HIR Model

Installation, Operation and Maintenance Manual

Delta Controls
CORPORATION

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MODEL HIR
HIGH TEMPERATURE INFRARED PYROMETER

Delta Controls Model HIR is an infrared temperature pyrometer specifically designed to measure the refractory temperature of Claus Process thermal reactors.

1. THEORY OF OPERATION

Model HIR uses infrared pyrometry to measure temperature. All materials radiate energy as a function of their absolute temperatures. Model HIR “looks” into the reactor and senses the amount and spectrum (wavelengths) of the infrared energy being emitted by the hot face of the refractory. The sensed energy is converted into a signal, which can be used to accurately display the refractory operating temperature.

1.1 Considerations when using Infrared Pyrometry in Claus Thermal Reactors

To effectively measure temperature, the instrument needs a clear, unobstructed view into the vessel. The infrared energy must pass through the reacting gases without being absorbed by them. The instrument must “look” through those same gases without seeing them or sensing their high temperatures. This is accomplished by using optical bandpass filters. The selected sensing spectrums avoid errors due to absorption, reflection, etc.

A potential problem using infrared pyrometry in a Claus thermal reactor is that sulfur or other solids can accumulate on the lens or in the nozzle which blocks the infrared radiation, and requires expensive maintenance to clean the lens and optical path. Model HIR is designed to be nearly maintenance free. When properly installed and operated, it maintains the lens, sighting window, and nozzle at a sufficiently high temperature to avoid sulfur buildup and reduces frequency of periodic cleaning.

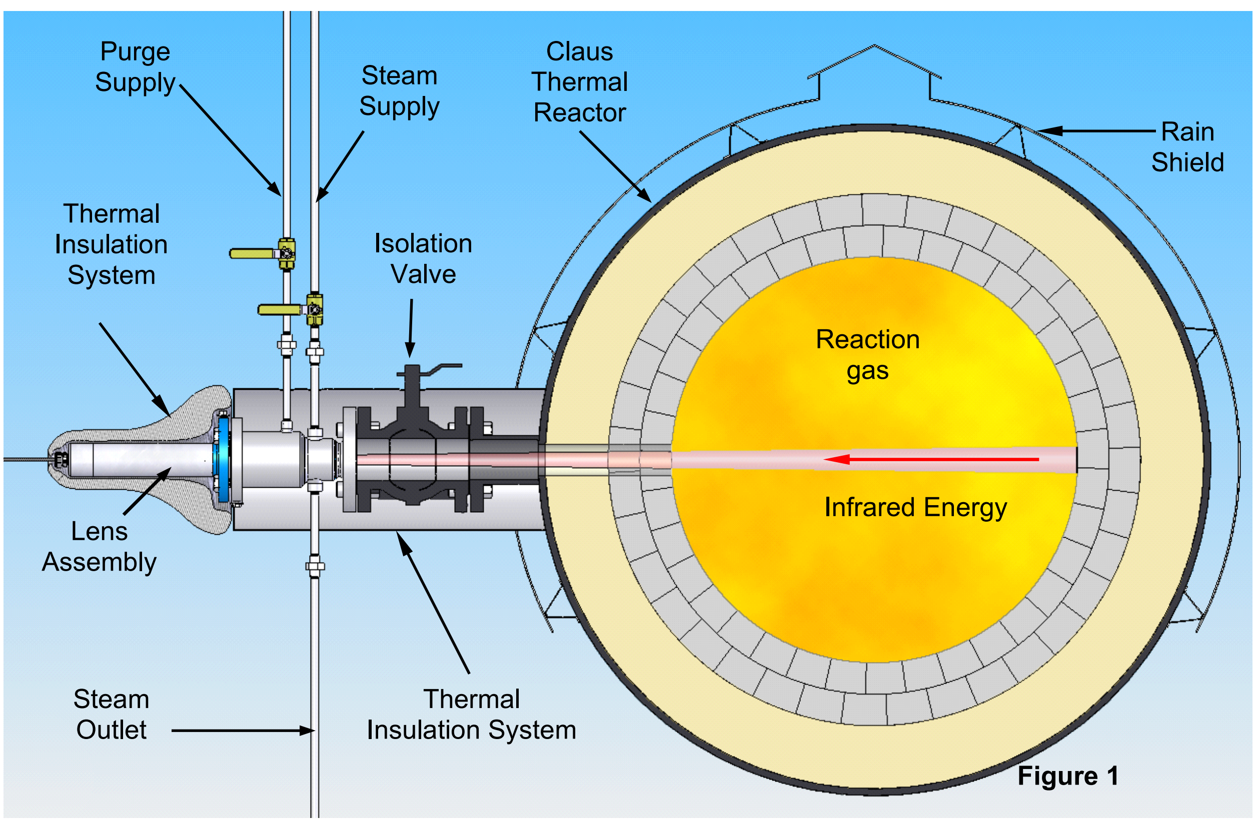

Figure 1

2. INSTALLATION

Figure 2 shows a typical installation. The HIR features a unique Steam Jacketed Lens Assembly that is mounted directly to the isolation valve, which is mounted on the vessel nozzle flange. The Steam Jacketed Lens Assembly is normally furnished in either a 2 inch or 3 inch flanged process connection size. Ensure the size and type flange on the nozzle isolation valve matches the Steam Jacketed Lens Assembly mounting flange received. If the connections do not match, contact Delta Controls to secure a unit with the necessary nozzle connection size and type.

