

TX and TS

Thermal dispersion switches

Measurement made easy

KTEK Level products



Introduction

This operating instruction manual provides the following information:

- Calibration / set point procedure - see page 5
- Configuration - see page 7
- Installation instructions - see page 12
- Troubleshooting - see page 18

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1.0 PRINCIPLE OF OPERATION

ABB's thermal dispersion switch consists of two temperature sensors (Resistance Temperature Detectors), heater, power supply, amplifier, current generator, comparator and a relay (DPDT) for output. The type of temperature sensor used is either a silicon semi-conductor, which is used on the standard units, or a platinum RTD which is used for high temperature applications (see ordering options on data sheets). The two sensors are separated a short distance apart from each other. The sensors are paired to track each other with temperature. These sensors have a resistance that is proportional to their temperature and are known for their accuracy over a wide temperature range.

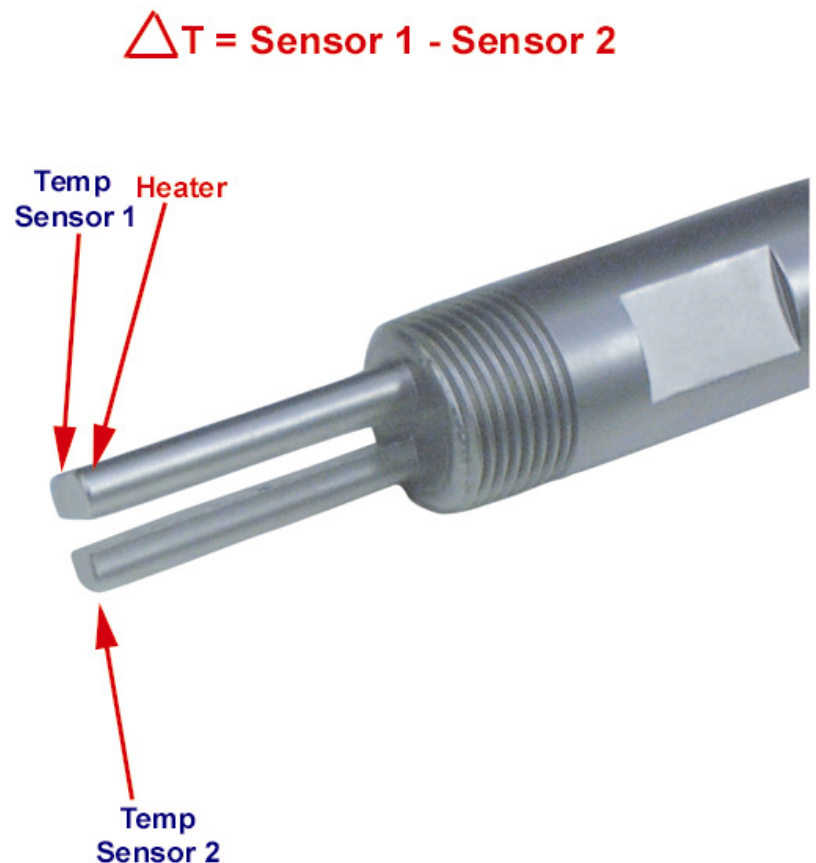
One part of the probe contains a heating element that raises the temperature of the sensor (*active* sensor) to a temperature above the temperature of the medium. The other sensor (*reference* sensor) acts as a benchmark by measuring the temperature of the medium. The switch can be thought of as a mass flow meter.

A constant current source is passed through both sensors to create a voltage differential that is proportional to the amount of heat absorbed or released by the sensors. As the medium begins to rise or flow against the probes, the molecules of the medium absorb more heat from the active sensor and the voltage differential begins to drop or as the flow rate increases, the voltage differential will decrease (inverse relationship).

This is the basic principal behind thermal dispersion, which allows the configuration of the instrument to trip on flow, level or temperature, to a set point or a combination of set points. The switch can be set to respond immediately to changes in level, flow or temperature. However, as you decrease the response time, the recovery time increases. There is an inherent time factor in any thermal dispersion switch due to the thermal conductivity of the medium, the type of metal used and the cross sectional area of the metal surrounding the sensors. The response time can be adjusted in a level or no-flow/flow application. But in a flow rate application, interface application or temperature application, there is no time compensation and the unit will not respond immediately. (See Data Sheet for specifications.)

A temperature change to the process or an atmospheric temperature change will not affect the setting because a change to the reference sensor will also effect the active sensor. This will result in an unchanged delta voltage and therefore no change in state.

ABB's line of thermal dispersion switches, the TX and TS are all analog switches. This makes it a simple switch, a rugged switch, and can be two distinct switches contained in one housing.



2.0 EXPLANATIONS

The TX Thermal Dispersion switch has two RTD elements, one of which is heated by a small, low wattage electric heating element. The thermal dispersion switch operates on the principle of a difference in thermal conductivity (TC) between mediums (air/vapor vs. liquid or high vs. low flows of air, vapor or liquid). Once the switch has stabilized in any given process condition, it can be adjusted such that a change (increase or decrease) in the amount of heat conducted away from the heated RTD (thermal dispersion) due to a change in thermal conductivity of the process at the sensors will cause the active (heated) RTD to change in temperature (resistance). This change may be an increase in temperature due to a decrease in Thermal Conductivity (TC) or a decrease in temperature due to an increase in TC. This change is detected by the TX switch module.

This approach to calibrating the TX thermal conductivity switch may be more easily understood than the preceding methods presented.

Understanding Switch Function:

1. An increase in flow, be it gas or liquid, or a change from gas to liquid at the sensor causes **more** heat to be conducted away from the heated element, due to an **increase** in thermal conductivity at the sensor and a resultant decrease in the “heated” element’s temperature. **The TX recognizes this change as a decrease in the differential temperature between the two RTD sensors.**
2. A decrease in flow or a change from liquid to a gas or vapor at the sensor results in **less** heat being conducted away from the heated element (RTD) due to a **decrease** in thermal conductivity at the sensor and a resulting increase in the “heated” element’s temperature. **The TX recognizes this change as an increase in the differential temperature between the two RTD sensors.**
3. A decision needs to be made regarding the failsafe operation required by the process control system. If fail safe is to be incorporated, the output relay and green LED should be energized at what is determined as the normal condition. JP3 jumpers are used to determine the relay action vs. the normal process condition. See the table on page 6.
4. JP3 jumpers can be either in a vertical position (State A) or a horizontal position (State B) – see page 6.

Failsafe “State” required (A or B) Setting JP3 Jumpers

See page 6 to determine the JP3 relay state (A or B) jumper settings required, considering fail safe requirements of the process. It is generally desired to have the green LED and the output relay energized with the normal process condition at the sensor, providing an alarm should power be lost to the TX switch. Set JP3 jumpers according to the particular application.

State A – Green LED and output relay are **energized** at High Thermal Conductivity (**Low sensor Delta T**) process condition – high level, high flow (process conditions are above set point).

State B – Green LED and output relay are **energized** at Low Thermal Conductivity (**High sensor Delta T**) process condition – low level, low flow (process conditions are below set point).

Relay State A – State B definitions (restated)

State A - The green LED and output relay are **energized** when the sensor is in the higher Thermal Conductivity (lower differential temperature) condition. Normal process conditions for Fail Safe operation. Flow is > set point; Level is above the sensor. The green LED and output relay are **de-energized** when the sensor is in the lower Thermal Conductivity (higher differential temperature) condition. Alarm process conditions for Fail Safe operation. Flow is < set point; Level is below the sensor.

State B - The green LED and output relay are **energized** when the sensor is in the lower Thermal Conductivity (higher differential temperature) condition. Normal process conditions for Fail Safe operation. Flow is < set point; Level is below the sensor. The green LED and output relay are **de-energized** when the sensor is in the higher Thermal Conductivity (lower differential temperature) condition. Alarm process conditions for Fail Safe operation. Flow is > set point; Level is above the sensor.

