

OPERATING INSTRUCTION MANUAL

Model 3422-series Compression Fitting Style Contacting Conductivity/Resistivity Sensors

(Enhanced Performance Design)

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In the interest of improving and updating its equipment, GLI reserves the right to alter specifications to equipment at any time.
A Member of the Environmental Instrumentation Group

HELPFUL IDENTIFIERS

In addition to information on installation and operation, this instruction manual may contain WARNINGS pertaining to user safety, CAUTIONS regarding possible sensor malfunction, and NOTES on important, useful operating guidelines.

A WARNING LOOKS LIKE THIS. ITS PURPOSE IS TO WARN THE USER OF THIS SENSOR OF THE POTENTIAL FOR PERSONAL INJURY.

A CAUTION LOOKS LIKE THIS. ITS PURPOSE IS TO ALERT THE USER OF THIS SENSOR TO POSSIBLE SENSOR MALFUNCTION OR DAMAGE.


 **NOTE:** *A note looks like this. Its purpose is to alert the user of this sensor to important operating information.*

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SENSOR WARRANTY/REPLACEMENT PLAN

GLI International, Inc. will replace or repair any sensor which fails due to defects in material or workmanship for a period of 1 year (12 months) from the date of shipment of this product from our facility. A warranty claim will not be honored if defects are not reported within the warranty period, or if GLI International determines that defects or damages are due to normal wear, misapplication, lack of maintenance, abuse, improper installation, alteration, or abnormal conditions. GLI International's obligation under this warranty shall be limited to, at its option, replacement or repair of this product. The product must be returned to GLI International, freight prepaid, for examination. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for replacement or repair. GLI International's liability shall not exceed the cost of the product. Under no circumstances will GLI International be liable for any incidental or consequential damages, whether to person or property. GLI International will not be liable for any other loss, damage or expense of any kind, including loss of profits, resulting from the installation, use, or inability to use this product.

PART ONE - INTRODUCTION

SECTION 1

GENERAL INFORMATION

1.1 Description

Benefits of Enhanced
Performance Design

Model 3422-series compression fitting style sensors are manufactured to exacting tolerances using high quality, rugged materials for demanding ultrapure water and pure water applications. Each sensor is:

- Individually tested to determine its absolute cell constant (shown on its label as $K =$), and its temperature element value (to the nearest 1.0 ohm). Entering each sensor's GLI-certified "K" value and temperature "T" factor during instrument configuration or calibration, ensures the highest possible measurement accuracy.
- Built with a Pt 1000 RTD temperature element located at its tip to provide exceptionally fast response to changes in temperature with high measuring accuracy ($\pm 0.2^{\circ}\text{C}$).

Sensor Characteristics

Basic Cell Constant: 0.05, 0.5, 1.0, 5.0, or 10.

Installation Style: For sensors with a 0.05 cell constant, use 1/2-inch or 3/4-inch male NPT compression fittings made of Kynar (PVDF) or 316 stainless steel. For sensors with any other cell constant, use a 3/4-inch male NPT compression fitting made of Kynar or 316 stainless steel. In all cases, the fitting enables the sensor to be insertion mounted, up to 4 inches/102 mm deep, into a pipe tee or vessel. Reversing the fitting enables the sensor to be fastened onto the end of a pipe for immersion mounting. A longer version of the sensor can be installed into a 316 stainless steel ball valve assembly to insert/retract the sensor without stopping the process flow. (GLI Model MH113M2C is required for sensors with a 0.05 cell constant, and Model MH114M3C for sensors with any other cell constant.) Maximum insertion depth is 7 inches (178 mm).

Termination Style: An integral 20 ft. (6 m) long cable or an integrally-mounted junction box (polypropylene, aluminum, or 316 stainless steel) with 3/4 inch female conduit connection.

1.2 Operating Precautions

Always consider the temperature/pressure ratings of the mounting hardware used to install the sensor. The sensor and hardware combination are an integrated system. The hardware material usually limits the system's temperature/pressure rating. Refer to Section 2 for complete specifications.

