OPERATION AND MAINTENANCE MANUAL

microtuf®

MODEL FS4200 SERIES – MASS FLOW SWITCH

MODEL LS3200 SERIES – POINT LEVEL SWITCH

DOCUMENT 3242-OM-07

REVISION 7

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MODEL NO._____ SERIAL NO._____

DATE OF SHIPMENT _____ INSTALLATION DATE_____

CUSTOMER TAG NO._____ PO NO._____

OPTIONS_____

_____

SPECIAL NOTES_____

_____

BEFORE STARTING

DELTA M appreciates your choosing our product for your liquid level or liquid/gas flow switching application. We are committed to providing reliable, quality instrumentation to our customers.

To ensure the maximum and intended benefit of this instrument, we encourage you to read this brief operation and maintenance manual in its entirety prior to unpacking and installing the unit.

The following precautions should be noted immediately:

- **WHEN INSTALLING YOUR DELTA M SWITCH INTO A PIPE OR VESSEL USE A 1 1/8 INCH (28.575mm) OPEN-END WRENCH TO TIGHTEN AT THE HEX FLATS OF THE MNPT OF A STANDARD SWITCH. (IF YOU HAVE A NON-STANDARD SWITCH AN ALTERNATE SIZE WRENCH MAY BE REQUIRED). DO NOT USE THE INSTRUMENT HEAD TO TIGHTEN THE SWITCH TO THE MOUNTING PORT. ROTATION OF THE INSTRUMENT HEAD WITH RESPECT TO THE SENSOR BODY CAN CAUSE INTERNAL WIRING DAMAGE (SEE FIGURES 1).**

- **THE SWITCH BODY MUST BE ORIENTED TO HAVE THE TWIN SENSORS PARALLEL TO THE LEVEL BEING DETECTED WHEN THE SENSOR IS INSTALLED HORIZONTALLY FOR POINT LEVEL APPLICATIONS. LIKEWISE, FOR FLOW APPLICATIONS, THE SWITCH BODY MUST BE ORIENTED TO HAVE THE TWIN SENSORS PERPENDICULAR TO THE FLOW BEING DETECTED. DUE TO THE PIPE THREAD MOUNTING, IT MAY BE NECESSARY TO MAKE A TRIAL FIT, ADD OR REMOVE TEFLON TAPE OR OTHER PIPE THREAD SEALANT, AND REINSTALL TO ACHIEVE A SATISFACTORY SEAL WITH THE SENSORS PROPERLY ORIENTED. FOR VERTICAL INSTALLATION OF SENSORS FOR POINT LEVEL DETECTION THE ORIENTATION MAKES NO DIFFERENCE. PROPER ORIENTATION IS MARKED ON THE SWITCH BODY FOR REFERENCE (SEE FIGURE 5).**

- **A GROUND WIRE MUST BE ATTACHED TO THE GROUND SCREW LOCATED INSIDE THE INSTRUMENT ENCLOSURE FOR PROPER OPERATION. FOR CENELEC/CE OPTION THE GROUND SCREW IS LOCATED OUTSIDE THE BODY OF THE INSTRUMENT ENCLOSURE (SEE FIGURE 6).**

- **BE SURE TO APPLY THE PROPER VOLTAGE AS CONFIGURED AT THE FACTORY. DO NOT APPLY 115 VAC TO 24 VDC VERSIONS OR 24 VDC TO 115 VAC VERSIONS. (LIKEWISE 230 VAC).**

- **FOR OPTIMUM OPERATION, CALIBRATION MUST BE ACCOMPLISHED AT ACTUAL PROCESS TEMPERATURE AND PRESSURE CONDITIONS IN GASES AND AT ACTUAL PROCESS TEMPERATURE CONDITIONS IN LIQUIDS.**

- **DO NOT SANDBLAST OR ABRASIVE CLEAN THE SENSING PROBES. THE SENSING PROBES COULD BE DAMAGED BY ABRASIVES.**

- **ALL DIMENSIONS GIVEN IN THIS MANUAL ARE IN INCHES (AND MILLIMETERS).**

If you have any questions prior to or during installation and calibration, please do not hesitate to call the factory for assistance. We want to ensure the very best possible installation and operational results for your benefit.

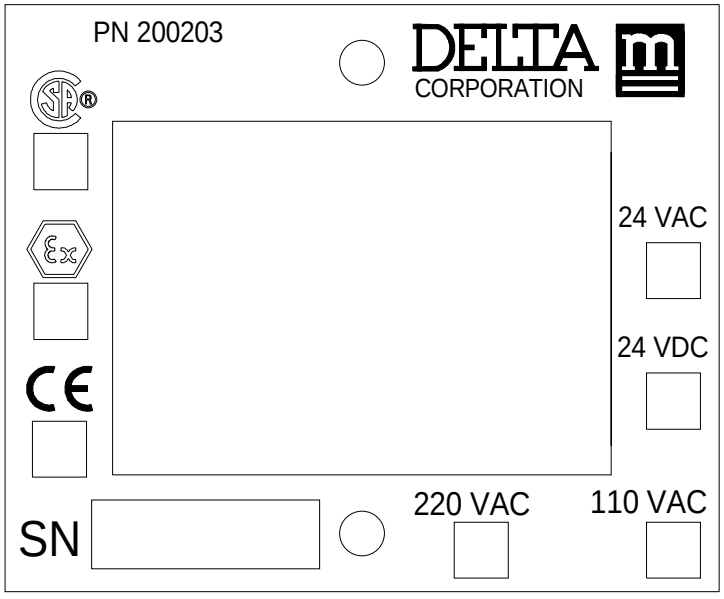
NOTICE

This manual covers the following model numbers:

microtuf® Series Models		FS4200	LS3200
Agency Approvals	Explosion-Proof rating	Mass Flow Switch	Point Level Switch
CENELEC European	EEx d IIB T4 (Killark Enclosure) EEx d IIC T4 (Akron Electric Enclosure) See Figure 1A and 1B	FS42CN	LS32CN
CSA Canadian Standards	T4A Class I, Group B,C,D Class II, Group E,F,G (Both Akron Electric and Killark)	FS42CS	LS32CS
Non-Approved	Non-Explosion Proof	FS42NX	LS32NX
Switch Kits (No Enclosures)	Not Rated	FS42SK	LS32SK
CE (Ref. Section 3.2.3 wiring)	EMC Directive: 89/336/EEC	Option – CE	Option -CE

SPECIAL NOTICE

The electronic assemblies contained in the microtuf® models are configured for specific voltages and have specific modifications to accommodate the various agency approvals. When ordering spare electronics, replacements, or exchanges in the field please ensure you identify the specific configuration you have by noting the boxes marked on the transformer configuration tag.



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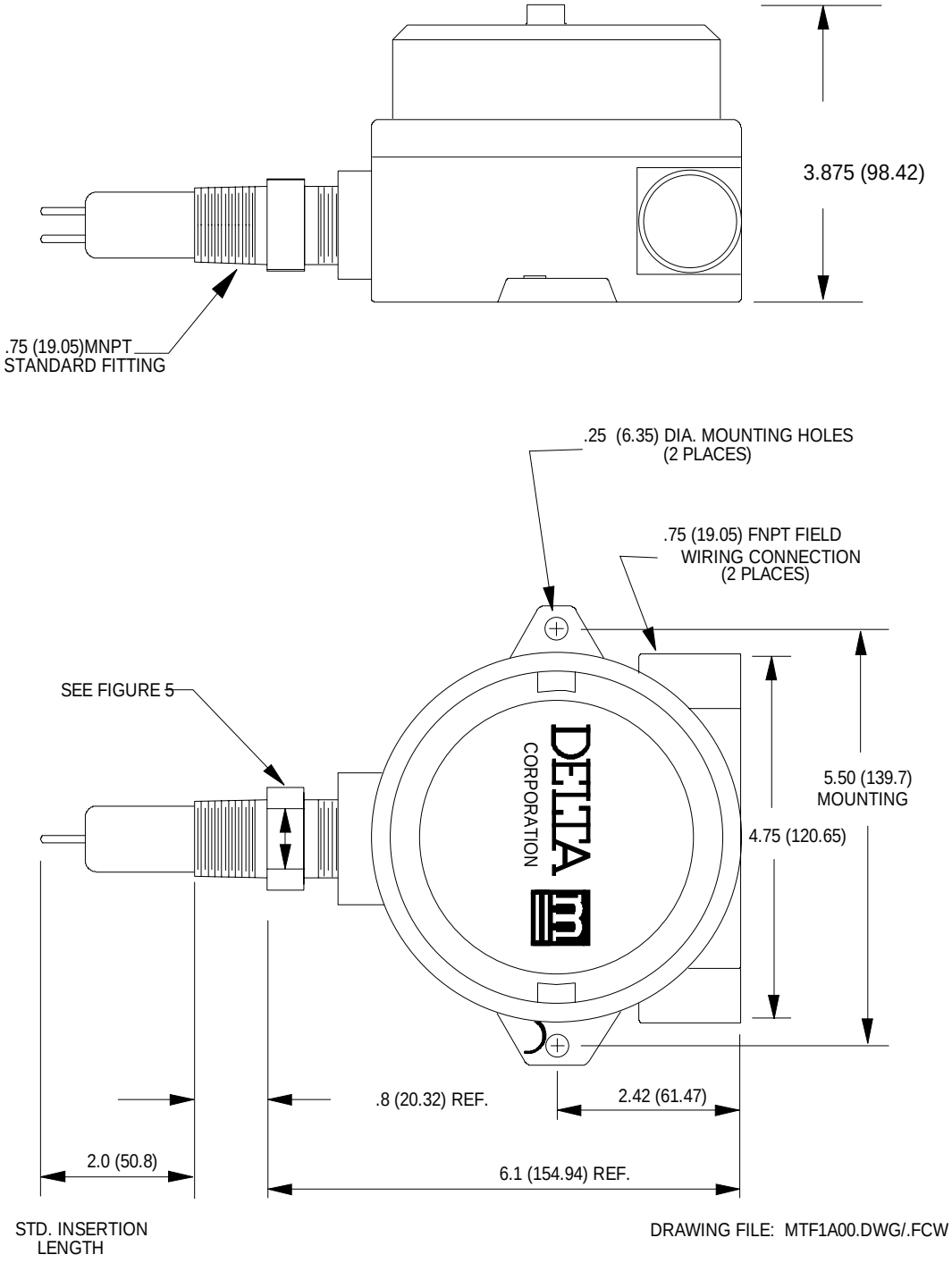
1.0 INTRODUCTION

The DELTA M microtuf® Switch is the state-of-the-art in gaseous and liquid flow switching or liquid level control. Flow or level detection is accomplished by using a high resolution **thermal differential** technique. The sensor wetted parts are of durable 316L series stainless steel, all welded construction with no moving parts. The switch is easy to install and adjust, giving reliable, low maintenance performance in the most demanding applications.

2.0 DESCRIPTION

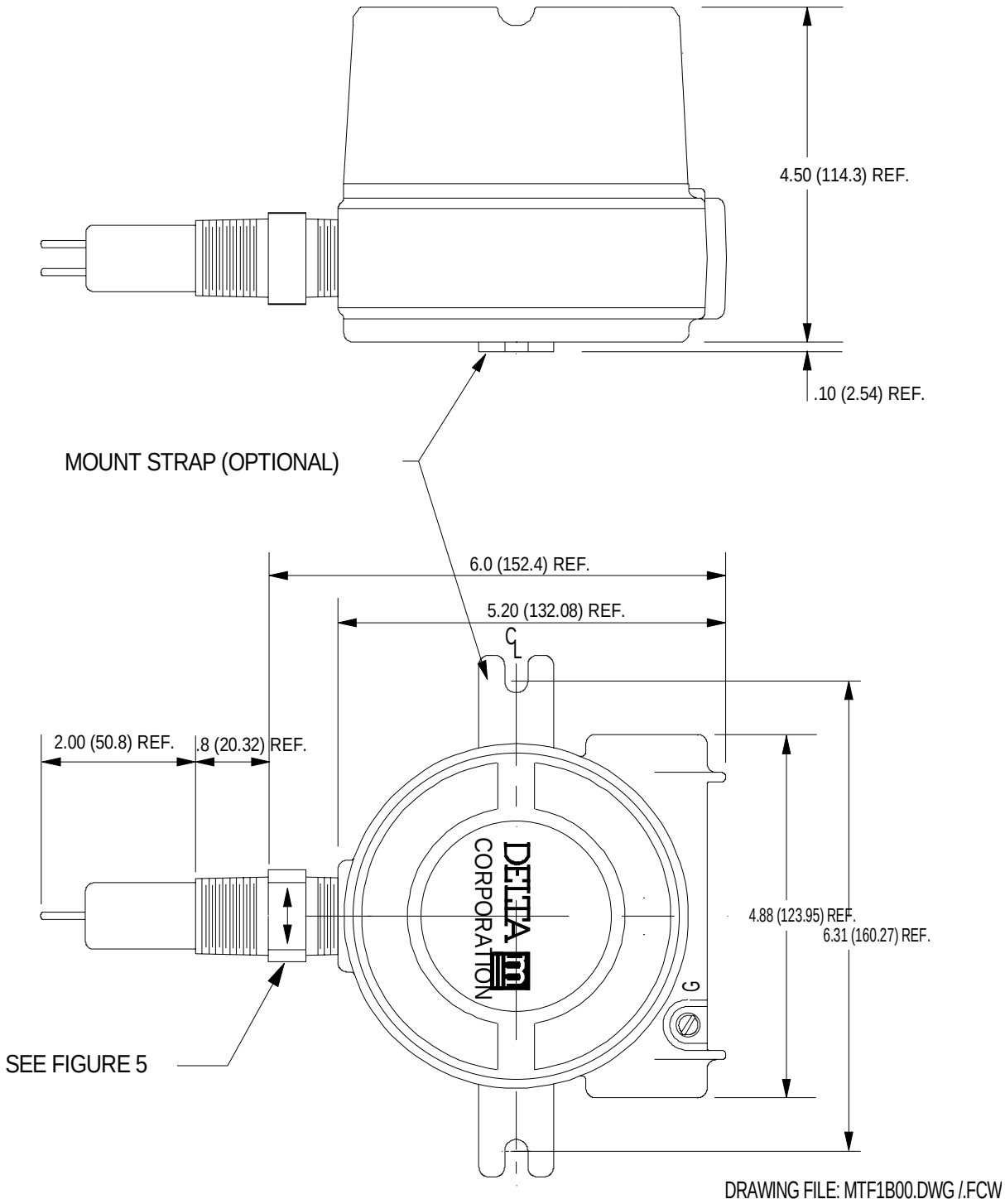
The microtuf® Switch uses a **thermal differential** technique to sense changes in the heat transfer characteristics of a media. Figures 1A and 1B show the outline of the microtuf® Switch. The sensor consists of a pair of matched, Resistance Temperature Detectors (RTD's) encased in twin 316L series stainless steel tubes. One RTD is self-heated using a constant DC current. The other RTD is unheated to provide an accurate process temperature reference. The **thermal differential** created between the heated and reference RTD pair is a function of the density and/or velocity of the media with which the sensor is in contact. Other physical properties may have a secondary effect as well. The differential is greatest at a no flow (or dry) condition and decreases as the rate of flow increases (or as a liquid quenches the sensor/wet condition).

The DELTA M Corporation sensor excitation method relies on constant current to the heated and reference sensors. Thus power to the heated sensor is not constant but changes linearly with temperature as the sensor resistance changes. Temperature compensation is accomplished by using the amplified reference sensor voltage which also changes linearly with temperature, as a dynamic reference. During calibration dry/no flow and wet/full flow conditions are impressed across the trip point potentiometer. Since this reference is not fixed but is set with respect to the reference sensor voltage, as temperature changes the trip point potentiometer voltage changes with temperature exactly the same as that of the heated sensor voltage with which it is being compared. Thus full temperature compensation is achieved with non constant power.



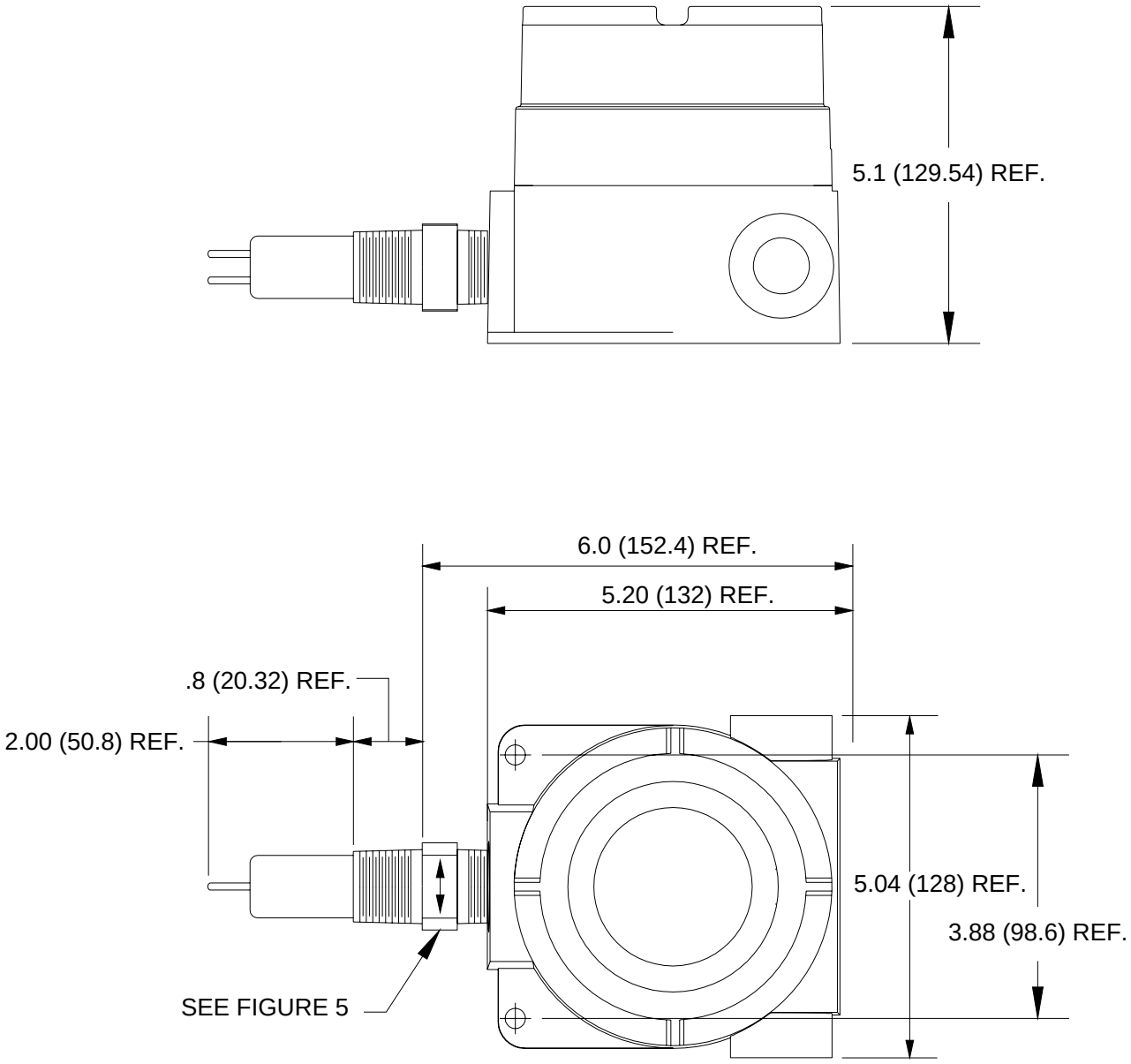
DIMENSIONS IN INCHES (MILLIMETERS)

FIGURE 1A LS3200/FS4200 microtuf® OUTLINE DIAGRAM STANDARD 2.0 INCH INSERTION (KILLARK ENCLOSURE – NEMA 4-EExd 11B, T4) (MTF1A00.DWG/.FCW)



DIMENSIONS IN INCHES (MILLIMETERS)

FIGURE 1B LS3200/FS4200 microtuf® OUTLINE DIAGRAM STANDARD 2.0 INCH INSERTION (AKRON ELECTRIC ENCLOSURE – NEMA 4X – EexdIIC, T4) (MTF1B00.DWG/.FCW)



DIMENSIONS IN INCHES (MILLIMETERS)

DRAWING FILE: CIXI.DWG

FIGURE 1C **LS3200/FS4200 microtuf® OUTLINE DIAGRAM STANDARD 2.0 INCH INSERTION (CIXI ENCLOSURE – NEMA 4X)(CIXI.DWG)**

2.1 Level Switching

The thermal differential created between the heated and reference unheated RTD pair is a function of the liquid or gas medium with which the sensor is in contact.

The point level measurement application uses the heat transfer differences between two media to detect liquid level. For example, air has a relatively poor heat transfer characteristic so the heated sensor will become relatively hot. If the sensor is then immersed in water, the relatively high heat transfer characteristics of water will cool the heated RTD surface causing a decrease in the signal output.

This same rational applies for any two media in contact with the sensor. Each medium will have its own characteristic heat transfer properties. As long as there is a reasonable difference in the heat transfer properties between the two media, the microtuf® can discriminate between them. Figure 2A shows the relative signal output of the microtuf® sensor to a range of different media. The maximum difference in output occurs between vacuum and liquid metal. However, a significant difference occurs between water and hydrocarbon liquids so the microtuf ® can be used to detect a water/hydrocarbon liquid-liquid interface. In general, the interface between any two media with differing heat transfer properties can be detected.

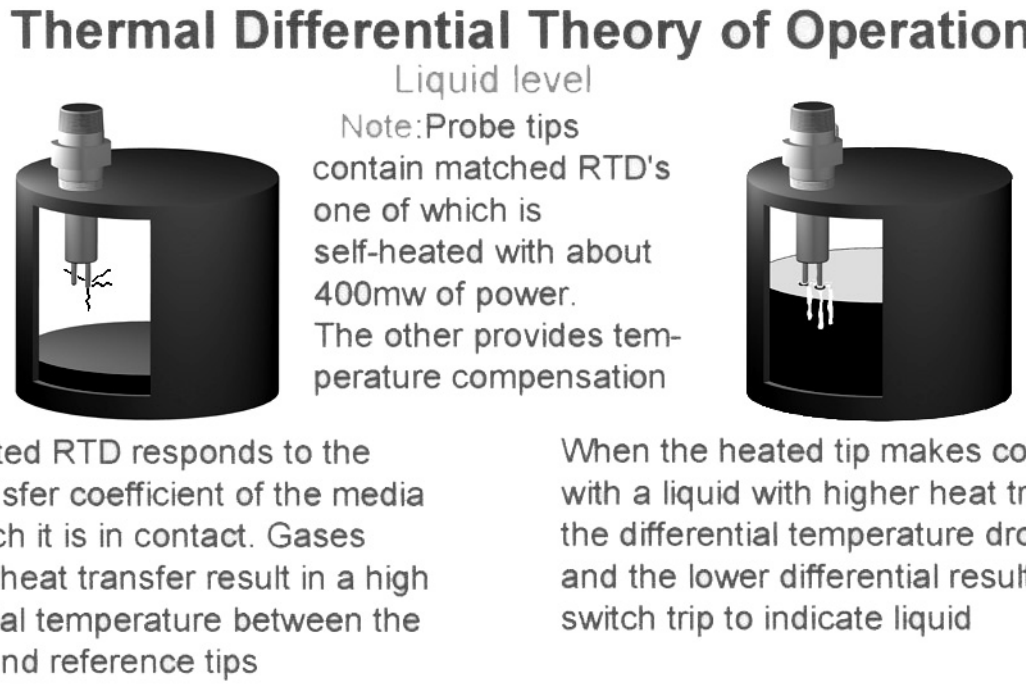
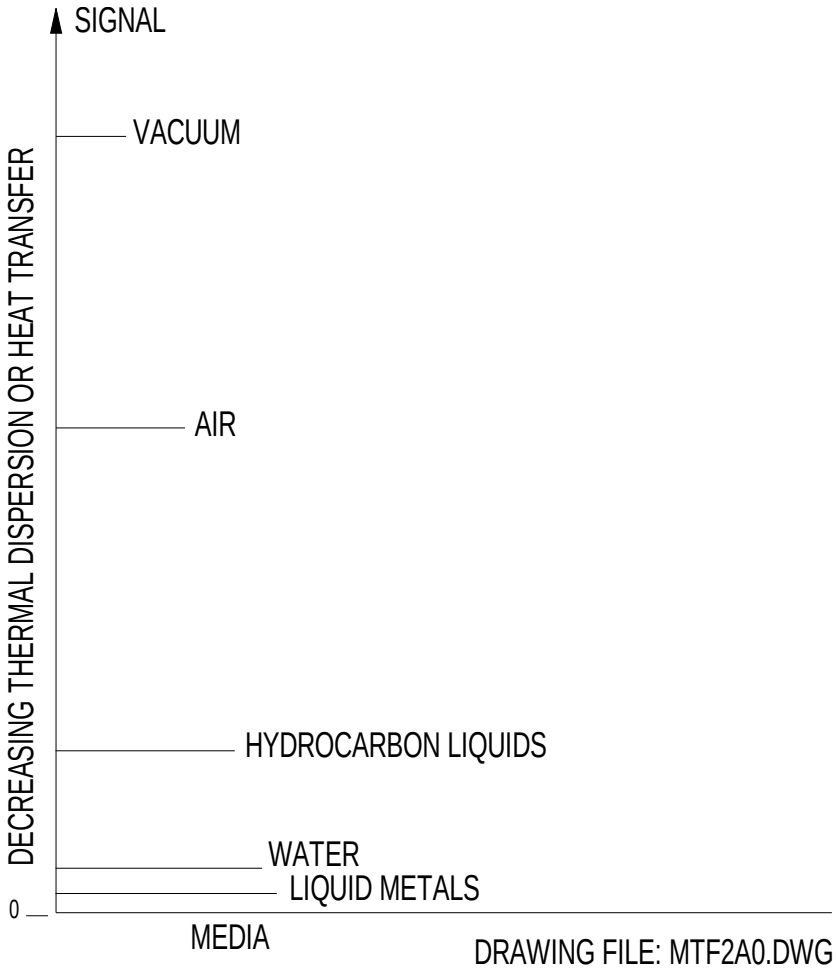


FIGURE 2A: RELATIVE CHANGE IN RESPONSE OF A HEATED RTD IMMERSED IN VARIOUS MEDIA

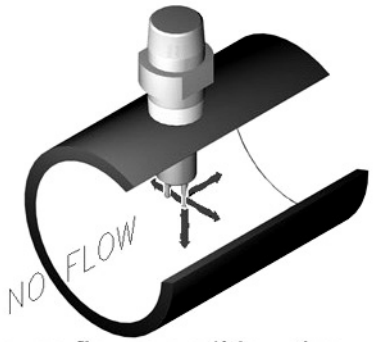


2.2 Flow Switching

Most mass flow monitoring techniques calculate mass indirectly by measuring volumetric flow such as gallons per minute or cubic cm per second, then either measure density separately or calculate it from temperature measurements of the fluid and, finally, combine density and volumetric flow to obtain mass flow. The DELTA M thermal-differential technique is one of two methods that directly measure the mass flow. For ease of comparison most flow applications are presented in terms of velocity which is independent of the flow cross sectional area (i.e. feet per second (FPS)). The true mass flow equivalent would be FPS multiplied by density but for simplicity FPS is used and density effects are ignored. This is normally not critical for flow switching applications.