3.0 CALIBRATION / SET POINT PROCEDURE

Determining High and Low Thermal Conductivity Process conditions

- I. It is usually easy to recognize the high and low thermal conductivity conditions when the switch is applied to liquid and vapor conditions (high and low level detection). The higher TC is almost always when the sensors are in the liquid phase.
- II. There are interface applications where the high and low TC process conditions may not be so obvious.
- III. The TX switch itself can be used to identify the high and low TC conditions.
 - A. Remove power from the TX.
 - B. Make connections to pins 1 and 3 of P2 (Pin 1 is nearest the green LED).
 1. Temporarily insert small pieces of solid wire in P1 or P2; or,
 2. Use ABB TX service plug connected to P1 on:
 - a. Main board (using gender changer adapter) for (single relay output); or,
 - b. Piggy-back board (dual set point/output, without gender changer adaptor).
 - c. Pin 1 is green wire; pin 3 is yellow wire on TX service plug.
 - C. Connect a mV meter to Pin 1 (-) and pin 3 (+)
 - D. Apply power to the TX. The mV read will be due to the difference in temperature between the Active Sensor and the Reference Sensor.
 - E. Change the process conditions at the TX sensors from Normal to Alarm, allowing time to stabilize (5 minutes) and log these mV values.
 1. Higher mV value indicates LOW Thermal Conductivity at the sensors (heat is not being conducted away as well from the Active sensor allowing the temperature of that sensor to increase).
 2. Lower mV value indicates HIGH Thermal Conductivity at the sensors (heat is being conducted away from the Active sensor, keeping the temperature at lower values).

3.1 Calibrate from HIGH TC (Thermal Conductivity) process conditions as follows:

JP3 State A - Green LED, output relay **energized** at **NORMAL** condition (High Thermal Conductivity (low differential temperature) conditions at the sensors); high level (level above sensor), flow above setpoint (see table page 6)

Notes:

1. If the TX switch is operated in **State A**, the TX switch should be adjusted (calibrated) in the **NORMAL** condition; Highest Thermal Conductivity conditions on the sensors (wet sensor, high flow); Green LED and output relay will be energized during and after calibration.
2. CW rotation of R18 turns LED ON.

Calibration Adjustments

1. Provide the **NORMAL** condition (**HIGH** Thermal Conductivity process condition (high level (level above the sensors), high flow)) at the sensor. Green LED and output relay **will be** energized after calibration.
2. Allow 5 minutes (minimum time) for switch temperature to stabilize.
3. Adjust R18 (drawing page 5) as follows:
 - a. If LED is On – slowly turn R18 counter clockwise (CCW) to OFF. Then turn CW until ON.
 - b. If LED is Off – slowly turn R18 clockwise (CW) until green LED turns ON
4. Turn R18 CW as follows for stable operation (no false alarms) (LED will be On):
 - a. Air – 1 full turn
 - b. Organics/Hydrocarbons – 2 full turns
 - c. Water – 3 full turns

Trimming the TX settings for optimum alarm return to normal time balance if required:

When the LED just turns ON, (3.b. above), the TX “alarm/recovery (return to normal) window” is positioned nearest to the process’s energized LED Normal (high TC; Low mV) value. This provides the shortest possible time to recognize (enter) the de-energized alarm condition, but the longest possible recovery time back to the energized (normal) state.

Step 4 is an attempt to provide closer equal response times (time to enter alarm vs. time to recognize normal conditions and exit the alarm condition) as well as stability from false alarms.

Note that adjusting R18 affects both alarm recognition time (time for the TX switch to recognize an alarm condition at the sensors) as well as recovery time (time for the TX switch to recognize that the conditions have returned to normal) by positioning the “alarm/recovery” window nearer the alarm or normal process condition mV values. **Note:** it is important to allow 5+ minutes of stabilization in any new process condition to obtain repeatable time values.

1. If the alarm entry time needs to be made faster **AND** the alarm recovery time (time to return to normal conditions) needs to be made slower, turn **R18 CCW** in ½-1 turn increments, moving the alarm/recovery window nearer the Alarm (Low TC; High mV) process condition.
2. If the alarm recovery time (time to return to normal energized state) needs to be made faster **AND** the alarm entry time needs to be made longer, turn **R18 CW** in ½ - 1 turn increments. This moves the alarm/recovery window closer to the Normal (High TC; Low mV) process condition.
3. Test the switch response after each adjustment until an acceptable balance in alarm entry time vs. recovery time (return to normal conditions) is established empirically.

3.2 Calibrate from Low TC (Thermal Conductivity) process conditions as follows:

JP3 State B - Green LED, output relay **energized** at **NORMAL** condition (LOW Thermal Conductivity, high differential temperature, conditions at the sensors); low level (level below sensor), flow below set point (see table page 6)

Notes:

1. If the TX switch is operated in **State B**, the TX switch should be adjusted (calibrated) in the **ALARM** condition; Highest Thermal Conductivity conditions on the sensors (wet sensor, high flow); Green LED and output relay will be de-energized during and after calibration.
2. CCW rotation of R18 turns LED ON.

Calibration Adjustments

1. Provide the **ALARM** condition (**High** Thermal Conductivity process condition (high level (level above sensor), high flow condition)) at the sensor. Green LED and output relay **will be** de-energized after calibration adjustments
2. Allow 5 minutes (minimum time) for switch temperature to stabilize.
3. Adjust R18 (see drawing page 5) as follows:
 - A. If LED is On – slowly turn R18 clockwise (CW) until the green LED turns OFF
 - B. If LED is Off – slowly turn R18 counter clockwise (CCW) until the green LED turns on – then slowly CW until it just turns OFF.
4. Turn R18 CW as follows for stable operation (no false alarms) (LED will be Off):
 - A. Air – ¼ turn
 - B. Organics/Hydrocarbons – ½ turn
 - C. Water – 1 full turn

3.3 Trimming the TX settings for optimum alarm entry/return to normal time balance if required:

When the R18 is adjusted such that the LED just turns off, (3.a/b. above), the TX “alarm/recovery (return to normal) window” is positioned nearest to the process’s de-energized LED Alarm (high TC; Low mV) value. This provides the shortest possible recovery time to recognize the energized LED Normal condition, but the longest possible time to enter the de-energized (Alarm) state.

Step 4 is an attempt to provide somewhat equal response times (time to enter alarm vs. time to recognize normal conditions and exit the alarm condition) as well as stability from false alarms. Note that adjusting R18 affects both alarm recognition time (time for the TX switch to recognize an alarm condition at the sensors) as well as recovery time (time for the TX switch to recognize that the conditions have returned to normal) by positioning the “alarm/recovery” window nearer the alarm or normal process condition mV values.

Note: it is important to allow 5+ minutes of stabilization in any new process condition to obtain repeatable time values.

1. If the alarm entry time needs to be made faster **AND** the alarm recovery time (time to return to normal conditions) needs to be made slower, turn **R18 CW** in ¼ - ½ turn increments. Test the switch response after each adjustment until an acceptable balance in alarm entry time vs. recovery time (return to normal conditions) is established empirically.

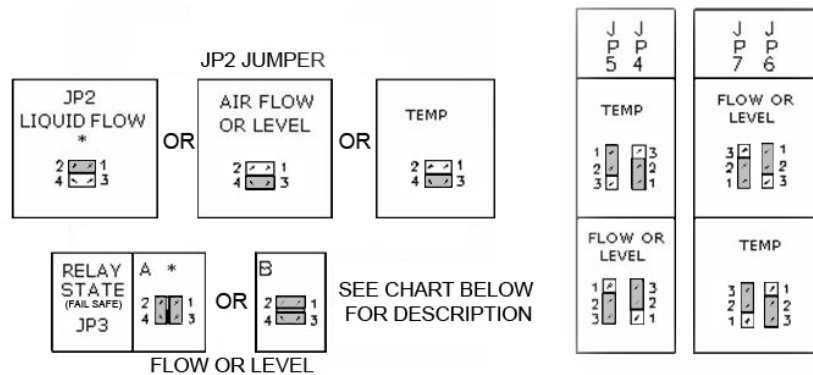
2. If the alarm recovery time (time to return to normal energized state) needs to be made faster **AND** the alarm entry time needs to be made longer, turn **R18 CCW** in ¼ - ½ turn increments. Test the switch response after each adjustment until an acceptable balance in alarm entry time vs. recovery time (return to normal conditions) is established empirically.

