OPERATION AND MAINTENANCE MANUAL

microtuf® II

MODEL FS2100 SERIES – MASS FLOW SWITCH

MODEL LS1100 SERIES – POINT LEVEL SWITCH

DOCUMENT 1121-OM-00

REVISION 00

NOVEMBER 2009

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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 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 FIGURE 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.**

- **BE SURE TO APPLY THE PROPER VOLTAGE AS CONFIGURED AT THE FACTORY. DO NOT APPLY AC VOLTAGE TO 24 VDC VERSIONS OR 24 VDC TO AC VERSIONS. THIS WILL DAMAGE THE UNITS AND VOID THE WARRANTY.**

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

- **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 at (800) 922-0083, 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® II Series Models		FS2100	LS1100
Agency Approvals	Explosion-Proof rating	Mass Flow Switch	Point Level Switch
Non-Approved	Non-Explosion Proof	FS21NX	LS11NX
Switch Kits (No Enclosures)	Not Rated	FS21SK	LS11SK

SPECIAL NOTICE

The electronic assemblies contained in the microtuf® II models are configured for specific voltages and have specific modifications. 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 serial number tag.

WARNING

THE WETTED SENSOR OF THE SWITCH IS OF AN ALL WELDED CONSTRUCTION CREATING A PRESSURE BOUNDARY FROM THE PROCESS FLUID (LIQUID OR GAS). ANY BREACH OF THIS BOUNDARY THROUGH CORROSION, MISTREATMENT, OR MISAPPLICATION COULD ALLOW THE PROCESS FLUID TO ENTER THE ENCLOSURE OF THE UNIT.

PROCEED WITH CAUTION WHEN OPENING THE ENCLOSURE AFTER A BREACH OF THE PRESSURE BOUNDARY TO AVOID CONTACT WITH ANY PROCESS FLUIDS THAT MAYBE CONTAINED WITHIN THE ENCLOSURE.

TABLE OF CONTENTS

1.0 INTRODUCTION

The DELTA M microtuf® II 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® II Switch uses a **thermal differential** technique to sense changes in the heat transfer characteristics of a media. Figure 1 shows the outline of the microtuf® II 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 not heated 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 in a level application.

The DELTA M Corporation sensor excitation method relies on constant current to the heated sensor. 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.

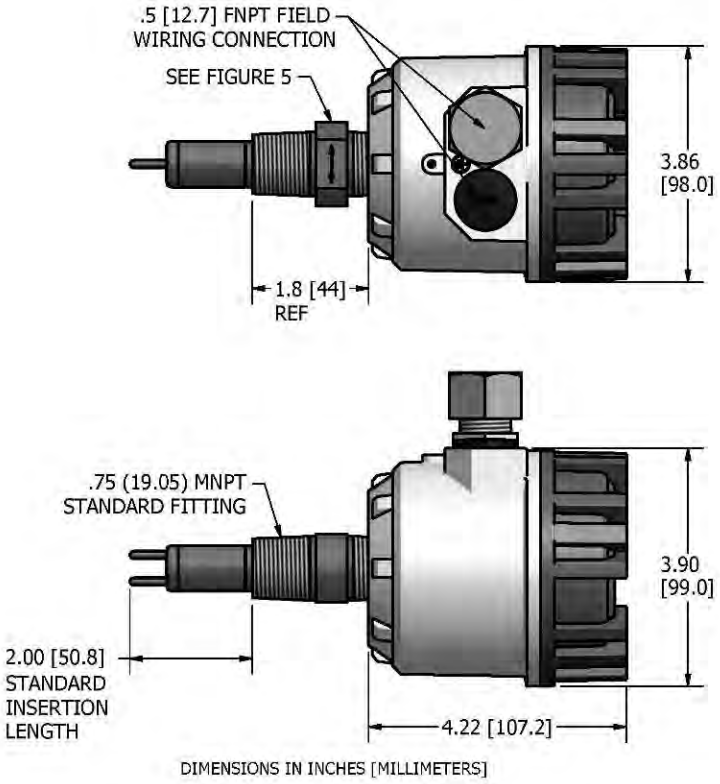


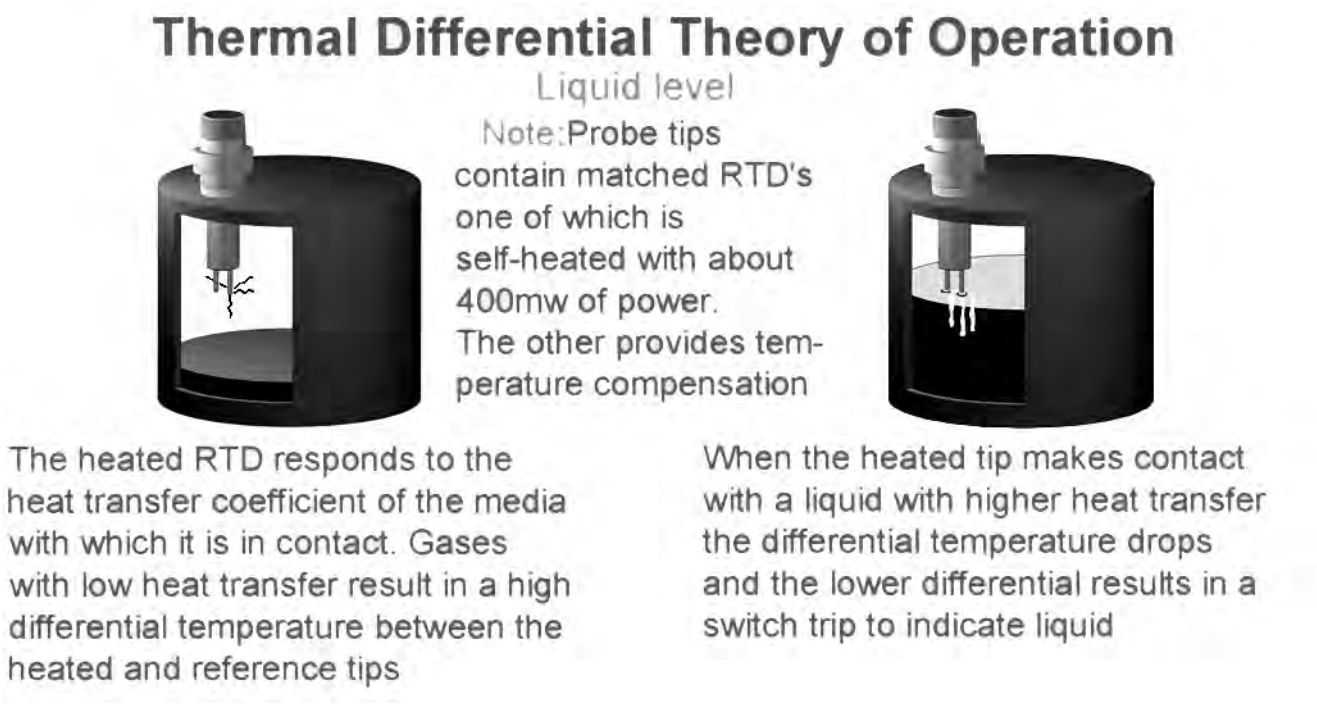
FIGURE 1 LS1100/FS2100 microtuf® II OUTLINE DIAGRAM STANDARD 2.0 INCH INSERTION

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® II can discriminate between them. Figure 2A shows the relative signal output of the microtuf® II 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 ® II 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.