SECTION 2

SPECIFICATIONS

Wetted Materials	Titanium electrodes (316 stainless steel outer electrode for extended sensor body style used with ball valve assembly), PTFE Teflon insulator, and treated Viton O-ring seals
Maximum Temperature	When used with Kynar (PVDF) compression fitting: 302°F at 25 psi (150°C at 1.7 bar) When used with 316 stainless steel compression fitting: 302°F at 200 psi (150°C at 13.7 bar) When used with 316 stainless steel GLI ball valve hardware assembly [^] : 257°F at 150 psi (125°C at 10.3 bar)
Maximum Pressure	When used with Kynar (PVDF) compression fitting: 150 psi at 97°F (10.3 bar at 36°C) When used with 316 stainless steel compression fitting: 200 psi at 302°F (13.7 bar at 150°C) When used with 316 stainless steel GLI ball valve hardware assembly [^] : 150 psi at 257°F (10.3 bar at 125°C)
	^ Other brands of ball valve hardware assemblies may reduce the listed rating.
Flow Rate	0-10 ft. (0-3 m) per second (fully immersed)
Temperature Compensator	Pt 1000 RTD
Sensor Cable:	
Integral (no junction box)	6 wire cable (4 conductors and two isolated shield wires); 20 ft. (6 m) long
Junction Box Head (optional)	6-position terminal strip supplied in integrally-mounted junction box (polypropylene, aluminum, or 316 stainless steel)

PART TWO - INSTALLATION

SECTION 1 LOCATION REQUIREMENTS

Locate the sensor as close as possible to the measuring instrument. Do not exceed a distance of 300 feet (91 m) between the sensor and instrument.

SECTION 2 MOUNTING

The Model 3422-series compression fitting style sensor may be insertion mounted into a pipe tee or vessel fitting. By reversing the compression fitting, the sensor can be fastened to the end of an appropriate length pipe for immersion mounting. The “longer version” compression style sensor is intended to be mounted into a ball valve assembly, enabling sensor removal without stopping the process flow. Figure 2-1 shows the sensor’s general dimensions.

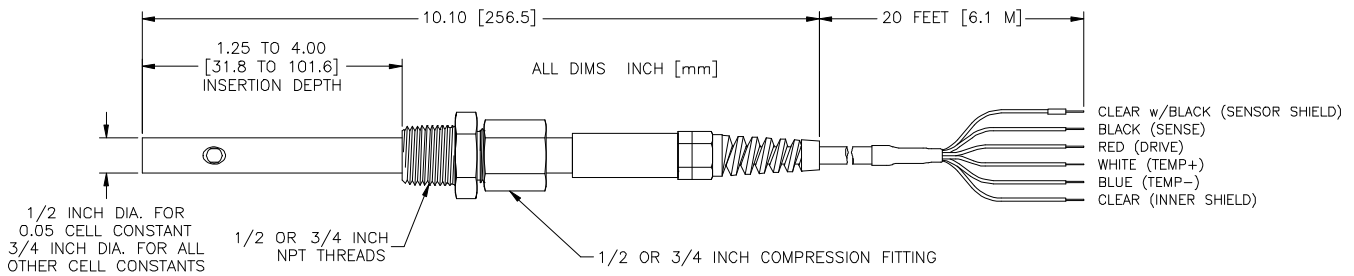


FIGURE 2-1 General Dimensions and Cable Wire Details

2.1 Insertion Mounting

To ensure optimum measurement performance, follow these guidelines when insertion mounting the sensor:

- Install the sensor into the pipe run so that the process flows directly into the end of the sensor (see Figure 2-2).
- Preferably, mount the sensor in a vertical position to eliminate the possibility of trapped air bubbles from contacting its electrodes which can cause measurement error. This also prevents loose pipe line sediment from accumulating and obstructing the sensor electrodes.

1. Install a pipe tee of appropriate size (1/2 to 2 inch) and material into the process pipe. If necessary, screw a respectively-sized reducer into the pipe tee.



NOTE: Use thread sealant on the mounting hardware threads to avoid leaks. **Recommendation:** Use Teflon tape or pipe sealant with Teflon. (Exception: For higher temperature solutions, sealing with Teflon tape may not be adequate.)

