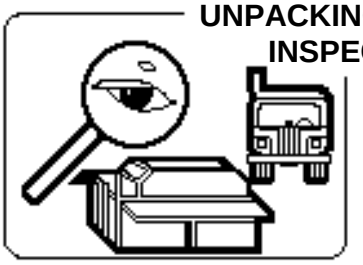
SCOPE OF MANUAL

This manual contains information concerning the installation, operation and maintenance of the Model 2500 level transmitter. To ensure proper performance of the recorder, the instructions given in this manual should be thoroughly understood and followed.

Keep the manual in a readily accessible location for future reference.

Changes and additions to the original edition of this manual will be covered by a "CHANGE NOTICE" supplied with the manual. The change notice will identify the sections in this manual where the changes have occurred.

Model 2500
TABLE OF CONTENTS



To avoid damage in transit, Badger products are shipped to the customer in special shipping containers. Upon receipt of the product, perform the following unpacking and inspection procedures:

NOTE: If damage to the shipping container is evident upon receipt, request the carrier to be present when the product is unpacked.

a. Carefully open the shipping container following any instructions that may be marked on the box. Remove all cushioning material surrounding the product and carefully lift the product from e container.

Retain the container and all packing material for possible use in reshipment or storage.

b. Visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the customer.

GENERAL DESCRIPTION

The Model 2500 ultrasonic level transmitter is designed to measure liquid levels up to 50 feet, dependent upon the transducer selected. The unit is microprocessor based and is fully programmable by a front panel keypad. It is supplied with a 2 line, 24 character per line LCD display which will indicate the level or level and volume being measured. The display is also used for providing meter status information and programming the meter.

The Model 2500 utilizes ultrasonic energy pulses that are transmitted from the sensor which in turn receives the pulses reflected from the liquid surface. The electronics measures the time it takes for the ultrasonic pulses to be transmitted and received and calculates the level of the fluid. The sensor is also capable of detecting the air temperature to ensure that the time of travel for the energy pulses is compensated to ensure accuracy in the level measurement.

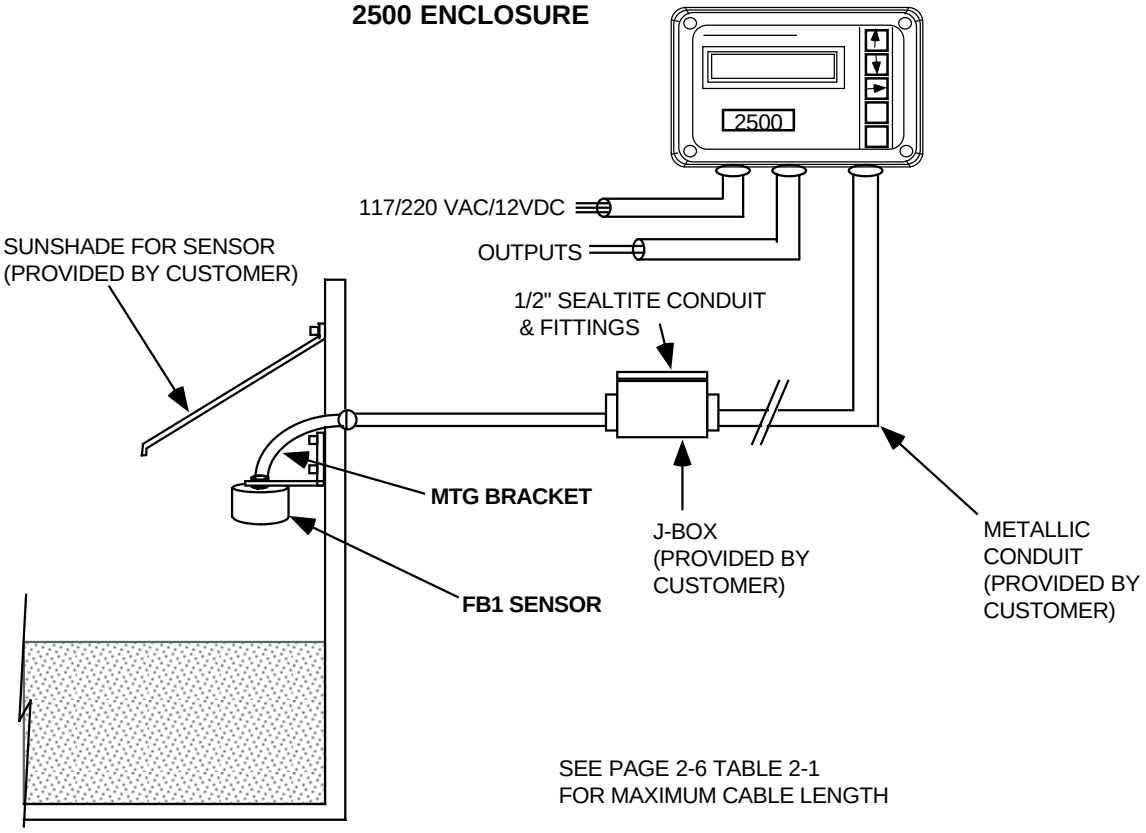
The general specifications for the Model 2500 are listed below. The next page is the system diagram for the installation of the Model 2500.

GENERAL SPECIFICATIONS

SPAN RANGE FB-1 SPAN RANGE FB-3	0-1 foot to 0-25 feet. Total range including offset distance is 26 feet. 0-1 foot to 0-50 feet. Total range including offset distance is 51 feet.
OFFSET REGION	Minimum distance from maximum fluid level to face of sensor is 12 inches.
OUTPUT	4-20 mADC isolated into a maximum load of 1000 ohms when operating on AC power. When operating on DC power the maximum load depends on the size of DC voltage powering 4-20 mA loop. Four programmable relays; SPDT 1 amp at 24 VDC/0.5 amp. at 120 VAC.
DISPLAY	2 line, 24 character per line, LCD. Indicates level or level and volume and alarm trip status.
PROGRAMMING	Front panel mounted 5 button key pad.
POWER	117/230 VAC +/- 10%, 50/60 HZ, 10 watts or 12-14 VDC.
ACCURACY FB-1 ACCURACY FB-2	+/- 0.1% of target distance or 0.08 inches whichever is greater. Repeatability: 0.2% +/- 0.2% of target distance or 0.16 inches whicheveris greater. Repeatability: 0.2%
SENSOR FB-1 SENSOR FB-2	Maximum cable length 300 feet. Temperature range: -20° F to 160° F (-30° C to 65° C) Maximum cable length 300 feet. Temperature range: -40° F to 194° F (-40° C to 90° C)
ELECTRONIC ENCLOSURE	NEMA 4X standard, temperature range: 32° F to 150°F (9° C to 65°C) Optional NEMA 4X with heater and thermostat, temperatures down to -40° F (-40° C)

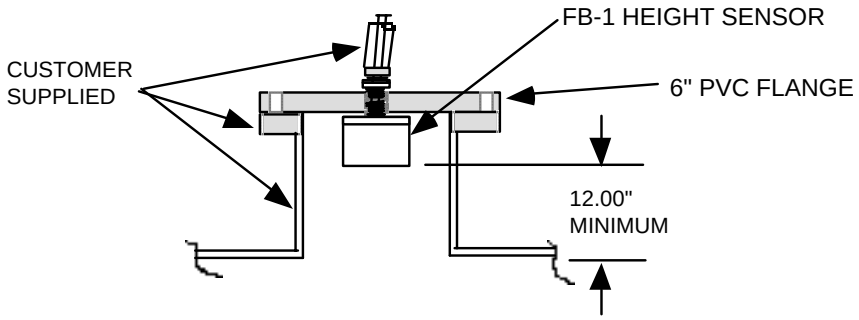
MODEL 2500 SYSTEM DIAGRAM

2500 ENCLOSURE

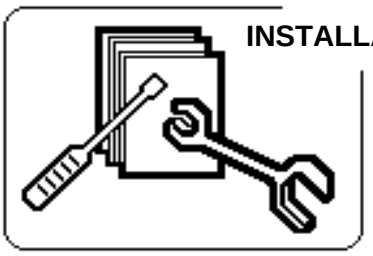


SEE PAGE 2-6 TABLE 2-1
FOR MAXIMUM CABLE LENGTH

2500 FLANGE MOUNT SENSOR



TANK



INSTALLATION

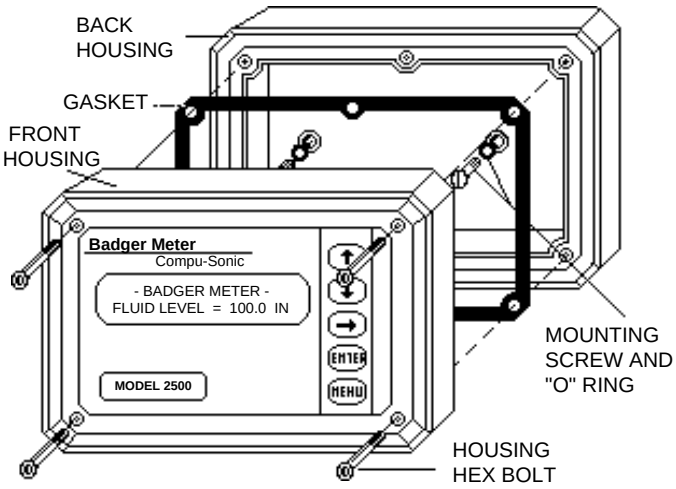


FIGURE 2-1

ELECTRONIC ENCLOSURE

The Model 2500 electronics is housed in a rugged, NEMA 4X rated, polycarbonate enclosure which can be wall mounted. Supplied with each unit are two 1/4-20 x 3/4 inch mounting screws for use with lead inserts, two 1/4-20 x 3/4 inch sheet metal screws for other wall materials, and two "O" rings necessary to maintain the NEMA 4X rating of the enclosure.

