

Water Cut Monitor

4528 Detector, CX-645 Probe, CSA Approved 4728 Monitor

Installation / Operation Manual

Bulletin MNIN003 Issue/Rev 0.0 (5/19)



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Introduction

The 4728 S & W Monitor used in conjunction with a Model 4528 Detector Card and Model CX-645 Probe, provides continuous on-line monitoring of percent water in crude oil.

The monitoring system measures changes in the product stream capacitance. The dielectric constant (Dk) (a key factor in capacitance measurement) of the product stream changes dramatically as water content varies. The change in capacitance is accurately measured and correlated to percent water by calibration against “shake out” data.

The Model 4728 displays the percent water on a digital indicator and indicator status lights continuously display the conditions measured by the system. Alarm relays and a 4-20 mA output can be used to connect the system to other supervisory or control elements.

Specifications

Input Power

115 VAC +/- 15%, 50/60 Hz, 2 watts
220 VAC (Optional)
14-28 Volts DC @ 130 mA

S&W Range

0-5%, 0-10%, or 0-20%

S&W Alarm Setpoint

0-100% of S&W Range

Input Signal

0-5V DC from 4528 Detector

Indicators

S&W / Setpoint LCD
Merchantable Oil LED, -Green
Excess S&W LED, -Red
Bypassing Oil LED, -Yellow

Outputs

4-20 mA analog

Relays

SPDT Relay, 10 Amp 250 VAC
1/2 Hp 250 VAC, 13A 120 VAC resistive
1/3 Hp 120 VAC, 10 A 30V DC resistive

Time Delay

0-90 seconds adjustable in 10 second steps.
Off delay approximately 10% of on delay time.

Temperature Range

-20°F to 160°F (-29°C to 71°C)

Enclosure

NEMA 4X, Fiberglass, water resistant
NEMA 7, Explosion Proof

Description	Part Number
Model 4728 Monitor/WP Housing	81001114
Model 4728 Monitor/EXP Housing	81001115
Model 4528 Detector	81001164

Percent Water Set Point

The Digital Indicator on the Model 4728 displays percent BS&W. The setpoint (BS&W Limit) can be observed by moving the percent BS&W/Setpoint switch to the lower or setpoint position. If it is desired to change the setpoint, rotate the setpoint adjust knob until the new limit value is displayed. The switch must be held in the lower position while performing this adjustment. When the switch is released the indicator will display the percent water.

Time Delay

The delay that occurs between excess BS&W indication and bypassing, relay transfer, is determined by the position of the time delay switch. The time is adjustable from 0-90 seconds in 10 second steps. The off delay, excess BS&W to merchantable oil, is approximately 10 % of the on delay (30 sec. on, 3 sec. off).

Analog Output

The analog output is 4-20 milliamperes corresponding to 0-5%, 0-10%, 0-20% depending on unit range. The 4-20 mA output function is accomplished by the use of a precision integrated circuit. The 4 mA point may be adjusted slightly with the zero control on the Model 4728. The 20 mA point is factory preset.

The Model 4728 utilizes a loop switch to determine whether the 4-20 mA loop will be self powered or powered by a remote supply. In the internal mode the unit will drive 4-20 mA through a maximum loop resistance of 600 ohms. Loop resistance values of >600 ohms are possible with an external power source.

In the external mode the current loop may be powered from an external power supply (40 volts max.) through a 3 wire circuit. Maximum loop resistance will be

$$R_{\text{loop}} = \frac{V_p - 13.5}{.02}$$

where V_p is the power supply voltage.

Note: Under no condition should power be applied to the “+” or “-” 4-20 mA terminals. Circuit damage will occur. See page 7 for hookup.

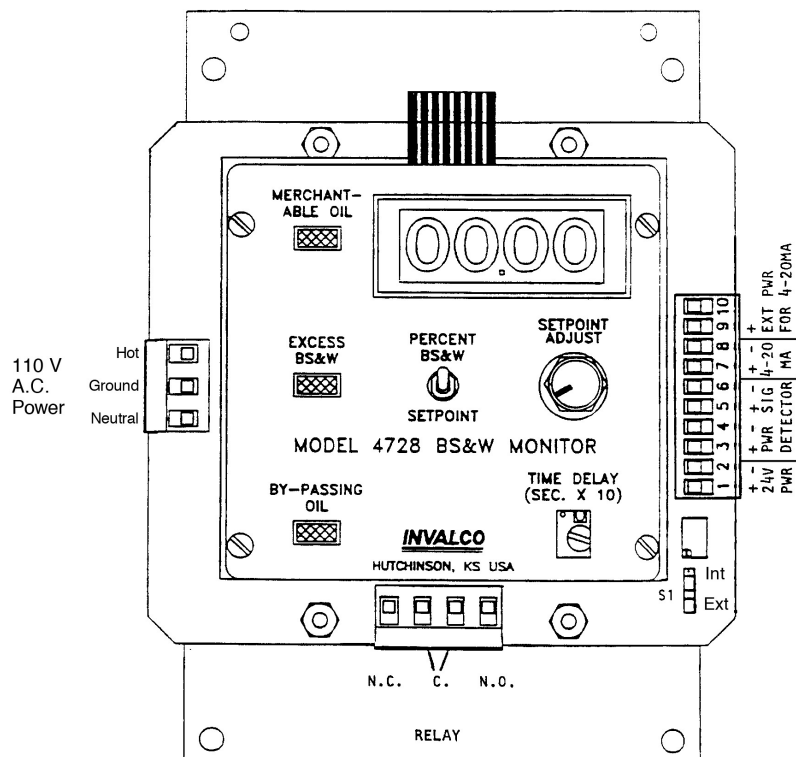
4728

The functions and locations of these three blocks on the P.C. card are as follows:

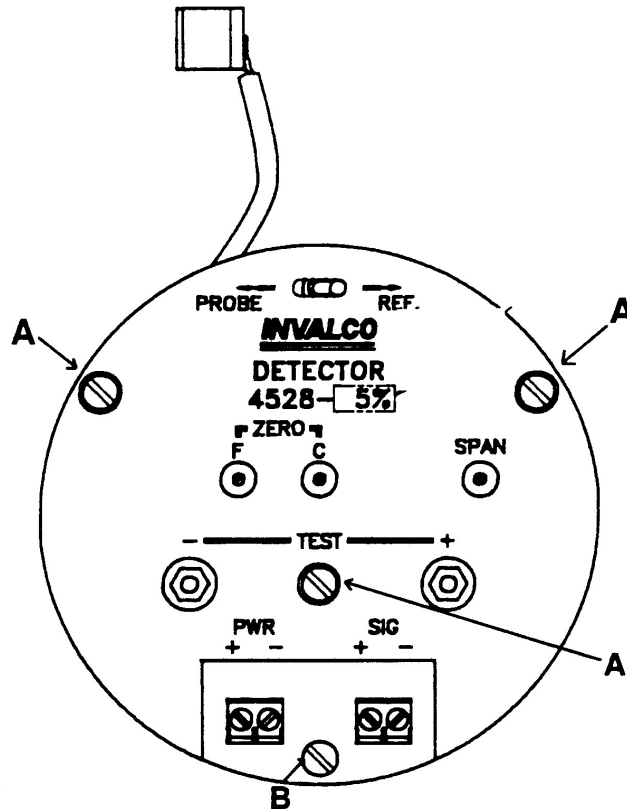
- (a) **Left side** - 110 V AC power input
- (b) **Bottom** - Relay contacts
- (c) **Right side** - Detector card connections, 4-20 mA hook-ups and 24 V DC power input for DC operation of the 4728.

Note: Switch S1 which is located at the lower right of the P.C. card. The position of this switch determines whether the 4-20 mA output is to be internally powered from the 4728, or externally powered from an outside source. Care must be taken to be sure this switch is in its proper position BEFORE an external 4-20 mA loop power source is connected. Failure to have the switch in the proper position may cause component failure and void the unit's warranty.

The function and operation of all other controls on the 4728 are as described in the manual.



Model 4528 Detector – Types A, B, and C

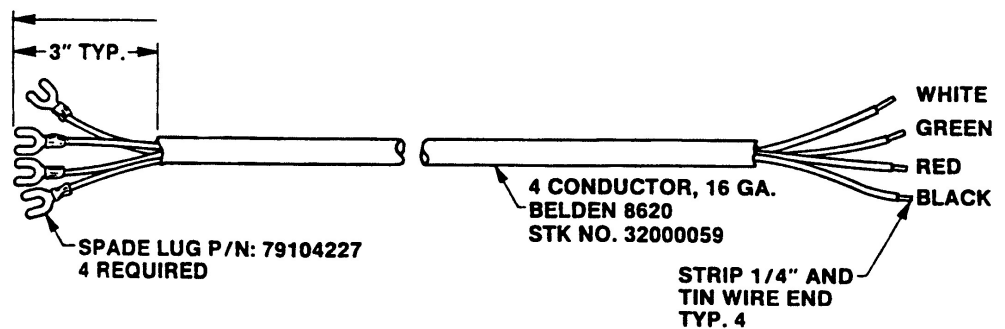
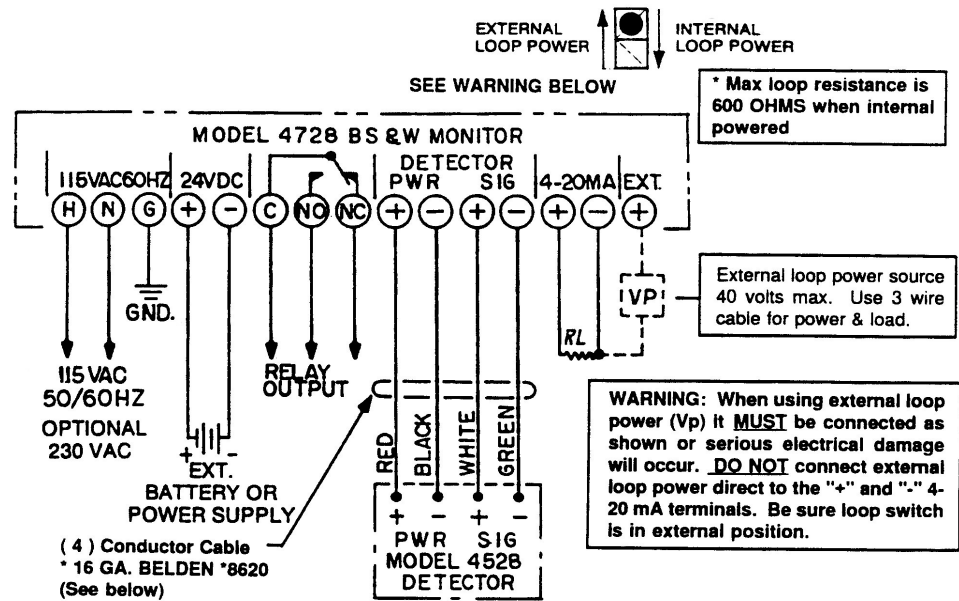


The Model 4528 Detector mounts in the explosion proof conduit on the capacitance probe. It converts water changes in the oil flowing through the probe to an output voltage that varies with the water.

