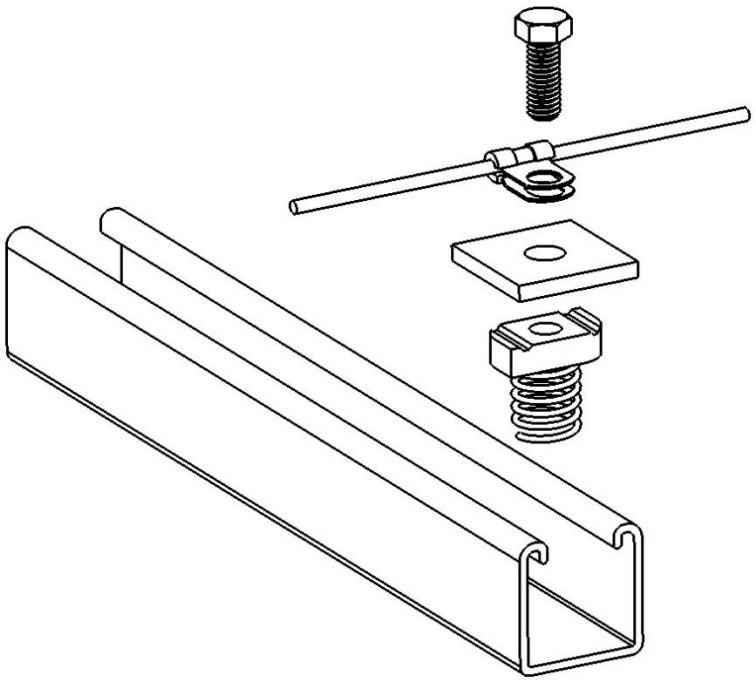
Figure 5: Sample 7EA Installation

MI CABLE INSTALLATION

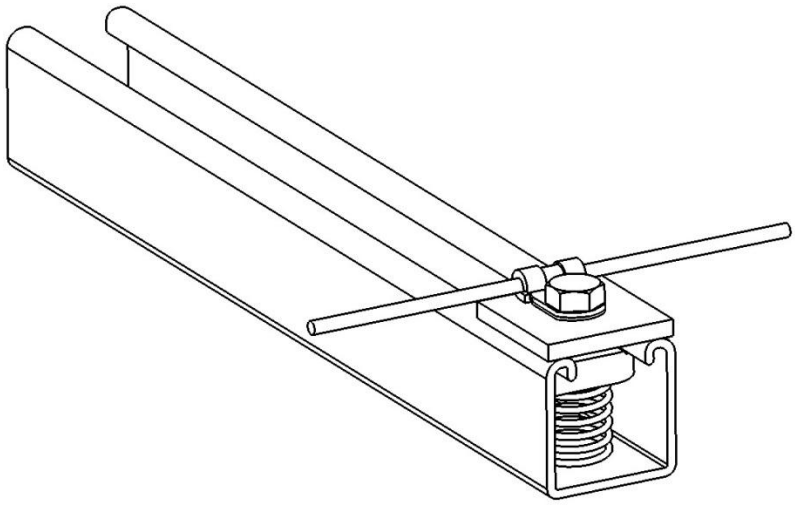
Mount the *sensor cable* to the strut channel using 1/8" cushioned loop clamps with silicone cushions. The silicone cushions prevent metal-to-metal contact under vibration, which can damage the MI cable. Vibration occurs at the hot end because the combustion chamber and sight tube vibrate. See the images below for the recommended cable mounting.