When mounting the Model 2500 Electronics, select a location that has good ventilation, temperature within the meter's specification, not subject to flooding, protection from accidental shock and provides for accessibility to operate the meter and for future service.

ENCLOSURE MOUNTING

To mount the enclosure use the 5/32 inch Allen wrench supplied in the mounting hardware package to loosen and remove all four hex bolts in the front of the housing (see Figure 2-1). Separate the front and back housings. **CAUTION: THERE IS A COAX SIGNAL WIRE AND A RIBBON CABLE CONNECTED TO THE POWER SUPPLY BOAR FROM THE FRONT HOUSING THAT WILL NEED TO BE DISCONNECTED WHEN REMOVING THE FRONT HOUSING (SEE FIGURE 2-2).** Place the front housing in a protected area so it will not be damaged while mounting the back housing.

To mount the back housing, two holes will need to be drilled in the wall 4.5 inches apart (center line to center line, see Figure 2-3). The size of the holes will depend on whether lead inserts are used or the mounting screws are screwed directly in e wall. Select the appropriate screws and place the "O" rings o the screws. With a 3/8 inch hex head driver, secure the back housing to the wall. **Since the power supply board is in the back housing, care should be taken to prevent damaging any components on the board.**

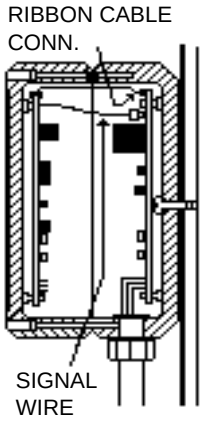


FIGURE 2-2

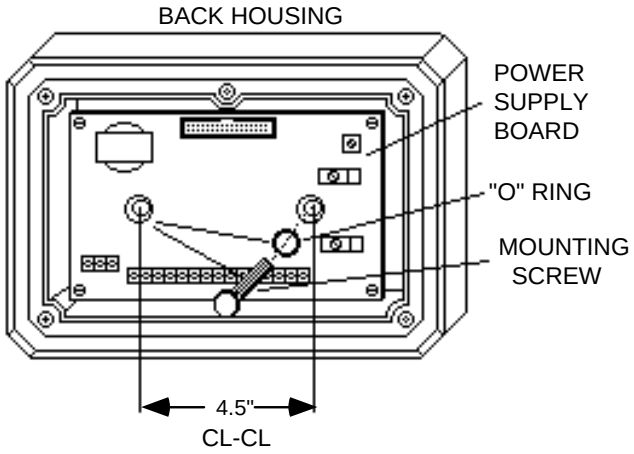


FIGURE 2-3

WIRING CONNECTIONS

The Model 2500 electronics enclosure is provided with four holes for 1/2 inch NPT conduit fittings. These holes are on the bottom of the back housing of the enclosure and allow entry for the 117/230 VAC power wires, sensor cable, 4-20 mADC signal output wires and the relay output wires. **Do not run the power wiring, sensor cable or signal output wires in the same conduit. This will affect the meter's operation.**

The terminals on the power supply board will accept 14 to 22 gauge wire. A small common screw driver will be required to loosen and tighten the screws. Figure 2-5 identifies the terminals for proper wiring.

Power connections. TB1 is the terminal block for the 117/230 VAC connections. Terminal 1 is the high side (black wire) connection. Terminal 2 is the low, or neutral, side (white wire) connection. Terminal 3 is the earth ground (green wire) connection.

TB2 terminals 1 and 2 are the connections for the DC power input if the meter is to be operated on battery power. Terminal 1 is the positive (+) connection and Terminal 2 is the negative (-) connection. The DC input voltage should be between 12 and 14 volts.

When operating the meter on DC power, an additional DC power source may be required to power the 4-20 mADC output. Refer to the 4-20 mA signal output in the following section for instructions.

Signal output connections. TB2 is the terminal block for the 4-20 mADC output signal and the four relay outputs.

4-20 mA OUTPUT - Terminals 3 and 6 are the connections for the 4-20 mA output when the meter is operated on AC power. Terminal 6 is the positive (+) connection and Terminal 3 is the negative (-) connection. **A jumper wire is connected between Terminals 4 and 5 when shipped from the factory. This jumper must be in place when operating the meter on AC power.**

If the meter is operate don DC (battery) power and a 4-20 mA output is required, an additional DC power source may be required. To properly connect the power source for the 4-20 mA output refer to Figure 2-5. Disconnect the jumper wire between Terminals 4 and 5. Connect the positive wire of the battery to Terminal 5, the negative wire of the battery to the negative input of the load (recorder) and connect the positive input of the load to Terminal 6. The minimum DC voltage required to power the 4-20 mA loop is 8 volts. The size of the DC voltage source needed will depend on the amount of resistance of the load connected to the 4-20 mA loop. To

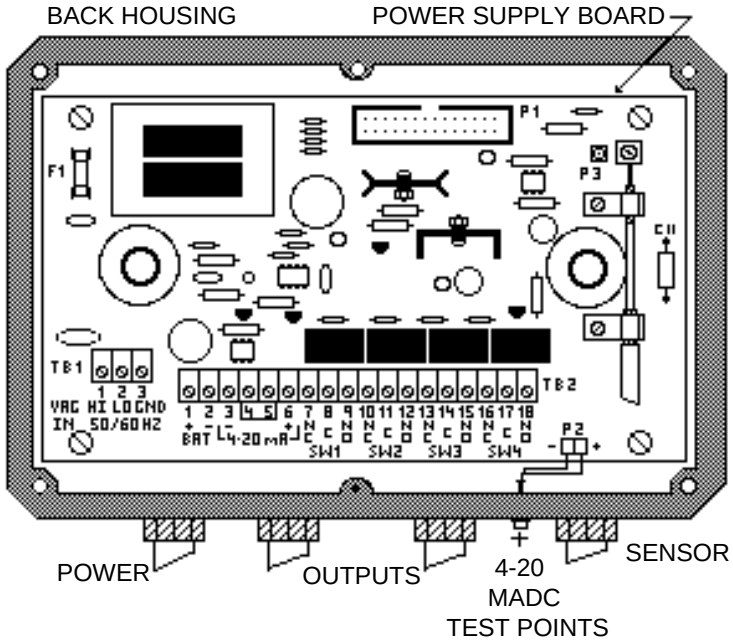


FIGURE 2-4
BACK HOUSING

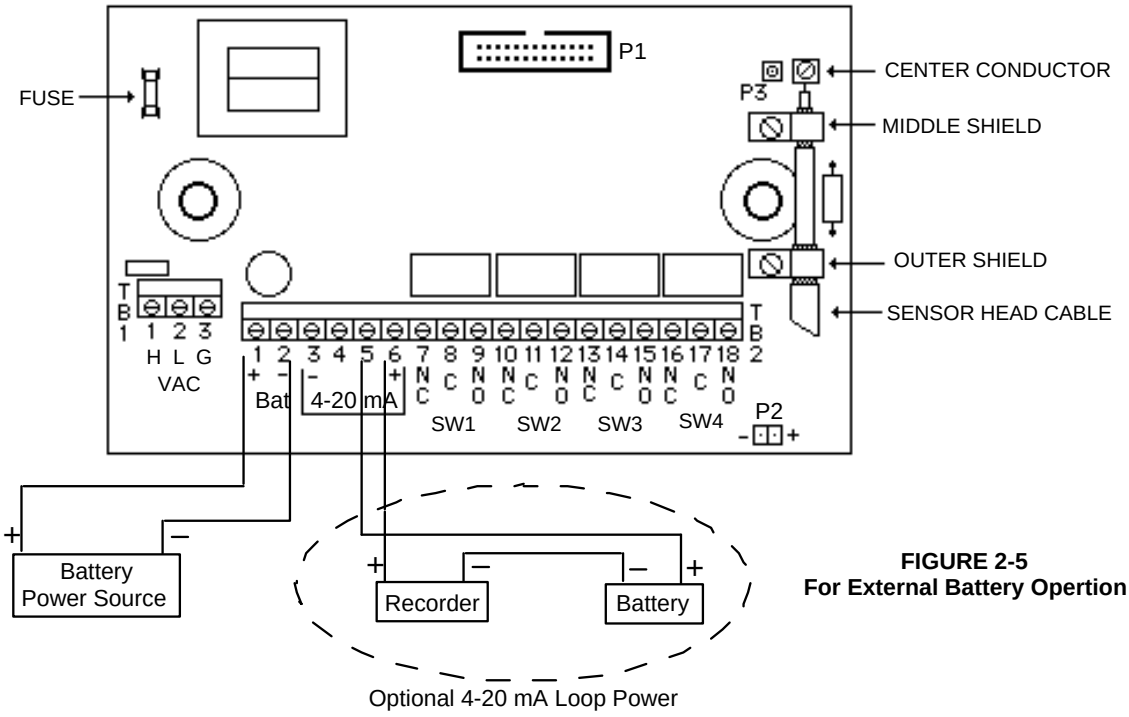


FIGURE 2-5
For External Battery Opertion

determine the maximum load for a specific DC power source, use the following equation:

(DC volts - 8)/2 X 100 = Max load resistance

That is, for a 12 volt power source the maximum load resistance would be 200 ohms (12-8)/2 X 100 = 200.