4.0 CONFIGURATION

The thermal dispersion line, TX and TS electronics module can be factory configured to accept power inputs of 90-130 VAC, 200-240 VAC at 50/60 Hz or 24 VDC. Maximum current draw with the dual switch point option is 180 ma and the maximum power draw is 5.5 Watts.

In addition, there are 6 jumper terminals JP2 through JP7 that allow you to set up the electronics for, Level, Liquid Flow, Air Flow, Granular Solids, and Temperature.

JUMPER SETTINGS FOR TX - 1000 BOARD (BOTTOM BOARD) *DEFAULT



All TX series switches can be configured to function as a **window comparator**. That is, to detect between two different flow rates or two different temperatures. The switch can monitor for a combination of level and temperature, or flow and temperature with the dual switch point option. With the dual switch point option board, the flow rate of a process can be monitored with the millivolt output (approximately 1 volt to 3 millivolts). The millivolt output has an inverse relationship to flow. In this configuration, the unit is two switches contained in one housing.

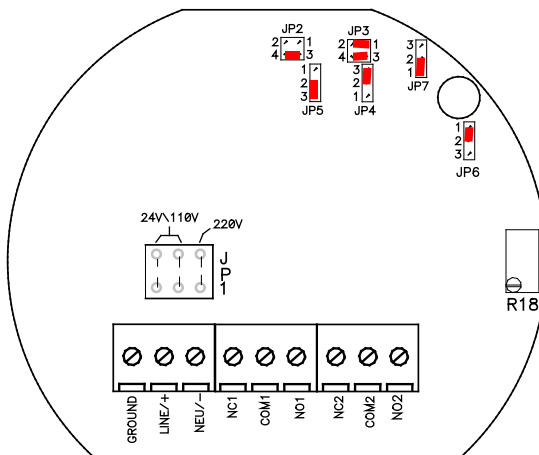
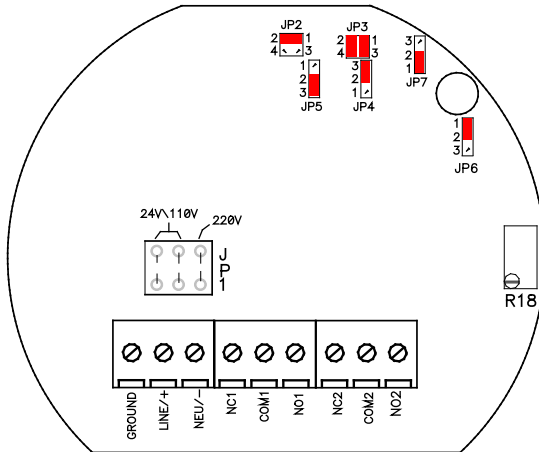
The output of basic unit consist of double pole–double throw (DPDT) relay. The dual switch (DS) option includes another DPDT relay.

4.0 CONFIGURATION (cont'd)

Default Setting

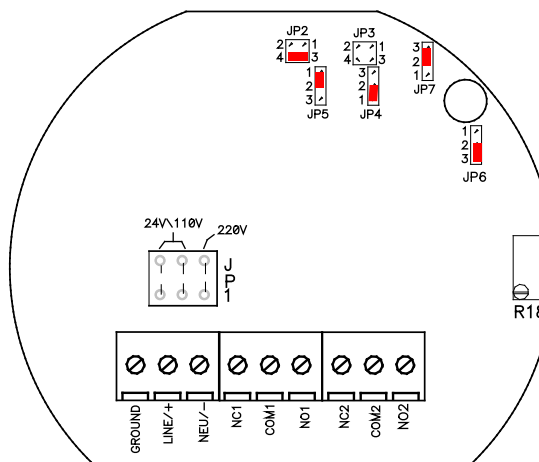
Switch set for **Liquid Flow** (Fail Safe Low Flow)

JP 3: Relay setting as shown for State A
Energizes when above flow set-point of R18
Two Jumpers x 2mm



Switch set for **Level or Air Flow** (Fail Safe) High Level or High Flow

JP3: Relay set for State B
Energizes when dry or below flow set-point above setting of R18
Two Jumpers x 2mm





Switch set for **Temperature**: uses only the reference sensor (STS or RTD)



JP3: Set for State A or B (as shown)
To energize below or above setting of R18



State A: Energize when temperature is below set-point

State B: Energize when temperature is above set-point

4.0 CONFIGURATION (cont'd)

LIQUID FLOW (BOTTOM BOARD) JP3 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On Fail Safe	Flow > Set-Point Normal Condition	Flow < Set-Point Normal Condition
Relay De-energized LED OFF	Flow < Set-Point	Flow > Set-Point

LEVEL OR AIR FLOW (BOTTOM BOARD) JP3 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On Fail Safe	WET or Air Flow > Set-Point Normal Condition	DRY or Air Flow < Set-Point Normal Condition
Relay De-energized LED OFF	DRY or Air Flow < Set-Point Normal Condition	WET or Air Flow > Set-Point Normal Condition

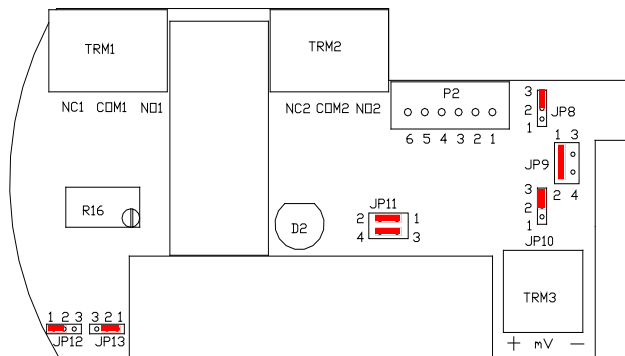
TEMPERATURE (BOTTOM BOARD) JP3 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On Fail Safe	Temperature < Set-Point Normal Condition	Temperature > Set-Point Normal Condition
Relay De-energized LED OFF	Temperature < Set-Point Normal Condition	Temperature < Set-Point Normal Condition

4.1 Second Switchpoint Option Board (Top Board)

The TX-2000 option board plugs into the TX-1000 main electronics module. It is mounted directly above the main module. It has two 3 pole terminal blocks that connect to the board's double-pole double-throw relay contacts. These contacts can be set to switch at a set point that is independent of the setting on the main board.

The second set point is controlled by the board's potentiometer R16. The board also has a 2 pole terminal block for an amplified millivolt-volt output of the delta voltage, that is between the Active and Reference sensors. The output is approximately 3 times that of the delta voltage. The output has an inverse relationship to flow and is not linear (the output voltage decreases as flow increases). The amplified output does not apply when used as a temperature switch.

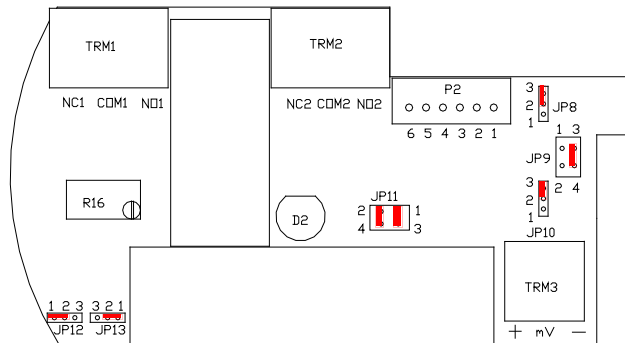
In addition, the board also has 6 jumper terminals JP8 through JP13 that allow you to set up the electronics for Liquid Flow, Air Flow, Level (Granular Solids & Liquid) and Temperature as follows:



Switch set for **Liquid Flow - Default** (Fail Safe Low)

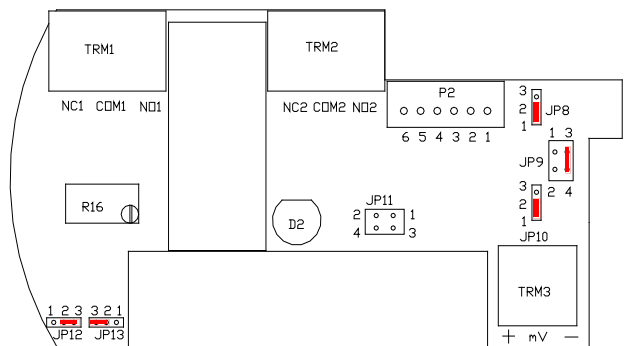
JP11: Relay setting as shown for State A