IMPORTANT: *The cable must be secured at least every 3ft. The minimum bend radius of the cable is 6 inches.*

1. Place the loop clamp on the *sensor cable* and position it over the opening in the strut channel.



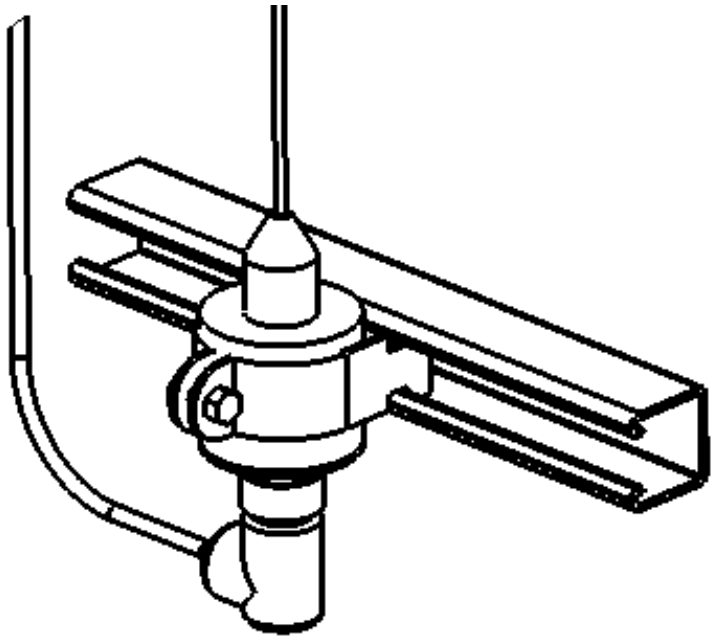
2. Place the mounting nut in the strut channel and secure the installation using a bolt.



At the Cool End, the extra cable should be looped and mounted to a nearby strut channel using any convenient means.

COOL END INSTALLATION

The *Cool End* is to be mounted in a location where the ambient temperature does not exceed the maximum operating temperature listed in the Specifications section. In most cases, this is below the turbine on the pedestal or I-beam on F-Class gas turbines or under the foot grating on E-Class gas turbines. Mount the *Cool End* to the strut channel using a 2-1/2" pipe clamp.



1. Mount the *Cool End* on a 1-5/8" strut channel using 2-1/2" pipe clamp.

2. Attach the *interconnecting cable* to the large connector on the bottom of the cold end as shown above. Spin the coupling nut on the connectors until the blue line on the cable connector completely covers the red line on the housing connector. This indicate the connectors are fully engaged.

3. The interconnect cable has a short, armored section on the connector end. The armor provides electrical shielding. The rest of the interconnect cable is not armored and must be routed through grounded conduit for electrical shielding. Ensure that only the armored cable section protrudes from the conduit. Reference the Interconnect Cable section of this manual for armored cable specifications.

4. The strut channel used for mounting the Cold Ends (electronics) must also be grounded.

IMPORTANT: *Do not use excessive torque when mating these connections as connector damage may result. The connectors should be engaged by hand without the use of tools.*

Note: *Do not discard the protective caps covering the connectors as they will be reinstalled to prevent damage to the connectors during maintenance outages.*

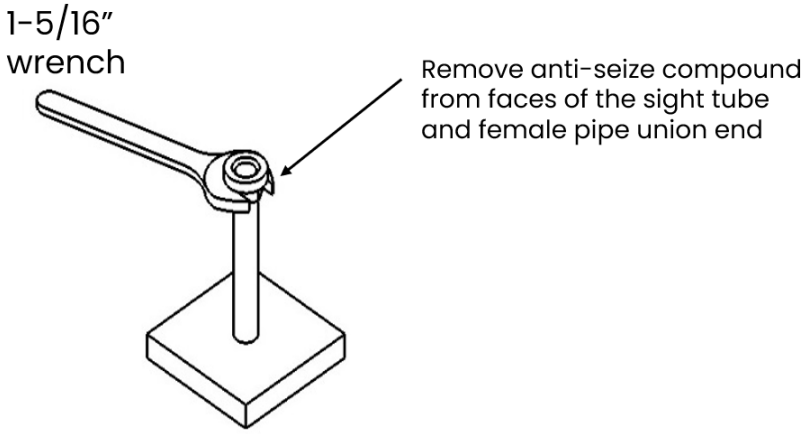
HOT END INSTALLATION

1. Before installing the Hot End onto the sight tube, perform a sensor functional test per the Sensor Checkout section. The flame sensor is installed to the sight tube using a pipe union. The pipe union consists of a 2-1/4" union nut, a female-end to be installed on the sight tube, and a male end that is integral to the flame sensor. To avoid damage to the sensor and the *sensor cable*, two wrenches must be used when installing the Hot End onto the sight tube. See the installation and removal steps below.