The maximum voltage for the 4-20 mA loop is 40 VDC.

Two test points are provided on the bottom of the back housing to allow adjustment of the 4-20 mADC signal. **A load must be connected to the 4-20 mADC output terminals for these test points to work.** Refer to the Operation Section for use when adjusting Zero and Span.

RELAY OUTPUTS - TB2 also is the terminal block for the connections for the relay outputs. Terminal connections 7 through 18 are used for the four relays which are marked SW1, SW2, SW3 and SW4. These relays are single pole double throw with a 1.0 amp 24 VDC or 0.5 amp 120 VAC current rating.

The wiring connections are marked on the printed circuit board below the terminal block. Each relay terminal is marked NC (normally closed), C (common) and NO (normally open). The normally open and normally closed positions are with the relay de-energized. The relays are energized when they are tripped by the assigned level or alarm. The relays can be assigned for different functions which are explained in the Operation Section of this manual.

Sensor cable connections. The cable for the sensor should be run in a separate metallic conduit. Leave approximately 4-1/2 inches of cable extending from the conduit in the enclosure. Refer to Figure 2-6 and prepare the cable ends in the following manner.

1. **Remove outer cable cover.** Measure 2-1/2" from the end of the cable. With a cutting tool, carefully cut through the outer covering completely around the cable making sure not to cut into the outer shield. Make another cut from the first cut to the end of the cable and remove the outer cover.

2. **Remove outer shield.** Measure 2" from the end of the cable. With a pair of small wire cutters, cut the shield around the cable at the measured point and remove the cut off shield.

3. **Remove middle cover.** Measure 1-1/4" from the end of the cable. With a cutting tool, carefully cut through the middle covering completely around the cable making sure not to cut into the middle shield. Make another cut from the first cut to the end of the cable and remove the middle cover.

4. **Remove middle shield.** Measure 3/4" from the end of the cable. With a pair of small wire cutters, cut the shield around the cable at the measured point and remove the cut off shield

5. **Remove inner cover.** Measure 5/8" from the end of the cable. With a cutting tool, or pair of wire strippers, carefully cut the inner covering completely around the cable, making sure not to cut into the center conductor and remove the inner cover.

After the end of the cable has been prepared, loosen the screws on the terminal for the center conductor. Remove the two cable clamps. Insert the center conductor of the sensor cable into the center conductor terminal and tighten the screw. Slightly pull on the cable to ensure that the wire is secured to the terminal

Place the two clamps over the middle and outer shields and secure them into place. Verify that the clamps are making good contact with the shields and that no wires of the shields are extending beyond their own clamp down area.

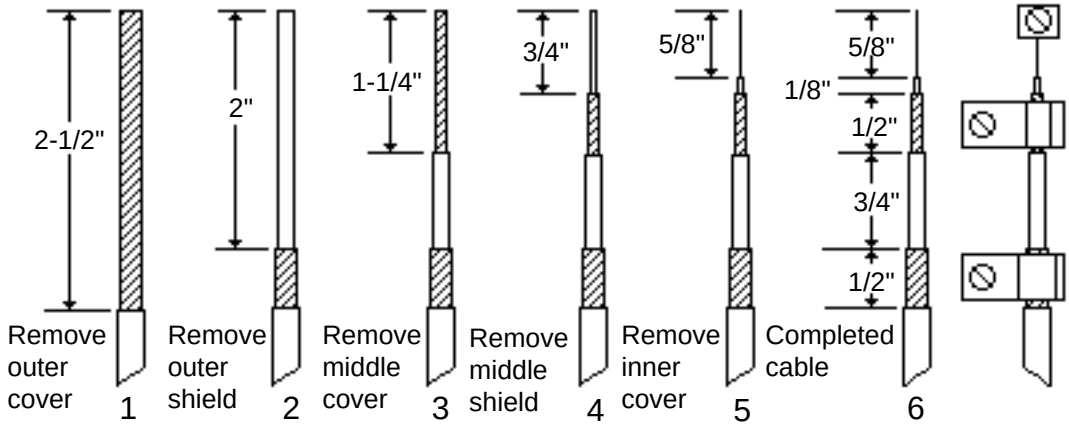


FIGURE 2-6

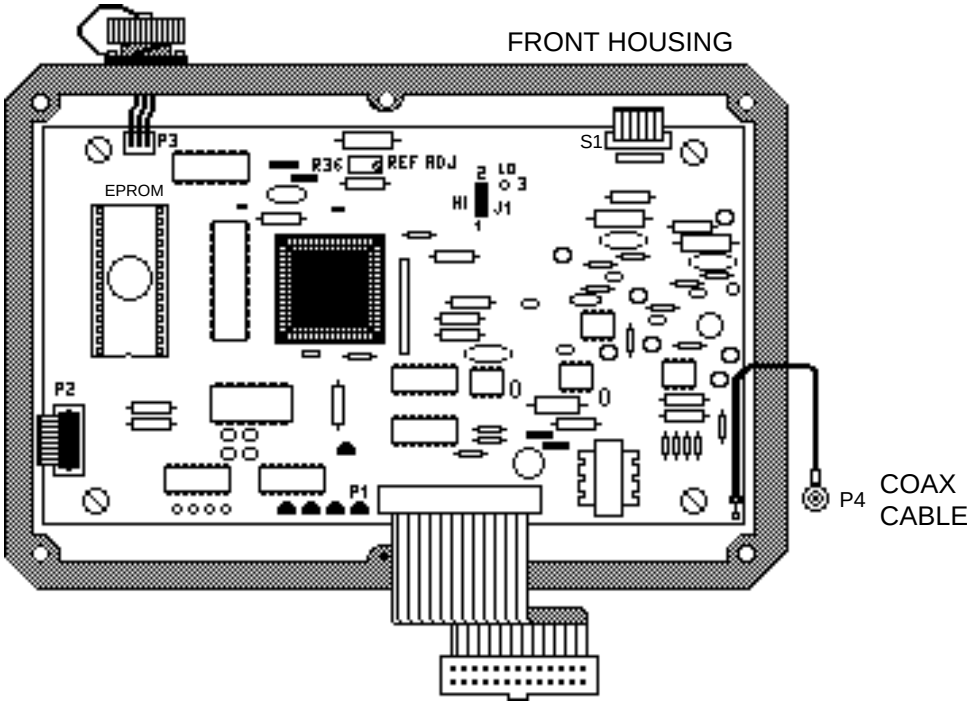
Front housing installation. After the wiring of the back housing is completed, the front housing can be reinstalled. The gasket is attached to the front housing to ensure proper alignment for maintaining a good seal.

Refer to Figure 2-7. Connect the ribbon cable plug S1 coming from the front housing into the socket connector P1 on the power supply in the back housing.

Connect the coax cable coming from the electronic board in the front housing to the connector P3 on the power supply board in the back housing.

Secure the front housing to the back housing with the four hex bolts.

This completes the enclosure installation procedure.


FRONT HOUSING
P3
R36
REF ADJ
S1
EPROM
2 LO
HI
J1
3
1
P2
P1
P4
COAX
CABLE

S1

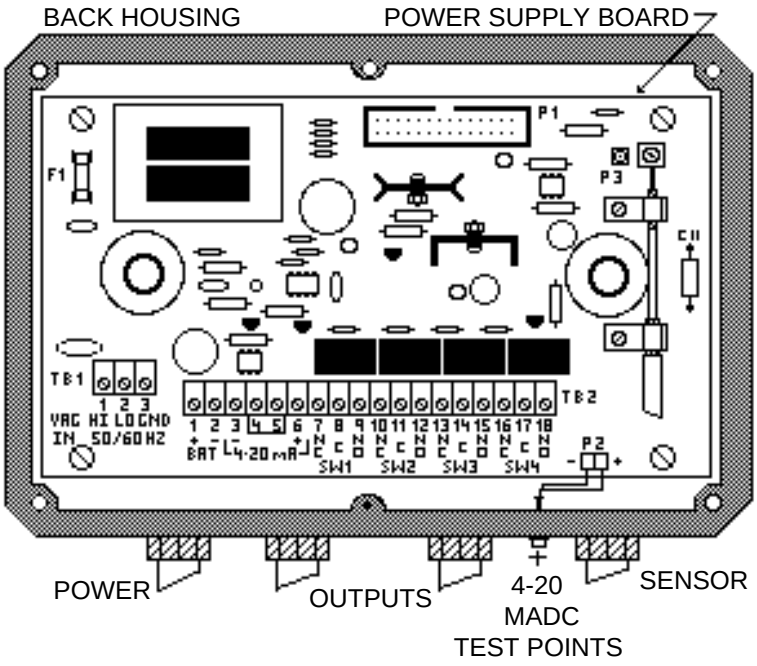

BACK HOUSING
POWER SUPPLY BOARD
P1
F1
P3
C11
TB1
1 2 3
VAC HI LO CMD
IN 50/60 HZ
TB2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
BAT 4-20 mA
SW1
SW2
SW3
SW4
P2
POWER
OUTPUTS
4-20
MADC
TEST POINTS
SENSOR

FIGURE 2-7

FB-1 (FULL FACE) SENSOR INSTALLATION

GENERAL DESCRIPTION

The Model 2500 FB-1 sensor is housed in a PVC plastic housing. The sensor is back filled with an epoxy resin. The sensor head has a 3/4 inch NPT mounting nipple to secure the sensor to the mounting bracket and attaching a conduit fitting for routing the sensor cable back to the electronic enclosure. **Metallic conduit must be used to run the sensor cable back to the electronics.** The sensor must be mounted level. An 'L' mounting bracket is supplied with the sensor.

