Model 611 Bubble Detector
and the
Model AF13 Series Inline Sensor
Installation and Operation Manual

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1. General Information

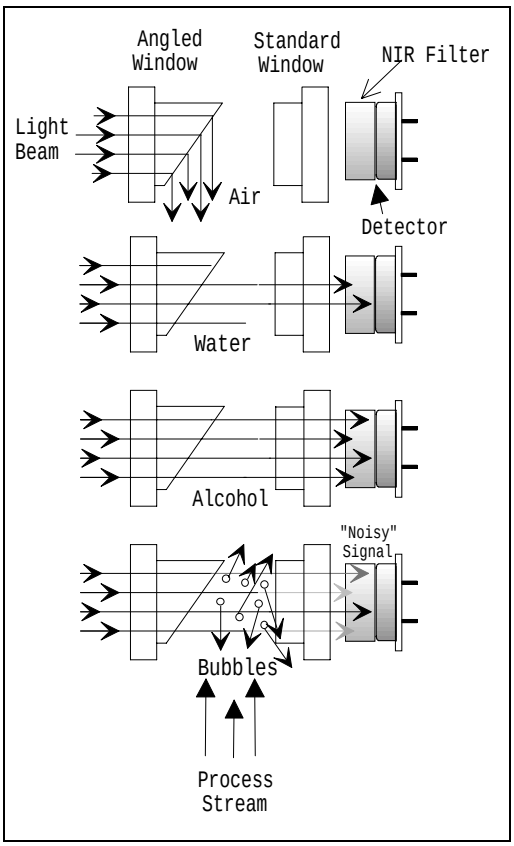
The Model 611 Bubble Detector, when used in conjunction with the Model AF13 Sensor, is designed to measure the presence of gas bubbles or foam in a liquid stream and full/empty pipe condition. In addition, the Model 611 will measure variation in the absorbance of the monitored liquid, allowing differentiation between liquid phases and mixtures such as water/alcohol. The unit includes setpoint functions and an analog output for connection to control systems and/or annunciators and indicators.

1.1 How the Model 611 Works

The Model 611/AF13 system continually monitors the process stream, measuring liquid absorbance and detecting bubbles due to entrained gas in the process stream.

Aqueous solutions exhibit an optical absorbance in the NIR (Near Infrared Region of the electromagnetic spectrum) when compared to air (an empty sample cell). By contrast, inorganic solvents such as alcohol exhibit little or no absorbance in the NIR when compared to water. These differences in absorbance allow the instrument to detect liquid phase variations. A photoelectric detector, fitted behind a filter allowing only NIR electromagnetic energy to pass through, senses changes in the level of transmitted light due to varying absorbance.

Unfortunately, many non-aqueous solvents exhibit a similar absorbance characteristic to air in the NIR. In order to provide the reliable detection of an empty pipe condition, the Model AF13 sensor is fitted with an angled window on the detector side of the cell. In the absence of liquid, nearly all of the transmitted light energy is deflected away from the photoelectric sensor by the angled window. This loss of signal is interpreted as the empty pipe condition.



Air bubbles entrained in the process stream scatter light. This light scattering is effectively independent of the liquid absorbance characteristic but will cause noise and disturb the absorbance measurement. When bubbles are present, light scattering occurs and is detected as a fast “noise” transient superimposed upon the liquid absorbance measurement.

The following diagram shows the behavior of the system for the various conditions described above. When the cell is empty, the detected light level is very low. Filling the system with water causes the window faces to be fully wetted and light detection increases. When the cell is filled with, for instance, alcohol, light detection increases to a maximum value.

The display on the front panel of the Model 611 is scaled 0 to 100, where an empty cell is 0, water is approximately 50 and alcohol would cause an indication of 100. In liquids that are a mixture of alcohol and water, the panel meter will show a value between 50 and 100, depending upon the mixture strength.

Figure 1 - Detector Optical Diagram

2. Description of the Model 611 Bubble Detector

2.1 Specifications

Input Signal:	Supplied by the Model AF13 Inline Sensor series
Range:	0 – 100% Air (0%) -Water (50%) -Organic Solvent (100%)
Resolution:	+/- 1 Digit
Repeatability:	+/- 0.5%
Display:	3½ Digit LCD
Analog Output:	4-20mA into 0-850 Ohm load
Control/Alarm Outputs:	Three independent SPDT relays rated at 0.5A, 115VAC/ 1A, 24VDC into a resistive load. Front panel LED lamps indicate the respective energized relay. Relays can be energized above or above set point (jumper selectable).
Control/Alarm Readout and Set Point:	Front panel mounted controls adjust the set points which are displayed on the front panel DVM. Selection for set point or process value is controlled with a 3 position toggle switch.
Power:	115/230 VAC +/- 15%, 50/60 Hz, 15 Watts (Optional 20-28VDC)
Operating Environment	Temperature; 0-55^{o}C Humidity; 0-90% RH, Non-condensing
Dimensions:	Standard Type 4 DIN Plug In Module, 3U x 14HP x 160 mm deep, 2.8"w x 5.06"h x 6.69"d
Weight:	Module less than one kilogram
Approvals	CE, T Mark (Safety and EMC) EN 61010, EN 55011, EN 50082-1

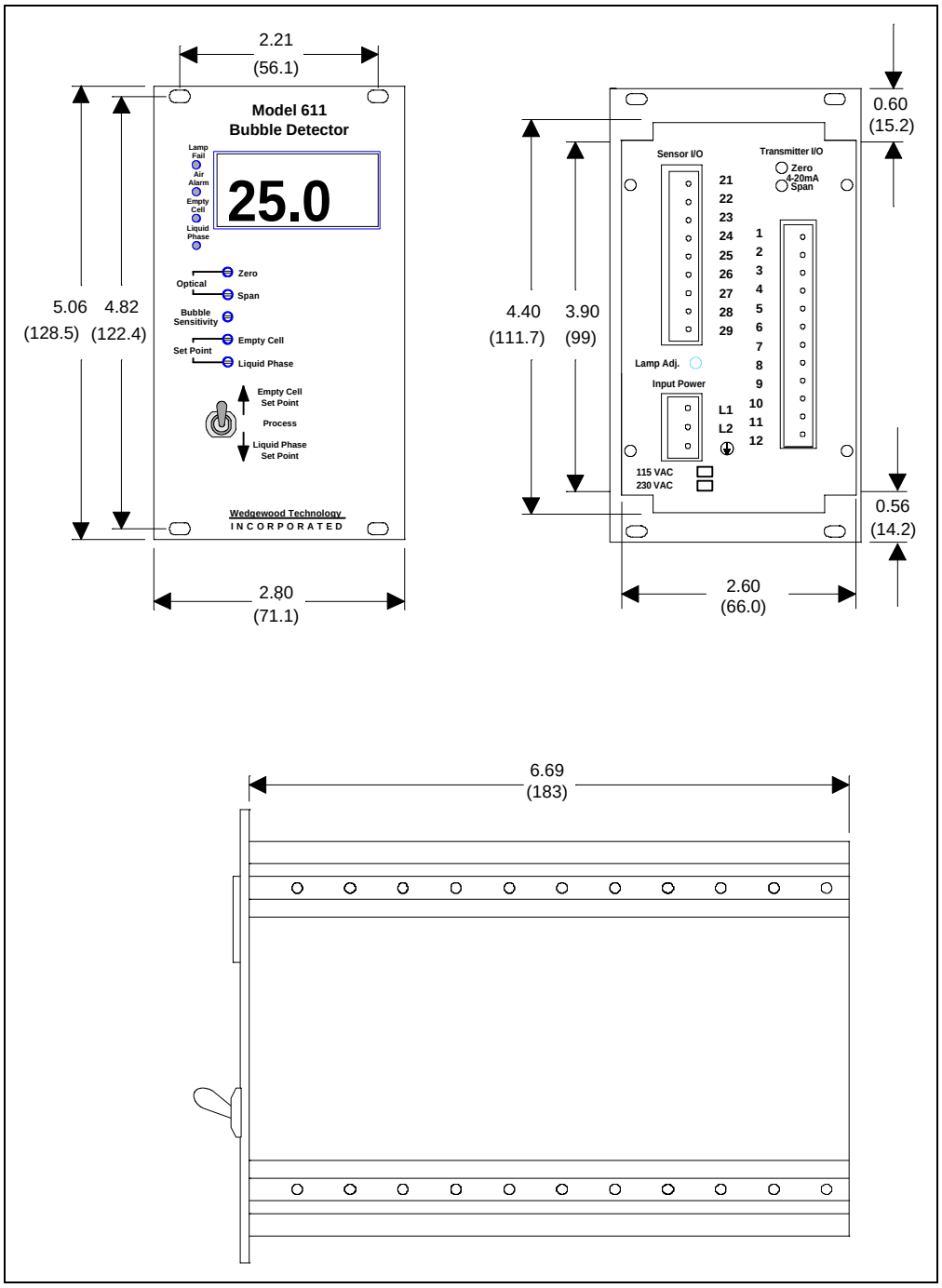


Figure 2 - Model 611 Bubble Detector Dimensions - Inches (mm)