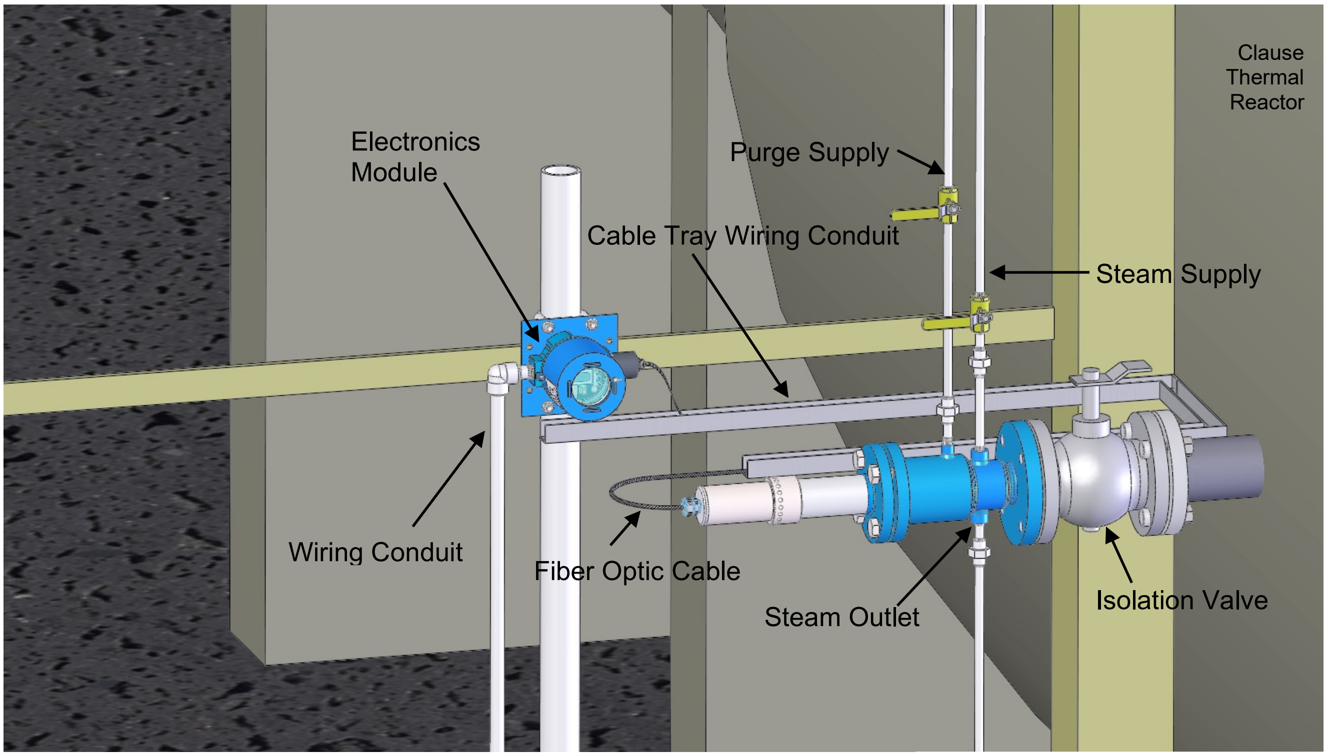

Figure 2 – Typica l Installation (Thermal insulation not shown)

2.1 Mounting the Steam Jacketed Lens Assembly

While the unit is down, check the isolation valve mounted on the vessel to ensure it operates properly and properly. Replace the valve if it appears to bind or if, there is any indication that it may leak. Close the valve [it will be opened after the reactor reaches a temperature over +572 °F (+300 °C)].

Bolt the flange of the Steam Jacketed Lens Assembly to the valve flange with the 1/8" NPT purge port at the top.

2.1.1 Steam Supply

Long-term reliability of this instrument requires the use of steam to maintain the temperature of the window and nozzle above the melting point of sulfur. Failure to maintain a high enough temperature can allow sulfur to solidify and build up on the window and nozzle surfaces, blocking the light and causing inaccurate temperature readings.

Connect the steam lines (in accordance with the best practices of your plant) to the upper (inlet) port and connect a bucket type steam trap to the lower (outlet) port of the assembly. The standard steam port connections are 1/4" NPT. Insulating the steam lines is recommended, though not shown in Figure 1.

2.1.2 Lens Purge

A 60 SCFH (28 L/min) flow of purge gas to the Steam Jacketed Lens Assembly is required. Ensure that the supply of purge gas is clean, oil free and dry. Any moisture or hydrocarbons in this purge gas may cause the inside of the lens window to coat. A coating will prevent some of the infrared energy from reaching the sensor, causing a low temperature reading to occur, and window cleaning to be required. Use a flow meter with a needle control valve suitable for a flow rate of approximately 10 SCFH to 90 SCFH air (0.5 L/min to 41.7 L/min). Connect the purge gas supply to the 1/8” NPT fitting on the top of the Steam Jacketed Assembly. Regulate the purge supply to 5 psig (0.34 bar) above reactor operating pressure. Delta Controls recommends using Model HFI Flush Gas Station (Figure 3) as it provides a conveniently packaged assembly of the necessary purge supply components. Connection of the Model HFI is shown in Figure 4.

