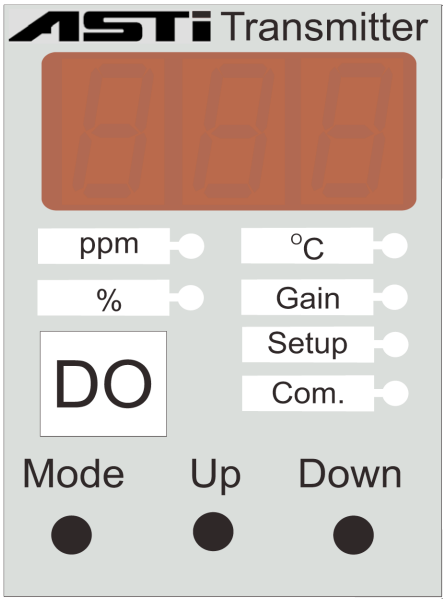
3TX–DO 3-Wire Dissolved Oxygen Transmitter

- 3TX-DO is a transmitter for Dissolved Oxygen (DO) & Temperature Measurement
- Measurement Ranges: Full Range 0-40ppm (0-400% saturation); Minimum Scaling 0-4ppm (0-40% saturation), 0-50 °C, 0.01 ppm resolution anywhere in range
- Most Galvanic (a.k.a. active self-polarizing) type DO sensors supported that have internal (automatic) temperature compensation of the mV potential per ppm unit
- Galvanic DO sensors have a true "zero" unlike polarographic (amperometric) DO sensors; no "zero" cal required but rather only a simple gain calibration in air
- Gain calibration is performed with sensor just dry in air; **Absolutely NO look-up tables or wet solutions required to calibrate your DO sensor with the 3TX-DO!**
- 3TX-DO has the preprogrammed the correct 100% saturation value for calibration at any temperature, elevation & pressure via automatic or manual gain cal mode
- % saturation computed with corrections for the temperature, pressure and salinity
- Display Dissolved Oxygen (DO) in ppm or % saturation units or Temperature in Celsius. Scalable analog output 0-20 or 4-20 mA for DO in ppm or % Saturation
- RS-485 MODbus Output sends DO ppm, % saturation as well as Temperature
- Galvanic isolation between sensor input and analog output (3000V rating)



FEATURES

The ASTI 3TX Family of Transmitters Consists Of:

3TX-pH: pH, ORP/mV and Temperature Transmitter with fully scalable 0/4-20mA output and MODbus (optional)
3TX-CON: Contacting Conductivity Transmitter with fully scalable 0/4-20mA output and MODbus (optional)
3TX-ISE: Ion Selective * Transmitter with fully scalable 0/4-20mA output and MODbus (optional)
3TX-DO: Dissolved Oxygen Transmitter with fully scalable 0/4-20mA output and MODbus (optional)
3TX-TEM: Adds scalable 0/4-20mA output of Temperature to 3TX-pH, 3TX-ISE, 3TX-CON or 3TX-DO transmitter.
3TX-REL: Alarm & relay controller (On/Off, TPC, PFC) for pH/ORP, ISE, DO & Conductivity measurement modules
3TX-TOT: Compute pH compensated "Total ISE" from ISE & pH analog inputs, 0/4-20mA analog & MODbus outputs
3TX-DAT: Datalogger & MODbus Master for up to 63 each 3TX transmitter modules with RS485 MODbus output

The 3TX family has a 3 digit display and 6 LEDs for setup and displaying values. The 'Mode' key is used to navigate.

Programming

The module is programmed by 3 keys on the front panel. The 'Mode' toggles and the 'Up' or 'Down' scroll through parameters. The parameter is altered via the 'Mode' and the value is changed using the 'Up' or 'Down'. **Parameter P01 is a "lock" which must be set to 'Off' to change ANY parameter, including the temperature & gain calibrations.**

** Ion selective measurement must be validated by ASTI factory prior to order. 3TX-ISE sold only as part of complete ISE system with mating ISE sensor.*

Input

Galvanic DO sensors have the Anode (-mV) connected to terminal 1 and Cathode (+mV) to terminal 2. The internally (self) temperature compensated mV potential is the basis for the DO ppm and % saturation display and output(s). Galvanic DO cells with mV response linear to DO ppm use 3TX-DO model whereas those with mV response linear to % saturation use 3TX-DO-T model. Galvanic DO cells with integral analog conventional preamplifiers use 3TX-DO-X model. The Pt100 or Pt1000 TC is connected to terminals 4 and 5 is the basis of the temperature measurement used to set the 100% saturation value for the gain calibration as well as to compute the % saturation state in the process.