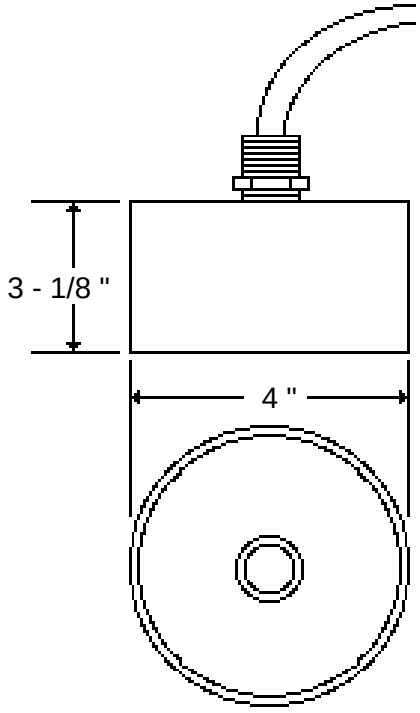
The sensor is supplied with 50, 100, 300, or 500 feet of continuous cable, but 300 feet is the maximum cable length for a target distance of 25 feet. Longer cable length can be used for shorter maximum target distances. Table 2-1A gives the maximum sensor cable length with respect to the maximum target distance. **Only Belden 922 cable should be used when adding cable to the sensor.**

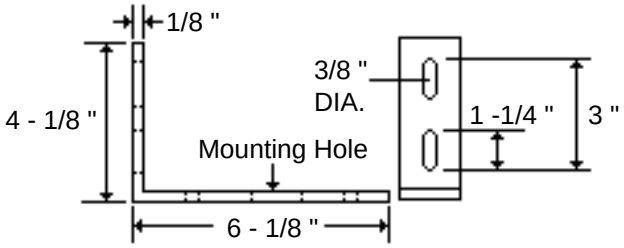
Maximum Target Distance in Feet	Maximum Cable Length in Feet
25	300
23	400
22	500
20	600
18	700
16	800
14	900
12	1000

TABLE 2-1A

A component change in the electronics may be required if the sensor cable length is changed from that shipped by the factory. The critical lengths of the cable for the component change are 150 feet and 500 feet. The following shows the component value for C11 according to the sensor cable length (see Figure 2-7, Page 2-5 for location):

0 to 150 feet — C11 = 6800PF
151 to 500 feet — C11 = no component
501 to 1000 feet — C11 = 470 uH





MOUNTING BRACKET

FB-3 (EXTENDED RANGE)
SENSOR INSTALLATION

GENERAL DESCRIPTION

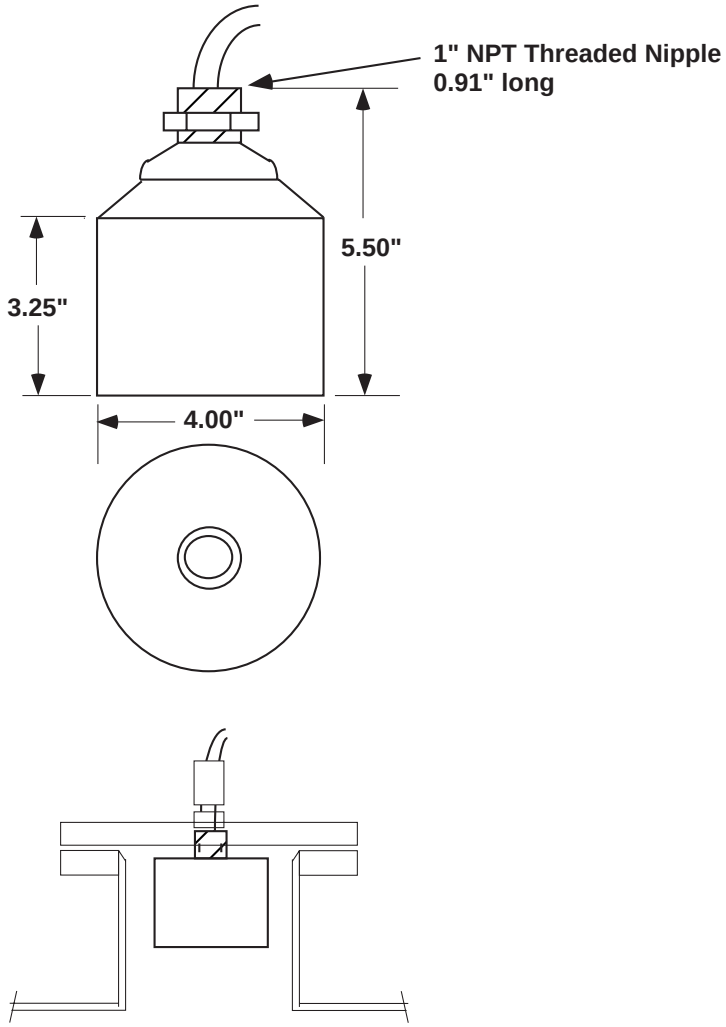
The Model 2500 FB-3 sensor is housed in a glass filled polyester housing with a glass reinforced epoxy face. The sensor is back filled with an epoxy resin. The sensor head has a 1 inch NPT threaded nipple designed to secure the sensor to the mounting fixture and attach the conduit fitting for routing the sensor cable back to the electronic enclosure.

Metallic conduit must be used to run the sensor cable back to the electronics.

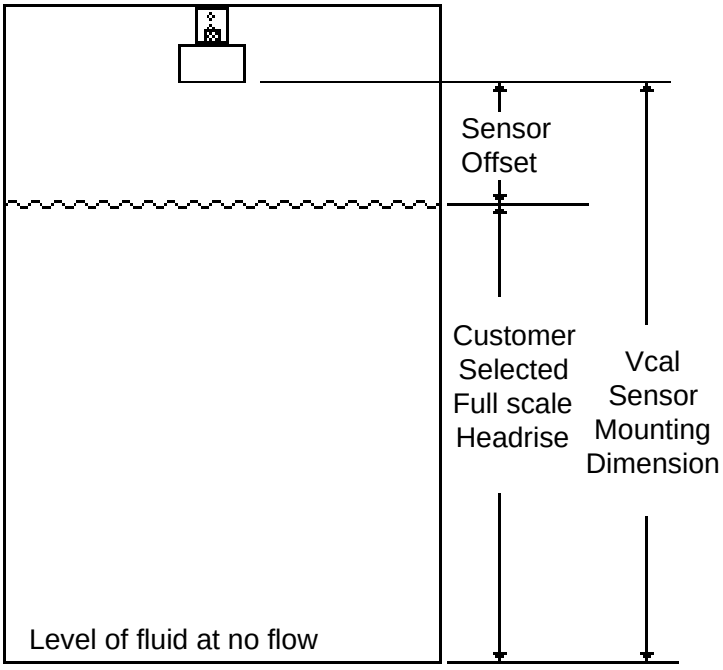
The sensor must be mounted level. An 'L' mounting bracket is supplied with the sensor.

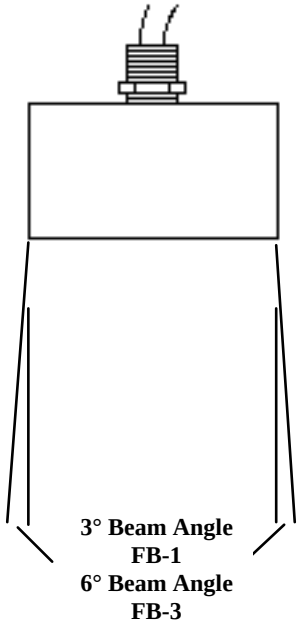
The sensor is supplied with 50, 100, 300, or 500 feet of continuous cable, but 300 feet is the maximum cable length for a target distance of 50 feet.

Only Belden 9222 cable should be used when adding cable to the sensor.



Suggested Flange Mounted Technique





NOTE:
If sensor is exposed to sunlight, a sun shield should be used. Refer to System Diagram, Page 1-3.

INSTALLATION

Installing the sensor requires exact measurements be made to ensure accurate level measurement with the Model 2500 transmitter. The meter is normally programmed at the factory to the specific application. Refer to the Data Sheet in the front of this manual for this information.

