



# Series 651

## RF Admittance Single-Point Level Switch

### General Instructions



#### General

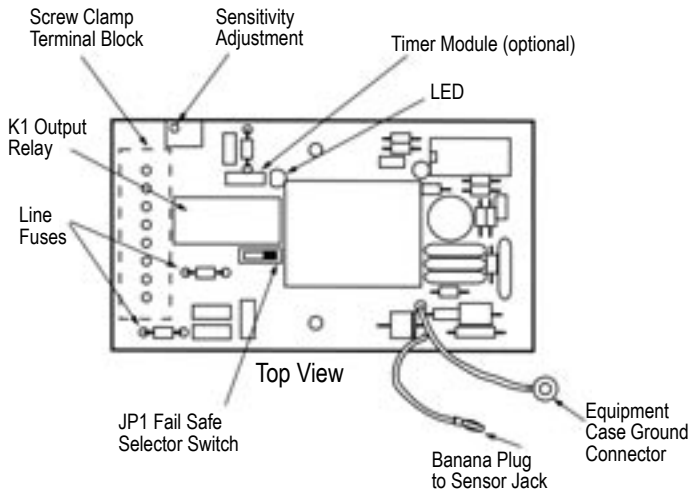
The Series 651 RF Admittance Single-Point Level Switch is a level control which uses dielectric constant and conductivity to detect the level of liquids, slurries, granulars, and solids. When used with any of the RF Probes, it will provide accurate switching for level processes.

The control features a fail-safe switch which reverses the operation of the relay. An LED inside the housing lights when the process is touching the probe. A sensitivity adjustment inside the control allows the user to increase or decrease sensitivity as needed. Optional time delay feature will delay switching on or off from 0 to 60 seconds.

#### Specifications

<b>Ambient temperature limits</b>	..... -40 to 176°F/ -40 to 80°C
<b>Process material density range</b>	..... 3 to 100lbs/ft <sup>3</sup> 45 to 1500kg/m <sup>3</sup>
<b>Process dielectric standard range</b>	..... 3 to 80
<b>Enclosure</b>	
Weathertight	..... NEMA 4, 4X, IP65
Explosion proof	..... Class I, Groups C & D; Class II, Groups E, F, & G; Division 1
<b>Output</b>	
DPDT relay	
Contact rating	..... 10 amp 250 VAC 10 amp 30 VDC (resistive)
<b>Fail safe</b>	..... Field selectable to rising or falling level
<b>Response time</b>	..... 0.5 seconds
<b>Power at sensor</b>	..... <10 μ joules
<b>Electrostatic discharge (ESD) protection</b>	
	8,000 Volts 70 amps
<b>Line surge suppression</b>	..... 1,000 Volts Line Voltage EMC
<b>Line power</b>	
Rating and tolerance	..... Max. current draw
12VDC± 10%	..... 100mA
24VDC± 10%	..... 50mA
120VAC± 10%	..... 20mA
240VAC± 10%	..... 10mA
<b>Shipping Weight</b>	..... 2.5 lbs / 1.2 kg (excludes sensor)

*Design and specifications are subject to change without notice. For latest revision, see [www.sorinc.com](http://www.sorinc.com).*

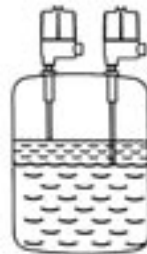


**FIGURE 1**

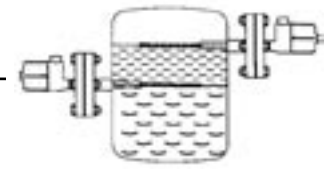
**Pre-Installation I/O Test and Calibration**

1. Remove instrument from shipping box and visually inspect for obvious physical damage. Report any shipping damage to the carrier. Report any internal discrepancies to the factory representative in your area. Record the serial number from the nameplate should conversation with the factory be necessary.
2. Remove housing cover.
3. Place instrument on an insulated surface or support so sensor does not touch a conductive surface.
4. Ensure area is safe and observe normal precautions for exposed and powered PC board.
5. Apply proper line power per page 4, and observe LED. (See Figure 1.)
6. Turn sensitivity adjustment clockwise (25 turns) to increase sensitivity until the LED illuminates indicating that the relay is energized. The unit is normally shipped in the most sensitive position.
7. The fail-safe mode selector switch JP1 is normally shipped in the lower position when the instrument is oriented with the sensor pointing downward (6 o'clock). When the instrument is powered up, the relay is de-energized (LED goes out) when no process material is on the sensor.
8. Turn sensitivity adjustment counterclockwise to decrease sensitivity until the LED goes out. This normally occurs within 2-1/2 to 3-1/2 turns from the full increase position.
9. Turn the sensitivity adjustment slowly clockwise, then counterclockwise, 1/2 to 1 turn to check the null position for verification that the bridge is balanced. It is desirable to closely bracket the position where the LED went out.
10. Turn the sensitivity adjustment one turn counterclockwise from the null position. Next, slowly move a hand toward the probe to touch it. The LED should stay out until the probe is touched. Should it illuminate when in close proximity, turn sensitivity control counterclockwise so the LED stays out until a hand touches the probe. Usually, 1-2 turns will locate the new null point.