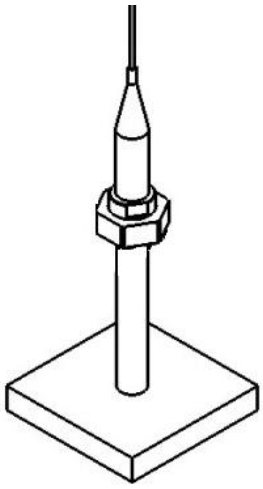
2. Apply a small amount of anti-seize compound, such as NEVER-SEEZ, PART NO NG-165, to the external threads of union nut and the threads of the sight tube prior to installing the Hot End of the flame sensor. Be sure the anti-seize compound applied to both parts is minimal and only applied below the 2nd thread. If anti-seize compound is applied to the face of the sight tube or union nut, upon heating, it can fog the window of the flame sensor and reduce output.

3. Inspect the window and clean if required. See the Cleaning the Sensor Window section.

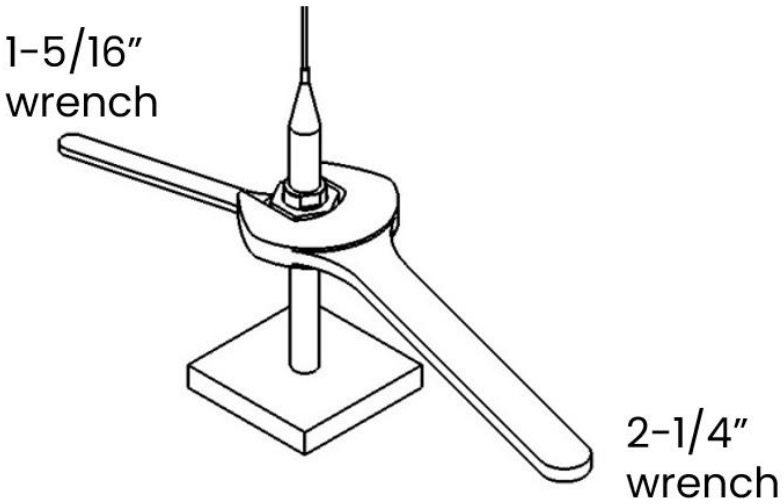
4. Tighten female pipe union onto the sight tube hand tight (3-4 full turns). Tighten with a 1-5/16" wrench approximately 2.5 additional turns.



5. Tighten the *union nut* to the f*emale pipe union* end by hand.



6. Use a 1-5/16" wrench to hold the f*emale pipe union end*. Tighten the *union nut* 120 ft.-lbs. using a 2-1/4" wrench. . While the union nut is being tightened, the female pipe union should stay stationary. Rotation of the hot end and MI cable can occur, but the rotation should not exceed ¼ turn.



7. To temporarily remove the hot end from the sight tube, reverse the instructions in step 6. The female pipe union end may be left on the sight tube. Remove the MI cable from a sufficient number of strut channel clamps and coil up the section of the hot end that is over the turbine. Tie up the coiled hot end and place to the side during outage activities.

CAUTION: THE FLAME SENSOR SEALS HIGH PRESSURES WITHIN THE TURBINE. THE UNION NUT AND FEMALE PIPE UNION END MUST BE TIGHTENED TO THE SPECIFIED TORQUE. INSUFFICIENT TORQUE COULD RESULT IN COMBUSTION GASES BEING RELEASED INTO THE TURBINE COMPARTMENT.

DO NOT WRENCH ON THE SENSOR BODY. ONLY APPLY WRENCHES TO THE HEXAGONAL FEMALE PIPE UNION END AND UNION NUT. WRENCHING ON THE SENSOR BODY MAY CAUSE HOT END DISASSEMBLY AND DAMAGE AND CAN RESULT IN THE MALFUNCTION OF THE SENSOR.