2.2 Front Panel Controls and Function

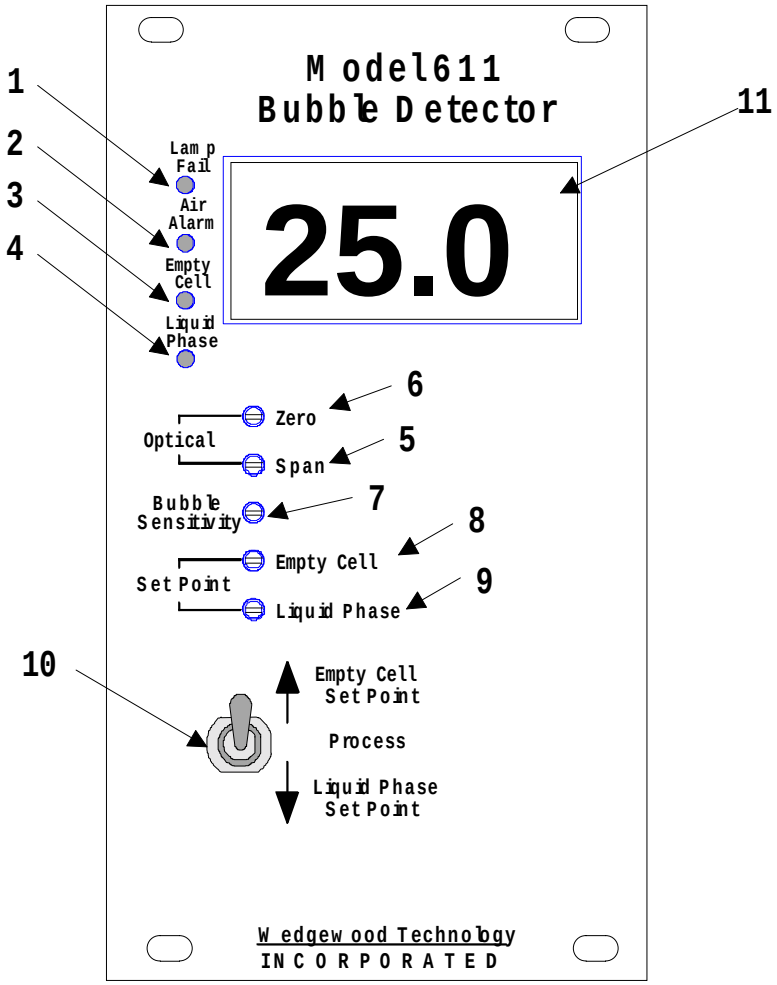


Figure 3 - Model 611 Front Panel Controls and Their Function

1. The **Lamp Fail** LED indicator illuminates when the lamp has burned out or if the lamp cable has been disconnected.

2. The **Air Alarm** LED indicator illuminates when bubbles are detected by the instrument.

3. The **Empty Cell** LED indicator illuminates when the Empty Cell setpoint has been exceeded.

4. The **Liquid Phase** LED indicator illuminates when the Liquid Phase setpoint has been exceeded.

5. The **Optical Span** adjustment sets the full scale span of the instrument.

6. The **Optical Zero** adjustment sets the optical zero of the system. The optical zero is adjusted with the sample cell empty (air).

7. The **Bubble Sensitivity** adjustment sets the threshold level for bubble detection. Turn the control CCW to decrease and CW to increase sensitivity.

8. The **Empty Cell Set Point** control adjusts the level at which an Empty Cell condition is detected.

9. The **Liquid Phase Set Point** control adjusts the level at which the Liquid Phase change detection point occurs.

10. The **DVM Selector** switches the front panel DVM to display either the Liquid Phase Set Point, the Empty Cell Set Point or the process value.

11. The Liquid Crystal Display **DVM** displays the Process Value as measured by the sensor. The displayed value is a fixed 100.0% full scale.

2.3 Rear Panel Controls

1. The **4-20mA Zero** control allows independent adjustment of the current output to 4.00mA when the front panel LCD reads zero.

2. The **4-20mA Span** control independently adjusts the span of the current output and has a range of +/- 5% at 20.00mA.

3. The **Lamp Adj.** adjusts the voltage output to the lamp as measured across terminal 26 and 27 on the rear panel Sensor I/O connector. See Section 6 for lamp adjustment details.

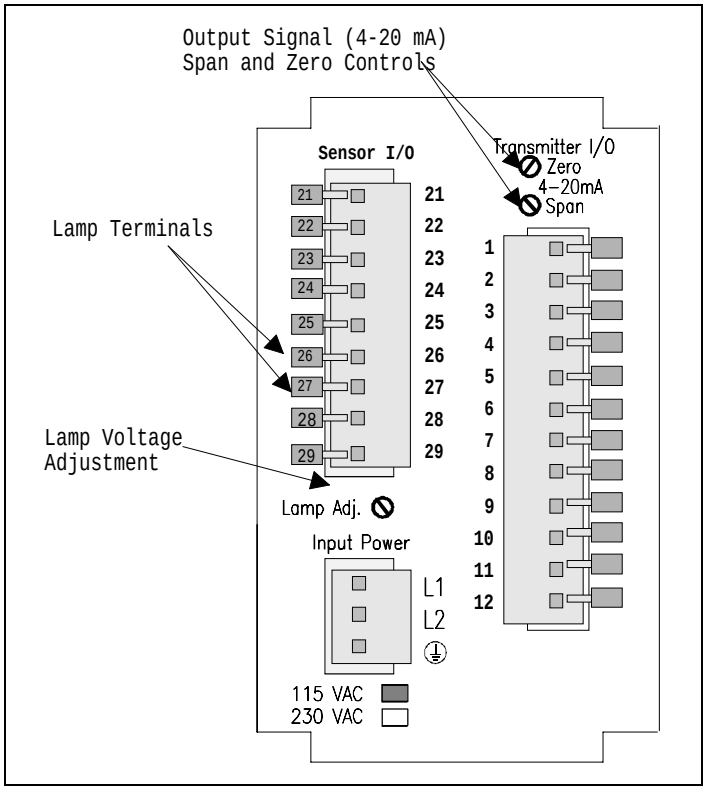


Figure 4 - Model 611 Rear Panel Controls and Location

3. Description of the Model AF13 Inline Sensor

3.1 Specification

Line Size:	1/4" To 4" In Diameter
Line Connection:	Sanitary Tri -Clover Female NPT Sanitary BVCO Swagelok Compression Flanged, *Other Styles Available*
Light Source:	Pre-Focused Incandescent Lamp
Lamp Life:	25,000 Hours At Rated Voltage
Detector:	Hermetically Sealed Silicon Photocurrent Cell
Optical Response:	400nm To 1150 Nm, Peaked At 950 Nm
Flowcell Materials	316L Stainless Steel (Polished Interior To R_a < 15µInch 316 Stainless Steel Kynar™ *Other Materials Available.*
Windows	Pyrex Fused Quartz
Seals	'O' Ring Seals. Buna-N, Viton, Silicone, EPR , EDPM, Kalrez™
Maximum Operating Pressure	Up To 100 BAR, 1500 Psi (Dependant Upon Line Connection Type)
Operating Temperature	0 To 90 °C Continuous, Up To 130 °C For 2 Hours (Stainless Steel Flowcells)
Cable Length	10 Ft, 25 Ft Standard - Up To 300 Feet (100 Meters) Maximum
Approvals	CE, T Mark (Safety And EMC) EN 61010, EN 55011, EN 50082-1
Options:	Explosion Proof Division 1, Groups B, C And D/EExd IIC T5 Special Sensors And Material Of Construction

