Reuter-Stokes

Flame Tracker

Operation and Maintenance Manual

Applicable to part numbers:

RS-FS-9001	Flame Tracker, Standard Gain
RS-FS-9001-25X	Flame Tracker, Increased Low Gain (ILG)

FS-9001OM

Revision: V

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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

Throughout this manual, when necessary, notes are used to identify considerations.

Definitions:

WARNING: IDENTIFIES INFORMATION ABOUT PRACTICES OR CIRCUMSTANCES THAT CAN CAUSE AN EXPLOSION IN A HAZARDOUS ENVIRONMENT, WHICH MAY LEAD TO PERSONAL INJURY OR DEATH, PROPERTY DAMAGE, OR ECONOMIC LOSS.

CAUTION: IDENTIFIES INFORMATION ABOUT PRACTICES OR CIRCUMSTANCES THAT CAN LEAD TO PERSONAL INJURY OR DEATH, PROPERTY DAMAGE, OR ECON0MIC LOSS. CAUTIONS HELP YOU IDENTIFY A HAZARD, AVOID A HAZARD, AND RECOGNIZE THE CONSEQUENCES.

NOTE: IDENTIFIES INFORMATION THAT IS CRITICAL FOR SUCCESSFUL APPLICATION AND UNDERSTANDING OF THE PRODUCT.

GENERAL DESCRIPTION

The Flame Tracker is an ultraviolet (UV) light sensitive detector used to measure the intensity of the flame in the combustion cans of a gas turbine. Due to the use of the silicon carbide photodiode, the Flame Tracker is very sensitive to the UV light generated by hydrocarbon and hydrogen flames. Being a UV sensitive device, the Flame Tracker is not sensitive to the infrared light generated by the hot combustion can components so only the flame's light is detected.

The information contained in this document is applicable to all models of the Reuter-Stokes (RS) Flame Tracker listed on the title page. Differences between these models are shown in **Error! Reference source not found.**. Other than the gain, the sensors are identical.

Model	Gain
RS-FS-9001	Standard
RS-FS-9001-25X	Increased Low Gain (ILG)

Table 1: Flame Tracker Models

For the ILG model, the gain is increased by roughly 2.5X for a given flame input signal until the output reaches between 11 and 12 mA, at which point the output is the same for all models.

SPECIFICATIONS

Mechanical

Body Mount:	AISI316 Stainless Steel
Housing:	AISI304 Stainless Steel (sealed and Argon filled)
Connector	MIL-C-38999 Series III size 15 (5 pin)
Process:	3/4" NPT female
Sensing Element:	Silicon Carbide photodiode
Window:	Sapphire

Operating

Sensitivity (Standard)	>5 mA @ $1x10^{10}$ photons/in^2/sec. @ 310 nm
Sensitivity (ILG)	>6.5 mA @ $1x10^{10}$ photons/in^2/sec. @ 310 nm
Output:	4 - 20 mA dc, Max < 21 mA
Response time	<25 milliseconds
Power Requirements:	12 - 30 vdc @ > 100 mA
Temperature (ambient):	-40°F to 302°F (-40°C to 150°C)
	455°F (235°C) with specified cooling
Relative Humidity	100% Non-Condensing
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-O285PXXX. The right angle version of the interconnect cable is shown in **Error! Reference source not found.**. Dimensions shown are in inches (mm) and are reference only.