The output will be 0-5 volts regardless of the range of the detector (i.e. 0-5%, 0-10%, 0-20%). To mount the detector in the conduit the top aluminum plate must be removed. This can be accomplished by removing the three screws marked "A" in the above drawing and gently lifting the top plate off of the printed circuit board. Find the short white or red wire with the clip on it and gently pull the wire straight up. Remove the nut from screw "B". Insert the printed circuit board into the conduit. Position the board so the rod sticking up from the probe goes into the round hole on the printed circuit board, just below the "Probe" - "Ref" Switch. Center the P.C. Card over the mounting holes and insert screw "B". Push the clip on the end of the white or red wire down firmly on the rod coming up from the probe. Rotate the clip if necessary. Replace aluminum top

plate by using the three screws marked "A" on the drawing.

Wiring Diagram

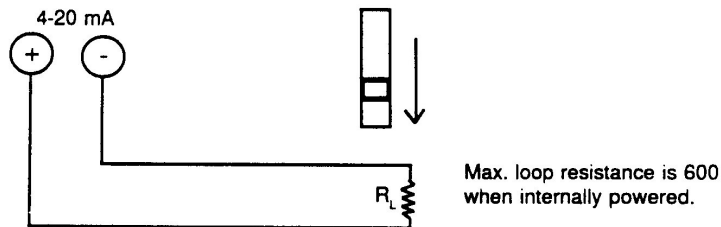


Note: Spade Lugs are not used on CSA Approved Model 4728.

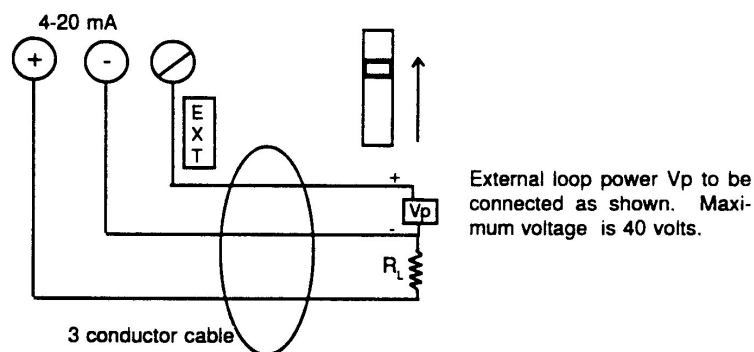
Note: Typical Interconnecting cable between Detector and Readout. Maximum recommended length is 300 feet.

4-20 mA Loop

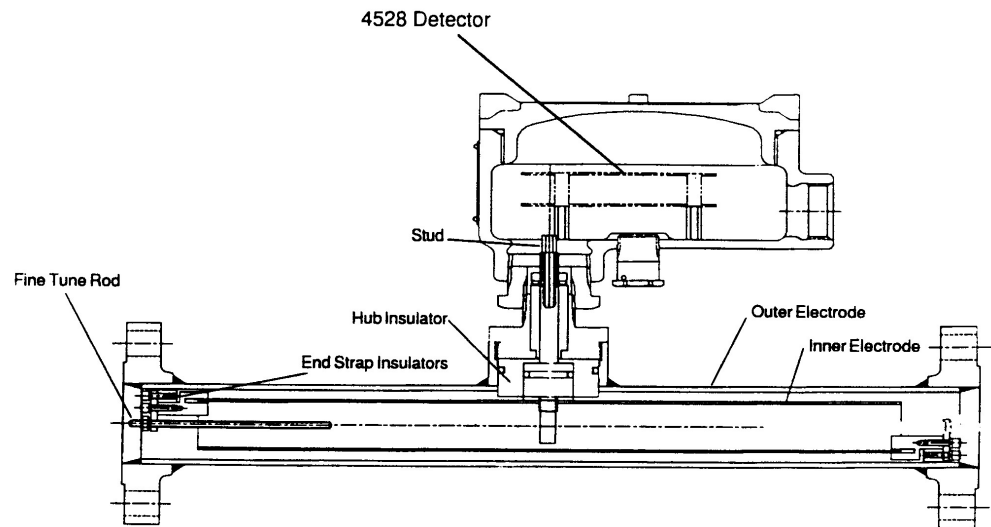
Internal Powered:



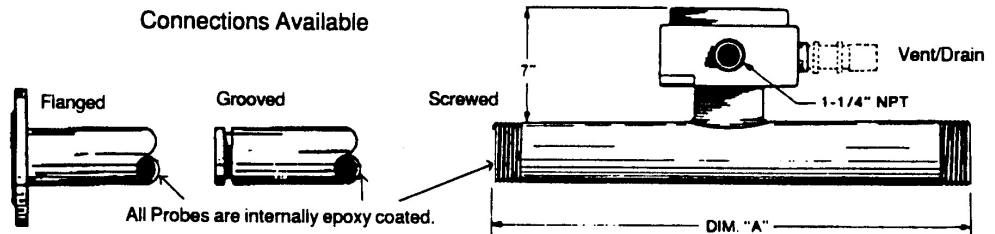
External Powered:



Warning: Loop Switch MUST be up in external position BEFORE connecting external power on 4728 with bottom terminal strip. Loop Switch MUST be up before connecting external power on CSA Approved Model 4728 with the two sides and bottom terminal strips.



The probe is constructed of two concentric tubes. Wetted and internal surfaces are coated with a fused epoxy powder. The inner tube is insulated from the outer tube by PTFE (polytetrafluoroethylene) spacers and is electrically connected to a terminal within the sensor housing. The internal element spacers can be fitted with trimmer rods should it be necessary to adjust the base capacitance.