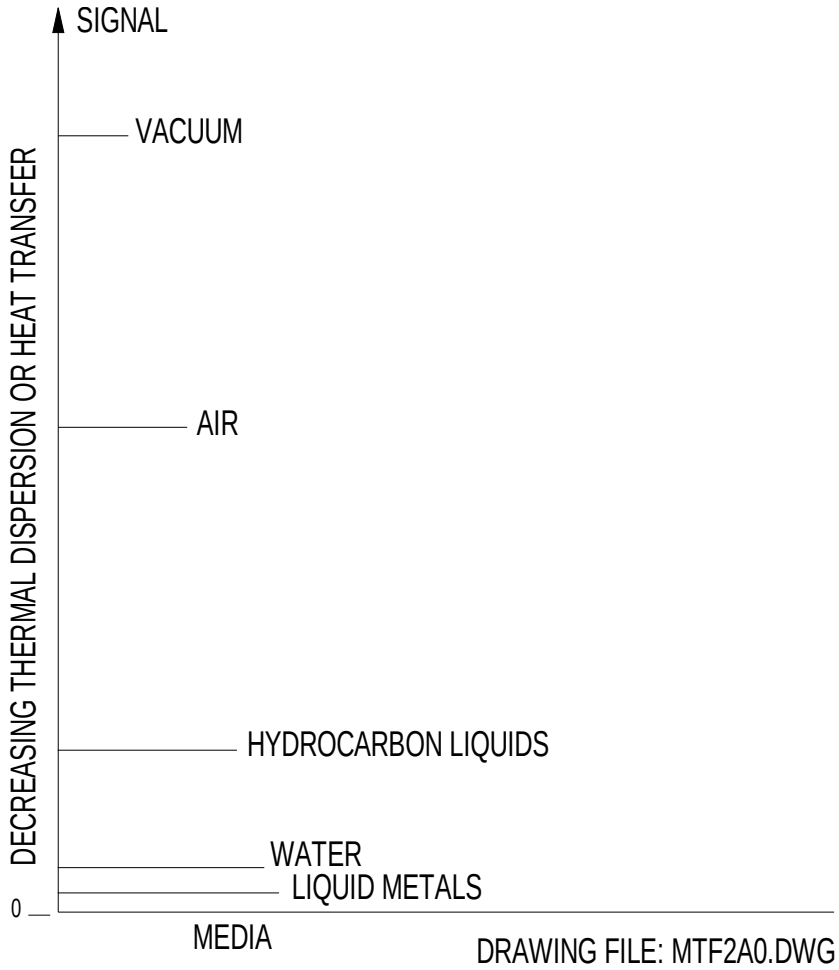


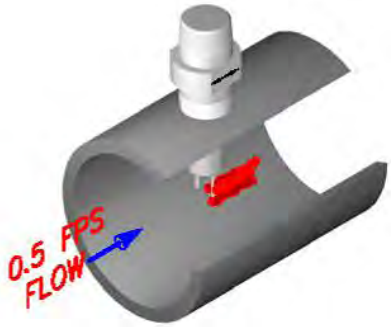
FIGURE 2A: RELATIVE CHANGE IN RESPONSE OF A HEATED RTD IMMERSED IN VARIOUS MEDIA

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® II compares this change to a preset flow trip point to switch the output. Figure 2B shows the model FS2100 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 sensitivity 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 2.5 FPS for water and 0.01 to 5 FPS Hydrocarbons. 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.

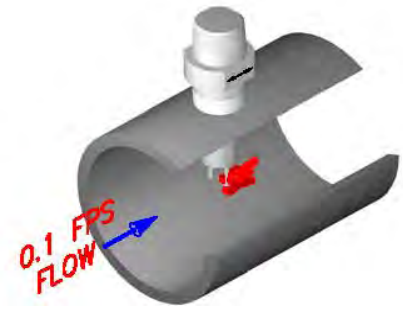
For a no flow condition the thermal differential between the two tips is high because of relatively low heat transfer.



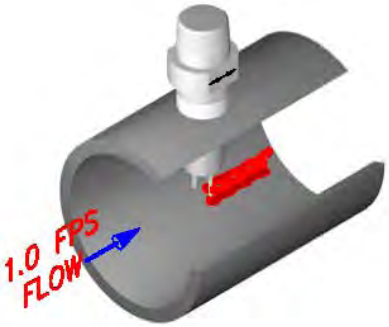
When the lower differential matches the customer select flow velocity trip point (set point) the switch relay and red LED are tripped.

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 2.5 FPS are measurable. In Hydrocarbons velocities from .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 flow is above the trip point the differential is smaller than at the set point and the relay and LED remain tripped.

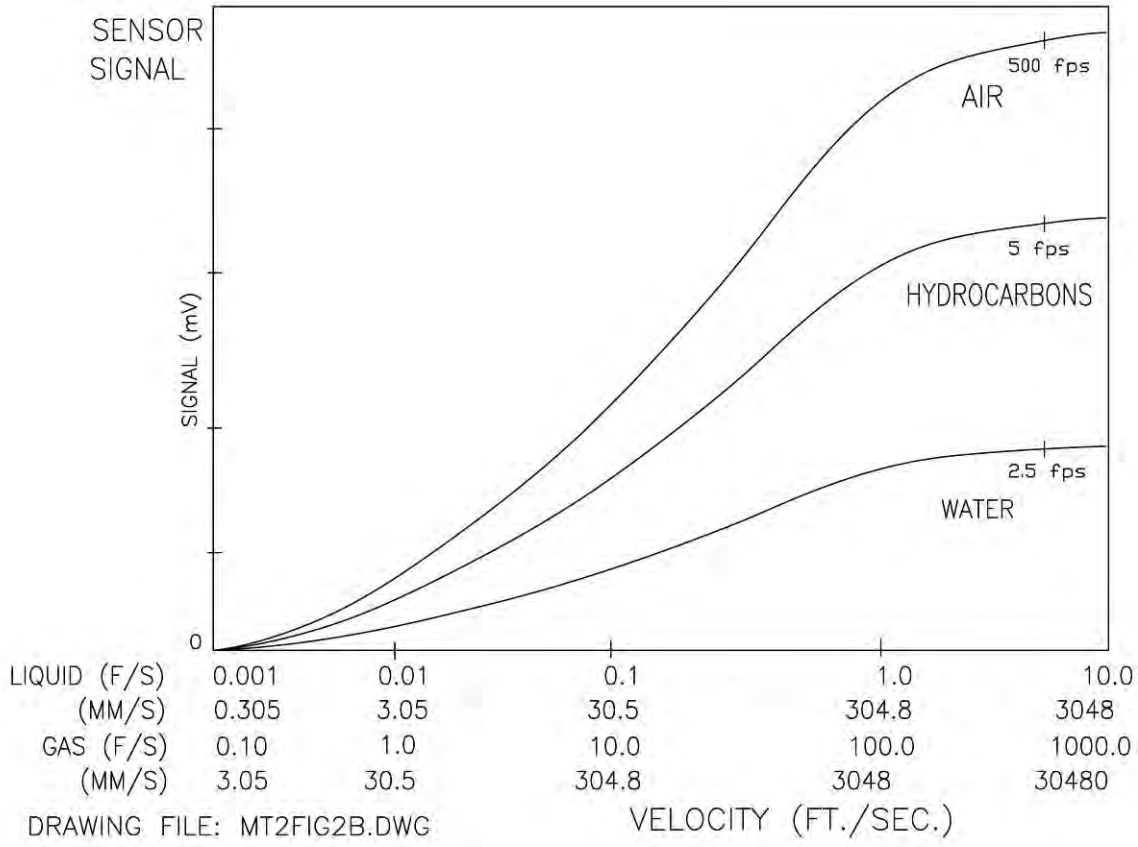


FIGURE 2B microtuf® II MODEL FS2100 FLOW RESPONSE FOR THREE MEDIA

Figure 3 shows a block diagram of the microtuf® II 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).

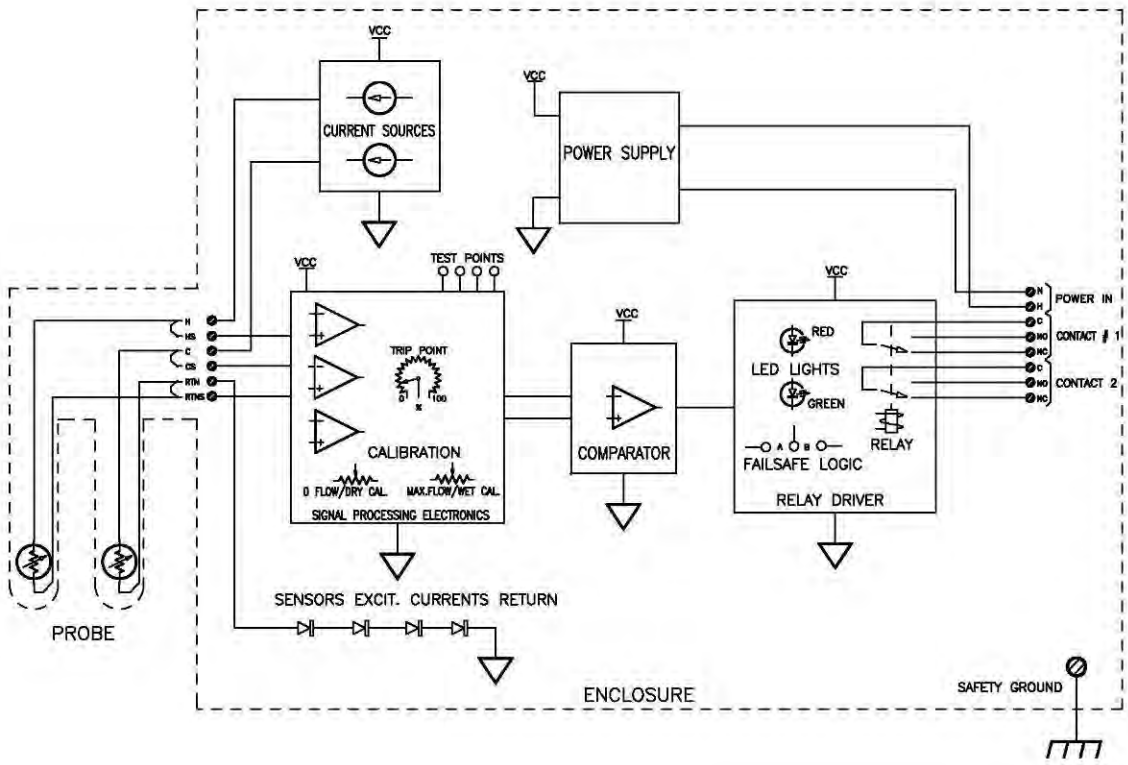


FIGURE 3: microtuf® II SERIES SWITCH BLOCK DIAGRAM
MODELS LS1100/FS2100 SERIES

The instrument enclosure mounted on top of unit contains the microtuf® II Switch electronics module with field wiring on top (see Figure 4.0). For applications where the electronics must be located away from the sensors due to elevated process temperature, accessibility, vibration, etc., another instrument head containing the electronics is remotely located (See option RE-Remote Electronics section 3.2.2).