Default: Energizes above flow set-point



Switch set for **Air Flow & Level** (Fail Safe High)

JP11: Relay setting as shown for State B Energizes when DRY or below flow set-point



Switch set for **Temperature**: uses only the reference sensor (STS or RTD)



JP11: Set for State A or B (as shown above)



To energize below or above setting of R16



State A: Energize when temperature is above set-point

State B: Energize when temperature is below set-point

4.1 Second Switchpoint Option Board (Top Board) (cont'd)

LIQUID FLOW (TOP BOARD) JP11 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On	Flow < Set-Point	Flow > Set-Point
Relay De-energized LED OFF	Flow > Set-Point	Flow < Set-Point

LEVEL OR AIR FLOW (TOP BOARD) JP11 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On	DRY or Air Flow < Set-Point	WET or Air Flow > Set-Point
Relay De-energized LED OFF	WET or Air Flow > Set-Point	DRY or Flow < Set-Point

LEVEL OR AIR FLOW (TOP BOARD) JP11 Jumper Configuration		
CONDITION	State A 	State B 
Relay Energized LED On	Temperature > Set-Point	Temperature < Set-Point
Relay De-energized LED OFF	Temperature < Set-Point	Temperature > Set-Point

5.0 INSTALLATION

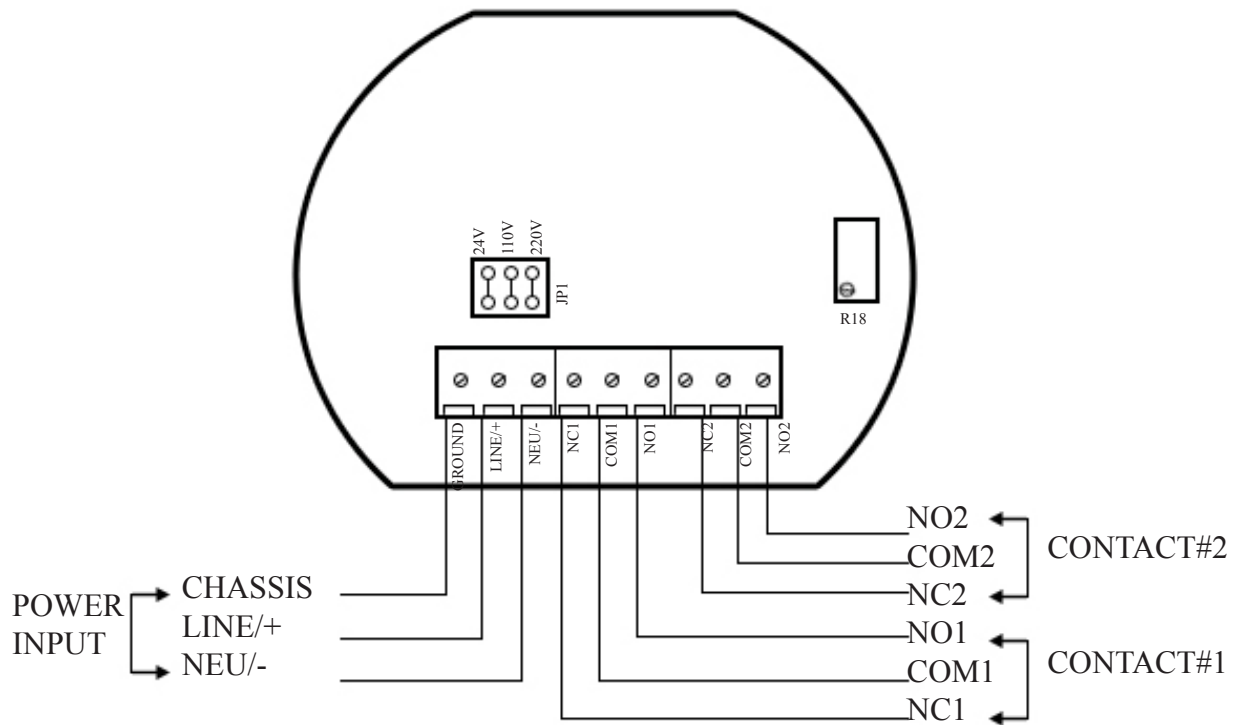
The instrument should be inserted into process line so that the wrench flats (the two flat sections between the pipe threads that permit you to torque the sensor head threads into the process line with a wrench) are perpendicular to the direction of flow. It is recommended that in flow rate applications the larger diameter tube on the sensor be oriented upstream to the direction of flow.

For mounting threaded units to process line, it is recommended that:

A half-coupling, thread-o-let or the like be used. It is ideal that the probes extend into the line being monitored. If a pipe tee is used it is recommended that the leg used to mount the instrument be the same as the instrument connection size (1" MNPT type). The standard instrument (1.8 inch) will fit in a 1 ½" X 1 ½" X 1" or larger tee. The 1.2 inch option units are available to insert directly into a 1" or ¾" tee.

For mounting flanged units, the wrench flats on the sensor head should similarly, be parallel to flow. For liquid service, fill the process line so that the probe is surrounded by liquid. Then provide wiring to the housing according to the following wiring detail:

5.1 Wiring Diagram



Output: (All Series) = 1 Double Pole-Double Throw (DPDT) Relay, Max: 8 amps or 250 Volts or 740 VA or 373 Watts

Dual Switch Point Option Board (All Series) = 1 (DPDT) Relay, Max: 8 amps or 250 Volts or 740 VA or 373 Watts with millivolt output = (3 times the delta voltage)

Note: Dual Compartment Housing – **Total of 2 sets of contacts** only (single switch point 1 DPDT, dual switch point 2 independent SPDT). **MAX means do not exceed!**

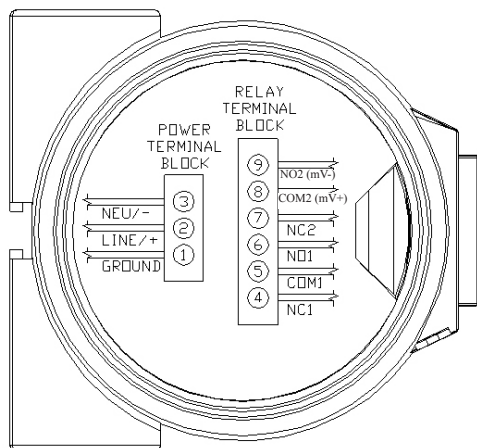
5.2 Wiring Diagram - Dual Compartment Housing

Wiring diagram for dual compartment housing (aluminum and stainless steel). With the dual compartment housing option and /DS option there will only be one SPDT switch (form C) available for each board. (You lose the DPDT function on each board.) Normal terminal configuration is relay. (Optional output in mV) on terminal 8,9.

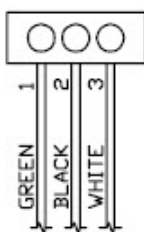
Optional:

Amplified MV out put on

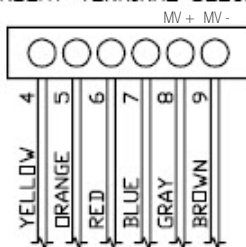
- Dual compartment enclosure.
- Use Relay Terminal 8 & 9.
- Terminal 7 not used.



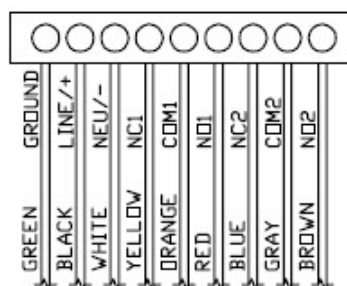
POWER TERMINAL BLOCK



RELAY TERMINAL BLOCK



ELECTRONICS TERMINAL BLOCK



5.3 Installation for Liquid Level Operation

- SIDE MOUNTED**—The instrument can be mounted directly to the vessel being monitored or in a standpipe parallel to the vessel. It is recommended that the probe extend into vessel/stand pipe in highly viscous products. This is best accomplished by using a half-coupling or thread-o-let for the standard threaded unit.
- TOP MOUNTED**—For top mounted installation it is recommended that the electrical/conduit connection be isolated by such means as a potting Y so that moisture can not enter the housing.

