ENGLISH

Model 105

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Delta Controls CORPORATION

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Before installation and operation, please read this manual and take note of all safety instructions. Wear required personal protective equipment during installation, operation, and maintenance. Use this product only if it is in good condition. Delta Controls Corporation is not liable for damage caused by improper or non-designated use.

Delta Controls Corporation reserves the right to modify technical data without prior notice.

Engineered Reliability

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1. Introduction

1.1 Series Overview

The Delta Controls Series 100 units can handle many applications where it is impossible, impractical, or uneconomical to use other types of switches. These electronic units are particularly advantageous when measuring interfaces, corrosive liquids, and granular solids or where a small physical size requirement is a factor. They are externally powered and do not rely on the relatively low force that is produced by liquid floatation or displacement, are insensitive to foam, tolerant of agitation, bubbles which are entrained, and work under vibration conditions.

Series 100 units can detect solid materials just as they can liquids.

In general, electronic probe type units have physically small sensors, and therefore, can utilize smaller process vessel openings and connections than can most other switches. Small size is an advantage in pilot plants and other applications where space is limited. Installed cost savings due to connection size and labor can be substantial, particularly if alloy metals are required. External cage mounted units for continuous processes are also available in various configurations.

1.2 Model Overview

Delta Controls Model 105 is a capacitance switch for use in demanding level sensing applications. The 105 is designed to switch when material rises on the sensing probe to a preset elevation. It features high sensitivity, excellent stability, and low susceptibility to external electrical noise.

The unit is designed to detect high or low levels of liquids, interfaces, slurries, and solids. The sensed material may be conductive (water, acid, caustic) or nonconductive (oil, wheat, gasoline). The dielectric constant of the material can be as low as 1.30 when the proper high gain probe is selected. All water-based compounds and most medium weight hydrocarbons (ammonia, crude oil, Freon, fuel oil, lube grease) require only basic probes.

The unit is designed for mounting on the top of a tank, container, or open pit. It is usually good practice for the sensing probe to extend down from the top and 6 inches (15.24 cm) below the point at which each level switching action is to occur. The unit can also be mounted such that its sensor extends in from the side of the container; however, the probe must be selected so that it is not adversely affected by material buildup, or broken off if the process material is a solid. A horizontal installation is also limited to point alarm action.

1.3 Theory of Operation

A capacitor is formed by the sensing probe and a ground plane (usually the tank wall, but can be a parallel rod or plate). Series 100 instruments measure the amount of process material present by accurately measuring how much energy will flow from the probe to ground due to capacitance. In general, more energy flows as the elevation of the material between the probe and ground increases. This energy flow is directly proportional to the material elevation and is used to produce relay-switching action for either point alarm or differential control.

The amount of energy flow is a function of the probe size, ground plane distance and the dielectric constant (Dc) of the process material. The Dc of each material is a unique property specific to that particular material. This property can be described as the ease with which AC energy can travel through the material filling the space separating the two plates of a capacitor. Empty space (with a Dc = 1.0) transfers the least amount of energy and is, therefore, used as a reference for other materials. The actual Dc value for a specific material is a ratio of its energy transfer characteristic to that of empty space (a hard vacuum). For example: gasoline has a Dc value of 2.0, which means that twice as much energy will transfer through gasoline as will through a hard vacuum. A precise value of a material's Dc is not normally needed for Series 100 selection, installation, or calibration. In general, if a material is conductive, it has a Dc value high enough that the transfer effect is dominant and the actual Dc value can be ignored. Gases (such as air, nitrogen, etc.) have Dc values very close to 1.0; therefore, their effects can be ignored. Nonconductive materials have Dc values ranging from 1.5 to 55.0 and consideration must be given to probe and range selection to ensure that an adequate signal to noise ratio is maintained.

1.3.1 Liquid Sensing Probes, General

The correct selection of a sensing probe is a necessity for trouble free and reliable operation. Sensing probes are selected by considering the process temperature and pressure, the Dielectric Constant of the material, and mounting requirements.

1.3.2 Liquid Sensing Probes, Mounting Considerations

The probe-sensing rod may be installed in either of two general positions: vertically or horizontally. The simplest method is top of vessel vertical down mounting. A vertical or angled probe position is required for an application requiring adjustable differential control action. Horizontal mounting can be used to produce single point alarm action but, special attention must be given to ensure that the mounting method does not allow sediments and residue to collect around the probe.