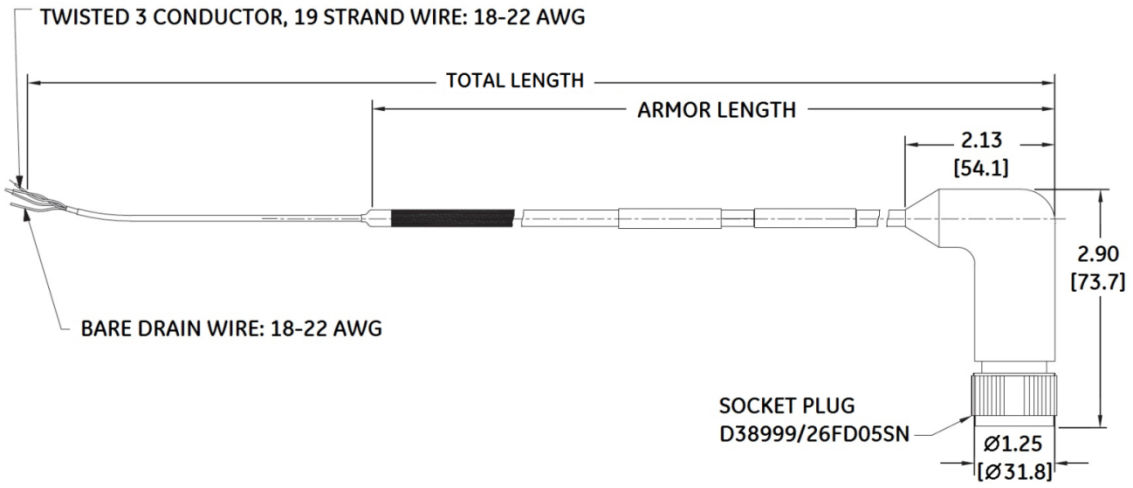

Figure 1: 4-20 mA Interconnect Cable

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

Voltage (max) : 300 VRMS

Temperature (max) : 482°F (250°C)

The available cable part numbers are listed in **Error! Reference source not found.**.

Interconnecting Cable Part Number	Total Length ft [m]	Armor Length in [cm]	Connector Type
RS-E2-0285P001	60-62 [18.3-18.9]	36 [14.2]	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 [14.2]	Right Angle
RS-E2-0285P021	15-17 [11.9-12.50]	36 [14.2]	Right Angle
RS-E2-0285P011	60-62 [18.3-18.9]	36 [14.2]	Straight
RS-E2-0285P012	120-122 [36.6-37.2]	36 [14.2]	Straight
RS-E2-0285P013	60-62 [18.3-18.9]	96 [243.84]	Straight
RS-E2-0285P010	60-62 [18.3-18.9]	120 [304.8]	Straight