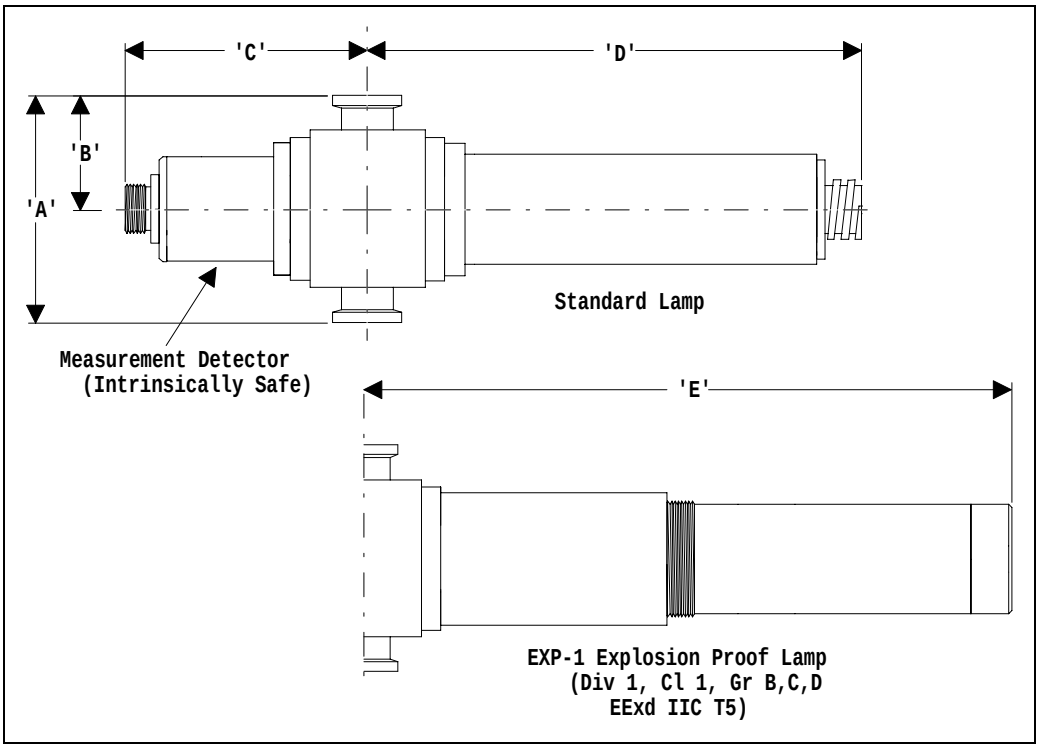


Figure 5 - Typical AF13 Inline Sensors for Bubble Detection

		'A'		'B'		'C'		'D'		'E' *	
Line Size	**Connection**	**Inch**	**mm**	**Inch**	**mm**	**Inch**	**mm**	**Inch**	**mm**	**Inch**	**mm**
¼"	Tri-Clover	3.25	82.6	1.63	41.3	3.47	88.0	7.06	179	9.26	235
½"	Tri-Clover	3.25	82.6	1.63	41.3	3.47	88.0	7.06	179	9.26	235
¾"	Tri-Clover	3.25	82.6	1.63	41.3	3.47	88.0	7.06	179	9.26	235
1"	Tri-Clover	3.25	82.6	1.63	41.3	3.67	91.3	7.26	184	9.45	240
1 ½"	Tri-Clover	3.25	82.6	1.63	41.3	3.67	91.3	7.26	184	9.45	240
2"	Tri-Clover	3.25	82.6	1.63	41.3	4.06	103	7.65	194	9.85	250
2 ½"	Tri-Clover	3.5	88.9	1.75	44.5	4.31	104	7.90	200	10.1	256
3"	Tri-Clover	4.5	114	2.25	57.2	4.41	112	8.00	203	10.2	259
4"	Tri-Clover	4.88	124	2.44	62.0	4.89	124	8.47	215	10.7	271

** Dimension given less Explosion Proof Fittings and/or Flexible Conduit.*

Table 1 - AF13 Standard and Explosion Proof Tri-Clover Sensor Dimensions.

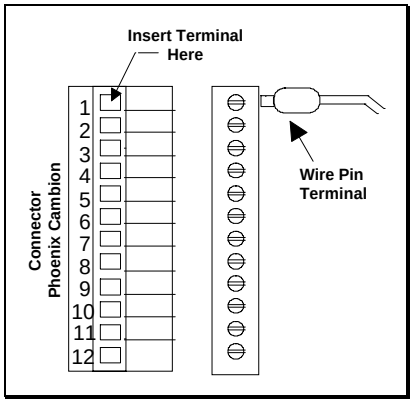
4. Installation

4.1 Model 611 Transmitter Installation

Before beginning installation, inspect the transmitter, sensor, and supplied cable set for any signs of shipping damage. Report any visual damage or discrepancies to Wedgewood Technology and the Shipper immediately.

The Model 611 Bubble Detector transmitter is a 3U, 14HP DIN enclosure, Type 4, which can be installed a variety of panel, wall and bench-top housings. Refer to Figure 2 for mounting dimensions. Mount or install the transmitter into an enclosure or area that is not subject to excessive vibration or shock and will protect the instrument from materials such as water and chemicals. Allow enough clearance behind it for cable access.

4.2 Model 611 Cables and Wiring

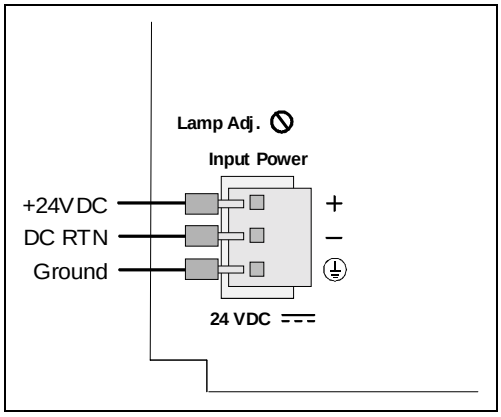


All wiring terminals are located on the back panel of the Model 611. Transmitter/sensor interconnection cables supplied with the system have all been pre-terminated and labeled for ease of installation. Refer to Figures 7 and 8 for a full terminal function description.

Cables installed for signal connection (i.e. analog outputs, lamp fail output) should be shielded twisted pairs. When routing the cables, separate signal cables from power wiring. Prepare and terminate all cable ends as per figure 6.

Figure 6 - Wire Terminal Preparation

4.3 DC Input Power Option



For instruments supplied for 24VDC operation, only the power input connection is changed. Figure 7 shows the connection detail for a 24VDC unit.

Figure 7 - Model 611 Wiring Diagram (DC Input Version)

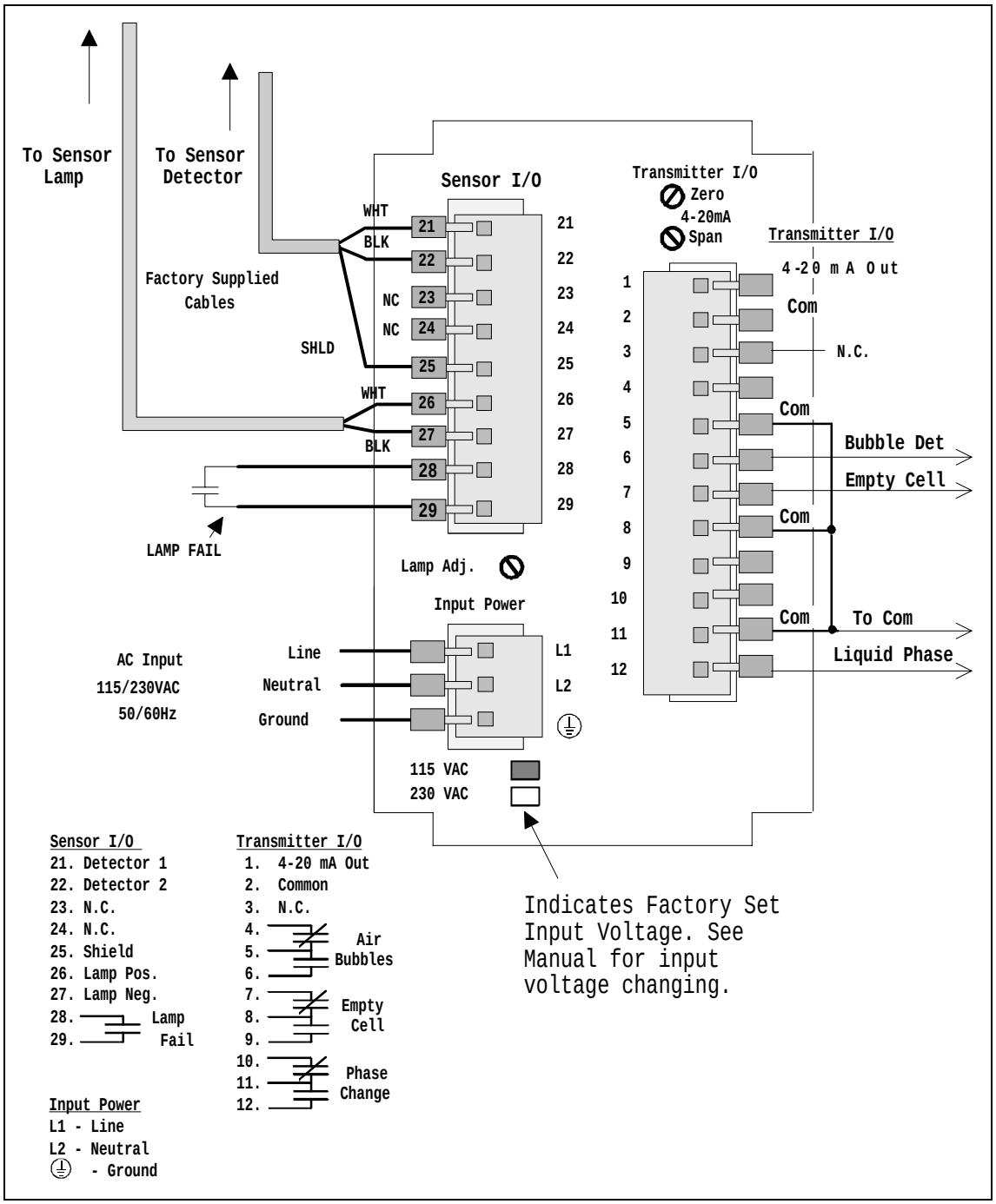


Figure 8 - Transmitter Terminal Identification and Wiring

Figure 8 is the wiring diagram for a typical installation. The connection to the relay control signal outputs is shown with the default relay indicator configuration. With the sample cell empty, the Empty Cell indicator is ON with the Air Bubble and Liquid Phase indicators OFF. Indicators and relay contacts change above set point.

4.4 AF13 Sensor Installation

Sensors can be installed either directly in a process line or in a by-pass line. They can be mounted either vertically or horizontally. If mounted horizontally, the sensor lamp and detector housings must be horizontal. This will insure that the optical windows are in a vertical position and help prevent build up on the window surfaces

When installing, adequate space should be allowed for the connection of cables at the ends of the lamp and detector housings. Access to these areas is also important for connection/disconnection purposes. Sensor bodies should be supported when in line and care should be taken to ensure they are protected against damage caused by external forces such as carts on adjacent walkways.