11. It is desirable to simulate the actual application conditions so the device can be more precisely bench tested/calibrated, ensuring better on-line performance.
12. When practical, use a small container of actual process material. If the actual process vessel is metal, use a metal container (coffee can, etc.) and ground it to the instrument housing. If the actual process vessel is an insulator, such as fiberglass, use a plastic container.
13. Immerse the sensor in the process material; the LED should illuminate. If not, it may be necessary to increase sensitivity.
14. To detect an interface, such as oil/water or foam/liquid, the lighter material must be on the sensor, then tuned out. Then adjust the sensitivity to detect the heavier process material. (See Figures 2 & 3.)



**FIGURE 2**



**FIGURE 3**

15. Time Delay: The Series 650 has a built-in 0.5 second delay to energize the output relay. An adjustable delay feature is optional. (See Figure 1, Timer Module.)

0.5 delay ON up to 60 seconds OFF  
 0.5 delay OFF up to 60 seconds ON

The optional time delay is a 12-turn pot; full CCW is 0.5 sec, full CW is 60 sec. When the timer board is unplugged, delay is 0.5 sec.

This option may be used to increase the dead band at set point, compensate for wave effects or turbulence and free fall time in solids.

**NOTE:** Use **delay ON** with JP1 fail-safe in upper position.

Use **delay OFF** with JP1 fail-safe in lower position. (Opposite position of JP1 will reverse operation.)

**Installation**

**Standard configuration** is a 3/4" NPT(M) pipe nipple that threads into a 3/4" NPT(F) vessel nozzle of half coupling. Allow a 4-inch turn radius for the housing. (See Figures 4 and 5.) Sometimes open tanks, vats, sumps or basins require a locally made bracket mount similar to shown in Figure 8.

**Optional configuration** is a raised face ANSI flange. See catalog 1100 for selection. (See Figures 6 and 7.)

**Orientation.** The control can be mounted in any position. Sensitivity is optimized when the greatest surface area of the sensor is parallel to the process level. (See Figures 4 & 6.)

When the process is adhesive, i.e. it tends to coat the sensor, it may be desirable to mount the unit on a 45° angle to reduce product build-up and to increase its effective surface area. (See Figures 8 and 9.)

Placement and orientation of the sensor in a vessel is frequently determined by available nozzles. The sensor should be away from fill points to avoid false trips. The insulator bushing on the sensor should protrude a minimum of 1" from the inner wall of the vessel. The sensor must not touch any metal, nor should conductive product build-up be allowed to bridge between the sensor and a grounded metal tank wall.

If the sensor is a solid rod it may be cut or bent for clearance or placement. Use a 3-inch radius if a bend is required. It is permissible to increase sensor length by welding a length of identical rod to the supplied sensor. If the sensor is flexible cable, do not cut or modify it in any way, as sensor integrity will be compromised.

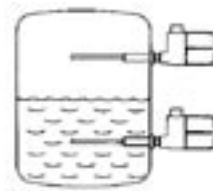


FIGURE 4

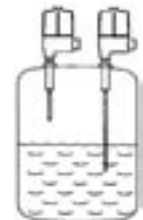


FIGURE 5

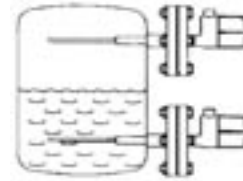


FIGURE 6

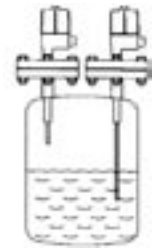


FIGURE 7

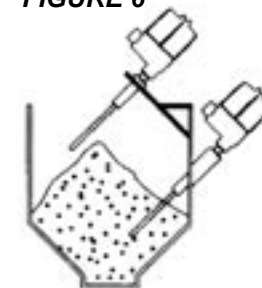


FIGURE 8

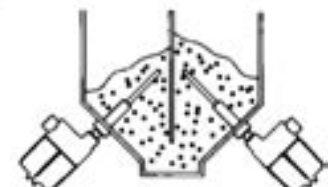


FIGURE 9

## Electrical Connections

**CAUTION:** Electrical power must be disconnected from explosion-proof models before the cover is removed. Failure to do so could result in severe personal injury or substantial property damage.

### Terminal Block Label

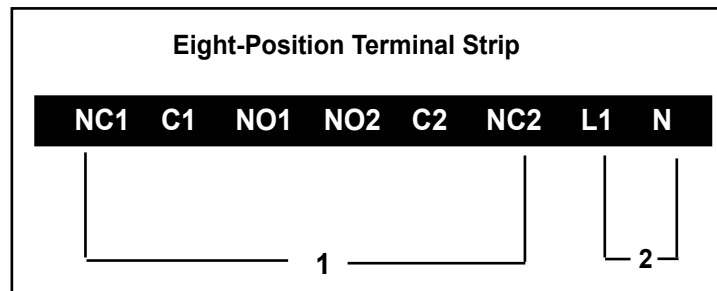


FIGURE 10

**Output - 1** DPDT relay: 10 amp 250 VAC; 10 amp 30 VDC (resistive)  
 See Figure 10 Connect external circuit wires as required to screw clamp terminals marked:  
 C1 (Common)  
 NO1 (Normally Open)  
 NC1 (Normally Closed)  
 C2 (Common)  
 NO2 (Normally Open)  
 NC2 (Normally Closed)

Line Power - 2	Voltage Limits	Max. Current Draw	Board Marking
See Figure 10	120 (95-130) VAC	20 mA	Li, N (shown)
	240 (195-250) VAC	10 mA	Li, L2
	24 ± 10% VDC	50mA	+ -
	12 ± 10% VDC	100 mA	+ -

Ensure that wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.

