



**PRIME TIME EVAPORATION EFFICIENCY  
 CASE STUDY**

**E3 SOLUTIONS RESEARCH AND TESTING POND  
 DADE CITY, FLORIDA**

**May 28, 2019**

**OBJECTIVE**

The general objective of this study was to verify and confirm the evaporation rate performance of the patented Varimax® technology during prime evaporation time.

**SUMMARY OF FINDINGS**

| <b>Testing time</b> | <b>Varimax®<br/>Evaporation Rate</b> | <b>Varimax® Operating<br/>Efficiency</b> |
|---------------------|--------------------------------------|--|
| 12 h*               | 2.7 times natural<br>evaporation     | 53%                                      |

\*Prime evaporation time occurs during sunlight hours.

**BACKGROUND**

E3 Solutions LLC uses its own Research and Testing Pond located in Dade City, FL to perform research and development activities and evaporation rate testing. The pond sits approximately 118 ft. above sea level, and it is filled with well water pumped from approximately 1,000 ft away.

Enhanced evaporation efficiencies are based upon the local weather conditions when E3 technology is in operation. During this study, E3 documented the observed data during prime evaporation time for the 12 sunlight hours at E3’s Research and Testing Pond (Table 1).

E3's purpose for evaluating the Varimax® evaporation performance during prime time is to document the equipment's efficiency during daylight hours. The obtained data from this case study is of great value to strategically plan customized Varimax® applications that maximize the wastewater evaporation. Also, the recorded prime evaporation data provides empirical evidence of the Varimax® high evaporation efficiencies during the daylight hours and reduces electricity consumption by operating during daylight hours only.

## TESTING AND DATA COLLECTION

On May 28<sup>th</sup>, 2019, from 7:00 AM to 7:00 PM, one (1) Varimax® unit operated continuously on the 150' x 150' test pond with a total water flow throughput of 10 GPM. The water flow rate on the Varimax® was pre-set using a Hydronix 2-20 GPM visual flow meter shown in Figure 1. All settings, pictures, and readings were performed by an Engineering Intern for E3 Solutions, LLC.



**Figure 1.** Hydronix Flow Meter rate set at 10GPM.

Pond drop measurements were measured and recorded using a Banner U-Gage Ultrasonic Sensor mounted on top of a fixed 3" PVC pipe with the sensor directed down towards the top of the pond water level. Increases from original digital measurement will reflect pond level drop and decreases will reflect pond level rises. The sensor is calibrated per manufacturer requirements and the results are displayed on a Precision Digital PD765 Trident Reader using 0-10V DC parameters with 0V set at 3.9" and 10V set at 39". The sensor readings are set to capture 1/100 of an inch of pond level drop for evaporation accuracy. Please view specification sheets added after of the conclusion section. See Figures 2 and 3.



**Figure 2.** Precision Digital Part# PD765-6R0-00 with 24-Volt upgrade Part# PDX765-6X0-1.



**Figure 3.** Banner Engineering Part# T30UXUAQ8.

## Weather Conditions

The weather conditions during this daylight evaporation test were favorable for evaporation due to low relative humidity, high atmospheric temperature and virtually no rain (Table 1).

The natural evaporation during the test period was 0.10".

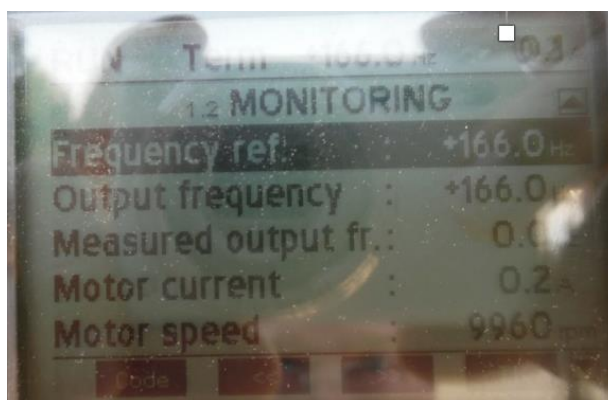
**Table 1.** Weather data for Dade City, Fl. during study time using [Florida Automated Weather Network](#) (FAWN) located 6 miles away from the test pond.