Figure 3 Model HFI Flush Gas Station

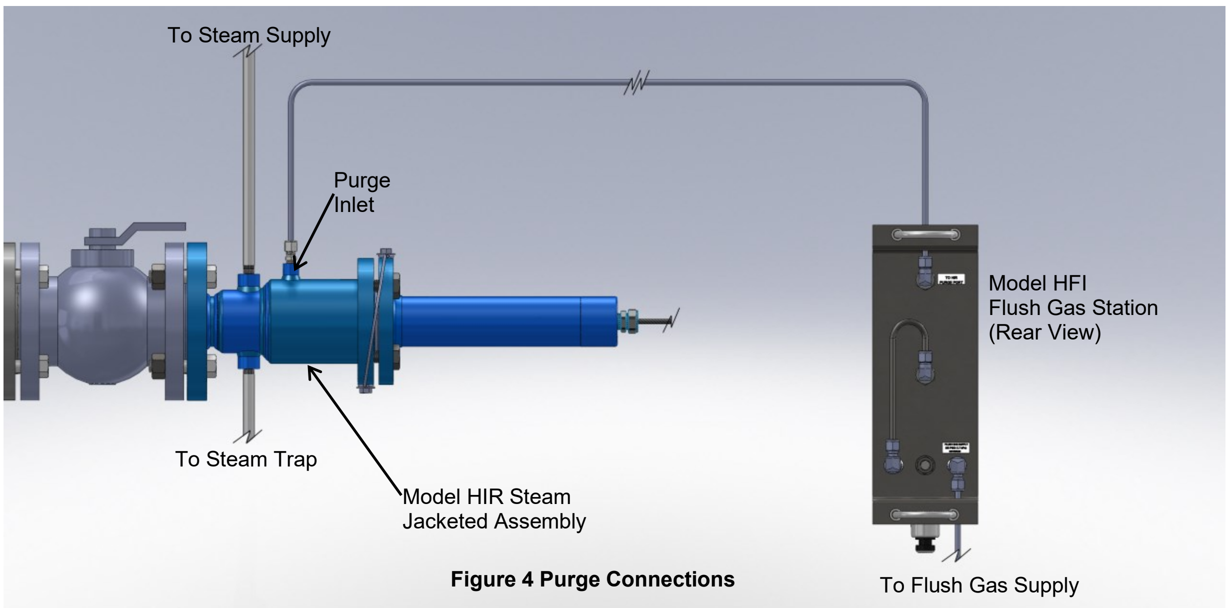

Figure 4 Purge Connections

2.2 Thermal Insulation

To prevent sulfur from plugging the optical path, it is important that a temperature above +250 °F (+121 °C) be maintained on the nozzle, isolation valve, and Steam Jacketed Lens Assembly. In most cases, the heat from the reactor and steam body are not sufficient to keep the temperature of the valve and lens assembly above this temperature unless they are insulated. It is important, therefore, that insulation be installed around the nozzle, valve, and lens assembly, as shown in Figure 1, in accordance with the best practices of your plant. Adequacy of the insulation should be tested by verifying that the lens assembly flange and the isolation valve body are above +250 °F (+121 °C) under the most unfavorable conditions (wind, rain, snow, etc.)

2.3 Installing the Electronics Housing

A mounting location must be provided nearby for the electronics module. Choose a location that is protected from the heat of the reactor, such that the maximum ambient temperature of the electronics is not exceeded. For convenience in performing optical alignment, the electronics display

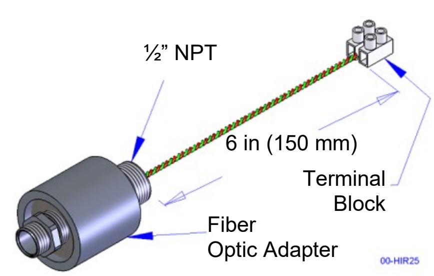

Figure 5 Fiber Optic Adapter

should be visible to an operator standing at the Steam Jacketed Lens Assembly.

2.3.1 Remote Sensor Mounting – Option RS

Under some circumstances, it is impractical to mount the electronics close to the lens body. Extending the fiber optic cable is not possible, due to losses that would occur in a longer fiber. However, it is possible to mount the electronics housing farther from the lens body by mounting the fiber optic adapter (Figure 5) at the end of the 10 feet (3 meters) fiber optic cable, and extending the sensor wires back to the remotely mounted electronics housing, as shown in Figure 6.

The following considerations should be observed when remotely mounting the fiber optic adapter:

- The fiber optic adapter must be mounted in a location with an ambient temperature of 0 °F to +185 °F (-18 °C to +85 °C).
- The recommended maximum extension is 25 feet (7.6 meters).
- Install twisted cable pair between the fiber optic adapter and the electronics housing. The twisted pair MUST be run through metallic conduit. Note that F-range models use two twisted pairs (4 wires total). Other models use a single twisted pair.
- Do not install other wires in the same conduit with the sensor wires.
- Conduit should be appropriate for the area classification. Seals should be installed near the electronics housing, in accordance with governing code.

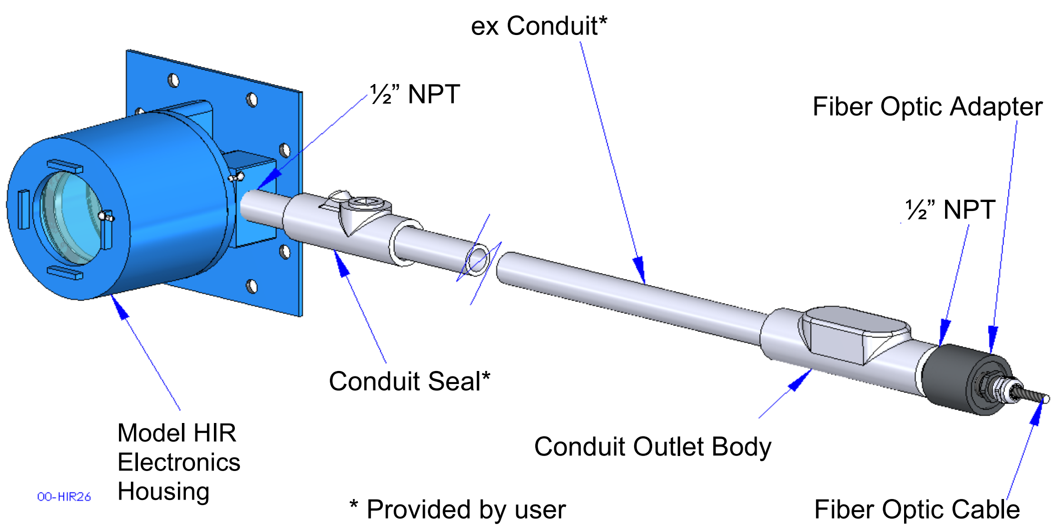

Figure 6 Typical Installation of Remote Fiber Optic Adapter

The loop wiring conduit connection on Model HIR is ¾" NPT. Unless the 'RS' (remote sensor) option is specified, the fiber optic adapter is normally factory installed in the ½" NPT opening in the housing.

Wire the electronics module in accordance with local governing code.

A green external earthing screw is located near the threaded conduit entry. An internal green earthing screw is also provided inside the housing. To connect to the internal earthing screw, you must first move the electronics module by removing the two screws holding the module down. Replace the module and hold-down screws after connecting the earth ground conductor.

Note: If, for any reason, the fiber optic adapter must be unscrewed from the electronics housing, first make sure the fiber optic adapter sensor wires are disconnected from the electronics module terminals.

2.3.2 Flameproof Installation

When type ‘d’ flameproof protection is employed, wire the HIR as shown in Figure 7 or Figure 8. Use certified cable glands and conduit seals for all flameproof installations.