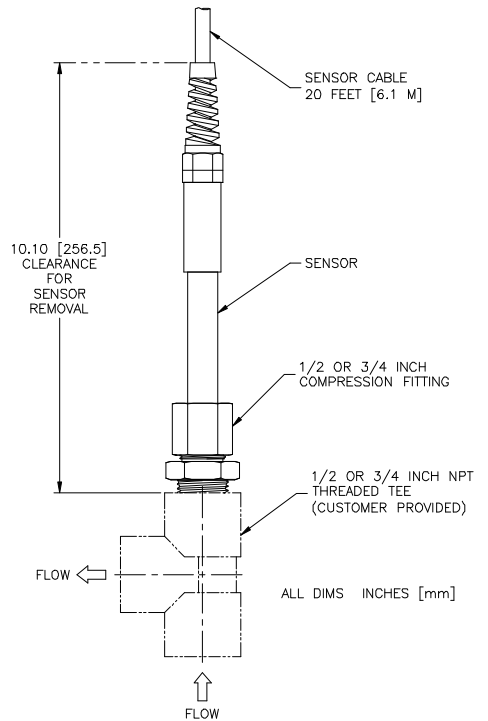


FIGURE 2-2 Insertion Mounting Details

2. Remove the compression fitting from the sensor and screw it into the pipe tee (or reducer, if used).
3. Electrically connect sensor to analyzer. Refer to analyzer instruction manual for details.
4. Calibrate analyzer using procedure in analyzer instruction manual.
5. After calibration, mount the sensor into the tee:
 - A. Place compression nut and ferrule onto the sensor, compression nut first.



NOTE: Correctly orient the ferrule onto the sensor as shown in Figure 2-3 to get an effective seal.

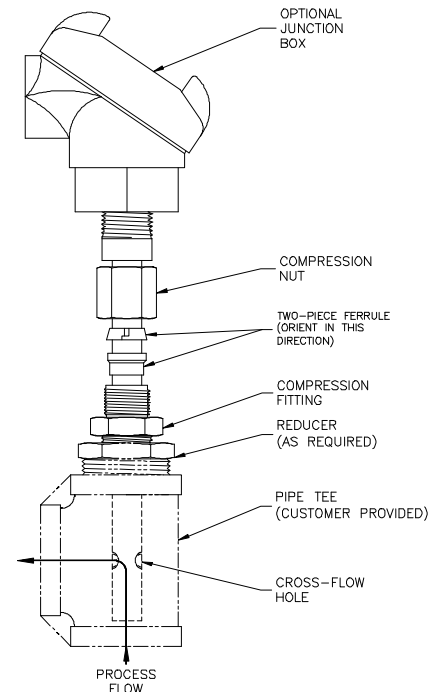


FIGURE 2-3 Compression Fitting Parts Arrangement For Insertion Mounting

- B. Insert the sensor into the compression fitting. Then adjust the insertion depth to position the sensor's "cross-flow" holes at the center of the tee, and directly in the process flow path.



NOTE: Rotate the sensor to align one of its "cross-flow" holes with the exiting process flow path as shown in Figure 2-3.

CAUTION: AFTER TIGHTENING THE COMPRESSION NUT, THE FERRULE WILL BE PERMANENTLY CRIMPED. THEREFORE, MAKE SURE THAT THE SENSOR IS INSERTED TO THE PROPER DEPTH BEFORE TIGHTENING THE COMPRESSION NUT.

- C. With the sensor properly positioned, tighten the compression nut onto the compression fitting to crimp the ferrule. Use one wrench to hold the fitting and another to turn the nut 1 to 1-1/4 turns. This should provide an effective process seal. Also, the crimped ferrule becomes a convenient reference indicator for insertion depth when re-inserting the sensor after cleaning.

This completes the insertion mounting.



Installation Tip!

Re-using Compression Fitting, Nut, and Crimped Ferrule:

If the sensor is re-installed, the compression fitting and nut can be re-used. The crimped ferrule, however, may need to be cut away from the sensor to remove it, making it unusable. If you can remove the crimped ferrule without destroying it, and if it can still provide an effective process seal, you can probably re-use it at least the number of times listed below:

Recommended Crimped Ferrule Re-use

Ferrule Material	Number of Re-uses
316 stainless steel	1 after initial use
Kynar® (PVDF)	3 after initial use

2.2 Immersion Mounting

1. Reverse the compression fitting assembly on the sensor so that the longer threaded section faces towards the sensor cable end (see Figure 2-4).
2. Position the compression fitting assembly at the far cable end of the sensor body and tighten the compression nut onto the compression fitting. Use one wrench to hold the fitting and another to turn the nut 1 to 1-1/4 turns to crimp the ferrule. This provides a process seal.
3. Route the sensor cable through a pipe of an appropriate material and length. Screw the compression fitting onto the end of the pipe (or coupling, if used).



NOTE: Use thread sealant on the pipe threads to avoid leaks. **Recommendation:** Use Teflon tape or pipe sealant with Teflon. (Exception: For higher temperature solutions, sealing with Teflon tape may not be adequate.)

4. Fasten a Unilet junction box onto the other end of the pipe.
5. Run interconnect cable from the analyzer into the Unilet junction box. Connect the sensor and interconnect cable wires, by matching colors, to the terminals in the junction box. Fasten the cover onto the junction box.
6. Electrically connect the sensor interconnect cable wires to the analyzer. Refer to the analyzer instruction manual for details.
7. Calibrate the analyzer using the procedure in the analyzer instruction manual.
8. After calibration, mount the sensor into the process.