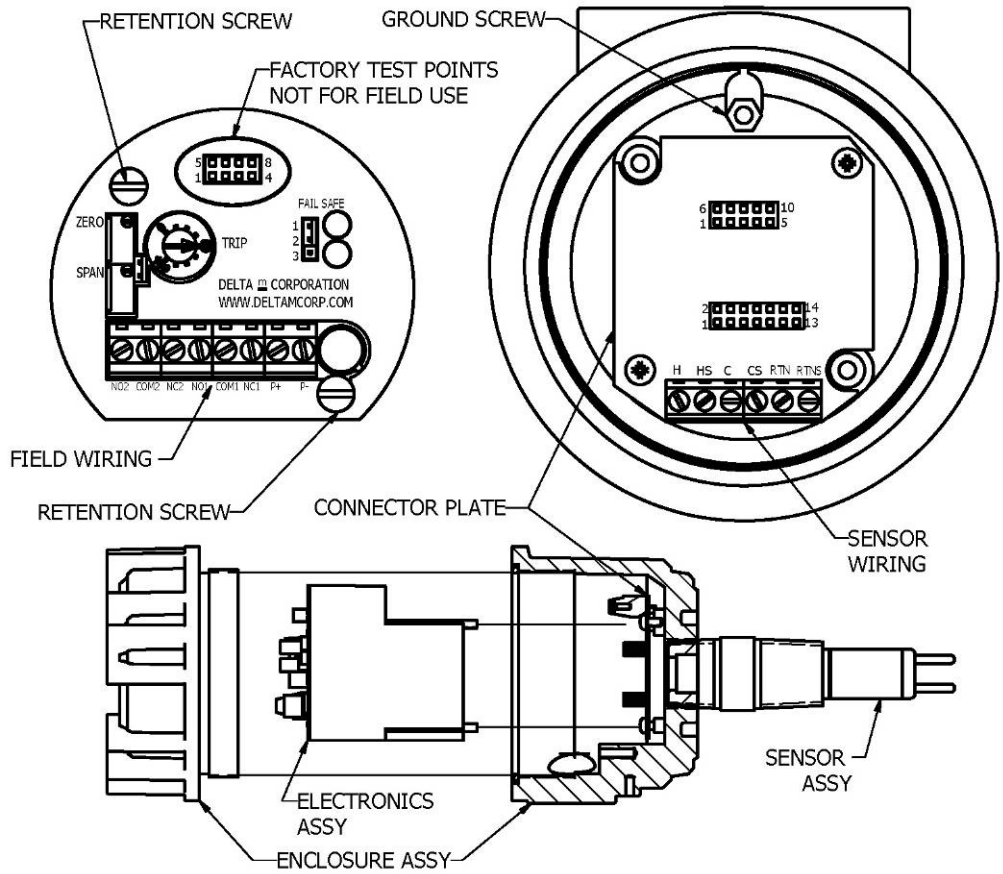


FIGURE 4 microtuf® II SWITCH ASSEMBLY

3.0 INSTALLATION

3.1 Mechanical Installation

The standard microtuf® II 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. It is recommended that the power wiring and relay output wiring be installed using separate conduits to the enclosure.**

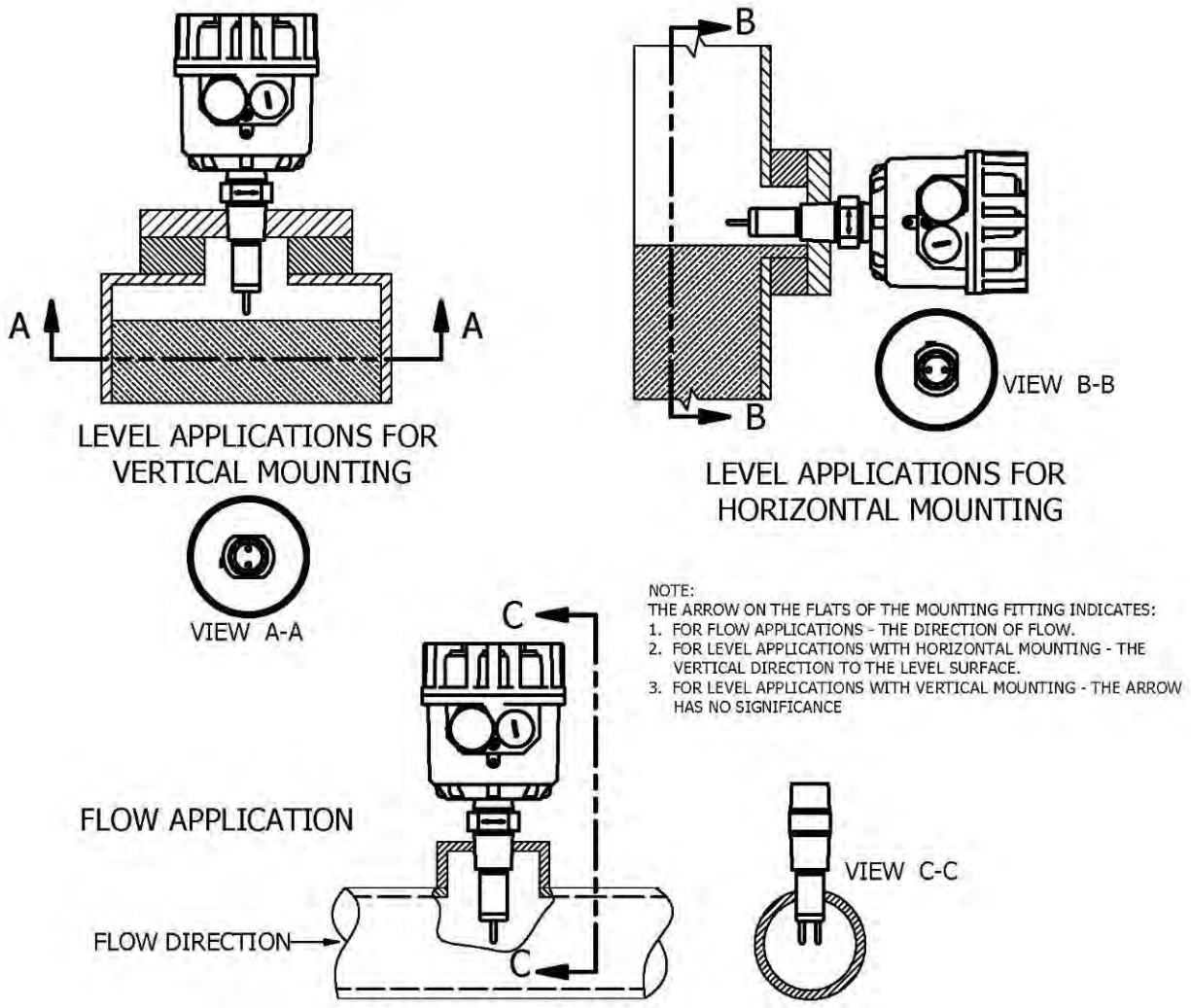


FIGURE 5: PROPER ORIENTATION OF THE SENSOR PROBE FOR LEVEL AND FLOW APPLICATION IS INDICATED BY THE ARROW ON THE FLAT OF THE MOUNTING FITTING. (MTF500.DWG/.FCW)

3.2 Electrical Installation

3.2.1 Local Electronics (LE Option/Standard)

Remove the instrument enclosure lid by unscrewing in a counter clockwise direction. Connect power and alarm relay wiring to Terminal Block B as shown in Figure 6A.

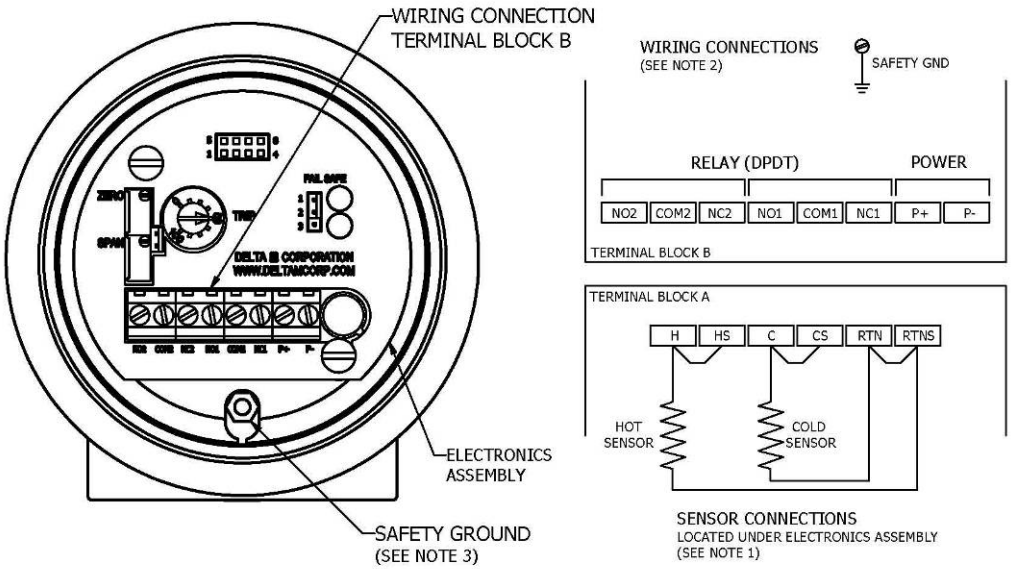


FIGURE 6.0 microtuf® II SWITCH LOCAL ELECTRONICS FIELD WIRING DIAGRAM (MTF600FCW/.DWG)

NOTES:

1. **Connections to sensors Terminal Block A are factory installed and should not be disconnected in the field.**
2. **For 90 to 260 VAC VDC operation (factory prepared), connect +positive to P+ and negative to P-. For 90 to 260 VAC connect hot to P+ and neutral to P-.**
3. **Connect ground wire to ground screw located in 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 OF THE INSTRUMENT ENCLOSURE FOR PROPER OPERATION.