| <i>Period</i>        | <i>T<sub>avg</sub></i><br><i>(F)</i> | <i>Dew Point<sub>avg</sub></i><br><i>(F)</i> | <i>Rel Hum<sub>avg</sub></i><br><i>(%)</i> | <i>Rain tot</i><br><i>(in)</i> | <i>Solar Radiation<sub>avg</sub></i><br><i>(w/m<sup>2</sup>)</i> | <i>Wind<sub>avg</sub></i><br><i>(mph)</i> |
|----------------------|--------------------------------------|--|--|--------------------------------|--|---|
| 28 May 2019 7:00 AM  | 78.33                                | 71.65  | 80   | 0                              | 228.92   | 3.65                                      |
| 28 May 2019 8:00 AM  | 82.55                                | 71.01  | 68   | 0.02                           | 432.4  | 3.68                                      |
| 28 May 2019 9:00 AM  | 86.64                                | 68.63  | 55   | 0                              | 598.3  | 3.73                                      |
| 28 May 2019 10:00 AM | 88.75                                | 67.95  | 50   | 0                              | 750.5  | 3.23                                      |
| 28 May 2019 11:00 AM | 91.58                                | 68.03  | 46   | 0                              | 846.5  | 5.08                                      |
| 28 May 2019 12:00 PM | 93.52                                | 65.3   | 40   | 0                              | 893  | 5.65                                      |
| 28 May 2019 1:00 PM  | 94.52                                | 65.52  | 39   | 0                              | 770.95   | 5.59                                      |
| 28 May 2019 2:00 PM  | 95.56                                | 62.92  | 34   | 0                              | 824  | 6.28                                      |
| 28 May 2019 3:00 PM  | 96.02                                | 62.46  | 33   | 0                              | 674.77   | 7.14                                      |
| 28 May 2019 4:00 PM  | 95.81                                | 62.11  | 33   | 0                              | 518.25   | 7.02                                      |
| 28 May 2019 5:00 PM  | 95.07                                | 60.2   | 32   | 0                              | 319.03   | 6.93                                      |
| 28 May 2019 6:00 PM  | 93.35                                | 61.13  | 34   | 0                              | 125.95   | 5.24                                      |
| 28 May 2019 7:00 PM  | 89.05                                | 63.01  | 42   | 0                              | 8.93   | 2.32                                      |

### Additional Settings and Readings

E3 Solutions test pond control panel uses a Schneider Electric Variable Frequency Drive (VFD) for setting atomizer speeds to determine ideal settings for flow rates in order to obtain the best atomized micron spectra for the testing period. The VFD was set at 166 Hertz or 9960 RPM's. See Figure 4.

Results from the Banner Sensor are shown in hundredths scale. See Figures 5 & 6.



**Figure 4.** Schneider VFD settings  
166 Htz./9960 RPM's.



**Figure 5.** Banner Sensor Reading at beginning of evaporation test = 12.87”.



**Figure 6.** Banner Sensor Reading at ending of evaporation test = 13.24”.

## RESULTS

### *Prime Time Evaporation Efficiency*

- *Total pond evaporation measurement:*

Utilizing the measurements recorded at the Research and Testing Pond in Dade City, FL, the following calculations established the total gallons of water removed during **12 hours** of operation.

#### Formulas

*Evaporation calculation in gallons for pond measurements:*

$$L \times W \times D \times 7.48 = TGE$$

*Total Gallons of Water Evaporated (formula 1)*

*L, pond length, ft*

*W, pond width, ft*

*D, pond drop, ft, i.e., drop in water level due to evaporation*

*7.48, EPA conversion factor*

#### Calculation formula 1

$$TGE_{12h} = 13.24'' - 12.87'' = 0.37'' \div 12 = 0.031'$$

$$TGE_{12h} = 150' \times 150' \times 0.031' \times 7.48 = \mathbf{5,217 \text{ gallons evaporated}}$$



- *Varimax® water throughput measurement:*

The total volume of water that was drawn from the pond and processed through the two Varimax® units during this 12 h test was recorded and totalized.

12 h x 10 GPM X 60 min of water flow throughput = **7,200 gallons**

- *Pan Evaporation measurement:*

The total water volume drawn from the pond due to natural evaporation (Evapotranspiration, ET) recorded was 0.1" for the 12 h test.

$$ET_{12h} \mathbf{0.1''} \div 12 = 0.008'$$

$$ET_{12h} = 150' \times 150' \times 0.008' \times 7.48 = \mathbf{1,402} \text{ gallons naturally evaporated}$$

- *Varimax® Achieved Efficiency*

During the 12 h of prime evaporation time, the actual onsite pond measurements were recorded along with the Varimax® total water flow throughput data.