NOTE: UNION NUT SELF-ALIGNS THE FLAME SENSOR BODY TO THE SITE TUBE. THE UNION NUT MUST BE TIGHTENED TO THE SPECIFIED TORQUE. INSUFFICIENT TORQUE COULD RESULT IN POOR FLAME SENSOR SENSITIVITY.

WIRING TO THE CONTROLLER

The sensors are connected to the turbine junction box with *interconnecting cable* RS-E2-0285PXXX. The RS-E2-0285PXXX consists of black, white and green wires twisted and shielded.

IMPORTANT: *All interconnecting cables must be in grounded conduit. The green wire must be connected to earth ground at the junction box. Do not connect the shields to each other or to earth ground at any location. The shields should be individually jumped through all junction boxes and connected to the proper ground terminal at the controller.*

The polarity of the *interconnecting cable* is as follows; white is positive and black is negative/signal return. Reverse polarity will not damage the sensor but will prevent it from operating. Signal cables from the junction box to the controller should be 18

gauge (1.02 mm) twisted shielded pair. The extension cable from the junction box to the controller is the customer's responsibility.

The Flame Tracker Dry is connected to the controller through an active intrinsically safe barrier. Do not use passive barriers since they will prevent the sensor from operating properly. The two recommended barriers are the STAHL 9001/51-280-110-141 and the MTL 7706+. They can be operated from any well-filtered DC supply from 20 volts to 30 volts. The nominal operating voltage is 24 VDC. The power supply should be capable of providing 100 milliamps and must be current limited. The sensor is protected against reverse polarity.

The power supply must be protected to prevent the supply voltage from exceeding 30 volts in normal use and more than 42 volts under transient conditions. The maximum value for the sense resistor plus the wire resistance is dependent on the supply voltage. At 24 volts this value is 560 ohms. Resistance values for other voltages can be determined from the chart in Figure 6.