5.3.1 Installation for Flow Rates (Minimum and Maximum)

This switch can be also be configured to detect between a minimum or a maximum flow rate or a minimum/maximum temperature. With the dual circuit board option the unit can also detect a flow rate and temperature in one housing. The output relays would be wired in series.

PROCEDURE FOR LIQUID LEVEL OPERATION

A. The instrument detects the thermal conductivity of the medium surrounding the probe and therefore can detect the interfaces of many different mediums. The following list is provided to give examples of typical thermal conductivity of different mediums. Refer to “wet” as a medium with a relatively “good” thermal conductivity and “dry” as a medium that has a relatively “poor” thermal conductivity.

- “OK”
 - air or gas
 - foam
 - granular solids & powders
 - hydrocarbons / organics
 - emulsions
- “Best”
 - aqueous

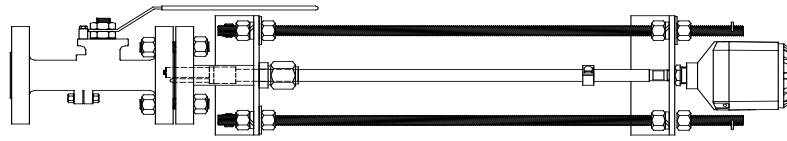
NOTE: The thermal conductivity of a clear liquid will be better compared to the same liquid containing a high concentration of solids.

C. The instrument is factory default is set for liquid flow detection. For level or temperature applications, change the configuration as detailed in “configuration” earlier in the manual.

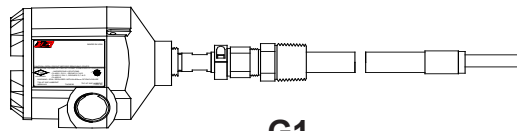
5.4 Installation for Remote Electronics

The remote electronics housing is used when the process environment is at a temperature that exceeds the maximum operating temperature (140°F or 65°C) of the electronics module. The remote housing simply contains a terminal block interface for a cable, which connects to another housing containing the electronics that is located in a more suitable environment. The cable can be one of two types, each of which is designed for a specific temperature range. See page 19, Appendix A

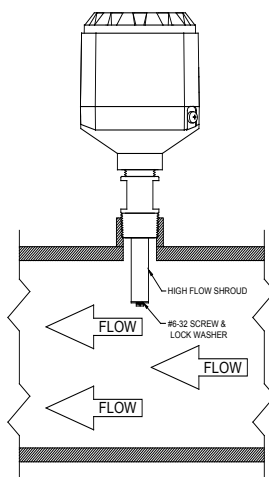
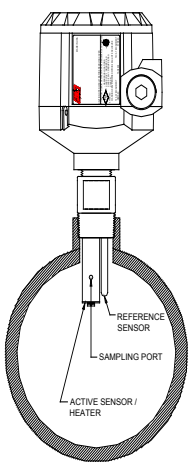
5.5 Installation Setup



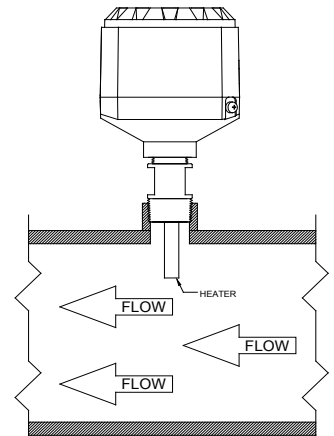
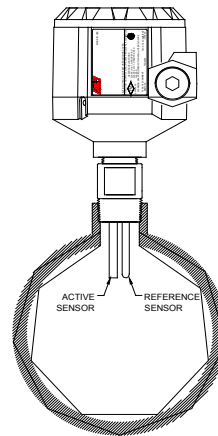
* For use on flanged valves only. **G2**



G1



High Flow Option



TX - Standard Unit

In flow applications the switch must see laminar flow. To assure laminar flow, allow a length of 10 times the diameter of the pipe size after a turn in a pipe before inserting the switch. If inserting the unit in a "tee" the tee size should be the same size as the line or smaller. A larger diameter tee will allow the water to expand and cause false trip to occur because of vortices and/or eddy currents .

The switch must be installed as show above in a flow application. Rotating the switch from this position will cause the switch to respond slower and will alter a calibrated set-point.

6.0 FLOW RATE DETECTION

Configure circuit board jumpers JP3 (Relay State A) so the relay will be energized (green LED on) at the minimum flow rate then adjust as follows:

Allow the product to flow at the minimum rate for approximately three minutes. (This will allow the unit to establish an accurate flow set point and delta voltage.) **The orientation of the probe is important to minimize the time to respond to a minimum flow rate.** If the probe head is turned after adjustment, the unit will not respond correctly. Adjustment could be problematic due to the minimum torque required to the probe head and its orientation. The switch should never be installed near a bend in the pipe.

Adjust potentiometer (R18 on drawing p.7) on circuit board until green LED changes state as follows, at flow or at level:

- If LED is on - turn potentiometer counterclockwise
- If LED is off - turn potentiometer clockwise

Adjust the pot where the green LED is just on, this is the set-point. A flow rate greater than the minimum will keep the LED on and the relay energized. A flow rate less than the minimum will turn off the LED and de-energized the relay. In State B, the relay can be made to work so the LED is off above a flow rate. The hysteresis is about 10 mV. Moving JP3 to (Relay State B) reverses the function of the relay and the LED. When the LED is on the relay is energized.

There is an inherent time delay that can not be compensated in a flow rate, interface or temperature application. The larger the difference in flow rates (minimum and maximum) the longer it will take the switch to respond. If a quicker response time is needed, the TQ version may be the solution. For small flow rates, the IX or IM (in line unit) would be the option. The delta voltage will decrease. With the dual switch point (top board) the delta voltage can be monitored and/or plotted to determine flow rate (inverse relationship and non-linear). The voltage output can not be used with temperature.

This switch can be configured to detect the interface between any two of the following mediums: granular solids (sand) and liquid (oil), foam and liquids, hydrocarbons (oil) and aqueous solutions (water), or whenever there is a unique separation of product/s with reference to its thermal conductivity. The unit would likely be mounted horizontally (or vertically with an extended probe) and the insertion level of the switch would be the level of the interface. The board setting can be adjusted so the LED is ON or OFF (JP3/JP11 setting) when the interface is detected. Consult factory for options and settings in this application.

7.0 INTERFACE DETECTION

This switch can be configured to detect the interface between any two of the following mediums: granular solids (sand) and liquid (oil), foam and liquids, hydrocarbons (oil) and aqueous solutions (water), or whenever there is a unique separation of products with reference to thermal conductivity. The unit would likely be mounted horizontally (or vertically with an extended probe) and the insertion level of the switch would be at the level of the interface. The board setting can be adjusted so the LED is ON or OFF (JP3/JP11) when the interface is detected.

1. Determine Normal Process Condition
2. Decide whether relay is energized or de-energized at normal conditions
3. Determine if T.C. (Thermal Conductivity) is high or low at normal conditions. Measure change in voltage (P2 pins 1,3) - higher voltage is lower T.C.
4. Based on above data and choices, See section 3.1 or 3.2.

8.0 TEMPERATURE SWITCH OPTION

In the temperature switch configuration, the heater can be disabled and the active RTD is not used. The reference RTD is used to measure the temperature of the process medium. The resistance of the reference RTD is directly proportional to temperature. The unit is shipped with the default settings unless otherwise stated on the order. A temperature set point can be verified or changed by placing a resistance decade box across pins 1 & 2 of connector P2. Pin 1 is located closest to the edge of the board. Once the desired set point temperature has been decided, the resistance of the decade box can be used to set the point where the relay energizes (LED on):

TABLE 1: OHMS / Deg. F for silicone temperature sensor - Standard

Resistance calculation = $[(0.0053(\text{temp in degrees F})^2) + 3.4187(\text{temp in degrees F}) + 704.99]$ ohms.