When the sensor is inserted into a liquid or gas the heated RTD is strongly affected by the velocity of the medium. Flow past the heated RTD changes the heat transferred from the surface of the sensor. This cooling effect reduces the temperature of the sensor. The microtuf® compares this change to a preset flow trip point to switch the output. Figure 2B shows the model FS4200 signal change vs. flow rate for air, light hydrocarbon liquids, and water. The signal change vs velocity has the same general shape for all three media but the change is larger for air and the sensitive range is different for each. For air and most gaseous media the range is 0.1 to 500 feet per second (FPS). For most liquid media the

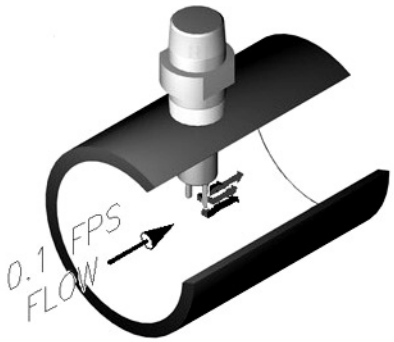
range is 0.01 to 5 FPS. Appendices in section 9.0 contain flow conversion information to facilitate conversion from various units and pipe dimensions into flow velocity in feet per second.



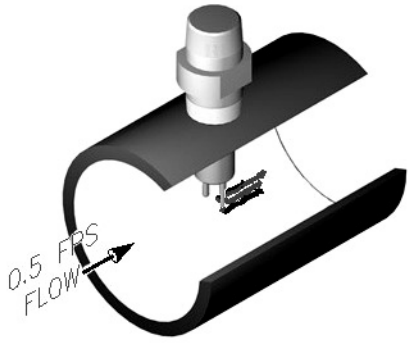
For a no flow condition the thermal differential between the two tips is high because of relatively low heat transfer.

Gas Or Liquid Flow

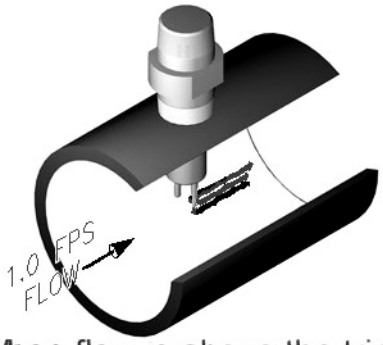
Note: The fluid velocity and heat absorption ability determine the differential between the tips. Their combination determines the measurable velocity. In water velocities from 0.01 to 5 FPS are measurable, whereas in air velocities of 0.1 to 500 FPS can be measured



Flow across the tips decreases the thermal differential because of the higher heat transfer of flowing fluids. This differential is compared with the trip point.



When the lower differential matches the customer select flow velocity trip point (set point) the switch relay and red LED are tripped.



When flow is above the trip point the differential is smaller than at the set point and the relay and Led remain tripped.

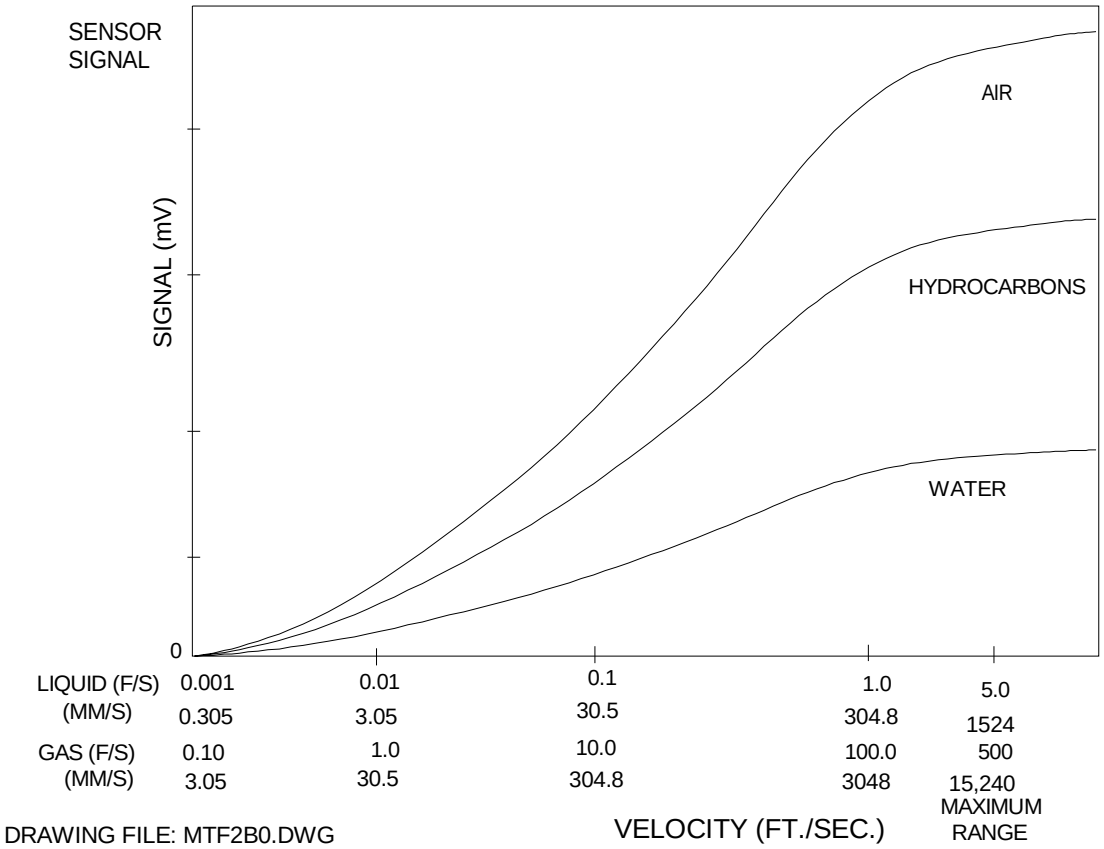
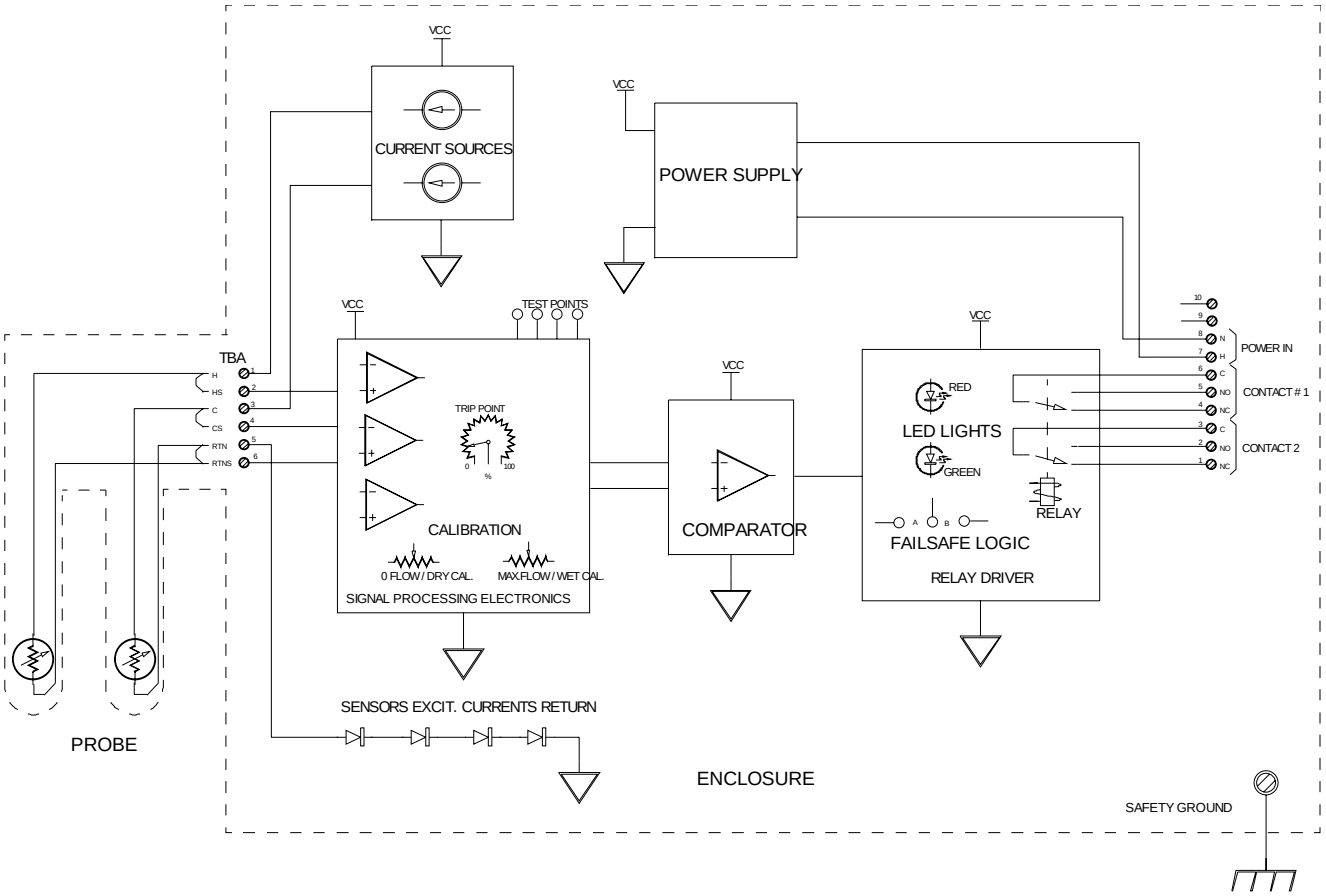


FIGURE 2B microtuf® MODEL FS4200 FLOW RESPONSE FOR THREE MEDIA

Figure 3.A shows a block diagram of the microtuf® switch.

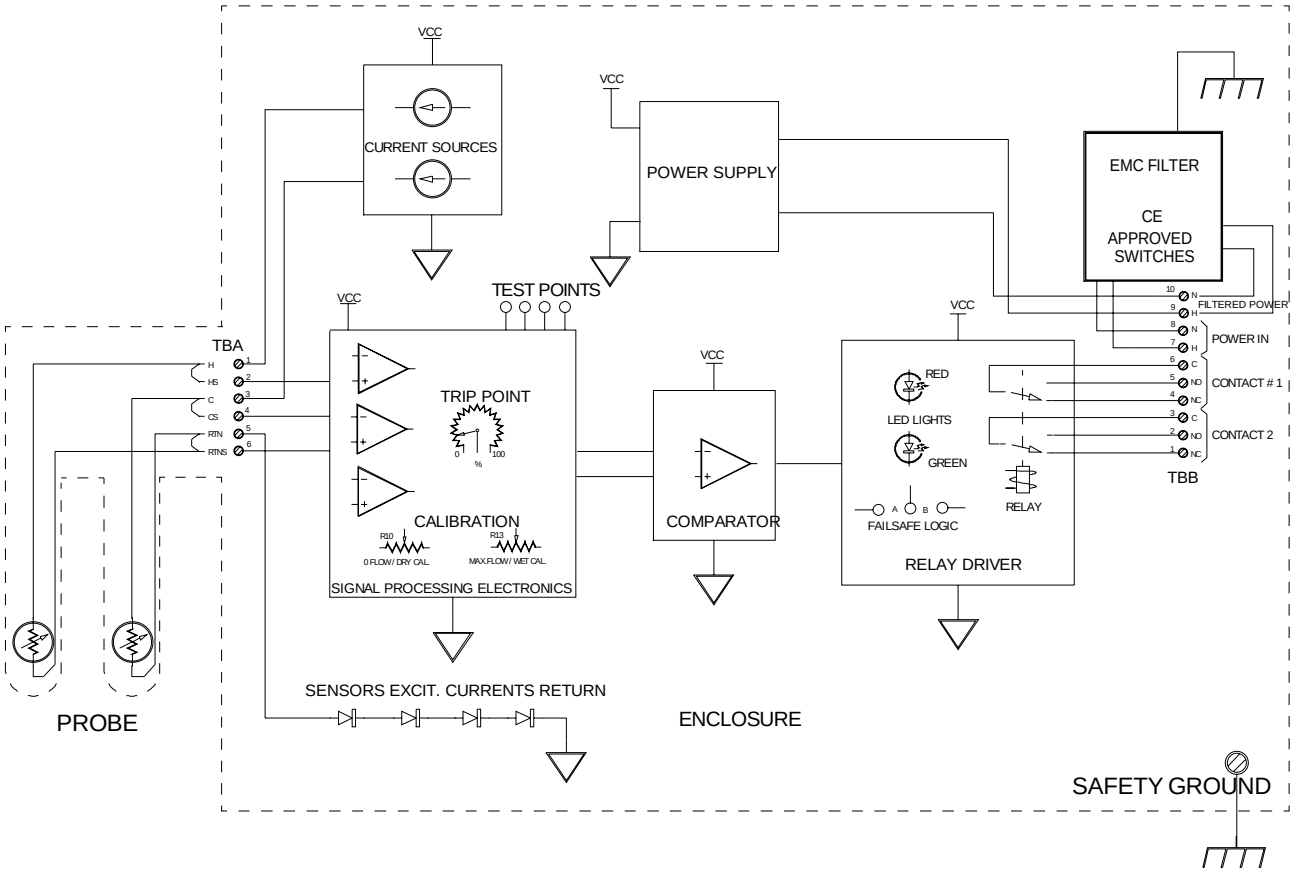
Once the switch is set to respond to the minimum and maximum flow rates (or wet vs. dry conditions), the trip point is set by adjusting the Trip Adjust Potentiometer. Solid state electronics transform the flow (or wetting) induced temperature differential into a voltage that is compared to a control voltage. Matching voltages cause actuation of a relay to indicate a change in state (flow vs. no-flow or dry vs. wet).



DRAWING FILE: MTF3A00.DWG/.FCW

FIGURE 3A: MICROTUF SERIES SWITCH BLOCK DIAGRAM
MODELS LS32CS/FS42CS, LS32CN/FS42CN, LS32NX/FS42NX, AND LS32SK/FS42SK
(MTF3A00.DWG/.FCW)

Figure 3B shows a block diagram of the microtuf® switch with the addition of an EMC filter required for the CE options (see section 7.0).



DRAWING FILE: MTF3B00.DWG

FIGURE 3B: MICROTUF MODELS **WITH THE CE OPTION** SWITCH BLOCK DIAGRAM (MTF3B00.DWG)

The instrument enclosure at the top of unit contains the microtuf® Switch electronics board which is removable to access the terminal block and facilitate field wiring (see Figure 4.0). For applications where the electronics must be located away from the sensors due to elevated process temperature, accessibility, etc., another instrument head containing the electronics is remotely located (See option RE-Remote Electronics section 3.2.2).

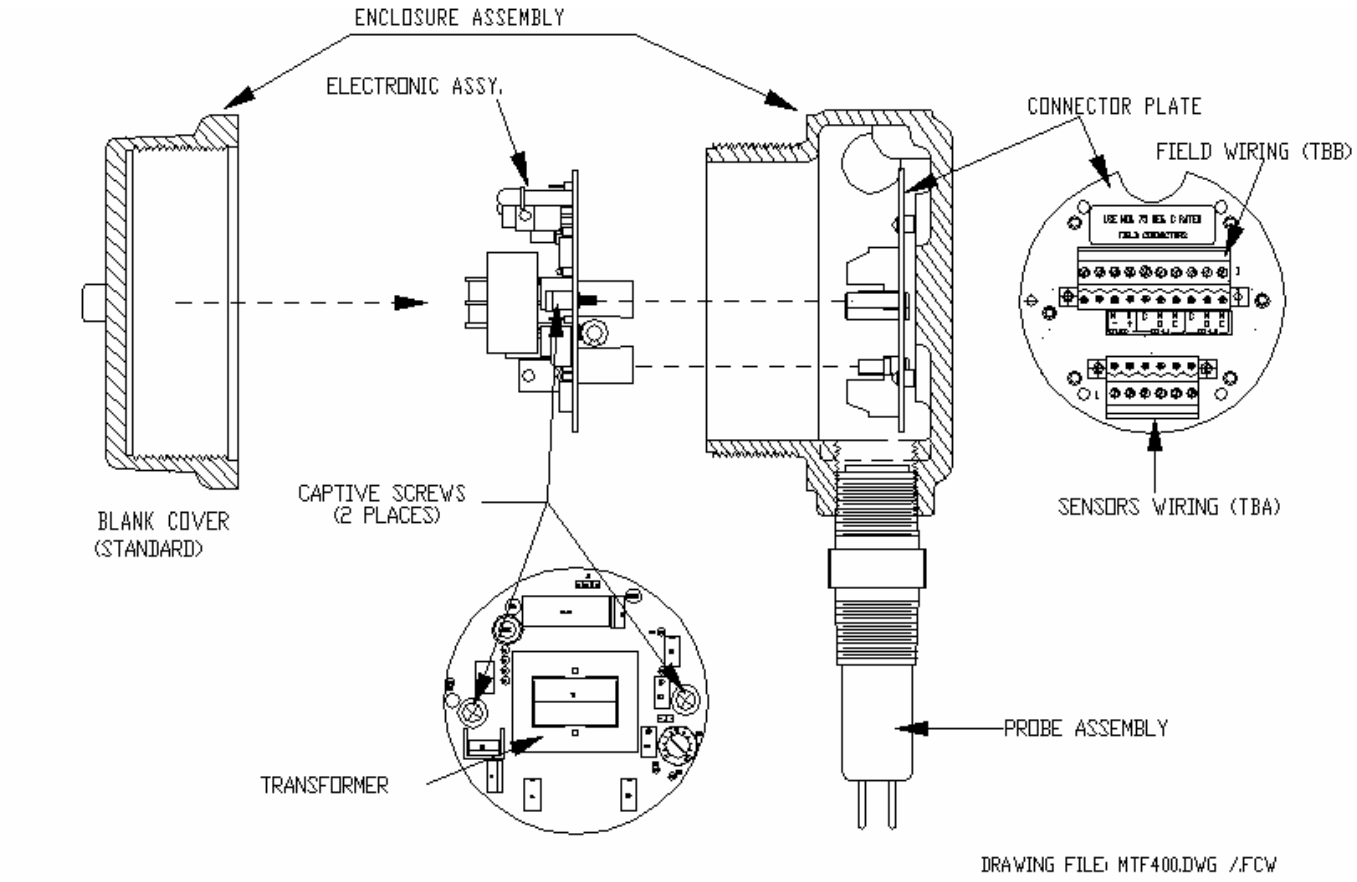


FIGURE 4 microtuf® SWITCH ASSEMBLY (MTF400.DWG/.FCW)

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3.0 INSTALLATION

3.1 Mechanical Installation

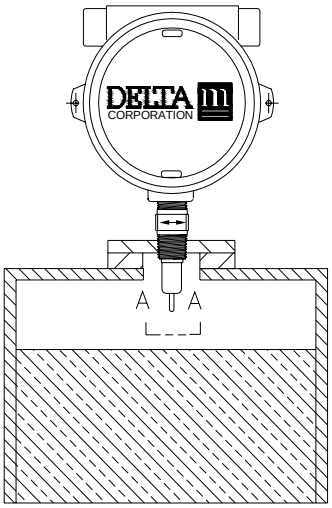
The standard microtuf® Switch has a .75 inch (19.05mm) MNPT mount designed for easy installation through a threaded port. Optional configurations include .5" (12.7mm) or 1.0" (25.4mm) MNPT and flange mounts. Conduit is recommended for all wiring to the switch.

IMPORTANT

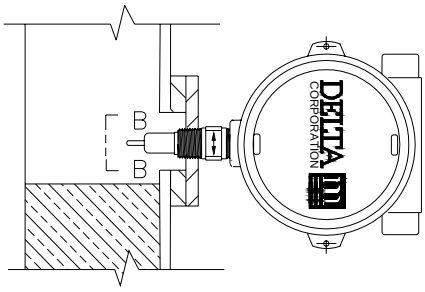
WHEN INSTALLING YOUR DELTA M SWITCH INTO A PIPE OR VESSEL USE A 1 1/8 INCH (28.575mm) OPEN-END WRENCH TO TIGHTEN AT THE HEX FLATS OF THE MNPT OF A STANDARD SWITCH. (IF YOU HAVE A NON-STANDARD SWITCH AN ALTERNATE SIZE WRENCH MAY BE REQUIRED). DO NOT USE THE INSTRUMENT HEAD TO TIGHTEN THE SWITCH TO THE MOUNTING PORT. ROTATION OF THE INSTRUMENT HEAD WITH RESPECT TO THE SENSOR BODY CAN CAUSE INTERNAL WIRING DAMAGE.

IMPORTANT

THE SWITCH BODY MUST BE ORIENTED TO HAVE THE TWIN SENSORS PROPERLY ORIENTED. DUE TO THE PIPE THREAD MOUNTING, IT MAY BE NECESSARY TO MAKE A TRIAL FIT, ADD OR REMOVE TEFLON TAPE OR OTHER PIPE THREAD SEALANT, AND REINSTALL TO ACHIEVE A SATISFACTORY SEAL WITH THE SENSORS PROPERLY ORIENTED. PROPER ORIENTATION IS MARKED ON THE SWITCH BODY FOR REFERENCE. SEE FIGURE 5.0 FOR DETAILS.



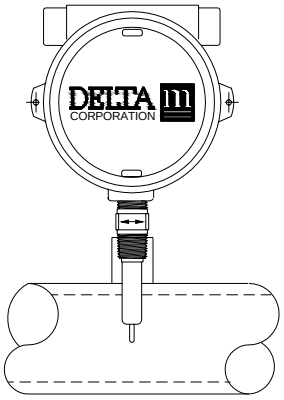
LEVEL APPLICATION
FOR VERTICAL MOUNTING



LEVEL APPLICATION
FOR HORIZONTAL MOUNTING

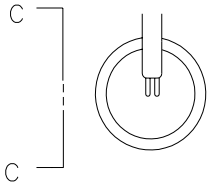
VIEW B–B

VIEW A–A



FLOW APPLICATION

NOTES:
THE ARROWS ON THE FLATS OF THE MOUNTING FITTING INDICATES:
1. FOR FLOW APPLICATION–THE DIRECTION OF FLOW.
2. FOR LEVEL APPLICATION WITH HORIZONTAL MOUNTING–THE DIRECTION OF VERTICAL TO THE LEVEL SURFACE.
3. FOR LEVEL APPLICATION WITH VERTICAL MOUNTING–THE DIRECTION OF THE ARROW HAS NO SIGNIFICANCE.
4. INSERTION LENGTH SHOULD NORMALLY POSITION SENSOR TIPS AT 1/4 DIAMETER INTO PIPE (I.D.)



VIEW C–C

DRAWING FILE: FIG5.FCW

FIGURE 5: PROPER ORIENTATION OF THE SENSOR PROBE FOR LEVEL AND FLOW APPLICATION IS INDICATED BY THE ARROW ON THE FLAT OF THE MOUNTING FITTING. (MTF500.DWG/.FCW)

3.2 Electrical Installation

3.2.1 Local Electronics (LE Option/Standard)

Remove the instrument enclosure lid by unscrewing in a counter clockwise direction. Unscrew (CCW) the printed circuit board captive screws (See Figure 4.0 for locations). Remove the PC board by grasping the transformer and pulling it straight out. Connect power and alarm relay wiring to Terminal Block (TBB) as shown in Figure 6.0. Reinstall the microtuf® Switch electronics and tighten the captive screws.

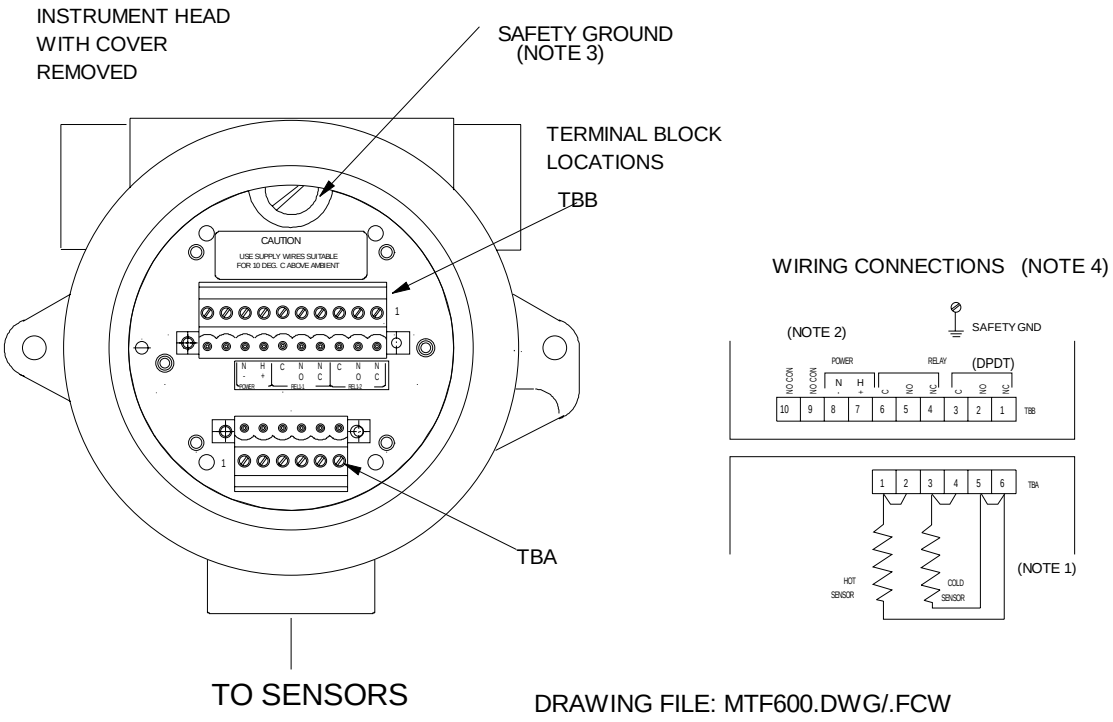


FIGURE 6.0 microtuf® SWITCH LOCAL ELECTRONICS FIELD WIRING DIAGRAM (MTF600FCW/.DWG)

NOTES:

1. **Connections to sensors terminal block A (TBA) are factory installed and should not be disconnected in the field. Note Jumpers 1-2, 3-4, and 5-6 must be in place on TBA for proper operation of local electronics.**
2. **For 24 VDC operation (factory prepared), connect +positive to TBB7 and –negative return to TBB8. For 110 VAC or 220 VAC connect hot to TBB7 and neutral to TBB8.**
3. **Connect ground wire to ground screw located in or on the instrument enclosure.**
4. **Use supply wires suitable for 10 Degrees C above ambient.**

IMPORTANT

A GROUND WIRE MUST BE ATTACHED TO THE GROUND SCREW LOCATED INSIDE OR OUTSIDE OF THE INSTRUMENT ENCLOSURE FOR PROPER OPERATION.