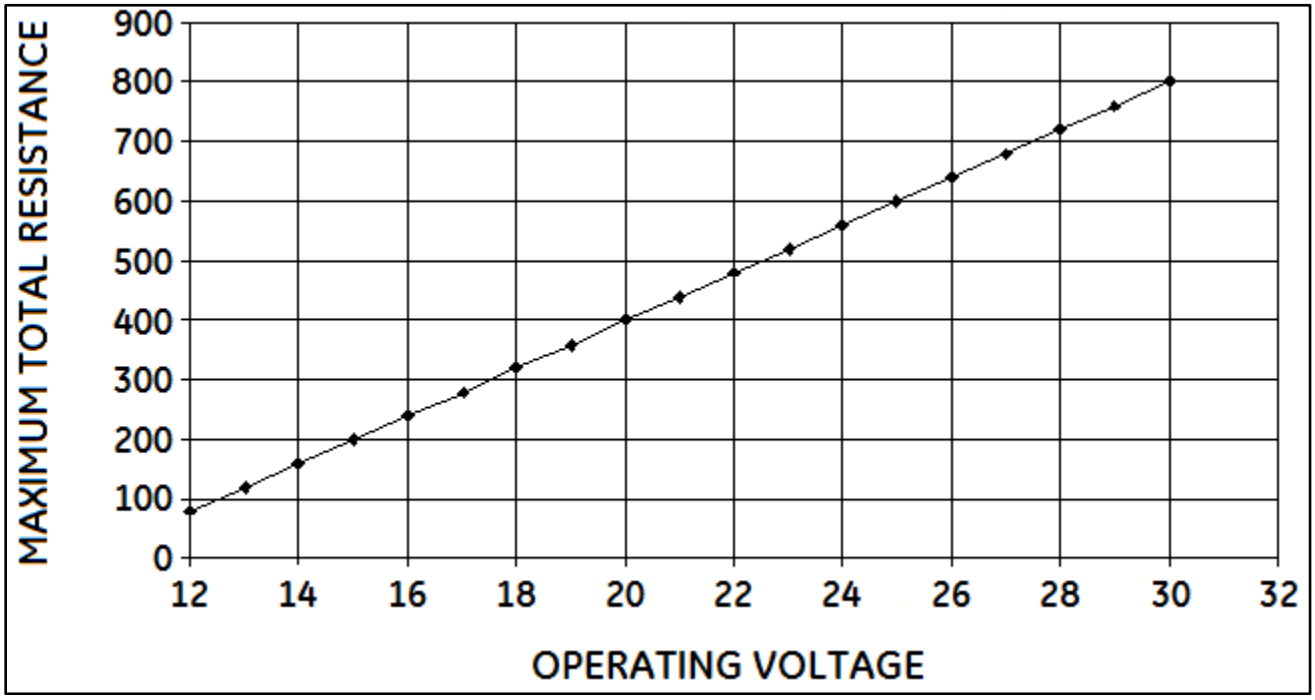


Figure 6: Maximum Resistance vs. Operating Voltage

Figure 3 shows the preferred wiring for the sensor with the R_{sense} of the controller in the return line of the sensor. This configuration can be used with controllers that have single ended inputs (one side of the input grounded) or differential inputs (neither side of the input grounded). For the interconnecting cable pinout see Table 3: Cool End Connector Pinout

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SENSOR CHECKOUT

WARNING: Do not disconnect while the circuit is energized (live) unless the area is known to be non-hazardous.

CAUTION: The **Flame Tracker Dry** is designed to operate at extreme temperatures. Do not attempt to work on the **Flame Tracker Dry** until it has reached a safe handling temperature.

AVERTISSMENT! risque d'explosion. Ne pas brancher ni debrancher sous tension.

Disconnect the hot ends from the turbine. Apply power to the sensors. Check the current values at the controller for each of the sensors. The sensors are sensitive to light, and may have some reading, depending on the ambient light level.

Test each sensor by covering the port to see the no light intensity signal, and with a flashlight to see a positive reading. With no light, the reading should be 3.9 to 4.1 mA, while with a good UV light source, the reading should be above 8 milliamps.

Variations in flashlight type, strength, or battery voltage may cause variation in signal output. UV inspection flashlights with a UV wavelength between 245-365 nm work best. An LED flashlight may not work for this application. The sensor checkout is intended as a field test for general functionality only and is not a controlled or quantitative test. If a sensor is outside these rough limits, see the Troubleshooting section.

Inspect the sensor window. If necessary, clean the window according to the Clean the Sensor Window section and repeat the sensor checkout process. Reattach the hot end to the sight tube according to the Hot End Installation section. Once all sensors are attached to the sight tubes, check that all sensors are reading between 3.9 and 4.1 milliamps at the control system.

CONTROLLER SETUP

The Flame Sensor provides a minimum output as listed in the Specifications section when exposed to the minimum flame intensity specified. In most turbines, the set point for flame off should be set to 6.25%, which is equal to 5 milliamps. The set point for Flame On varies depending on the gas turbine, often being set at 10% or 12.5%. If the light intensity levels are too low for these settings, there may be other problems. Refer to the Troubleshooting section.

MAINTENANCE

WARNING: Do not disconnect while the circuit is energized (live) unless the area is known to be non-hazardous.

CAUTION: The Flame Tracker Dry is designed to operate at extreme temperatures. Do not attempt to work on the Flame Sensor or the cable until they have reached to a safe handling temperature.

AVERTISSMENT! risque d'explosion. ne pas brancher ni debrancher sous tension.

Any time that the FTD 325 hot end is removed from the sight tube, an anti-seize compound should be applied to the mounting thread prior to reinstallation of the sensor. This is to reduce the risk of galling. See the Hot End Installation section for details.

The Flame Sensor output will deteriorate as the lens becomes dirty. It is recommended, when initially installed, that the signal level be recorded during normal operation. During subsequent running, the signal level should be compared with the initial values. If a significant reduction in the signal level is noticed, then it is recommended that the lens be cleaned at the next opportunity (with the turbine shut down and cold).