This completes the immersion mounting.

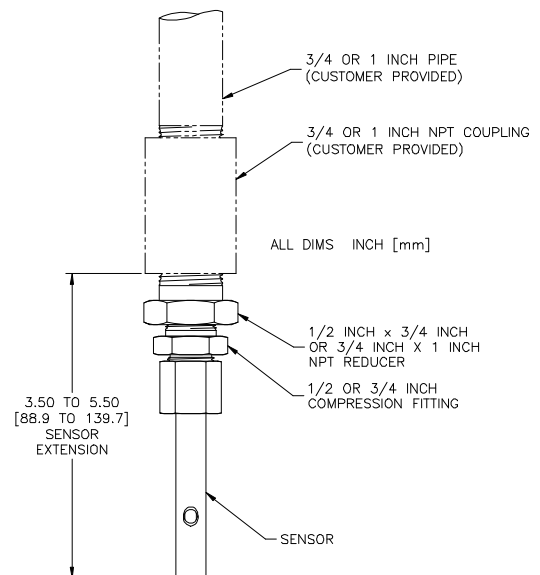


FIGURE 2-4
Immersion Mounting Details

2.3 Ball Valve Mounting

Performance Guidelines

The Model 3422-series compression style sensor is offered in an “extended sensor body” style for use with a ball valve mounting hardware assembly. After installation, the sensor can be inserted into/retracted from the process without stopping the flow.

To ensure optimum measurement performance, follow these guidelines when ball valve mounting the sensor:

- Install the sensor into the pipe run so that the process flow directly contacts the end of the sensor (Figure 2-5).
- Do not exceed the maximum temperature and pressure ratings of 257°F at 150 psi (125°C at 10.3 bar) for the sensor/hardware combination.

WARNING: DO NOT INSERT THE SENSOR INTO A PRESSURIZED SOLUTION THAT EXCEEDS THE SPECIFIED TEMPERATURE/PRESSURE LIMITS OF THE SENSOR AND BALL VALVE ASSEMBLY. THIS CONDITION IS DANGEROUS.