The dimension that is used when mounting the sensor is the vertical calibrated (Vcal) mounting distance. This is the distance from the surface of the fluid at no (zero) flow, to the face (bottom) of the sensor. There are two regions that make up the Vcal distance. These are the **sensor offset** and the customer selected **active region**.

The **sensor offset** is the distance from the maximum level of the fluid to the face of the sensor. The minimum offset for the FB-1 sensor is 12 inches. For the extended range (FB-3) sensor,it is 24 inches.

The **active region** is the total level change to be measured by the Model 2500. This is also referred to as the span of the meter. The minimum span is 0 to 1 foot and the maximum span is 0 to 25 feet for the FB-1 and 0 to 2 foot and maximum span is 0 to 50 feet for the FB-3.

Another aspect that must be considered when mounting the sensor is the distance of the sensor from the walls of the container in which the fluid is held. If the sensor is too close to the wall, reflections may occur which could cause inaccuracies in the level measurement. For example, the beam angle of the transmitted signal from the FB-1 sensor face is a maximum of 6 degrees. To determine the distance the sensor needs to be mounted from the wall, multiply the Vcal distance times 0.0524. This will give the distance required from the wall to the sensor housing. Similar consideration should be given for the FB-3 sensor.

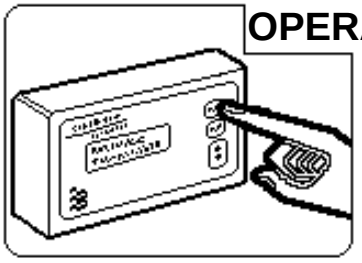
The exit hole for the sensor cable on the top of the housing for the FB-1 is a 3/4 inch NPT nipple which is used to mount the sensor to the mounting bracket and connecting the conduit for the cable. For the FB-3 sensor it is 1" NPT. **The cable should be run in a metallic conduit to prevent any stray noise interference from affecting the meter's operation.**

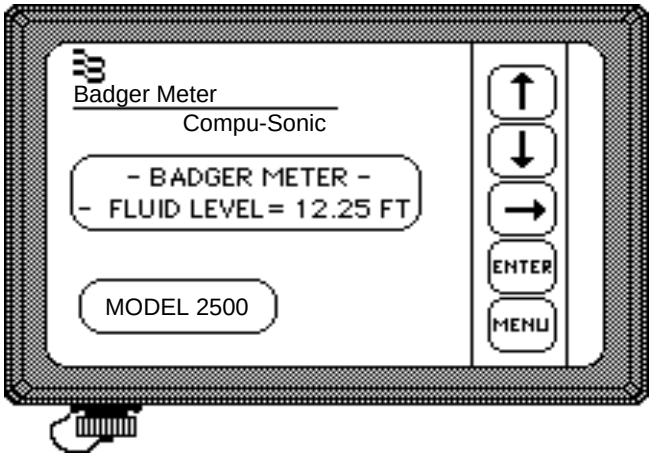
The mounting bracket provided with the sensor can be mounted directly to the wall for Vcal distances of 5 feet or less. An extension, or mounting brace, to the mounting bracket will be required for Vcal distances greater than 5 feet.

When installing the sensor it is imperative that it be level. A level should be place don top of the sensor and adjustments made to the mounting bracket to ensure the sensor face is level to the fluid. **This leveling is critical to proper operation of the meter.**

This completes the sensor installation procedure. Refer to the Electronic Wiring section for connecting the sensor cable to the electronics.

OPERATION





GENERAL DESCRIPTION

The Model 2500 is an ultrasonic level transmitter designed to measure fluid levels up to 25 feet. The meter is equipped with a 2-line, 24 character per line LCD display, 4-20 mADC signal output, 4 programmable relays and an RS232 serial communications port.

The Model 2500 is microprocessor based and is fully programmable by the front panel key pad. The meter can be programmed for either level or level and volume. There are five keys that are used to access meter status information or to program the meter. These keys are the MENU, ENTER, UP arrow, DOWN arrow and RIGHT arrow.

The MENU key allows access to the Status Mode or Calibration Mode of the meter. It also can be used to return to normal operation any time you are in the Status or Calibration Mode. If you press the MENU key while in the Calibration Mode, the processor will store any changes made up to that point but will retain the previous programming after that point and return to the normal operating screen.

The ENTER key is used to store any data changes that are made in the Calibration Mode.

The UP, DOWN, and RIGHT arrow keys are used for selecting or making changes in the various screens of the meter while in the Calibration Mode.

To prevent unauthorized entry into the Calibration Mode of the meter, there is a security screen that requires the correct security code to be entered in order to gain access.

When power is first applied, the display will show the model number across the top line with the software revision number on the bottom line.

```
MODEL 2500 LEVEL METER
SOFTWARE REV. - X.XX
```

This will be displayed for about 3 seconds and then the next screen will show the serial number of the unit as shown below:

```
- BADGER METER-
SERIAL NUMBER XXXXXXXX
```

This will be displayed for about 3 seconds and then one of the next two screens will be displayed depending on whether your unit has been programmed for level only measurement or level and volume measurement.

```
- BADGER METER -
-  FLUID LEVEL  =  XXX.X IN.
```

OR

```
VOLUME 1000  X  100        GAL
*   FLUID LEVEL  =  XXX.X IN.
```

These two screens are considered the normal operating screens. In the lower left corner of the display there will be either a flashing '-' or '*'. The '-' indicates that the meter is functioning properly and that there are no alarms or relays tripped. The '*' indicates that there are alarms or relays tripped.

The meter will display Xs for the volume and/or level until a valid echo is received.

The following two sections describe the operation of the Status and Calibration Modes.

STATUS MODE

The Status Mode allows the user to determine what alarms or relays are tripped. It also allows the direct reading of the measured distance from the sensor head to the fluid level, the receiver gain, and the measured temperature. It also has a self test screen that will perform diagnostics of the electronics.

To enter into the Status Mode, press the MENU key and the following screen will appear:

```
PRESS UP FOR CALIBRATION
PRESS DOWN FOR STATUS
```

This screen allows entry into the Calibration Mode or the Status Mode. Press the DOWN arrow key and the following screen will appear:

```
ALARMS TRIPPED
ECHO 4-20 PNT#1
```

This screen indicates any malfunction alarms or set points that are tripped. The following are the possible alarms:

ECHO:	Loss of return echo
4-20:	Open 4-20 mA loop circuit
EEPRM:	Failure of the EEPROM in the microprocessor
OVRR:	Fluid level is above maximum set span of the level meter
PNT#1:	Set point #1
PNT#2:	Set point #2
PNT#3:	Set point #3
PNT#4:	Set point #4

To leave the Status Mode, press the MENU and the meter will return to the normal operating mode. Pressing the ENTER key will step through the Status Mode screens.

Press the ENTER key and the following screen will appear:

```
RELAYS TRIPPED
RLY#1  RLY#2  RLY#3  RLY#4
```

This screen indicates the relays that are tripped. These relays may be assigned to set points or error alarms. The assignment of these are covered in the Calibration Mode Section.

Press the ENTER key and the following screen will appear:

```
FLUID LEVEL  =  XXX.X  IN
DISTANCE  =  XXX.X  IN
```

This screen indicates the fluid level and the measured distance from the sensor face to the fluid level. Adding these two values should equal the Vcal dimension. If the indicated distance is not correct, refer to the Calibration Mode instructions for correction.

Press the ENTER key and the following screen will appear:

```
RX GAIN XX          TEMP. +XX.XX° C
SIGNAL □ □ □ □
```

This screen indicates the received signal strength and the temperature at the sensor head in degrees Celsius. A receiver gain of 0 indicates maximum signal strength and 99 indicates minimum signal strength. The bottom line of the screen will indicate the signal strength with black squares. There should be at least 4 squares for good meter operation.

Press the ENTER key and the following screen will appear:

```
SELF TEST
PRESS UP TO ACTIVATE
```

This screen allows entry into the self test diagnostics routine. Press the UP arrow and the following screen will appear:

```
SELF TEST
EEPROM => TESTING
```

This screen indicates that the EEPROM of the microprocessor is being bested. After a few seconds the "TESTING" message will change to either "PASSED" or "FAILED". The following screen will appear:

```
SELF TEST
SENSOR TX => TESTING
```

This screen indicates that the meter is testing the sensor head to determine if it is transmitting a signal. After a few seconds the "TESTING" message will change to either "PASSED" or "FAILED". The following screen will appear:

SELF TEST
SENSOR ECHO => TESTING

This screen indicates that the meter is testing for the presence of a return echo. After a few seconds the "TESTING" message will change to either "PASSED" or "FAILED".

The display will then return to the main self test screen. You may repeat the self test, return to the Normal Operating Mode by pressing the MENU key, or continue with the Status Mode screens by pressing the ENTER key.

Press the ENTER key and the following screen will appear:

LEVEL SIMULATION
PRESS UP TO ACTIVATE

This screen allows the entry into the Level Simulation Mode. This screen simulates the level from 0 to the maximum programmed range. **The 4-20 mA output and the relays follow the simulated level. Devices connected to these outputs will be turned on and off.**

Press the UP arrow key and the following screen will appear:

- BADGER METER -
S FLUID LEVEL = 000.0 IN

This screen allows the user to simulate the level or level and volume measurement of the Model 2500. On the bottom left corner of the display there will be a flashing 'S'. This is to remind the user that the meter is in the Simulation Mode and not actually measuring level.