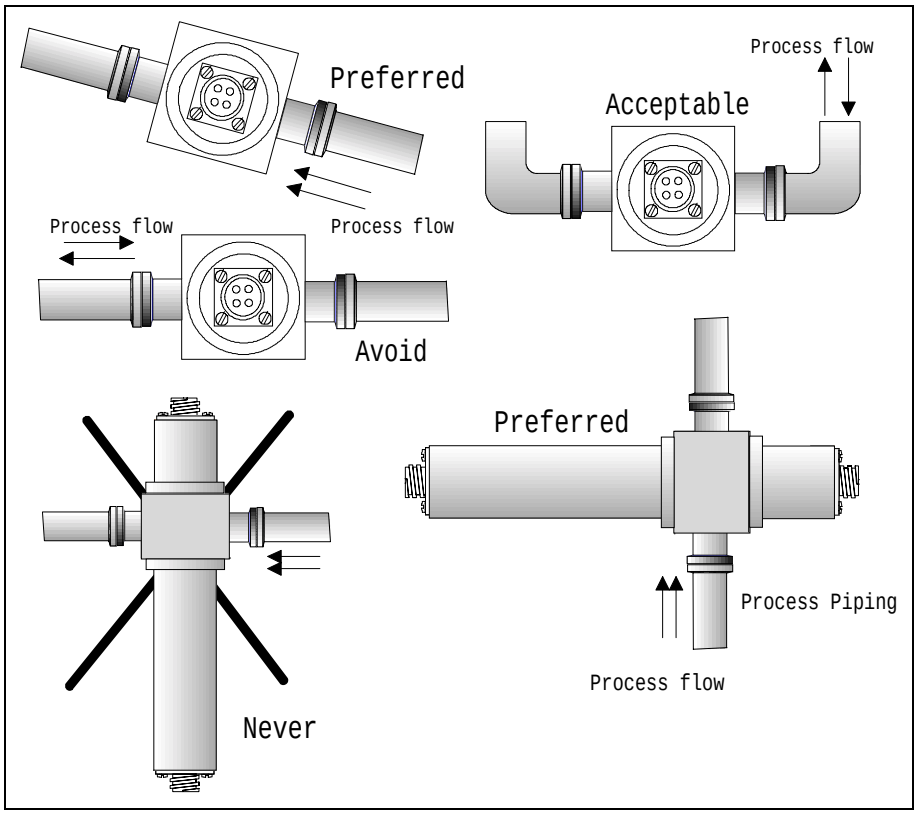


Figure 9 - Installation of AF13 Series Sensors in Process Lines

4.5 Transmitter/Sensor Interconnecting Cabling

Figures 10, shows the interconnecting cable for AF13 sensor when located in a non-hazardous location. Figures 11 and 12 illustrate the ISO (EExd IIC, T5) and the USA (Cl. 1, Div 1, Gr. B, C and D) the hazardous versions of the AF13 sensor. Before installation, review local Electrical Code regulations for further information and installation requirements.

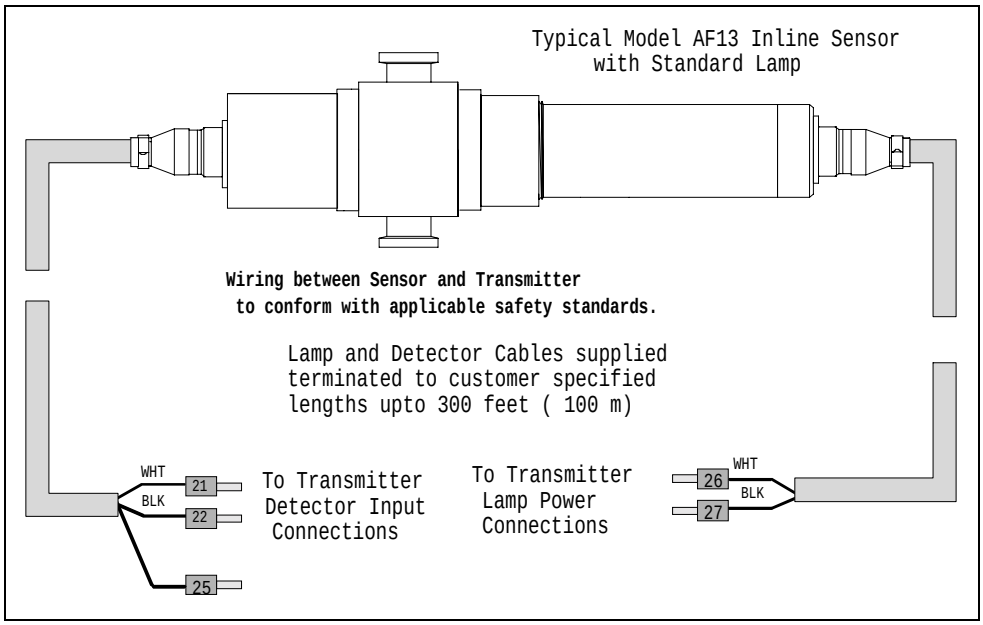


Figure 10 - Model 611 Wiring Diagram (Standard Installation)