These records are used to establish the actual evaporation rate during the test period.

$$\text{Operating Evaporation Rate, OER} = \frac{\text{Pond Evaporation} - ET}{\text{Varimax water throughput}}$$

*(formula 2)*

$$\mathbf{OER = (5,217 - 1,402 \text{ gallons})} \div \mathbf{7,200 \text{ gallons} = 53\%}$$

### **Varimax® vs. Natural Evaporation**

$$\text{Evaporation ratio} = \frac{\text{Pond Evaporation} - ET}{\text{Natural Evaporation}}$$

*(formula 3)*

$$\text{Varimax® evaporated water} = \text{Pond Evaporation} - ET = \mathbf{3,815} \text{ gallons}$$

$$\mathbf{Evaporation ratio = 3,815} \div \mathbf{1,402 = 2.7}$$



## CONCLUSIONS

The evaporation efficiency during daylight prime evaporation time was observed to be 53% for the Varimax® operating units during this 12 h study in Dade City. E3 Solutions enhanced evaporation technology showed an evaporation rate of 2.7 times the natural evaporation. These results support the Varimax® evaporation system operation during prime evaporation hours at practical water evaporation projects.

Attachments: Spec sheets Hydronix meter; Banner Sensor; Digital Reader.



## PFM/AFM/IFM Series

Panel Mount/Panel Mount Adjustable/  
Inline Flow Meters

- ✓ Flow calibrations from 0.1-1 GPM to 60-200 GPM available
- ✓ Panel Mount, Panel Mount Adjustable and Inline style available
- ✓ Stainless Steel internals



### HYDRONIX PFM/AFM/IFM SERIES FLOW METERS

have easy to read scales that are silk screened onto the acrylic bodies and are extremely accurate. With the attractive design and durable construction the acrylic bodies are practically unbreakable. You will soon make these your flow meters of choice.

| PFM SERIES SPECIFICATIONS |                                  |             |            |
|---------------------------|----------------------------------|-------------|------------|
| Part Number               | Description                      | Calibration |            |
|                           |                                  | GPM         | LPM        |
| PFM-011                   | PANEL MOUNT FLOWMETER: 1/4" MNPT | 0.1~1       | 0.4~3.8    |
| PFM-022                   | PANEL MOUNT FLOWMETER: 3/8" MNPT | 0.2~2       | 0.8~7.6    |
| PFM-055                   | PANEL MOUNT FLOWMETER: 1/2" MNPT | 0.5~5       | 1.9~18.9   |
| PFM-210                   | PANEL MOUNT FLOWMETER: 3/4" MNPT | 2~10        | 7.6~37.8   |
| PFM-216                   | PANEL MOUNT FLOWMETER: 1" MNPT   | 2~16        | 7.6~60.6   |
| PFM-424                   | PANEL MOUNT FLOWMETER: 1" MNPT   | 4~24        | 15.1~90.8  |
| PFM-535                   | PANEL MOUNT FLOWMETER: 1" MNPT   | 5~35        | 18.9~132.5 |

| AFM SERIES SPECIFICATIONS |                                  |             |            |
|---------------------------|----------------------------------|-------------|------------|
| Part Number               | Description                      | Calibration |            |
|                           |                                  | GPM         | LPM        |
| AFM-011                   | PANEL MOUNT FLOWMETER: 1/4" MNPT | 0.1~1       | 0.4~3.8    |
| AFM-022                   | PANEL MOUNT FLOWMETER: 3/8" MNPT | 0.2~2       | 0.8~7.6    |
| AFM-055                   | PANEL MOUNT FLOWMETER: 1/2" MNPT | 0.5~5       | 1.9~18.9   |
| AFM-210                   | PANEL MOUNT FLOWMETER: 3/4" MNPT | 2~10        | 7.6~37.8   |
| AFM-216                   | PANEL MOUNT FLOWMETER: 1" MNPT   | 2~16        | 7.6~60.6   |
| AFM-624                   | PANEL MOUNT FLOWMETER: 1" MNPT   | 6~24        | 22.7~90.8  |
| AFM-1035                  | PANEL MOUNT FLOWMETER: 1" MNPT   | 10~35       | 37.8~132.5 |