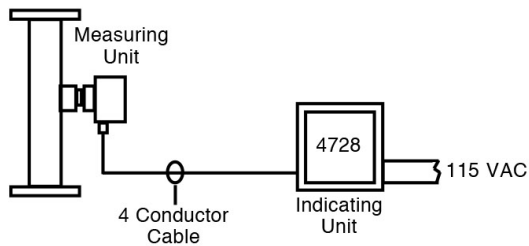
Pipe Sizes Available

Pipe Size	Dim. "A"
2"	17"
3", 4", 6", 8"	32"

Nominal Pipe Size	Catalog Model Number	Stock Number
2"	CX-645-200-BGP	81001190
3"	CX-645-300-BGP	81001195
4"	CX-645-400-BGP	81001200
6"	CX-645-600-BGP	81001205
2"	CX-645-200-BFP	81001191
3"	CX-645-300-BFP	81001196
4"	CX-645-400-BFP	81001201
6"	CX-645-600-BFP	81001206
2"	CX-645-230-BGP	81001192
3"	CX-645-330-BGP	81001197
4"	CX-645-430-BGP	81001202
6"	CX-645-630-BGP	81001207
2"	CX-645-260-BGP	81001193
3"	CX-645-360-BGP	81001198
4"	CX-645-460-BGP	81001203
6"	CX-645-660-BGP	81001208

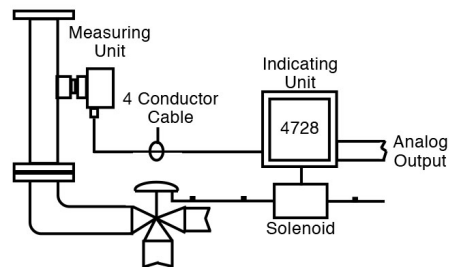
Note: Field Conversion kit to modify Model CX-201 Probes to CX-645 configuration available. Stock No. 49020402

Typical Applications



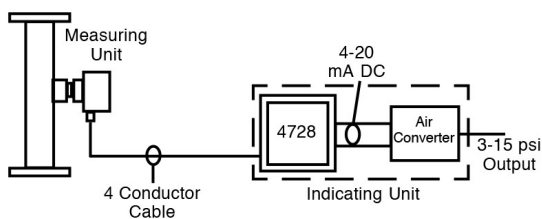
Percent Water Indication

In this application the Indicating Unit provides percent water reading on the front panel. The Indicating Unit maybe located near the Measuring Unit or at a remote-central control room.



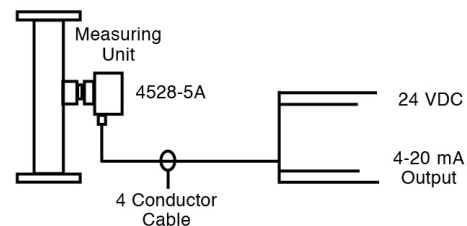
Percent Water Indication and Set-Point Control

In this application the adjustable alarm may be used to operate a diverter valve should the water content exceed a preset percentage. Local indication is provided and an analog output for other indication and control functions is available.



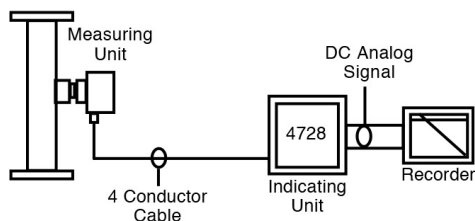
Percent Water Indication and Pneumatic Control

In this application an analog to air converter may be mounted adjacent to or remote from the Indicating Unit housing. A 3-15 psi pneumatic output signal is provided directly proportional to the percent water in the process.



Percent Water Indication

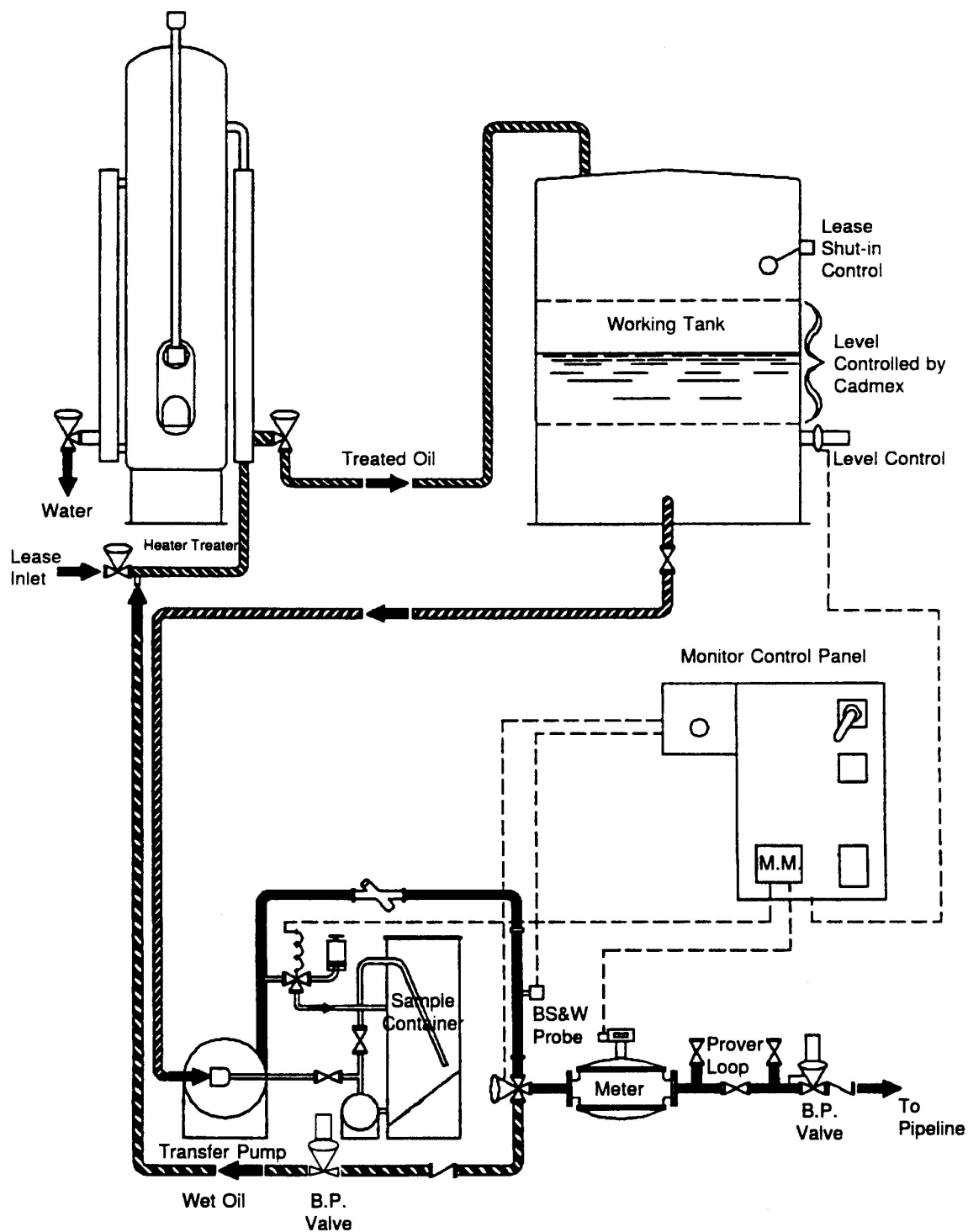
In this application the Model 4528-5A Detector only is used to provide an analog output proportion to water cut. The 4728 Indicating Unit is not required.