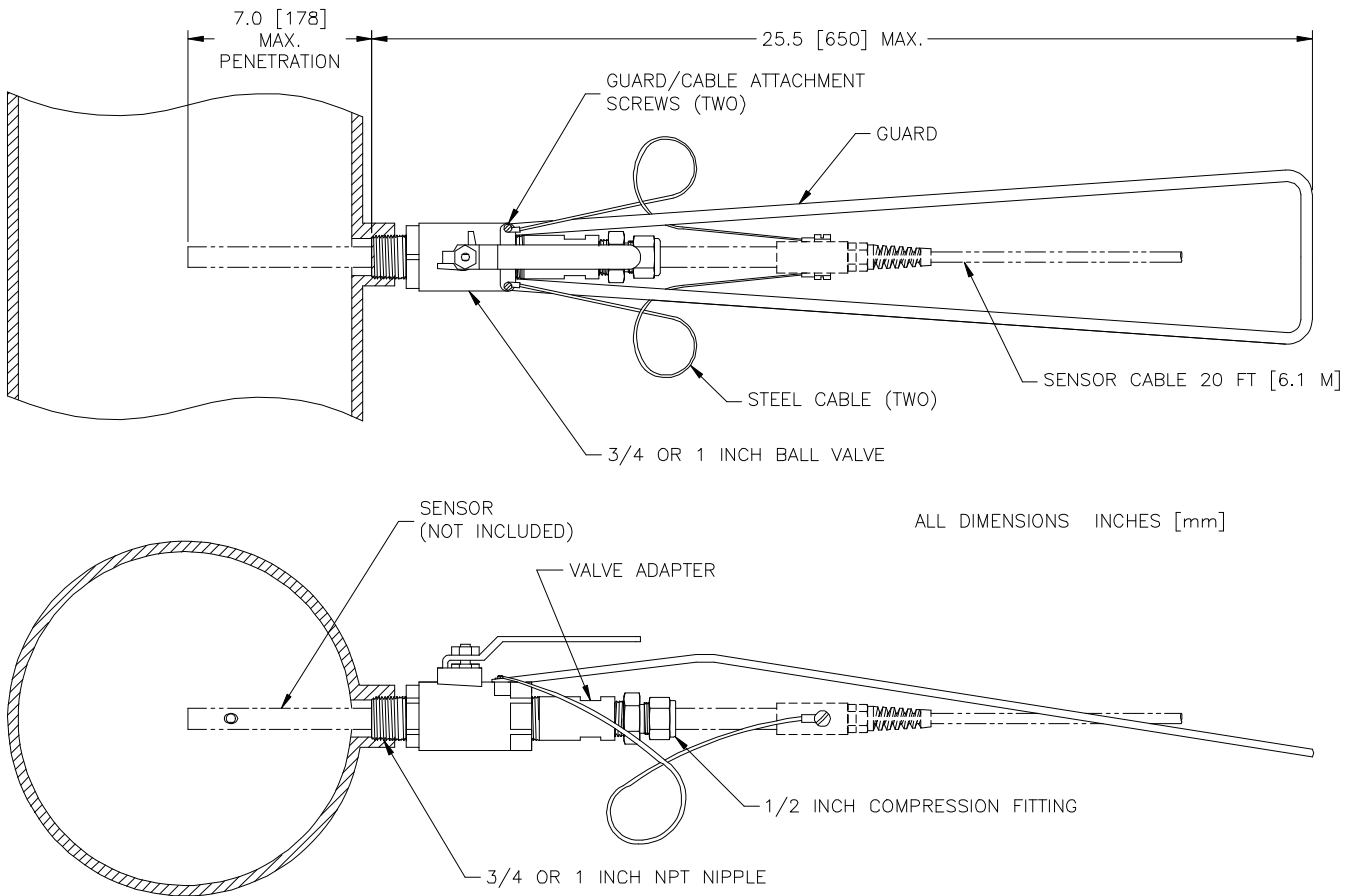


FIGURE 2-5 Ball Valve Assembly Mounting Details

Sensor Location/ Position Guidelines



Along the Pipe: Install the sensor in a straight section of the process pipe.

NOTE: *The sensor is designed for full pipe flow use. A partially filled pipe and trapped air bubbles will cause measurement error.*

Radial Pipe Positions

- For Horizontal Pipe Run: The best sensor position around the circumference of a horizontal pipe is vertically on top. Other suitable positions are between vertical and 45°.



NOTE: *Avoid mounting the sensor horizontally into the pipe (sideways) or below horizontal. Rust particles and other types of loose pipe line sediment could accumulate and obstruct the sensor electrodes.*

- For Vertical Pipe Run: When mounting the sensor in a vertical pipe, there should be an upward flow direction in the pipe to ensure full pipe flow contact with the sensor electrodes. Any sensor position around the circumference of a vertical pipe is acceptable.

Mounting Ball Valve Assembly into Non-pressurized Pipe

First, with the sensor removed, install the ball valve assembly using the following two steps. Then install the sensor into the mounted, non-pressurized ball valve assembly using the steps described in the next subsection.

1. Install an NPT fitting (3/4-inch for MH113M2C ball valve assembly or 1-inch for MH114M3C ball valve assembly) into the process pipe.



NOTE: *Use thread sealant on the mounting hardware threads to avoid leaks. **Recommendation:** Use Teflon tape or pipe sealant with Teflon. (Exception: For higher temperature solutions, sealing with Teflon tape may not be adequate.)*

2. Fasten the nipple of the ball valve assembly into the process pipe's NPT fitting (3/4-inch or 1-inch) and securely tighten.

Installing Sensor into Non-pressurized Ball Valve Assembly

1. Remove the compression fitting from the sensor and screw it into the back of the ball valve assembly.
2. Electrically connect the sensor to the analyzer. Refer to the analyzer instruction manual for details.
3. Calibrate the analyzer using the procedure in the analyzer instruction manual.

4. With the ball valve fully open (ON position), carefully install the sensor into the assembly:

A. Make sure the compression nut and ferrule are positioned onto the sensor, compression nut first.



NOTE: *Correctly orient the ferrule onto the sensor as shown in Figure 2-3 to get an effective seal.*

B. Lubricate the sensor body with water so that it slides easier past the internal O-ring seals of the ball valve assembly.

C. Insert the sensor into the compression fitting on the back of the ball valve assembly. Then adjust the insertion depth to position the sensor's "cross-flow" holes toward the center of the pipe flow (Figure 2-5).



NOTE: *Align one of the sensor's "cross-flow" holes with the exiting process flow path by slightly turning the sensor.*

CAUTION: AFTER TIGHTENING THE COMPRESSION NUT, THE FERRULE WILL BE PERMANENTLY CRIMPED. THEREFORE, MAKE SURE THAT THE SENSOR IS INSERTED TO THE PROPER DEPTH BEFORE TIGHTENING THE COMPRESSION NUT.