- 120 VAC**  
(651K7)
1. Remove cover.
  2. Observe all applicable electrical codes and recognized wiring practices.
  3. Remove two #4 mounting screws and slide out PC board to expose green ground screw (Internal Primary Equipment Ground/Earth) in base of housing.
  4. Connect ground wire to green ground screw on base of housing. (Ground wire should be a minimum of 18-AWG.)
  5. Reposition PC board, replace and tighten mounting screws. Ensure that banana plug on sensor lead wire is secure in sensor jack.
  6. Connect hot line power wire (typically black) to **L1** position on screw clamp terminal block.
  7. Connect neutral line power wire (typically white) to **N** position on screw clamp terminal block.
  8. Replace cover.
  9. Apply power as desired.

- 240 VAC**  
(651K8)
1. Perform Steps 1 through 6 on page 3.
  2. Connect second hot line power wire (typically red) to **L2** position.
  3. Perform Steps 8 and 9 on page 3.

**12 VDC**  
(651K5)  
**24 VDC**  
(651K6)

1. Perform Steps 1 through 5 on page 3 if a case or equipment ground wire is provided for connection to earth ground.
2. Connect positive line power wire to screw clamp terminal marked (+).
3. Connect negative line power wire to screw clamp terminal marked (-).
4. Replace cover.
5. Apply power as desired.

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**WARNING:** This product must be installed with an explosion-proof breather vent per Agency requirements and the National Electric Code — Article 501, Section F, paragraph 3.

## Fail-Safe Mode

The fail-safe mode on either rising or falling level can be easily changed in the field. See procedure and chart below and on page 5.

**NOTE:** Upon loss of power, or some component failures, the output relay is de-energized and its contacts return to the “shelf position” NC (Normally Closed) to signal an alarm condition regardless of process level.

1. Disconnect line power supply.

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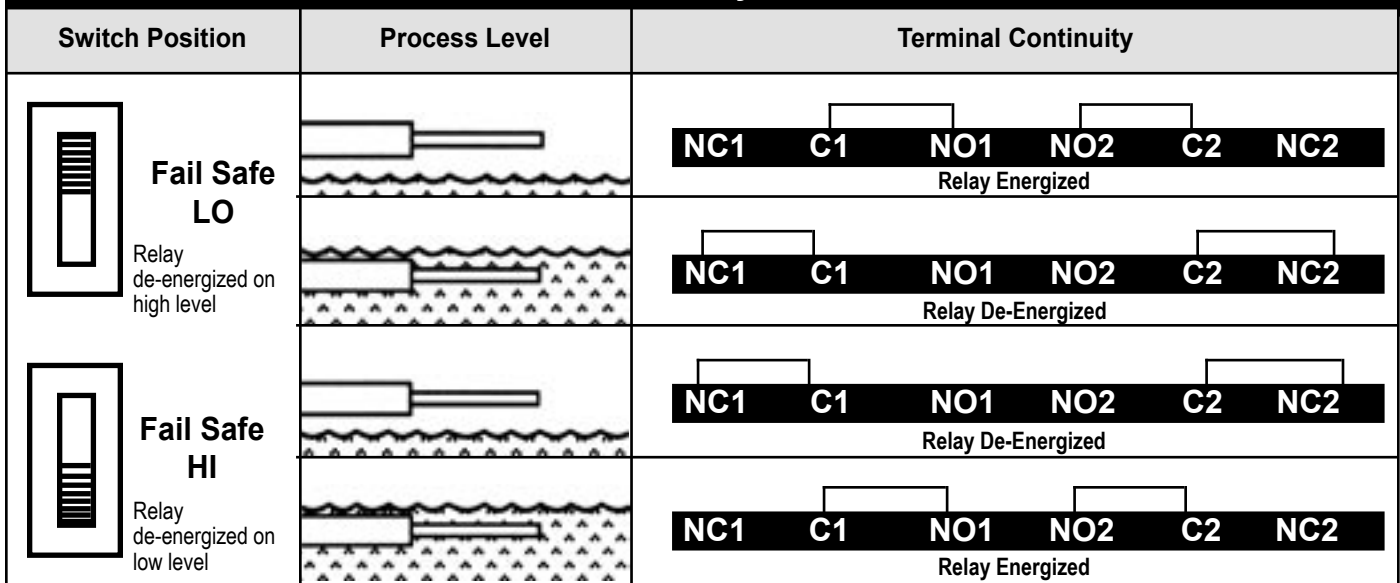
**CAUTION:** Electrical power must be disconnected from explosion-proof models before the cover is removed. Failure to do so could result in severe personal injury or substantial property damage.

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2. Remove the housing cover.
3. Determine whether switched external circuit must open or close (make or break) upon loss of power to the instrument.