| IFM SERIES SPECIFICATIONS |                               |             |             |
|---------------------------|-------------------------------|-------------|-------------|
| Part Number               | Description                   | Calibration |             |
|                           |                               | GPM         | LPM         |
| IFM-011                   | INLINE FLOWMETER: 1/2" FNPT   | 0.1~1       | 0.4~3.8     |
| IFM-022                   | INLINE FLOWMETER: 1/2" FNPT   | 0.2~2       | 0.8~7.6     |
| IFM-055                   | INLINE FLOWMETER: 1/2" FNPT   | 0.5~5       | 1.9~18.9    |
| IFM-110                   | INLINE FLOWMETER: 3/4" FNPT   | 1~10        | 3.8~37.8    |
| IFM-220                   | INLINE FLOWMETER: 1" FNPT     | 2~20        | 7.6~75.7    |
| IFM-530                   | INLINE FLOWMETER: 1" FNPT     | 5~30        | 18.9~113.6  |
| IFM-2060                  | INLINE FLOWMETER: 1 1/2" MNPT | 20~60       | 75.7~227.1  |
| IFM-20100                 | INLINE FLOWMETER: 2" FNPT     | 20~100      | 75.7~378.5  |
| IFM-40120                 | INLINE FLOWMETER: 2" FNPT     | 40~120      | 151.4~454.2 |
| IFM-50150                 | INLINE FLOWMETER: 2" FNPT     | 50~150      | 189.3~567.8 |
| IFM-60200                 | INLINE FLOWMETER: 2" FNPT     | 60~200      | 227.1~757.1 |

### Product Features

- Easy to read
- Quality construction
- Corrosion and wear resistant
- Screen printed permanent scales on body (GPM/LPM)
- Dependable performance
- Individually packaged

### Materials of Construction

|              |                     |
|--------------|---------------------|
| Body:        | Acrylic, Plastic    |
| O-Rings:     | EPDM                |
| Connections: | Polypropylene       |
| Guide:       | 304 Stainless Steel |
| Float:       | 304 Stainless Steel |

### Temperature Rating

|            |              |
|------------|--------------|
| Max. Temp: | 120°F (49°C) |
|------------|--------------|

### Pressure Rating

|                |                   |
|----------------|-------------------|
| Max. Pressure: | 120 PSI (827 KPA) |
| Accuracy:      | +/- 5%            |

*Flow meters are tested and calibrated for water only. Although they may be suitable for other liquids, Hydronix will not guarantee them.*

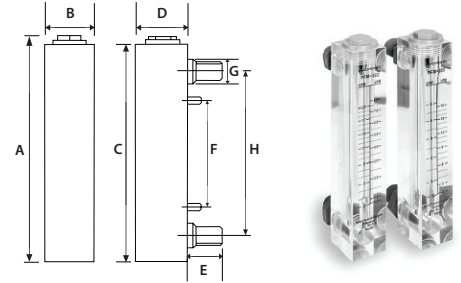


# PFM SERIES/AFM SERIES/IFM SERIES

Panel Mount/Panel Mount Adjustable/  
Inline Flow Meters Data Sheet

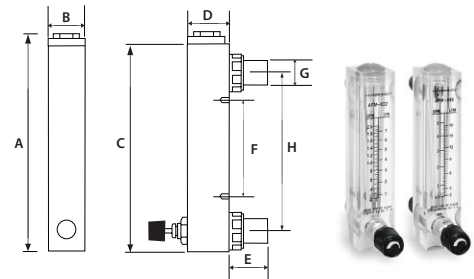
## PFM SERIES SPECIFICATIONS

| Part Number | Dimension (Inches) |      |      |      |      |      |      |      |
|-------------|--------------------|------|------|------|------|------|------|------|
|             | A                  | B    | C    | D    | E    | F    | G    | H    |
| PFM-011     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| PFM-022     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| PFM-055     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| PFM-210     | 9.17               | 1.54 | 8.66 | 1.73 | 1.65 | 3.94 | 1.46 | 6.50 |
| PFM-216     | 9.17               | 1.54 | 8.66 | 1.73 | 1.65 | 3.94 | 1.46 | 6.50 |
| PFM-424     | 9.96               | 1.73 | 9.45 | 1.97 | 1.22 | 3.94 | 1.46 | 6.89 |
| PFM-535     | 9.96               | 1.73 | 9.45 | 1.97 | 1.22 | 3.94 | 1.46 | 6.89 |