D. With the sensor properly positioned, tighten the compression nut onto the compression fitting to crimp the ferrule. Use one wrench to hold the fitting and another to turn the nut 1 to 1-1/4 turns. This should provide an effective process seal. Also, the crimped ferrule becomes a convenient reference indicator for the insertion depth when re-inserting the sensor after cleaning.

This completes the ball valve assembly mounting.



Installation Tip!

Re-using Compression Fitting, Nut, and Crimped Ferrule:

If the sensor is re-installed, the compression fitting and nut can be re-used. The crimped ferrule, however, may need to be cut away from the sensor to remove it, making it unusable. If you can remove the crimped ferrule without destroying it, and if it can still provide an effective process seal, you can probably re-use it at least once more.

Retracting Sensor from Pressurized Pipe

WARNING: RETRACTING THE SENSOR FROM A PRESSURIZED PIPE CAN BE DANGEROUS. ALWAYS CHECK THAT THE CABLES AND GUARD ARE PROPERLY INSTALLED ON THE HARDWARE ASSEMBLY BEFORE OPENING THE BALL VALVE. THIS RESTRICTS THE SENSOR'S OUTWARD MOVEMENT.

ALSO, DO NOT ATTEMPT TO RETRACT THE SENSOR WHEN THE PROCESS PRESSURE IS GREATER THAN 50 PSI (3.4 BAR). IF THIS CANNOT BE AVOIDED, USE EXTREME CAUTION.

1. With the ball valve fully open (ON position), hold the sensor against the process pressure and carefully unscrew the compression nut. Slowly retract the sensor from the process to its fully retracted position.

CAUTION: AT HIGH PROCESS PRESSURES, THE SENSOR MAY RAPIDLY MOVE TO ITS RESTRICTED, FULLY RETRACTED POSITION.

2. Turn the ball valve to its fully closed (OFF) position.
3. Unfasten the two guard/cable attachment screws, and remove the cables and guard.
4. Remove the sensor from the ball valve assembly.

Re-inserting Sensor into Pressurized Pipe



1. With the ball valve fully closed (OFF position), carefully insert the sensor into the assembly until it just touches the closed ball valve.

NOTE: *Lubricate the sensor body with water so that it slides easier past the internal O-ring seals of the ball valve assembly.*

2. Install the guard and cables using both attachment screws.

WARNING: A SENSOR MOUNTED IN A PRESSURIZED PIPE CAN BE DANGEROUS. BEFORE OPENING THE BALL VALVE, ALWAYS INSTALL THE GUARD AND CABLES TO RESTRICT THE SENSOR'S OUTWARD MOVEMENT.

3. Turn the ball valve to its fully open (ON) position.
4. Insert the sensor until it reaches its "crimped" reference position established when it was first installed.
5. Tighten the compression nut onto the compression fitting. Use one wrench to hold the fitting and another to turn the nut.

SECTION 3

SENSOR/INTERCONNECT CABLE DETAILS

3.1 Sensor Cable
Details

The sensor's integral cable is a 6-wire crosslinked polyethylene-jacketed cable with 4 conductors and two isolated shield wires. Refer to Figure 2-1 for the function and color of each wire in the sensor's integral cable.

3.2 Interconnect Cable
Details

The GLI interconnect cable (part number 1W1100) is provided with unfinished ends since it must often be shortened during installation. This interconnect cable replaces the 99X1W4000 cable which is no longer available. The 1W1100 cable is very similar to the sensor's integral cable except that it has two additional conductors (green and yellow) which are not required. When stripping the interconnect cable during termination, purposely cut off these green and yellow wires from each end of the stripped-back cable. This ensures the same wire color coding used by the sensor's integral cable.



NOTE: *GLI strongly recommends using only its 1W1100 interconnect cable. If a different cable is used, it must have equivalent construction: four conductors, and two separate isolated shields -- one shielding the signal, and one shielding the overall cable. These specific cable characteristics protect the measurement signal from electromagnetic interferences. Using a cable with different construction may interfere with the measurement system's ability to properly measure.*

To correctly terminate the ends of the interconnect cable, refer to Figure 2-6 and follow this procedure:

1. Carefully strip back 2-1/4 inches of the outer cable jacket, the outer shield foil, and the cellophane binder. This exposes the sensor shield wire, the inner shield wire, and the three foil-wrapped wire pairs.
2. Cut off the exposed 2-1/4 inches of only the yellow and green wire pair.
3. Peel back and cut off the exposed inner shield foil from the red/black and blue/white wire pairs.
4. Carefully strip back an additional 1/2 inch of the outer cable jacket and outer shield foil.