Percent Water Recording

In this application the Indicating Unit provides local reading on an indicating meter and provides an analog output signal to a standard recorder. In place of the recorder this output could be connected to a meter, computer input, or any other DC input device.

Typical Tank Flow Diagram



Detector Calibration – 4528 0-5 VDC Output

In July 1993 the 4528 Detector was changed to no longer have a negative output. An empty probe or low Dk will cause the unit to read zero. A shortened probe or a probe full of water will read bad oil. The coarse and fine adjustments were changed from variable capacitors to 25 turn pots. The single four point terminal strip on the bottom of the P.C. Card was changed to two colored two point connectors.

Calibration 4528 Detector 0-5%

1. Connect power and probe detector chassis/indicator unit as shown on the interconnecting wiring diagram.
2. Turn on power/system to cause oil to flow through probe. Allow flow to stabilize.
3. Take grindout of water in oil. For calibration purposes the oil should preferably have less than 1% water in it.
4. Apply power to Model 4728 indicator unit. Ignore lights until calibration is complete.
5. A. 4528 Detector
 1. Set probe/ref. switch at top of chassis to probe position.
 2. Set DC volt meter on 0-10 volt scale. Insert leads into test jacks on detector face or watch digital readout on face of Model 4728 indicator unit.
 3. Turn the fine zero (marked ZERO F) clockwise (CW) 25 turns until the pot is fully CW. Full clockwise is indicated by a "clicking" feel and sound when the pot is turned.
 4. Turn the fine zero back counter clockwise (CCW) approximately 10 turns.
 5. Turn the coarse zero pot (marked ZERO C) 25 turns full counter clockwise. Listen for clicks.
 6. Turn the coarse zero CW until the reading is at or near the grindout value. Do not tune through zero. Always approach the grindout value from the CW direction.
 7. Next, turn the fine zero to get complete agreement of the displayed reading to the grindout value. For example if the grindout was 0.3, then the volt meter/indicator should read 0.3.

Note: Due to calibration differences, the volt meter and indicator readings may not read exactly the same.

 8. Move Probe/Ref. switch to Ref. position.
 9. Adjust span control to make reading show 5.00 higher than the grindout. (i.e. if grindout was .3 span control is adjusted to show reading of 5.30.)
 10. On a 10% Detector turn COARSE/FINE tuning adjustments as required to make voltmeter read 1/2 the water cut.
 11. On a 20% Detector turn COARSE/FINE tuning adjustments as required to make voltmeter read 1/4 the water cut.

Remove volt meter. Move Probe/Ref. switch to probe position.
6. A. 4728 Readout Unit
 1. Pull and hold the S&W/Set Point Switch down. Turn set point adjust knob to obtain reading at which monitor is to divert. Release switch.
 2. Turn the time delay switch in lower right with a small screwdriver to set time delay for output relay to actuate after excess S&W light comes on. Multiply number in window above screwdriver slot by 10 to get time delay in seconds.
7. Calibration is complete.

Detector Calibration – 4528-X A with 4-20mA Module Mounted "Piggy Back" on Detector Card