4. Determine whether switched external circuit must open or close (make or break) at a discrete level on rising or falling level when the instrument is powered.
5. High-Level Fail Safe means the output relay will de-energize under high level conditions and alarm a high-level condition upon loss of power. Conversely, Low-Level Fail Safe means the output relay will de-energize under low-level conditions and alarm a low-level condition upon loss of power.
6. The terminal block is labeled for a de-energized relay. Connect external circuit lead wires to terminal block for desired logic. See chart on page 5.
7. Use needle-nose pliers to switch JP1 to Position A (lower) or Position B (upper) to change fail-safe mode.
8. Replace housing cover.
9. Connect line power supply as shown on pages 3 and 4.

## Continuity Chart



### Circuit Board Replacement

1. Disconnect power to the unit.
2. Remove the housing cover.
3. Remove two mounting screws and slide out PC board to expose green ground screw in the bottom of the housing.
4. Remove the ground screw and ring terminal from inside the housing.
5. Disconnect the banana plug from the sensor.
6. Connect the banana plug from the new board to the sensor. Make sure the connection is tight.
7. Slide the ring terminal onto the ground screw. Replace the ground screw in the bottom of the housing.
8. Slide the PC board into the grooves in the plastic ring inside the housing.
9. Replace the two mounting screws into the plastic ring. These screws are self-tapping. Do not overtighten.

**Replacement Circuit Boards** can only be ordered from SOR. Match the first five characters of your model number with those shown below to select the proper replacement board part number.

SOR Model Number	Power Supply	Circuit Board Part Number
651K5	12 VDC	99-401
651K6	24 VDC	99-376
651K7	12- VAC	99-377
651KB	240 VAC	99-378

### Fuse Replacement

1. Disconnect power to the unit.
2. Remove the housing cover.
3. Remove two mounting screws and slide out PC board.
4. Remove the fuse(s) from the circuit board.
5. Install replacement fuse(s).
6. Slide the PC board into the grooves in the plastic ring inside the housing.
7. Replace the two mounting screws into the plastic ring. These screws are self-tapping. Do not over tighten.
8. Replace the housing cover. Reconnect power to the unit.

**Replacement Fuses** (1/8A 250V) may be ordered from SOR or from a third-party supplier. asVDC, 24VDC, and 120VDC units require one fuse. 240VAC units require two fuses.

SOR part number	2806-004
Littelfuse part number	251.125
Bussman part number	MCR-1/8

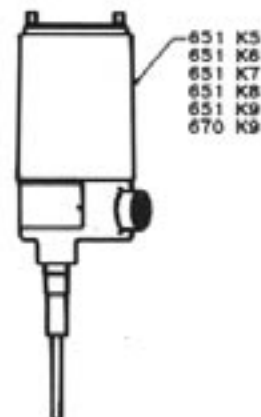
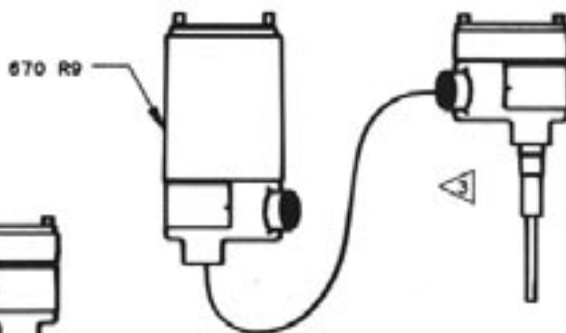
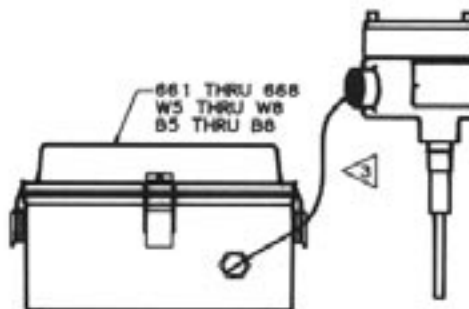
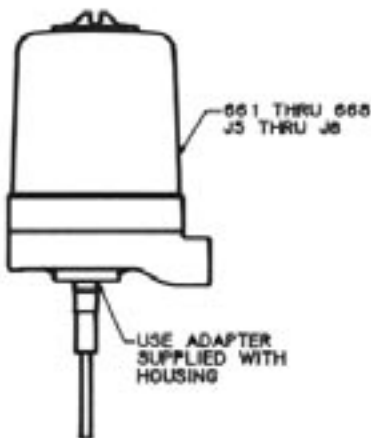
### Sensor Replacement

1. Disconnect power to the unit.
2. Remove the housing cover.
3. Remove two mounting screws and slide out the PC board to expose the sensor connection in the bottom of the housing.
4. Disconnect the banana plug from the sensor.
5. Unscrew the sensor from the housing.
6. Apply thread sealant such as Teflon tape to the male threads of the new sensor.