TEMP F	0	+5	+10	+15	+20	+25	+30	+35	+40	+45
-50	547	562	577	592	607	623	639	655	671	688
0	705	722	740	757	775	794	812	831	850	870
50	889	909	929	950	970	991	1012	1034	1056	1078
100	1100	1122	1145	1168	1192	1215	1239	1263	1287	1312
150	1337	1362	1388	1413	1439	1466	1492	1519	1546	1573
200	1601	1629	1657	1685	1714	1743	1772	1801	1831	1861
250	1891	1921	1952	1983	2014	2046	2078	2110	2142	2175
300	2208	2241	2274	2308	2342	2376	2410	2445	2480	2515
350	2551	2587	2623	2659	2695	2732	2769	2807	2844	2882

TABLE 2: OHMS / Deg. F - HIGH TEMP OPTION (/H1 or /H2): (Platinum RTD)

Resistance calculation = $[(-0.0002(\text{temp in degrees F})^2) + 2.1288(\text{temp in degrees F}) + 932.05]$ ohms.

TEMP F	0	+10	+20	+30	+40	+50	+60	+70	+80	+90
-300	275.4	297.9	320.3	342.7	365	387.4	409.6	431.8	450	476.2
-200	498.3	520.4	542.4	564.4	586.3	608.2	630.1	651.9	673.7	695.5
-100	717.2	738.8	760.5	782.1	803.6	825.1	846.6	868.0	889.4	910.7
0	932.1	953.3	974.5	995.7	1016.9	1038.0	1059.1	1080.1	1101.1	1122.0
100	1142.9	1163.8	1184.6	1205.4	1226.2	1246.9	1267.5	1288.2	1308.8	1329.3
200	1349.8	1370.3	1390.7	1411.1	1431.4	1451.8	1472.0	1492.2	1512.4	1532.6
300	1552.7	1572.8	1592.8	1612.8	1632.7	1652.6	1672.5	1692.3	1712.1	1731.9
400	1751.6	1771.2	1790.9	1810.5	1830.0	1849.5	1869.0	1888.4	1907.8	1927.1
500	1946.5	1965.7	1984.9	2004.1	2023.3	2042.4	2061.5	2080.5	2099.5	2118.4
600	2137.3	2156.2	2175.0	2193.8	2212.6	2231.3	2249.9	2268.6	2287.2	2305.7
700	2324.2	2342.7	2361.1	2379.5	2397.8	2416.2	2434.4	2452.6	2470.8	2489.0
800	2507.1	2525.2	2543.2	2561.2	2579.1	2597.0	2614.9	2632.7	2650.5	2668.3
900	2686.0	2703.6	2721.3	2738.9	2756.4	2773.9	2791.4	2808.8	2826.2	2843.5

Example 1: At (-20 F) (Standard RTD) the resistance is **639** ohms (see table1)

Example 2: Using platinum RTD, the resistance at -20 °F is calculated as follows:

Set Point Resistance = $(0.0002)(-20)^2 + 2.1288(-20) + 932.05 = 889.6$ ohms (Table 2 = 889.4 ohms)

With the resistance decade box connection across pins 1 & 2, adjust R18 until the LED just turns off. Decreasing the resistance of the decade box now will cause a drop in temperature and resistance, and the relay to energize and the LED to turn on.

State A is the default configuration for the relay from the factory. Other jumpers must be move to set the switch for temperature operation. The relay is de-energized (LED off) until the temperature drop below the set point. If it is desired that the relay energize when the temperature rises above the set point then configure JP3 for State B.

9.0 TROUBLESHOOTING

9.1 Voltage / Resistance Measurements and Jumper Settings (Main Board)

Check JP3 (Main board – bottom board only)

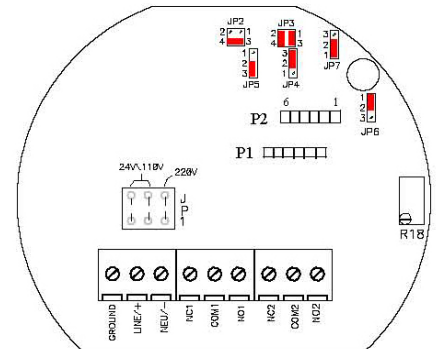
Jumpers set on 2-4, 1-3 (Default setting) (jumpers set vertically) relay to energized (LED ON) below set-point.

- Jumper setting 1-2, 3-4 (jumpers set horizontally) relay to energize (LED ON) above set point

9.2 Procedure for measuring voltage to the sensor using DVM (with power applied)

P2 Sensor Plug – (Pin 1 next to Q3 and toward edge of board)

- Pins 1-2: 1.xx volt DC (Pin 1 – Green or Yellow Wire; Ref Sensor)
- Pins 1-4: 7.xx volts DC
- Pins 2-4: 6 volts DC (Pin 4 -Red Wire; Negative side of PS)
- Pins 3-2: 1.xx volt DC (Pin 2 -Black Wire; Common to RTD)
- Pins 3-4: 7.xx volts DC (Pin 3 – Yellow Wire; Active Sensor)
- Pins 5-4: 17 volts DC on the TX only (Pin 5 – Red Wire)
18.5 volts DC on the TS
- Pins 1-3: DELTA VOLTAGE = (active sensor vs. reference sensor)
Air - TX (HO Model) = 350mV, (H1 & H2 Model) = 141mV;
TS Model = 460mV
Water - TX (HO Model) = 30mV, (H1 & H2 Model) = 10mV,
TS Model = 90mV



9.2.1 With power disconnected measure resistance of Heater and Sensors

P2 Sensor Plug (disconnected) – Female Connector (Pin 2 – Black Wire, Common to RTD)

- Pins 4-5: 172 ohms on the TX only (Red Wires)
470 ohms on the TS (Red Wires)
- Pins 1-2: 1K ohm @ ambient temperature (RTD Reference Sensor) (Green & Black)
- Pins 3-2: 1K ohm @ ambient temperature (RTD Active Sensor) (Yellow & Black)

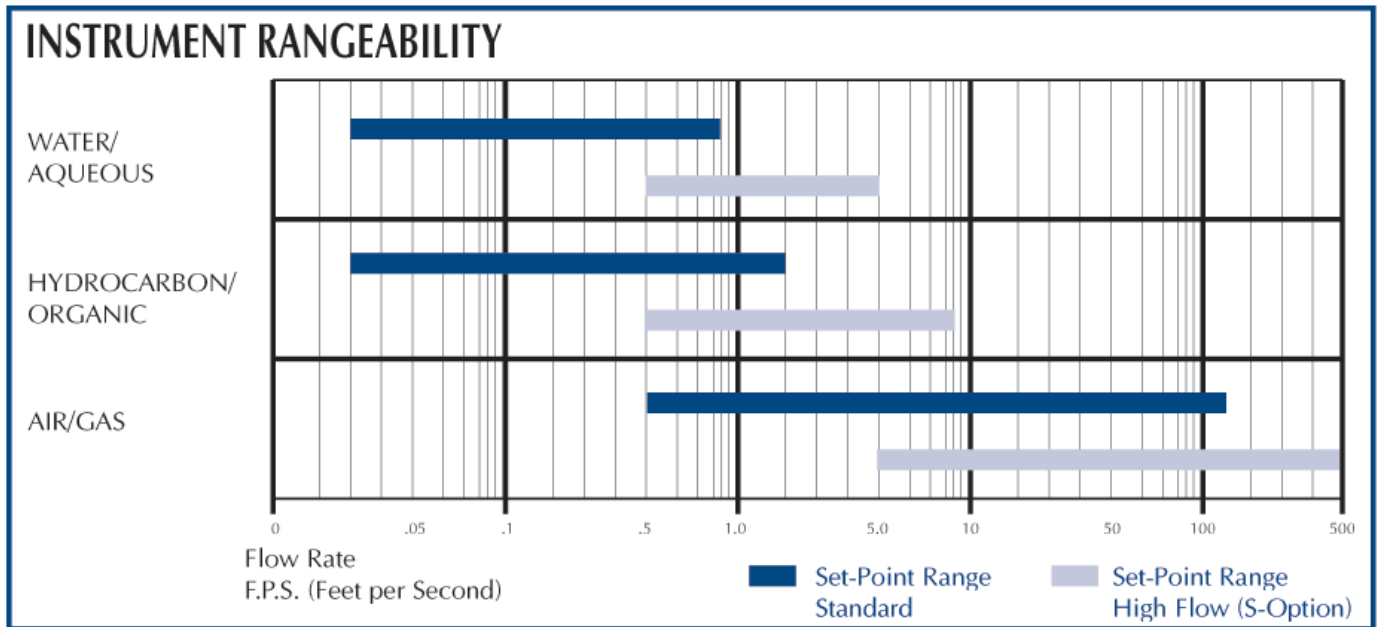
If the voltage measurements are incorrect then suspect board failure. If resistance measurements are incorrect suspect probe failure. Please call ABB Service Department for a replacement board or probe. If the voltage and resistance measurements are correct suspect incorrect setup or not allowing enough time for unit to switch. The switch has an inherent time delay.