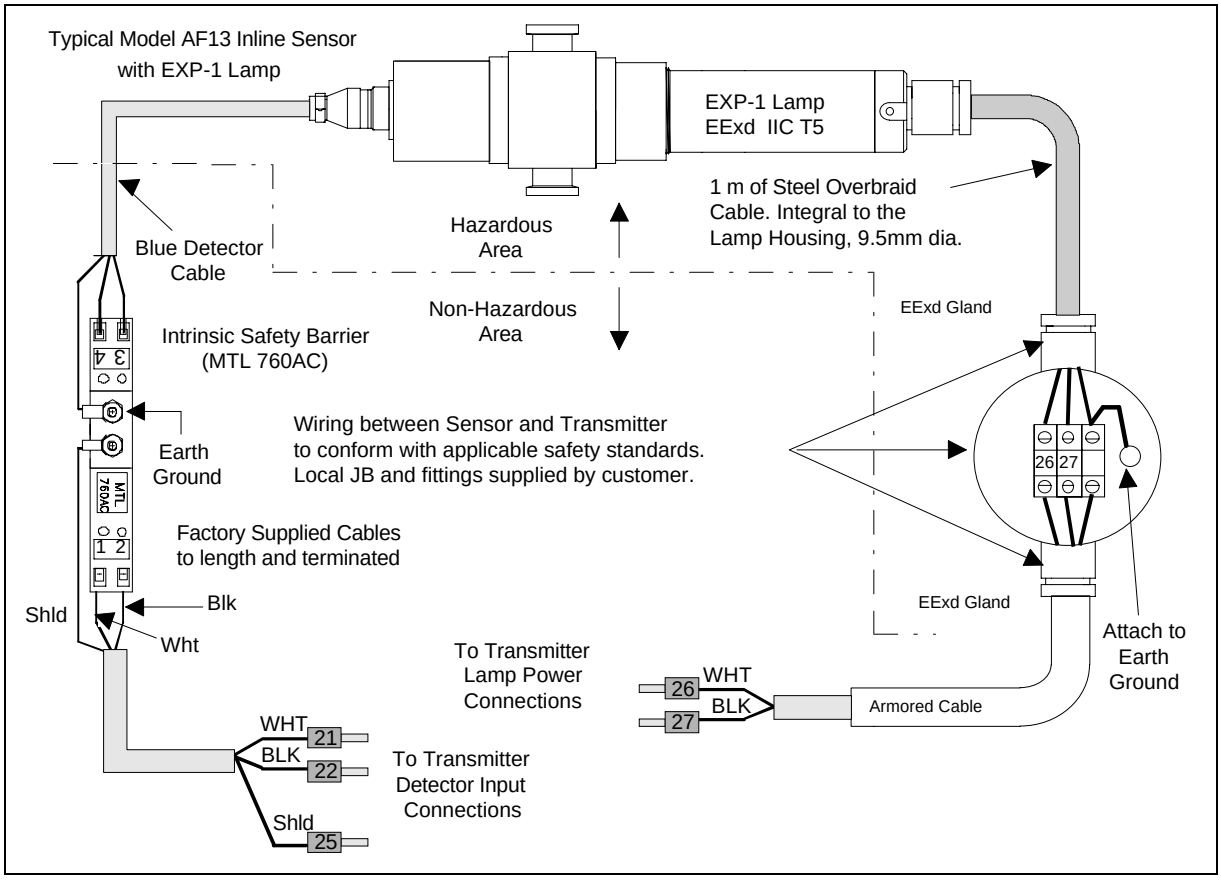


Figure 11 - Model 611 Wiring Diagram for EExd IIC Explosion Proof Installation

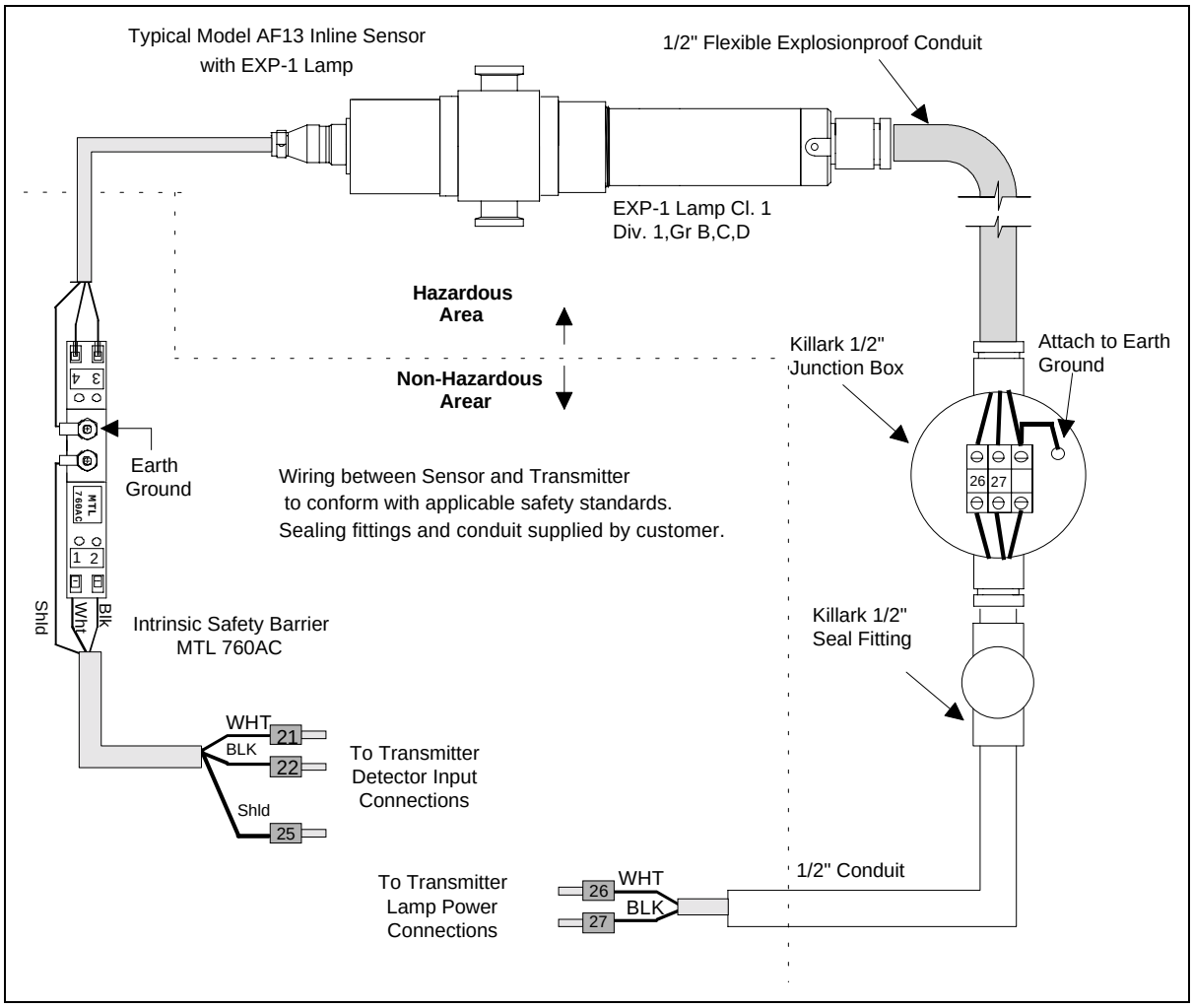


Figure 12 - Model 611 Wiring Diagram for Cl. 1, Div. 1, Gr. B, C and D Explosion Proof Installation

5. Operation of the Model 611 Bubble Detector

5.1 Initial Start-Up

To start up the instrument, follow the steps detailed below:

1. Ensure the sensor is connected and the connectors are properly secured with their locking ferrules.
2. Connect power to the transmitter and leave for 15 minutes to warm-up the sensor.
3. Make sure the sensor is empty and dry.
4. Carefully adjust the **Optical Zero** control on the front panel until the front panel DVM reads **0.0**.
5. Connect an accurate multi-meter to the 4 to 20mA analog output (Terminals 1 and 2), in series with a 250 ohm load. The 250 ohm load is only necessary if the instrument is not connected to any other device (see figure 13).
6. Adjust the "**4 to 20mA Zero**" control located on the rear panel to give a 4.00mA reading on the multi-meter.
7. Fill the sample cell with the non-aqueous liquid (organic solvent) used in the process and adjust the **Optical Span** control on the front panel until the front panel meter reads **100.0**.
8. Adjust the "**4 to 20mA Span**" control located on the rear panel to give a 20.00mA reading on the multi-meter.
9. Fill the sensor with water and check that the front panel DVM reads approximately 50% of scale. Note the DVM reading with water in the cell. This is the optical value of the liquid. Set the **DVM Selector** Switch to the **Empty Cell Set Point** position and adjust the **Empty Cell Set Point** to approximately half of the value read with water in the cell (25%). This will be the **Empty Cell** Alarm point.
10. Fill the cell with the desired mixture of water and organic solvent and set the **DVM Selector** switch to the **Liquid Phase Set Point** position. Adjust the **Liquid Phase Set Point** until the phase alarm indicator illuminates. This establishes the alarm point for the Liquid Phase.
11. The **Bubble Alarm** sensitivity has been nominally set at the factory. If more or less sensitivity is needed, adjust the **Bubble Sensitivity** as required. The adjustment in independent of other adjustments and is not interactive with them.
12. After calibration, set the **DVM Selector** switch in the **Process** position.
13. Disconnect the test multi-meter setup.

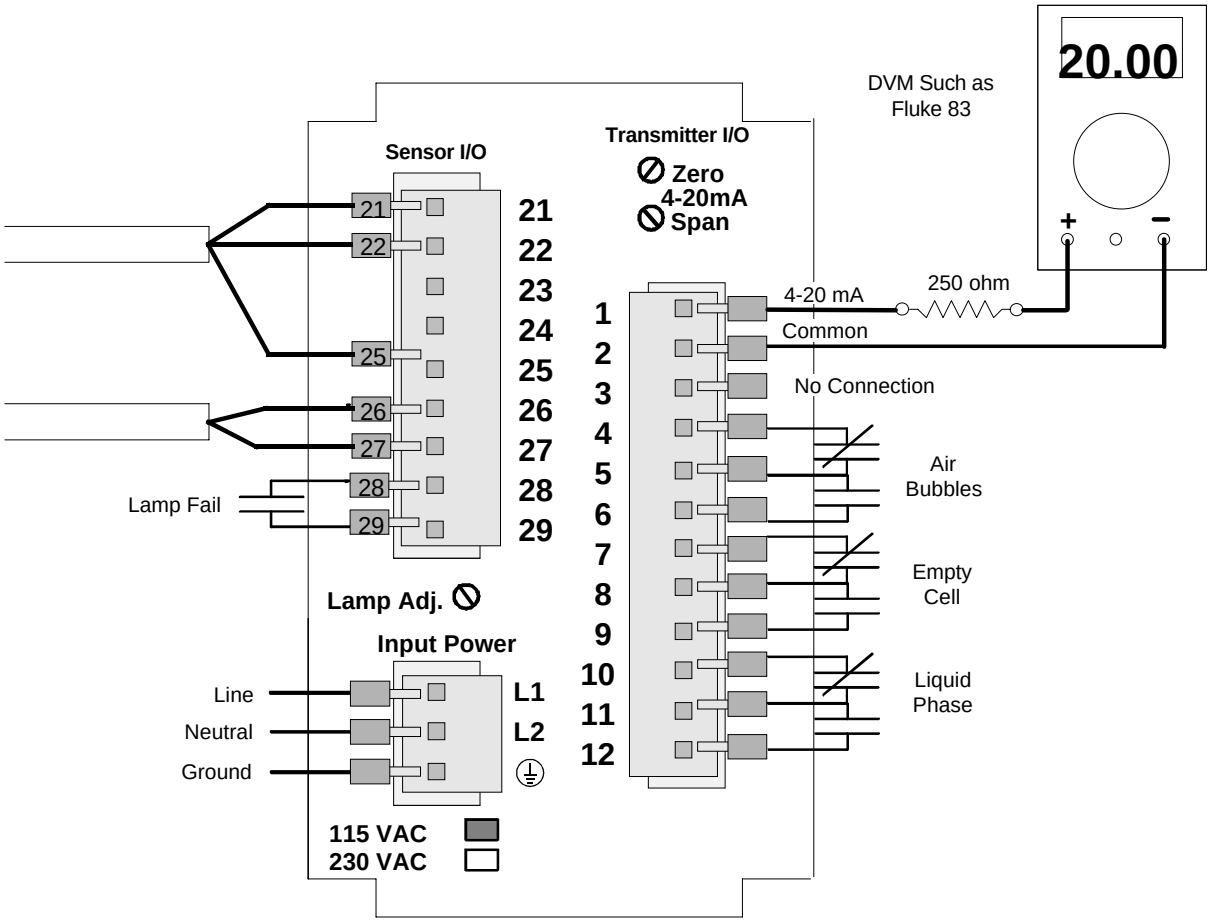


Figure 13 - Start-Up/Calibration Test Set-up

The instrument is ready for use. Note: if a multi-meter is not available, the output can be adjusted against other connected devices such as a chart recorder, PLC or data acquisition system.

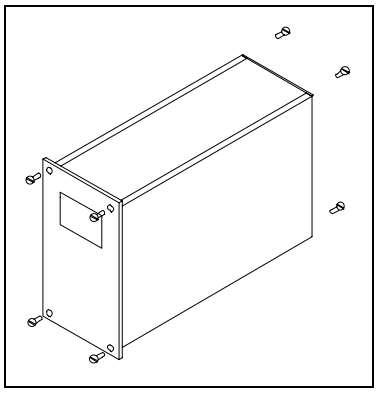
6. Model 611 Transmitter and Sensor Maintenance

6.1 Model 611 Transmitter

Once the unit is in operation, there is no requirement to access the interior of the Model 611 Bubble Detector transmitter housing for normal day to day operation and calibration.

Qualified maintenance staff only should carry out the procedures described in this section.