14885 West 105th Street Lenexa, Kansas 66215 USA  
Tel. 913-888-2630 Fax 913-888-0767

DRAWING NO. 9093-010



SENSOR/ELECTRONICS COMBINATIONS	
ELECTRONICS	SENSOR STYLES
651	
661-668	CB, CC, CE, CF, CH, & CJ
670	

- NOTE:
1. ONLY THOSE FMRC APPROVED SENSOR/ELECTRONICS COMBINATIONS LISTED ABOVE ARE VALID.
  2. SENSOR/ELECTRONICS COMBINATION IS CERTIFIED FOR THE LESSER HAZARDOUS LOCATION RATING OF THE SENSOR OR THE ELECTRONICS HOUSING, FOR EXAMPLE THE ASSEMBLY OF A GROUP B SENSOR WITH A GROUP C HOUSING IS CERTIFIED FOR GROUP C.
  3. WIRING SHALL BE INSTALLED IN COMPLIANCE WITH THE NATIONAL ELECTRIC CODE FOR HAZARDOUS (CLASSIFIED) LOCATIONS. SUITABLE LISTED SEAL FITTINGS SHALL BE INSTALLED WITHIN 18" OF EACH ENCLOSURE ENTRANCE.
  4. A MINIMUM OF 5 FULL THREAD ENGAGEMENT BETWEEN ALL NPT THREAD JOINTS AND BETWEEN PROBE AND HOUSING CONNECTIONS IS REQUIRED PER NEC.

THIS DRAWING NOT TO BE CHANGED WITHOUT FM APPROVAL.

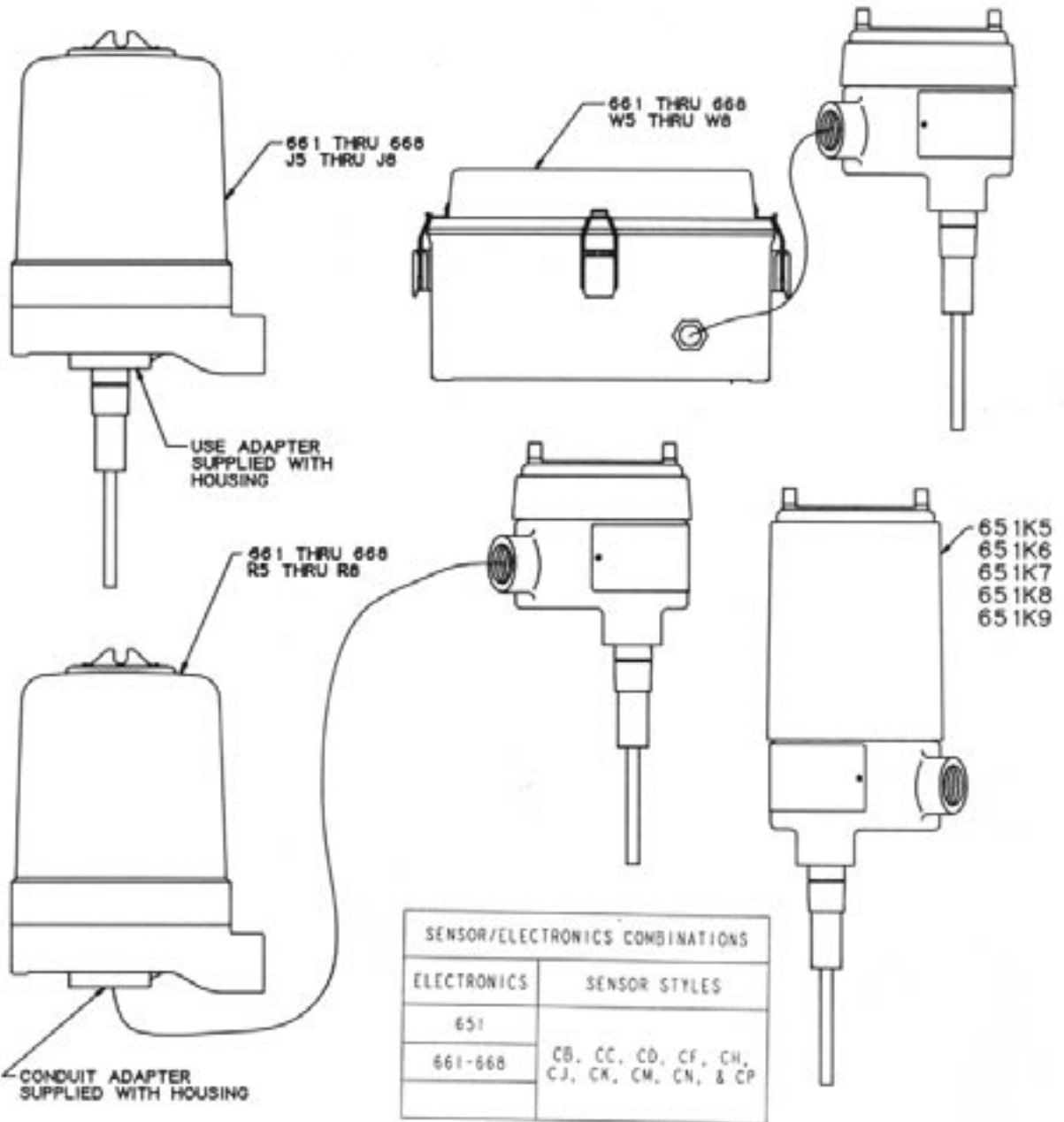
1	EO-3874	WJM	6/25/96	MLS	6/25/96	MLS
2	EO-4281	WJM	7/1/96	MLS	7/1/96	MLS

TITLE INSTALLATION DRAWING FM RF EXPF PROBE/ELECTRONICS COMBINATIONS		BY WJM	DATE 6/25/96	DRAWING NO. 9093-010	REV 2
APPROVED [Signature]		DATE 7/1/96	SHEET 1 OF 1		