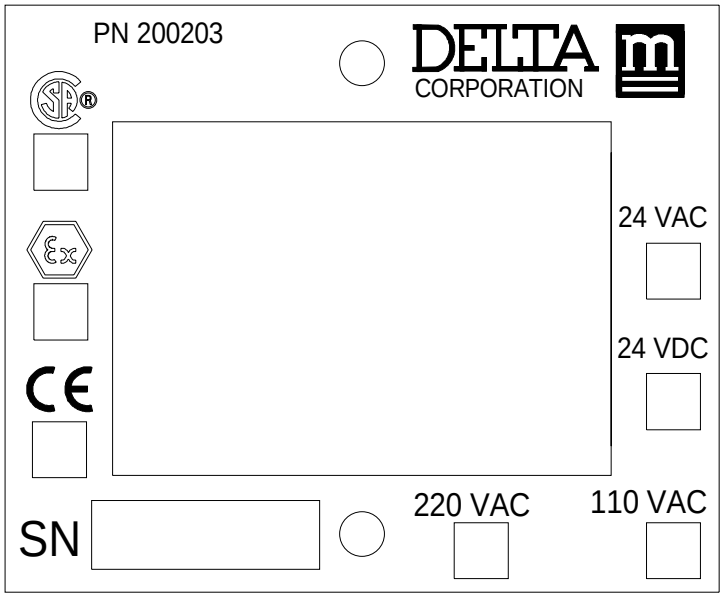
3.2.2 Remote Electronics (RE Option)

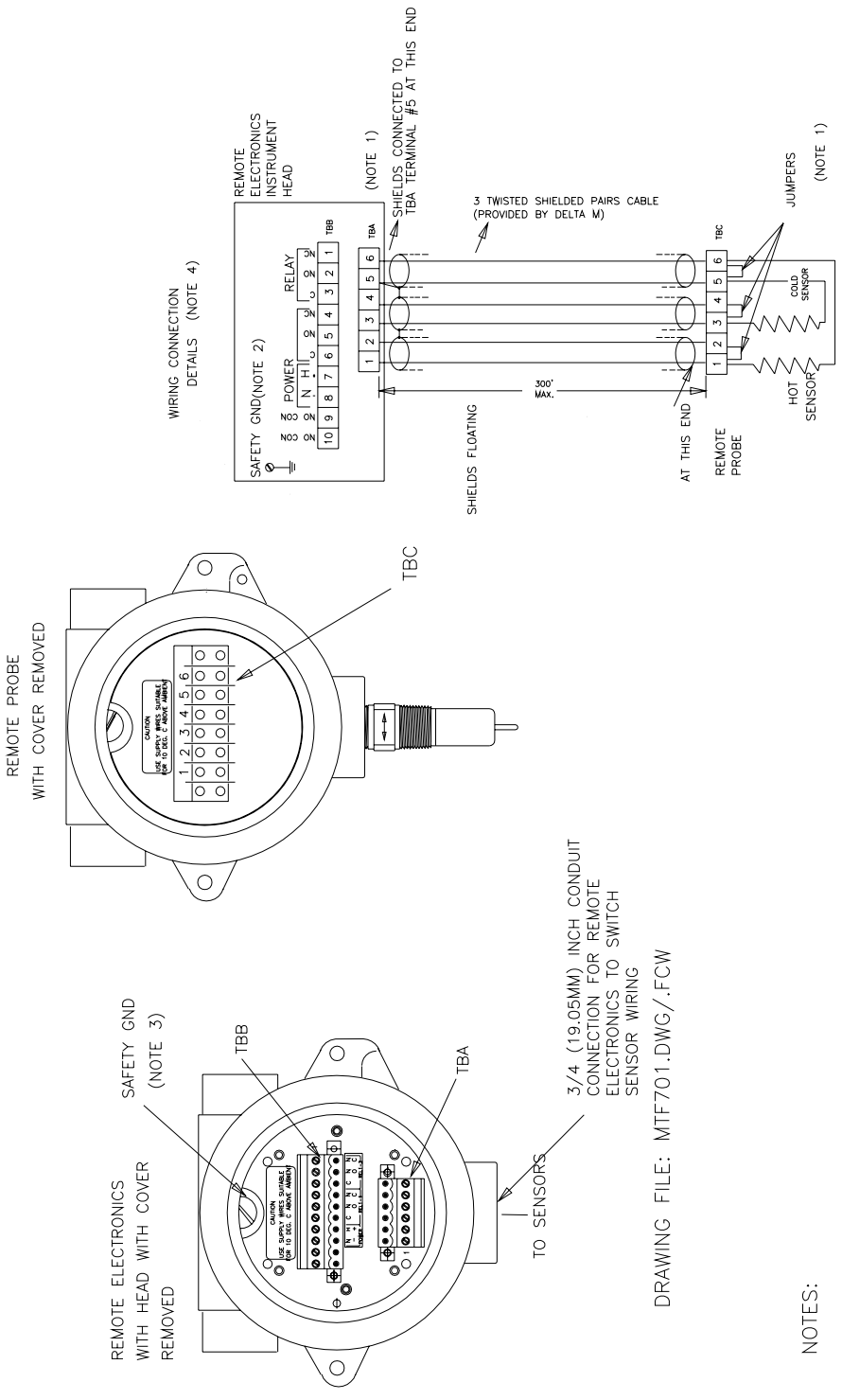
For the remote electronics option, mount the remote instrument head using two mounting wings or bracket provided. Connect the switch wiring between the microtuf® Switch remote electronics as shown in Figure 7.0. Connect power wiring and alarm relay wiring to the remote enclosure as shown in Figure 7.0. Upon completion of wiring reinstall the microtuf® Switch electronics and secure with the captive screws.

IMPORTANT
BE SURE TO APPLY THE PROPER VOLTAGE AS CONFIGURED AT THE FACTORY. DO NOT APPLY 110 VAC TO 24 VDC VERSIONS OR 24 VDC TO 110 VAC VERSIONS (LIKEWISE 220 VAC). NOTE THAT ALL VOLTAGES ARE NOMINAL.

SPECIAL NOTICE

The electronic assemblies contained in the microtuf® models are configured for specific voltages and have specific modifications to accommodate the various agency approvals. When ordering spare electronics, replacements, or exchanges in the field please ensure you identify the specific configuration you have by noting the boxes marked on the transformer configuration tag and the serial number.





NOTES:

1. JUMPER WIRES 1–2, 3–4, AND 5–6 MUST BE IN PLACE ON TBC IN THE REMOTE PROBE FOR PROPER OPERATION OF THE REMOTED ELECTRONICS.
2. FOR 24VDC OPERATION (FACTORY PREPARED), CONNECT + POSITIVE TO TBB7 AND – NEGATIVE RETURN TO TBB8. FOR 115VAC OR 230 VAC CONNECT HOT TO TBB7 AND NEUTRAL TO TBB8.
3. CONNECT GROUND WIRE TO GROUND SCREW LOCATED IN OR ON THE INSTRUMENT ENCLOSURE.
4. USE SUPPLY WIRES SUITABLE FOR 10 DEGREE C ABOVE AMBIENT.

FIGURE 7A microtuf® FLOW SWITCH REMOTE ELECTRONICS OPTION FIELD WIRING DIAGRAM (MTF701.DWG/.FCW)

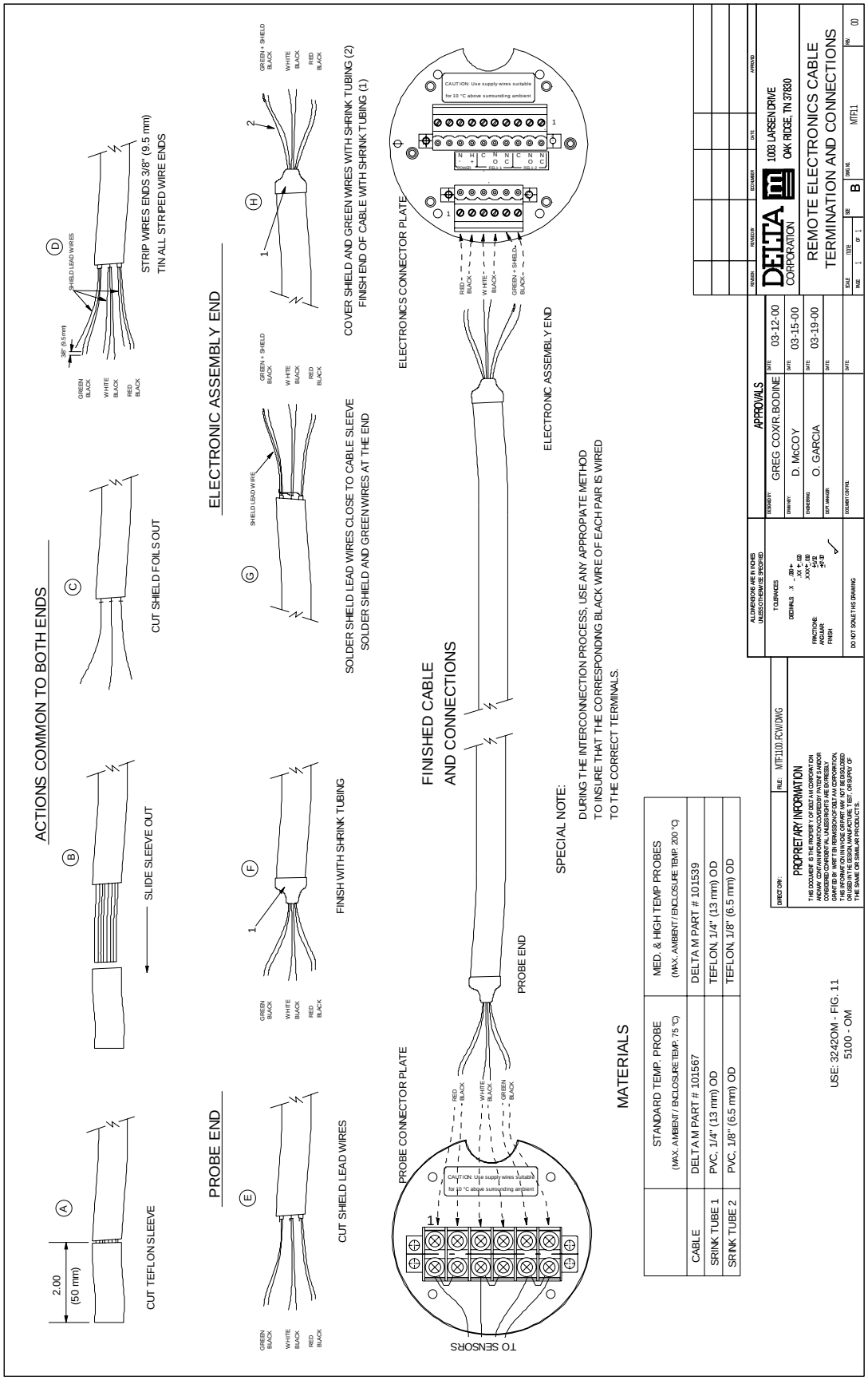


FIGURE 7B microtuf® REMOTE ELECTRONICS CABLE TERMINATION AND CONNECTIONS

3.2 Electrical Installation

3.2.3 CE Option Filter Board Connector Plate Wiring (CE Option)

Remove the instrument enclosure lid by unscrewing in a counter clockwise direction. Unscrew (CCW) the printed circuit board captive screws (See Figure 4.0 for locations). Remove the PC board by grasping the transformer and pulling it straight out. Connect power and alarm relay wiring to Power Block as shown in Figure 6A. Reinstall the microtuf® Switch electronics and tighten the captive screws.

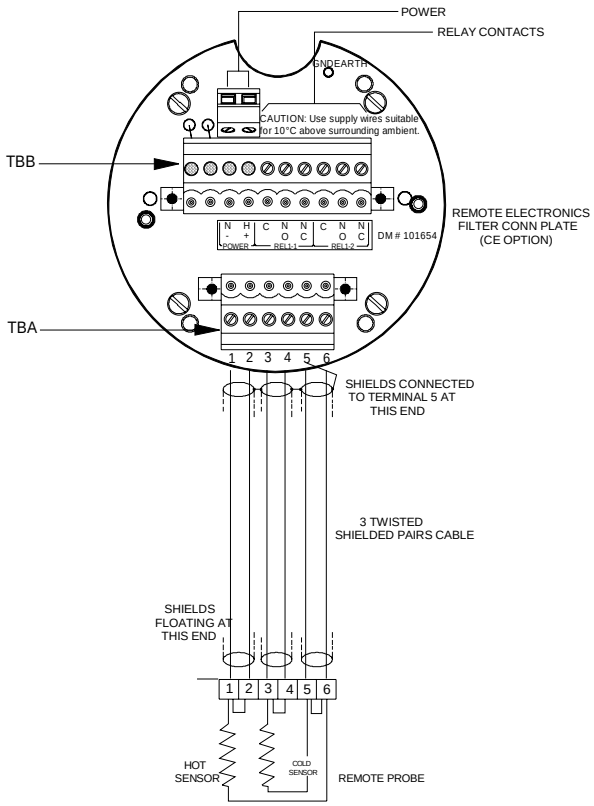


FIGURE 6A microtuf® SWITCH REMOTE ELECTRONICS FIELD WIRING DIAGRAM (MTF6A00FCW/.DWG)

NOTES:

1. **Connections to sensors terminal block A (TBA) are factory installed and should not be disconnected in the field. Note Jumpers 1-2, 3-4, and 5-6 must be in place on TBA for proper operation of local electronics.**
2. **For 24 VDC operation (factory prepared), connect +positive to TBB7 and –negative return to TBB8. For 110 VAC or 220 VAC connect hot to TBB7 and neutral to TBB8.**
3. **Connect ground wire to ground screw located in or on the instrument enclosure.**
4. **Use supply wires suitable for 10 Degree C above ambient.**

IMPORTANT

A GROUND WIRE MUST BE ATTACHED TO THE GROUND SCREW LOCATED INSIDE OR OUTSIDE OF THE INSTRUMENT ENCLOSURE FOR PROPER OPERATION.

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4.0 OPERATION AND CALIBRATION OF THE microtuf® FS4200 SWITCH FOR FLOW APPLICATIONS

4.1 Pre-Operational Check

With the switch installed and process conditions at no-flow, the following procedure can be used to verify preliminary operation.

4.1.1 Remove the instrument enclosure cover by turning counter clockwise (ccw) to expose the microtuf® Switch electronics.

4.1.2 Turn on power at its source.

4.1.3 Observe that either the red or green LED comes on.

4.1.4 If neither lamp illuminates refer to the trouble shooting Section, 6.2.

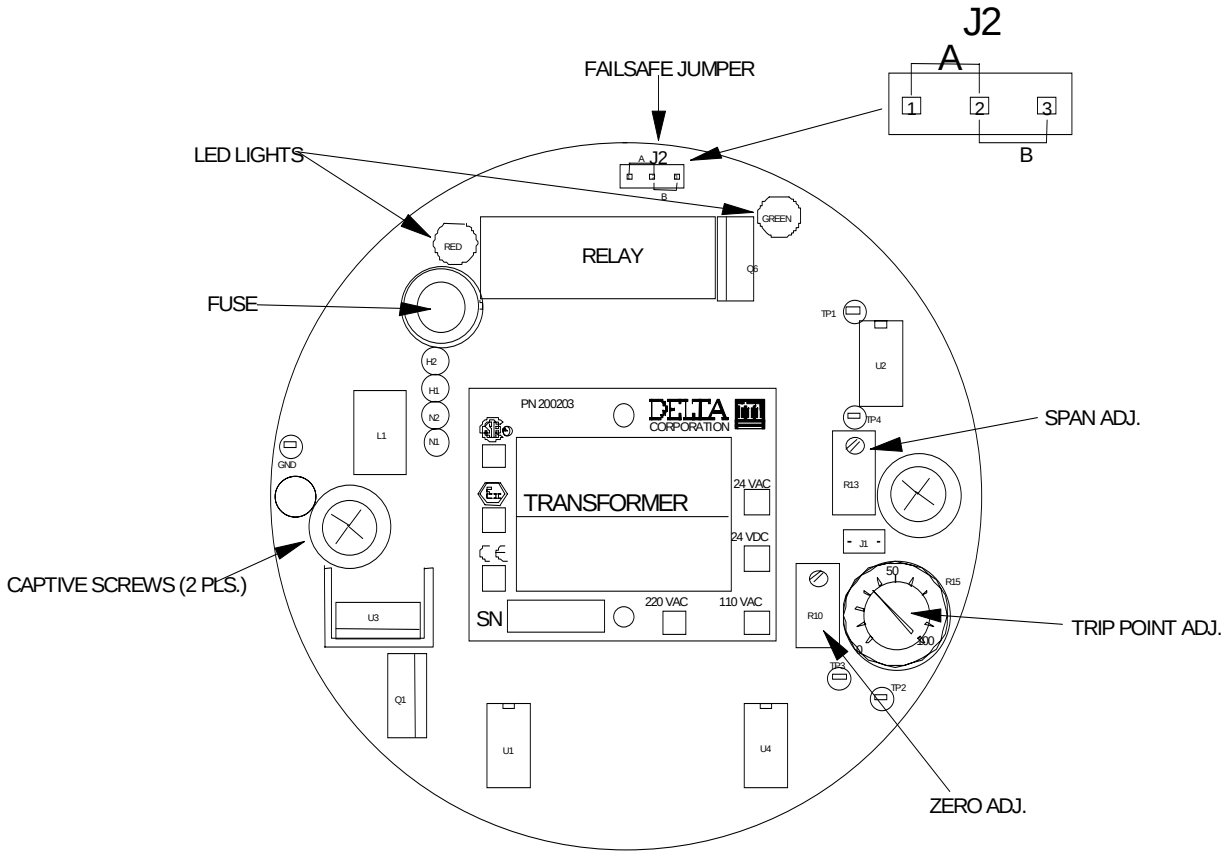
4.2 L.E.D. and Relay Status Logic (Fail-safe)

4.2.1 The L.E.D.s (Red; Green) are an indication of the sensors status (ie. flow below the setpoint or flow above the set point) and are not affected by the position of the failsafe jumper J-2. The failsafe jumper J-2 changes the relay activation status allowing the user to select the failsafe power off condition most appropriate to the application. Refer to the tables below that show the logic conditions between the sensors, L.E.D. lights, relay coil and contacts for each position of the failsafe jumper J-2.

4.2.2 Normal Operation (as set at factory)

The switch comes configured from the factory with the following operation with the J-2 jumper in the B(2-3) position. (Refer to Figure 8.0.)

SENSOR STATUS	RED LED	GREEN LED	RELAY COIL STATUS	RELAY CONTACT STATUS
No Flow or Flow Below Set Point	ON	OFF	Activated	o NC o NO
Flow or Flow Above Set Point	OFF	ON	Deactivated	o NC o NO



DRAWING FILE: MTF800.DWG/.FCW

FIGURE 8.0 microtuf® SWITCH ELECTRONICS (MTF800.FCW/.DWG)

4.2.3 Alternate Operation (Field Selectable)

The relay logic may be reversed by moving the J-2 jumper to position A(1-2). (Refer to Figure 8.0.)

SENSOR STATUS	RED LED	GREEN LED	RELAY COIL STATUS	RELAY CONTACT STATUS
No Flow or Flow Below Set Point	ON	OFF	Deactivated	o NC o NO
Flow or Flow Above Set Point	OFF	ON	Activated	o NC o NO

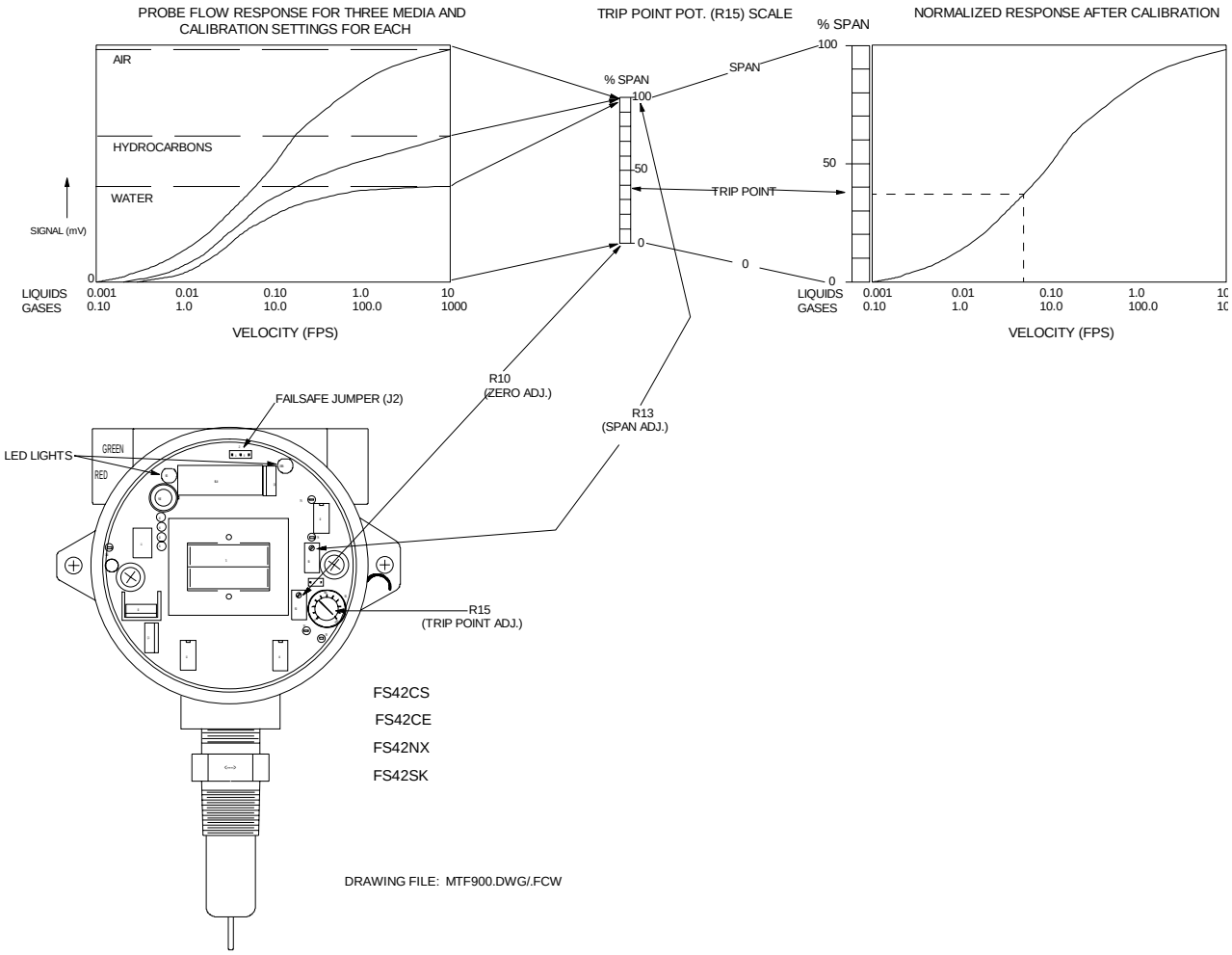


FIGURE 9.0 microtuf® FS4200 FLOW SWITCH CALIBRATION REFERENCE DRAWING
(MTF900.DWG.FCW)

4.3 Calibration – Flow

****IMPORTANT****
FOR OPTIMUM OPERATION, CALIBRATION MUST BE ACCOMPLISHED AT ACTUAL PROCESS TEMPERATURE AND PRESSURE CONDITIONS IN GASES AND AT ACTUAL PROCESS TEMPERATURE CONDITIONS IN LIQUIDS.

See Figures 8.0 and 9.0 for location of potentiometers and LEDS on electronics PCB.

4.3.1 Calibration Procedure for Flow Switches

1. Remove the instrument enclosure lid by turning ccw.
2. Apply power to FS4200. **Allow 5 minute warm-up.**
3. Ensure that the pipeline is filled with fluid and at no or minimum flow.
4. Set the trip adjust pot to zero fully counterclockwise (fully ccw).
5. Adjust the zero adjust pot so that the Red LED just does illuminate. This is a 25 turn pot. If the Green LED is on, turn the pot ccw. If the Red LED is on, turn the pot clockwise (cw).
6. Toggle the zero adjust pot back and forth until the switching point is well defined. Leave the Red LED illuminated.
7. Adjust the liquid or gas flow to maximum velocity. Insure that the flow is homogenous, constant and free of bubbles if a liquid.

   NOTE

   The flow rate (maximum) should be at least 5 fps (liquid) or 500 fps (gas) if possible for best calibration.
8. Set the trip adjust pot to 100 (fully cw).
9. Adjust the span adjust pot so that the Green LED just does illuminate. This is a 25 turn pot. If the Green LED is on, turn the pot cw. If the Red LED is on, turn the pot ccw.
10. Toggle the span adjust pot back and forth until the switching point is well defined. Leave the Green LED illuminated.
11. If the switch is to be used for flow - no flow, set the trip adjust pot to 50 and go to step 14. (Note: This adjustment can be set for tripping points between 10% and 90% of the span from no flow to max flow).
12. A more exact flow rate setting may be made by establishing the flow at the desired rate with a separate flow meter and proceeding to step 13, to establish the trip point.
13. Adjust the trip adjust pot to obtain a trip as exhibited by an LED illumination. If a trip on decreasing flow is desired set for Red LED illumination. If a trip on increasing flow is desired set for Green LED illumination.
14. Verify that the switch will reset by returning the actual product flow to the maximum or minimum flow rates.

5.0 OPERATION AND CALIBRATION OF THE microtuf® LS3200 SERIES SWITCH FOR POINT LEVEL APPLICATIONS

5.1 Pre-Operational Check

The switch is installed **and the product level is below sensor level (dry)**, the following procedure can be used to verify preliminary operation.

1. Remove the instrument enclosure cover by turning counter clockwise to expose the LS3200 Switch electronics.
2. Turn on power at its source.
3. Observe that either the red or green LED comes on.
4. If neither lamp illuminates refer to the trouble shooting Section, 6.2.

5.2 L.E.D. and Relay Status Logic (Fail-Safe)

5.2.1 The L.E.D.s (Red and Green) are an indication of the sensors status (ie. dry or wet) and are not affected by the position of the fail-safe jumper J-2. The fail-safe jumper J-2 changes the relay activation status allowing the user to select the fail-safe power off condition most appropriate to the application. Refer to the tables below that show the logic conditions between the sensors, L.E.D. lights, relay coil and contacts for each position of the fail-safe jumper J-2.

5.2.2 Normal Operation (as set at factory)

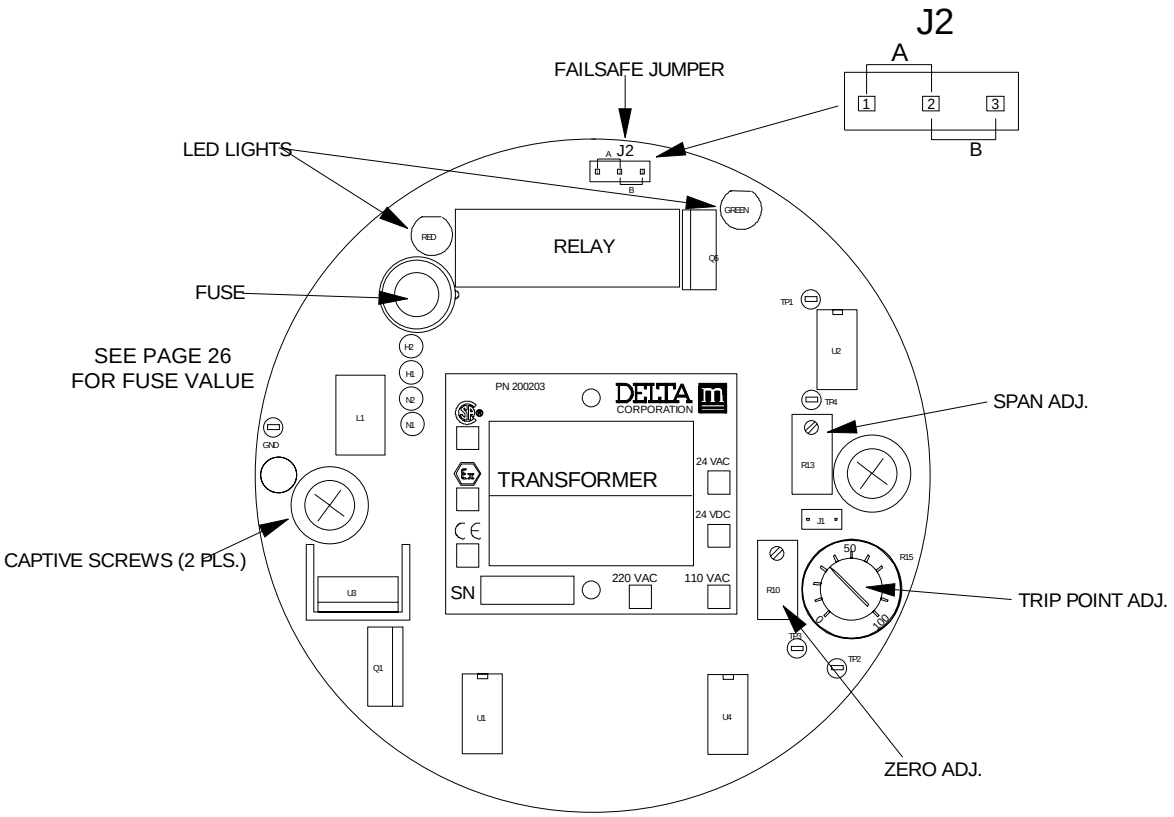
The switch comes configured from the factory with the following operation with the J-2 jumper in the B (2-3) position. (Refer to Figure 8.0.)