3.2.2 Remote Electronics (RE Option)

For the remote electronics option, install field wiring between the local enclosure and the remote instrument head with conduit. Connect the switch wiring between the microtuf® II Switch remote electronics as shown in Figures 7A and 7B. Connect power wiring and alarm relay wiring to the remote enclosure as shown in Figure 7A and 7B.

IMPORTANT
BE SURE TO APPLY THE PROPER VOLTAGE AS CONFIGURED AT THE FACTORY. DO NOT APPLY AC TO DC VERSIONS OR DC TO AC VERSIONS.

SPECIAL NOTICE

The electronic assemblies contained in the microtuf® II models are configured for specific voltages. When ordering spare electronics, replacements, or exchanges in the field please ensure you identify the specific configuration you have by noting the options marked on the serial number tag.

WARNING: ELECTROCUTION HAZARD
TUCK WIRES BEHIND STANDOFF TO PREVENT ABRADING OF WIRES WHEN CLOSING LID.

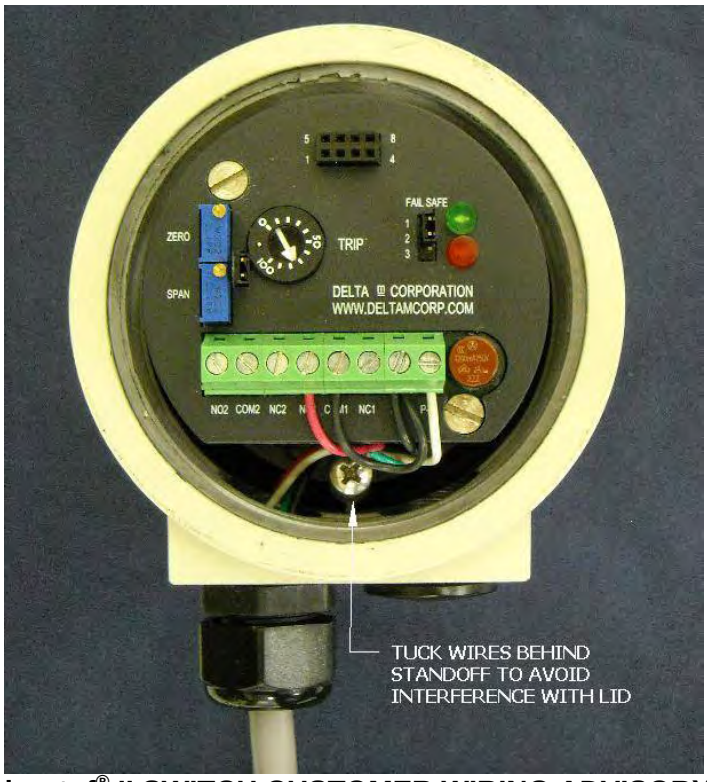


FIGURE 6A: microtuf® II SWITCH CUSTOMER WIRING ADVISORY

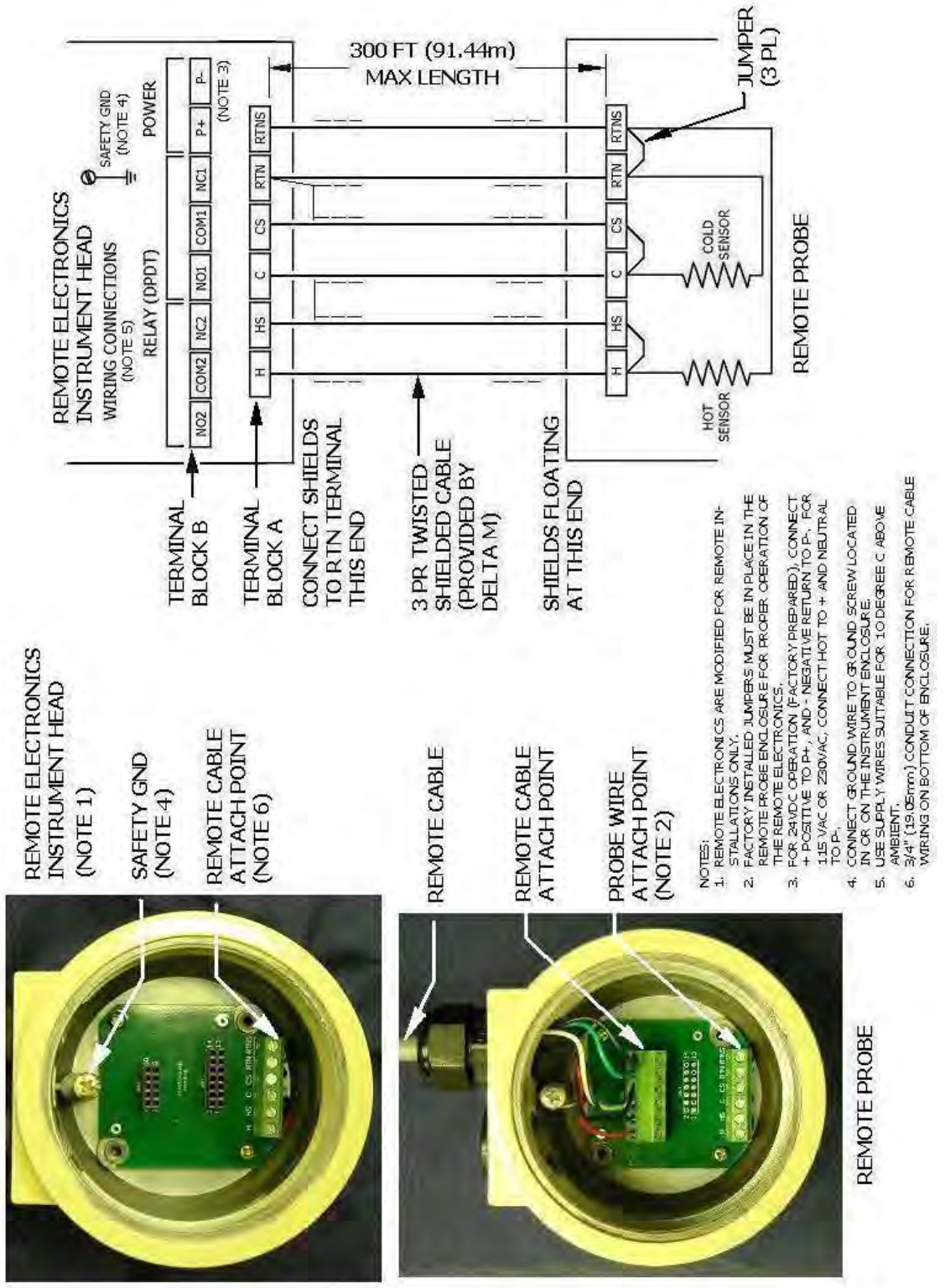


FIGURE 7A microtuf® II FLOW SWITCH REMOTE ELECTRONICS OPTION FIELD WIRING DIAGRAM (MTF701.DWG/.FCW)