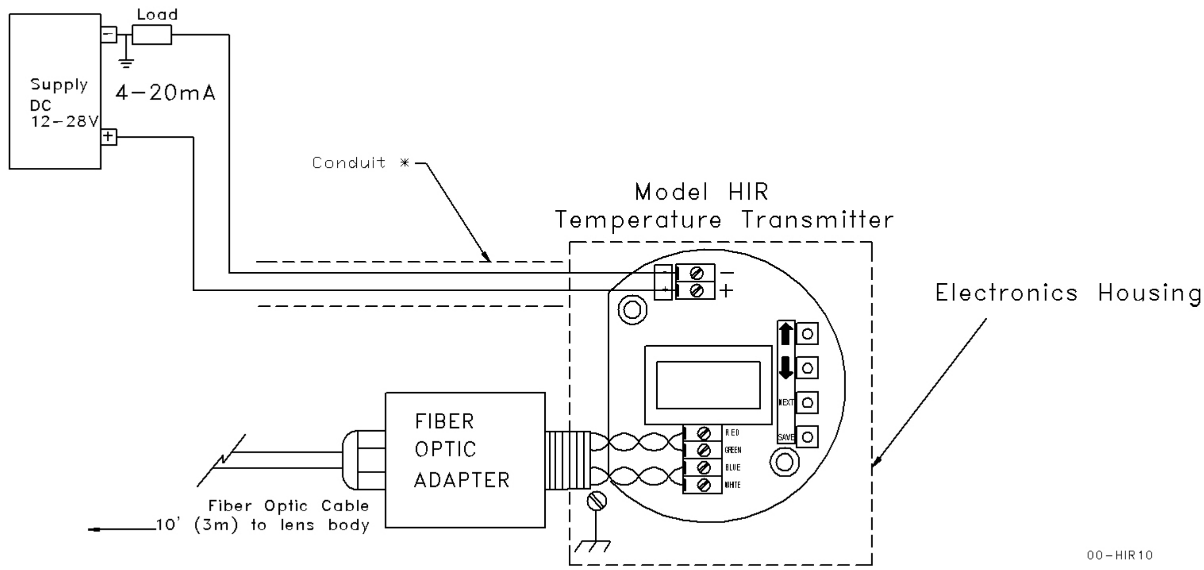

Figure 7 Typical Wiring

Note: F-range shown; other ranges use a two-wire fiber optic adapter

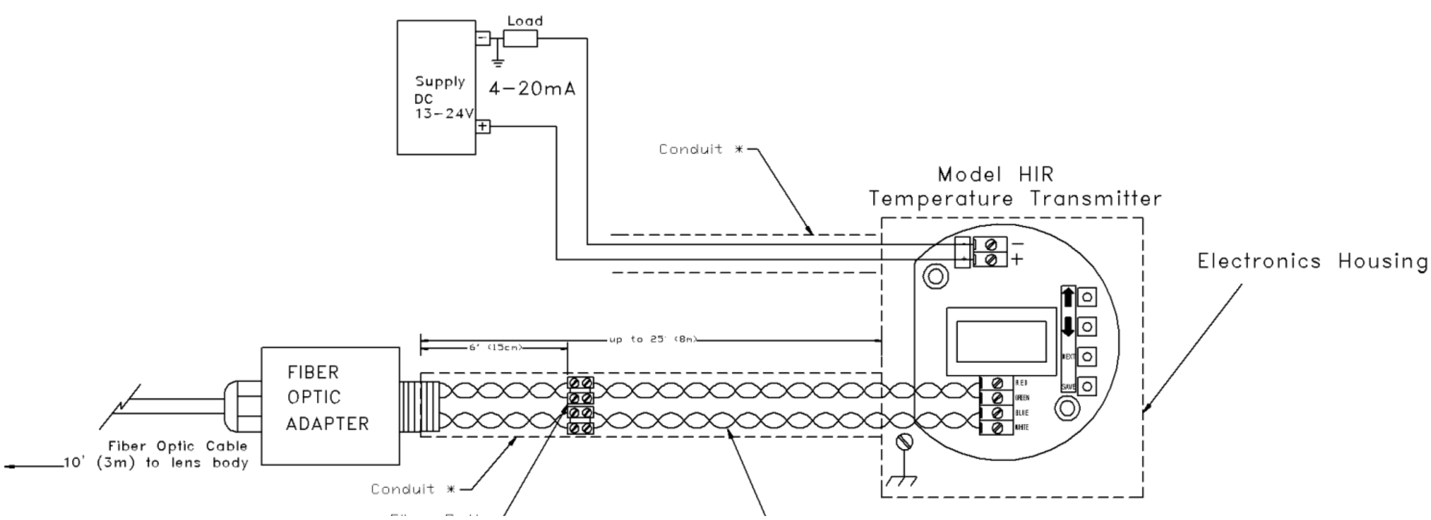

Figure 8 Typical Wiring - Option RS (Remote Sensor)

Note: F-range shown; other ranges use a two-wire fiber optic adapter

2.4 Connecting the Fiber Optic Cable

Use care in handling the fiber optic cable. Even though it is armored, sheathed, and sealed for durability, individual glass fibers within the cable can be damaged by mishandling. Avoid dropping, shocking, kinking, pulling, or sharply bending the cable. When routing the fiber optic cable, it is important to observe the minimum bend radius specification of 3 inches (7.6 cm). Bending the fiber optic cable more sharply than specified radius can result in low temperature readings due to excessive infrared energy losses in the cable.

The fiber optic cable is connected to a sensor in the fiber optic adapter as shown in Figure 9.

1. Insert the cable into the fiber optic adapter. The cable must be inserted all the way to the bottom of the adapter hole for the cable grip to seat and to avoid calibration errors.
2. Tighten the cable grip to seal the cable against moisture.