1. A. Calibration 4528-X A With 4-20 mA Module Mounted "Piggy Back" on Detector Card
 1. Remove Detector aluminum face plate by removing the three 6-32 mounting screws and the bottom screw on P.C. Card.
 2. Mount the P.C. Card in the conduit by using the short screws removed from the Detector assembly. Be sure the upper left screw at 10 o'clock is tight as this screw "grounds" the P.C. Card to the conduit. Retain all screws for future use.
 3. Connect 24 V.D.C. to the left terminal block of the detector. Observe polarity. Press clip (on probe wire) onto the stud coming into conduit from probe.
 4. Turn on power/system to cause oil to flow through the probe. Allow flow to stabilize. For calibration purposes the oil should preferably have less than 1% water in it.
 5. Set Probe/Ref. switch at top of chassis to probe position.
 6. Set a DC volt meter to 0-10 volt scale. Insert leads into test jacks on detector face.
 7. Turn the Fine Zero (marked ZERO F) clockwise (CW) 25 turns until the pot is fully CW. Full clockwise is indicated by a "clicking feel and sound when the pot is turned.
 8. Turn the fine zero back counter clockwise (CCW) approximately 10 turns.
 9. Turn the coarse zero pot (marked ZERO C) 25 turns full counter clockwise. Listen for clicks.
 10. Turn the coarse zero CW until the volt meter reads 0.00 to 0.05. Do not turn pot past point where numbers stop getting smaller.
 11. Next, turn the fine zero to get as small a reading possible on volt meter.
 12. Move Probe/Ref. switch to Ref. position.
 13. Adjust output span control to make volt meter show 5.00 volts.
 14. Move Probe/Ref. switch to Probe position.
 15. Remove volt meter leads from test sockets. Turn volt meter to milliampere setting and connect leads to "signal" terminals.
 16. Adjust the single, small blue pot (R1) on piggy-back module to get reading of 4 mA on meter.
 17. Reinstall Detector face plate using the long 6-32 screws at the 10 o'clock and 2 o'clock positions and the short screws at the middle and bottom.
 18. Remove volt meter leads from signal terminals. Turn volt meter back to voltage setting and insert leads into red and black sockets.
 19. Run a "shake-out" of oil going through probe to determine amount of water in it.
 20. On a 5% Detector turn COARSE/FINE tuning adjustments as required to make voltmeter read the water cut.
 21. On a 10% Detector turn COARSE/FINE tuning adjustments as required to make voltmeter read 1/2 the water cut.
 22. On a 20% Detector turn COARSE/FINE tuning adjustments as required to make voltmeter read 1/4 the water cut.
 23. Remove volt meter.
 24. Connect field wiring as required to the signal terminals for 4-20 mA output.

Notes:

1. This procedure initially sets the detector with 0-5 volts to which you adjust the 4-20 mA output, then the reading is offset to match the amount of water in the oil in the probe.
2. The 4-20 mA loop is internally powered from the 4528-A. DO NOT USE an external loop power source. The 4528-5A Detector Card is designed to supply a 4-20 mA signal direct to an external readout device. It is not designed to be used with a Model 4728 Readout Unit.
3. Maximum Loop Resistance is 250 ohms.
4. Shielded, twisted pair wire is recommended for the 4-20 mA output. Ground the shield at one end of the wire only, preferably at the "Readout" end.
5. Starting in mid-year 2000, the 4 mA pot adjusting screw will be accessible through a hole, just to the right of the "test" wording, for adjustment without removing the aluminum detector face plate. Be aware that this adjusts the 4 mA only, the 20 mA is automatically adjusted electronically.

Detector Information – Type B and C

Type “C” Detector with Fail-safe Switch - This switch allows the output from the Detector Chassis to be tailored to the requirements of the customer.

The Fail-safe Switch is located on the upper right side of the printed circuit board under the cover plate. The normal position of the switch is in the Low Fail-safe position and is so shipped from the factory. Due to the functionality of the detector output when in the High Fail-safe position, care should be observed when using it to prevent possible undesired readings.

Below is a chart showing the detector output under certain conditions with the switch in either the low or high Fail-safe position:

Conditions	Low Fail-Safe	High Fail-Safe
Ovrange	8 to 9 Volts	8 to 9 Volts
Underrange	0 Volts	8 to 9 Volts
Open Probe	0 Volts	8 to 9 Volts
Shorted Probe	8 to 9 Volts	8 to 9 Volts

Note: All voltage readings are DC volts taken on the SIG+ and SIG- Terminals of the 4528 Chassis.

Ovrange - Approximately two times S&W range of the chassis.

Underrange - Approximately 2% below zero.

Open Probe - Chassis Pickup wire is not connected to the probe.

Shorted Probe - Occurs when electrical short exists in the probe.

Installation Hints

- Always install probe up stream of dump valve anytime probe is mounted on oil line coming off treater, separator, etc... Never install downstream as gas will break out to some degree as oil goes from vessel pressure to lower line pressure after dump valve. These gas bubbles will be irregular in size and volume as oil flows through probe. Erratic monitor readings will result.
- Vertical flow through probe is recommended. Either up or down, but not horizontal. Water often will drop out of oil unless the flow velocity is very high, and if the probe is mounted horizontally in a slightly low spot, water will build up in probe with resulting erroneous readings.
- Always locate the oil sample removal point as close as possible to the probe. Preferably downstream of and below probe in elevation. Failure to have sample point and measuring point (probe) in close proximity can result in water measurement inaccuracies which often are flow rate sensitive.
- L.A.C.T. Systems should always have back pressure valves on both the “good” and “bad” oil lines leading from the L.A.C.T. Constant pressure on the oil in the probe is essential for close measurement.