SENSOR STATUS	RED LED	GREEN LED	RELAY COIL STATUS	RELAY CONTACT STATUS
Dry, or Lower Thermal Dispersion Fluid (ie. hydrocarbons)	ON	OFF	Activated	o NC / o NO
Wet, or Higher Thermal Dispersion Fluid (ie. water)	OFF	ON	Deactivated	o NC / o NO

5.2.3 Alternate Operation (Field Selectable)

The relay logic may be reversed by moving the J-2 jumper to position A(1-2). (Refer to Figure 8.0.)

SENSOR STATUS	RED LED	GREEN LED	RELAY COIL STATUS	RELAY CONTACT STATUS
Dry, or Lower Thermal Dispersion Fluid (ie. hydrocarbons)	ON	OFF	Deactivated	o NC o NO
Wet, or Higher Thermal Dispersion Fluid (ie. water)	OFF	ON	Activated	o NC o NO



DRAWING FILE: MTF800.DWG/.FCW

FIGURE 8.0 microtuf® SWITCH ELECTRONICS (MTF800.FCW/.DWG)

5.3 Calibration – Level

****IMPORTANT****

FOR OPTIMUM OPERATION CALIBRATION MUST BE ACCOMPLISHED AT ACTUAL PROCESS TEMPERATURE CONDITIONS.

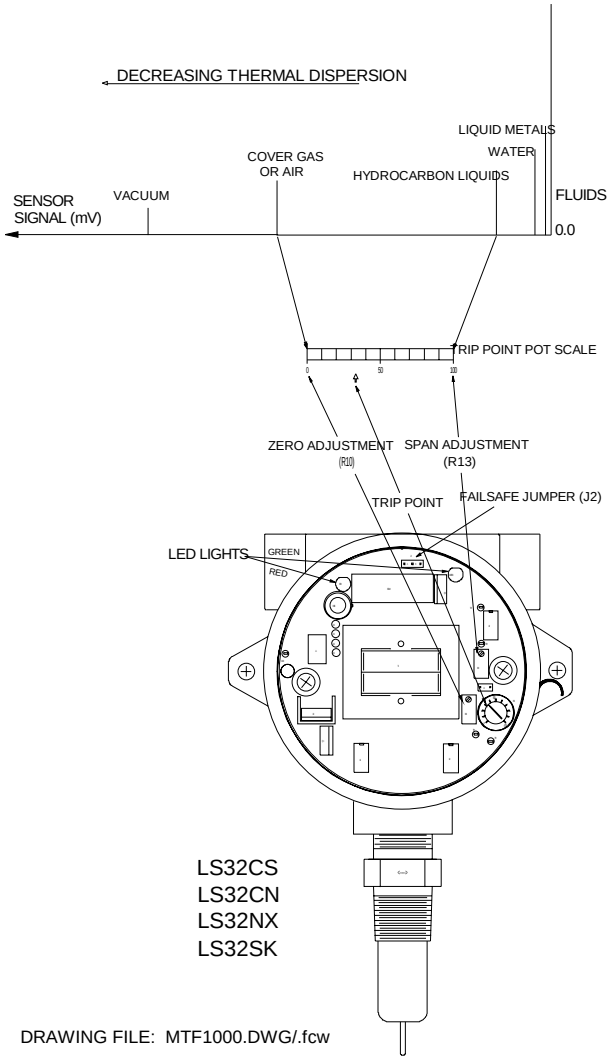


FIGURE 10.0 microtuf® LS3200 POINT LEVEL SWITCH CALIBRATION REFERENCE DRAWING (MTF1000.DWG/.FCW)

5.3 Calibration - Level

Using Figure 10.0 as a location guide adjust the system as follows:

1. Remove the instrument enclosure lid by turning ccw.

2. Apply power to the unit. **Allow 5 minute warm-up.**

3. For optimum calibration results, wet sensor and drain but do not dry.

4. Ensure that the tank liquid level is below the probe sensor tips.

5. Set the trip adjust pot to zero, fully counterclockwise (fully ccw).

6. Adjust the zero adjust pot so that the Red LED just does illuminate. This is a 25 turn pot. If the green LED is on, turn the pot counterclockwise (ccw). If red LED is on, turn the pot clockwise (cw).

7. Toggle the zero adjust pot back and forth until the switching point is well defined. Leave the Red LED illuminated.

8. Raise the level of the liquid to be detected until the probe/sensor tips are submerged and wet (covered).

9. Set the trip adjust pot to 100 (fully cw).

10. Adjust the span adjust pot so that the Green LED just does illuminate. This is a 25 turn pot. If the Green LED is on, turn the pot cw. If the Red LED is on, turn the pot ccw.

11. Toggle the span adjust pot back and forth until the switching point is well defined. Leave the green LED illuminated.

12. Adjust the trip adjust pot to 80 and the calibration is complete. Setting this pot to 80 gives an approximate equal trip time from wet to dry and from dry to wet. Setting this pot closer to zero will speed up dry to wet trip time and slow down wet to dry trip time. Setting this pot closer to 100 will slow down the dry to wet trip time and speed up wet to dry trip time.

6.0 MAINTENANCE AND TROUBLE SHOOTING

6.1 Cleaning

The switch can be cleaned by soaking, spraying solvents or detergent-and-water onto the sensor tubes, or by ultrasonic cleaning.

Lime deposits can be safely removed by soaking in 20% hydrochloric acid. Warming to 150°F is permissible to speed this process. The acid must be thoroughly rinsed off once cleaned.

For unusual cleaning problems, call DELTA M and determine the exact materials of construction and chemical compatibility before using strong acids or unusual cleansers.

****IMPORTANT****

DO NOT SANDBLAST OR ABRASIVE CLEAN THE SENSING PROBES. THE SENSING PROBES COULD BE DAMAGED BY ABRASIVES.

6.2 Troubleshooting

6.2.1 Power and Continuity Verification

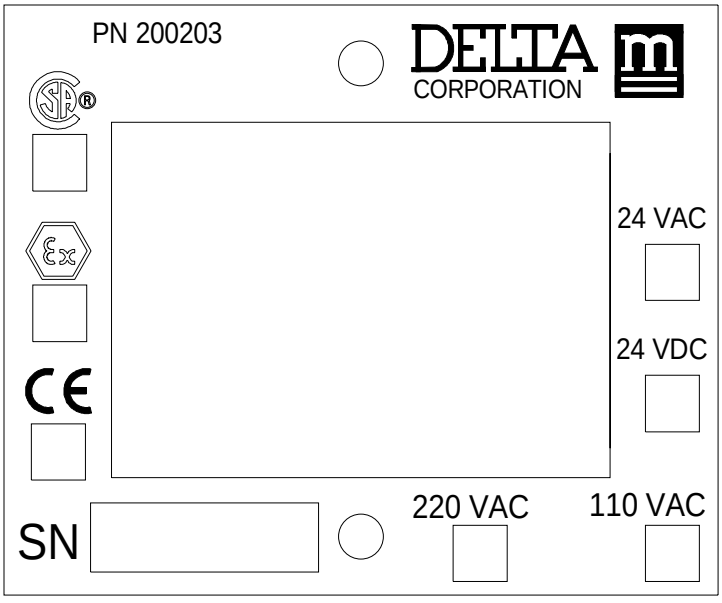
1. Turn power off to the microtuf® Switch.
2. Remove the instrument enclosure cover (ccw).
3. Loosen the two PC captive screws (see Figure 4.0 for location).
4. Unplug the PC board from the instrument enclosure by pulling straight out on the transformer.
5. Reapply power and verify correct voltage at pins 7 (positive for DC) and 8 (negative for DC) of TBB (see Figures 6.0 or 7.0).
6. If voltage is correct, verify the fuse (F1) on the PC board is not blown (See Figure 8.0). If fuse is not blown proceed to 6.2.2.
7. If fuse is blown replace with appropriate value (See 7.0 Specification).

6.2.2 Sensor/Electronics Functionality Verification

1. Turn power off to microtuf® Switch.
2. Allow a 5 minute cool down.
3. Measure the resistance of each RTD at pins 1 and 6 of TBA (see Figure 6.0 or 7.0) for the hot RTD and pins 3 and 5 of TBA for the cold RTD. These resistances should be 110 ± 10 ohms (with sensors at approximately 70°F) and within 5% of each other in value.
4. Measure the insulation resistance between pin 1 of TBA and the case of the microtuf® Switch. It should be greater than 20 megohms.
5. If the microtuf® Switch sensor assembly resistances are not as specified above, the switch sensor assembly must be replaced.
6. If the microtuf® Switch sensor assembly resistances are as specified, the microtuf® Switch PC electronic board must be replaced.

SPECIAL NOTICE

The electronic assemblies contained in the microtuf® models are configured for specific voltages and have specific modifications to accommodate the various agency approvals. When ordering spare electronics, replacements, or exchanges in the field please ensure you identify the specific configuration you have by noting the boxes marked on the transformer configuration tag.



7.0 SPECIFICATIONS

TYPE: Thermal Differential-Dual RTD Sensors

PROCESS CONNECTIONS: 0.75” (19.05mm) MNPT Standard, 0.5"(12.7mm), 1" (25.4mm) MNPT, and various flanges optional.

INSERTION LENGTH: Two inch (50.8mm) Standard, (shorter 0.5 inch (12.7mm) and longer to 120 inch (3048mm) optional).

CONSTRUCTION MATERIALS: Wetted parts are 316L SS welded construction (alternate materials for corrosive environments available as options. Consult factory.)

AGENCY INSTRUMENT RATINGS:
CSA Explosion Proof: (CS series) T4A
Class I, Group B, C, and D
Class II, Group E, F, and G
CENELEC/Explosion Proof (CN Series):
EEx d IIC T4(Akron Electric Enclosure)
EEx d IIB T4(Killark Enclosure)
CE: EMC Directive: 89/336/EEC (CE Option)

OPERATING TEMPERATURE:
Process: -70°C to + 200°C (-100°F to +390°F) standard
(to + 600°C (+1000°F) optional
Electronics: -40°C to +60°C (-40°F to +140°F)

PRESSURE RATED: To 3000 psig (20.4 MPa)

RANGE
Gaseous Mass Flow: 0.1 to 500 fps
Liquid Mass Flow: 0.01 to 5 fps

REPEATABILITY: ± 1% of Set Point or ± 1/32 inch (±.8mm)

TIME RESPONSE: 0.5 to 10 seconds no-flow (dry) to flow (wet) and 2 to 60 seconds flow (wet) to no-flow (dry) (application dependent)

INPUT POWER: 110 Vac, 50/60HZ standard. (220 Vac, 50/60HZ, 24 Vdc, or 24 Vac optional); 3.1w. maximum.

FUSE REQUIREMENTS (F1):

	DELTA M PART NO.	
	CSA/FM	CENELEC
110 Vac: 1/4 amp	101603	101605
220 Vac: 1/4 amp	101603	101605
24 Vdc: 1/4 amp	101603	101605

OUTPUT: 5A, 250 VAC, DPDT Standard (Optional 10A, 250 Vac SPDT)
5A 30 VDC

STABILITY: Temperature compensated over entire range.

8.0 WARRANTY AND SERVICE

8.1 Warranty

DELTA M Corporation warranties microtuf® switches for a period of two years from the date of shipment and will repair or replace this product in the event of a defect in materials or workmanship. To have a product repaired, it should be returned at customer's expense, after obtaining return authorization as described in Section 8.2, to a repair facility designated by DELTA M and, after repair, DELTA M will prepay transportation to return the product to the customer. This limited warranty only covers failures due to defects in materials or workmanship which occur during normal use.

LIMITS AND EXCLUSIONS

DELTA M CORPORATION SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, LOSS OF USE, LOSS OF SALES, OR INCONVENIENCE) RESULTING FROM THE USE OF THESE PRODUCTS, OR ARISING OUT OF ANY BREACH OF THIS WARRANTY. EXCEPT AS SET FORTH ABOVE, THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OR WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

8.2 Service

To receive prompt service call DELTA M's Customer Service Dept. (865) 483-1569 or toll free 1-800-922-0083. A representative will assist you in determining if the unit must be returned to the factory. A Return Authorization Number (RAN) will be given and should clearly mark the outside of the returning package. **Prior to calling, be sure to have the model number and serial number information for quick identification and service response.**

8.3 Spare Parts List

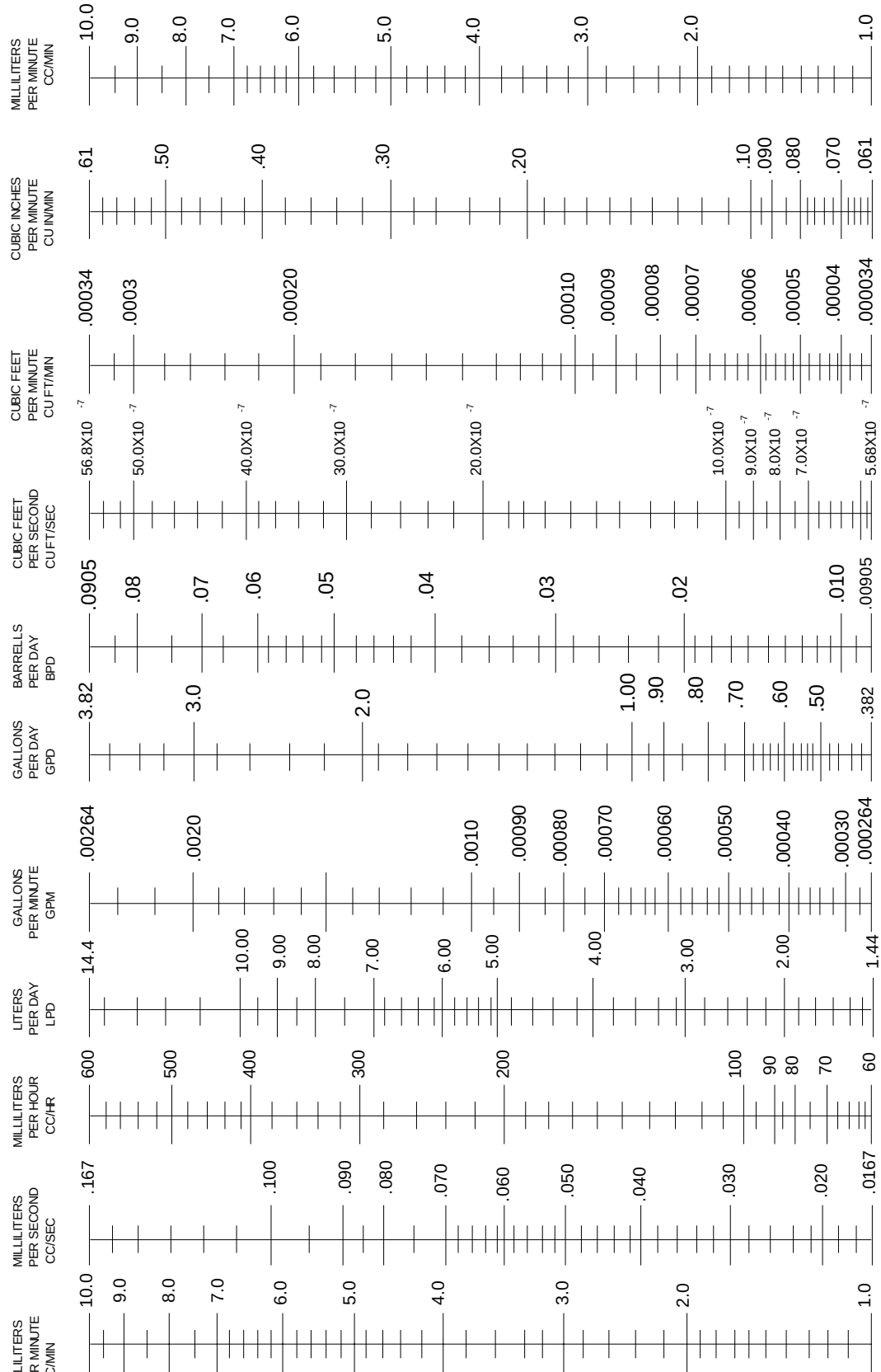
Part No.	Description
Microtuf Electronics	
200203.1	FS42/LS32 – 110Vac
200203.2	FS42/LS32- 24Vdc
200203.3	FS42/LS32 - 220Vac
200203.5	FS42/LS32 w/ HS Relay (Specify Voltage)
200540.1	FS4100/LS3100 -110Vac
200540.2	FS4100/LS3100 - 24Vdc
200540.3	FS4100/LS3100 - 220Vac
Connector Plates	
200202	FS42/LS32 –Local Electronics
200450	Remote Connector Plate
200182	Remote – MT & HT Options
Fuses	
101603	FS42/LS32 - Wickmann 3740250041
101605	FS42/LS32-Cenelec Wickmann 3720250041
Manuals	
101740	MicroTuf Manual
Enclosures	
101790	Standard Enclosure
101797	Standard Enclosure w/ Cenelec Approval
101798	Standard Enclosure w/ Glass Window
101611	Enclosure for Failure Alarm Option-Std.
101612	Enclosure for Failure Alarm Option – Cenelec
101613	Enclosure for Failure Alarm Option-Glass Window
Cable	
101567	Cable- Standard
101539	Cable- MT/HT Option
Sensor	
200711	Sensor Assy. .75-S6-2.00
200087	Sensor Assy. 1.00-S6-2.00
N/A	Sensor Assy. .50-S6-2.00
N/A	Other determined by original part no.

9.1 VOLUME FLOW CONVERSION CHART

Convert known units to cubic feet per second (CFPS) or gallons per minute (GPM) for use with Chart A.2

TO CONVERT FROM	TO	MULTIPLY BY
Gallons Per Minute (GPM)	Cubic Feet Per Per Second (CFPS)	2.228 E-03
Gallons Per Day (GPD)	CFPS	1.547 E-06
Barrels Per Day (BPD)	CFPS	6.531 E-5
Cubic Ft. Per Minute (CFPM)	CFPS	1.667 E-02
Cubic In. Per Minute (CIPM)	CFPS	9.645 E-06
Milliliters Per Minute (MLPM)	CFPS	5.886 E-07
Milliliters Per Second (MLPS)	CFPS	3.531 E-05
Milliliters Per Hour (MLPH)	CPFS	9.810 E-09
Liters Per Day (LPD)	CPFS	4.087 E-07
Gallons Per Day (GPD)	GPM	6.944 E-04
Barrels Per Day (BPD)	GPM	2.931 E-02
Cubic Ft. Per Second (CFPS)	GPM	4.488 E+02
Cubic Ft. Per Minute (CFPM)	GPM	7.481
Cubic In. Per Minute (CIPM)	GPM	4.329 E-03
Milliliters Per Minute (MLPM)	GPM	2.642 E-04
Milliliters Per Second (MLPS)	GPM	4.403 E-06
Milliliters Per Hour (MLPH)	GPM	1.585 E-02
Liters Per Day (LPD)	GPM	1.835 E-04

9.2 FLOW CONVERSION CHART



THIS LINE CHART PROVIDES AN EASY METHOD FOR CONVERTING UNITS OF VOLUME FLOW. SIMPLY DRAW A LINE PERPENDICULAR TO THE SCALE LINES THROUGH A VALUE OF FLOW AND READ THE EQUIVALENT VALUE ON ANY OF THE OTHER SCALES.

9.3 FLOW OF WATER THROUGH SCHEDULE 40 STEEL PIPE

FLOW OF WATER
Flow of Water Through Schedule 40 Steel Pipe

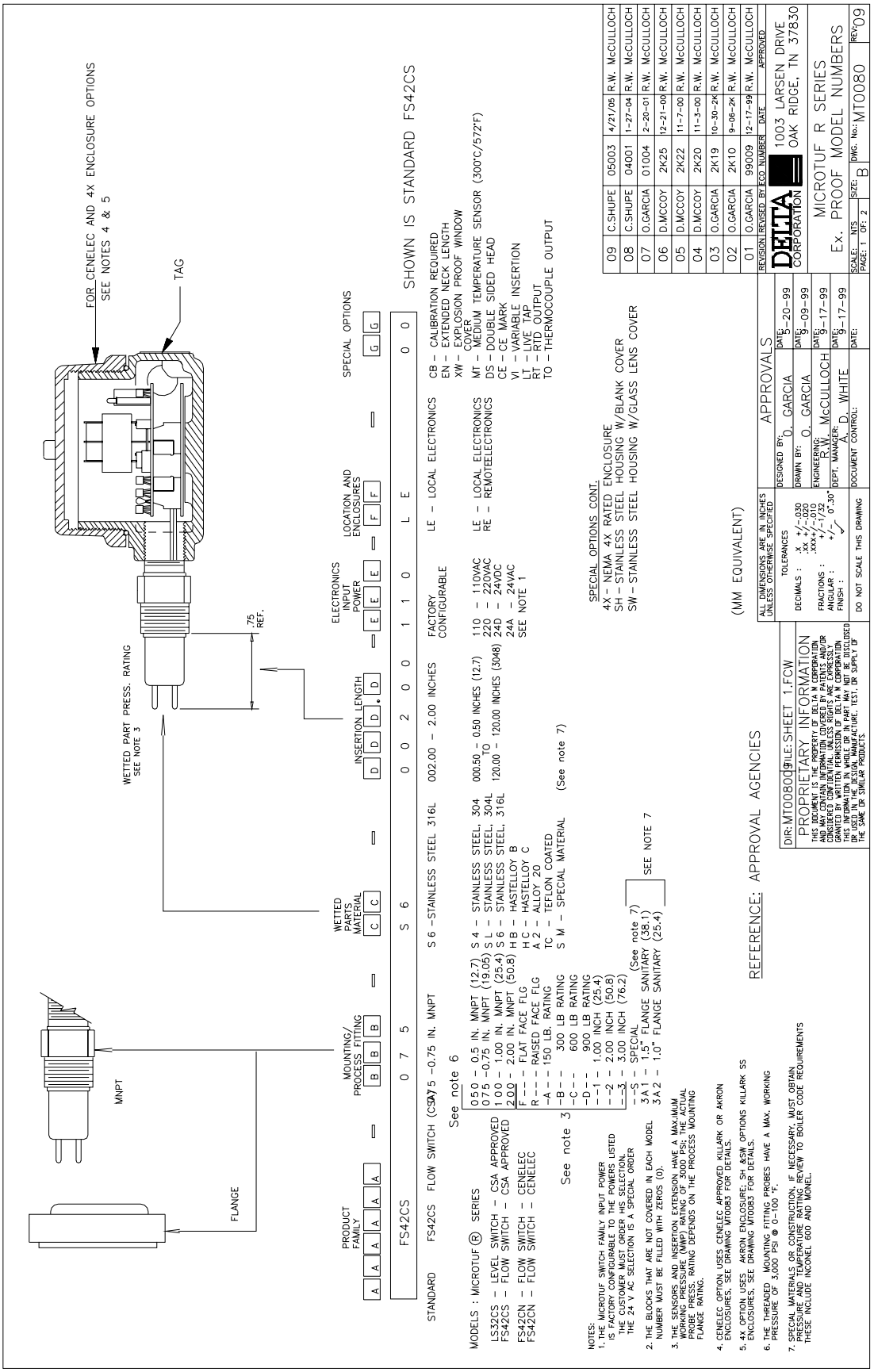
Pressure Drop per 100 feet and Velocity in Schedule 40 Pipe for Water at 60 F.