Table 2: Available 4-20 mA Cables

MECHANICAL DIMENSIONS

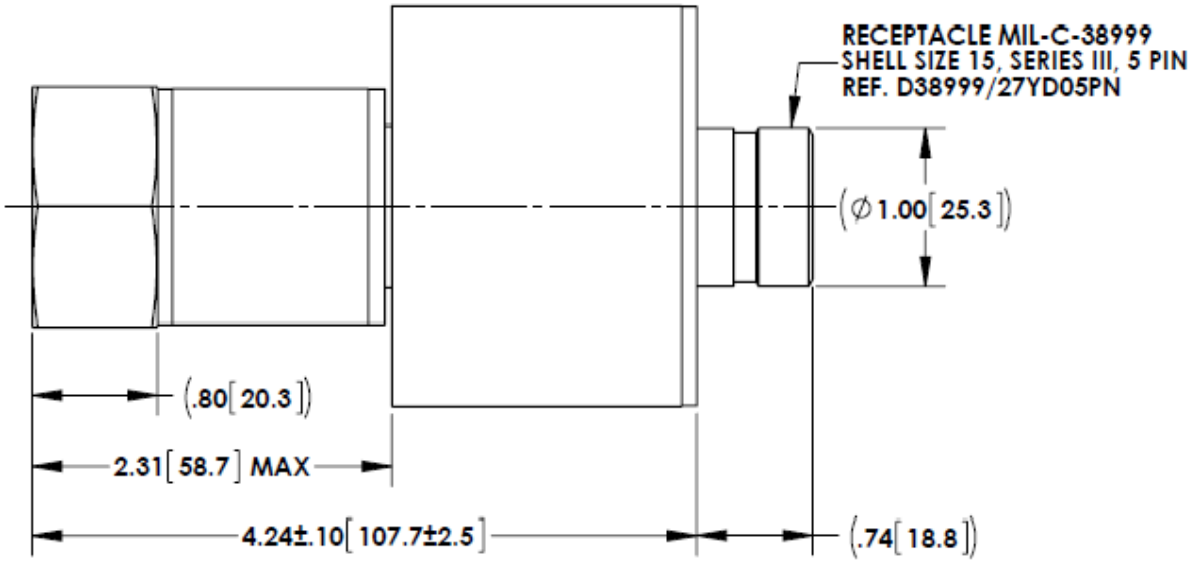

Figure 2: Housing Side View

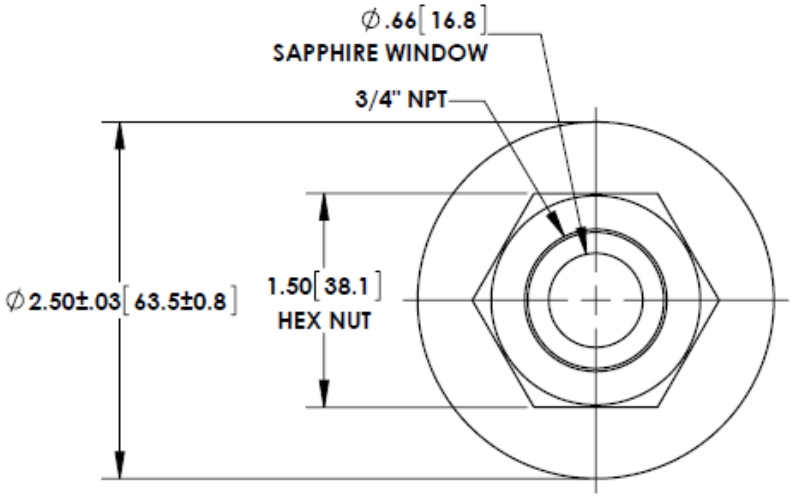

Figure 3: Housing Front View

SENSOR

Error! Reference source not found. is a block diagram of the Flame Tracker. The sensor has a sapphire window that is transparent to UV light and can withstand the compressor discharge temperature and pressure. It has a lens inside that focuses the light on a silicon carbide photodiode. The amplifier circuit has a high initial gain, which automatically shifts to a lower gain in order to accommodate a wide range of input light level without saturating. The sensor regulates the supply current in proportion to the amount of UV light present. Both power and signal are transmitted on the same two wires. The sensor can be powered from a dc voltage between 12 and 30 volts. The sensor is sealed and filled with dry argon.