1.3.3 Probes for Granular Solids and Powders

Sensing of dry granular solids is usually limited to producing single point alarm switch action. This is due to the small variations in the percentage of moisture in bulk solids. These small variations will produce large changes in the total material Dielectric Constant (Dc) because of the exceptionally high Dc of water. Moisture variations in solid materials are very common and can be caused by such conditions as atmospheric condensation, adsorption, etc. Single point alarm type switches will operate over a wide range of dielectric constant variations and are therefore, recommended for solids service. Adjustable differential switching control will usually work satisfactorily if the two switch points are widely spaced and are well away from the sensing probe ends.

Solids service usually requires stronger, heavier duty probes than those required for liquid service.

1.3.4 Probes for Viscous Liquids

Highly viscous and clinging liquids may adhere to a probe mounted horizontally in sufficient quantity to prevent switching after the fluid level has dropped. A simple solution is to mount the probe at an angle, as shown in the figure below , such that the clinging liquid collects at the tip, forms droplets, and drops off of the sensing rod. This also minimizes buildup and increases the speed of response.

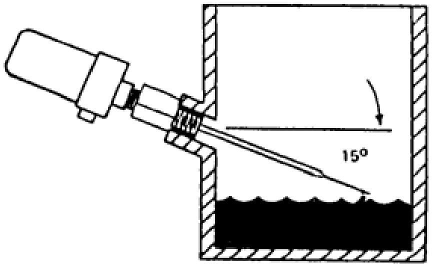

Figure 1

1.4 Adjustments

(Refer to Figure 2 for the locations of the following controls.)

SETPOINT ADJUSTMENT - This multi-turn potentiometer is used to set the upper-level point at which the unit switches.

DIFFERENTIAL ADJUSTMENT - This 22-turn potentiometer is used to set the lower-level point at which the unit switches. When this control is fully counterclockwise, “Differential” is inactive, and the lower switch point is the same as the upper switch point.

The differential band will be below the setpoint if direct action is selected, or above the setpoint if reverse action is selected.

REVERSE/DIRECT ACTION SELECTION - The unit is equipped with a jumper which selects either “Direct” or “Reverse” action. In the Direct position, the relay is energized when material is above the setpoint. In the Reverse position, the relay is energized when material is below the setpoint. The relay status indicator comes on when the relay is energized.

Most alarm applications require that the relay be energized under normal level conditions and de-energized to signal an alarm. This usually provides extra alarm reliability since a broken alarm circuit wire, instrument power loss, etc. will result in an alarm signal. A normally energized relay requires Direct action for low level alarm (signals on falling level) and Reverse action for high level alarm (signals on rising level). The jumper should be positioned to get the action which is best for your application.

TIME DELAY ADJUSTMENT - This 22-turn potentiometer is used to set the delay between the time the switch point is reached, and the time the relay actually switches. Relay operation is delayed in both directions, both when energizing and when de-energizing. The delay can be varied from almost no delay to over one minute.