Discharge		⅛″		¼″		⅜″		½″		¾″		1″		1¼″		1½″	
Gallons per Minute	Cubic Ft. per Second	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.	Velocity Feet per Second	Press. Drop Lbs. per Sq. In.
.2	0.000446	1.13	1.86	0.616	0.359												
.3	0.000668	1.69	4.22	0.924	0.903	0.504	0.159	0.317	0.061								
.4	0.000891	2.26	6.98	1.23	1.61	0.672	0.345	0.422	0.086								
.5	0.00111	2.82	10.5	1.54	2.39	0.840	0.539	0.528	0.167	0.301	0.033						
.6	0.00134	3.39	14.7	1.85	3.29	1.01	0.751	0.633	0.240	0.361	0.041						
.8	0.00178	4.52	25.0	2.46	5.44	1.34	1.25	0.844	0.408	0.481	0.102						
1	0.00223	5.65	37.2	3.08	8.28	1.68	1.85	1.06	0.600	0.602	0.155	0.371	0.048				
2	0.00446	11.29	134.4	6.16	30.1	3.36	6.58	2.11	2.10	1.20	0.526	0.743	0.164	0.429	0.044		
3	0.00668			9.25	64.1	5.04	13.9	3.17	4.33	1.81	1.09	1.114	0.336	0.644	0.090	0.473	0.043
4	0.00891			12.33	111.2	6.72	23.9	4.22	7.42	2.41	1.83	1.49	0.565	0.858	0.150	0.630	0.071
5	0.01114		2″			8.40	36.7	5.28	11.2	3.01	2.75	1.86	0.835	1.073	0.223	0.788	0.104
6	0.01337	0.574	0.044		2½″	10.08	51.9	6.33	15.8	3.61	3.84	2.23	1.17	1.29	0.309	0.946	0.145
8	0.01782	0.765	0.073			13.44	91.1	8.45	27.7	4.81	6.60	2.97	1.99	1.72	0.518	1.26	0.241
10	0.02228	0.956	0.108	0.670	0.046			10.56	42.4	6.02	9.99	3.71	2.99	2.15	0.774	1.58	0.361
15	0.03342	1.43	0.224	1.01	0.094		3″			9.03	21.6	5.57	6.36	3.22	1.63	2.37	0.755
20	0.04456	1.91	0.375	1.34	0.158	0.868	0.056		3½″	12.03	37.8	7.43	10.9	4.29	2.78	3.16	1.28
25	0.05570	2.39	0.561	1.68	0.234	1.09	0.083	0.812	0.041		4″	9.28	16.7	5.37	4.22	3.94	1.93
30	0.06684	2.87	0.786	2.01	0.327	1.30	0.114	0.974	0.056			11.14	23.8	6.44	5.92	4.73	2.72
35	0.07798	3.35	1.05	2.35	0.436	1.52	0.151	1.14	0.704	0.882	0.041	12.99	32.2	7.51	7.90	5.52	3.64
40	0.08912	3.83	1.35	2.68	0.556	1.74	0.192	1.30	0.095	1.01	0.052	14.85	41.5	8.59	10.24	6.30	4.65
45	0.1003	4.30	1.67	3.02	0.668	1.95	0.239	1.46	0.117	1.13	0.064			9.67	12.80	7.09	5.85
50	0.1114	4.78	2.03	3.35	0.839	2.17	0.288	1.62	0.142	1.26	0.076		5″	10.74	15.66	7.88	7.15
60	0.1337	5.74	2.87	4.02	1.18	2.60	0.406	1.95	0.204	1.51	0.107			12.89	22.2	9.47	10.21
70	0.1560	6.70	3.84	4.69	1.59	3.04	0.540	2.27	0.261	1.76	0.143	1.12	0.047			11.05	13.71
80	0.1782	7.65	4.97	5.36	2.03	3.47	0.687	2.60	0.334	2.02	0.180	1.28	0.060		6″	12.62	17.59
90	0.2005	8.60	6.20	6.03	2.53	3.91	0.861	2.92	0.416	2.27	0.224	1.44	0.074			14.20	22.0
100	0.2228	9.56	7.59	6.70	3.09	4.34	1.05	3.25	0.509	2.52	0.272	1.60	0.090	1.11	0.036	15.78	26.9
125	0.2785	11.97	11.76	8.38	4.71	5.43	1.61	4.06	0.769	3.15	0.415	2.01	0.135	1.39	0.055	19.72	41.4
150	0.3342	14.36	16.70	10.05	6.69	6.51	2.24	4.87	1.08	3.78	0.580	2.41	0.190	1.67	0.077		
175	0.3899	16.75	22.3	11.73	8.97	7.60	3.00	5.68	1.44	4.41	0.774	2.81	0.253	1.94	0.102		8″
200	0.4456	19.14	28.8	13.42	11.68	8.68	3.87	6.49	1.85	5.04	0.985	3.21	0.323	2.22	0.130		
225	0.5013	...	...	15.09	14.63	9.77	4.83	7.30	2.32	5.67	1.23	3.61	0.401	2.50	0.162	1.44	0.043
250	0.557	...	...	...	...	10.85	5.93	8.12	2.84	6.30	1.46	4.01	0.495	2.78	0.195	1.60	0.051
275	0.6127	...	...	...	...	11.94	7.14	8.93	3.40	6.93	1.79	4.41	0.583	3.05	0.234	1.76	0.061
300	0.6684	...	...	...	...	13.00	8.36	9.74	4.02	7.56	2.11	4.81	0.683	3.33	0.275	1.92	0.072
325	0.7241	...	...	...	...	14.12	9.89	10.53	4.09	8.19	2.47	5.21	0.797	3.61	0.320	2.08	0.083
350	0.7798			...	...	...	...	11.36	5.41	8.82	2.84	5.62	0.919	3.89	0.367	2.24	0.095
375	0.8355			...	...	...	...	12.17	6.18	9.45	3.25	6.02	1.05	4.16	0.416	2.40	0.108
400	0.8912			...	...	...	...	12.98	7.03	10.08	3.68	6.42	1.19	4.44	0.471	2.56	0.121
425	0.9469			...	...	...	...	13.80	7.89	10.71	4.12	6.82	1.33	4.72	0.529	2.73	0.136
450	1.003		10″	...	...	...	...	14.61	8.80	11.34	4.60	7.22	1.48	5.00	0.590	2.89	0.151
475	1.059	1.93	0.054			...	...	...	...	11.97	5.12	7.62	1.64	5.27	0.653	3.04	0.166
500	1.114	2.03	0.059			...	...	...	...	12.60	5.65	8.02	1.81	5.55	0.720	3.21	0.182
550	1.225	2.24	0.071			...	...	...	...	13.85	6.79	8.82	2.17	6.11	0.861	3.53	0.219
600	1.337	2.44	0.083			...	...	...	...	15.12	8.04	9.63	2.55	6.66	1.02	3.85	0.258
650	1.448	2.64	0.097		12″	...	...	...	...	...	...	10.43	2.98	7.22	1.18	4.17	0.301
700	1.560	2.85	0.112	2.01	0.047			...	...	...	...	11.23	3.43	7.78	1.35	4.49	0.343
750	1.671	3.05	0.127	2.15	0.054		14″	...	...	...	...	12.03	3.92	8.33	1.55	4.81	0.392
800	1.782	3.25	0.143	2.29	0.061			...	...	...	...	12.83	4.43	8.88	1.75	5.13	0.443
850	1.894	3.46	0.160	2.44	0.068	2.02	0.042	...	...	...	...	13.64	5.00	9.44	1.96	5.45	0.497
900	2.005	3.66	0.179	2.58	0.075	2.13	0.047	...	...	...	...	14.44	5.58	9.99	2.18	5.77	0.554
950	2.117	3.86	0.198	2.72	0.083	2.25	0.052			...	...	15.24	6.21	10.55	2.42	6.09	0.613
1 000	2.228	4.07	0.218	2.87	0.091	2.37	0.057		16″	...	...	16.04	6.84	11.10	2.68	6.41	0.675
1 100	2.451	4.48	0.260	3.15	0.110	2.61	0.068			...	...	17.65	8.23	12.22	3.22	7.05	0.807
1 200	2.674	4.88	0.306	3.44	0.128	2.85	0.080	2.18	0.042	...	...	...	...	13.33	3.81	7.70	0.948
1 300	2.896	5.29	0.355	3.73	0.150	3.08	0.093	2.36	0.048	...	...	...	...	14.43	4.45	8.33	1.11
1 400	3.119	5.70	0.409	4.01	0.171	3.32	0.107	2.54	0.055					15.55	5.13	8.98	1.28
1 500	3.342	6.10	0.466	4.30	0.195	3.56	0.122	2.72	0.063		18″			16.66	5.85	9.62	1.46
1 600	3.565	6.51	0.527	4.59	0.219	3.79	0.138	2.90	0.071					17.77	6.61	10.26	1.65
1 800	4.010	7.32	0.663	5.16	0.276	4.27	0.172	3.27	0.088	2.58	0.050			19.99	8.37	11.54	2.08
2 000	4.456	8.14	0.808	5.73	0.339	4.74	0.209	3.63	0.107	2.87	0.060		20″	22.21	10.3	12.82	2.55
2 500	5.570	10.17	1.24	7.17	0.515	5.93	0.321	4.54	0.163	3.59	0.091					16.03	3.94
3 000	6.684	12.20	1.76	8.60	0.731	7.11	0.451	5.45	0.232	4.30	0.129	3.46	0.075		24″	19.24	5.59
3 500	7.798	14.24	2.38	10.03	0.982	8.30	0.607	6.35	0.312	5.02	0.173	4.04	0.101			22.44	7.56
4 000	8.912	16.27	3.08	11.47	1.27	9.48	0.787	7.26	0.401	5.74	0.222	4.62	0.129	3.19	0.052	25.65	9.80
4 500	10.03	18.31	3.87	12.90	1.60	10.67	0.990	8.17	0.503	6.46	0.280	5.20	0.162	3.59	0.065	28.87	12.2
5 000	11.14	20.35	4.71	14.33	1.95	11.85	1.21	9.08	0.617	7.17	0.340	5.77	0.199	3.99	0.079	...	...
6 000	13.37	24.41	6.74	17.20	2.77	14.23	1.71	10.89	0.877	8.61	0.483	6.93	0.280	4.79	0.111	...	...
7 000	15.60	28.49	9.11	20.07	3.74	16.60	2.31	12.71	1.18	10.04	0.652	8.08	0.376	5.59	0.150	...	...
8 000	17.82	...	...	22.93	4.84	18.96	2.99	14.52	1.51	11.47	0.839	9.23	0.488	6.38	0.192	...	...
9 000	20.05	...	...	25.79	6.09	21.34	3.76	16.34	1.90	12.91	1.05	10.39	0.608	7.18	0.242	...	...
10 000	22.28	...	...	28.66	7.46	23.71	4.61	18.15	2.34	14.34	1.28	11.54	0.739	7.98	0.294	...	...
12 000	26.74	...	...	34.40	10.7	28.45	6.59	21.79	3.33	17.21	1.83	13.85	1.06	9.58	0.416	...	...
14 000	31.19	...	...	...	...	33.19	8.89	25.42	4.49	20.08	2.45	16.16	1.43	11.17	0.562	...	...
16 000	35.65	...	...	...	...	...	...	29.05	5.83	22.95	3.18	18.47	1.85	12.77	0.723	...	...
18 000	40.10	...	...	...	...	...	...	32.68	7.31	25.82	4.03	20.77	2.32	14.36	0.907	...	...
20 000	44.56	...	...	...	...	...	...	36.31	9.03	28.69	4.93	23.08	2.86	15.96	1.12	...	...

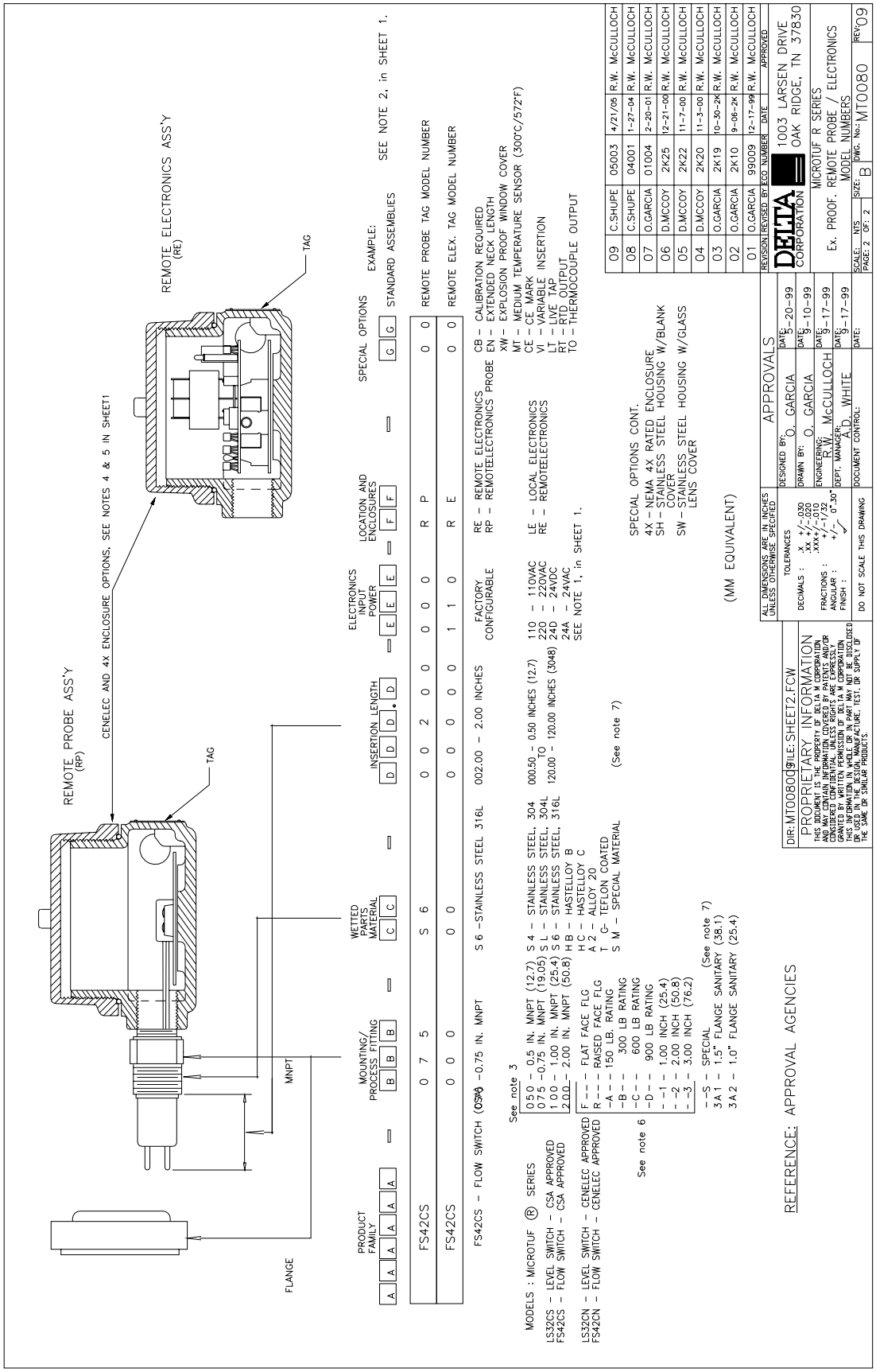
For pipe lengths other than 100 feet, the pressure drop is proportional to the length. Thus, for 50 feet of pipe, the pressure drop is approximately one-half the value given in the table . . . for 300 feet, three times the given value, etc.

Velocity is a function of the cross sectional flow area; thus, it is constant for a given flow rate and is independent of pipe length.

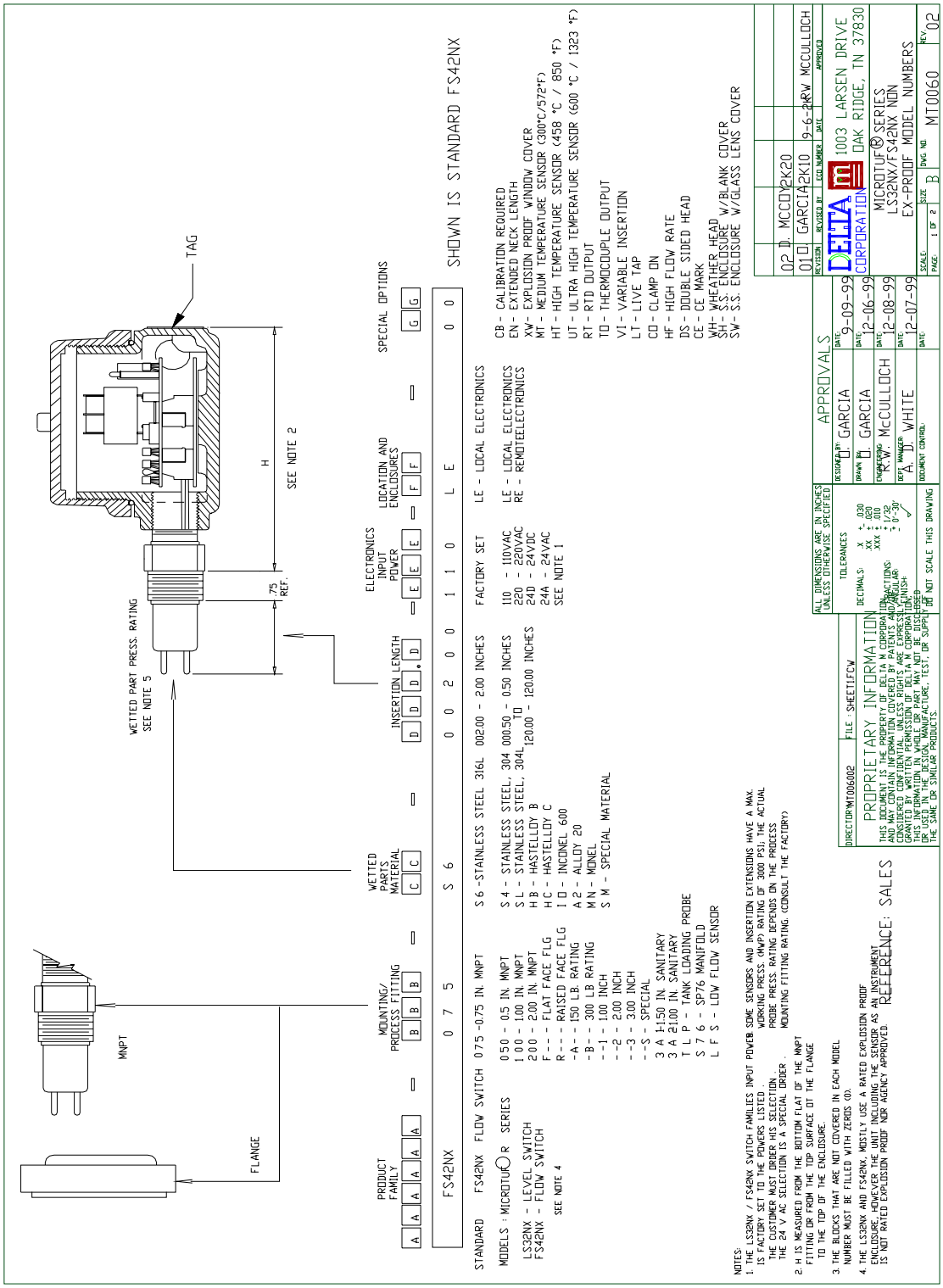
9.4 MODEL NUMBER DESIGNATION AND AVAILABLE OPTIONS



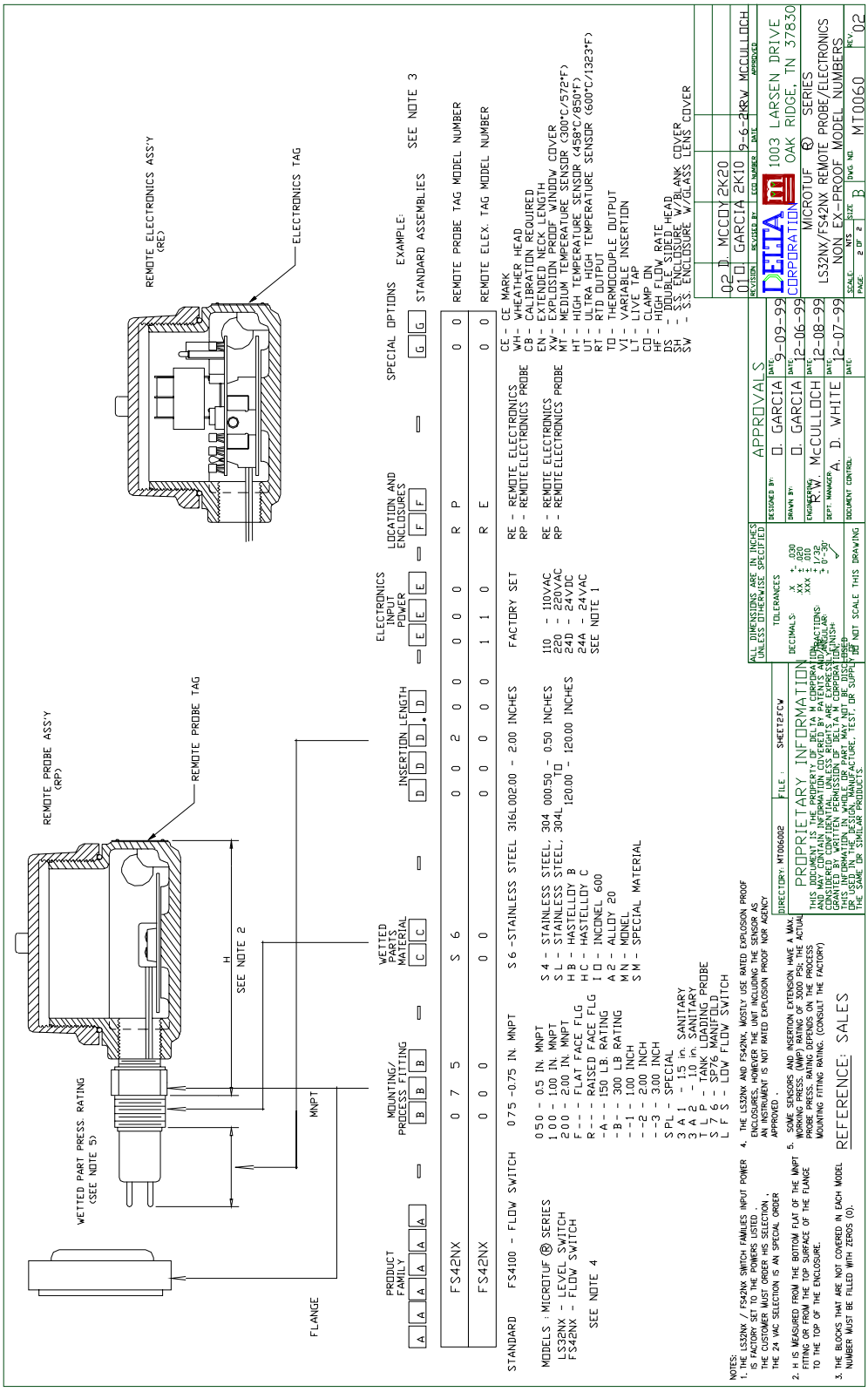
9.4 MODEL NUMBER DESIGNATION AND AVAILABLE OPTIONS



MODEL NUMBER DESIGNATION AND AVAILABLE OPTIONS



9.4 MODEL NUMBER DESIGNATION AND AVAILABLE OPTIONS



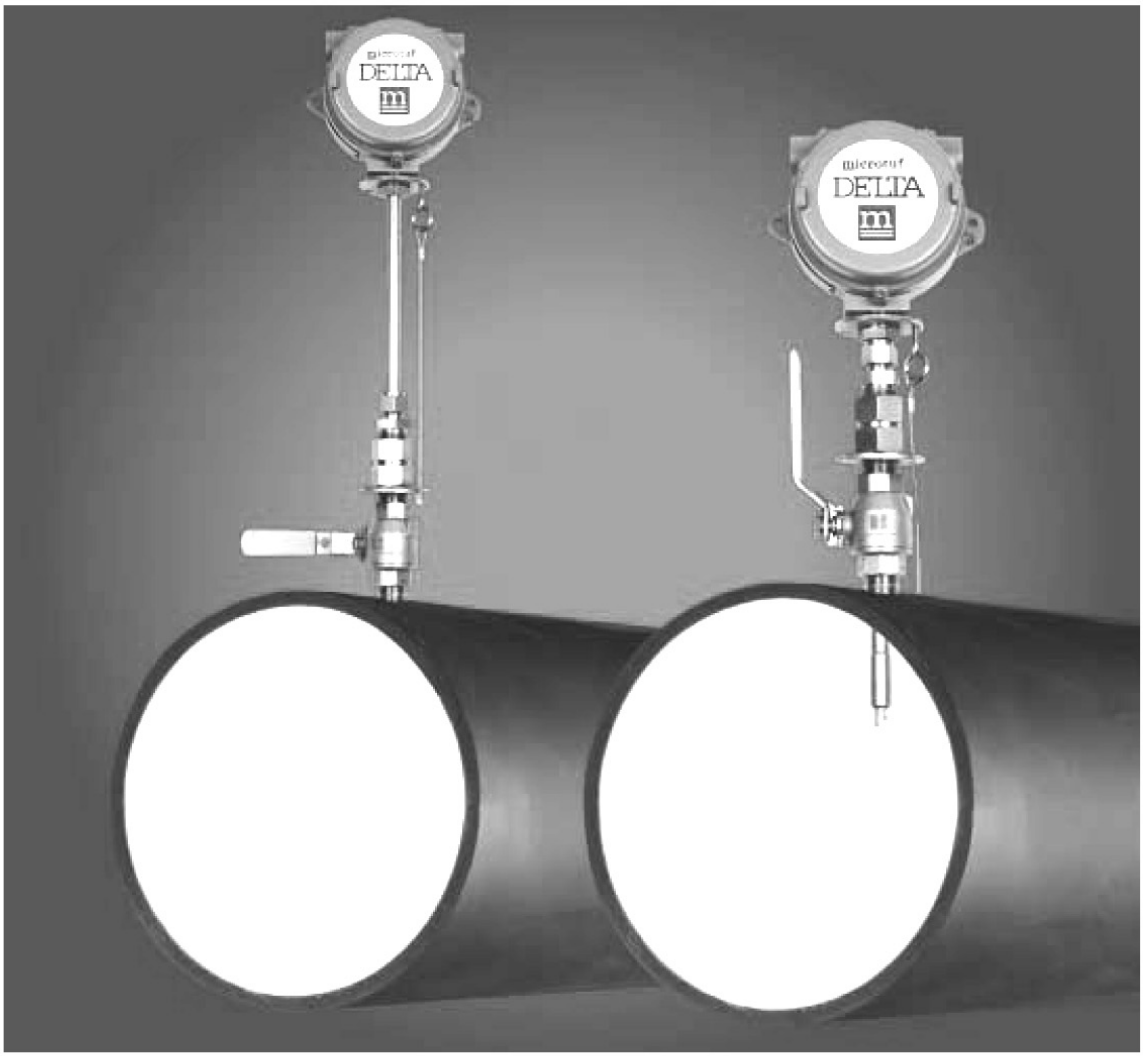
10.0OPTIONS

10.1 LIVETAP (LT)

DELTA m® CORPORATION

Livetap (LT)

Specifications & Operating Instructions



- Allows for the safe insertion and removal of DELTA M switches without interrupting the flow in your pipelines.
- For use with both the VERSA-SWITCH® and microtuf® line of DELTA M switches.
- External extraction gauge lets you know when the switch is clear of the valve.
- Standard Stainless Steel Construction.
- Operating temperature rating of 390° F. Allows for use in many high temperature applications.
- Dual safety restraint design to aid in the prevention of accidents.
- Live tap may be installed in both tanks and pipes without regard for orientation.
- Operating pressure rating of 300 psig.

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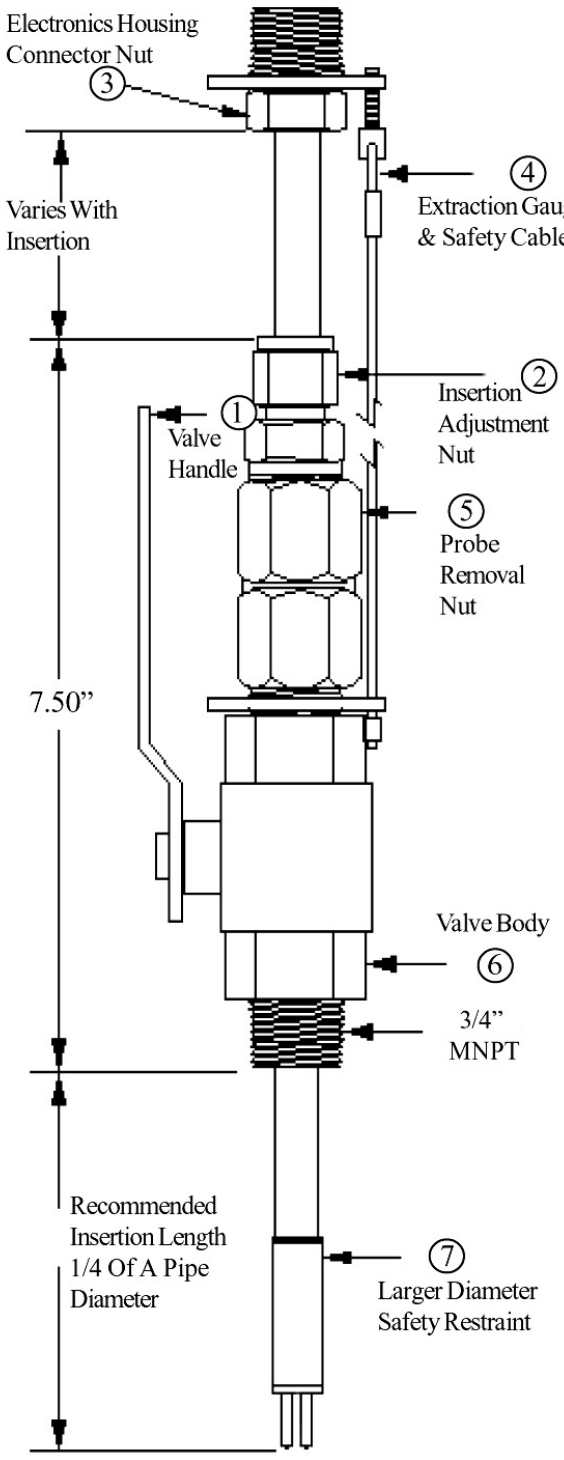
VERSA-SWITCH® and microtuf® Switch Option

Livetap (LT)
Operating Instructions



Installation

DELTA M's Livetap needs to be installed using industry standard piping practices. Install Livetap using the valve body (6) only to tighten.