14685 West 105th Street Lenexa, Kansas 66215 USA  
Tel. 913-888-2630 Fax 913-888-0767

DRAWING NO. 9093-011



SENSOR/ELECTRONICS COMBINATIONS	
ELECTRONICS	SENSOR STYLES
651	
661-668	CB, CC, CD, CF, CH, CJ, CK, CM, CN, & CP

NOTE:  
 1. ONLY THOSE SENSOR/ELECTRONICS COMBINATIONS LISTED ABOVE ARE VALID.  
 2. SENSOR/ELECTRONICS COMBINATION IS CERTIFIED FOR THE LESSER HAZARDOUS LOCATION RATING OF THE SENSOR OR THE ELECTRONICS HOUSING. FOR EXAMPLE THE ASSEMBLY OF A GROUP B SENSOR WITH A GROUP C HOUSING IS CERTIFIED FOR GROUP C.  
 3. WIRING SHALL BE INSTALLED IN COMPLIANCE WITH APPLICABLE CSA EXPLOSION PROOF STANDARDS FOR HAZARDOUS LOCATIONS.

THIS DRAWING NOT TO BE CHANGED WITHOUT CSA APPROVAL.

1	EO-3812	J. Wlg	9-6-96	MLS	JW
2	EO-4281	MLS	9/10/96	MLS	JW

TITLE INSTALLATION DRAWING CSA RF EXPF PROBE/ELECTRONICS COMBINATIONS		BY JWlg	DATE 9-6-96	DRAWING NO. 9093-011	REV 2
		APPD JWC	DATE 9-9-96	SHEET 1 OF 1	

7. Thread the new sensor into the bottom of the housing.
8. Connect the banana plug into the new sensor.  
Make sure the connection is tight.
9. Slide the PC board into the grooves in the plastic ring inside the housing.
10. Replace the two mounting screws into the plastic ring.  
These screws are self-tapping. Do not overtighten.
11. Replace the housing cover.

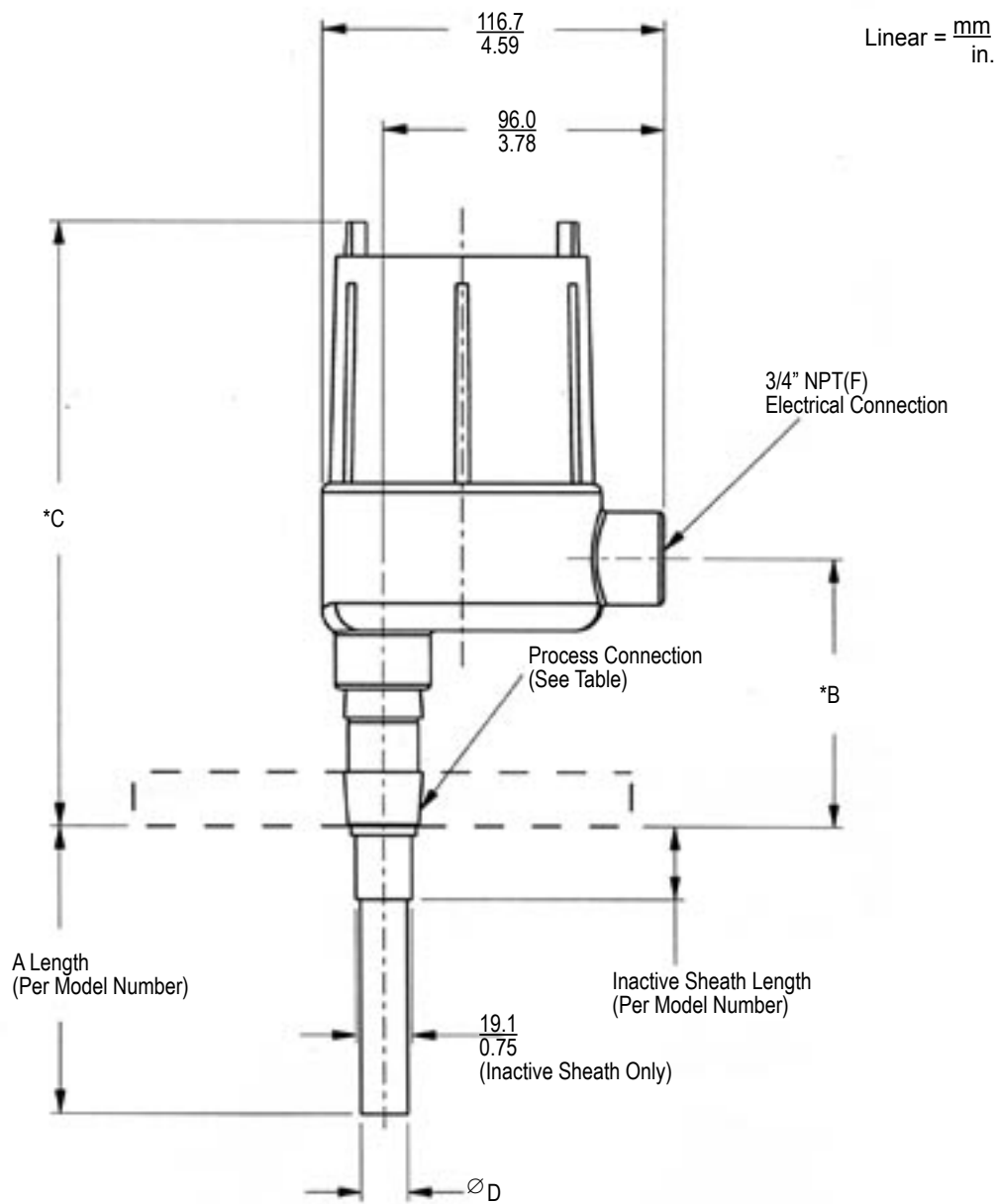
### Replacement Sensors

See Form 1100 RF Catalog for Model Numbers of Replacement Sensors.