Analog Output (Standard)

The 3TX-DO, 3TX-DO-T & 3TX-DO-X transmitters have a scalable & selectable analog 0-20 or 4-20 mA standard or inverted output. The scaling between the minimum (0mA or 4mA) and maximum (20mA) output is 10% to 100% of the 0-40 ppm or 0-400% saturation DO full range scale, where low and high outputs can be arbitrarily selected. The analog output is galvanically isolated from input and proportional to DO ppm or DO % saturation as configured.

MODbus (Optional)

Data is transferred using MODbus RTU for multidrop communication using RS485. The Modbus master may be the 3TX-DAT or any SCADA system. When units are ordered with MODbus, a Windows datalogging software is freely provided. The MODbus option allows for the DO value in ppm and percent (%) saturation units to be sent simultaneously as well as the process temperature.

TECHNICAL SPECIFICATIONS

Mechanical

Housing:	Lexan UL94V-0 (Upper part) Noryl UL94V-0 (Lower part)
Mounting:	M36 for 35 mm DIN rail
IP Class:	Housing IP40. Connector IP20
Connector:	Max 16A. Max 2.5 mm² Max torque 0.6 Nm
Temp.:	Usage -15 to +50 °C (Storage -35 to +75 °C)
Weight:	75 grams (2.64 ounces)
Dimensions:	D 58 x W 36 x H 86 mm (2.3" X 1.4" X 3.4")
CE mark:	EN61326A

Electrical

Power Supply:	24VDC ±10%
Consumption:	60 mA max
Resolution:	0.01 ppm anywhere in the range
Galvanic Sensor	1.0-6.0 mV per ppm for 3TX-DO(-X)
Response Range:	0.25-2.50 mV per % saturation (-T)
Accuracy:	±1% Excluding Sensor (Ideal)
Temp Sensor:	Pt100 or Pt1000
Temp Range:	0-50°C ± 0.2°C
DO Temp Comp:	Automatic in all configurations
Analog Output:	0-20mA or 4-20mA, max. 500Ω

DO Sensor Type	Full Scale Maximum DO Range (Nominal)	Minimum Range at 10% of Maximum Full Range
Self-Polarizing Galvanic	0 to 40.0 ppm (0-400%)	0 to 4.00 ppm (0-40%)

OUTPUT SCALING NOTES: The 4-20mA scaling can be arbitrarily set provided the difference is at least 10% of the 0-40ppm or 0-400% saturation full range. The mininum difference between the 4mA (P14) & 20mA (P15) setpoints is 4ppm or 40% saturation. The analog output is fully reversible (see P13). Analog & MODbus outputs can be scaled anywhere between the minimum 10% & 100% maximum limits. The MODbus output scaling will follow the analog setpoints (see next page).

PARAMETERS

Function and Programming

The 21 parameters are shown to the right. For access, please see page 1. **If the softwarelock (Par. no. 1) is "On" the parameters can only be read. Set Software Lock to "Off "to change values.**

Par. no. 2 sets module's address for MODbus communication.
Par. no. 3 sets temp. to manual (set) or automatic from sensor.
Par. no. 4 sets the temp. value when in fixed (set) mode for P03.
Par no. 5 sets the ambient barometric air pressure in units of mmHg. This value is used in the gain calibration and for calculating the % DO saturation. Any barometer at (or near) installation site can supply the pressure in these common units.
Par. no. 6 is the salinity of the process sample in units of PSU.
Par. no. 7 is the wire gauge (AWG) for the sensor cable used.
Par. no. 8 is the length of sensor cable in units of feet.
Par. no. 9 sets mode used to compute % saturation. The default automatic mode uses DO ppm and computes the % saturation based upon the given temperature, air pressure and salinity. Manual mode uses a fixed DO ppm to define 100% saturation.
Par. no. 10 defines the DO ppm that constitues 100% saturation condition when P09 is set to manual mode.
Par. no. 11 selects the analog output (and MODbus output mode if present) of the dissolved oxygen (DO) transmitter in units of ppm or % saturation; these units are also used for P14 & P15.
Par. no. 12 sets the analog output to either 0-20 mA or 4-20 mA.
Par. no. 13 allows setting the output to be inverted (i.e. for use in control) with the output corresponding to 20-0mA or 20-4mA.
Par. no. 14 sets 0/4mA output scaling in DO ppm or % sat units.
Par. no. 15 sets 20mA output scaling in DO ppm or % sat units. See output scaling notes above for limits on P14 & P15 setpoints.
Par. no. 16 display/adjust gain value. Units are mV per ppm or mV per % saturation based upon which 3TX-DO model is used.
Par. no. 17 Offset adjustment for 0/4mA low analog output trim.
Par. no. 18 Gain adjustment for 20mA high analog output trim.
Par. no. 19 If no keys are pressed for 10 minutes, display will show flasing bar (Energy Save Mode). Pressing any key to exit.
Par. no. 20 sets baudrate of 9,600 or 19,200 per MODbus master.
Par. no. 21 Feature to reset the analyzer back to factory default.