Probe Insertion

First the valve handle (1) must be in the open position (handle turned so that it is parallel to the probe).

Second loosen nut (2) so that probe can be pushed into the pipe or tank by putting pressure on the switch head.

Third make sure that nut (3) touches nut (2). This ensures that the probe has been inserted the proper distance.

Fourth tighten nut (2). This will lock the probe in the inserted position.

Probe Removal

First loosen nut (2). This will allow for the removal of the switch from the flow stream by gently pulling on the switch head.

Second make sure that safety cable (4) is taut. This will ensure that the probe is clear of the valve.

Third close valve handle (1) (handle turned so that it is perpendicular to the probe).

Fourth loosen nut (5) completely. This will allow the probe with the larger diameter safety restraint assembly (7) to be removed from the valve assembly.

Form Number (DML 1008.02)

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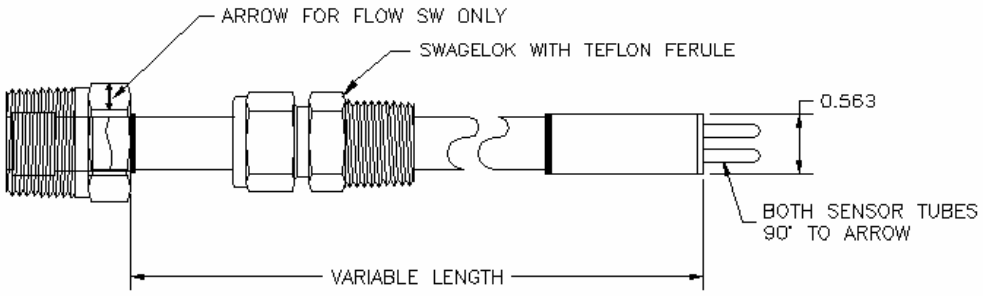
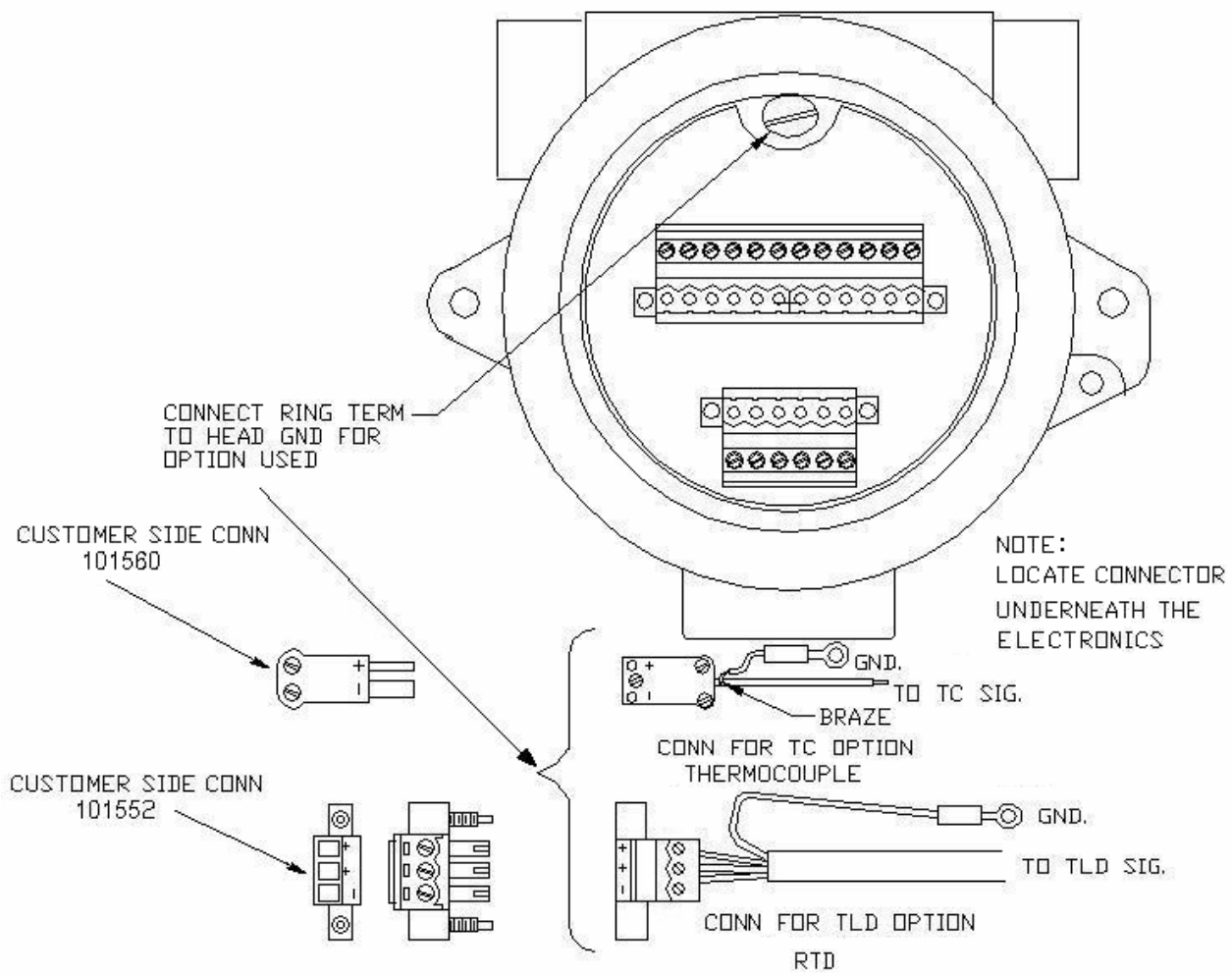
10.2 VARIABLE INSERTION (VI)



MAX PRESSURE AT TEFLON
SEAL IS 10 PSI

10.3 THERMOCOUPLE OUTPUT (TO) and 10.4 RTD OUTPUT (RT)

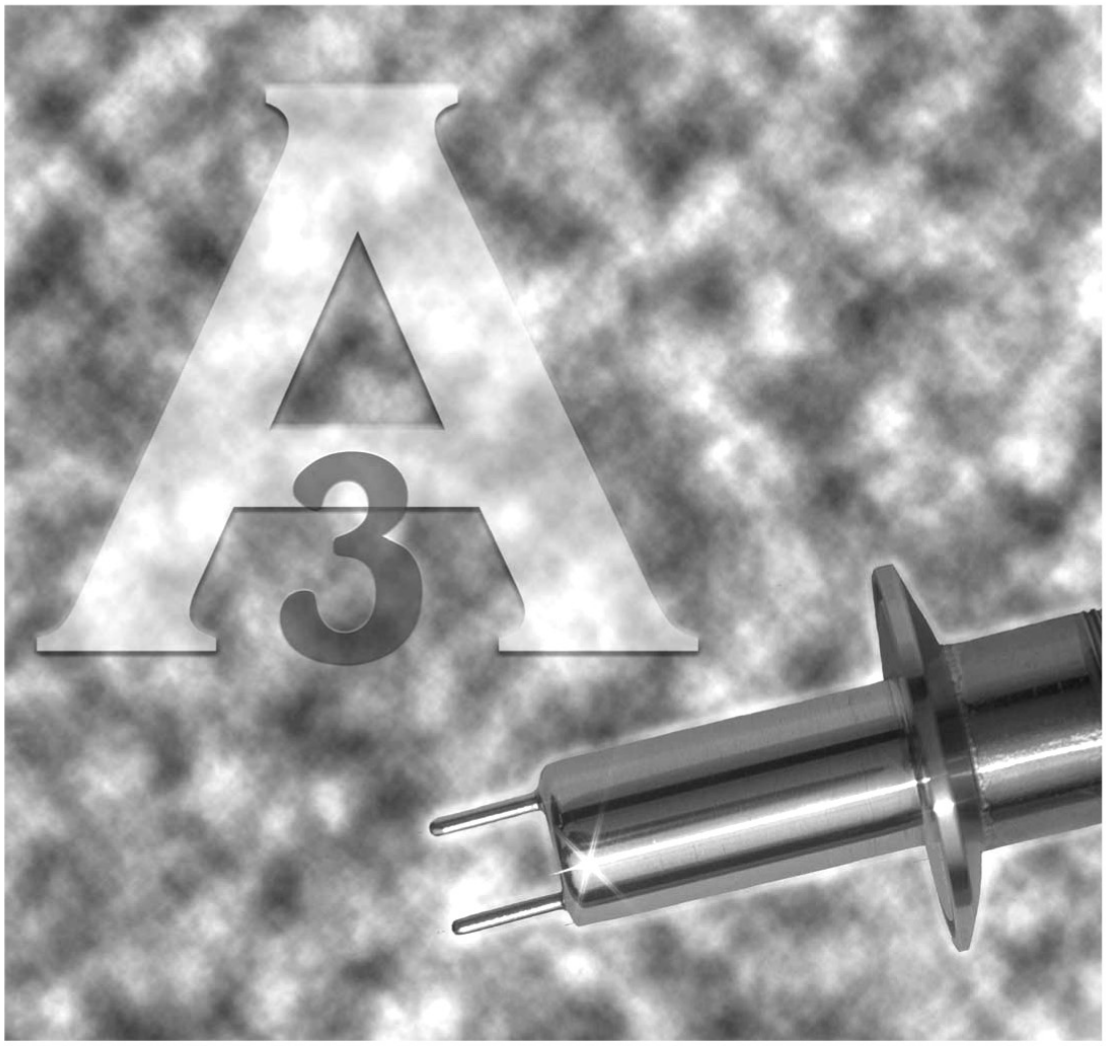


OPTION DRAWING
RT – RTD OUTPUT
TO – THERMOCOUPLE

10.5 SANITARY (3A1)

DELTA m CORPORATION

3A Sanitary Switch
Specifications & Operating Instructions



- DELTA M Corporation has received the authority to apply the 3-A symbol to our flow and level switches.
- For use with both the VERSA-SWITCH ® and microtuf® line of DELTA M switches.
- Standard operating temperature range of -100°F to 390°F with options to 850°F.
- Standard Stainless Steel Construction.
- 3-A Authorization No. 950 issued to DELTA M by 3-A Sanitary Standards Symbol Administrative Council
- Designed for use in both food, beverage, and pharmaceutical applications.
- Available with insertion length to suit your specific level or flow application.
- Operating pressure rating of 1500 psig.

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VERSA-SWITCH® & microtuf® Switch Option

* Shown Above with Optional Sanitary Tee

Operating Instructions

Installation

DELTA M's Sanitary Switch Option is to be installed using industry standard piping practices. Make sure that you have selected the proper gasket and clamp designed for your pressure, temperature and process fluid.

A3 Sanitary Switch

SPECIFICATIONS

Sensor Type:
Thermal Differential, Dual RTD Sensors

Process Connection:
Standard 1.5 inch sanitary
Optionally 1.0 inch and larger

Insertion Length:
Standard 2.53 inch
Optionally custom length to suit your specific application.

Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)
Medium temp to +572°F (+300°C)
High temp to +850°F (+458°C)

Materials of Construction:
Standard all welded 316L series stainless steel with nickel filler.

Operating Pressure Range:
Standard to 1500 psia (102 bar) with the proper clamp and gasket.

Operating Range:
Adjustable flow rate (feet per second - fps), typical: 0.01 to 5.0 fps liquids and 0.1 to 500 fps gases

Response Time:
Sensor response time 0.5 to 10 seconds media dependent

Stability:
Drift < .5% from calibrated setpoint over a range of ±50° F. Temperature compensated throughout entire range

Repeatability:
±1% of setpoint

Form Nuniber (DML1001.02)

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10.6 SP76 MANIFOLD (S76)

SP76 Compliant Mass Flow Switch

SPECIFICATIONS

Sensor

Type:
Thermal Differential, Dual RTD Sensors
Process Connection:
SP 76 Compliant 1.5 x 1.5 inch
Sensor Dimensions:
Height 4.4 inch
Width 1.5 inch
Length 1.5 inch
Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)
Materials of Construction:
Standard 316L Series Stainless Steel
Operating Pressure Range:
Standard to 3000 psia (207 bar)

Electronics

Power:
Standard 110VAC Optionally 220VAC, or 24VDC at 3 watts (No heater power required)
Operating Temperature Range:
Standard -40°F to +140°F (-40°C to +60°C)
Outputs:
microtuf®
DPDT Relay contacts rated at 5 amp, 250 VAC with fail safe capability
VERSA-SWITCH®
Independent primary relay DPDT and secondary relay SPDT, contacts rated at 5 amp, 250 VAC with fail safe capability; built in time delay 0 to 300 seconds for each channel
Self-Test:
Integral and automatic during power up
Enclosure:
Explosion proof; NEMA 3, 4, 7, and 9; CSA, FM, UL, CENELEC, and EECS approved

Instrument

Operating Range:
Adjustable flow rate (feet per second - fps), typical: 0.01 to 5.0 fps liquids and 0.1 to 500 fps gases
Response Time:
Sensor response time 0.5 to 10 seconds media dependent
Stability:
Drift < .5% from calibrated setpoint over a range of ±50° F. Temperature compensated throughout entire range
Repeatability:
±1% of setpoint
Approvals:
Intrinsically Safe when used with IS option and proper barriers Class 1 Div. 1 Groups A,B, C, & D

Model Number Selection Guide

Code Model
VS5100 - Dual Channel VERSA-SWITCH
VS51NX- Dual Channel Non Explosion Proof
FS51SC - Single Channel Mass Flow Switch
FS51NX- Single Channel Flow Non Explosion Proof
FS42CS - CSA Approved Switch
FS42CN - CENELEC Approved Switch
FS42NX - Non Explosion Proof Switch

Code - Process Connection
S76 - SP76 Compliant

Code - Sensor Material
S6 - 316L Stainless Steel (std)
SM - Special Material

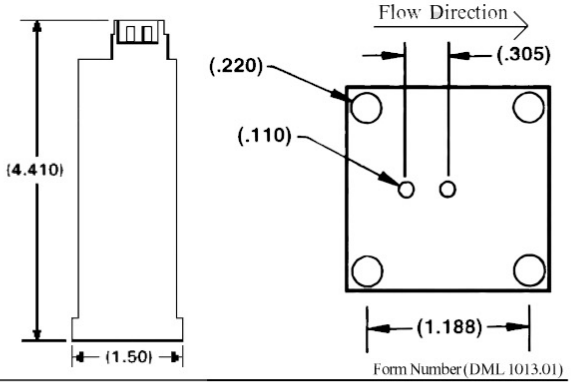
Code - Insertion Length
000.00 -000.00 inch (std)

Code - Power Input
FLD - Field Config. (Versa only)
110 - 110 VAC
220 - 220 VAC
24D - 24 VDC
24A - 24 VAC(Versa only)

Code - Configuration
RE-Remote Electronics

Code - Special Option
QD - Quick Disconnect (Standard)
XW- X Proof Window
DS - Double Sided
FA - Failure Alarm (VS5100 Only)
RT - RTD Output
TO-Thermocouple Out
CA - Additional Cable
CE - CE Approved
NP - Pipe Connection
IS - Intrinsically Safe

FS42NX - S76 -S6 - 000.00-24D-RE-QD Model Number



Form Number (DML 1013.01)

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10.7 TANK LOADING PROBE (TLP)

DELTA m CORPORATION

Truck & Rail Car Loading Sensor

DELTA M has a specially designed sensor for use in loading trucks and railcars. This unit has a quick locking clamp that attaches to the manhole and allows the probe to be adjusted to the desired level inside of the tank. These units can be used in hazardous areas and corrosive environments. The use of these sensors has been instrumental in preventing spills caused by accidental over filling and in preventing the time and cost involved in off loading material when a truck has been filled beyond its weight restrictions.

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SPECIFICATIONS

Sensor

Type:
Thermal Differential, Dual RTD Sensors
Process Connection:
Automatically latching clamp
Insertion Length:
Standard 32.0 inch
Optionally 12 inch to 96 inches
Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)
Medium Temperature to +572°F (+300°C)
Materials of Construction:
Standard 316L Series Stainless Steel
Optionally Hastelloy, Monel, Inconel and other exotic materials
Operating Pressure Range:
Standard to 3000 psia (207 bar)

Electronics

Power:
Standard 110VAC Optionally 220VAC, or 24VDC at 3 watts (No heater power required)
Operating Temperature Range:
Standard -40°F to +140°F (-40°C to +60°C)
Outputs:
microtuff®
DPDT Relay contacts rated at 5 amp, 250 VAC with fail safe capability
VERSA-SWITCH®
Independent primary relay DPDT and secondary relay SPDT, contacts rated at 5 amp, 250 VAC with fail safe capability; built in time delay 0 to 300 seconds for each channel
Self-Test:
Integral and automatic during power up
Enclosure:
Explosion proof; NEMA 3, 4X, 7, and 9; CSA, FM, UL, CENELEC, and EECS approved

Instrument

Operating Range:
Switch on level change of .03 inch. Available with insertion lengths from 12 to 96 inches.
Response Time:
Sensor response time 0.1 to 1 second media dependent
Stability:
Drift < .5% from calibrated setpoint over a range of ±50° F. Temperature compensated throughout entire range.
Repeatability:
±1% of setpoint
Approvals:
Opptionally CE, CSA,CENELEC
Class 1 Div. 1 Groups B, C, & D when used with explosion proof cable and conduit.
Intrinsically Safe when used with IS option and proper barriers Class 1 Div. 1 Groups A,B, C, & D

Code Model
VS5100 - Dual Channel VERSA-SWITCH
VS51NX- Dual Channel Non Explosion Proof
LS51SC - Single Channel Mass Flow Switch
LS51NX- Single Channel Flow Non Explosion Proof
LS32CS - CSA Approved Switch
LS32CN - CENELEC Approved Switch
LS32NX - Non Explosion Proof Switch

Code - Process Connection
TLP - Truck Loading Probe

Code - Sensor Material
S6 - 316L Stainless Steel (std)
HB - Hastelloy B
HC - Hastelloy C
IO - Inconel 600
MN - Monel
A2 - Alloy 20
SM - Special Material

Code - Insertion Length
32.00 -32.00 inch (std)
00.00 - 12" to 96.00" in .25"

Code - Power Input
FLD - Field Config. (Versa only)
110 - 110 VAC
220 - 220 VAC
24D - 24 VDC
24A - 24 VAC(Versa only)

Code - Configuration
RE-Remote Electronics (std)
RC-Remote Control Unit

Code - SpecialOption
CO- Clamp On (std)
XW- X proof Window
DS - Double Sided
FA - Failure Alarm (VS5100 Only)
RT - RTD Output
TO-Thermocouple Out
CA - Additional Cable
CE - CE Approved
IS - Intrinsically Safe (LS32NX only)
XC- X Proof Cable

LS32NX - TLP - S6 - 32.00 - 24D - RE -CO Model Number

Represented In Your Area By

Form Number (DML 1016.00)

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10.8 LOW FLOW (LF)

DELTA m® CORPORATION

Low Flow Sensor

- Developed for low flow gas and liquid applications where reliability and durability are mandatory
- Very low internal volume so that sample times are very short and sample system response remains quick
- All Welded Stainless Steel Construction
- For use with both the VERSA-SWITCH® and microtuf® line of DELTA M switches
- Standard operating temperature range of -100° F to 390° F
- 1/4 inch FNPT process ports that can easily be adapted to tubing by using standard fittings

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SPECIFICATIONS

Sensor

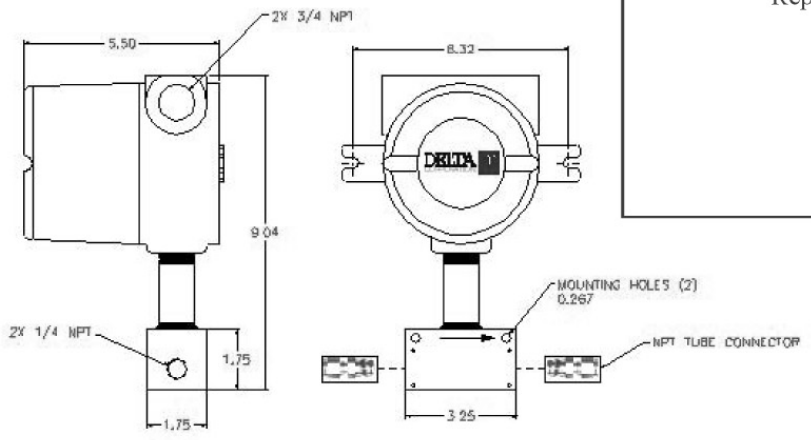
Type:
Thermal Differential, Dual RTD Sensors
Process Connection:
1/4" FNPT (2) Inlet and Outlet
Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)
Material of Construction:
Standard 316L Series Stainless Steel
Operating Pressure Range:
Standard to 3000 psia (207 bar)

Electronics

Power:
Standard:110VAC, Optionally: 220VAC, 24VDC or 24VAC at 3 watts (No heater power required)
Operating Temperature Range:
Standard -40°F to +140°F (-40°C to +60°C)
Outputs:
microtuf®
DPDT Relay contacts rated at 5 amp, 250 VAC with fail safe capability
VERSA-SWITCH®
Independent primary relay DPDT and secondary relay SPDT, contacts rated at 5 amp, 250 VAC with fail safe capability; built in time delay 0 to 300 seconds for each channel
Self-Test:
Integral and automatic during power up
Enclosure:
Explosion proof; NEMA 3, 4X, 7, and 9; CSA, FM, UL, and EECS approved

Instrument

Operating Range:
.33ccm to 2000ccm in liquid and 30ccm to 200,000ccm in gas
Approvals:
Optionally CE, CSA,
Class 1 Div. 1 Groups B, C, & D



INTERNAL VOLUME= 0.038 in³

Model Number Selection Guide

Code Model
VS5100 - Dual Channel VERSA-SWITCH
VS51NX- Dual Channel Non Explosion Proof
FS51SC - Single Channel Mass Flow Switch
FS51NX- Single Channel Flow Non Explosion Proof
FS42CS - CSA Approved Switch
FS42NX - Non Explosion Proof Switch

Code - Process Connection
LFS - Low Flow Sensor

Code - Sensor Material
S6 - 316L Stainless Steel (std)

Code - Insertion Length
00.00 - None

Code - Power Input
FLD - Field Config. (Versa only)
110 - 110 VAC
220 - 220 VAC
24D - 24 VDC
24A - 24 VAC

Code - Configuration
LE-Local Electronics (std)
RE-Remote Electronics

Code - Special Option
OO - No Special Option
XW- X Proof Window
PC - Potted Cable
FA - Failure Alarm (VS5100 Only)
RT - RTD Output
TO-Thermocouple Out
CA - Additional Cable
CE - CE Approved (microtuf® Only)
QD - Quick Disconnect
CB - Calibration req.

FS42CS - LFS - S6 - 00.00 - 110 -LE-OO Model Number

Represented In Your Area By

Form Number (DML 1018.00)

DELTA M Corporation - 1003 Larsen Drive - Oak Ridge, Tennessee 37830 - USA - Phone: (865) 483-1569 - Fax (865) 483-1142 - http://www.deltamcorp.com

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10.9 INTRINSICALLY SAFE (IS)

INTRINSIC SAFETY WITH BARRIER DOCUMENTATION LIST

I. DOCUMENTATION TO BE SENT WITH PRODUCT

1. Control Drawing (MT0085): Must be sent with the product and be addressed by the application engineer and/or the Intrinsic Safety responsible engineer of the plant.

   Contains: The Intrinsic Safety entity parameters and the field wiring parameters, the recommended field wiring types to use and the worse case surface temperatures for the hot sensor. Has the wiring interconnections between the sensors and the barriers (controlled wiring) and the wiring between the barriers and the electronics has the terminal identification after the power and relay contacts output for the electronic assembly.

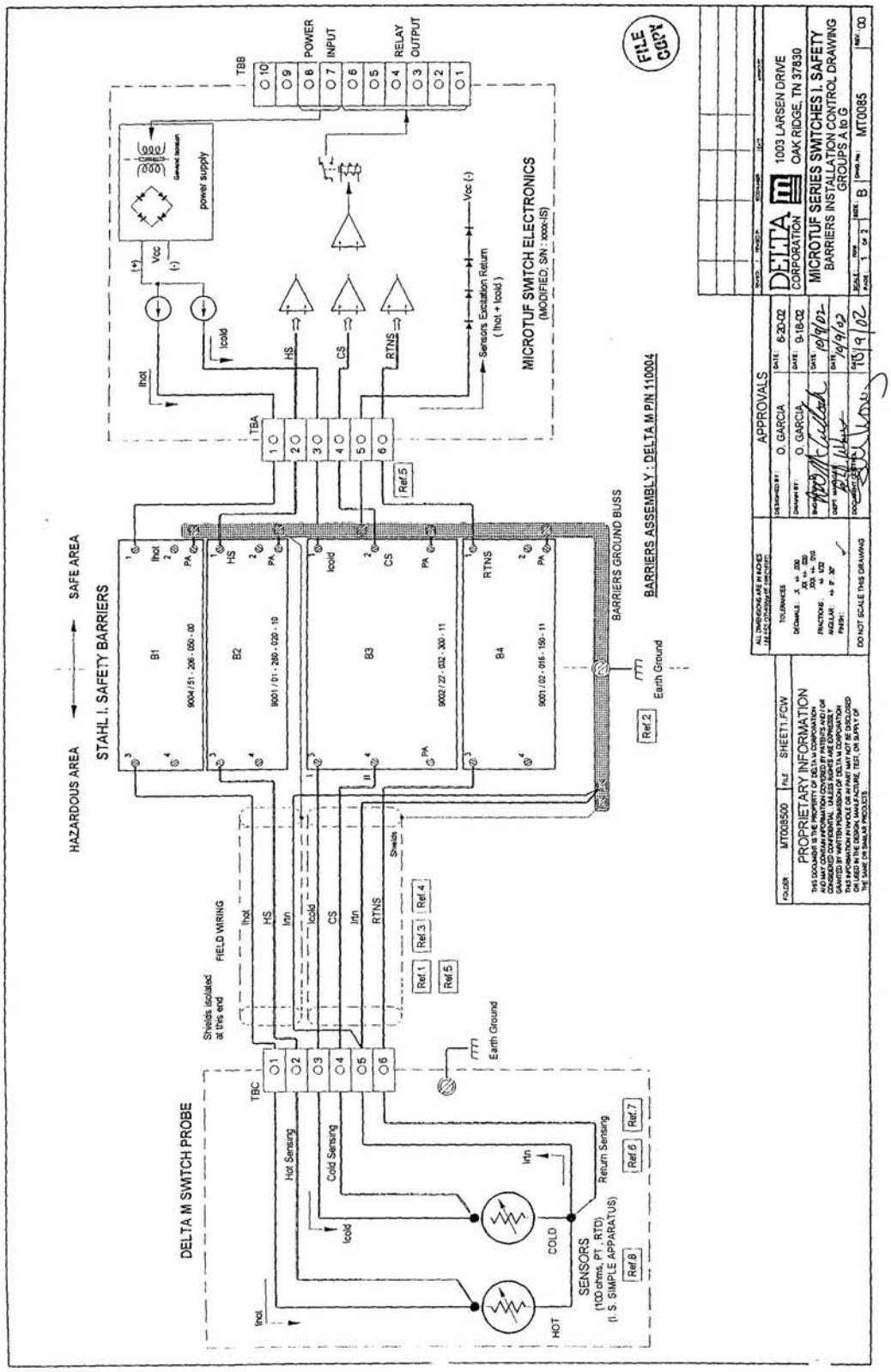
2. Drawing ISB62: Is a drawing with the overall dimensions and mounting footprint of the different enclosures including fiberglass Nema 4 and 4X, metallic Nema 4 and 4X, and Explosion Proof enclosures. This drawing should be delivered when the P.O. is received to the engineer in charge of the installation or with the deliverables.