Flame Tracker, RS-FS-9001-XXX

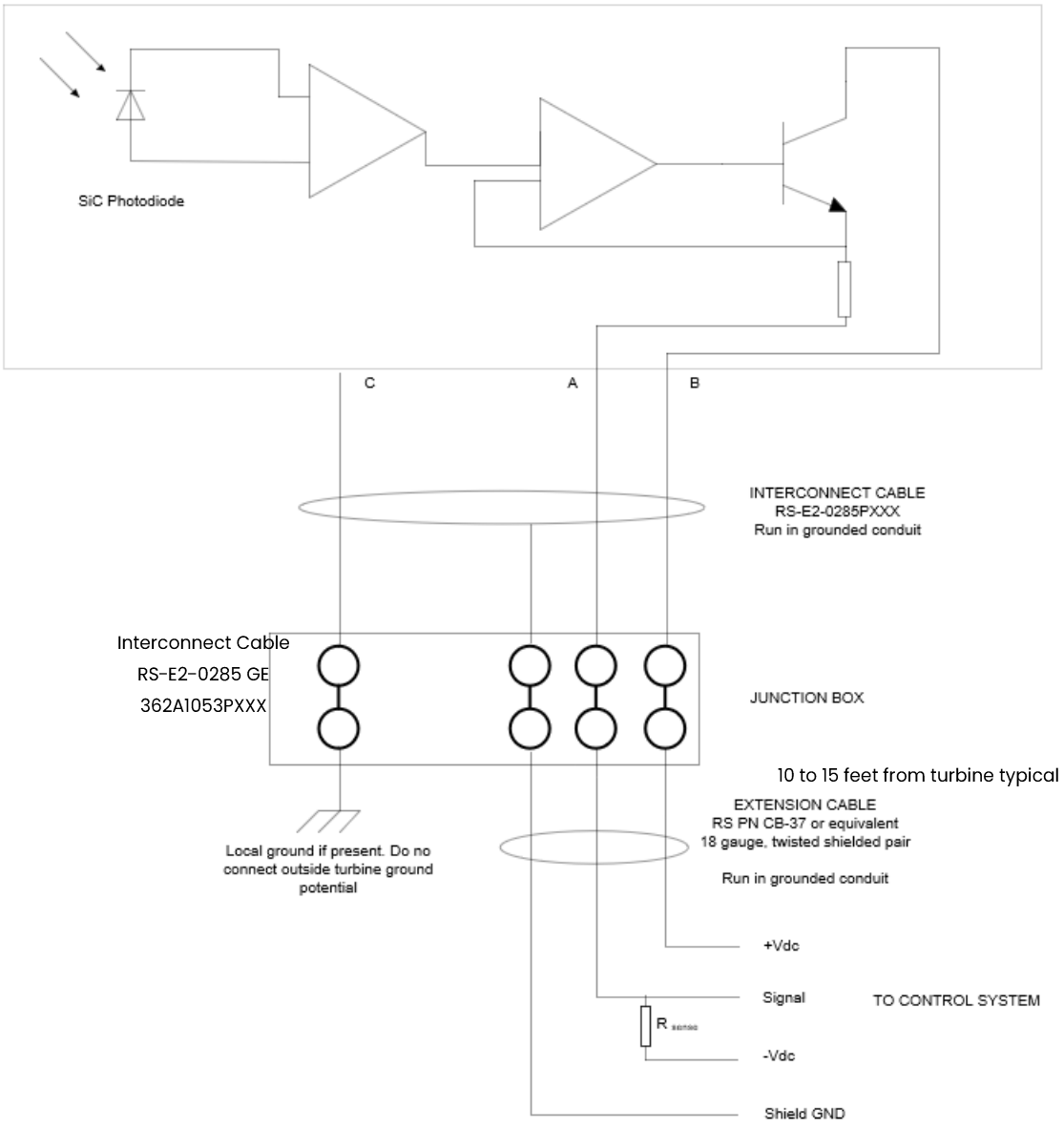

Figure 4: Flame Sensor Wiring Diagram

INSTALLATION

MECHANICAL

The maximum operating temperature for the flame sensor is 302° F (150° C). If the peak ambient temperature at the location of the sensor exceeds this then cooling will be required. There are three methods available for cooling:

- Water-cooling
- Air-cooling with ambient air
- Air-cooling with pressurized air.

Water-cooling requires the use of a water-cooling coil Part Number SP-566. The water-cooling coil requires water at a temperature of 50° F to 135° F (10° C to 57° C) at a flow rate of 1.0 gpm (3.8 lpm) per sensor. When using water-cooling the flame sensor can be operated to an ambient temperature of (455°F) 235°C.

Air-cooling with ambient air can be used in installations where the enclosure is cooled with forced air. This would be typical of LM2500 and LM6000 aircraft engine applications. The air velocity at the sensor must be 5 ft/sec (1.5 m/sec), or greater, at a temperature of 50° F (10° C), or less, above outside ambient. Under these conditions the sensors will operate at outside ambient temperatures up to 140° F (60° C).