List of Parameters

No	Parameter	Description	Range	Default
01	Lock	Software Lock	On / Off	On
02	Address	MODbus Node	Off, 1…247	Off
03	Temperature	Select Temp Input Mode	Set, Pt100 or Pt1000	Pt100
04	Manual Temp	Temp if P03 is Manual Mode	0…50	25
05	Barometric Air Presssure	pressure in mm Hg units	600 to 900	760
06	Salinity	PSU Units	0 to 50	0
07	Wire Gauge	Sensor AWG	20, 22, 24	22
08	Cable Length	Length in feet	1…999 feet	23
09	% Saturation Computation	Computation % Saturation	Automatic or Manual	Auto
10	Manual Saturation	ppm for 100% Saturation	4.00 to 40.0 ppm	10.0
11	Input for Iout	Input for the analog output	**DO ppm or % Saturation**	DO ppm
12	Analog Output Type	Type of Output	4-20mA, 0-20mA	4-20
13	Output mode	Inversion Setting	noninverted, inverted	n.inv
14	0/4mA Low Output Scale	Low Output (DO Units)	0%-90% of Full Range	0%
15	20mA High Output Scale	High Output (DO Units)	10%-100% of Full Range	100%
16	Working Gain (Slope)	mV per DO ppm or % Sat	1.0-6.0 or 0.25-2.50 (-T)	**3.75 or 1.10 (-T)**
17	0/4mA Offset	Trim Low	±9.99% *	0.00
18	20mA Gain	Trim High	±9.99% *	0.00
19	Energy Save	Energy Save	On / Off	On
20	Baudrate	MODbus	**9,600 / 19,200**	19,200
21	Back to Default	Reset to Default	Def=Reset, Par=NoReset	Par

** Negative trim adjustments will be shown as flashing numbers.*

Calibration

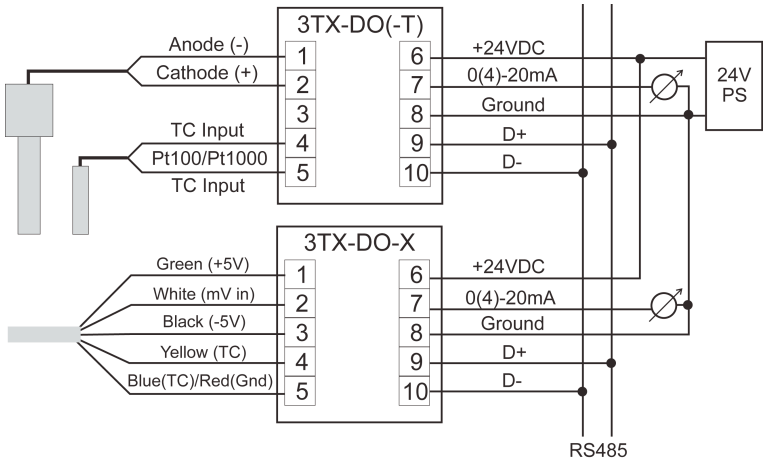
Use the 'Mode' key to select 'Gain' before removing the DO sensor from service. Perfrom gain calibration when the sensor is clean & dry and exposed to only air. If the relative humidity is not 100%, suspend sensor in air over a source of water for best results. Be sure to allow sufficient time for temperature & sensor reading to be quite stable to ensure a good gain calibration result.