To simulate a level, use the UP or DOWN arrow keys to change the fluid level value that is displayed on the screen. The maximum level that can be simulated is the maximum level that has been programmed into the meter.

To leave the level simulation screen, press the MENU key. The display will return to me normal operating screen.

This completes the Status Mode Section of the Model 2500.

CALIBRATION MODE

The Calibration Mode allows the user to calibrate the Model 2500 to the specific application for which the meter is to be used. The setting of set points and assignment of the relays is also accomplished in this mode.

To enter into the Calibration Mode, press the MENU key while the display is in the normal operating screen. The following screen will appear:

PRESS UP FOR CALIBRATION
PRESS DOWN FOR STATUS

Press the UP arrow key and the following screen will appear:

SECURITY ID
INPUT 4 DIGIT ID 0000

This screen is the security screen which requires the correct 4 digit number to allow entry into the Calibration Mode of the Model 2500. To change the value of each digit, move the line under the digit to be changed with the RIGHT arrow key and then use the UP or DOWN arrow keys to change the value of the digit. When the 4 digit number is correct press the ENTER key. If the number is incorrect the meter will go back to the normal operating screen. If the number is correct the following screen will appear:

LEVEL UNIT
UNIT SELECTION = XX

This display allows the selection of the unit of measure to be used. The selections are:

FT = Feet
IN = Inches
M = Meters
cm = Centimeters
mm = Millimeters

To make the unit selection, use the UP or DOWN arrow keys until the correct unit is displayed and then press the ENTER key. The following screen will then appear:

LEVEL ADJUSTMENT
SPAN = XXX.X IN.

This sets the maximum level to be measured for a specific application. The maximum level span can be set is 25 feet. The minimum level span can be set is 1 foot.

To adjust the span, use the RIGHT arrow key to move the line under the digit to be adjusted and then use the UP and DOWN arrow keys to change the value of the digit. After the desired span value has been set, press the ENTER key to store this new value. The following screen will appear:

LEVEL ADJUSTMENT
OFFSET = XXX.X IN.

This screen allows the adjustment of the offset region. The offset region is the distance from the maximum fluid level to the face of the sensor head. The minimum offset is 12 inches. **The total of the offset and span values should not be greater than 26 feet.** To change the value of the offset use the RIGHT arrow key to move the line under the digit to be changed and then use the UP and DOWN arrow keys to change the value of the digit. Once the correct value has been set, press the ENTER key to store this value. The following screen will appear:

OUTPUT DAMPING
XXX SECONDS

This screen allows the adjustment of the response time of the output signal to change sin fluid level. To change this value, use the UP or DOWN arrow keys to change to the desired value. The available values are 8, 16, 32, 64, 128, 256, 512 and 1024 seconds. Once the desired value is displayed, press the ENTER key to store this new value. The following screen will appear:

LOST ECHO DEFAULT
XXX SECONDS

This screen allows the setting of the time desired to hold the last level value after the loss of the return signal before defaulting to the selected no signal output value. The available time values are 8, 16, 32, 64, 128, 256, 512, 1024 seconds. Use the UP or DOWN arrow keys to change to the desired value and press the ENTER key. The following screen will appear:

SETPOINT # 01
ON AT XX% OFF AT XX%

This screen allows the setting of the set points for low or high alarms and the dead band. These values are in percent of the maximum span value (level or volume, see 4-20 and set points tracking screen). To make the set point a low alarm, the ON value must be lower than the OFF value. For example, if the ON value was 30% and the OFF value was 35% then this set point alarm will be activated at the level of 30% of span and below and will be deactivated at the level of 35% of span and above.

To make the set point a high alarm, the ON value must be higher than the OFF value. For example, if the ON value was 60% and the OFF value was 50% then this set point alarm will be activated at the level of 60% of span and above and will be deactivated at the level of 50% of span and below.

To set the desired values, use the RIGHT arrow key to move the line under the ON or OFF values and use the UP or DOWN arrow keys to change the values, then press the ENTER key to store the new values. The screen will then advance to the next set point. There are four set points available. After the last set point has been entered the following screen will appear:

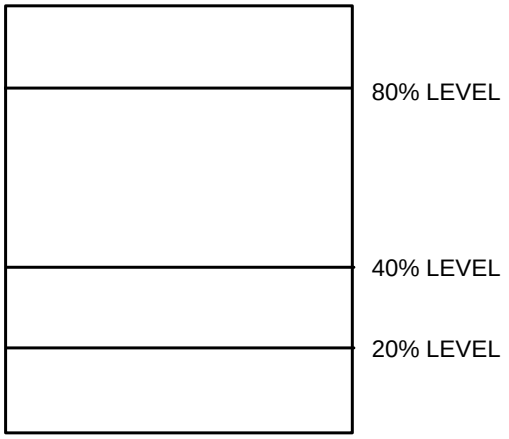
RELAY OVERRIDE
ACTIVATED -> NO

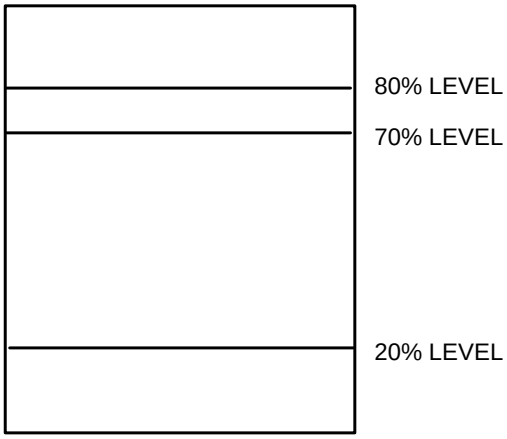
This screen allows the activation of the relay override feature. This feature has a set point override that can be used to override the normal set points that have been assigned to a group of relays. This is normally used for a pump up or pump down application. Use the UP or DOWN arrow keys to select YES or NO and then press the ENTER key. If NO is selected the display will go to the Pump Alternation screen. If YES is selected the following screen will appear:

RELAYS USED ->R1 R2 R3
ON AT 10% OFF AT 90%

This screen is used to select the relays that are to be controlled by the override set point and the setting of the set points. Up to three relays may be assigned to this feature. The following are examples of how this feature may be used.

The first example is for a pump up application. Two pumps are being used to maintain a certain level of water in a wet well. The pumps are to be alternated between pump up cycles. Set point #1 has been set as a low level alarm with its setting for the ON value being 40% and the OFF value being 80%. Relays #1 and #2 have been assigned to set point #1 and are being used to control Pumps #1 and #2 respectively. The Relay Override feature has been activated and the set points are ON at 20% and OFF at 80%.





When the water in the wet well goes down to the 40% level, Relay #1 will be activated which will turn on the #1 pump. When the water level in the wet well reaches the 80% level, Relay #1 will be deactivated which will turn off the #1 pump. When the water drops to the 40% level, Relay #2 will be activated which will turn on the #2 pump. When the water reaches the 80% level, Relay #2 will be deactivated which will turn off the #2 pump. This alternation will continue unless the water level goes down to the 20% level.

When the water goes down to the 20% level, the Relay Override feature takes control of the relays. The relay that is not activated at this time is activated, turning on its pump so that now both pumps are running. When the water reaches the 80% level, the Relay Override releases control, both Relays #1 and #2 are deactivated, and the meter returns to the normal alternation sequence.

The second example is for pump down application. Two pumps are being used to maintain a certain level of water in a wet well. The pumps are to be alternated between pump down cycles. Set point #1 has been set as a high level alarm with its setting for the ON value being 70% and the OFF value being 20%. Relays #1 and #2 have been assigned to set point #1 and are being used to control pumps #1 and #2 respectively. The Relay Override feature has been activated and the set points are ON at 80% and OFF at 20%.

When the water in the wet well reaches the 70% level, Relay #1 will be activated which will turn on the #1 pump. When the water in the wet well goes down to the 20% level, Relay #1 will be deactivated which will turn off the #1 pump. When the water reaches the 70% level, Relay #2 will be activated which will turn on the #2 pump. When the water goes down to the 20% level, Relay #2 will be deactivated which will turn off the #2 pump. This alternation will continue unless the water level reaches the 80% level.

When the water reaches the 80% level, the Relay Override takes control. The relay that is not activated at this time is activated turning o its pump so that now both pumps are running. When the water goes down to the 20% level, the Relay Override releases control, Relays #1 and #2 are deactivated, and the meter returns to me normal alternation sequence.