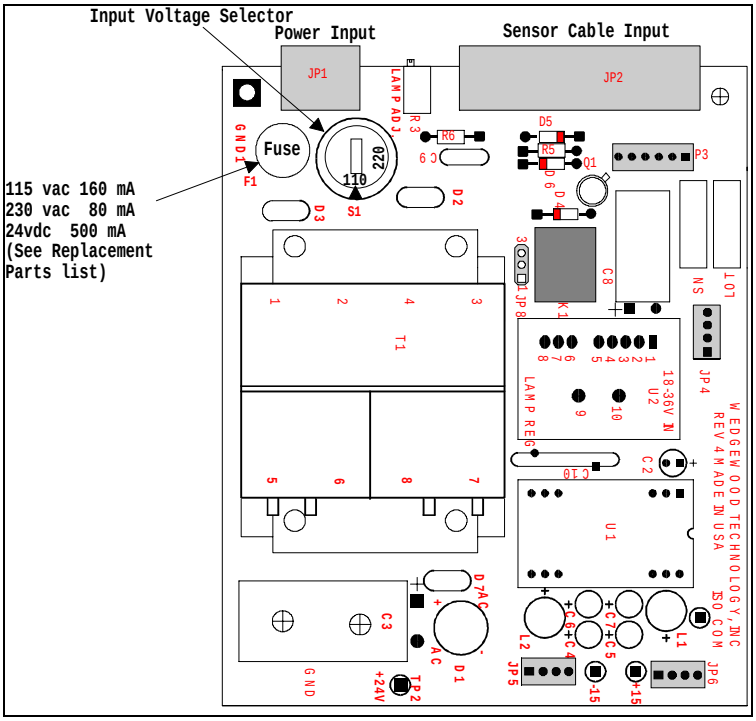
6.1.1 Accessing the Interior of the Model 611 Instrument



Before opening up the instrument case, **remove power to the instrument**. Inside the instrument there are two circuit boards, the Measurement and CPU Board attached to the left-hand side panel and the Power Supply Board attached to the right. Remove the front panel and rear panel screws on the right side of the module only (as viewed from the front). Fold out the right hand side panel and remove the top and bottom panels. Take care not to stress the interconnecting cables between the two circuit boards.

Figure 14 - Disassembly of the Transmitter Module

6.1.2 Fuse Replacement



The instrument's fuse is a plug-in type. It is located on the Power Supply Board inside the instrument. See figure 15 for the Power Supply Board layout and position of the fuse.

Fuse failure is normally caused by improper voltage selection and/or faulty wiring. Always replace the fuse with one of the correct rating for the input power supply

Figure 15 - AC/DC Power Supply PCB

6.1.3 Alarm Logic Programming

The Model 611 has 1 lamp fail alarm and 3 signal relay outputs. The lamp alarm output is an SPST relay contact, while the empty cell, bubble detect and liquid phase outputs are SPDT relay contacts. The front panel LED indicators can be configured to illuminate either above setpoint or below setpoint. To change configuration of the LED operation, it is necessary to change the position of the relevant jumpers on the transmitter motherboard. Figure 16 and 17 show the position and action of the jumpers.

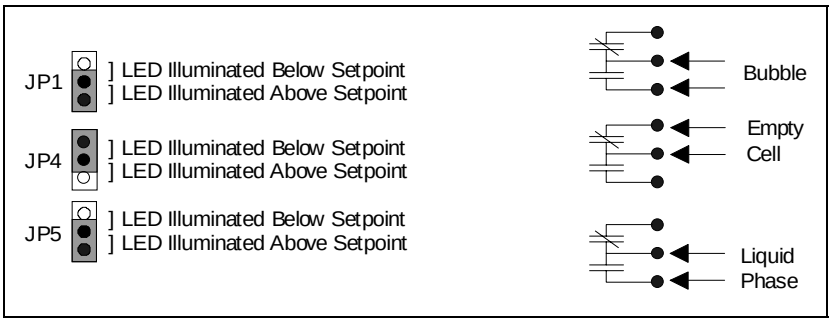


Figure 16 – LED Alarm Action Configuration

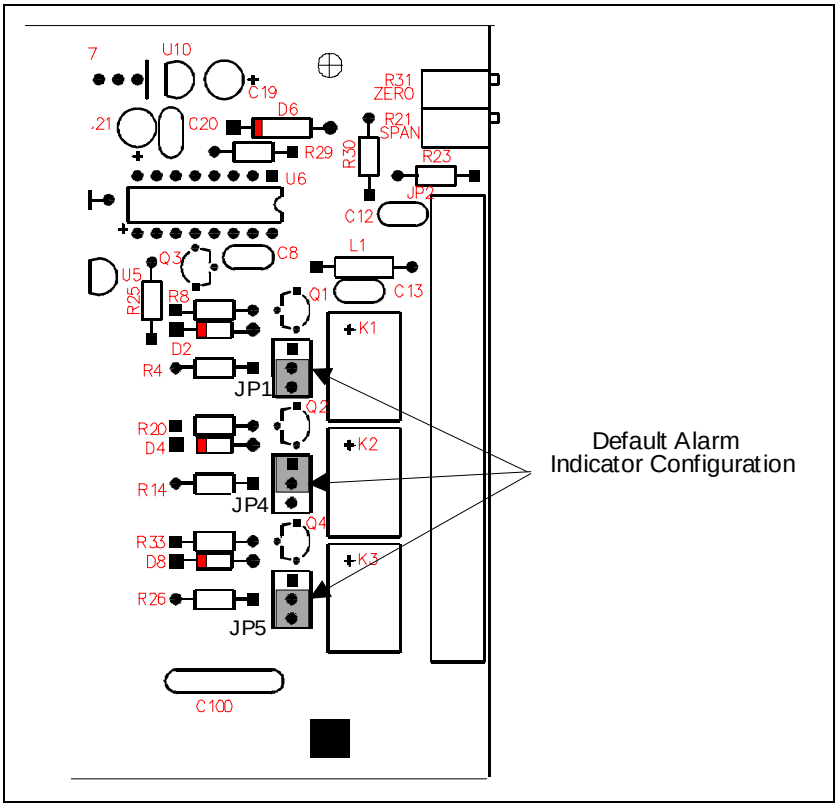


Figure 17 - Model 611 Bubble Detector Main PCB

6.1.4 Lamp Voltage Adjustment

To adjust the lamp voltage, use the following procedure:

While the Instrument is **ON**, measure the lamp voltage across the lamp output voltage terminals on the rear panel connector (terminals 26 and 27). A voltage of 4.7 to 4.9 VDC should be present. If not, adjust the **Lamp Adjust** control, located on the rear panel a value of 4.7 to 4.9 VDC.

6.2 Sensor Maintenance

Model AF13 sensors contain sensitive optical components and should be handled with care. Clean all optical components with a suitable lint free lens cleaning tissue and ethanol.

Under normal operating conditions, the sensors require very little routine maintenance. Inspect from time to time for signs of leakage, cable fraying, or for any abnormal conditions. If sensor cleaning and/or maintenance is required, remove the sensor from service and carry out as necessary.

Please refer to the cross-sectional view of the sensor below for parts location and function. A list of replacement parts can be found in the Section 7. Please reference the sensor Serial Number when ordering parts.

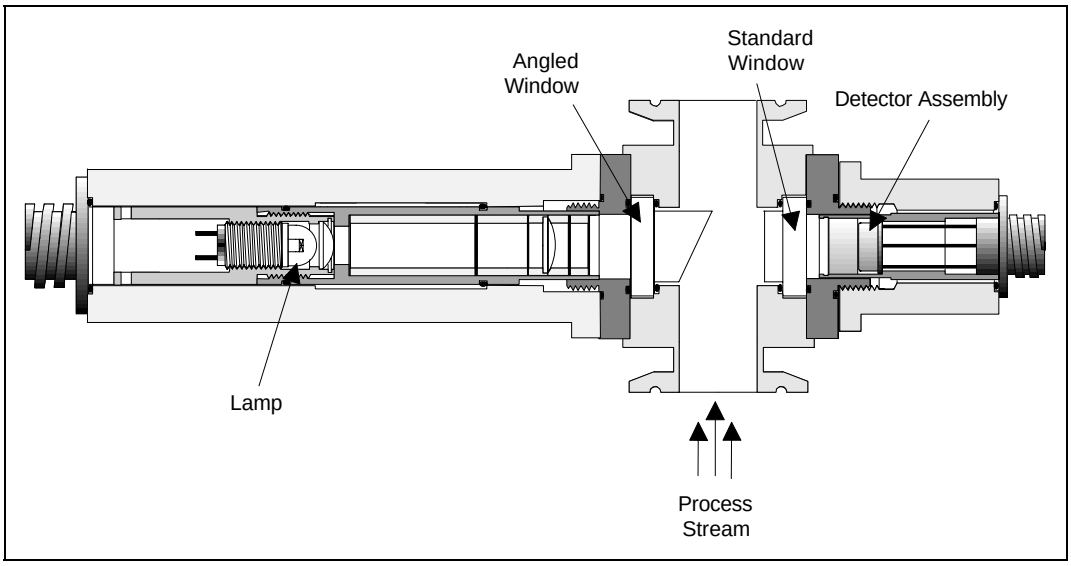


Figure 18 - Cross-sectional View Model AF13 Sensor with Standard Lamp

6.2.1 Preventative Maintenance

Periodic inspection of the sensor windows and seals is necessary to ensure continuous trouble-free operation of the system. To inspect the condition of the windows, disconnect the detector cable from the sensor and removing the detector housing by unscrewing it from the sensor window ring. Note that the instrument will still be energized, so if the monitor is being used in a controlling function, the control loop it is associated with is must be taken out of automatic mode during this operation. With the detector removed, visually inspect the sensor's interior. The windows should appear clean and no visual signs of leakage in the window area should be seen. Note: Slight to moderate window contamination is acceptable. This can be 'zeroed' out with the 'Optical Zero' control. If sensor cleaning and maintenance are required, remove the sensor from service and carry out in the normal way.