Three type of different galvanic dissolved oxygen sensors are supported by three different types of 3TX-DO transmitters:

3TX-DO – With mV response linear to DO ppm
3TX-DO-T – With mV response linear to DO % Saturation
3TX-DO-X – With mV response linear to DO ppm & integral conventional analog preamplifier

IMPORTANT: Be sure to perform a precise temperature calibration before performing any gain calibration.

Typical Installation



Auto Calibration Routine: To initiate an automatic calibration, simultaneously hold the 'Up' & 'Down' keys for three to five (3-5) seconds continuously and the display will then flash "CAL". After eight seconds, the unit will either return a value of 'Go" to indicate success or else a value of "Err" to indicate a failed calibration. You must press the 'Mode' key to exit the automatic calibrate mode.

Manual Calibration Routine: For a manual gain calibration, adjust using 'Up' or 'Down' keys until the display reads exactly "0.0". Positive deviations are shown as X.X or XX. Negative deviations are shown as -X.X or -XX. If a positive value is shown adjust with 'Down' key and if a negative value is shown adjust with 'Up' key. You must press the 'Mode' key to exit the manual calibrate mode.

DISPLAY FEATURES & NOTES: Temperature calibrated with "Up" or "Down" buttons in °C display mode. Result of gain calibration is viewed and/or modified in P16 (mV per ppm for 3TX-DO{-X} & mV per % saturation for 3TX-DO-T). Raw mV viewed by pressing 'Down' button in ppm or % display mode. 100% saturation for the current temp, pressure & salinity is viewed by pressing the 'Up' button in the ppm or % display mode.

MODBUS

In order to utilize the MODbus interface the 3TX-DO(-T) must be ordered with MODbus. 3TX-DO(-T) may be used as a slave for the 3TX-DAT or as a slave in a SCADA system or else with the free of charge Windows datalogging and graphing software.

With 3TX-DAT
If 3TX-DO is used together with 3TX-DAT the baud rate on the MODbus and address of 3TX-DO must be correctly set. **The baud rate (P20)** must be set to the baud rate of 3TX-DAT. The baud rate used being 19,200 or 9,600 is of no importance, as long as all units on the RS-485 MODbus network are set to the same baud rate.

The address (P02) must be unique in the network. In a network with the 3TX-DAT as master, all addresses must be assigned without omitting any address. The exact order is of no importance. In a network with a 3TX-DAT, up to 63 MODbus slaves may be connected, with valid addresses from 1 to 247.

In a SCADA system or with Windows software
Since different SCADA systems may have different restrictions. **The baud rate (P20)** must match that of the SCADA system. **The address (P02)** must be unique in the network. Max of 247 each 3TX units on one MODbus network, with repeaters after 32 units.

MODbus Scaling
MODbus scaling for DO process measurement is the same as analog output set by P14 & P15. The DO ppm and % saturation are sent via MODbus scaled together with a 10-fold factor, keyed by the units selected in P11. If P11 is DO ppm and scaled as 2-10 ppm, the corresponding % saturation will be 20-100 %. If P11 is DO % saturation and scaled as 50-200%, the corresponding DO ppm will be 5-20 ppm. Temperature is always scaled as 0-100 °C.

The 3TX-DO contains 2 measured values (Dissolved Oxygen ppm and temperature) and 1 computed value (% saturation). Access is gained through the function code *Read_Input_Registers (04)*.

Read_Input_Registers

Function code	Start address	Number of values
04	**1**	**1, 2 or 3**

Value 1 is DO in ppm units, value 2 is the DO in % saturation units and Value 3 is Temperature; all three values are transmitted in sequence; If 3 values are chosen then DO ppm, % saturation and temperature are transmitted. All values are rated to 0-1000 corresponding to the scaled range; the scaled DO ppm range is sent as 0-1000, the % saturation (always 10 times the DO ppm scaling) as 1024-2024 and finally the full scale temperature range (0-100 °C) is transmitted as 2048-3048.

The 3TX-DO gives access to different diagnostic values via *Diagnostics (08)*, as shown in the following.