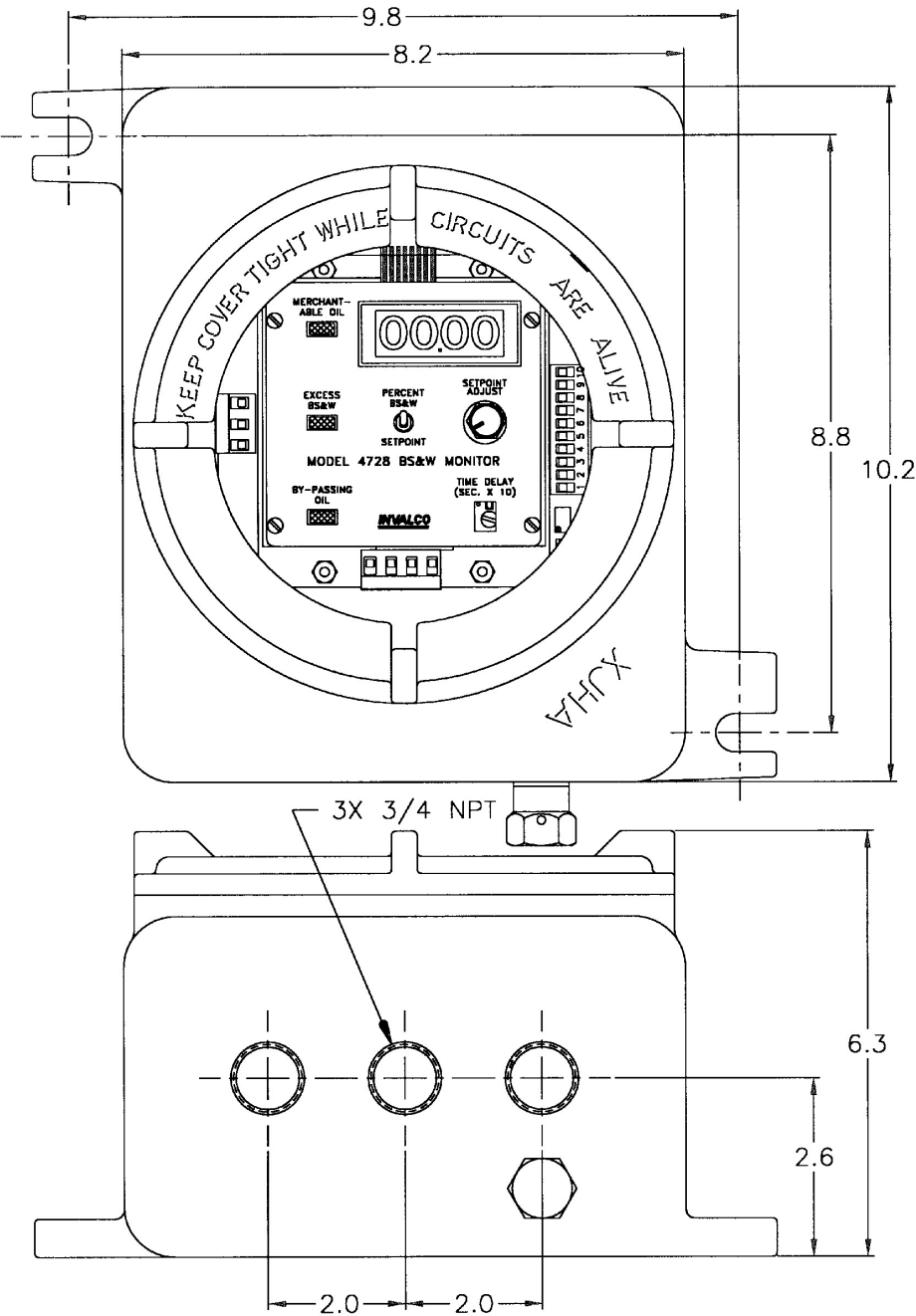
Troubleshooting

Problem	Possible Cause
4728 Readings fluctuate wildly during flow through probe, but are steady during no flow and shake out shows a steady amount of water.	1. Gas in oil caused by having probe downstream of a vessel dump valve. 2. Restricted suction to charge pump on L.A.C.T. unit resulting in cavitation and gas break out. 3. Inner electrode probe is loose.
Output gradually goes up over a period of time (sometimes only a matter of days up to several months) with water cut staying relatively consistent.	Normally caused by a buildup in probe such as paraffin, or a film being deposited by flow line chemicals. Often this can be determined by checking from the probe stud to ground for resistance and capacitance readings after removing the detector chassis. Resistance reading theoretically should be infinity, but good results are achievable down to 500,000 ohms. An empty probe should have a capacitance value of no more than 95 pf. A full probe with dry oil should measure between 135 pf to 200 pf depending on the Dk of the oil with high API gravity oils reading lowest and low API gravity oils reading highest. A digital volt meter set on low DC volts range should read less than .25 volts. A reading of any voltage indicates the probe insulators are becoming contaminated and should be changed. Normally, a monitor will operate in a normal manner up to .25 volts, but then the readings will become erratic. Solution to problem is elimination of coating buildup causes or periodic cleaning of probe with possible changing out of the probe teflon insulators.
No reading or LED lights on 4728.	No power applied or fuse blown.
No output from 4528 detector with probe full of oil.	1. No power or probe wire not attached to probe stud. Note: Starting in early 1994 a Hi/Low fail-safe switch was installed. The output will be 8-9 volts from the detector if the switch is in the hi fail-safe position and the probe wire is not attached to the probe. 2. 4528 Detector Card is bad. Replace card.
4-20 mA output varies rapidly while water cut is steady.	Heavy electrical static in air being picked up by 4-20 mA wiring. Use shielded twisted pair wire for 4-20 mA signal from 4728 Unit to external readout. Ground shield at 4728 Unit only. DO NOT ground shield at both ends of wire.