OPTIONAL DUAL POINT CIRCUIT BOARD (TOP BOARD)

If the bottom board and sensor measurements are correct and the top board LED goes on and off when the unit is immersed in water, then the set-point is not properly adjusted for the process.

10.0 APPENDIX A Instrument Rangeability

10.1 TX Series



11.0 APPENDIX B - Conversion Table

CONVERSION TABLE

VOLUMETRIC (G.P.M. OR C.F.M.) TO VELOCITY (F.P.S.)

LINE SIZE	1/8"	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"
Liquid Multiplier	5.65	3.08	1.68	0.5	0.602	0.371	0.215	0.158
Gas Multiplier	42.19	23.06	12.57	0.5	4.5	2.776	1.61	1.18

LINE SIZE	2"	2-1/2"	3"	3-1/2"	4"	5"	6"	8"
Liquid Multiplier	0.0956	0.067	0.0434	0.0325	0.0252	0.016	0.0111	0.006
Gas Multiplier	0.7161	0.519	0.3248	0.2427	0.1884	0.12	0.083	0.048

LINE SIZE	10"	12"	14"	16"	18"	20"	24"	
Liquid Multiplier	0.00407	0.00287	0.00237	0.001815	0.001434	0.001154	0.000798	
Gas Multiplier	0.0304	0.0209	0.0177	0.0136	0.0107	0.00863	0.00597	

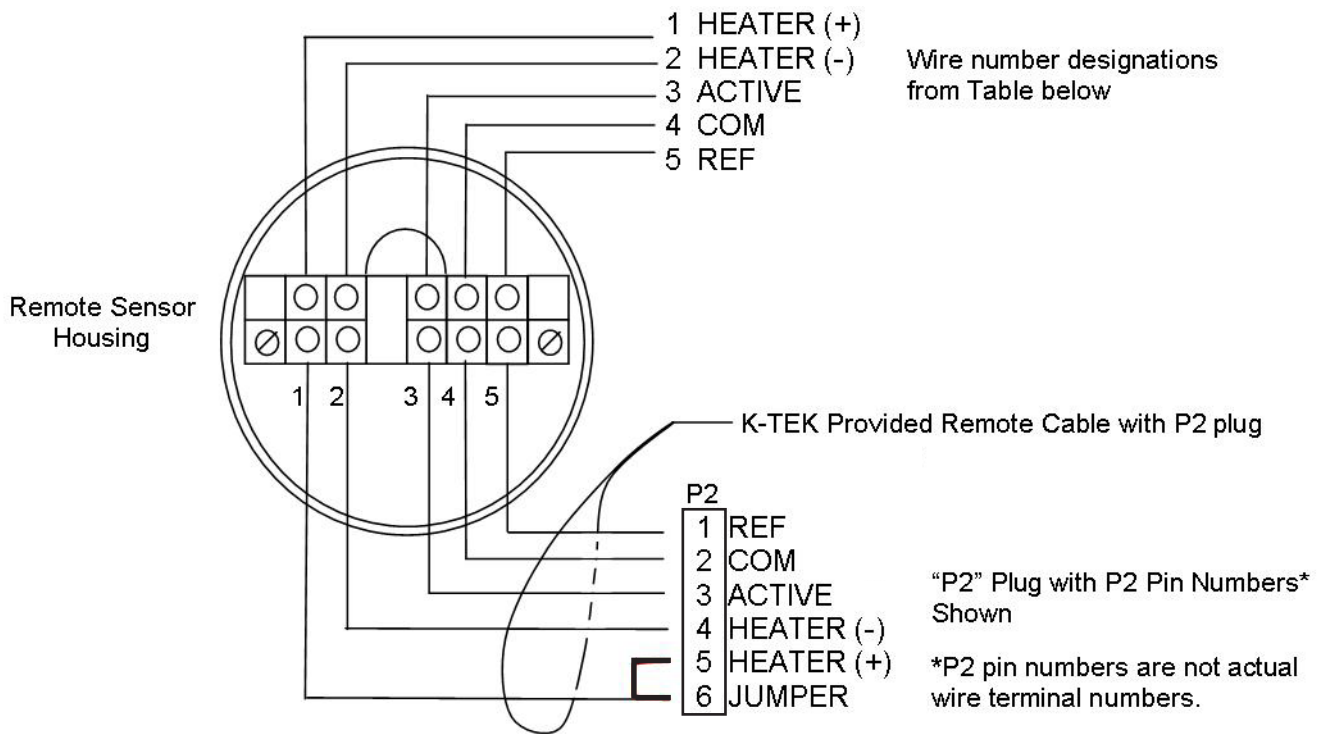
Examples:

Example 1: 100 CFM in 4" line = $100 \times .1884 = 18.84$ F.P.S.

Example 2: 10 G.P.M. in 3" line = $10 \times .0434 = .434$ F.P.S.