Diagnostics

Function Code	Sub Code (HEX)	Description
08	00	Return Query Data
	0A	Clear counters and diagnostics register
	0B	Return Bus Message Count
	0C	Return Bus Com Error count
	0D	Return Exception Error count
	0E	Return Slave Message count
	0F	Return Slave No Response count
	12	Return Bus Character Overrun count

ORDERING INFORMATION FOR 3TX FAMILY OF TRANSMITTERS

ENCLOSURE TYPE	
CODE	**DESCRIPTION**
3TX-0M	3TX Transmitter with No Enclosure
3TX-DIN	3TX Transmitter with No Enclosure; Preinstalled onto 35mm DIN-Rail
3TX-2MW	3TX Transmitter(s) with IP65 WeatherProof Enclosure; Up to 2 Total Modules (**Wall Installations Only**)
3TX-2M	3TX Transmitter(s) with IP65 WeatherProof Enclosure; Up to 2 Total Modules (Wall or Pipe Installations)
3TX-3MP	3TX Transmitter(s) with NEMA 4X Enclosure for ½-DIN **Panel Only**; Up to 3 Modules (**with Panel Bracket Assembly**)
3TX-3MF	3TX Transmitter(s) with NEMA 4X Enclosure; Up to 3 Total Modules (Wall or Pipe Installations)
3TX-4MW	3TX Transmitter(s) with IP65 WeatherProof Enclosure; Up to 4 Total Modules (**Wall Installations Only**)
3TX-4M	3TX Transmitter(s) with IP65 WeatherProof Enclosure; Up to 4 Total Modules (Wall or Pipe Installations)
3TX-6M ***	3TX Transmitter(s) with IP65 WeatherProof Enclosure; Up to 6 Total Modules (Wall or Pipe Installations)
3TX-7MF ***	3TX Transmitter(s) with NEMA 4X Enclosure; Up to 7 Total Modules (Wall or Pipe Installations)
3TX-9MF ***	3TX Transmitter(s) with NEMA 4X Enclosure; Up to 9 Total Modules (Wall or Pipe Installations)
MEASUREMENT MODULES ONE (1) THROUGH SEVEN (7)	
CODE	**DESCRIPTION**
-pH **	pH/ORP/mV/Temp Measurement Module / Transmitter
-HiQ-pH	Intelligent pH & ORP Transmitter for Smart Digital pH & ORP Sensors; **Both 4-20mA & MODBUS outputs standard**
-CON-CELL/RANGE	Contacting Conductivity Measurement Module / Transmitter (CELL Constant & RANGE in mS Defined at Time of Order)
-ISE-ION **	Ion Selective (ISE) Measurement Module / Transmitter (Ion Measurement Type ION Must be Defined at Time of Order) *
-DO **	Dissolved Oxygen Measurement Module / Transmitter For Galvanic Type DO sensors
OUTPUT OPTIONS FOR ANALOG MEASUREMENT MODULES (ONE OPTION MUST BE SELECTED FOR EACH MODULE)	
CODE	**DESCRIPTION**
-A	Single Fully Scalable Analog 0-20 or 4-20 mA Ouput Only
-D	Single Fully Scalable Analog 0-20 or 4-20 mA Ouput Only AND RS-485 MODbus Digital Output
ADD-ON MODULES FOR MEASUREMENT MODULE ENCLOSURE ASSEMBLIES	
CODE	**DESCRIPTION**
-PS	100 to 240 VAC 50/60 Hz Universal Power Supply Adapter for Line Powered Operation
-PS/BAT	Dual Isolated & Regulated 24VDC Power Supply Step-Up Converter for operation from 5V, 6V & 9V Batteries
-TEM	Scalable Analog 0-20 or 4-20mA Temperature Transmitter for Raw or Spliced Pt100/Pt1000 temperature element
-SW	On/Off Power Switch (½ Width of power supply module and ¼ width of standard 3TX transmitter)
-REL	Alarm and Relay Controller Module for 3TX-pH, 3TX-ISE, 3TX-CON and 3TX-DO measurement modules
-TOT	Compute pH compensated "Total ISE" from analog inputs for ISE & pH, 0/4-20mA analog & MODbus digital ouputs
-DAT	Datalogger & MODbusmaster for 3TX Transmitters with RS485 MODbus; Download & Setup via RS232/USB on Windows

Contact the factory for specific recommendations & ALL ISE inqueries. Pipe mounting bracket kits supplied separately. For 3MP, 3MF, 6M & 7MF enclosures power supply is not counted as a module for space purposes.