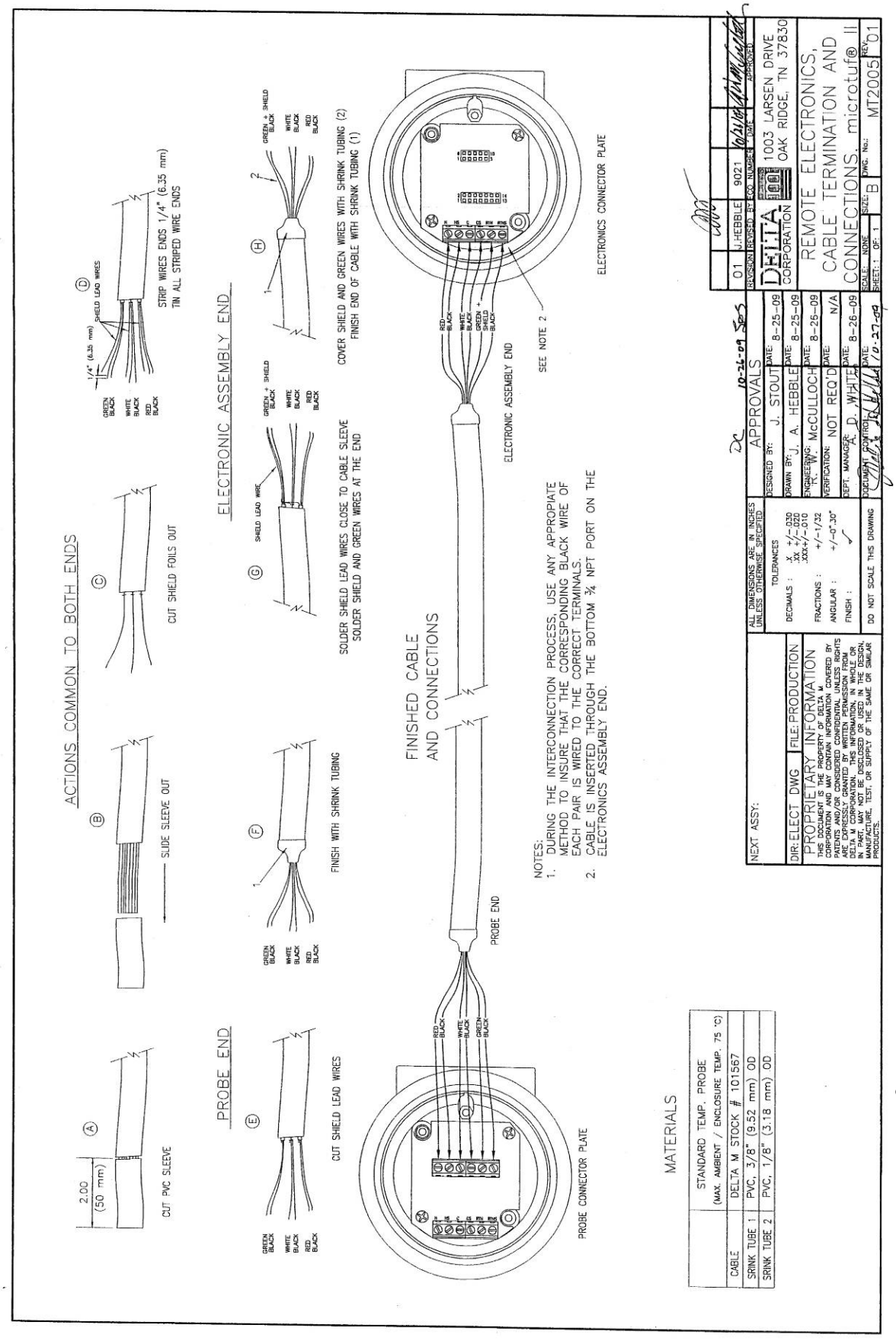


FIGURE 7B microtuf® II REMOTE ELECTRONICS CABLE TERMINATION AND CONNECTIONS

4.0 OPERATION AND CALIBRATION OF THE microtuf® II FS2100 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 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 (i.e. flow below the setpoint or flow above the set point) and are not affected by the position of the Fail Safe. The Fail Safe jumper 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.

4.2.2 Normal Operation (as set at factory)

The switch comes configured from the factory with the following operation with the Fail Safe 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

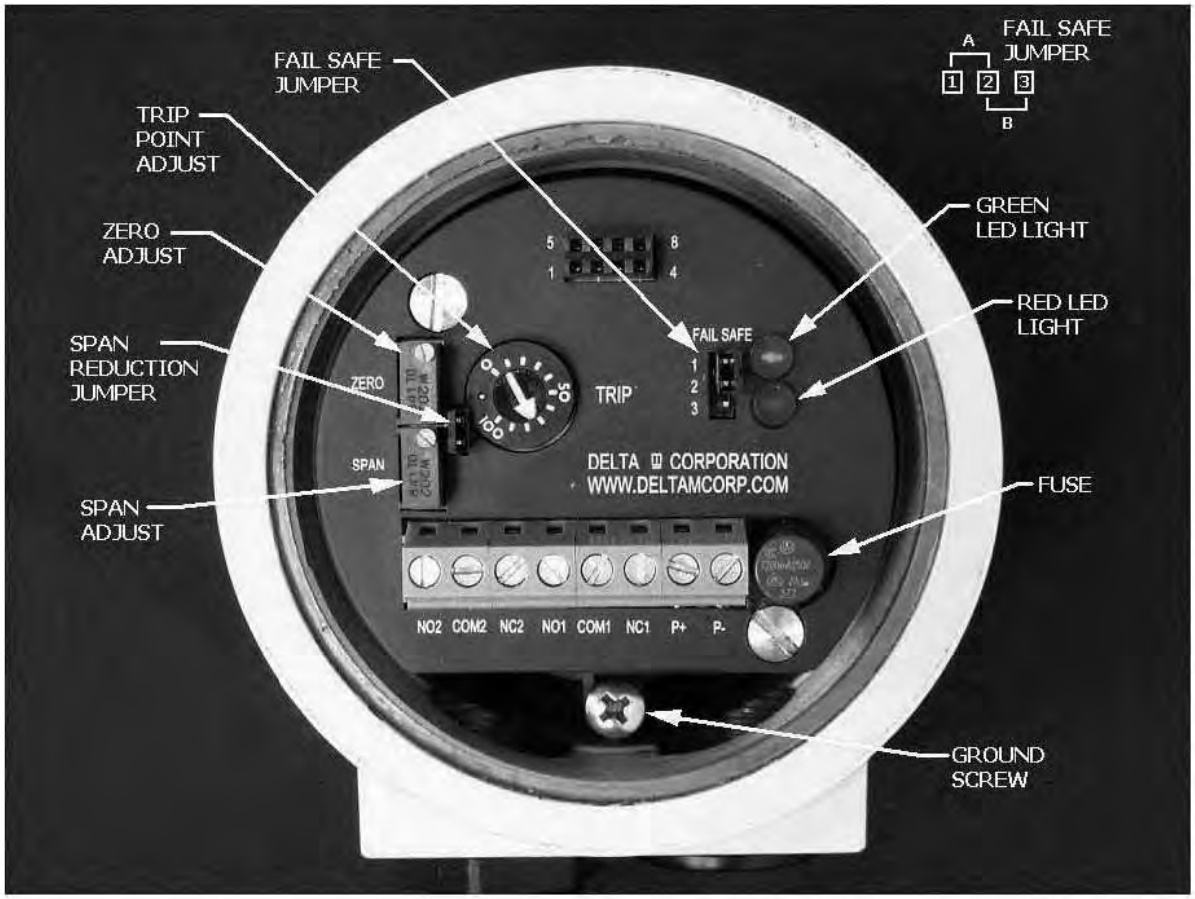


FIGURE 8.0 microtuf® II SWITCH ELECTRONICS

4.2.3 Alternate Operation (Field Selectable)

The relay logic may be reversed by moving the Fail Safe 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