II. BACKUP DOCUMENTATION

3. Letter from Stahl (9/13/02): Intrinsic Safety Third Party Intrinsic Safety Barrier Combination Evaluation for the combination of a zener diode barrier and an electronic barrier used in the hot sensor. This should be delivered to a customer **if** they require a third party evaluation of the intrinsic safety.

4. Back Up Article on Intrinsic Safety from Stahl: There is a reprint of an article provided by Stahl that explains how the combination of a zener diode and an electronic barrier works and how the Intrinsic Safety entity parameters are obtained. Copies of this article were delivered to Dan and Randy and are not in the rebuilt engineering folder of the design. This article should be provided to a plant Intrinsic Safety engineer if he/she has problems with the “Electronic Barrier”.

5. Drawings (ISB60, ISB61): Are intended to help in explaining to the customer how the electronic assembly, the barrier assembly and the sensor assemblies can be packaged and put together so the customer can decide what combination he needs.


HAZARDOUS AREA
SAFE AREA
STAHL I. SAFETY BARRIERS
B1
B2
B3
B4
9004 / 51 - 206 - 050 - 00
9001 / 01 - 280 - 020 - 10
9002 / 22 - 032 - 300 - 11
9001 / 02 - 016 - 150 - 11
BARRIERS GROUND BUSS
BARRIERS ASSEMBLY : DELTA M P/N 110004
Ref.2
Earth Ground
TBB
POWER
INPUT
RELAY
OUTPUT
power supply
MICROTUF SWITCH ELECTRONICS
(MODIFIED; S/N : 3000-IS)
Vcc (-)
Sensors Excitation Return
(Ihot + Icold)
Ihot
Icold
HS
CS
RTNS
TBA
Ref.5
FIELD WIRING
Shields isolated at this end
Shields
Irtn
Ref.1
Ref.3
Ref.4
TBC
DELTA M SWITCH PROBE
Hot Sensing
Cold Sensing
Return Sensing
SENSORS
(100 ohms, PT, RTD)
(I. S. SIMPLE APPARATUS)
Ref.6
Ref.7
Ref.8
COLD
HOT
FILE COPY
APPROVALS
O. GARCIA
6-20-02
9-18-02
10/9/02
10/9/02
DELTA M CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
MICROTUF SERIES SWITCHES I. SAFETY
BARRIERS INSTALLATION CONTROL DRAWING
GROUPS A to G
MT0085
PROPRIETARY INFORMATION
DO NOT SCALE THIS DRAWING

REFERENCES:

1.- THE INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE NFPA, 70 ARTICLE 504, AND ANSI / ISA - RP 12.6

2.- THE BARRIER MUST BE CONNECTED TO A SUITABLE GROUND ELECTRODE PER NFPA 70, ARTICLE 504, THE RESISTANCE OF THE GROUND PATH MUST BE LESS THAN 1 OHM.

3.- THE CAPACITANCE AND INDUCTANCE OF THE CABLES MUST BE RESTRICTED TO THE FOLLOWING VALUES :

HOT SENSOR CABLE :

GROUPS	Ca (uF)	La (mH)
A, B, E	.01	.15
C, D, F, G	.2	.10

COLD SENSOR CABLE :

GROUPS	Ca (uF)	La (mH)
A, B	1000	.12
C, E	1000	.8
D, F, G	1000	1.8

4.- ENTITY PARAMETERS :

HOT SENSOR :

Voc = 28 V.

Isc = 70 mA.

Po = 1.17 W.

COLD SENSOR :

Voc = 3.3 V.

Isc = 382.2 mA.

Po = .052 W.

5.- FIELD WIRING : TWISTED SHIELDED PAIRS or SHIELDED CABLES MIN. 24 AWG. WIRING BETWEEN ELCTRONICS AND BARRIERS: 3 TWISTED SHIELDED PAIRS DELTA M PART # 101567 PROVIDED WHEN REQUESTED BY CUSTOMER).

6.- THE HOT SENSOR SURFACE TEMPERATURE IN NORMAL OPERATION IS 67 °C (REFERENCED TO 40 °C AMBIENT)

7.- THE HOT SENSOR SURFACE TEMP. UNDER WORST CASE FAILURE IS 149 °C (REFERENCED TO 40 °C AMBIENT)

8.- SIMPLE APPARATUS IS DEFINED AS A DEVICE THAT WILL NEITHER GENERATE OR STORE MORE THAN :

1.2 V., 100 mA., 25 mW., or 20 uJ.

FILE COPY

FOLDER: MT008500 FILE: SHEET2.FCW

PROPRIETARY INFORMATION

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

TOLERANCES
DECIMALS: .X ± .030, .XX ± .020, .XXX ± .010
FRACTIONS ± 1/32
ANGULAR: ± 0° 30'
FINISH:

DO NOT SCALE THIS DRAWING

APPROVALS			
DESIGNED BY	O. GARCIA	DATE	6-20-02
DRAWN BY	O. GARCIA	DATE	9-18-02
ENGINEERING	[signature]	DATE	10/9/02
DEPT MANAGER	[signature]	DATE	10/9/02
DOCUMENT CONTROL	[signature]	DATE	10/9/02

DELTA m CORPORATION 1003 LARSEN DRIVE OAK RIDGE, TN 37830

MICROTUF SERIES SWITCHES I. SAFETY BARRIERS INSTALLATION CONTROL DRAWING GROUPS A to G

SCALE: NONE PAGE: 2 of 2 SIZE: B DWG No. MT0085 REV: 00

the easy way!!

INNOVATIVE EXPLOSION PROTECTION

STAHL

Sep. 13, 2002

Mr. Omar Garcia
Senior Electrical Engineer
DELTA M Corporation
1003 Larsen Drive
Oak Ridge, TN 37830

Re: Intrinsic Safety Barrier Combination Evaluation
Ref: Your letter dated Aug. 19, 2002

Dear Mr. Garcia,
thank you very much for your request.
As discussed earlier the evaluation of intrinsically safe circuit combinations with I.S.-circuits using constant current output limitation stages must be evaluated using the appropriate ignition curves provided earlier to you.

Summary:
The evaluation of barrier combination connected in parallel relative to common ground using Stahl barrier model nos. 9004/51-206-050-00 and 9001/01-280-020-10 reveals that this combination of I.S.-circuit connections remains safe for connection to sensors located in hazardous locations classified as:
Class I, II, III; Div. 1 and 2; Groups A, B, C, D, E, F and G with the following intrinsically safe parameters:

Open circuit voltage, V_{oc}	28V	
Short circuit current, I_{sc}	70mA	
Max. power, P_o	1.17W	
	Hazardous Location Groups	
	A,B,E	C,D,F,G
Int. capacitance C_i+C_{wire}	10nF	0.2µF
Int. inductance L_i+L_{wire}	0.15mH	10mH

Comments:
Please see the attached ignition curves for your information.
In fact, if it helps to improve the performance of the application the resistive barrier 9001/01-280-020-10 may be substituted with a barrier with an Isc not exceeding about 140mA [(190 - 50)mA] and the Voc remaining at 28Vdc without negatively impacting the I.S.- safety parameters. Of course, the max. power transfer will increase.
A suitable barrier may be Stahl model no. 9001/01-280-110-10.

Please let me know if we can be of further assistance to you.

Winni Faulring

R. Stahl, Inc.
45 Northwestern Drive Salem, NH 03079 Tel. 800-782-4357 Fax. 603-870-9290 e-mail: sales@rstahl.com

IS1 the easy way!!

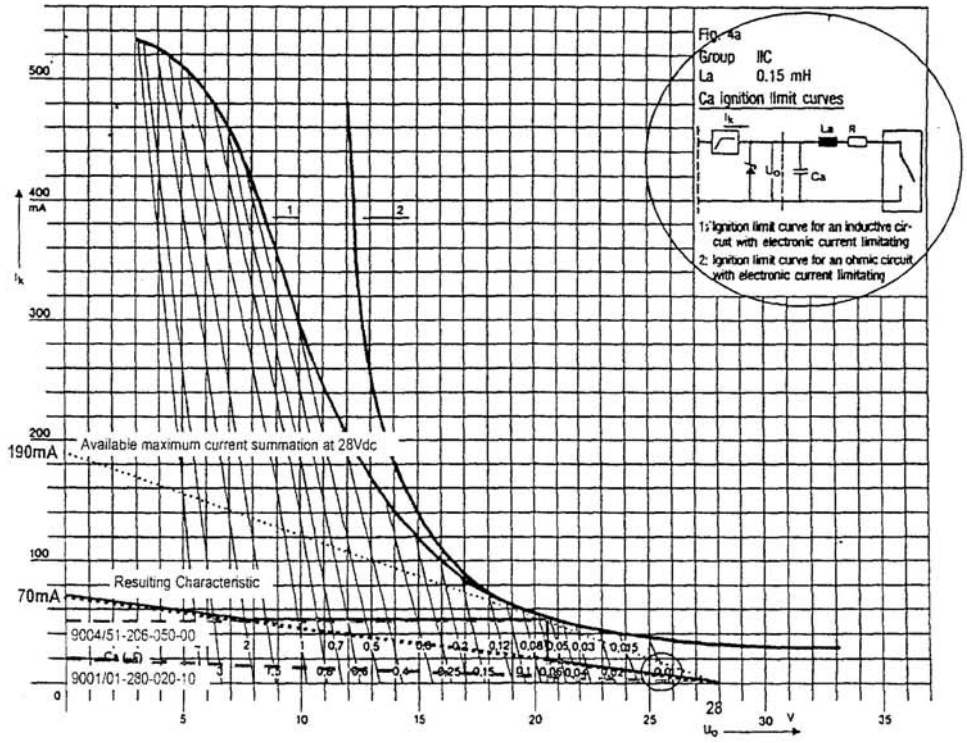
INNOVATIVE EXPLOSION PROTECTION

STAHL

Sep. 13, 2002

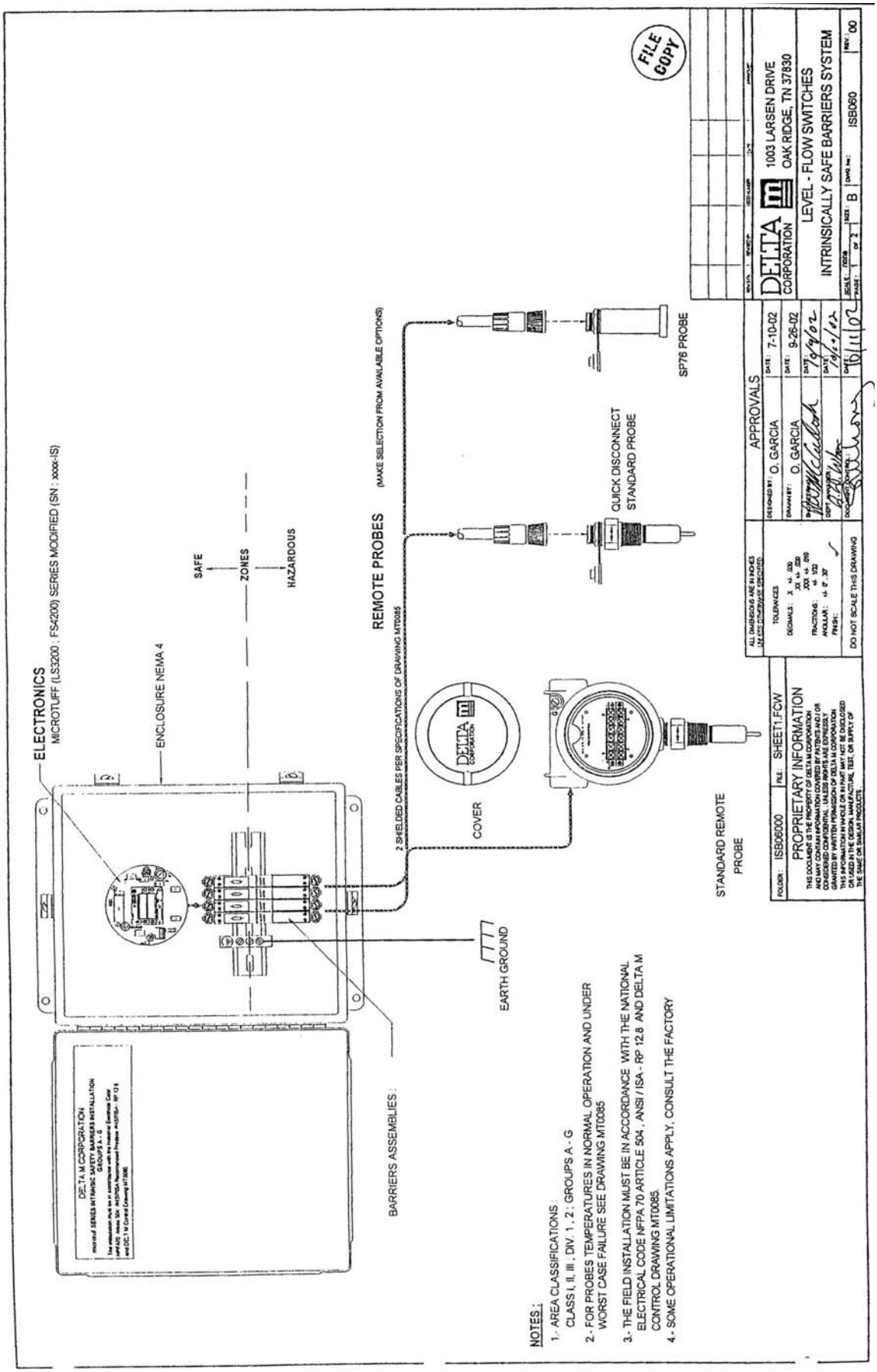
Mr. Omar Garcia
Senior Electrical Engineer

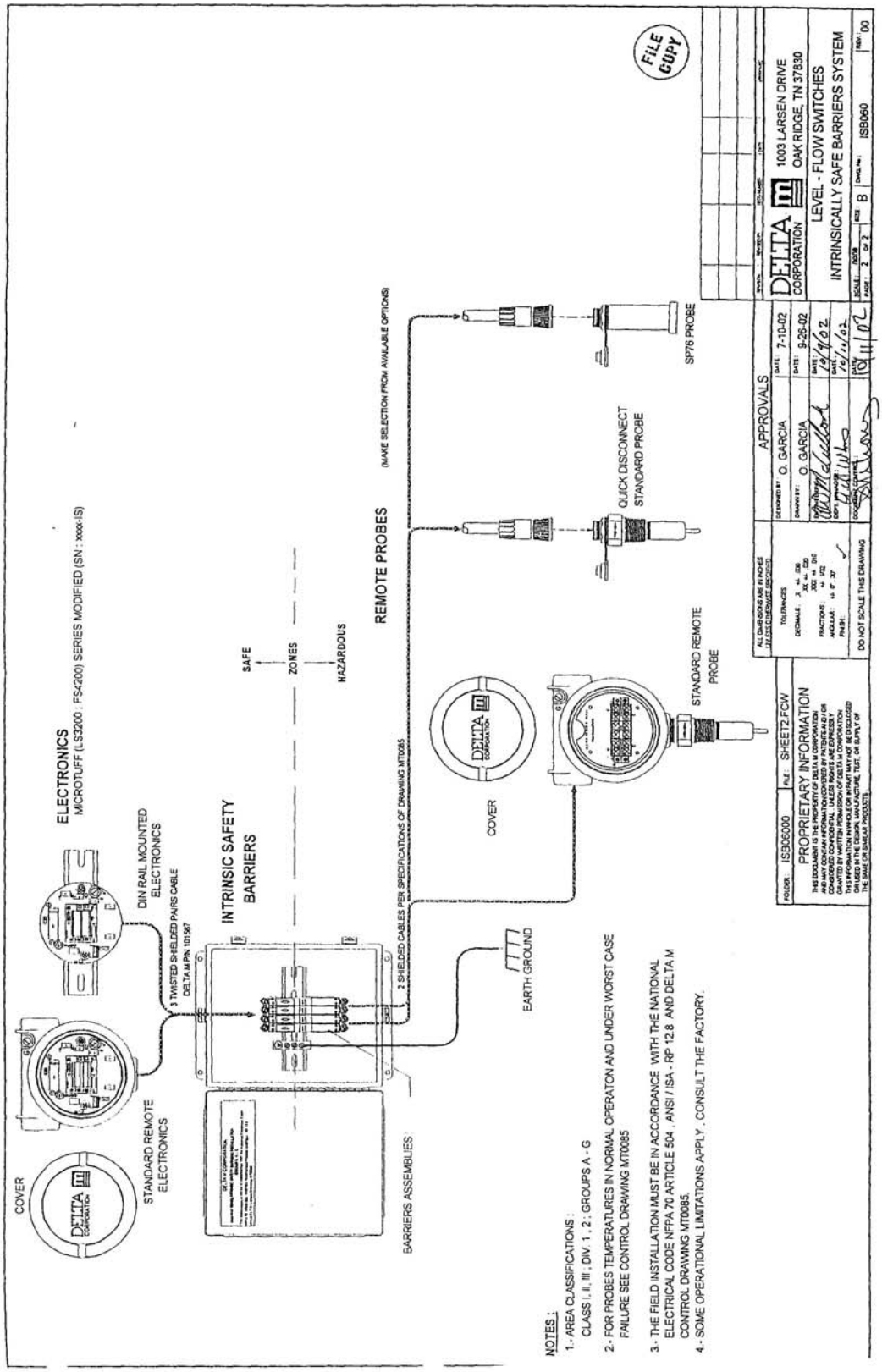
Limitation Curve diagram for I.S-circuit combinations with electronic current limitations
Hazardous location Groups A to G

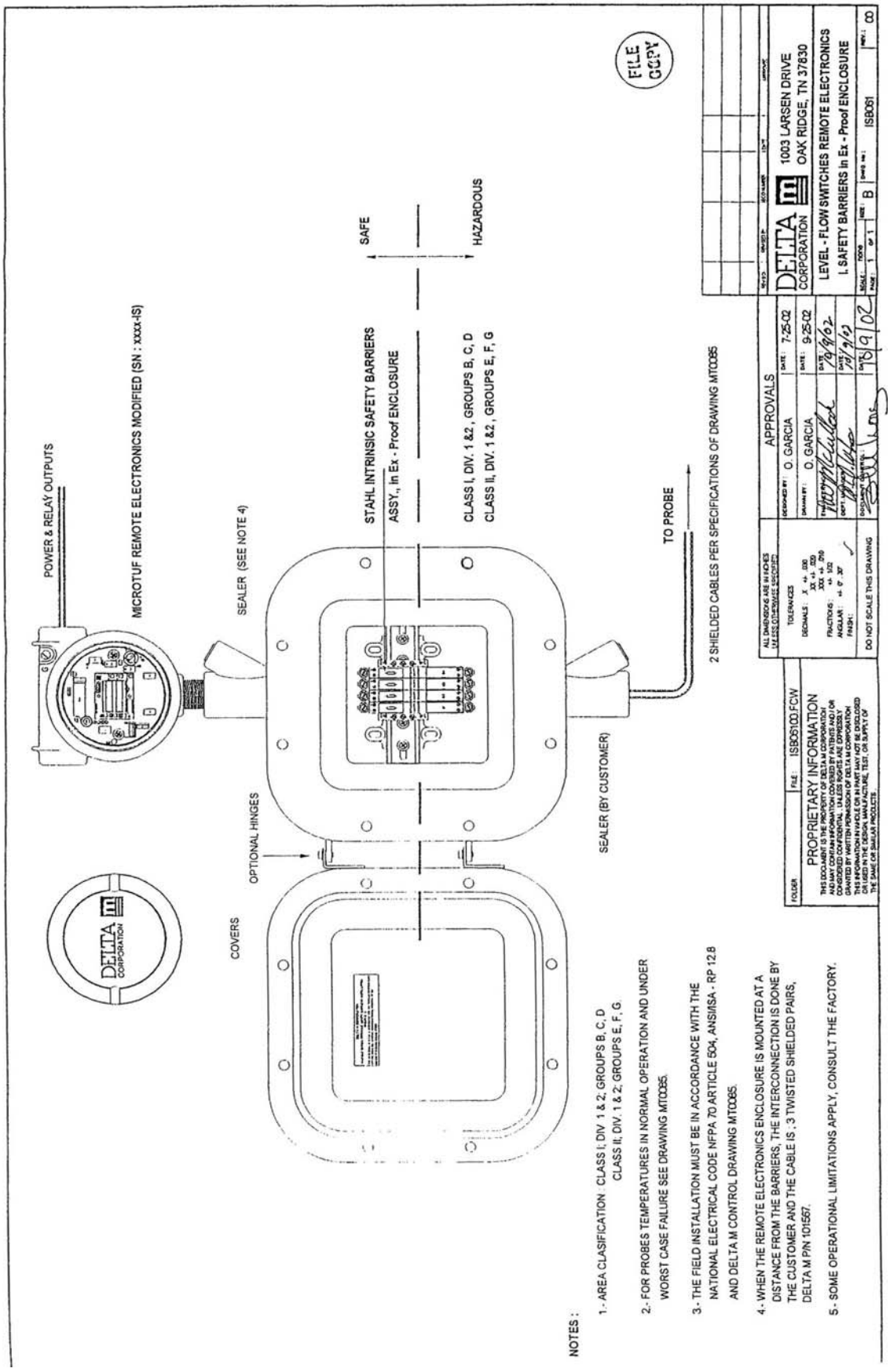


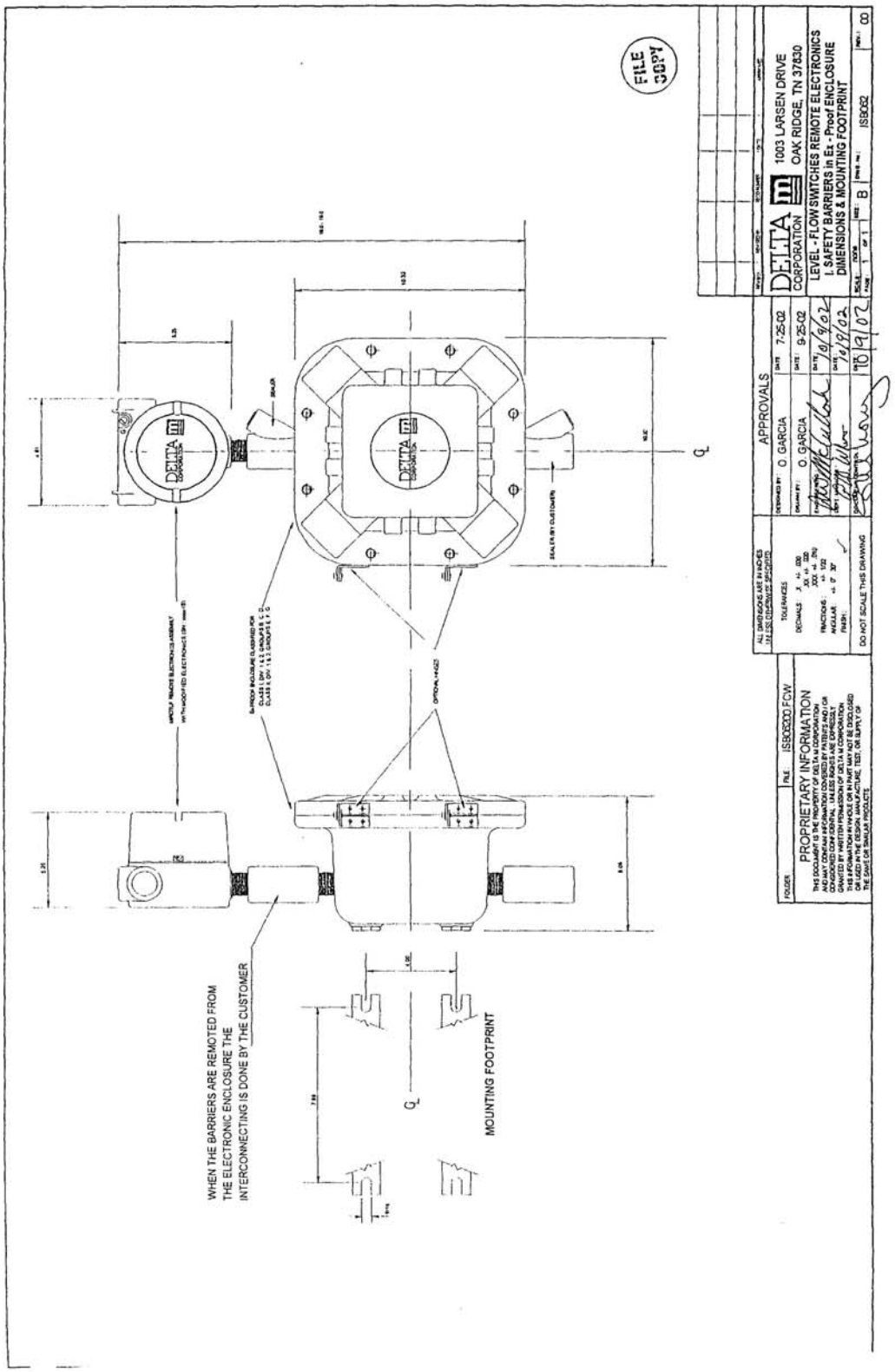
Conclusion:
All sections of the resulting value combinations are at or below the ignition limitation curve, thus the combination remains safe for the parameters as specified above.