Model: **3TX-2M-pH-A-CON-1.0/50-D**
Description: Dual Channel Transmitter Assy w/ Weatherproof Enclosure (2 Total Modules); 1 each pH Measurement w/ Analog Output; 1 each Contacting Conductivity Measurement w/ Cell Constant 1.0/cm & Full Range 0-50mS/cm (Min Scaling 0-5.0mS/cm); with Analog and Digital MODbus RS-485 Outputs (No AC Power Supply)

Model: **3TX-3MP-ISE-F-A-pH-A-TOT-PS**
Description: Dual Channel Total Fluoride Measurement Transmitter Assembly with NEMA 4X (UL) Enclosure for ½-DIN Panel Mounting Installations (for 3 Total Modules); 1 each ISE Fluoride Ion and 1 each pH Measurement Module with Analog Output Only; 1 each TOT module to compute total fluoride ($HF + F^-$) with Analog & MODbus Outputs for all free fluoride, total fluoride, pH and temperature; With Universal 11 Power Supply Module

Model: **3TX-3MF-DO-D-TEM-SW-PS**
Description: Dissolve Oxygen Transmitter Assembly with NEMA 4X CSA/UL rated Enclosure; Field or Wall Mounting Installations (3 Module Max); 1 each DO transmitter for galvanic type dissolved oxygen sensors; Scalable Analog & MODbus Output for DO ppm, saturation & Temperature; 115/230 Power Supply with On/Off Switch

Model: **3TX-4MW-ISE-NH4-A-pH-A-TOT-PS**
Description: Dual Channel Total Ammonia Measurement Transmitter Assembly; Weatherproof Wall Mount Only Enclosure (4 Modules Max); 1 each ISE Ammonium Ion and 1 each pH Measurement Module with Analog Output Only; 1 each TOT to compute total ammonia (NH_3) with Analog & MODbus Outputs; With 115/230 Power Supply

Model: **3TX-6M-ISE-NH4-A-pH-A-TOT-ISE-NO2-A-pH-D-DO-D-PS**
Description: Five Channel Transmitter Assembly with Weatherproof Enclosure (for 6 Total Modules); 1 each ISE Ammonium Ion and 1 each pH Measurement Module with Analog Output Only; 1 each TOT module to compute total ammonia (NH_3) with Analog & MODbus Outputs; 1 each ISE Nitrite Ion with Analog Output Only; 1 each ORP Measurement Module and 1 each DO transmitter for galvanic active self-polarizing type sensors both with Scalable Analog & MODbus Outputs; With 115/230 Power Supply

Model: **3TX-6M-ISE-X-F-D-REL-pH-X-D-REL-CON-10.0/500-D-DAT-PS**
Description: Triple Channel Transmitter Assembly with Weatherproof Enclosure (for 6 Total Modules Max); 1 each Preamp Style Fluoride ISE Measurement Module & 1 each Preamp Style pH Measurement Module with Alarm/Relay Controller for both Fluoride ISE & pH; 1 each Contacting Conductivity Measurement with K=10.0/cm & Full Range 0-500mS; Analog & MODbus Outputs for All Measurements; DAT Datalogger/MODbusmaster Module to record all parameters; Universal 115/230 Power Supply

Model: **3TX-7MF-ISE-NH4-D-ISE-NO3-D-ISE-NO2-D-pH-D-CON-1.0/50-D-DO-D-DAT**
Description: Six Channel Measuring Transmitter Assembly Optimized for Low-Power Battery Operation; with NEMA 4X CSA/UL rated Enclosure (7 Module Max); 1 each ISE Ammonium Ion, 1 each ISE Nitrate Ion and 1 each ISE Nitrite Ion Module; 1 each pH module; 1 each Contacting Conductivity K= 1.0/cm & Full Range 0-50mS; 1 each Dissolved Oxygen module; Analog & MODbus Outputs for all Measurements & Temp; DAT Datalogger/MODbusmaster for continuous datalogging of all parameters

** For sensors with integral **preamplifiers**, order the pH/ORP transmitters as **–pH-X** and the ion selective (ISE) transmitters as **–ISE-X** and dissolved oxygen (DO) transmitters as **–DO-X**
*** For 2" NPT pipe mounting installations, an additional adapter plate must also be ordered for the 6M, 7MF & 9MF enclosures (inquire to factory for details).

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