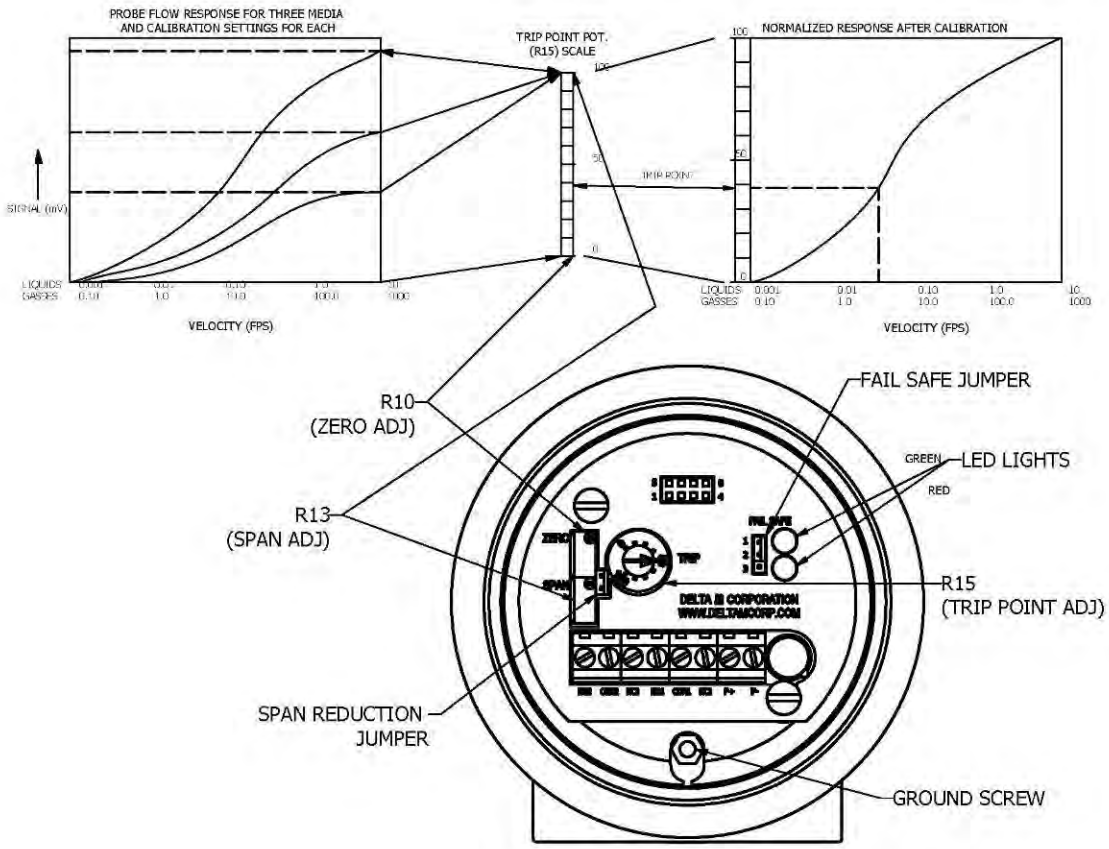


FIGURE 9.0 microtuf® II FS2100 FLOW SWITCH CALIBRATION REFERENCE DRAWING

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 FS2100. **Allow 10 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 allowing 30 seconds between each toggle until the switching point no longer changes. Leave the Red LED illuminated.
7. Adjust the liquid or gas flow to maximum possible velocity. Insure that the flow is homogenous, constant and free of bubbles if a liquid. A minimum of 150 or 200 fps in gas is a good 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 allowing 30 seconds between each toggle until the switching point no longer changes. 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® II LS1100 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 LS1100 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 (i.e. dry or wet) and are not affected by the position of the Fail Safe jumper. The Fail Safe jumper 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.

5.2.2 Normal Operation (as set at factory)

The switch comes configured from the factory with the following operation with the Fail Safe 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 (i.e. hydrocarbons)	ON	OFF	Activated →	o NC o NO
Wet, or Higher Thermal Dispersion Fluid (i.e. water)	OFF	ON	Deactivated →	o NC o NO

5.2.3 Alternate Operation (Field Selectable)

The relay logic may be reversed by moving the Fail Safe 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 (i.e. hydrocarbons)	ON	OFF	Deactivated	o NC o NO
Wet, or Higher Thermal Dispersion Fluid (i.e. water)	OFF	ON	Activated	o NC o NO

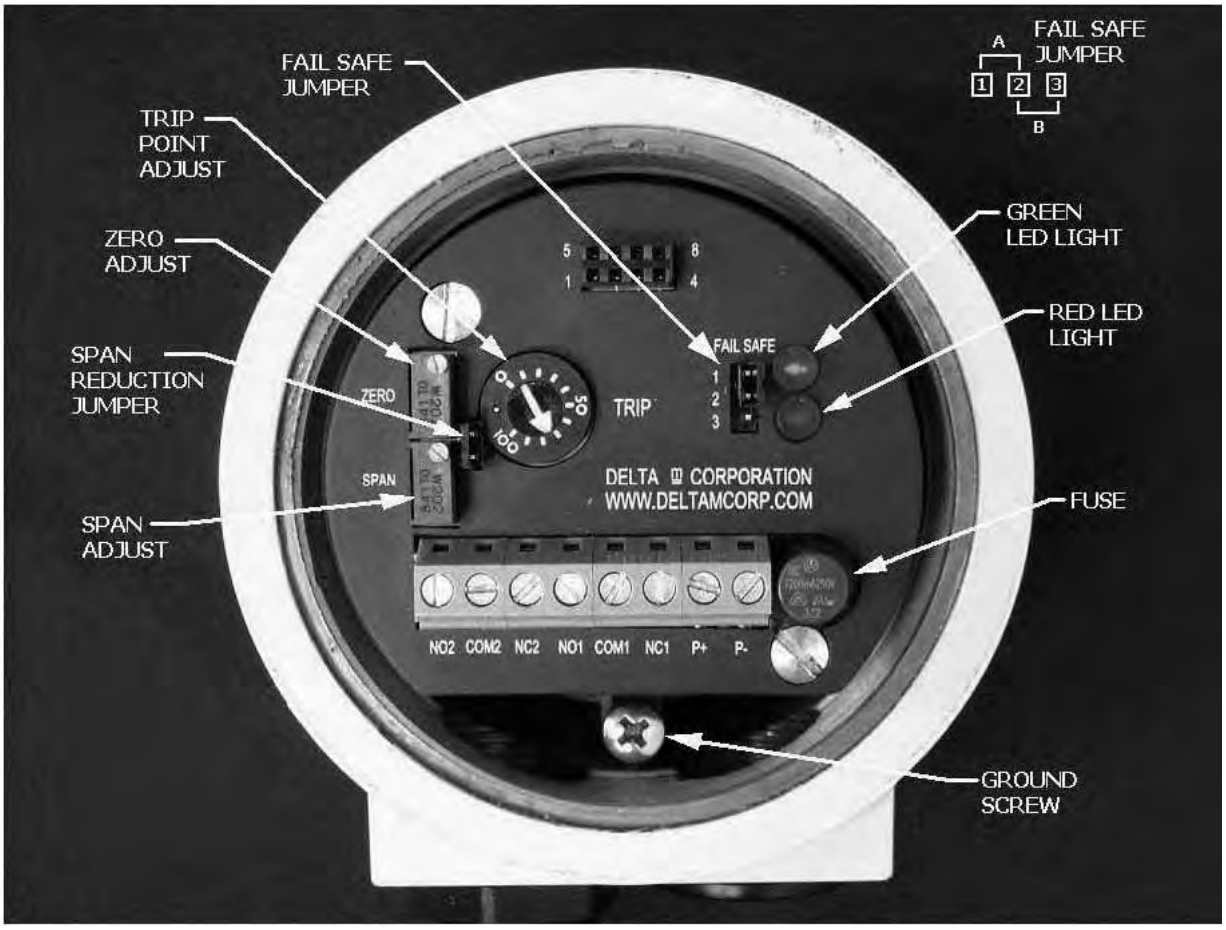


FIGURE 8.0 microtuf® II SWITCH ELECTRONICS

5.3 Calibration – Level

****IMPORTANT****

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

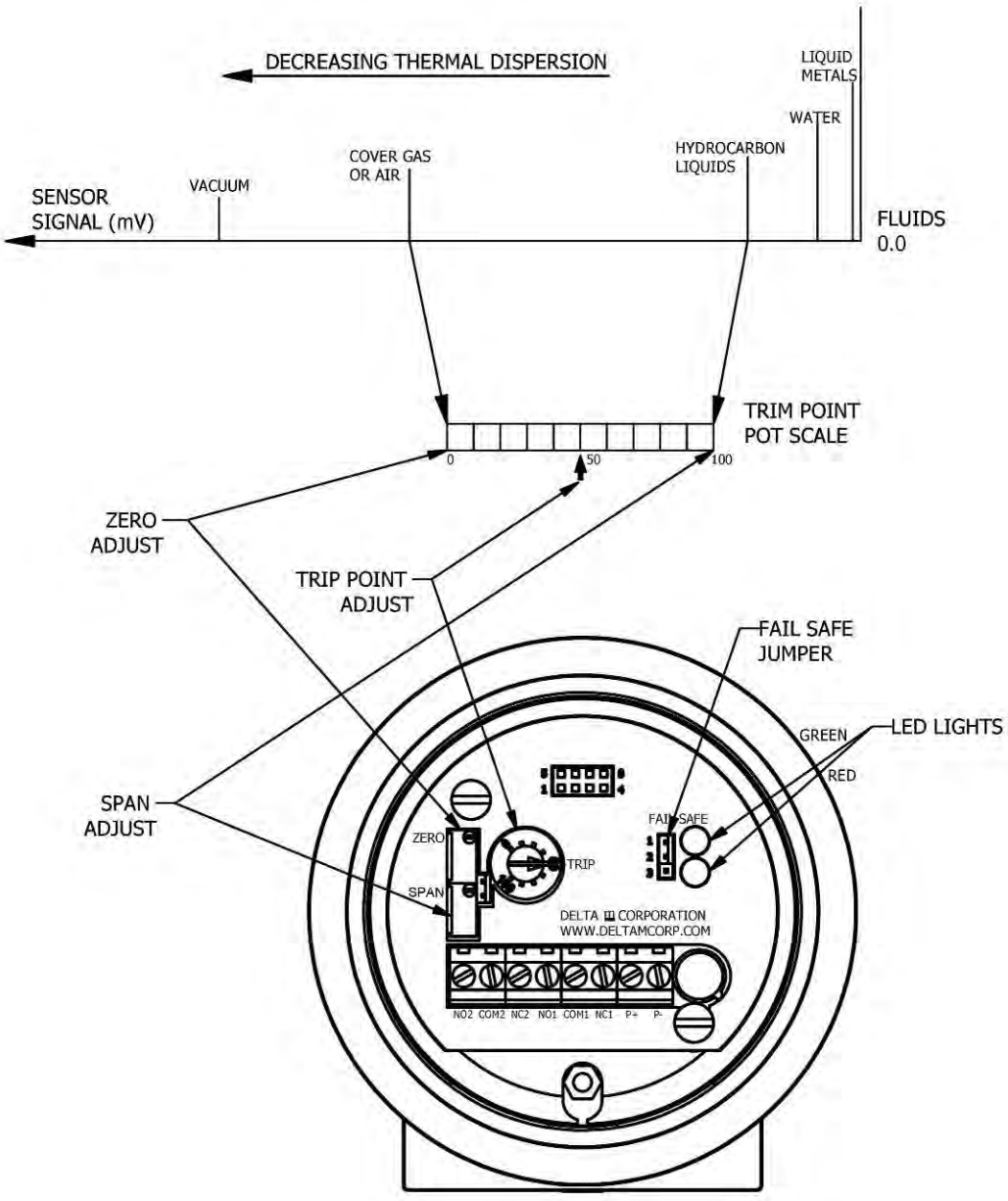


FIGURE 10.0 microtuf® II LS1100 POINT LEVEL SWITCH CALIBRATION

5.3 Calibration - Level

Using Figure 10.0 and Figure 8.0 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 10 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 stable and 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 stable and 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® II Switch.
2. Remove the instrument enclosure cover (ccw).
3. Reapply power and verify correct voltage at P+ and P- of terminal strip B on top of electronic assembly (See Figures 6.0 or 6A).
4. If voltage is correct, turn power off and pull fuse. 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.
5. 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® II Switch.