6.2.2 Sensor Window and Gasket Replacement

Please refer to figure 18 for the location of the windows and seals within the sensor. The window and window seals are designed so that the windows 'float' between the 'O' Ring gaskets. Therefore, no special torquing is required to insure proper seal pressure. When re-assembling, do not over-tighten the window ring mounting screws.

To replace the windows and window seals, use the following procedure.

1. Remove the lamp and the detector housings.

2. Remove the socket head screws from one window ring and remove the ring (refer to figure 19).

3. While holding the sensor, gently push the window out of the sensor from the inside.

4. Repeat for the other window.

5. Inspect the windows and clean as necessary. Check for any signs of abrasive wear or chipping. If any is noted, the windows should be replaced. The 'O' rings that are removed should be discarded and replace with new 'O' rings of the same type. Re-assemble the sensor in the reverse order.

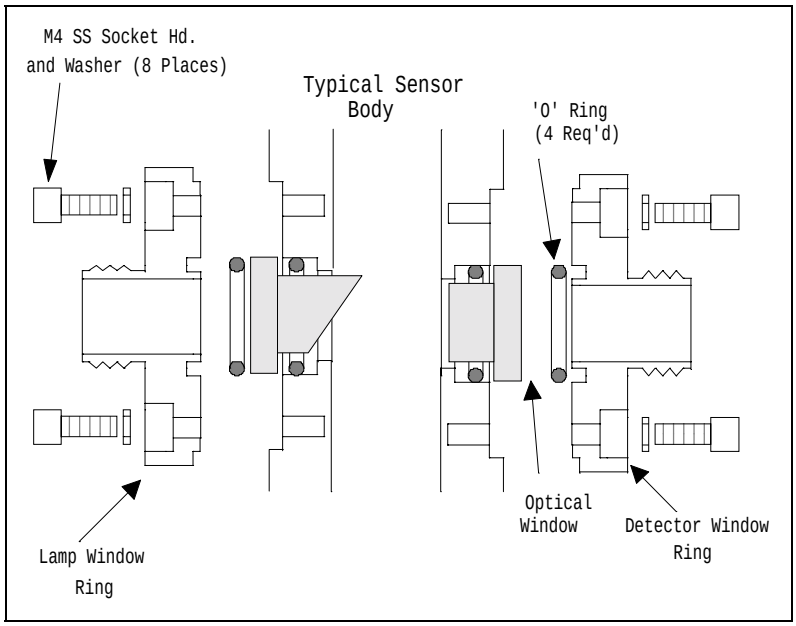


Figure 19 - Window Replacement (Exploded View)

6.2.3 Detector Replacement

Replacement detectors are supplied as part of the connector assembly. To replace, remove the four Stainless Steel screws and washers holding the connector into the housing and remove the complete assembly. Replace in the reverse order.

6.2.4 Standard Lamp Replacement Procedure

If lamp failure is suspected, disconnect the detector cable from the sensor and remove the detector housing by unscrewing it from the sensor window ring. Look into the sensor's detector window to see if the lamp is operating. If there is no light from the lamp, replacement of the lamp module is necessary. To replace the lamp module, disconnect the lamp cable and unscrew the lamp housing from the sensor body.

Remove the 4 Philip head screws and washers from the lamp connector and carefully remove the lamp module and projection optics from the housing. The lamp is an integral part of the connector assembly. This assembly screws into the projection optics assembly. Carefully unscrew the lamp assembly and replace with a new one. **Do not over tighten.** Insert the new lamp module with the connector mounting holes aligned with the tapped holes in the lamp housing body. The 'O' ring located on the projection optics centers the module in the housing. A second 'O' ring fits in the end grove of the lamp housing and the connector body. Place this 'O' ring in the lamp housing first. The fit between the 'O' ring and the lamp housing may seem tight, but this is normal. Insert the lamp module fully and replace the 4 Philip head M3 screws and washers.

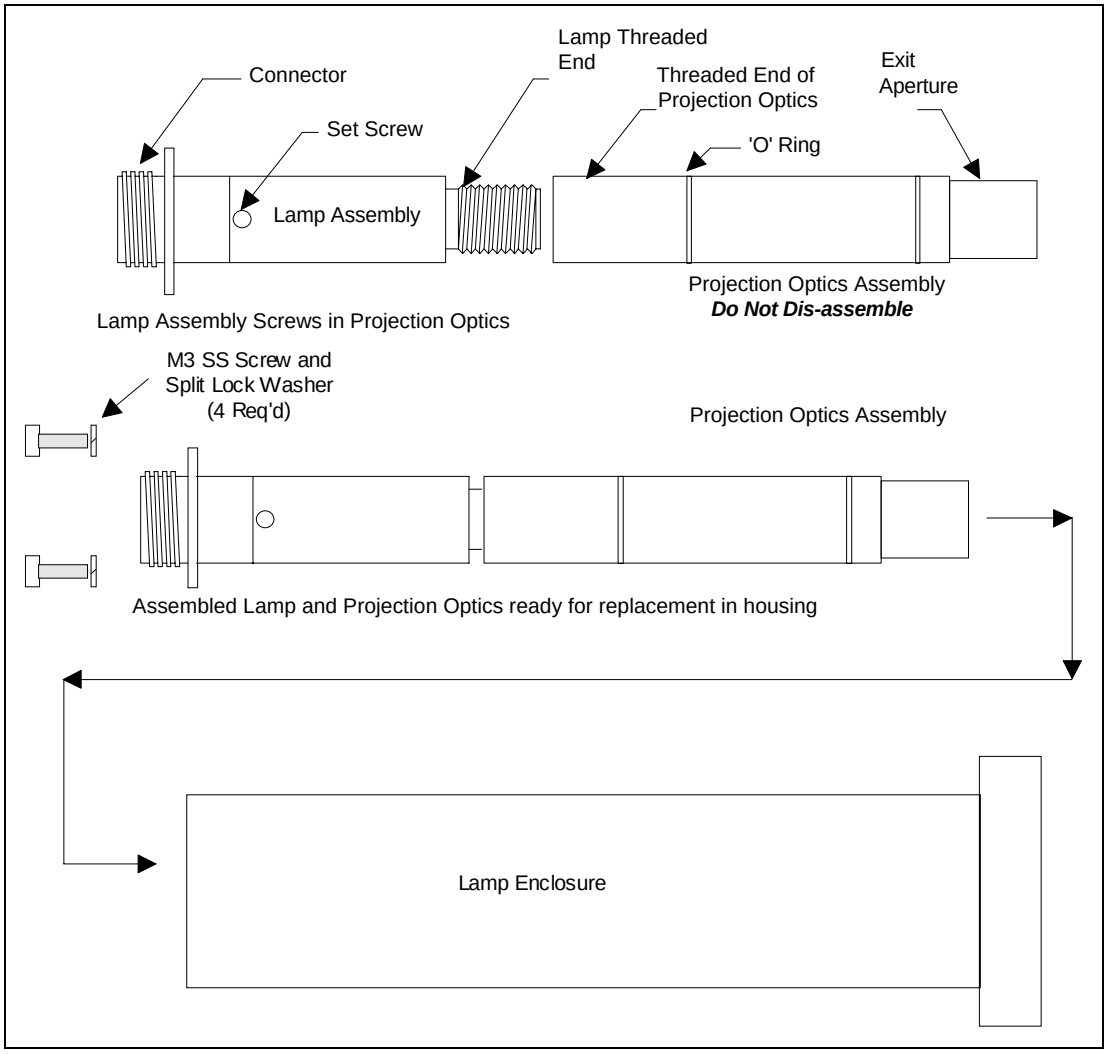


Figure 20 - Lamp Replacement for Standard Projection Optics

6.2.5 Explosion Proof Lamp Replacement Procedure

1. Disconnect any power to the system and tag **"INSTRUMENT OUT OF SERVICE DO NOT APPLY POWER".** ***[****Remember, the sensor is located in a hazardous area and proper procedures must be followed.]*

2. Disconnect the lamp cable leads and ground wire located in the local junction box.

3. Loosen and remove the flexible braided conduit or cable from the junction box.

4. Unscrew the lamp assembly from the sensor. Turn the complete assembly, including braided conduit or cable to avoid twisting wires.

5. Loosen the lamp housing endcap locking set screw (M3 set screw).

6. Holding the body of the housing, unscrew the endcap (counter-clockwise), removing the end cap and lamp holder assembly from the lamp housing.

7. Loosen and remove the lamp retaining set screw.

8. Remove the lamp power wires from the terminal block. Push the lamp socket through the mounting bracket to remove.

9. Unscrew the lamp from the holder (CCW) and replace with new lamp assembly.

10. The lamp assembly is now refitted on the lamp holder block and the retaining set screw tightened. The lamp leads are connected to the terminal block and the screws tightened.

11. Reassemble the lamp housing in the reverse order. Make sure that the 'O' ring is in place and in good condition. Replace if necessary. When screwing the endcap and lamp assembly onto the housing, tighten hand-tight only. Over-tightening can cause 'galling' and damage the threads.