NOTE: *Be careful not to damage the exposed section of the cellophane binder.*

5. Carefully position a 2-1/2 inch long piece of shrink tubing or tape on the bare sensor shield wire 1/4-inch from the end as shown in Figure 2-6 to insulate and distinguish it from the inner shield wire. Doing this exposes 1/4-inch of bare shield wire beyond the tubing or tape for connection purposes.
6. Carefully position a 1-inch long piece of shrink tubing or tape on the cable as shown in Figure 2-6 to secure all wires.



NOTE: Do not fold back the cellophane binder exposed in step 4.

7. Using an ohmmeter or test light, verify that the sensor shield wire you insulated is not shorted to the bare inner shield wire. If the wires are shorted, cut the cable to get a new unfinished end and start over at step 1.
8. Strip 1/4 inch of insulation from the ends of the red, black, white, and blue wires. Tin these leads, the insulated sensor shield wire, and the bare inner shield wire with solder.
9. Connect the interconnect cable to the analyzer in the same way as the sensor cable, by matching colors as indicated.

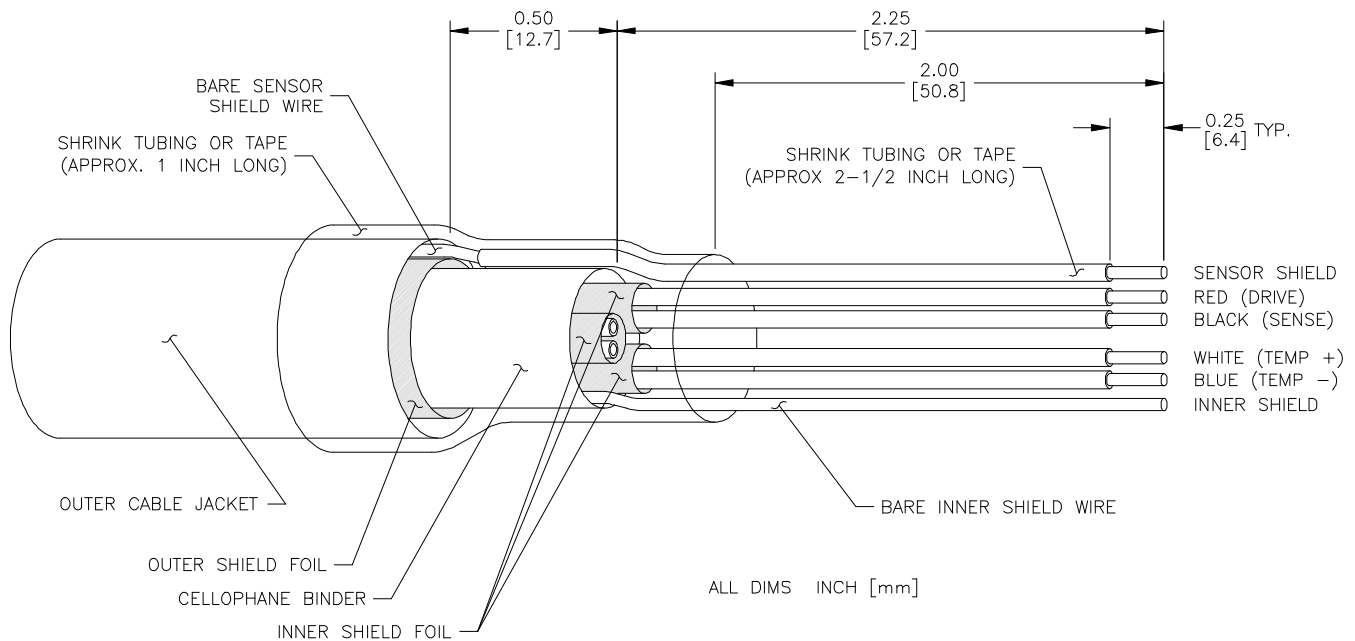


FIGURE 2-6 Interconnect Cable Termination Details

3.3 Connecting Interconnect Cable

- **To Integral Junction Box Head:** Connect the four colored wires and two shields of the interconnect cable to the six terminals inside the junction box head, following the wire designations shown inside the junction box cover.
- **To Analyzer:** Refer to the instrument instruction manual and connect the interconnect cable wires to appropriate SENSOR terminals in the same way as the sensor wires would be directly connected.