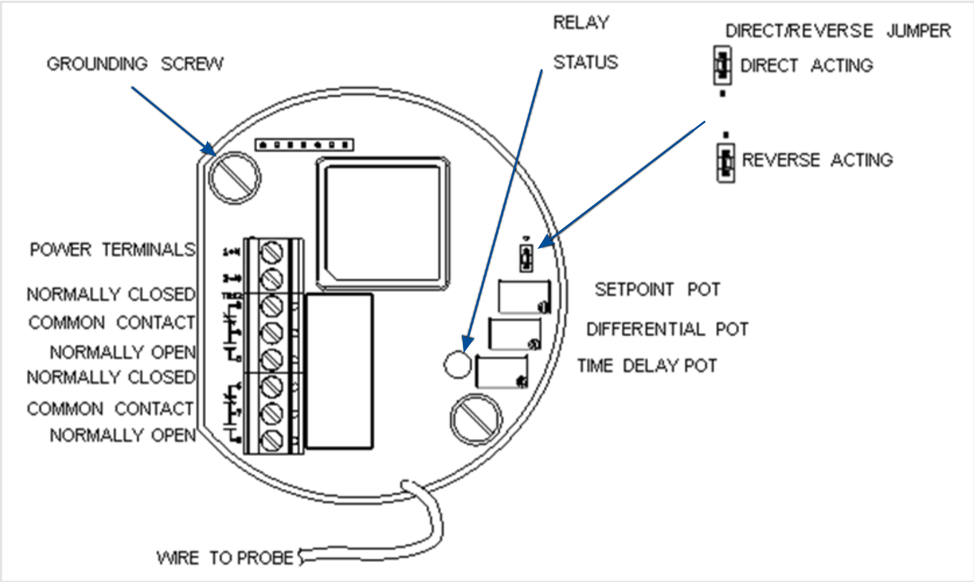

Figure 2: Operating Layout

2. Installation

2.1 Mounting and Wiring

Select a mounting point and hook up arrangement in accordance with good instrument practice. If the probe is to be mounted in the horizontal position, the selected mounting point should be at the level of the material at which the control action is desired.

All wiring should be done in accordance with a governing code, such as the National Electrical Code. When installing in Hazardous Locations, seals must be installed within 50mm of the housing.

WARNING

Do not incorrectly wire the unit or provide incorrect supply power. These and other errors such as wiring a VAC supply across a relay contact to ground can destroy the unit.

Refer to Figure 2 for proper connections. On AC powered units (Model 105-1), terminal 1 is connected to Hot and terminal 2 is connected to Neutral. On DC powered units (Model 105-3), terminal 1 is connected to +24V and terminal 2 is connected to -24V.

2.2 Orientation of the Probe

See below graphic for ways to orient and install the probe.

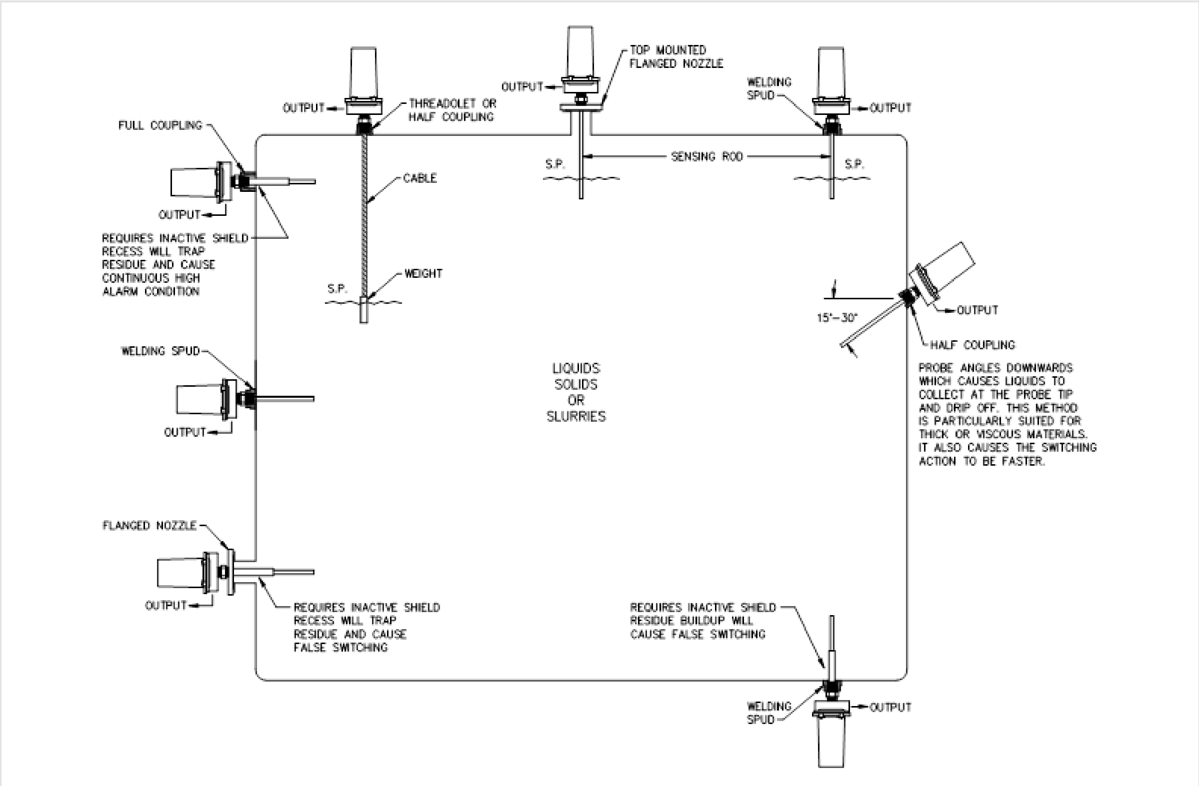

Figure 3: Probe Mounting Locations

2.3 Remote Location of the Electronics Unit

Units designed for remote operation have an additional terminal block instead of the basic top pigtail probe connection.