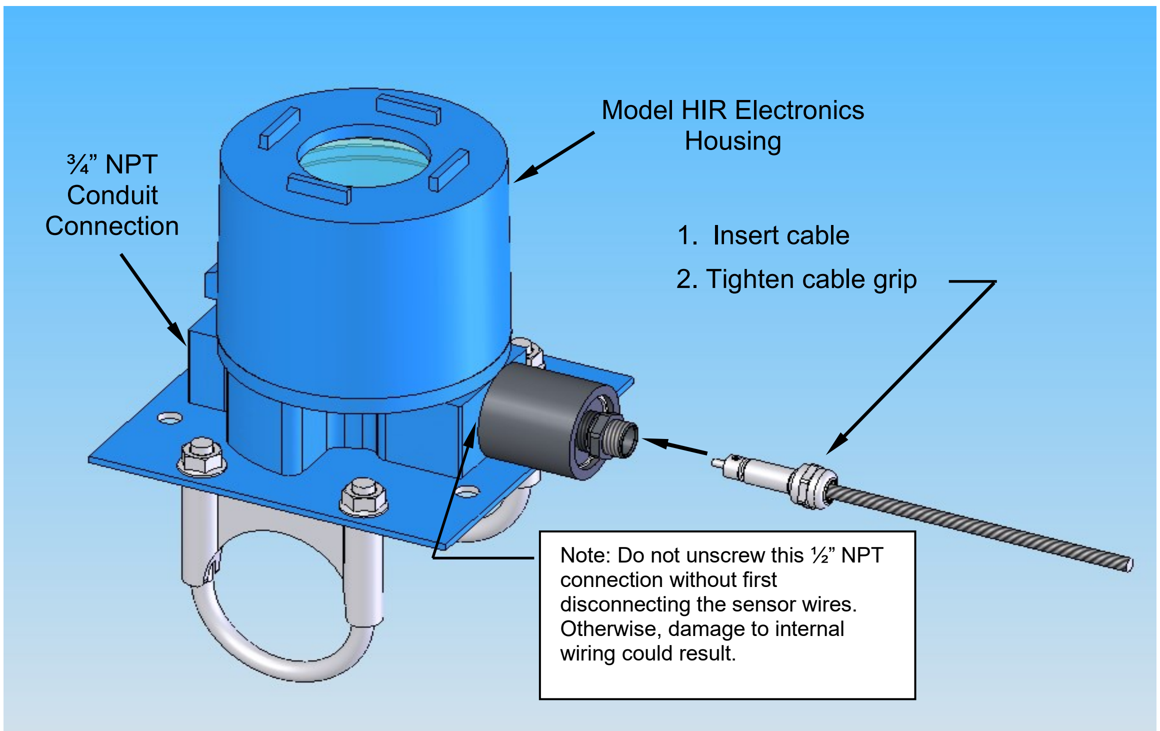

Figure 9 – Inserting the Fiber Optic Cable

2.5 Optical Alignment

The fiber optic lens is aligned at the factory to look straight down the nozzle's bore. The alignment should be visually checked prior to using the instrument. This alignment check is only possible when there is light inside the reactor vessel, either with the vessel opened and lighted prior to operation, or from the light from the reaction after startup.

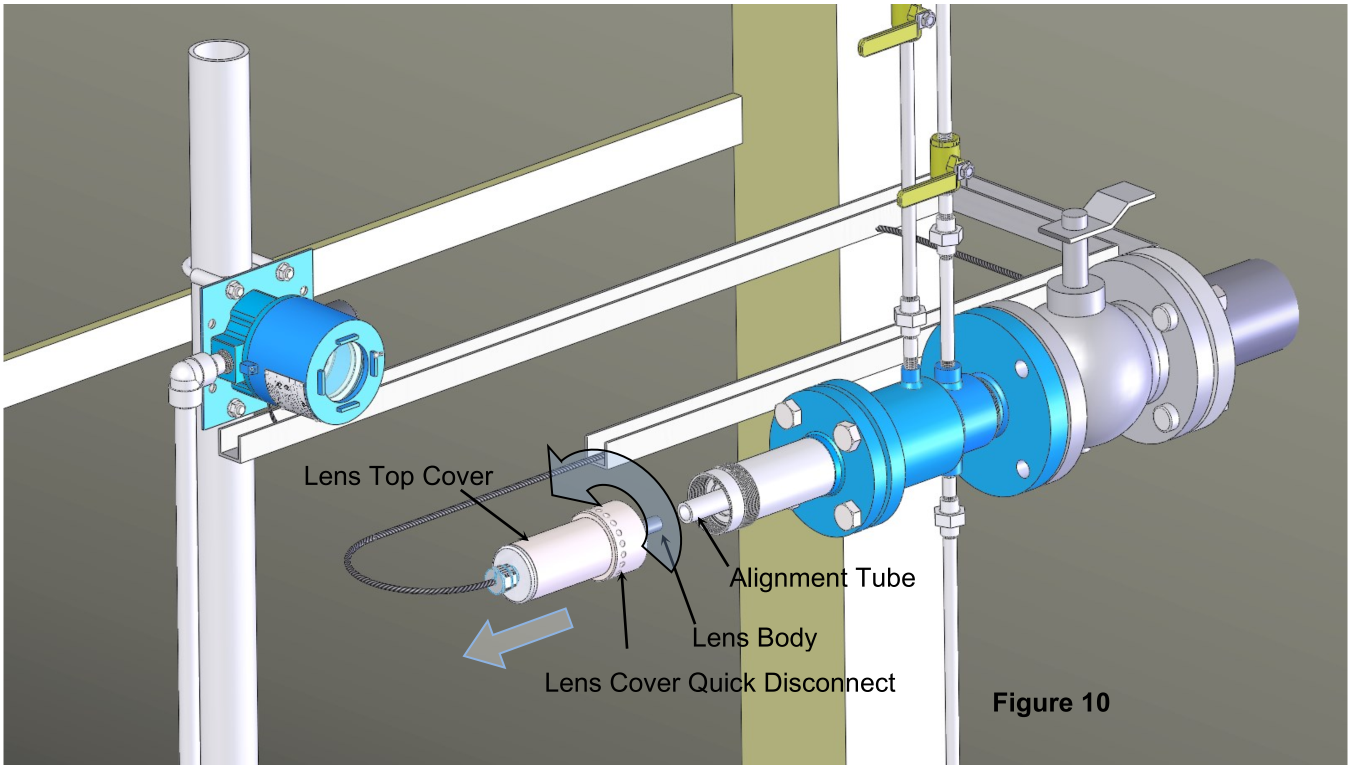

Figure 10

To view the optical path:

1. Unscrew the lens cover quick disconnect and remove the lens top cover as shown in Figure 10. Be careful not to allow the weight of the cover to damage the fiber optic cable.
2. Open the isolation valve.
3. Sight down the Alignment Tube, through the process window and into the reaction chamber.