PART THREE - SERVICE AND MAINTENANCE

SECTION 1

RECOMMENDED CLEANING PROCEDURE

Keep the sensor reasonably clean to maintain measurement accuracy. The time between cleanings (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience.

1. Remove most contaminate buildup by carefully wiping the inner electrode rod, and the concentric outer electrode tube (inner and outer surfaces) with a soft clean cloth. Then rinse the sensor with clean, warm water.
2. Prepare a mild soap solution. Use warm water and dish-washing detergent, Borax hand soap, or a similar soap.
3. Soak the sensor for 2 to 3 minutes in the soap solution.
4. Use a small bristle brush, cotton swab (Q-tip), or pipe cleaner to scrub the entire measuring end of the sensor, thoroughly cleaning the electrode surfaces. If detergent solution cleaning cannot remove surface deposits, use muriatic acid (or another dilute acid) to dissolve the deposits. The acid should be as dilute as possible, but yet strong enough to clean. Experience will help determine which acid to use and how dilute it can be. Some stubborn coatings may require a different cleaning agent. For assistance in these difficult cases, contact the GLI Service Department.

Before cleaning with acid, determine if any hazardous reaction products could form. (Example: A sensor used in a cyanide bath should not be put directly into a strong acid for cleaning because poisonous cyanide gas could be produced.) Acids are hazardous. Wear appropriate eye protection and clothing in accordance with Material Safety Data Sheet recommendations.

Soak the sensor in dilute acid for **no more than 5 minutes**. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize any remaining acid.

5. Rinse the sensor in clean, warm water.
6. Calibrate the analyzer using the procedure in the analyzer instruction manual. If calibration cannot be attained, check the sensor using the procedure in Part Three, Section 2.1.

SECTION 2

TROUBLESHOOTING

2.1 Checking Sensor Operation

Use the troubleshooting section in the analyzer instruction manual to determine whether the sensor or analyzer is inoperative. If you suspect the sensor, check it using this procedure:

1. Disconnect the sensor from the analyzer (or junction box, if using interconnect cable).
2. Clean the sensor using the procedure in Part Three, Section 1.
3. Using an ohmmeter, check all of the measurement point resistance readings shown in Table A below.



NOTE: Be sure that the ohmmeter is set to its highest range for all infinite (open circuit) resistance readings shown in Table A.

Table A -- SENSOR OPERATIONAL (RESISTANCE) CHECKS	
Measurement Points	Correct Resistance Readings
Between blue and white wires	1089-1106 ohms at 23-27°C
Between red wire and sensor body	Less than 5 ohms
Between black wire and inner electrode	Less than 5 ohms
Between black and red wires	Infinite (open circuit)
Between black and white wires	Infinite (open circuit)
Between red and white wires	Infinite (open circuit)
Between red and inner shield wires	Infinite (open circuit)
Between black and inner shield wires	Infinite (open circuit)
Between white and inner shield wires	Infinite (open circuit)
Between outer and inner shield wires	Infinite (open circuit)

4. If you cannot get the required readings for one or more of the resistance checks in step 3, the sensor is probably inoperative. Refer to GLI's warranty/replacement plan on page 4 for sensor replacement details. If all resistance checks are okay, the sensor may still be inoperative. In this case, more extensive troubleshooting is required. Please consult the GLI Customer Service Department for details.

2.2 Customer Assistance

If you need assistance in troubleshooting or repair service, please contact your local GLI representative, or the GLI Customer Service Department at:

GLI International, Inc. Telephone: [800] 543-8907
 9020 West Dean Road Telefax: [414] 355-8346
 Milwaukee, Wisconsin 53224

— GLI SERVICE DEPARTMENT HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	8:30 a.m. to 5:30 p.m.	7:30 a.m. to 4:30 p.m.	6:30 a.m. to 3:30 p.m.	5:30 a.m. to 2:30 p.m.
Friday	8:30 a.m. to 4:00 p.m.	7:30 a.m. to 3:00 p.m.	6:30 a.m. to 2:00 p.m.	5:30 a.m. to 1:00 p.m.

All sensors returned for repair or replacement must be freight prepaid and include the following information:

1. A clearly written description of the malfunction.
2. Name of person to contact and the phone number where they can be reached.
3. Proper return address for shipping sensor(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.
4. A purchase order if sensor(s) is out of warranty to cover costs of repair.



NOTE: *If the sensor is damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept sensors returned for repair or replacement unless they are thoroughly cleaned and all process chemicals are removed.*