The electronics unit may be located up to 50 feet (15.24 m) away from the sensing probe. The capacitance of the interconnecting coaxial cable is 14pF per foot of length. This capacitance is in parallel with the probe and reduces the total length of material-covered probe that can be “zeroed out” by the setpoint adjustment. The amount of remote distance should be limited. Remotely mounting the electronics is usually done for one of the following reasons:

A. Removes the electronics unit from a harsh environment such as high temperature, low temperature, high radiation or high vibration levels.

B. Moves the electronics unit to ground level from the top of a tank for ease of installation, testing and maintenance.

C. Moves the electronics unit out of an area that is unsafe or potentially hazardous to maintenance and inspection personnel.

The sensing probe is connected to the electronics module using RG-62U coaxial cable. Refer to Figure 4 for coaxial cable wiring. The center conductor of the probe coax is connected to terminal 11. An identical length of RG-62U coaxial cable is connected to terminal 9. The shields of both coaxes are joined together and connected to terminal 10. The compensation coax acts to cancel changes due to temperature, etc that occur in the probe coax. The 105 will operate without the compensation coax; however, the switch points may drift as the ambient temperature changes. The probe coax and compensation coax should be identical in length and run side by side together in the same conduit.

At the probe, the center conductor of the probe coax is connected to the screw terminal on the probe. The shield should be connected to the ground terminal of the probe housing. The compensation coax is left unconnected in the probe housing.

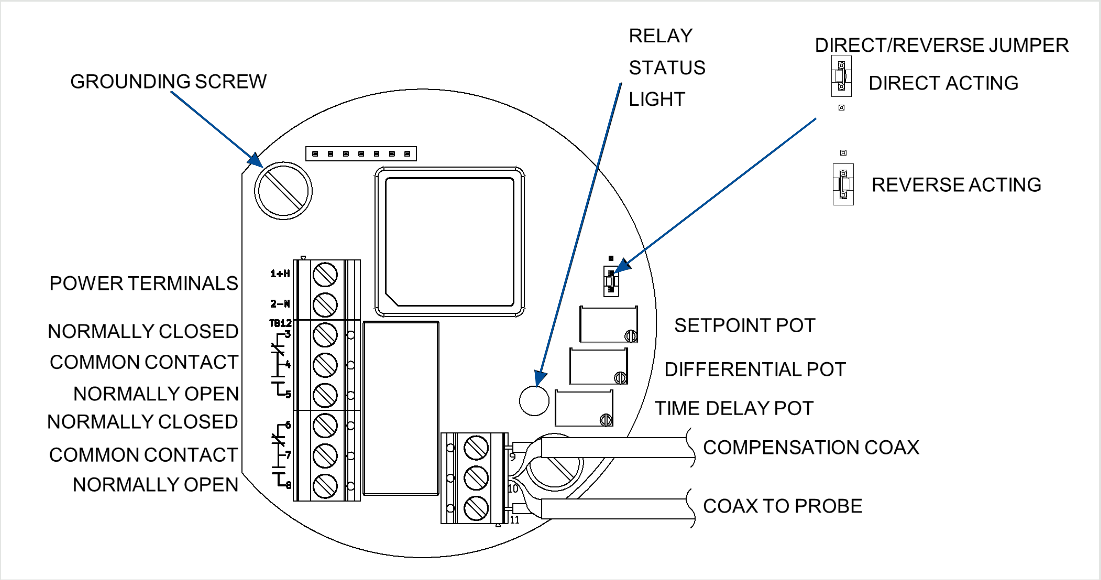

Figure 4: Probe Connection Wiring of Remote Mounted Electronic Module

3. Calibration Procedures

3.1 Calibration for Point Level Alarm Service

A. Put the Direct/Reverse action selection to the Direct position. Turn the time delay and differential adjustments fully counterclockwise.