2. Allow a 5 minute cool down.

3. Measure the resistance of each RTD at pins H and RTNS of sensor terminal strip under electronics assembly (See Figure 6.0 or 7.0) for the hot RTD and pins C and RTN of terminal A 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 H, C, RTN and RTNS of terminal strip and the case of the microtuf® II Switch. It should be greater than 20 megohms.

5. If the microtuf® II Switch sensor assembly resistances are not as specified above, the switch sensor assembly must be replaced.

6. If the microtuf® II Switch sensor assembly resistances are as specified, the microtuf® II Switch PC electronic board must be replaced.

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.)
OPERATING TEMPERATURE:	Process: -70°C to + 200°C (-100°F to +390°F) standard 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 2.5 fps for water, 5 fps for hydrocarbons
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:	90-260 VAC, 4w, 50/60HZ standard (Optional 24 VDC, 3w); maximum
FUSE REQUIREMENTS (F1):	¼ Amp, Delta M PN# 101603
OUTPUT:	5A, 250 VAC, DPDT Standard 5A 30 VDC
STABILITY:	Temperature compensated over entire range.

8.0 WARRANTY AND SERVICE

8.1 Warranty

DELTA M Corporation warranties microtuf® II 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.**

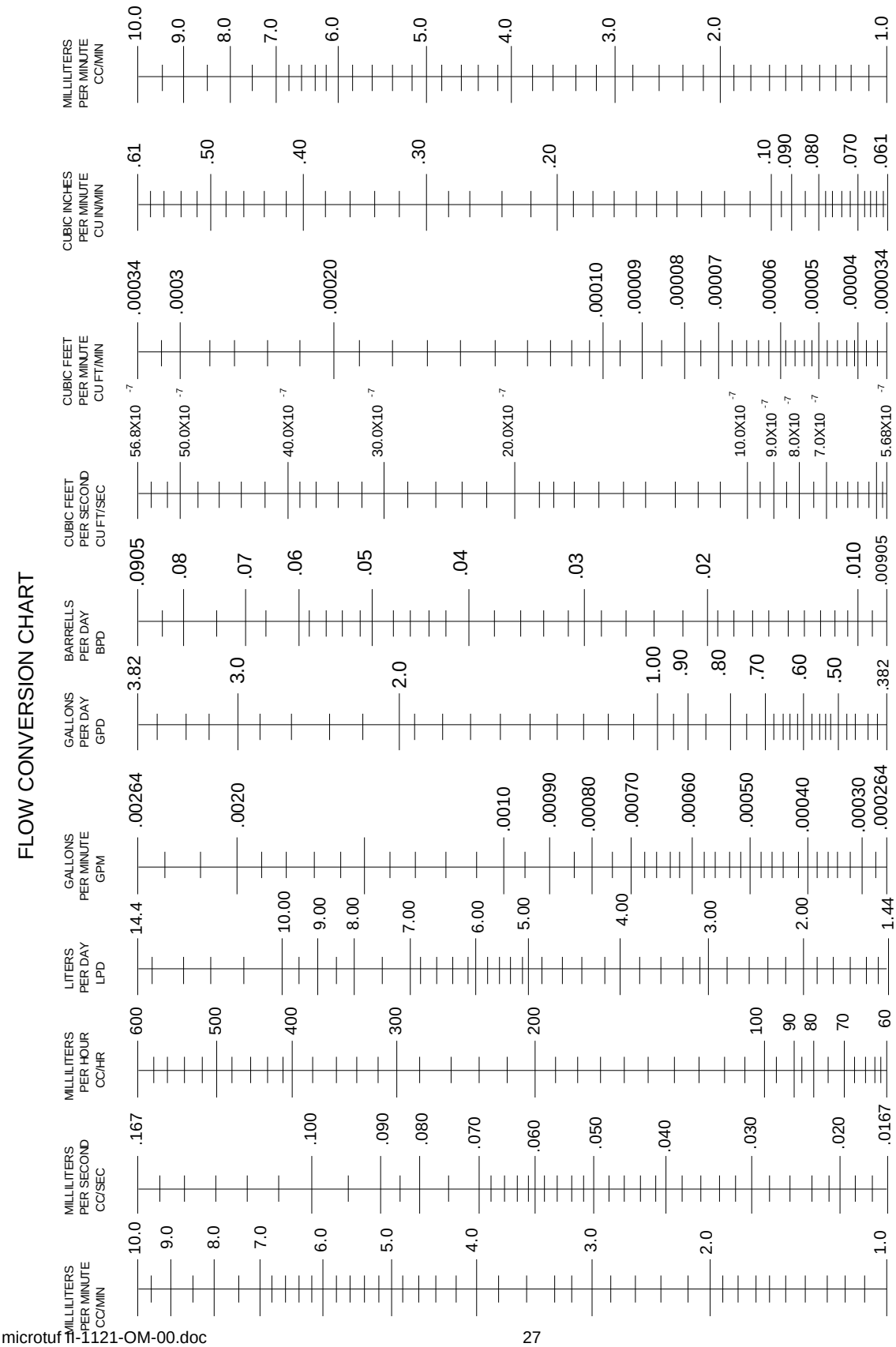
9.0 APPENDIX

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

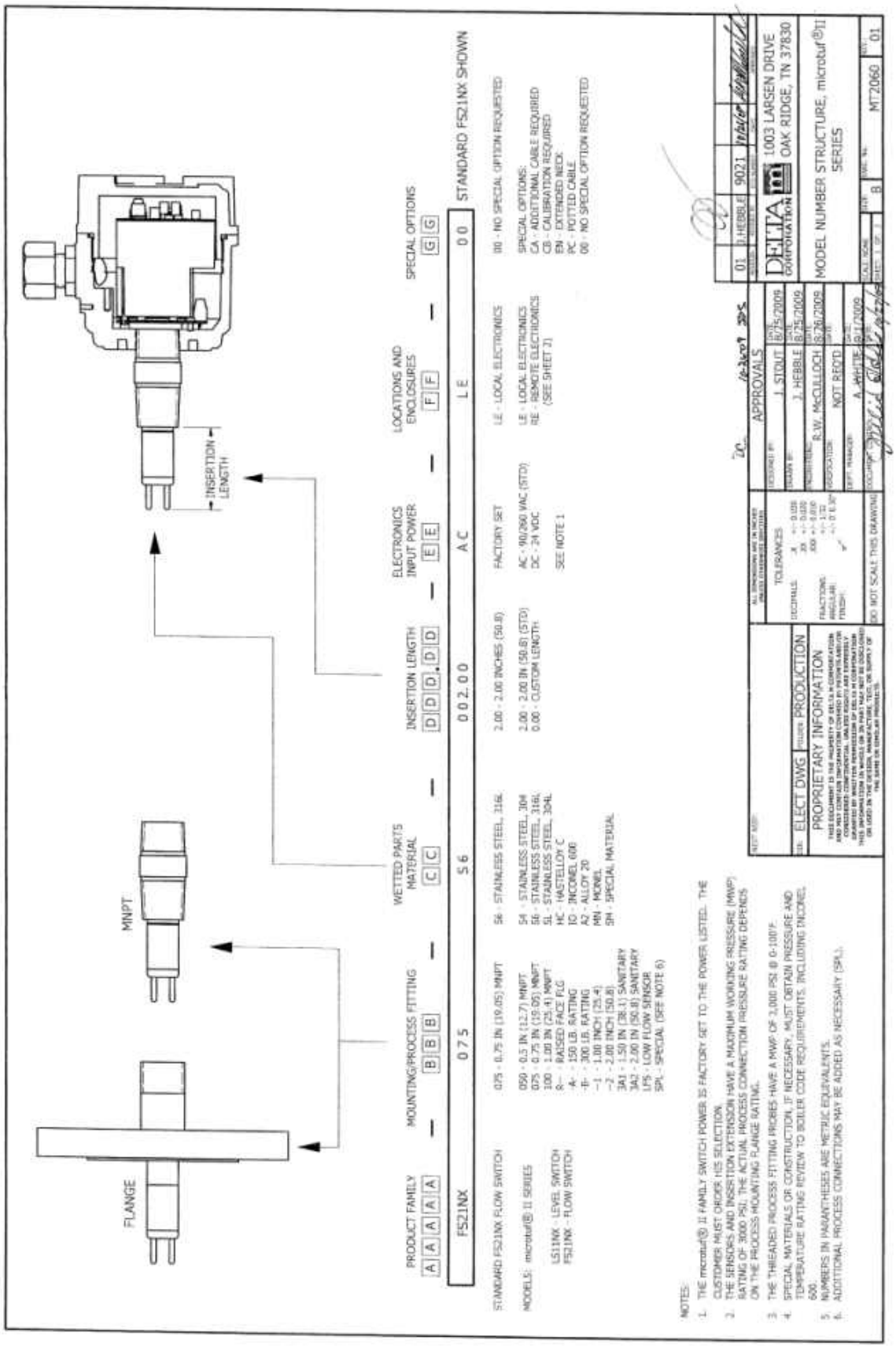
Pressure Drop per 100 feet and Velocity in Schedule 40 Pipe for Water at 60 F.