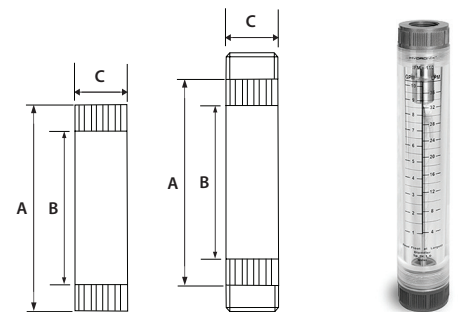
## AFM SERIES SPECIFICATIONS

| Part Number | Dimension (Inches) |      |      |      |      |      |      |      |
|-------------|--------------------|------|------|------|------|------|------|------|
|             | A                  | B    | C    | D    | E    | F    | G    | H    |
| AFM-011     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| AFM-022     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| AFM-055     | 8.50               | 1.26 | 8.11 | 1.46 | 1.42 | 3.94 | 1.10 | 6.50 |
| AFM-210     | 9.17               | 1.54 | 8.66 | 1.73 | 1.65 | 3.94 | 1.46 | 6.50 |
| AFM-216     | 9.17               | 1.54 | 8.66 | 1.73 | 1.65 | 3.94 | 1.46 | 6.50 |
| AFM-624     | 9.96               | 1.73 | 9.45 | 1.97 | 1.22 | 3.94 | 1.46 | 6.89 |
| AFM-1035    | 9.96               | 1.73 | 9.45 | 1.97 | 1.22 | 3.94 | 1.46 | 6.89 |

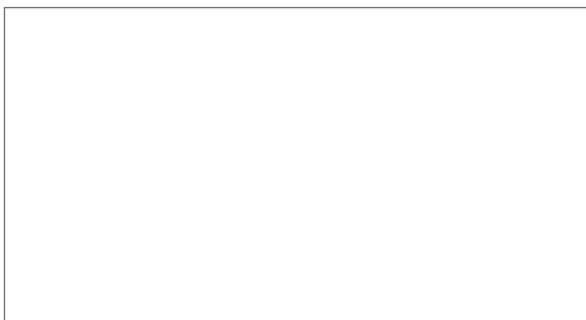


## IFM SERIES SPECIFICATIONS

| Part Number | Dimension (Inches) |       |      |
|-------------|--------------------|-------|------|
|             | A                  | B     | C    |
| IFM-022     | 8.27               | 7.09  | 1.26 |
| IFM-055     | 8.27               | 7.09  | 1.26 |
| IFM-110     | 10.94              | 9.29  | 1.77 |
| IFM-220     | 10.43              | 9.25  | 2.01 |
| IFM-530     | 10.43              | 9.25  | 2.01 |
| IFM-2060    | 12.05              | 9.25  | 2.01 |
| IFM-20100   | 13.39              | 10.63 | 2.95 |
| IFM-40120   | 13.39              | 10.63 | 2.95 |
| IFM-50150   | 13.39              | 10.63 | 2.95 |
| IFM-60200   | 13.39              | 10.63 | 2.95 |



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# U-GAGE® T30UX Series with Analog Output



## Datasheet

Ultrasonic Sensor with TEACH-Mode Configuration



- 1, 2 and 3 m (3.28, 6.56, and 9.84 ft) versions with short dead zones (10% of max range)
- Built-in temperature compensation
- Fast, easy-to-use TEACH-Mode programming; no potentiometer adjustments
- Configure with either a positive or negative analog output slope
- Remote TEACH for security and convenience
- Wide operating temperature range of  $-40^{\circ}$  to  $+70^{\circ}$  C ( $-40^{\circ}$  to  $+158^{\circ}$  F)
- Choose either 0 to 10V dc or 4 to 20 mA output model
- Compact, self-contained, right-angle sensor package with fully encapsulated electronics

## Models

| Models         | Range and Frequency               | Cable <sup>1</sup>          | Supply Voltage | Analog Output | Response Time               |
|----------------|-----------------------------------|-----------------------------|----------------|---------------|-----------------------------|
| <b>T30UXUA</b> | 100 mm to 1 m (3.9 in to 39 in)   | Standard 2 m (6.5 ft) cable | 10 to 30 V dc  | 0 to 10 V dc  | 45 ms or 105 ms selectable  |
| <b>T30UXIA</b> | 224 kHz                           |                             |                | 4 to 20 mA    |                             |
| <b>T30UXUB</b> | 200 mm to 2 m (7.8 in to 78 in)   |                             |                | 0 to 10 V dc  | 92 ms or 222 ms selectable  |
| <b>T30UXIB</b> | 174 kHz                           |                             |                | 4 to 20 mA    |                             |
| <b>T30UXUC</b> | 300 mm to 3 m (11.8 in to 118 in) |                             |                | 0 to 10 V dc  | 135 ms or 318 ms selectable |
| <b>T30UXIC</b> | 114 kHz                           |                             |                | 4 to 20 mA    |                             |



### WARNING: Not To Be Used for Personnel Protection

**Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death.** This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

## Overview

The U-GAGE® T30UX is an easy-to-use ultrasonic sensor with extended range and built-in temperature compensation. Simple push button configuration provides flexibility for a variety of applications.