During offline water washes, water is mixed with detergent, rust, and other contaminants and can be deposited on the flame sensor window. It is recommended to clean the flame sensor windows after each offline water wash.

CLEANING THE SENSOR WINDOW

CAUTION: Use all solvents with caution since most are toxic, flammable, or both. Read product data sheets and MSDS sheets carefully before using any solvents.

Inspect the sensor window under good lighting to identify the potential source of contamination (liquid fuel, carbon particles from combustion, ambient dust particles, liquid fuel, oils etc.).

Recommended solvents for cleaning the sapphire sensor windows are isopropyl alcohol (isopropanol) followed by acetone of high purity, 99% purity.

Cleaning equipment: Wear powder-free gloves (Latex or Nitrile) to avoid transferring oils and contaminants from your hands to the optics. Use cleaning material appropriate for sapphire optical components such as cotton swabs, cotton balls, or Kimtech wipes. Tweezers can be used to hold the cleaning material.

Use canned or compressed air to remove loose contaminants. Use dry cleaning material to remove any remaining moisture. Do not use a circular motion, which can spread contaminants and scratch the window. Wet the cleaning material with solvent but do not saturate it; it should be damp, not dripping. Using tweezers or fingers, gently wipe the sensor window from the center toward the outside. If needed, repeat the process with a new piece of dampened cleaning material. If isopropyl alcohol does not remove the contaminants, repeat the process with acetone.

After cleaning, inspect the optic window again under good lighting to ensure all contaminants have been removed. If any contaminants remain, repeat the cleaning process.

CONDENSATION

While condensation is most common on the secondary position of DLN1 combustion systems, it can occur on other positions or combustion systems. It is more common in environments with high humidity. The operator can often tell that condensation exists if the low output is worst at start-up and the signal increases as the gas turbine warms up and the condensation evaporates.

The operator can also determine its existence by removing the flame sensor from the sight tube as soon as possible after a shut-down. Water droplets will be visible on the flame sensor window. Make sure the sensor is cool enough and the environment is non-hazardous before removing the flame sensor from the sight tube.

Condensation cannot be eliminated in all applications but there are measures that can be used to reduce its effects. Contact Reuter-Stokes for more information.

TROUBLESHOOTING

WARNING: Do not disconnect while the circuit is energized (live) unless the area is known to be non-hazardous.

CAUTION: The flame sensor operates at extreme temperatures. Do not attempt to work on the flame sensor until it has reached a safe handling temperature.

AVERTISSMENT! risque d'explosion. ne pas brancher ni debrancher sous tension.

Problem	Cause	Solution
No current flows	1. Reversed polarity 2. Open wire 3. No 12-30V supply	1. Change polarity at junction box, flame sensor module (if applicable – Mark V and below) 2. Check connections at junction box, flame sensor module (if applicable – Mark V and below) 3. Check voltage supply supply at the connector of the interconnect cable to ensure power is reaching sensor
Low sensitivity during checkout or operation	1. Dirty window 2. Grounded cable 3. Tube mount not torqued	1. Use the section Cleaning the Sensor Window 2. Check cables for grounds 3. Check torque, torque to specified values
Low flame intensity signal during operation	1. Misalignment of the sensor mount 2. Dirty window 3. Tube mount not torqued	1. Check the squareness of all flanges and pipes of the sensor mount. 2. Verify that the sensors have a clear view of the flame. 3. Ensure the sight tube is properly torqued to the combustion chamber. 4. Ensure that the pipe union of the hot end in properly torqued.
Periodic low reading on secondaries of DLN1 turbines	1. Condensation on the sensor window that can occur under high humidity situations.	1. See Condensation section

No flame indication	1. Cable connection open 2. Open wire 3. No-12-30V supply 4. Interconnecting cable has failed	1. Check connections at junction box, flame sensor module (if applicable – Mark V and below) 2. Check voltage supply to ensure power is reaching sensor 3. Check voltage supply to ensure power is reaching sensor