Recommended Spare Parts

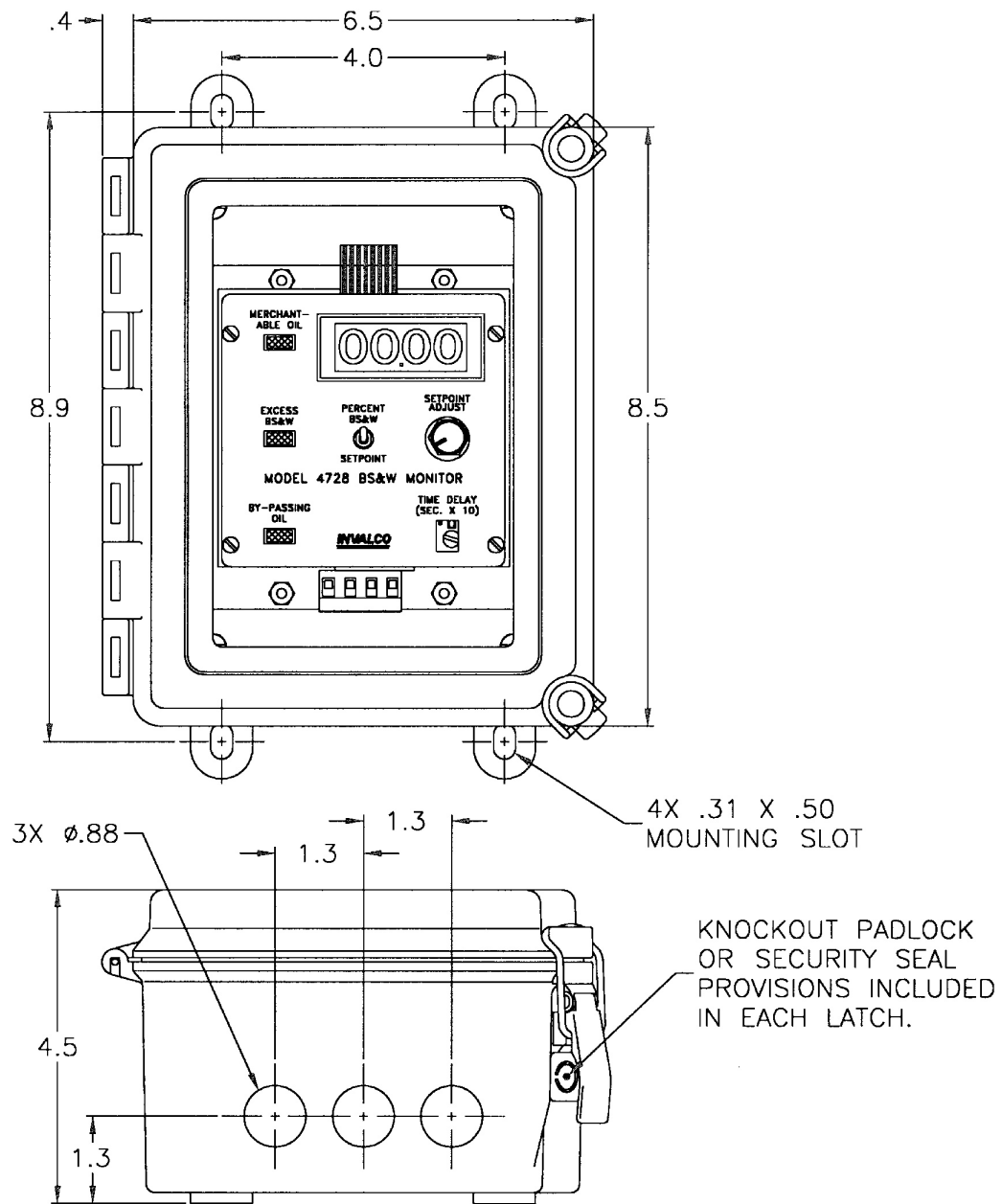
1. 1/2 amp slo-blo fuses p/n 68108327
2. Relay p/n 36017183
3. Detector
 - 0-5% p/n 81001164
 - 0-10% p/n 81001160
 - 0-20% p/n 81001161
 - 0-5% (4-20mA) p/n 81001295
 - 0-20% p/n 81001296

4728 with Explosion-proof Enclosure – Dimensional Drawing



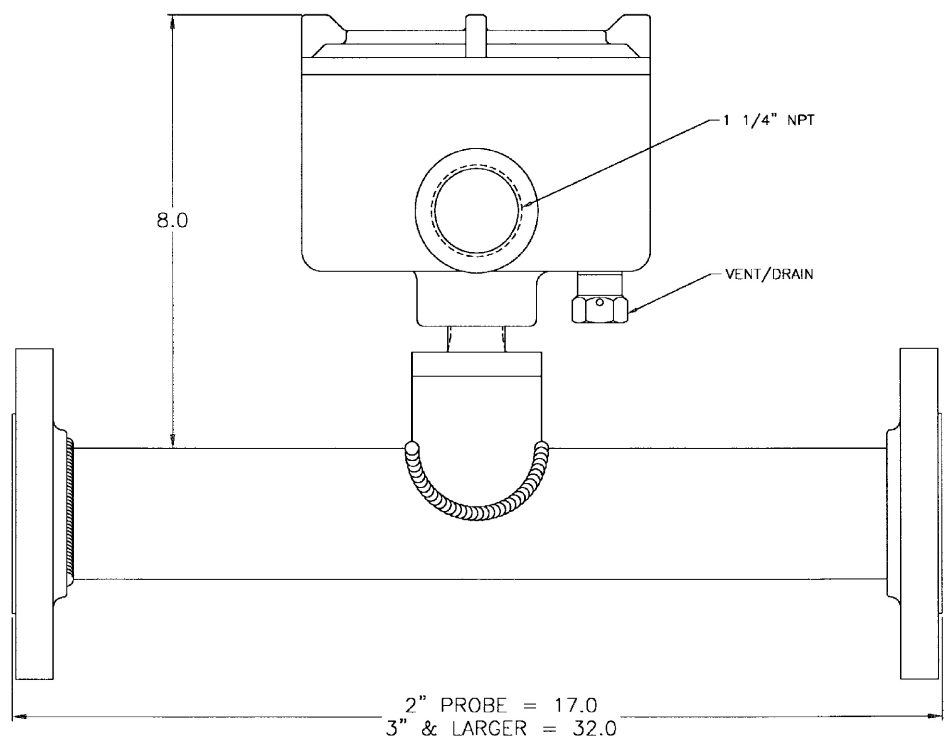
Measurements are in inches.

4728 with Weather-proof Enclosure - Dimensional Drawing



Measurements are in inches.

CX-645 Probe – Dimensional Drawing



Measurements are in inches.

Technical Support

Contact Information:

Field Service Response Center

24/7 Technical Support/Schedule

a Technician: 1-844-798-3819

System Installation Supervision,
Start-Up, Commissioning Services,
and Training Available

The specifications contained herein are subject to change without notice and any user of said specifications should verify from the manufacturer that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications which may have been changed and are no longer in effect.

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