To assign the desired relays in the Relay Override feature, use the UP or DOWN arrow keys to change the relay number over the line. Then use the RIGHT arrow key to move the line to the next relay assignment position. There are three Relay Used positions on the screen, and for the above examples the first line of the screen could be as follows:

RELAYS USED -> R1 R1 R2
OR
RELAYS USED -. R1 R2 R2

After you have assigned a relay to the third relay used position, press the RIGHT arrow key again and the line will move under the ON % digits. Use the UP or DOWN arrow keys to change to the desired value. Press the RIGHT arrow key again and the line will move under the OFF % digits. Use the UP or DOWN arrow keys to change to the desired value. After you have made the desired changes to this screen, press the ENTER key. The following screen will appear:

PUMP ALTERNATION
ACTIVATED -> NO

This screen allows the activation of the pump alternation feature. Use the UP or DOWN arrow keys to change to YES or NO and press the ENTER key. If NO is selected, go to the RELAY ASSIGNMENT screen at the bottom of the page. If YES is selected the following screen will appear:

POINTS - P#1 P#2 - - - - - -
RELAYS - R#1 R32 R#3 R#4

In this screen the selection of the set point and the relays to be activated by the set point are made. Up to four set points and four relays can be used in the pump alternation mode. The RIGHT arrow key is used to move the cursor under the four positions of the set points and relays. Each set point position can have any of the four set points or a blank represented by (- - -). Each relay position can have any of the four relays or a blank represented by (- - -). Use the UP or DOWN arrow keys to select the desired set points and relays.

The following two examples will be used to explain the various set ups for the pump alternation screen.

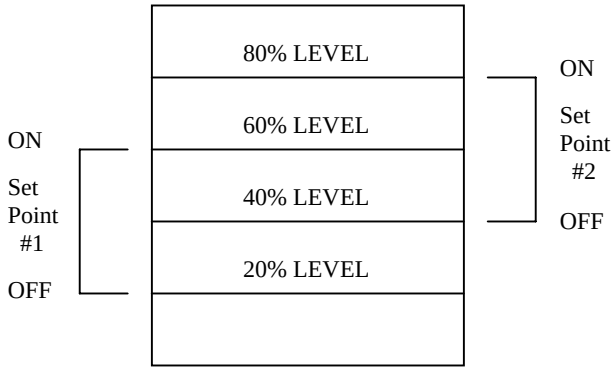
The first example will be the pump up or down application used for the Relay Override example. The screen below shows the proper selection for this situation.

```
POINTS - P#1 --- --- ---
RELAYS - R#1 R#2 --- ---
```

Set point #1 is selected for the first point position and blanks are selected for the three other positions. Relay #1 is selected for the first relay position and Relay #2 for the second position. Blanks are selected for the third and fourth relay position. These settings will cause Relay #1 (pump #1) and Relay #2 (pump #2) to operate alternately each time set point #1 is tripped.

The second example is an application where there are three pumps on a wet well. There is a need to have two set points to handle the various inflow conditions. The normal flow conditions require a high level set point to turn on one pump at 60% of the maximum height in the wet well and to turn it off at 20% of the height. At high inflow conditions a second high level set point is required to turn on a second pump at 80% of the maximum level in the wet well and turn off the pump at 40% of the maximum height. It is also desired for the pumps to be alternated to provide equal usage and wear.

The diagram below shows the control levels of Set Points #1 and #2.



The screen below shows the proper settings for this situation:

```
POINTS - P#1 P#2 --- ---
RELAYS - R#1 R#2 R#3
```

Once the set point and relay assignments have been made press the ENTER key to store these assignments. After the ENTER key is pressed the following screen will appear:

```
RELAY ASSIGNMENT
RELAY 01 => ECHO
```

In this screen the four relays are assigned to activate on alarms selected from the menu. Any relays that have been used in the Pump Alternation assignments will not be displayed for assignment. The assignments available are:

ECHO = Lost return echo
EEPRM = Failure of the EEPROM
OVRR = Level above the set span
4-20 = 4-20 mA output loop circuit open
PNT#4 = Set point number 4
PNT#3 = Set point number 3
PNT#2 = Set point number 2
PNT#1 = Set point number 1

Once the desired alarm has been selected for Relay #1, press the ENTER key to store this assignment. The screen will advance through the available relays. After the last relay assignment has been made the following screen will appear:

```
VOLUME LABEL
INITIALS - GAL
```

This screen allows the selection of the volume units if the meter is to indicate volume. If volume indication is desired, use the UP or DOWN arrow keys to change the label to the desired volume. The following are the available labels:

M3 = Cubic meters
L = Liters
CFT = Cubic feet
BAR = Barrels
IGL = Imperial gallons
GAL = Gallons
NONE = Level only operation
OPTION = Allows the use of any three letters, "/" or "." for special volume initials.

If NONE is selected the Model 2500 will measure level only. After pressing the ENTER key the meter will go to the 4-20 Current Calibration screen.

If OPTION is selected the user is allowed to enter any three letters, a "/", or a"." to represent a volume unit not listed under the standard available units. To enter into the OPTION selection press the ENTER key and the following screen will appear:

VOLUME LABEL
OPTIONAL INITIALS = XXX

This screen allows the entry of optional initials for the volume units desired. Use the RIGHT arrow key to move the line under the position to be changed. Use the UP or DOWN arrow keys to scroll to the desired letter. After all three positions have the desired initials, press the ENTER key to store this initial.

After the ENTER key has been pressed for the desired volume label, the following screen will appear:

TANK MAXIMUM LEVEL
LEVEL = XXX.X IN.

If a volume initial was selected this screen asks for the maximum level of the tank. This is the maximum level capacity and may not be the same as the span set previously in the calibration procedure. Use the RIGHT arrow key to position the line under the digit to be adjusted. Use the UP or DOWN arrow keys to change to the desired value. Press the ENTER key to store this value. The following screen will appear:

VOLUME MULTIPLIER
GAL X 1000

This screen allows the selection of the multiplier for the volume display. The volume display can be up to four digits. If the tank being metered has a capacity of 1,000,000 gallons then a multiplier of 1000 would be required. Use the UP or DOWN arrow keys to select the desired multiplier. The available multipliers are: .001, .01, .1, 1, 10, 100, 1000 and 10,000. Press the ENTER key to store this value. The following screen will appear:

TANK FULLSCALE VOLUME
1000 X 1000 GAL

This screen allows the setting of the full scale volume of the tank. Remember this is the maximum capacity of the tank and not just the volume to be measured. Use the RIGHT arrow key to position the line under the digit to be changed. Use the UP or DOWN arrow keys to change the digit to the correct value. Press the ENTER key to store this value. The following screen will appear:

FUNCTION SELECTION
TANK TYPE -> TYPE X

This screen allows the selection of the type or shape of tank that is being used. Type 1 is a rectangular or vertical cylinder with flat ends, Type 2 is a horizontal cylinder with flat ends. Shapes for Types 3 to 7 have not been assigned. The OPTION selection allows the entry of a special curve to produce the area of a special shaped container. Go to Page 3-9 for instructions.

Use the UP or DOWN arrow keys to scroll to the desired tank type and press the ENTER key to store this selection. The following screen will appear:

4-20 OUT AND SETPOINTS
TRACK -> LEVEL

This screen selects the tracking of the 4-20 mA output and the set points to follow either the percentage of level or volume change. This screen will only be shown if a volume label is selected. Use the UP or DOWN arrow keys to select level or volume and then press the ENTER key. The following screen will appear:

4-20 CURRENT CALIBRATION
PRESS UP TO CHANGE

This screen allows the entry into the calibration screens for the 4-20 mA current output. Press the UP arrow key and the following screen will appear:

4-20 M.A CALIBRATION
ZERO WORD = 2345

This screen allows the adjustment of the zero level output value for 4 mA. The 4-20 mA output can be monitored on the test jacks on the bottom of the back half of the housing. **The 4-20 mA output must be connected to a load for the test points to work.** Use the RIGHT arrow key to position the line under the digit to be adjusted. Fine adjustment is made on the most right digit with the adjustment becoming more coarse with each digit to the left. Use the UP or DOWN arrow keys to adjust for the correct value. The value of the Zero Word is for reference only. Press the ENTER key to store the value. The following screen will appear:

4-20 M.A CALIBRATION
SPAN WORD = C345

This screen allows the adjustment of the maximum span level output of 20 mA. The 4-20 mA output can be monitored on the test jacks on the bottom of the back half of the housing. **The 4-20 mA output must be connected to a load for the test points to work.** Use the RIGHT arrow key to position the line under the digit to be adjusted. Fine adjustment is made on the most right digit with the adjustment becoming more coarse with each digit to the left. Use the UP or DOWN arrow keys to adjust for the correct value. The value of Span Word is for reference only. Press the ENTER key to store the value. The following screen will appear:

```
4-20 M.A CALIBRATION
DEFAULT WORD  =  2345
```

This screen allows the setting of the 4-20 mA output signal when the meter goes into a default condition due to the loss of a return signal. This value is set depending on the user's desire for the value of the output to indicate a default condition. The 4-20 mA output can be monitored on the test jacks on the bottom of the back half of the housing. **The 4-20 mA output must be connected to a load for the test points to work.** Use the RIGHT arrow key to position the line under the digit to be adjusted. Fine adjustment is made on the most right digit with the adjustment becoming more coarse with each digit to the left. Use the UP or DOWN arrow keys to adjust for the correct value. Press the ENTER key to store the value. The following screen will appear:

```
DISTANCE CALIBRATION
PRESS UP TO CHANGE
```

This screen allows entry into the distance calibration screen which enables the calibration of the transmitter if necessary. This is set at the factory and only needs to be checked every three months. Do not set the distance calibration to an arbitrary number. The display shows the actual distance from the sensor to the surface at that measurement cycle. Checking will require measuring from the bottom of the sensor (face) to the water, then setting the distance calibration to this measurement. Press the UP arrow key and the following screen will appear:

```
DISTANCE CALIBRATION
NEAR DIST. => XX.XX IN
```

This screen calibrates the meter for the maximum flow level. If this adjustment is made, the fluid surface should be smooth to assure a steady reading. The near distance calibration should be made during high flow - surface of fluid at, or close to, the maximum (full scale) level. **Do not perform this calibration if the distance from the sensor to the surface is greater than 48 inches.** The display shows the distance from the surface of the fluid to the sensor.