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			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		6″	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		
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		8″
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	...	...

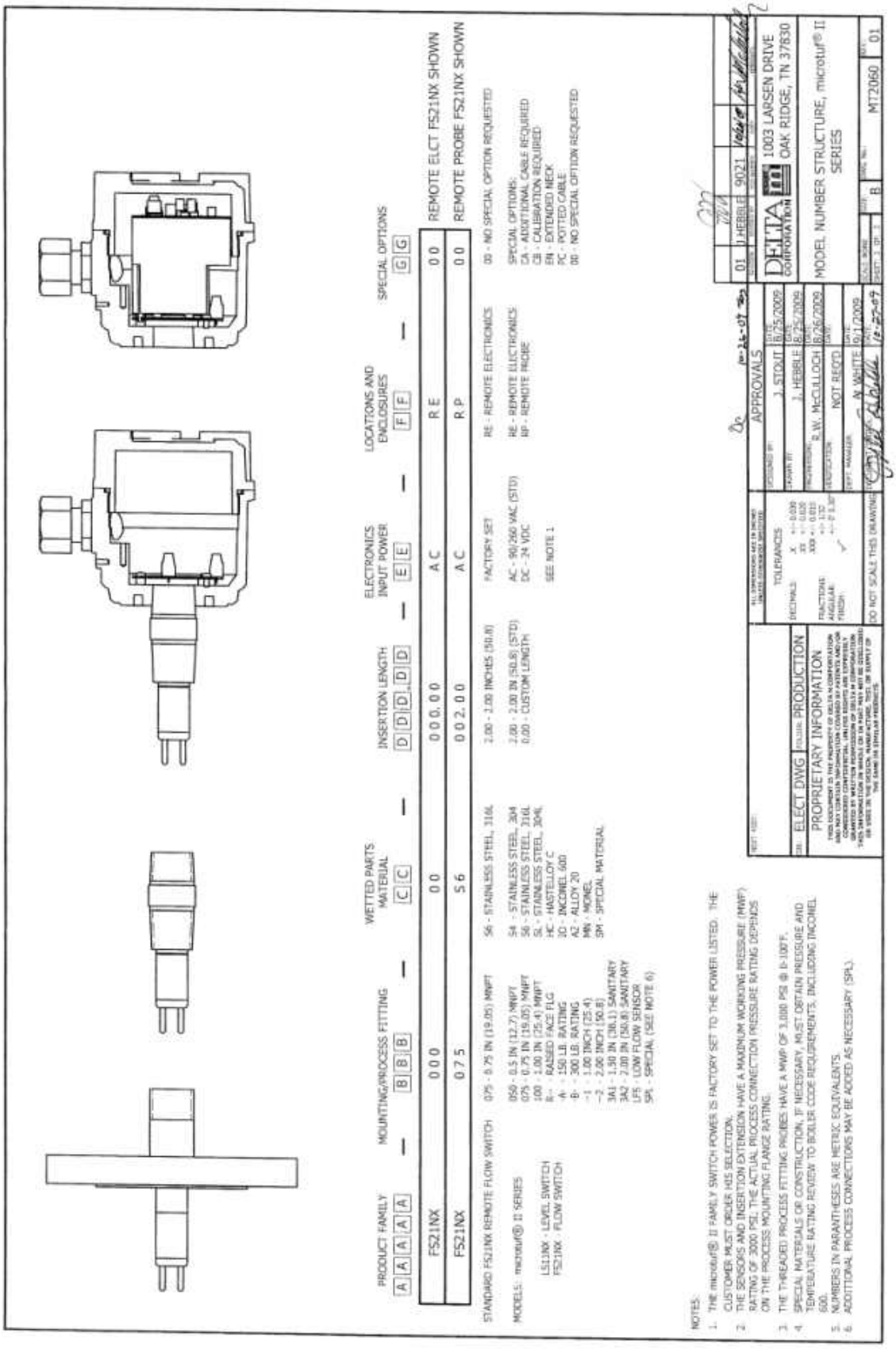
For pipe lengths other than 100 feet, the pressure drop is proportional to the length. Thus, for 50 feet of pipe, the pressure drop is approximately one-half the value given in the table . . . for 300 feet, three times the given value, etc.

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 (sheet 1)



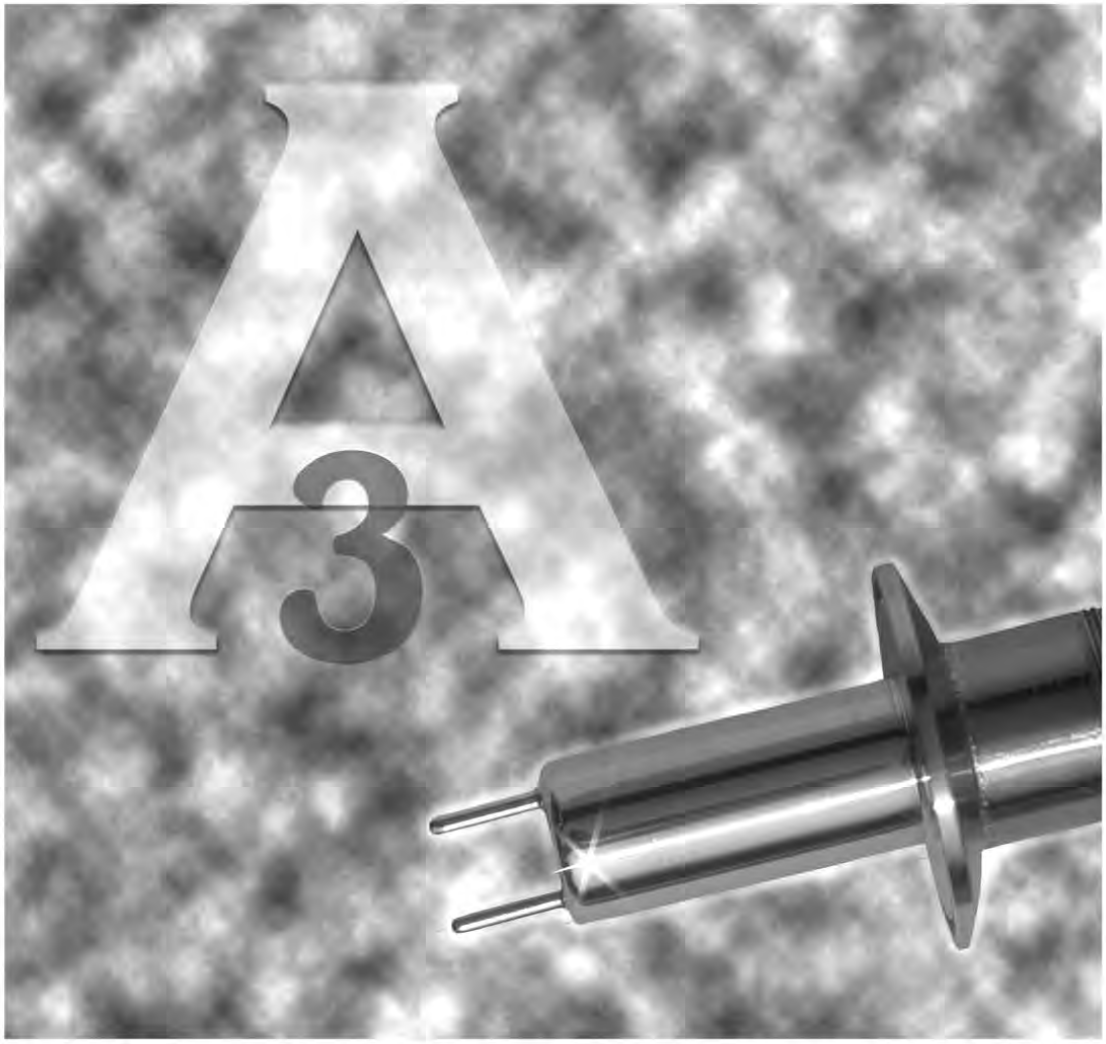
9.4 MODEL NUMBER DESIGNATION AND AVAILABLE OPTIONS (sheet 2)



10.0 OPTIONS
10.1 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.

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

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 Number (DML1001.02)

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