B. Turn the setpoint adjustment fully counterclockwise (relay de-energized).

C. Fill the tank to the desired switching point elevation (low or high).

D. Turn the setpoint adjustment clockwise until the relay just energizes.

E. Turn the setpoint adjustment slowly back counterclockwise until the relay just de-energizes, noting the amount of rotation. Turn the setpoint half of the noted rotation clockwise, which centers the switch point in the switching band.

F. Put the action selector in the desired position, usually direct for low level alarm, or reverse for high-level failsafe.

G. The “Differential” adjustment may be turned slightly in the clockwise direction to overcome relay “chatter” due to small waves or disturbances occurring on the surface of a liquid. Alternately, turn the “Time Delay” adjustment somewhat clockwise to achieve a similar result.

H. Calibration is complete. Replace the cover, and tighten it to ensure that the “O” ring seals.

3.2 Calibration for Interface Detection Service

A. An insulated sensing probe with jacket is usually required for most applications.

B. Put the Direct/Reverse action selection to the Direct position. Turn the time delay and differential adjustments fully counterclockwise.

C. Turn the setpoint adjustment fully counterclockwise (relay de-energized in air or hydrocarbons).

D. Install the Model 105 into the vessel or pipeline containing the interface to be detected.

E. A liquid must completely cover the active section of the probe and you must know which liquid it is.

- If it is the nonconductive liquid: turn the setpoint adjustment slowly clockwise until the relay just energizes. Turn the setpoint back counterclockwise until the relay just de-energizes. Turn the setpoint very slowly back clockwise until the relay just energizes, and then counterclockwise until the relay just de-energizes. Turn the setpoint an additional 1/8 to 1/4 turn counterclockwise to insure that the setpoint is securely set in the conductive condition. Change the liquid to the conductive one; the relay should energize; if it does not, carefully repeat the procedure, it will work if carefully done.
- If it is the conductive liquid: the relay will be energized. Turn the setpoint adjustment slowly clockwise until the relay just de-energizes. Very slowly turn the setpoint back counterclockwise until the relay just energizes. Turn the setpoint counterclockwise an additional 1/8 to 1/4 turn to insure that the setpoint is securely set in the conductive condition.

NOTE

If the probe being used has a bare sensing rod, the conductive liquid may be so highly conductive that the relay cannot be de-energized when the setpoint is turned clockwise. In this circumstance, calibrate the Model 105 using the nonconductive liquid as the reference.

F. Move the action selector in the desired position,

- In “Direct” for de-energized relay alarm to indicate “nonconductive liquid”.
- In “Reverse” for a de-energized relay alarm to indicate “conductive liquid”.

G. The time delay adjustment may be turned slightly clockwise to prevent relay “chatter” due to slugs of the new liquid passing during interface passage in a pipeline.

H. The time delay adjustment may be turned slightly clockwise to prevent relay “chatter” when a mixed interface, or “rag layer”, is passing the probe during transition from one liquid to another. Note that adding time delay will usually not be satisfactory because the thickness and velocity of the interface, or “rag layer,” are usually unknown as well as variable. Differential control can only be used if the amount of differential set in is considerably wider than the thickness of the interface, or “rag layer.”

I. Calibration is complete, replace the cover, and tighten it to assure that the “O” ring seals completely.

3.3 Calibration for Differential Switching Control Service

A. Move the Direct/Reverse action selection to the Direct position.

B. Turn all pots fully counterclockwise (relay de-energized).

C. Fill the tank to the desired higher switching point elevation.

D. Turn the setpoint adjustment clockwise until the relay just energizes.

E. Turn the differential adjustment fully clockwise (relay must stay energized, if it does not, and then repeat steps C through E).

F. Lower the tank material level to the desired lower switching point elevation. The distance changed must be wider than the rag layer thickness.

G. Slowly turn the differential adjustment counter-clockwise until the relay just de-energizes.

Calibration is now complete. The relay will energize when the material level rises to the “high” point, and will stay energized until the level falls to the “low” point. It will then de-energize and stay de-energized until the level again rises to the “high” point.

H. Model 105 may now be changed for Reverse Action. If desired, move the Direct/Reverse jumper to the reverse position. This will cause the relay to de-energize at the “high” point and stay de-energized until the material falls to the “low” point.