Checking will require measuring from the bottom of the sensor (face) to the surface of the fluid and adjusting the distance calibration to this measurement. Use the UP or DOWN arrow keys to adjust to the correct value. Allow time for the meter to settle. Press the RIGHT arrow key. The following screen will appear:

```
DISTANCE CALIBRATION
FAR DIST.  =>  XX.X IN
```

This screen calibrates the meter for the zero flow level. If this adjustment is made, the fluid surface should be smooth to assure a steady reading. The far distance calibration should be made during low flow - surface of fluid at, or close to, the minimum (zero) level. **Do not perform this calibration if the distance from the sensor to the surface is less than 72 inches.** The display shows the distance from the surface of the fluid to the sensor.

Checking will require measuring from e bottom of the sensor (face) to the surface of the fluid and adjusting the distance calibration to this measurement. Use the UP or DOWN arrow keys to adjust to the correct value. Allow time for the meter to settle. Press the ENTER key and the following screen will appear:

```
SECURITY ID
PRESS UP TO CHANGE
```

This screen allows the entry of the user's security identification number. When the meter is shipped from the factory, the security number is 0000. To prevent unauthorized entry into the Calibration Mode, the user should select a number, record the number and store it in a secure area. In the even the security number is lost, access can be made through a special procedure. Call 918-836-8411 for instructions. Press the UP arrow key to enter into the Security ID screen. The following screen will appear:

```
SECURITY ID
INPUT 4 DIGIT ID XXXX
```

This screen allows the user to enter a new Security ID number. Use the RIGHT arrow key to move the line under the desired digit to change. Use the UP or DOWN arrow keys to change the digit to the desired value. Press the ENTER key to store the new Security ID number. The following screen will appear:

```
- STORING PARAMETERS -
PARAMETERS->STORED
```

This screen indicates that the new parameters are being stored into the EEPROM of the microprocessor. The display will then return to the normal operating screen.

The Calibration Mode does not have to be stepped all the way through to make changes in the calibration. Once the desired change(s) is (are) made, the MENU key can be pressed instead of the ENTER key and the microprocessor will store the new changes and return to the normal operating screen.

This completes the Calibration Mode Section of the Model 2500.

OPTIONAL PROGRAMMING SCREEN

SPECIAL VOLUME CURVE PROGRAMMING

The Model 2500 has an OPTION selection available for the user to program 16 points of any height versus volume (H/V) curve for volume indication. The following will describe this procedure. We will begin with the volume FUNCTION SELECTION screen.

```
FUNCTION SELECTION
TANK TYPE -> OPTION
```

Use the UP or DOWN arrow key to select OPTION from the TANK TYPE menu and then press the ENTER key. The following screen will appear:

```
OPTIONAL H CURVE
POINT 0  =  FFFF
```

This screen begins with the first point of the Height (H) portion of the H/V curve. The input data is required to be in hexadecimal form. Point 0 is the first point and should be the first low end point of the curve. The zero height point need not be input because this is already assumed. Each of the 16 points will represent a percentage of the maximum height of the fluid at the maximum capacity of the tank.

The hexadecimal value FFFF (65535 decimal) represents 100% of the maximum height. It will be necessary to determine the decimal value of the desired percentage of the maximum height for each point. Pages 3-11 and 3-12 explain the procedure for converting hexadecimal to decimal and decimal to hexadecimal. The following is an example of a 16 point curve with the percent of maximum height to the corresponding decimal and hexadecimal values.

Point	Height	%Max	Decimal	Hexadecimal
0	04.8"	2	1311	051F
1	07.2"	3	1966	07AE
2	12.0"	5	3277	OCCD
3	16.8"	7	4587	11EB
4	21.6"	9	5898	170A
5	28.8"	12	7864	1EB8
6	36.0"	15	9830	2666
7	43.2"	18	11796	2E14
8	50.4"	21	13762	35C2
9	60.0"	25	16384	4000
A	72.0"	30	19660	4CCC
B	84.0"	35	22937	5999
C	108.0"	45	29491	7333
D	160.8"	67	43908	AB84
E	199.2	83	54394	D47A
F	240.0"	100	65535	FFFF

Use the RIGHT arrow key to move the cursor under each digit and use the UP or DOWN arrow keys to change to the desired value. After all four digits have been properly set, press the ENTER key. Do this for each point. After point F, the following screen will appear:

```
OPTIONAL V CURVE
POINT 0= FFFF
```

This screen begins the inputting of the volume (V) that corresponds to the same data point for the height just programmed. Use the same procedure as with the height points only divide the volume at 04.8" of height by maximum volume of the tank. Multiply this times 65535 and then convert to hexadecimal. For example:

If the maximum volume of the tank is 30,000 gallons (at 240") and the volume at 4.8" (Point 0 from height curve example) is 200 gallons, then:

200/300000 = .006667 x 65535 = 436.9 = 1B5 Hex

so Point 0 = 01B5. Use this procedure for each volume point.

Use the RIGHT arrow key to move the cursor under each digit and use the UP or DOWN arrow keys to change to the desired value. After all four digits have been properly set, press the ENTER key. Do this for each point. After point F, the 4-20 Out and Setpoints screen will appear. Return to Page 3-7 to complete the programming procedure.

To verify the H/V curve just programmed, go to the Level Simulation screen in the Status Mode and simulate the level and check the volume indicated. Refer to Page 3-2 for instructions.

The factory will provide a special H/V table upon request.

This completes the procedure for programming an optional H/V curve in the Model 2500.

HEXADECIMAL SYSTEM

The purpose of the hexadecimal number system is simply to reduce the number of units necessary for representing any given numerical figure,, thereby reducing the amount of space in memory necessary to retain it.

A decimal (normal) number is converted to a corresponding hexadecimal number which consists of fewer characters.

The hexadecimal number system consists of only 16 characters which are shown below by the boldface characters.

0 = **0**
1 = **1**
2 = **2**
3 = **3**
4 = **4**
5 = **5**
6 = **6**
7 = **7**
8 = **8**
9 = **9**
10 = **A**
11 = **B**
12 = **C**
13 = **D**
14 = **E**
15 = **F**

These characters may be arranged in various sequences to produce an infinite number of representations of decimal numbers. For example: 6D4C = 27,980.

CONVERSION OF DECIMAL WHOLE NUMBER TO HEXADECIMAL NUMBER

1. Divide the decimal number by 16.
   Example: 57420/16=3588.75

2. Multiply only the fractional part of the product by 16 to arrive at the first character in the hexadecimal equivalent. Remember, all numbers produced in this step are shown above. Also note that the product may have no fraction (.000) which would result in zero as the hexadecimal number.
   Example: .75 X 16 = 12 = C

3. Divide the whole number portion of the product by 16, thereby producing yet another number.
   Example: 3588/16=224.25

4. Repeat steps 2 and 3 in a cyclical fashion until the numerator to be divided in step 3 is less than 16. At that point, the numerator represents the final character in the hexadecimal sequence.

EXAMPLE: CONVERT 57,420 INTO A HEXADECIMAL NUMBER.

1.) 57,420/16=3588.75

2.) .75 X 16 = 12 = **C**

3.) 3,588/16=224.25

2.) .25 X 16 = **4**

3.) 224/16=14.00

2.) .00 X 16 = **0**

3.) 14 = E

57,420 = E04C

CONVERSION OF A WHOLE HEXADECIMAL NUMBER TO A DECIMAL NUMBER

1. Multiply the leftmost character in the hexadecimal number by 16.
   Example: **E** = 14 X 16 = 224

2. Add to the product previously found the value of the next character.
   Example: 224 + 0 = 224

3. Multiply the previously found product by 16.
   Example: 224 X 16 = 3584

4. Repeat steps 2 and 3 in a cyclical fashion until you have added the last hexadecimal character. Do not multiply beyond that point.

   EXAMPLE: Convert **E04C** into a decimal number.

   1.) **E** = 14; 14 X 16 = 224

   2.) 224 + 0 = 224

   3.) 224 X 16 = 3584

   2.) 3584 + 4 = 3588

   3.) 3588 X 16 = 57,408

   4.) 57,408 + 12 = 57, 420

   E04C = 57,420

WARRANTY

Badger warrants meters and parts manufactured by it and supplied hereunder to be free from defects in materials and workmanship for a period of 18 months from date of shipment or 12 months from date of installation, whichever period shall be shorter. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option. Seller's obligation hereunder shall be limited to such repair and replacedment and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discover and, at Seller's option, return of such meters, or parts f.o.b. to Seller's factory. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES WHATSOEVER IN-CLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT OF TITLE) OF MERCHANTABILITY AND FITNESS FOR A PARTICU-LAR PURPOSE. Badger shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

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