Easy-to-see indicator LEDs communicate the status of the sensor. The Green "Power" LED ON indicates that the sensor is in Run Mode (the sensor's normal operating condition). The Red "Signal" LED indicates the target signal strength. The Amber "Output" LED indicates that the output is enabled and the sensor is receiving a signal within the window limits. The Amber "Mode" LED indicates the currently selected mode (fast or slow).

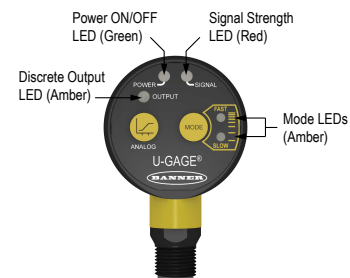


Figure 1. Features

<sup>1</sup> Only standard 2 m (6.5 ft) cable models are listed. To order the 4-Pin Euro-Style integral QD, add suffix "Q8" to the model number (for example, **T30UXUAQ8**). To order the 150 mm (6 in) PUR pigtail cable with 4-Pin threaded Euro-Style QD, add suffix "QPMA" to the model number (for example, **T30UXUAQPMA**). To order the 9 m (30 ft) cable, add suffix "W/30" to the model number (for example, **T30UXUA W/30**). A model with a QD connector requires a mating cable; see [Quick-Disconnect Cables](#) on page 10.



## Principles of Operation

Ultrasonic sensors emit one or multiple pulses of ultrasonic energy, which travel through the air at the speed of sound. A portion of this energy reflects off the target and travels back to the sensor. The sensor measures the total time required for the energy to reach the target and return to the sensor. The distance to the object is then calculated using the following formula:  **$D = ct \div 2$**

**D** = distance from the sensor to the target

**c** = speed of sound in air

**t** = transit time for the ultrasonic pulse

To improve accuracy, an ultrasonic sensor may average the results of several pulses before outputting a new value.

## Temperature Effects

The speed of sound is dependent upon the composition, pressure and temperature of the gas in which it is traveling. For most ultrasonic applications, the composition and pressure of the gas are relatively fixed, while the temperature may fluctuate.

In air, the speed of sound varies with temperature according to the following approximation:

In metric  
units:

$$C_{m/s} = 20 \sqrt{273 + T_C}$$

**C<sub>m/s</sub>** = speed of sound in meters per second

**T<sub>C</sub>** = temperature in °C

In English units:

$$C_{ft/s} = 49 \sqrt{460 + T_F}$$

**C<sub>ft/s</sub>** = speed of sound in feet per second

**T<sub>F</sub>** = temperature in °F

## Temperature Compensation

Changes in air temperature affect the speed of sound, which in turn affects the total time for the echo measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This shift is approximately 3.5% of the limit distance for a 20° C change in temperature.

The T30UX series ultrasonic sensors are temperature compensated. This reduces the error due to temperature by about 90%. The sensor will maintain its window limits to within 2.2% over the -40° to +70° C (-40° to +158° F) operating range of the sensor.



### NOTE:

- Exposure to direct sunlight can affect the sensor's ability to accurately compensate for changes in temperature.
- If the sensor is measuring across a temperature gradient, the compensation will be less effective.

## Configuration Instructions

### Sensor Configuration

Two TEACH methods may be used to configure the sensor:

- Teach individual minimum and maximum limits, or
- Use Auto-Window feature to center a sensing window around the taught position.

The sensor may be configured either via its push button, or via a remote switch. Remote configuration also may be used to disable the push button, preventing unauthorized personnel from adjusting the configuration settings. To access this feature, connect the white wire of the sensor to 0V dc, with a remote configuration switch between the sensor and the voltage.

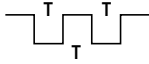
Configuration is accomplished by following the sequence of input pulses. The duration of each pulse (corresponding to a push button "click"), and the period between multiple pulses, are as "T": **0.04 seconds < T < 0.8 seconds**

Remote line configuration requires a greater than 1 second pause between pulse sequences.