Test Conditions: 60°F, 14.7PSIA, SCH. 40 Line

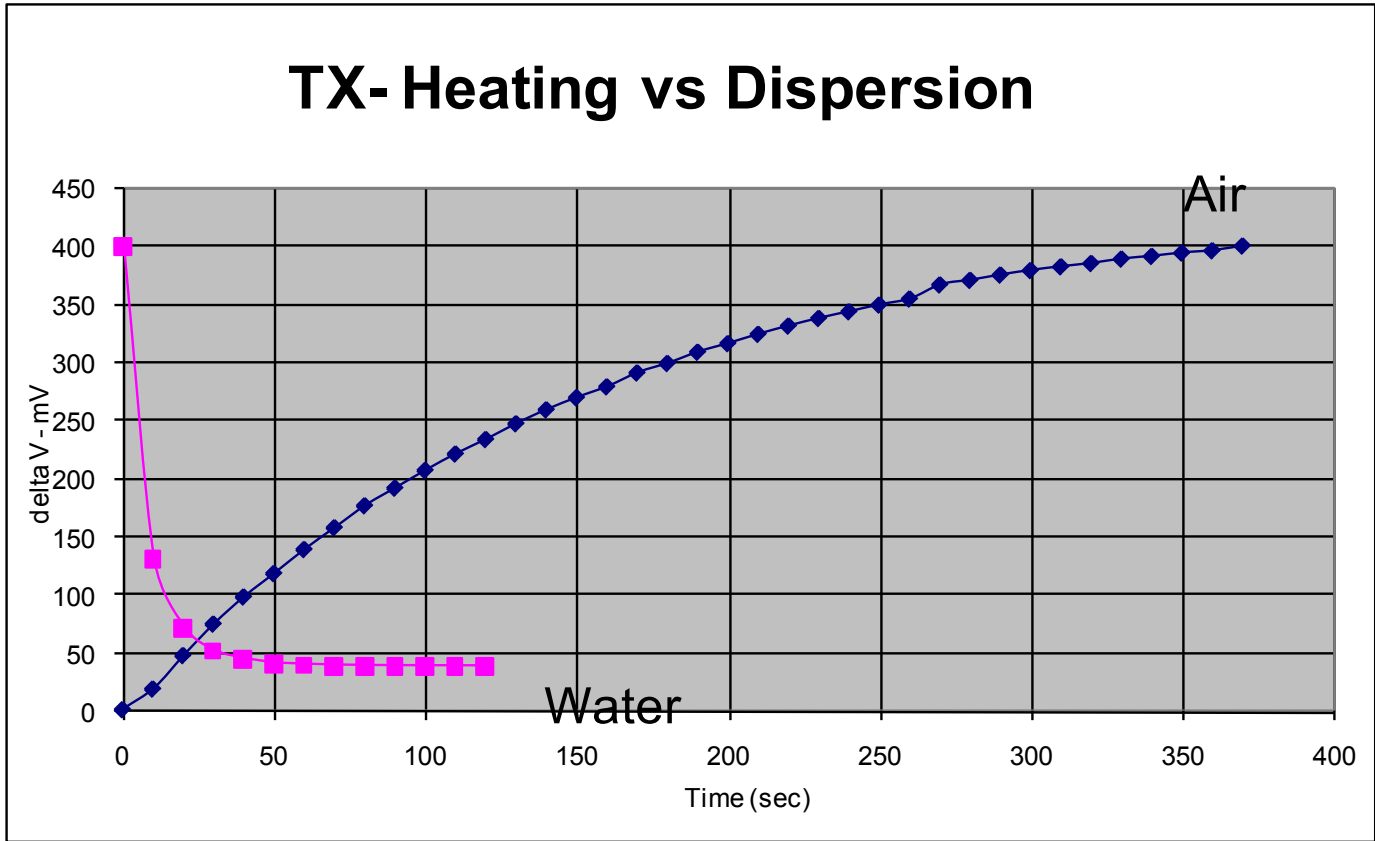
12.0 APPENDIX C - Remote Mounting



	TERMINAL NUMBER					
	1	2		3	4	5
	HTR	HTR		ACT	COM	REF
Standard Temperature Range	RED	RED		YEL	BLK	GRN
Special Temperature Range, Option H1 -320°F - +500°F	RED	RED		WHT	BLK	GRN
SEE WIRE MARKERS						

Special Temperature Range, Option H2 -100°F - +900°F	TERMINAL NUMBER					
	1	2		3	4	5
	HTR	HTR		ACT	COM	REF
Integral Electronics	RED	RED		YEL	BLK	GRN
Remote Electronics Type J Cable (PVC)	BLUE	WHITE + DRAIN		WHT	BLK	GRN
Remote Electronics Type F Cable (Teflon® (registered trademark of DuPont))	RED OF PAIR 1 RED FOIL	BLACK OF PAIR 1 + DRAIN OF PAIR 3		WHITE OF PAIR 2 GRN FOIL	BLACKS OF PAIRS 2 & 3	GREEN OF PAIR 3 BLUE FOIL

13.0 APPENDIX D - TX Heating vs. Dispersion



Above is a graph of the model TX probe. The longer line depicts the time response of the RTD by internal heating. The shorter line depicts the delta voltage or delta temperature or delta resistance decreasing when immersed in water.

14.0 WARRANTY STATEMENT

5 YEAR WARRANTY FOR:

KM26 Magnetic Liquid Level Gauges; MagWave Dual Chamber System; LS Series Mechanical Level Switches (LS500, LS550, LS600, LS700, LS800 & LS900); EC External Chambers, STW Stilling Wells and ST95 Seal Pots.

3 YEAR WARRANTY FOR:

KCAP300 & KCAP400 capacitance switches.

2 YEAR WARRANTY FOR:

AT100, AT100S and AT200 series transmitters; RS80 and RS85 liquid vibrating fork switches; RLT100 and RLT200 reed switch level transmitters; TX, TS, TQ, IX and IM thermal dispersion switches; IR10 and PP10 External Relays; MT2000, MT5000, MT5100 and MT5200 radar level transmitters; RI100 Repeat Indicators; KP paddle switches; A02, A75 & A77 RF capacitance level switches and A38 RF capacitance level transmitters; Buoyancy Level Switches (MS50, MS10, MS8D & MS8F); Magnetic Level Switches (MS30, MS40, MS41, PS35 & PS45).

1 YEAR WARRANTY FOR:

KM50 gauging device; AT500 and AT600 series transmitters; LaserMeter and SureShot series laser transmitters; LPM200 digital indicator; DPM100 digital indicators; APM100 analog indicators; KVIEW series digital indicators and controllers; SF50 and SF60 vibrating fork switches, KB Electro-Mechanical Continuous Measuring Devices, KSONIK ultrasonic level switches, transmitters & transducers, ChuteMaster Microwave Transmitter / Receiver and TiltMaster Switches.

SPECIAL WARRANTY CONSIDERATIONS:

ABB does not honor OEM warranties for items not manufactured by ABB (i.e. Palm Pilots). These claims should be handled directly with the OEM.

ABB will repair or replace, at ABB's election, defective items which are returned to ABB by the original purchaser within the period specified above from the shipment date of the item and which is found, upon examination by ABB, to its satisfaction, to contain defects in materials or workmanship which arose only under normal use and service and which were not the result of either alterations, misuse, abuse, improper or inadequate adjustments, applications or servicing of the product. ABB's warranty does not include onsite repair or services. Field service rates can be supplied on request.

If a product is believed to be defective, the original purchaser shall notify ABB and request a Returned Material Authorization before returning the material to ABB, with transportation prepaid by the purchaser. (To expedite all returns/repairs from outside of the United States, consult ABB's customer service team (service@ktekcorp.com) to determine an optimal solution for shipping method and turnaround time.) The product, with repaired or replaced parts, shall be returned to the purchaser at any point in the world with transportation prepaid by ABB for best-way transportation only. ABB is not responsible for expedited shipping charges. If the product is shipped to ABB freight collect, then it will be returned to the customer freight collect.

If inspection by ABB does not disclose any defects in material or workmanship, ABB's normal charges for repair and shipment shall apply (minimum 250.00 USD).

The materials of construction for all ABB products are clearly specified and it is the responsibility of the purchaser to determine the compatibility of the materials for the application.

THE FOREGOING WARRANTY IS ABB'S SOLE WARRANTY AND ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE, ARE EXCLUDED AND NEGATED TO THE MAXIMUM EXTENT PERMITTED BY LAW. NO PERSON OR REPRESENTATIVE IS AUTHORIZED TO EXTEND ANY OTHER WARRANTY OR CREATE FOR ABB ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ABB'S PRODUCTS. THE REMEDIES SET FORTH IN THIS WARRANTY ARE EXCLUSIVE OF ALL OTHER REMEDIES AGAINST ABB. ABB SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR SPECIAL DAMAGES OF ANY KIND. ABB'S SOLE OBLIGATION SHALL BE TO REPAIR OR REPLACE PARTS (FOUND TO BE DEFECTIVE IN MATERIALS OR WORKMANSHIP) WHICH ARE RETURNED BY THE PURCHASER TO ABB.

15.0 CUSTOMER SUPPORT

ABB (USA, Canada, International)

18321 Swamp Road
Prairieville, LA 70769 USA
Tel: (1) 225.673.6100
Fax: (1) 225.673.2525
Email: service@ktekcorp.com
Website: www.abb.com/level

15.1 ABB RMA Form



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Email: service@ktekcorp.com
Toll Free: (800) 735-5835

***** IMPORTANT CUSTOMER NOTICE: PLEASE READ PRIOR TO RETURNING PRODUCTS TO ABB*****

Be sure to include the Return Authorization (RA) number on the shipping label or package to the attention: Customer Service. A copy of this document should also be included with the packing list. ABB wants to maintain a safe work environment for its employees. In the event, the returned product or material has been in contact with a potentially hazardous chemical, per federal regulations, the customer must provide evidence of decontamination and the related chemical composition and characteristics. In order to expedite your return, please include the applicable Material Safety Data Sheets (MSDS) and decontamination tags by affixing these documents in close proximity to the shipment label for identification purposes. (January 18, 2006)

Return Authorization Form

Customer:	Date:
Contact Name:	Product:
Contact Email:	Serial No:
Contact Phone:	Job No:
Contact Fax:	Service Rep:

Completed by Customer

Reason:

Problem Found: None

Action None

Requested:

Is expedited return shipping requested?

☐ Yes

If yes, please provide a purchase order or your shipper's account number (ex FedEx or UPS).

ABB pays return transport via standard ground shipments only.

Account #:

If purchase order is issued, a copy of purchase order must be included with return authorization documentation.

Is ABB authorized to repair items determined to be non-warranty?

☐ Yes

If yes, a copy of purchase order must be included with return authorization documentation.

Customer
PO#:

Date:

Has product been in contact with any potentially hazardous chemical?

☐ Yes

If yes, documentation product and forward MSDS to ABB. "ATTN: Customer Service"

Return Repaired Product to Address

Shipping Address:

Billing Address:

Ship Via:

Contact us

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Service