## Troubleshooting Guide

Symptom/Proble	Possible Cause	Corrective Action
LED will not illuminate, even at maximum sensitivity setting (full clockwise 25 turns)	<ol style="list-style-type: none"> <li>1. Antenna banana plug loose or disconnected.</li> <li>2. No power to circuit.</li> <li>3. Blown fuse.</li> <li>4. Faulty sensing circuit.</li> </ol>	<ol style="list-style-type: none"> <li>1. Plug antenna banana plug securely into sensor jack.</li> <li>2. Check voltage at terminal block as appropriate.  L1 N            95-130 VAC  L1 L2          195-250 VAC  + -            24 + 10% VDC  + -            12 + 1 0% VDC</li> <li>3. Replace line fuses F1 and F2.</li> <li>4. Replace PC board.</li> </ol>
LED remains illuminated, even at minimum sensitivity setting (full counterclockwise 25 turns)	<ol style="list-style-type: none"> <li>1. Antenna lead unplugged and touching housing or other ground.</li> <li>2. Antenna is shorted to case or ground.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean banana plug and insert into sensor jack.</li> <li>2. Ensure that bare end of antenna is not touching any metal part. Remove P1 if LED goes dark. Clean, repair or replace sensor assembly.</li> </ol>
LED remains illuminated and goes out, but output relay is inoperative.	<ol style="list-style-type: none"> <li>1. Bad driver transistor.</li> <li>2. K1 relay contact damage.</li> <li>3. Burned or broken lands terminal feed through K1.</li> </ol>	<ol style="list-style-type: none"> <li>1. Move JP1 to other position. If relay operates normally, replace PC board.</li> <li>2. Check condition of relay contacts and max load of external switched circuit.</li> <li>3. Replace K1 relay or PC board.</li> </ol>
Device will not detect process material.	<ol style="list-style-type: none"> <li>1. Sensitivity improperly set.</li> <li>2. Highly conductive product.</li> <li>3. Heavy conductive product build-up on sensor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Recalibrate according to Pre-Installation I/O Test and Calibration instructions on Page 2.</li> <li>2. Use sheathed sensor.</li> <li>3. Use sheathed sensor and periodically remove build-up.</li> </ol>
Calibration drifts	<ol style="list-style-type: none"> <li>1. Widely varying dielectric due to changing process material.</li> <li>2. Highly conductive product.</li> <li>3. Heavy conductive product build-up on sensor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Recalibrate according to Pre-Installation I/O Test and Calibration instructions on Page 2.</li> <li>2. Use sheathed sensor.</li> <li>3. Use sheathed sensor and periodically remove build-up.</li> </ol>
Corroded sensor	Process material has chemically attacked sensor.	Use coated or sheathed sensor to provide corrosion resistance.
Eroded or abraded sensor	Fast flowing or agitated process has physically attacked sensor.	Consider other sensor material or design, relocating sensor or a stilling well in liquid process.