### Mode Setup - Response Speed

Analog sensor models can be set up for either "Fast" or "Slow" response time. A button click or pulse on the remote line is: 0.04 s < T < 0.8 s.

1. Enter Response Speed Mode setup mode.

| Method              | Action  | Result  |
|---------------------|---|---|
| <b>Push Button</b>  | Push and hold MODE push button for > 2 seconds.   | Power LED: OFF<br>Mode LED: Flashing Amber shows previously selected mode |
| <b>Remote Input</b> | Double-pulse the remote line.  | Power LED: OFF<br>Mode LED: Flashing Amber shows previously selected mode |

2. Select the speed.

| Method              | Action   | Result  |
|---------------------|--|---|
| <b>Push Button</b>  | Click the MODE button to cycle to the correct selection: Fast or Slow. | Power LED: OFF<br>Mode LED: Amber flashes to indicate currently selected mode (120 second time out <sup>2</sup> ) |
| <b>Remote Input</b> | Single-pulse to select Slow; double-pulse to select Fast.              | Power LED: ON Green<br>Mode LED: ON Amber shows selected mode (Sensor returns to RUN mode)                        |

3. Save and return to Run mode.

| Method              | Action   | Result  |
|---------------------|--|---|
| <b>Push Button</b>  | Push and hold the MODE button for more than 2 seconds.     | Power LED: ON Green<br>Mode LED: ON Amber for selected mode |
| <b>Remote Input</b> | No action is required; the sensor will return to Run Mode. | None  |

## Analog Output

The U-GAGE T30UX series sensor may be configured for either a positive or a negative output slope, based on which condition is taught first (see [Figure 2](#) on page 3). If the near limit is taught first, the slope will be positive; if the far limit is taught first, the slope will be negative. Banner's scalable analog output automatically distributes the output signal over the width of the programmed sensing window.

The U-GAGE T30UX also features a 2-second hold upon loss of the received signal, which is useful for harsh and unstable applications. In the event of signal loss for longer than 2 seconds, the analog output goes to 3.6 mA or 0V dc, which may be used to trigger an alarm.

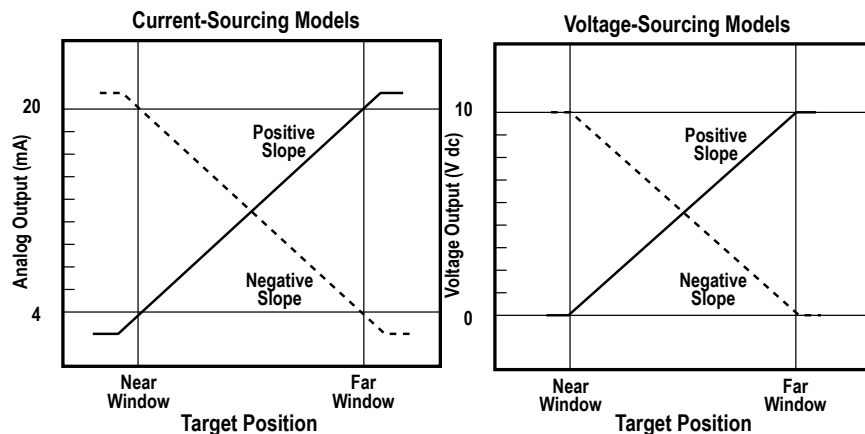


Figure 2. Positive and Negative Output Slopes

## Teaching Minimum and Maximum Limits

### General Notes on Teaching


- The sensor returns to RUN mode if the first TEACH condition is not registered within 120 seconds after the initial 2 second hold on the Analog button.

<sup>2</sup> The sensor will revert to previously saved configuration and return to RUN mode if TEACH is inactive for 120 seconds after the initial 2 second hold on push button


- To exit TEACH mode without saving any changes, press and hold the Analog button or remote line longer than 2 seconds (before teaching the second limit). The sensor reverts to the last saved limits.
  - After the first limit is taught, the sensor remains in TEACH mode until the TEACH sequence is finished or exited by a 2 second hold on the Analog button or remote line.
  - A button click or pulse on the remote line is:  $0.04\text{ s} < T < 0.8\text{ s}$ .
- Enter TEACH mode.