12. Mount the complete lamp housing back onto the sensor and reinstall the braided conduit or armored cable into the junction box. Re-connect all electrical connections. Check all conduit connections and junction box cover plate for tightness. Reapply power to the system and remove warning tags, etc.

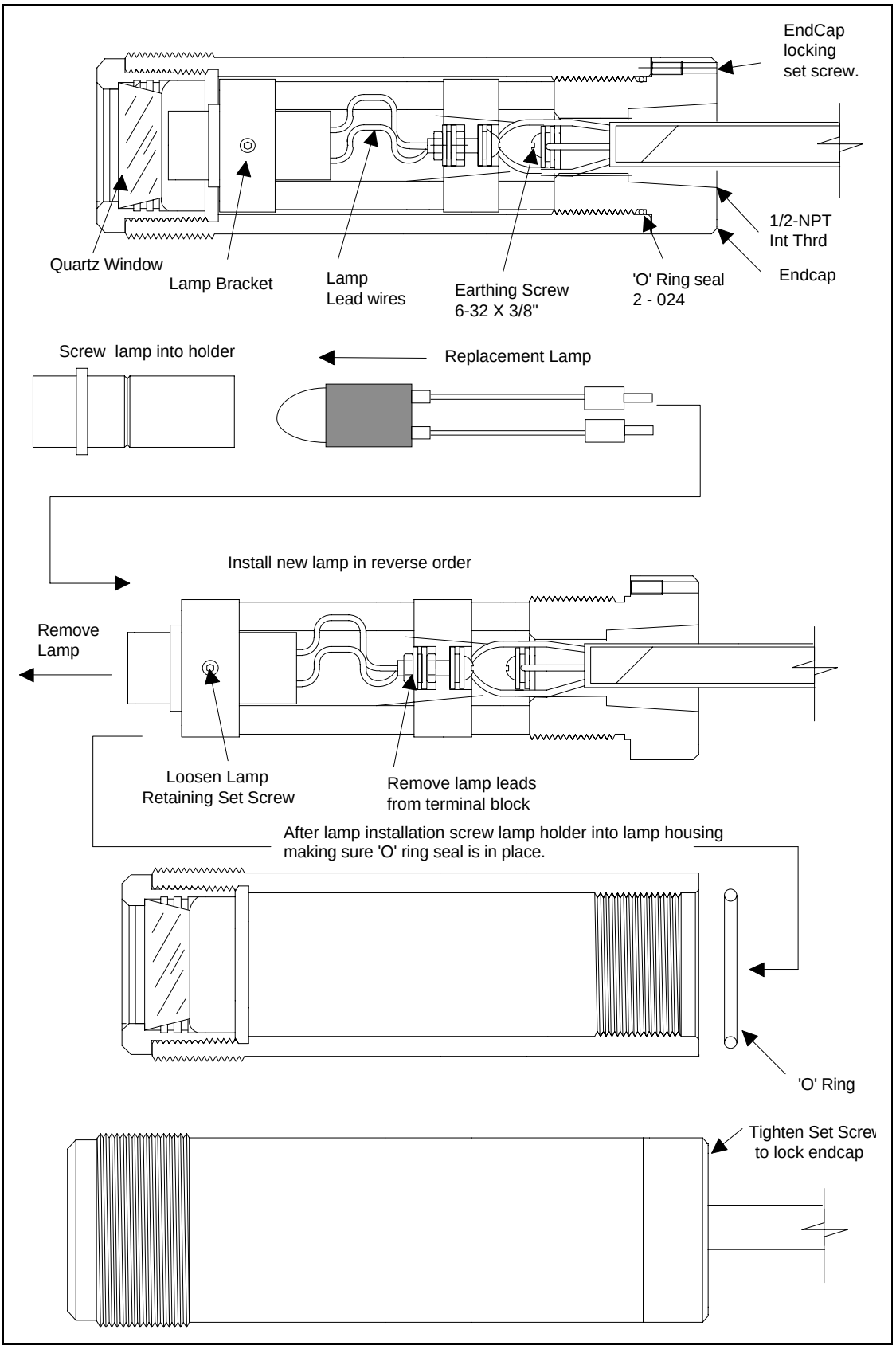


Figure 21- Explosion Proof Lamp Replacement Procedure

7. Replacement Parts List

7.1 Model 611 Monitor

Fuse, Slo-Blo, 250v (115vac), 160mA MST160	1678-0160-00
Fuse, Slo-Blo, 250v (230vac), 80mA MST80	1678-0080-00

7.2 Model AF13 Inline Sensor

14mm A Quartz Window	1420-0140-01
18mm E Quartz Window	1420-0180-03
19mm B Quartz Window	1420-0190-03
23mm D Quartz Window	1420-0230-03
24mm C Quartz Window	1420-0240-03
Angled 14mm Quartz Window	1420-0140-11
Window Gasket Kit, Silicon Rubber	A000-0610-00
Window Gasket Kit, Viton	A000-0610-01
Window Gasket Kit, Kalrez	A000-0610-04
Window Gasket Kit, EPR(EDPM)	A000-0610-05
Replacement Lamp Assembly (Standard Lamp)	A011-0670-22
Replacement Incandescent Lamp (EXP-1)	A011-5110-00
Projection Optics with Lamp Assembly (STD)	A011-0670-32
Projection Optics (Explosion Proof)	A011-4671-00
Replacement Detector Assembly	A012-0610-22
950 nm Interference Filter	1410-0950-00
Standard Cable Set - 10ft	A050-0612-10
Standard Cable Set - 25ft	A050-0612-25

8. Additional Drawings

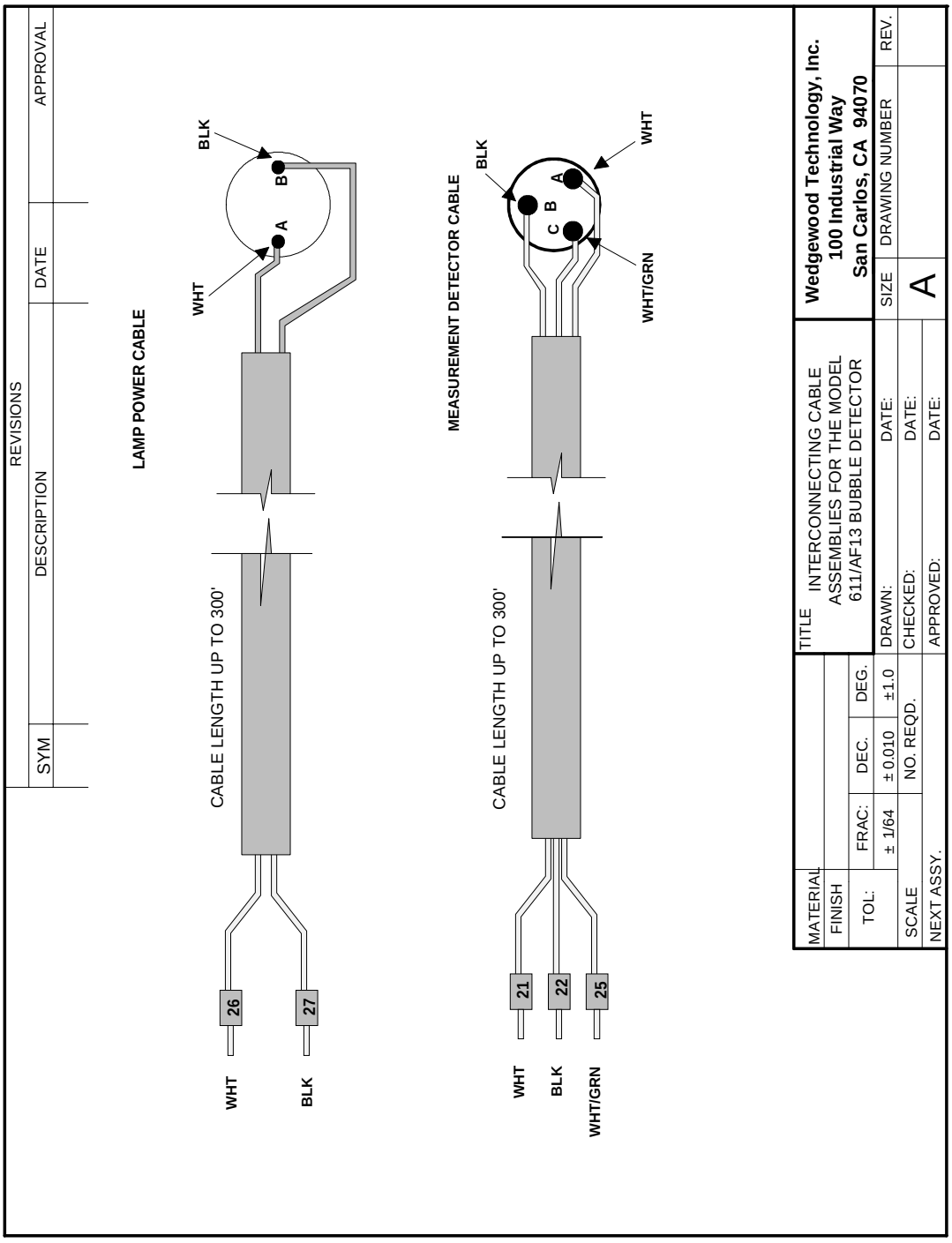


Figure 22 - Model 611/AF13 Cable Drawing

W A R R A N T Y

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