Table 4: Troubleshooting

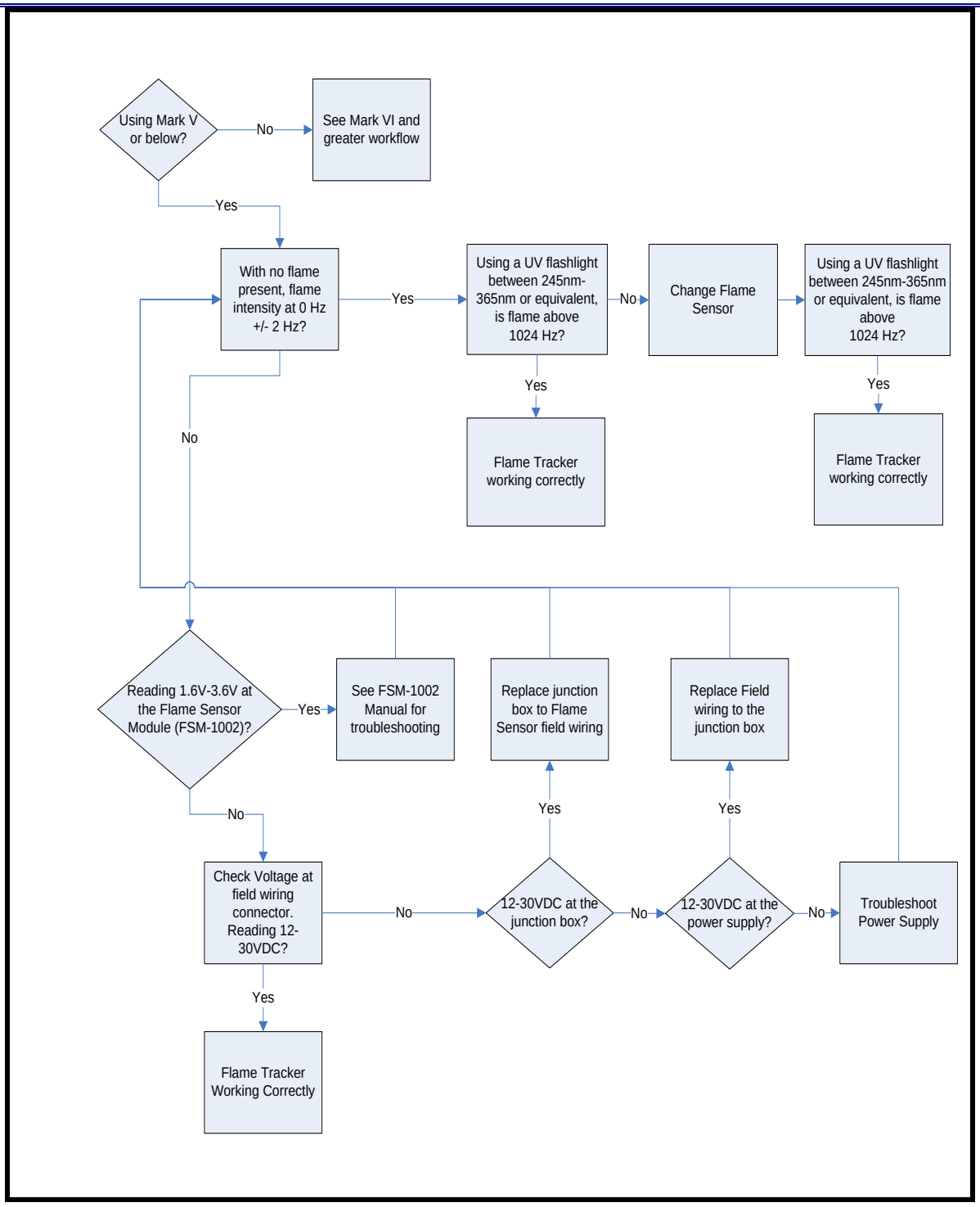

Figure 7: Mark V and Below Control System Troubleshooting Flow Diagram

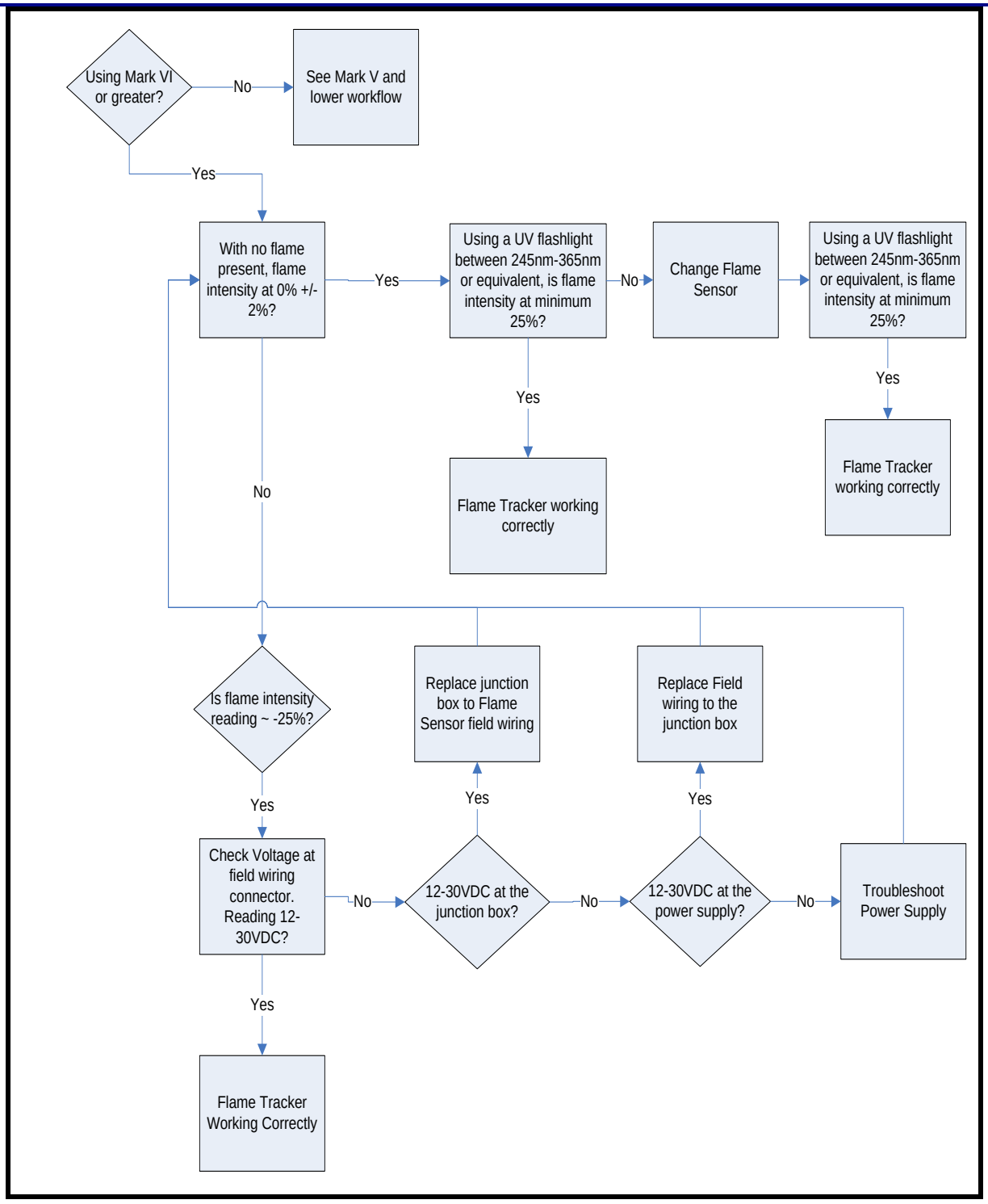

Figure 8: Mark VI and Greater Control System Troubleshooting Flow Diagram

CUSTOMER SUPPORT CENTERS

For Sales, Service and Technical Support:

Reuter-Stokes

8499 Darrow Rd.

Twinsburg, Ohio 44087

U.S.A.

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