# Dimensions - K Housing Configuration (Explosion Proof Integral)



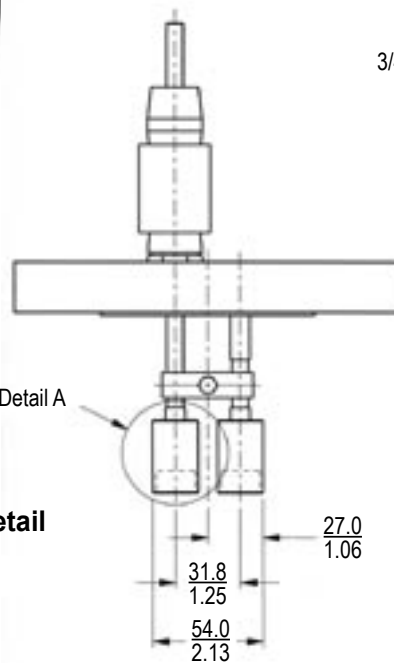
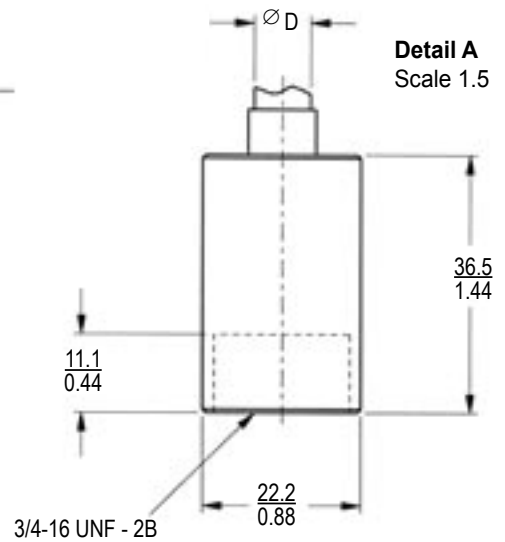
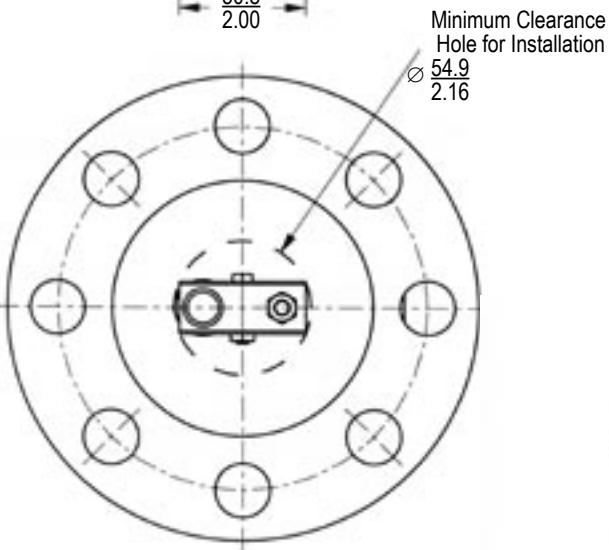
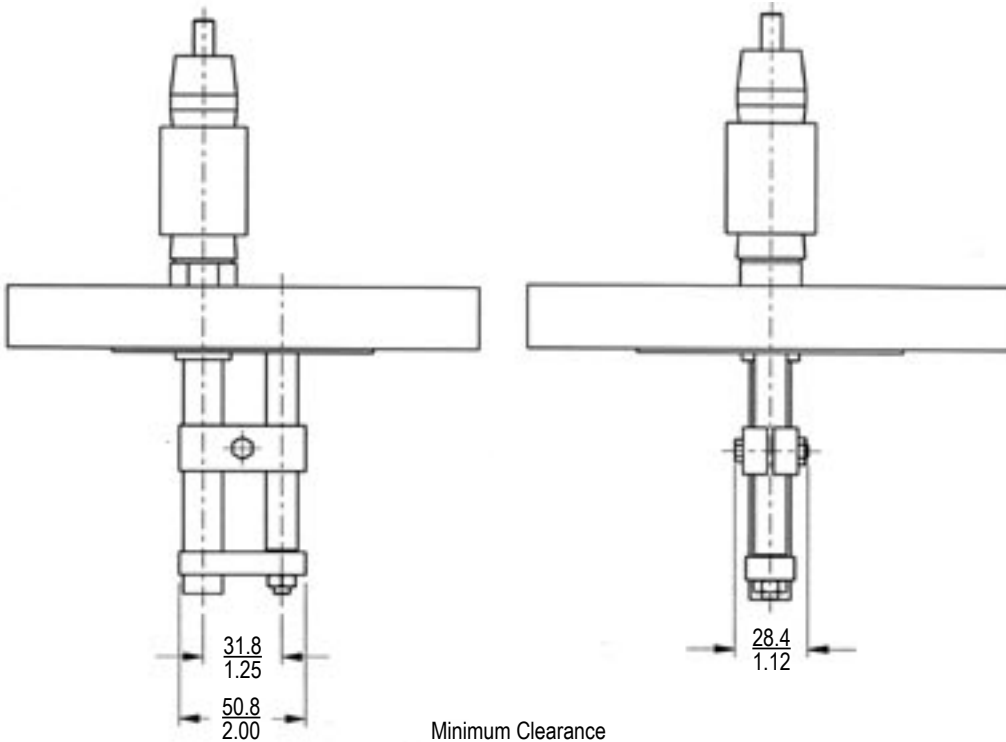
Process Connection	Dim B		Dim C	
	Cable Probe	All Other Probes	Cable Probe	All Other Probes
3/4" NPT(M)	<u>87.8</u> 3.46	<u>94.1</u> 3.71	<u>205.2</u> 8.08	<u>211.64</u> 8.33
1, 1-1/2, & 2" NPT(M)	<u>99.7</u> 3.92	<u>97.3</u> 3.83	<u>217.2</u> 8.55	<u>214.8</u> 8.46
Flanged	<u>158.5</u> 6.24	<u>158.5</u> 6.24	<u>276.0</u> 10.87	<u>276.0</u> 10.87
Stilling Well	N/A	<u>120.0</u> 4.72	N/A	<u>237.5</u> 9.35
Sanitary	N/A	<u>94.1</u> 3.71	N/A	<u>211.6</u> 8.33

DWG. # 0390652

# Dimensions (Other Sensors)

## Dual Rigid Probe Detail

Linear =  $\frac{\text{mm}}{\text{in.}}$



See Detail A

## Dual Cable Probe Detail

DWG. # 0390652

Sensor Style	Ø D
Bare	$\frac{12.7}{0.50}$
Sheath	$\frac{15.9}{0.63}$
Bare with Stilling Well	$\frac{26.7}{1.05}$
Sheath with Stilling Well	$\frac{26.7}{1.05}$
Cable	$\frac{7.90}{0.31}$
Inactive Sheath	$\frac{15.9}{0.63}$
Sanitary	$\frac{15.9}{0.63}$