4. Maintenance

No periodic nor scheduled maintenance is required for the Model 105.

5. Troubleshooting

In the event of malfunction or failure of a unit:

A. Visually inspect the unit for mechanical defects such as broken wires, etc. Check to see that supply power is provided.

B. Temporarily disconnect the relay connections.

C. Set the Direct/Reverse jumper to Direct.

D. Turn the “Time Delay” adjustment and the “Differential” adjustment fully counter clockwise.

E. Remove the probe wire from the probe terminal. Turn the setpoint pot 22 turns counterclockwise. The relay should be de-energized. Turn the setpoint pot clockwise until the relay just energizes, then turn it counterclockwise until the relay just de-energizes. You should now be able to cause the unit to switch by touching the probe terminal. Using a small screwdriver, and holding the metal shaft; touch the top of the probe terminal with the screwdriver and the metal housing with the other hand.

CAUTION

Do not touch the supply power terminals.

F. With the probe wire still disconnected, measure the resistance between the probe wire and the PCB mounting bracket. This value should be greater than 1 Megohm. If not, then the sensing probe is likely shorted to ground.

G. Reconnect the probe wire to the probe terminal.

- If no problem is found, recheck and carefully perform the calibration procedure.
- If a problem is found in step F, replace the circuit module.
- If a problem is found in step G, replace the probe.

H. Reconnect the relay connections.

6. Specifications

Level Range:	Switching at any point along the selected probe's length.
Differential:	Adjustable to any point within the range.
Relay Contacts:	5 A at 250 VAC DPDT; sealed for corrosive conditions
Time Delay:	0.25 seconds to 60 seconds adjustable
Supply Voltage:	
105-1	120-240 VAC 50/60 Hz 35 mA
105-3	24 VDC 50 mA
Ambient Operating Temperature:	-40 °F to +185 °F (-40 °C to 85 °C)
Temperature Effect (0 to 150 °F):	±0.25pF; typically < 0.1 inch (2 mm) in water.
Housing Material:	Aluminum, PVC, stainless steel (other materials available)
Hazardous Location Ratings:	
Applied Hazardous Location Standards	IEC 60079-0:2011 Ed. 6 IEC 60079-1:2014 Ed. 7
Applied Hazardous Location Standards	EN 60079-0:2012/A11:2013 EN 60079-1:2014
Certifications:	Housing is Third Party Listed by CSA NRTL/C Class I, Gr B,C,D; Class 2, Gr E,F,G; Class 3; Encl 4x

7. Model Numbering System

MODEL EXAMPLE	MODEL	-	SUPPLY VOLTAGE	-	HOUSING RATING	-	OPTIONS[1]
	105	-	1	-	7WR	-	15P

MODEL	DESCRIPTION
105	Capacitance Level Switch, DPDT

SUPPLY VOLTAGE	DESCRIPTION
1	120-240 ACV
3	24 DCV

HOUSING RATING	DESCRIPTION
AA	None
4XI	Environment-proof, 4X, PVC, integral mount
4XR	Environment-proof, 4X, PVC, remote mount
7WI	Explosion-proof, 7X, aluminum, Classes 1 & 2, Divisions 1 & 2, Groups BCD, EFG, integral mount [3]
7WR	Explosion-proof, 7X, aluminum, Classes 1 & 2, Divisions 1 & 2, Groups BCD, EFG, remote mount
7TI	Explosion-proof, 7X, 300 Stainless Steel, Classes 1 & 2, Divisions 1 & 2, Groups BCD, EFG, integral mount
7TR	Explosion-proof, 7X, 300 Stainless Steel, Classes 1 & 2, Divisions 1 & 2, Groups BCD, EFG, remote mount

OPTIONS[1-3]	DESCRIPTION
AA	None (integral)
PSM	Housing mounting bracket for remote mounting (surface or 2 in pipe mounting) [2]
**P	** feet of interconnecting cable for remote mounting, includes sensor and compensation cable, 160 °F (71 °C), PVC [2]
**D	** feet of interconnecting cable for remote mounting, includes sensor and compensation cable, 400 °F (204 °C), FEP [2]
ZZ2	Special housing orientation; ranged for low dielectric sensitivity for dry media; single direction time delay; set to time delay energizing of the relay; adjustable [3]

Contact Us

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