The light from the reaction vessel should appear centered in the Alignment Tube. If it is not, the Alignment Tube should be aligned as follows:

4. Loosen the three alignment clamp screws using a 9/64" hex wrench (Figure 11).
5. Manually adjust alignment tube until light is centered.
6. Tighten the three alignment clamp screws.
7. Re-check the alignment to make sure the alignment tube did not move while tightening the clamp screws.
8. Replace the Lens Top Cover, making sure that the Lens Body is inserted into the Alignment Tube, and tighten the Lens Cover Quick Disconnect.

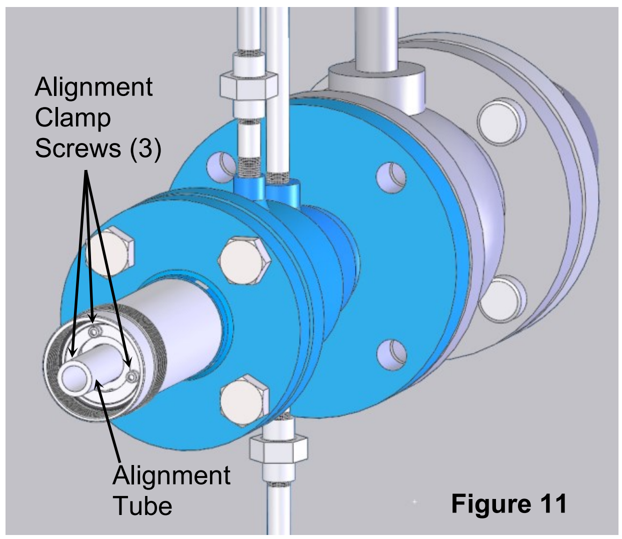

Figure 11

3. OPERATION

Caution: When used with type ‘d’ flameproof protection, do not open cover when circuits are energized nor when hazardous gasses might be present.

Model HIR user interface consists of an LCD display and 4 setup pushbuttons. The temperature characteristics of the display are such that you should only calibrate the unit when the ambient temperature is between 0 °F and +140 °F (-18 °C through +60 °C). Outside this temperature range, the transmitter will operate properly, but the display may be difficult to read.

Pushbuttons:

↑ Pressing the UP button causes the value displayed to be incremented. Holding the button down causes the value to continue upward at an ever-increasing rate.

↓ Pressing the DOWN button causes the value displayed to be decremented. Holding the button down causes the value to continue downward at an ever-increasing rate.

NEXT Pressing this button shifts the display to the next setup parameter.

SAVE Pressing the SAVE button saves all calibration values and setup parameters. The display will indicate "Saving..." to verify that the values are being saved.

3.1 Setup Parameters

IR Temp	This parameter displays the temperature as measured by the infrared sensor. When displaying this parameter, the signal strength is also displayed. (Refer to section 3.4 Preventative Maintenance: Signal Strength.)
LOOP mA	Loop current transmitted in milliamperes
LOOP %	Loop current as a percentage where 0 % = 4 mA and 100 % = 20 mA
Units	This parameter sets the units of measure for temperatures. Use the up or down arrows to toggle between degrees Fahrenheit and Celsius.
4mA =	Zero scale temperature, i.e., the temperature corresponding to 4.00mA loop current.
20mA	Full scale temperature, i.e., the temperature corresponding to 20.00 mA loop current.
Lo Alarm	Low alarm setpoint – If the measured temperature falls below this setpoint, the Low Alarm bit will be set in the HART Device Status and an exclamation (!) will appear next to the displayed temperature.
Hi Alarm	Hi alarm setpoint – If the measured temperature rises above this setpoint, the High Alarm bit will be set in the HART Device Status and an exclamation (!) will appear next to the displayed temperature.
Sig Alarm	Signal level alarm setpoint – If optical occlusions cause the amount of light reaching the sensor to fall below this level the Signal Alarm bit will be set in the HART Device Status and ‘LOW!” will appear in the signal display field when displaying the IR TEMP parameter. Enter a number between 0 and 100 where 0 means light is completely blocked. 100 means no blockage. Typical values would be 50 to 70.

The parameters listed below are normally used only during factory setup. However, they can be accessed by pressing and holding the NEXT button while simultaneously pressing the UP arrow button.

> **CAUTION:** Accessing these parameters can result in at least momentary disruption of the transmitted 4-20 mA signal as described below under Zero Adj and Span Adj.

Version	Software/Hardware Revision number
Cal Temp	Calibration Temperature
LowCutoff	Temperature below which the unit will not read.
HART ADDR	When using HART in multidrop mode, this parameter sets the HART address on the bus.
LOOP CTL	0 = normal (current follows temperature); 1 = multidrop (loop set to 4.00 mA); 2 = manual. When set to 2 (manual), current can be set by changing the LOOP mA parameter above. **Note:** LOOP CNTRL = 2 is used for testing purposes only and reverts to 0 on device reset or cycling power.
Zero Adj	When accessed, current loop immediately transmits 0 scale or 4 mA. Adjust parameter up or down until device measuring the output current indicates exactly 4.00 mA. **CAUTION:** Accessing this parameter causes the temperature measurement to STOP transmitting and instead transmits Zero Scale. **Be sure that any equipment connected to this transmitter is prepared for the disruption in the temperature signal level before accessing this parameter**.
Span Adj	When accessed, instrument immediately transmits full scale or 20 mA. Adjust parameter up or down until the device measuring the output current indicates exactly 20.00 mA. **CAUTION:** Accessing this parameter will cause the transmitter to transmit Full Scale Temperature. **Be sure that any equipment connected to this transmitter is prepared for the disruption in the temperature signal level before accessing this parameter.**
ALRM ACTN	Alarm Action – This controls how current loop responds to a detected diagnostic alarm. 0 = drive high (22.0 mA); 1 = drive low (3.6 mA); 2 = hold; 3 = ignore. **NOTE:** This alarm action is based only on internal consistency checks that are used to detect hardware failures. If a diagnostic alarm is detected, check the wiring between the fiber optic adapter and the electronics module and/or consult the factory. The alarm action can be tested by disconnecting the red or green wire to the fiber optic adapter while the pyrometer is looking at a hot reactor or other incandescent light source.
DAMPING	The measurement time constant in seconds. Higher numbers provide more smoothing.
MemCmd	Factory Use Only

3.2 Initial Startup

1. Confirm the nozzle isolation valve is closed. This prevents any foreign matter from collecting on the viewport window during refractory dry out, curing and hydrocarbon firing.
2. Establish steam flow to the Steam Jacketed Assembly and ensure that the steam trap is functioning properly. This assures that condensation will not accumulate on the viewport.
3. After verifying that the Steam Jacketed Lens Assembly is up to temperature, open the isolation valve.