Air-cooling with pressurized air requires the use of Air-Cooling Can, Reuter-Stokes Part Number RS-E2-0259 or RS-E2-0259-MFR. The Air-Cooing Can is installed in the same manner as the water-cooling coil. The Air-Cooling Can requires 25 psi (172.3 kPa) minimum at 120° F (49° C) maximum.

The following steps describe the installation of the Flame Tracker onto the sight tube. Do not perform that installation until after a functional test has been performed. See the Sensor Checkout section of this manual for details on the functional test.

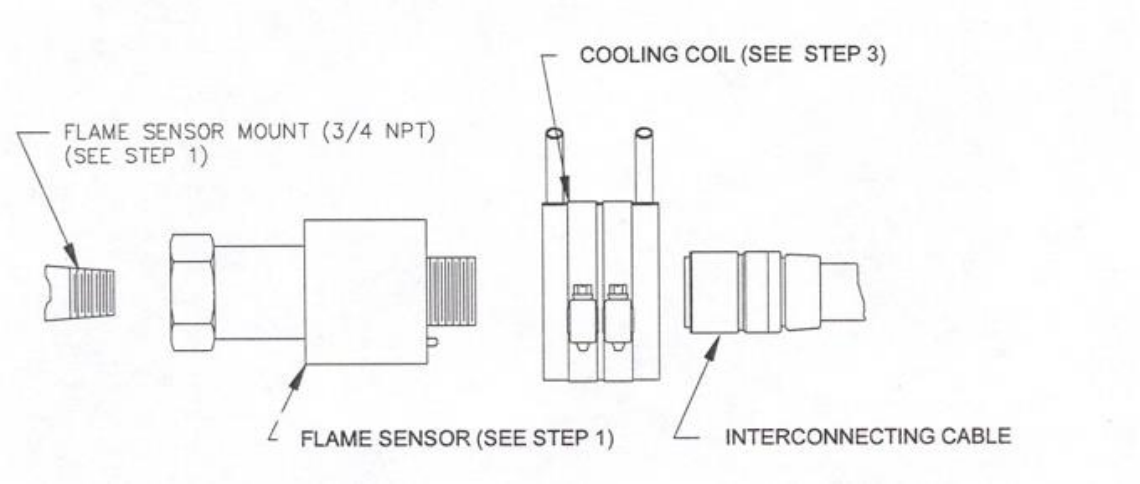

Figure 5: Water Cooling Jacket Installation Instructions

1. Ensure that the cooling coil is not attached to the flame sensor during installation or removal of the sensor from the sight tube. The cooling coil can apply an unwanted torque and cause disassembly and malfunction of the flame sensor.

2. Apply a small amount of Never-Seez PN NG-165 to threads of sight tube prior to installation. Be sure the Never-Seez applied to the sight tube is minimal and only applied below the 2nd thread. If Never-Seez is applied to the face of the sight tube, upon heating, it can fog the window of the Flame Sensor.

3. Inspect the window and clean with Isopropanol-soaked swab. Install the Flame Tracker onto the sight tube in a hand tight fashion (3-4 Full turns). Complete the installation by tightening with a wrench approximately 2.5 additional turns. Tighten further as required to align keys on cable connector with slots in sensor connector.

4. Slide cooling coil over Flame Sensor major diameter and orient tubes on the coil as required for assembly. Tighten clamps 50-60 in. lbs. (Install Swagelok fittings re-torque clamps to 50-60 in. lbs. after first shut down.) Connect the source cooling water to the cooling coil.

Note: 50 - 60 in. lbs. = 5.6 - 6.8 Nm. When installing the Water-Cooling Coil, ensure that the edge of the Sheet Metal Band is not in contact with the cooling tubes. This will ensure that no rubbing or fretting of the cooling tubes by the band's edge will occur during turbine operation.

Note: Whether using the air-cooing can or the water-cooling coil for the sensor, maintenance inspections of the cooling system need to occur regularly to check for leaks and possible rubbing against other parts of the turbine.