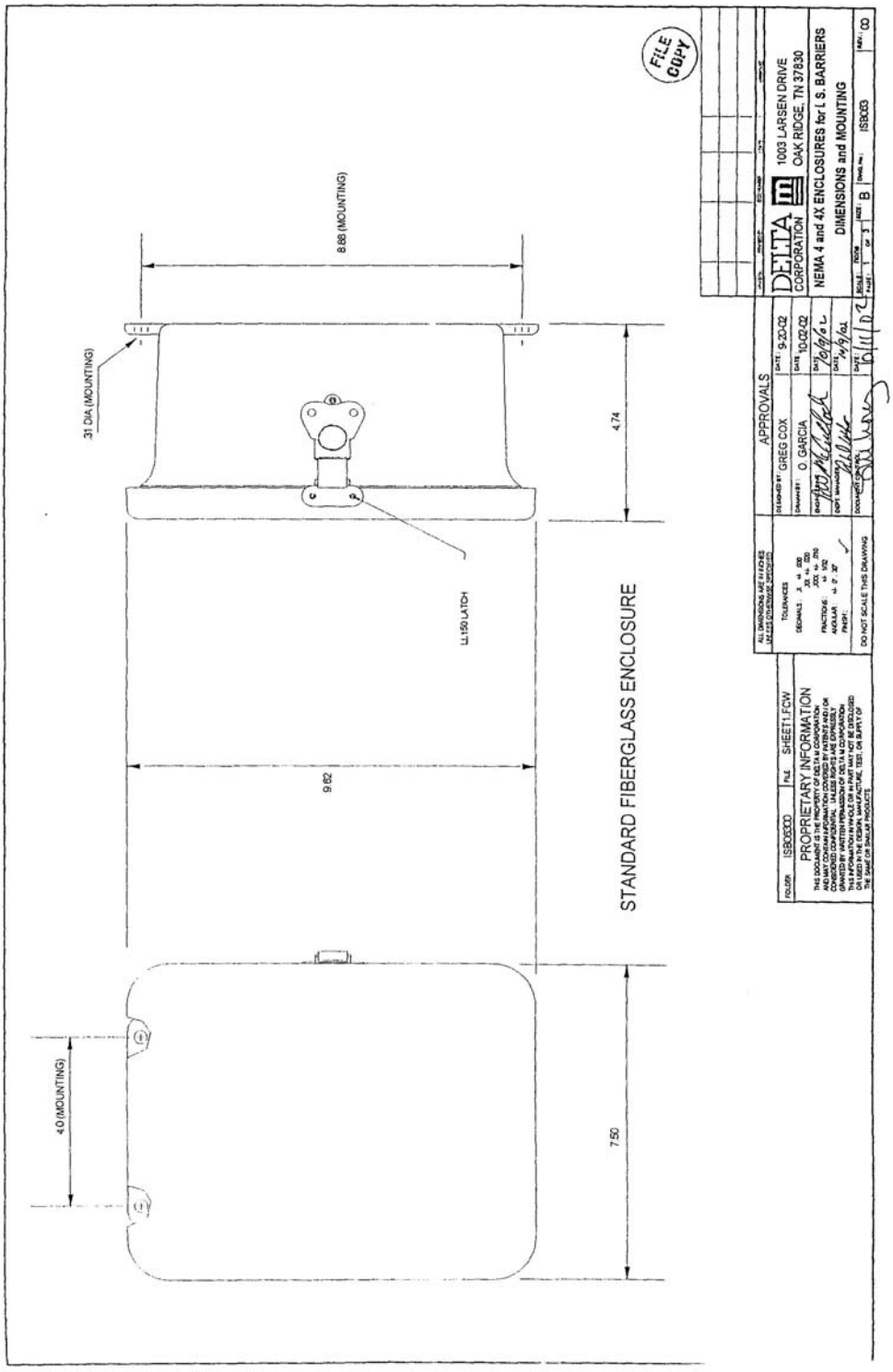
R. Stahl, Inc.
45 Northwestern Drive Salem, NH 03079 Tel. 800-782-4357 Fax. 603-870-9290 e-mail: sales@rstahl.com

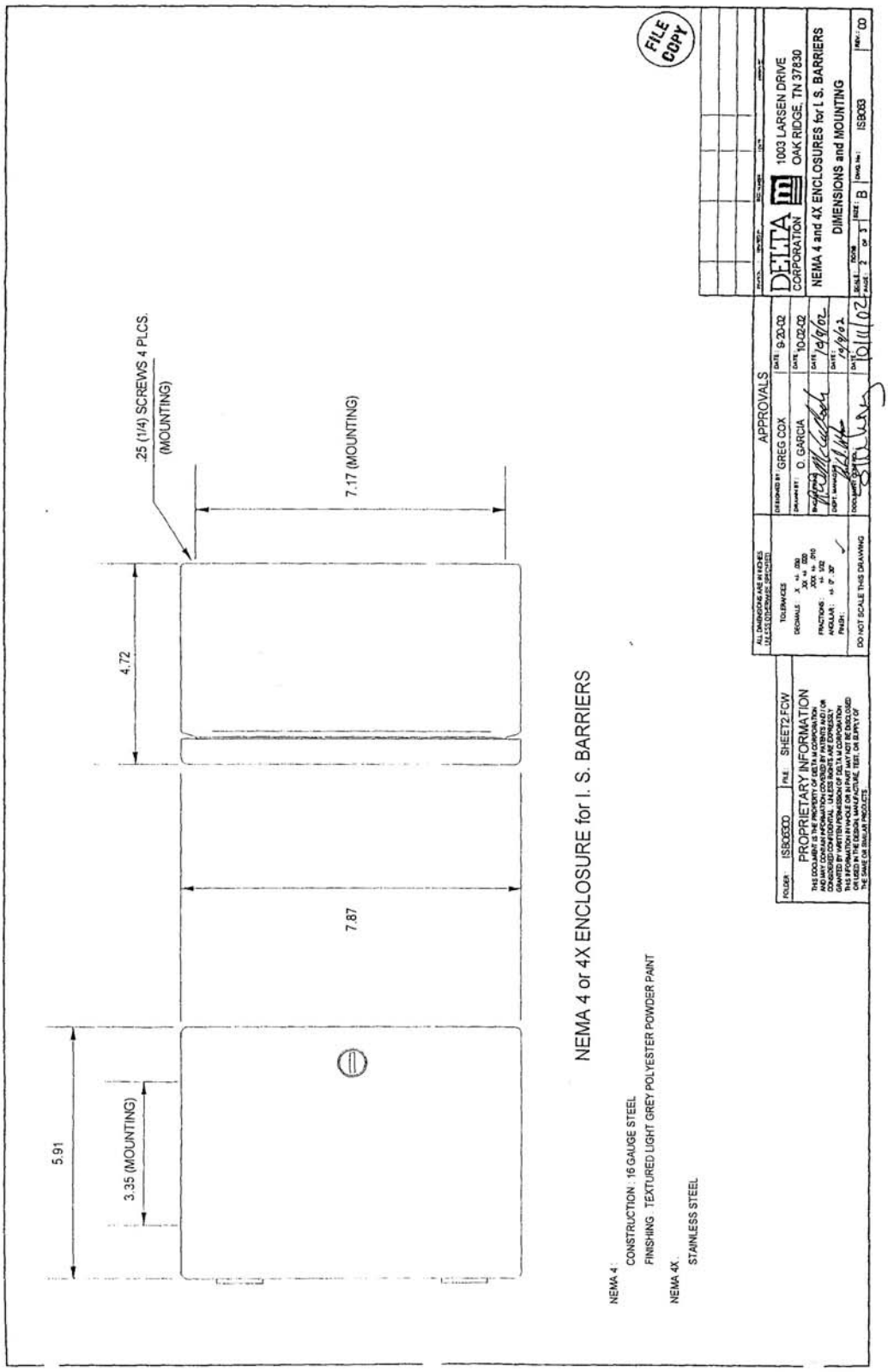

ELECTRONICS
MICROTUFF (LS3200 ; FS4200) SERIES MODIFIED (SN : xxxx-IS)
ENCLOSURE NEMA 4
SAFE
ZONES
HAZARDOUS
REMOTE PROBES
(MAKE SELECTION FROM AVAILABLE OPTIONS)
2 SHIELDED CABLES PER SPECIFICATIONS OF DRAWING MT0085
QUICK DISCONNECT STANDARD PROBE
SP76 PROBE
COVER
STANDARD REMOTE PROBE
BARRIERS ASSEMBLIES :
EARTH GROUND
DELTA M CORPORATION
NOTES :
1.- AREA CLASSIFICATIONS :
CLASS I, II, III , DIV. 1 , 2 ; GROUPS A - G
2.- FOR PROBES TEMPERATURES IN NORMAL OPERATION AND UNDER WORST CASE FAILURE SEE DRAWING MT0085
3.- THE FIELD INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE NFPA 70 ARTICLE 504 , ANSI / ISA - RP 12.8 AND DELTA M CONTROL DRAWING MT0085.
4.- SOME OPERATIONAL LIMITATIONS APPLY, CONSULT THE FACTORY
APPROVALS
DESIGNED BY O. GARCIA DATE: 7-10-02
DRAWN BY: O. GARCIA DATE: 9-26-02
DATE
DATE
FOLDER: ISB06000 FILE: SHEET1.FCW
PROPRIETARY INFORMATION
DELTA CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
LEVEL - FLOW SWITCHES
INTRINSICALLY SAFE BARRIERS SYSTEM
SIZE B
ISB060
REV 00
DO NOT SCALE THIS DRAWING
FILE COPY


ELECTRONICS
MICROTUFF (LS3200 ; FS4200) SERIES MODIFIED (SN : xxxx-IS)
DIN RAIL MOUNTED ELECTRONICS
3 TWISTED SHIELDED PAIRS CABLE DELTA M P/N 101567
INTRINSIC SAFETY BARRIERS
SAFE
ZONES
HAZARDOUS
REMOTE PROBES
(MAKE SELECTION FROM AVAILABLE OPTIONS)
2 SHIELDED CABLES PER SPECIFICATIONS OF DRAWING MT0085
COVER
STANDARD REMOTE ELECTRONICS
BARRIERS ASSEMBLIES
EARTH GROUND
QUICK DISCONNECT STANDARD PROBE
SP76 PROBE
STANDARD REMOTE PROBE
FILE COPY
APPROVALS
O. GARCIA 7-10-02
O. GARCIA 9-26-02
DELTA M CORPORATION
1003 LARSEN DRIVE OAK RIDGE, TN 37830
LEVEL - FLOW SWITCHES
INTRINSICALLY SAFE BARRIERS SYSTEM
ISB060
PROPRIETARY INFORMATION
NOTES :
1.- AREA CLASSIFICATIONS :
CLASS I, II, III ; DIV 1 , 2 ; GROUPS A - G
2.- FOR PROBES TEMPERATURES IN NORMAL OPERATON AND UNDER WORST CASE FAILURE SEE CONTROL DRAWING MT0085
3.- THE FIELD INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE NFPA 70 ARTICLE 504 , ANSI / ISA - RP 12.8 AND DELTA M CONTROL DRAWING MT0085.
4.- SOME OPERATIONAL LIMITATIONS APPLY , CONSULT THE FACTORY.


POWER & RELAY OUTPUTS
MICROTUF REMOTE ELECTRONICS MODIFIED (SN : xxxx-HS)
SEALER (SEE NOTE 4)
STAHL INTRINSIC SAFETY BARRIERS
ASSY., In Ex - Proof ENCLOSURE
SAFE
HAZARDOUS
CLASS I, DIV. 1 &2 , GROUPS B, C, D
CLASS II, DIV. 1 &2 , GROUPS E, F, G
TO PROBE
2 SHIELDED CABLES PER SPECIFICATIONS OF DRAWING MT0085
COVERS
OPTIONAL HINGES
SEALER (BY CUSTOMER)
DELTA M CORPORATION
FILE COPY
NOTES :
1.- AREA CLASIFICATION CLASS I; DIV 1 &2; GROUPS B, C, D
CLASS II, DIV. 1 & 2; GROUPS E, F, G.
2.- FOR PROBES TEMPERATURES IN NORMAL OPERATION AND UNDER WORST CASE FAILURE SEE DRAWING MT0085.
3.- THE FIELD INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE NFPA 70 ARTICLE 504, ANSI/ISA - RP 12.8 AND DELTA M CONTROL DRAWING MT0085.
4.- WHEN THE REMOTE ELECTRONICS ENCLOSURE IS MOUNTED AT A DISTANCE FROM THE BARRIERS, THE INTERCONNECTION IS DONE BY THE CUSTOMER AND THE CABLE IS ; 3 TWISTED SHIELDED PAIRS, DELTA M P/N 101567.
5.- SOME OPERATIONAL LIMITATIONS APPLY, CONSULT THE FACTORY.
APPROVALS
DESIGNED BY: O. GARCIA DATE: 7-25-02
DRAWN BY: O. GARCIA DATE: 9-25-02
DATE: 9/9/02
DATE: 9/9/02
DATE: 9/9/02
DELTA M CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
LEVEL - FLOW SWITCHES REMOTE ELECTRONICS
I. SAFETY BARRIERS in Ex - Proof ENCLOSURE
SCALE: NONE
SHEET: 1 OF 1
SIZE: B
DWG NO: ISB061
REV: 00
PROPRIETARY INFORMATION
THIS DOCUMENT IS THE PROPERTY OF DELTA M CORPORATION AND MAY CONTAIN INFORMATION COVERED BY PATENTS AND/OR COPYRIGHTS OWNED BY DELTA M CORPORATION. IT IS LOANED SUBJECT TO THE AGREEMENT THAT NO COPY OR REPRODUCTION WILL BE MADE, EXCEPTS AS GRANTED BY WRITTEN PERMISSION OF DELTA M CORPORATION. THIS INFORMATION IN WHOLE OR IN PART MAY NOT BE DISCLOSED OR USED IN THE DESIGN, MANUFACTURE, TEST, OR SUPPLY OF THE SAME OR SIMILAR PRODUCTS.
FOLDER
FILE: ISB061.DCW
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
DECIMALS: X +/- .030
XX +/- .010
XXX +/- .010
FRACTIONS: +/- 1/32
ANGULAR: +/- 0° 30'
FINISH:
DO NOT SCALE THIS DRAWING


FILE 3689
DELTA M CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
LEVEL - FLOW SWITCHES REMOTE ELECTRONICS
I. SAFETY BARRIERS in Ex - Proof ENCLOSURE
DIMENSIONS & MOUNTING FOOTPRINT
APPROVALS
O. GARCIA 7-25-02
O. GARCIA 9-25-02
PROPRIETARY INFORMATION
DO NOT SCALE THIS DRAWING
WHEN THE BARRIERS ARE REMOTED FROM
THE ELECTRONIC ENCLOSURE THE
INTERCONNECTING IS DONE BY THE CUSTOMER
MOUNTING FOOTPRINT


8.86 (MOUNTING)
31 DIA (MOUNTING)
4.74
LL150 LATCH
9.62
STANDARD FIBERGLASS ENCLOSURE
4.0 (MOUNTING)
7.50
FILE COPY
APPROVALS
GREG COX
O. GARCIA
DELTA M CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
NEMA 4 and 4X ENCLOSURES for I. S. BARRIERS
DIMENSIONS and MOUNTING
ISB063
PROPRIETARY INFORMATION
DO NOT SCALE THIS DRAWING


.25 (1/4) SCREWS 4 PLCS.
(MOUNTING)
7.17 (MOUNTING)
4.72
7.87
3.35 (MOUNTING)
5.91
NEMA 4 or 4X ENCLOSURE for I. S. BARRIERS
NEMA 4:
CONSTRUCTION 16 GAUGE STEEL
FINISHING TEXTURED LIGHT GREY POLYESTER POWDER PAINT
NEMA 4X:
STAINLESS STEEL
FILE COPY
APPROVALS
DESIGNED BY GREG COX
DRAWN BY O. GARCIA
DATE 9-20-02
DATE 10-02-02
DELTA M CORPORATION
1003 LARSEN DRIVE
OAK RIDGE, TN 37830
NEMA 4 and 4X ENCLOSURES for I. S. BARRIERS
DIMENSIONS and MOUNTING
ISB03
PROPRIETARY INFORMATION

10.10 LIQUID LEVEL MULTI-POINT (MD/MP)

DELTA m® CORPORATION

Liquid Level Multi-Point

Single Insertion 2 To 6 Points

- Built to suit your specific needs.
- Number of points and location determined by customer.
- Switch points are independent of each other.
- Local or remote electronics.
- Removable, plug in electronics.
- All welded materials of construction 316L Stainless Steel (std).
- Free of all moving parts that can stick, coat or fail.
- Fast response time of .1 to 1 second on wetting, media dependent.
- Switch on level change of .03 inch without concern for changing temperature, density, dielectric constant or chemical composition.
- Self heating sensor design improves repeatability and reliability. No separate heater to fail or slow response time.
- Wide operating temperature range -100°F to +572°F (-70°C to +300°C).
- Temperature compensation circuitry eliminates false switching due to process temperature changes.

- Both the **VERSA-SWITCH®** and **microtuf®** families of multi-point level switches can provide a solution for your demanding point level applications.

DELTA M Corporation - 1003 Larsen Drive - Oak Ridge, Tennessee 37830 - USA - Phone: (865) 483-1569 - Fax (865) 483-1142 - http://www.deltamcorp.com

MODEL LM51NX
MODEL LM32NX

SPECIFICATIONS

Sensor

Type:
Thermal Differential, dual RTD sensors with no seperate heater
Process Connection:
Standard 1.50 inch MNPT
Optionally larger MNPT and flanges
Insertion Length:
Minimum 3.5 inches
Optionally Up to 120.0 inches
Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)
Medium Temperature to +572°F (+300°C)
Materials of Construction:
Standard 316L Series Stainless Steel (std)
Operating Pressure Range:
Standard to 3000 psia (207 bar)

Electronics

Power:
110VAC, 220 VAC, or 24 VDC at 3 watts (No heater power required)
Operating Temperature Range:
Standard -40°F to +140°F (-40°C to +60°C)
Optionally remote electronics for use in medium temperature environments
Outputs Per Switch Point:
Independent relay DPDT, contacts rated at 5 amp, 250 VAC with ability to set fail safe mode
Self-Test:
Integral and automatic during power up
Enclosure:
Choice of local explosion proof with; NEMA 3, 4, 4X, 7, and 9; CSA, FM, UL, CENELEC, and EECS approvals or non explosion proof local or remote

Instrument

Response Time:
Sensor response time 0.5 to 10 seconds media dependent
Response to Level Change:
Will respond to a level change as small as .03 inch.
Repeatability:
±1% of set point

Model Number Selection Guide

Code - Number of Points
0 - 2 to 6 Points 2.5 inches minimum between points

Code - Model
LM51NX - Dual Channel VERSA-SWITCH®
LM51SC - Single Channel VERSA-SWITCH®
LM32NX - Single Channel microtuf®

Code - Process Connection
150 - 1.5 Inch MNPT (std)
RC1 - Raised Face Flange 150 # 1.5 Inch
RA2 - Raised Face Flange 150 # 2 Inch
RD1 - Raised Face Flange 300 # 1.5 Inch
RB2 - Raised Face Flange 300 # 2 Inch
SPL - Special Process Connection

Code - Sensor Material
S6 - 316L Stainless Steel (std)
SM - Special Material

Code - Insertion Length
000.00 -3.50" to 120.00"

Code - Power Input
FLD - Field Configurable (VS)
110 - 110 VAC
220 - 220 VAC
24D - 24 VDC

Code - Configuration
LE - Local Electronics (2pt)
RE - Remote Electronics

Code - Special Options
OO - No Special Options
CB - Calibration
EN - Extended Neck
XW - X Proof Window
FA - Failure Alarm (VS)
MT - Med Temp (4pt)
CA - Additional Cable
OE- Optional Enclosure

2 -LM-51NX-150 - S6 - 012.00 - FLD - LE - 00

Notes: (VS) VERSA-SWITCH® only option
(_ pt) Maximum number of points for option

Local 2 pt only

Remote 2 pt

Local Representative

Form Number (DML 1007.03)

DELTA M Corporation - 1003 Larsen Drive - Oak Ridge, Tennessee 37830 - USA - Phone: (865) 483-1569 - Fax (865) 483-1142 - http://www.deltamcorp.com

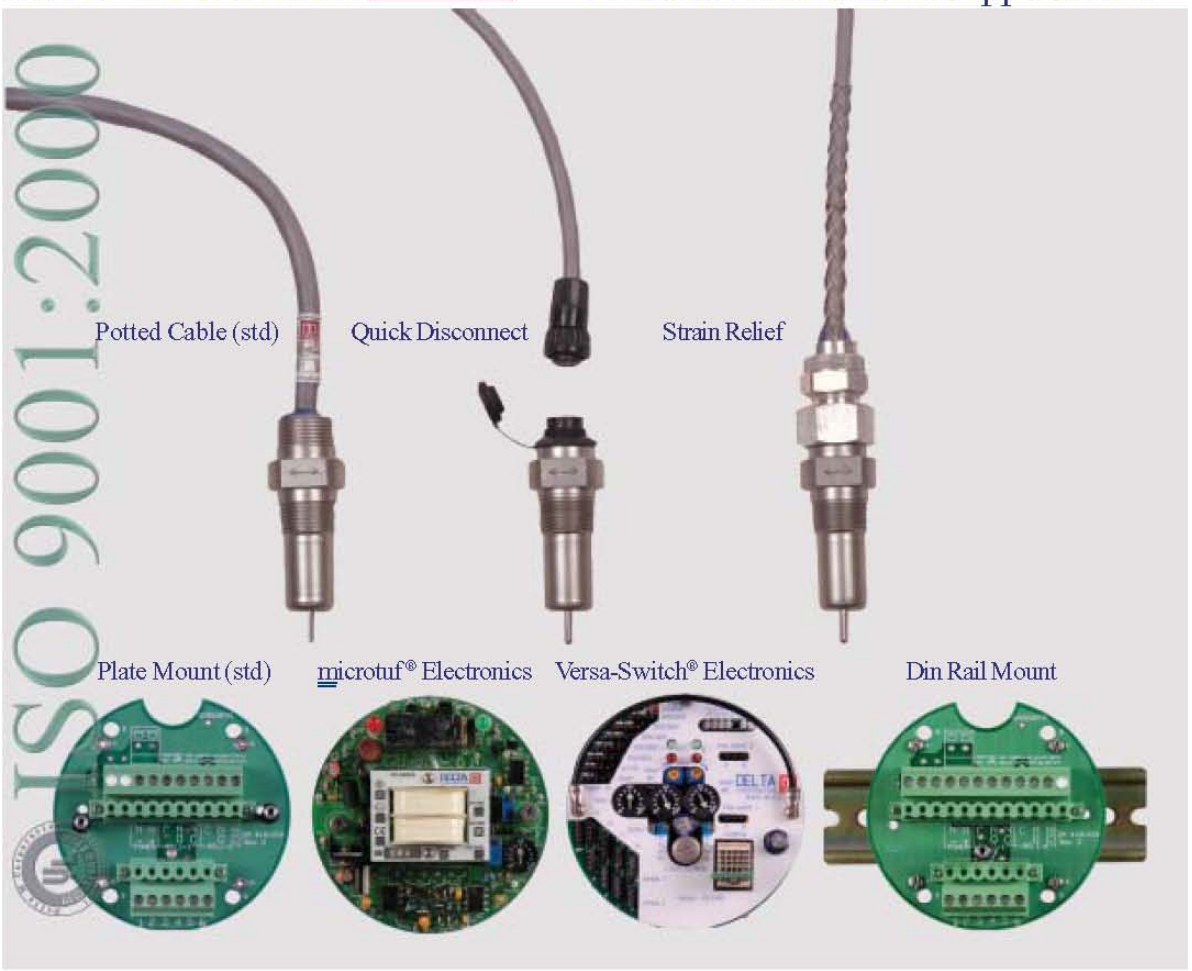
10.11 SWITCH KITS (SK)

DELTA m CORPORATION

Switch Kit(SK)

Versa-Switch® & microtuf®

For Both Flow & Level Applications



This product line is designed for organizations that are building their own systems and have no need for the housings normally associated with industrial instrumentation. By eliminating the housing you not only save space but you also reduce the cost of the instruments. The removable plug in electronics allows you to incorporate these switches into your systems in such away that the electronics remain easily removeable and replaceable without disturbing your wiring system. Our mounting plates are also available for DIN rail applications to further simplify installations.

- Both VERSA-SWITCH® and microtuf® family of switches are available.
- Handles both Mass flow and level switching applications equally well.
- Temperature outputs also available.
- All Welded Stainless Steel Constructon
- Free of all moving parts that can stick, coat or fail.
- Self heating sensor design improves repeatability. No separate heater to fail or slow response time.
- Removable, plug in electronics.

DELTA M Corporation - 1003 Larsen Drive - Oak Ridge, Tennessee 37830 - USA - Phone: (865) 483-1569 - Fax (865) 483-1142 - http://www.deltamcorp.com

Switch Kit

SPECIFICATIONS

Sensor

Type:
Thermal Differential, dual RTD sensors with no seperate heater

Process Connection:
Standard 0.75 inch MNPT
Optionally 0.25 inch and larger NPT and various other process connections such as sanitary, SP76, Low Flow and flanges

Insertion Length:
Standard 2.0 inch
Optionally 0.5inch or greater

Operating Temperature Range:
Standard -100°F to 390°F (-70°C to +200°C)

Materials of Construction:
Standard 316L Series Stainless Steel
Optionally Hastelloy, Monel, Inconel and other exotic materials

Operating Pressure Range:
Standard to 3000 psia (207 bar)

Electronics

Power:
Standard 110VAC Optionally 220VAC, 24VAC, or 24VDC at 3 watts (No heater power required)

Operating Temperature Range:
Standard -40°F to +140°F (-40°C to +60°C)
microtuf®

Outputs:
DPDT Relay contacts rated at 5 amp, 250 VAC with fail safe capability
VERSA-SWITCH®
Independent primary relay DPDT and secondary relay SPDT, contacts rated at 5 amp, 250 VAC with fail safe capability; built in time delay 0 to 300 seconds on each channel

Self-Test:
Integral and Automatic during power up

Instrument

Operating Range:
Adjustable Flow Rate (feet per second - fps), typical: 0.01 to 5.0 fps liquids and 0.1 to 500 fps gases

Response Time:
Sensor response time 0.5 to 10 seconds media dependent

Stability:
Drift < .5% from calibrated setpoint over a range of ±50° F. Temperature compensated throughout entire range

Repeatability:
±1% of setpoint

Approvals:
Switch Kits carry no approvals.

Model Number Selection Guide

Code - Model
VS51SK - Dual Channel VERSA-SWITCH
FS51SK - Single Channel Mass Flow VERSA-SWITCH
LS51SK - Single Channel Point Level VERSA-SWITCH
FS42SK - Microtuf Flow Switch
LS32SK - Microtuf Level Switch

Code - Process Connection
3A1 - 1.5 Inch Sanitary w/ 3A Stamp
075 - 0.75 Inch MNPT (std)
050 - 0.50 Inch MNPT
100 - 1 Inch MNPT
RA1 - Raised Face Flange 150 # 1 Inch
RA2 - Raised Face Flange 150 # 2 Inch
RB1 - Raised Face Flange 300 # 1 Inch
RB2 - Raised Face Flange 300 # 2 Inch
LFS - Low Flow Sensor
S76 - SP76 Sensor
SPL - Special

Code - Sensor Material
S6 - 316L Stainless Steel (std)
S4 - 304 Stainless Steel
SL - 304L Stainless Steel
HB - Hastelloy B
HC - Hastelloy C
IO - Inconel 600
MN - Monel
A2 - Alloy 20
SM - Special Material

Code - Insertion Length
002.00 - 2.00 Inch (std)
000.00 - 0.50" to 120.00" in .25 Increments
000.00 - Custom Length

Code - Power Input
FLD - Field Configurable (Versa only)
110 - 110 VAC
220 - 220 VAC
24D - 24 VDC
24A - 24 VAC

Code - Configuration
PM - Plate Mount (std)
DM - DIN Rail Mount

Code - Special Options
00 - No Special Option
CB - Calibration Required
VI - Variable Insertion
LT - Live Tap
FA - Failure Alarm (VS5100 only)
QD - Cable Quick Disconnect
SR - Cable Strain Relief
RT - RTD Output
TO - Thermocouple Output
CA - Additional PVC Cable

VS51SK- 075-S6-002.00- LD - PM - 00 Model Number

Represented In Your Area By

Form Number (DML 1019.00)

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