   Note: It is important to keep the isolation valve closed until the reactor temperature is above +572 °F (+300 °C) in order to prevent sulfur from condensing and solidifying on the window.

4. Turn purge gas pressure on and set the purge flow meter needle control valve to approximately 60 SCFH (28 L/min).
5. Apply power to the electronics module. “IR Temp” value will be displayed.
6. Press the NEXT button to display the “Units” parameter.
7. Press the UP or Down arrow buttons to toggle between Celsius or Fahrenheit and set as desired.
8. Press the NEXT button to display the “4mA=” parameter.
9. Press the UP or DOWN arrow buttons to set the temperature corresponding to 4.00 mA loop current.
10. Press the NEXT button to display the “20mA=” parameter.
11. Press the UP or DOWN arrow buttons to set the temperature corresponding to 20.00 mA loop current.
12. Press the SAVE button to save all changes. The display will briefly indicate “Saving…”

    Note: If you do not press SAVE, the changes you made above will not be remembered after a power fail.
13. Press the NEXT button to display the temperature.

3.3 Ratiometric Two-Wavelength Sensing

The HIR ‘F range’ transmitter measures the intensity of light at two different wavelengths to determine the temperature. This allows the measurement to be accurate even if there is a partial blockage of light due to material buildup (occlusion) on the window or in the nozzle. In essence, the measurement is based on the light’s color (wavelength), instead of the intensity, as is usually done with a single wavelength measurement. In addition to the temperature, the amount of occlusion can also be measured as a Signal Value number from 0 (completely blocked) and 100 (no blockage). The Signal Value appears on the display in small numbers below the temperature. If the number falls below the Signal Alarm setpoint, then “LOW!” appears next to the displayed signal level, and HART Additional Device Status Byte 1, bit 2 is set.

Note that below 1472 °F (800 °C), there is not enough infrared light at both wavelengths to make a two-wavelength measurement. Therefore, temperatures between 662 °F and 1472 °F (350 °C and 800 °C) are only measured with a single wavelength. In that case, the amount of blockage cannot be determined.

3.4 Preventive Maintenance

Model HIR is designed to give years of trouble-free operation without the need for service. In most cases, to achieve this performance, the only requirement is that the optical path (nozzle, valve, window) temperature be maintained above the freezing point of sulfur, and that the window purge be maintained to keep the window free of particulates. Thus, a preventive maintenance schedule should include periodic inspections to verify that:

1. The steam supply is on, the steam trap is functioning, and steam is heating the lens body,
2. The lens purge flows at the recommended rate of 60 SCFH (28 L/min), and
3. The thermal insulation as shown in Figure 1 is in place and in good condition.

Signal Strength Indication

Signal strength measurement (Signal=XXX.XX) is located beneath the temperature measurement when displaying the temperature parameter. This value should read between 0 and 100 and indicates the amount of light reaching the sensor relative to an unobstructed sight path. A value of ≥ 95 is normal. Values below 95 may indicate the occurrence of sight path attenuation, possibly due to material build-up on window or inside the nozzle.

The signal strength should be monitored periodically. If it drops significantly or if the optical path temperature or purge is suspected to be compromised, corrective action should be scheduled. This includes inspecting the optical sight path and performing any necessary sight glass or lens cleaning and / or nozzle cleanout. Refer to section 2.5 Optical Alignment for details.

3.5 Calibration

Calibration should be checked any time an anomaly is suspected or annually. The best way to check the calibration or to recalibrate the instrument is with a CLAUSTEMP® Model HIP Handheld Pyrometer. See www.claustemp.com.

To calibrate the HIR Pyrometer:

1. Measure reactor temperature using a CLAUSTEMP® model HIP handheld pyrometer or other means.
2. Ensure Model HIR has a clear sight path into the reactor.
3. Press and hold the NEXT button while simultaneously pressing the UP arrow button. Then release both buttons.
4. Press the NEXT button to display the CAL TEMP parameter.
5. Unlock the calibration feature by pressing and holding the NEXT button while simultaneously, pressing the DOWN arrow button. Then release both buttons.
6. Use the UP and Down arrow buttons to set the known reactor temperature.
7. Press the SAVE button. Calibration is complete.