ELECTRICAL

The sensors are connected to the turbine junction box with connector cable RS-E2-0285PXXX. The RS-E2-0285 consists of black, white and green wires twisted and shielded. All wiring 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 cable is as follows; white is positive and black is negative/signal return. Reverse polarity will not damage the sensor. Signal cable from the junction box to the Controller should be 18 gauge (1.02 mm) twisted shielded pair.

CONNECTOR PINOUT

The pinout for the MIL SPEC connector is shown in **Error! Reference source not found.**.

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: Connector Pinout

SENSOR CHECKOUT

Disconnect the sensors and unscrew them from the turbine. Plug the interconnect cables back into each of the sensors. Apply power to the sensors. Check the current values at the controller for each of the sensors. The sensors are sensitive to UV light, and may have some reading, depending on the ambient UV light level. Test each sensor by covering the window to see the no light signal, and with a UV light source to see a positive reading. With no light the reading should be 3.7 to 4.1 milliamps, while with most flashlights the reading should be above 8 milliamps. An LED flashlight may not work for this application. Variations in flashlight type, strength, or battery voltage may cause variation in signal output. UV inspection flashlights with a UV wavelength near 310 nm work best. Reuter-Stokes offers a UV pen light PN FS-9000-LP. The flashlight test 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.

Make sure the sapphire window is clean; if it needs cleaning, do this according to the maintenance instructions in the Maintenance section. Disconnect the sensor cables and reinstall the sensors according to the Mechanical section.

CONTROLLER SETUP

The Flame Sensor provides a minimum output as listed in the Specification section when exposed to the minimum UV light intensity (also listed in the Specification section). 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 intensity levels are too low for these settings there may be other problems. Low intensity levels may be a sign of 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. (RISQUE D'EXPLOSION. NE PAS CONNECTER OU DÉBRANCHER LE CÂBLE LORSQU'IL EST ÉNERGÉTIQUE)

CAUTION: The operating temperature range of the Flame Sensor is -40°F to 302°F (-40°C to 150°C). Do not attempt to work on the Flame Sensor or the cable until they have reached to a safe handling temperature.

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). Clean the lens with isopropyl alcohol or other residue free solvent compatible with Sapphire. In order to reduce the risk of galling, an anti-seize compound should be applied to the mounting thread prior to reinstallation of the sensor. The anti-seize compound should be a small amount and only applied below the 2nd thread.

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

Inspect the sensor window under good lighting to identify the potential source of contamination (liquid fuel, carbon particles from the combustion event or ambient dust particles, liquid fuel, oils, scratches 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. If available, canned air or compressed air. 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. Repeat if necessary. If any contaminants remain, repeat the cleaning process.

Avoid excessive pressure to prevent scratching or damaging the surface of the lens. Always use clean material to wipe the sensor window to avoid recontamination of the window surface.

TROUBLESHOOTING

WARNING: Do not disconnect while the circuit is energized (live) unless the area is known to be non-hazardous. (RISQUE D'EXPLOSION. NE PAS CONNECTER OU DÉBRANCHER LE CÂBLE LORSQU'IL EST ÉNERGÉTIQUE)

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.

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 to ensure power is reaching sensor
Low sensitivity during checkout or operation	1. Dirty window 2. Grounded cable 3. Sensor not properly torqued to sight tube	1. Clean window (Section 4.0) 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. Sensor not properly torqued to sight tube	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 tube mount is torqued

Periodic low reading on secondaries of DLN1 turbines	1. Condensation on the sensor window that can occur under high humidity situations.	1. A shorter mount tube (PN# E1-0058P002), available from Reuter Stokes may improve this condition. Please contact Reuter Stokes for further information.
No flame indication	1. Cable connection open 2. Open wire 3. No-12-30V supply	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

Table 4: Troubleshooting

CUSTOMER SUPPORT CENTER

For Sales, Service and Technical Support:

Reuter-Stokes

8499 Darrow Rd.

Twinsburg, Ohio 44087

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