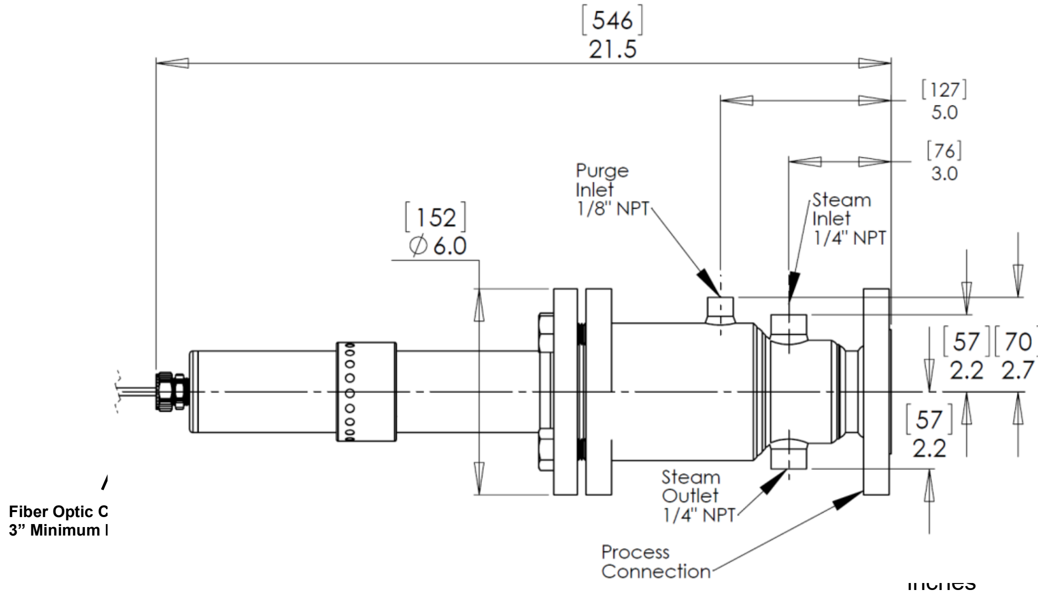

Figure 13 - Dimensions – Steam Jacketed Lens Assembly

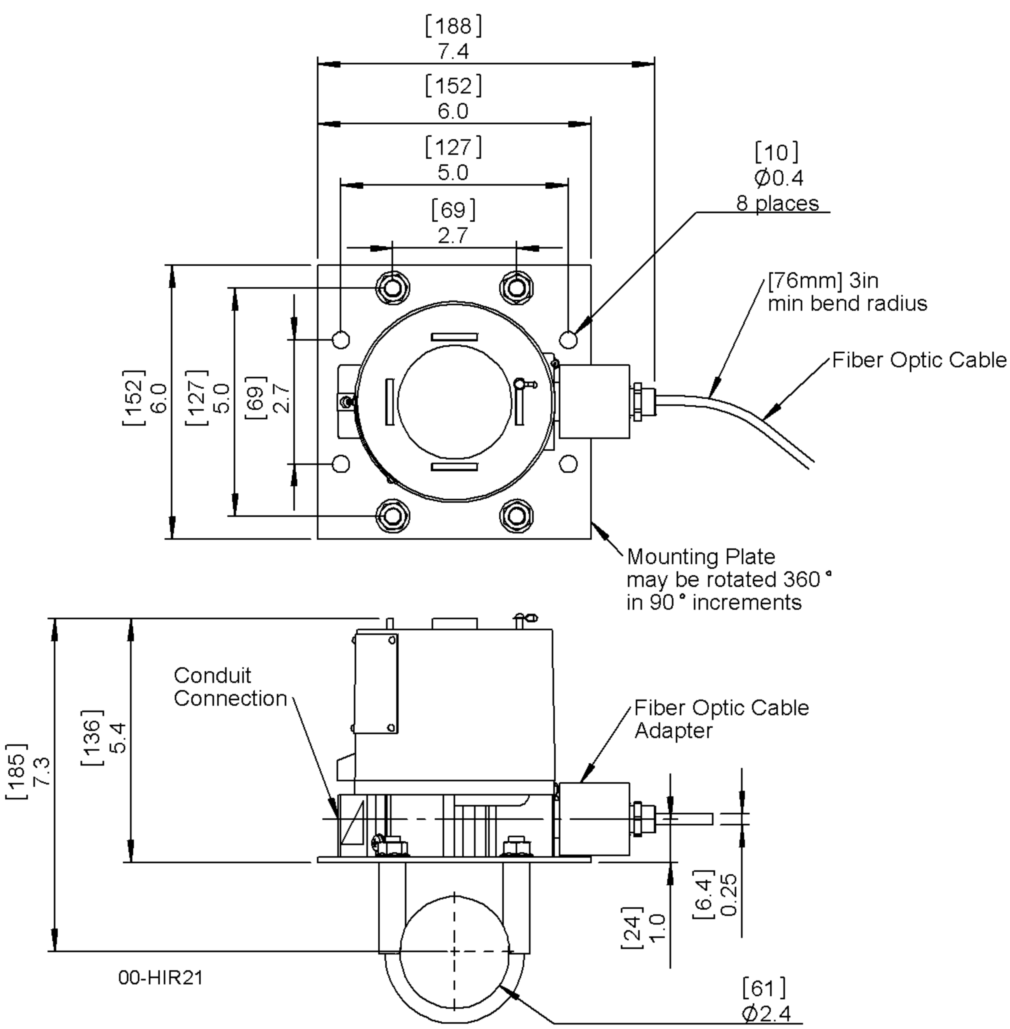

Figure 12 - Dimensions – Electronics Housing

4. SPECIFICATIONS

Range:	
“C” Range	+1472 °F to +3092 °F (+800 °C to +1700 °C)
“D” Range	+662 °F to +3092 °F (+350 °C to +1700 °C)
“F” Range Dual Wavelength Single Wavelength	 +1472 °F to +3092 °F (+800 °C to +1700 °C) +662 °F to +3092 °F (+350 °C to +1700 °C)
Accuracy	0.5 % of reading or 36 °F (±20 °C), whichever is greater
Repeatability	0.1 % of full-scale span
Warm-Up Time	60 seconds
Readout	High Contrast LCD Display
Output Signal:	4-20 mADC, 2-wire loop-powered
Hazardous Location Rating	II 2 G Ex d IIB+H2 T6 (When installed per section 2.3) IP65
Certifications	CSA 18CA70131733 Sira 18ATEX1044X IECEx SIR 18 0012X
Fiber Optic Cable:	Flexible PTFE over SS armor 10 feet (3 meters) standard length
Minimum Bend Radius	3 inches (7.6 cm)
Hot Lens Mounting	3” ANSI is standard on a flanged nozzle steam jacketed. Other types and sizes available
Ports:	
Steam Jacket in and out	50 psi to 100 psi (344 kPa to 689 kPa) for steam to heat the lens assembly
Nitrogen Purge	60 SCFH (28 L/min) typical
Housing Mounting	Vertical surface or 2-20 pipe stand with vertical or horizontal orientation
Housing Conduit Connection	¾” NPT
Ambient Temperature Limits:	
Fiber Optics & Lens	-40 °F to +400 °F (-40 °C to +204 °C)
Fiber Optics Adapter	-4 °F to +185 °F (-20 °C to 85 °C)
Electronics	-4 °F to +158 °F (-20 °C to +70 °C)
Maximum Process Pressure	150 psi (1034 kPa)

“X” behind the certification number indicates special conditions for safe use: “Flamepath joints are not intended to be repaired.”