| Method              | Action  | Result                           |
|---------------------|---|----------------------------------|
| <b>Push Button</b>  | Push and hold the Analog push button longer than 2 seconds. | Power LED: OFF<br>Output LED: ON |
| <b>Remote Input</b> | No action required; sensor is ready for first limit teach.  | None                             |

- Teach the first limit.

| Method              | Action  | Result   |
|---------------------|---|--|
| <b>Push Button</b>  | Position the target for the first limit (120 second time out).  | Signal LED: Must be ON Red or Flashing Red <sup>3</sup>  |
|                     | "Click" the Analog button.  | <b>Teach Accepted</b><br>Power LED: OFF<br>Output LED: Flashing<br><b>Teach Not Accepted</b><br>Output LED: ON |
| <b>Remote Input</b> | Position the target for the first limit.  | <b>Signal LED:</b> Must be ON Red or Flashing Red <sup>3</sup>   |
|                     | Single-pulse the remote line.  | <b>Teach Accepted</b><br>Power LED: OFF<br>Output LED: Flashing<br><b>Teach Not Accepted</b><br>Power LED: ON  |

- Teach the second limit.

| Method              | Action  | Result  |
|---------------------|---|---|
| <b>Push Button</b>  | Position the target for the second limit (no time out).   | Signal LED: Must be ON Red or Flashing Red  |
|                     | "Click" the Analog button.  | <b>Teach Accepted</b><br>Output LED: ON<br>Power LED: ON<br><b>Teach Not Accepted</b><br>Output LED: Flashing<br>Power LED: OFF       |
| <b>Remote Input</b> | Position the target for the second limit (no time out).   | <b>Signal LED:</b> Must be ON Red or Flashing Red.  |
|                     | Single-pulse the remote line.  | <b>Teach Accepted</b><br>Output LED: Turns ON<br>Power LED: ON<br><b>Teach Not Accepted</b><br>Output LED: Flashing<br>Power LED: OFF |

## Teaching Limits Using the Auto-Window Feature

Teaching the same limit twice automatically centers a 100 mm window on the taught position .

### General Notes on Teaching

- The sensor returns to RUN mode if the TEACH condition is not registered within 120 seconds after the initial 2 second hold on the Analog button.
- To exit TEACH mode without saving any changes, press and hold the Analog button or remote line longer than 2 seconds (before teaching the second limit). The sensor will revert to the last saved limits.


<sup>3</sup> Sensor will not Teach or indicate "Teach Not Accepted" when there is no signal present (Signal LED Red or Flashing Red)

- After the first limit is taught, the sensor remains in TEACH mode until the TEACH sequence is finished or exited by a 2 second hold on the Analog button or remote line.
- A button click or pulse on the remote line is:  $0.04\text{ s} < T < 0.8\text{ s}$ .


1. Enter TEACH mode.

| Method              | Action   | Result                           |
|---------------------|--|----------------------------------|
| <b>Push Button</b>  | Push and hold the Analog button longer than 2 seconds.             | Power LED: OFF<br>Output LED: ON |
| <b>Remote Input</b> | No action required; the sensor is ready for the first limit teach. | None                             |

2. Teach the first limit.

| Method              | Action   | Result   |
|---------------------|--|--|
| <b>Push Button</b>  | Position the target for the center of window (120 second time out).  | Signal LED: Must be ON Red or Flashing Red <sup>4</sup>  |
|                     | Click the Analog push button.  | <b>Teach Accepted</b><br>Power LED: OFF<br>Output LED: Flashing<br><b>Teach Not Accepted</b><br>Output LED: ON |
| <b>Remote Input</b> | Position the target for the center of window.  | Signal LED: Must be ON Red or Flashing Red <sup>4</sup>  |
|                     | Single-pulse the remote line.<br> | <b>Teach Accepted</b><br>Power LED: OFF<br>Output LED: Flashing<br><b>Teach Not Accepted</b><br>Output LED: ON |

3. Re-teach the limit.

| Method              | Action  | Result  |
|---------------------|---|---|
| <b>Push Button</b>  | Without moving the target, "click" the Analog push button again   | <b>Teach Accepted</b><br>Output LED: ON<br>Power LED: ON<br><b>Teach Not Accepted</b><br>Output LED: Flashing<br>Power LED: OFF |
| <b>Remote Input</b> | Without moving the target, single-pulse the remote line again.<br> | <b>Teach Accepted</b><br>Output LED: ON<br>Power LED: ON<br><b>Teach Not Accepted</b><br>Output LED: Flashing<br>Power LED: OFF |

## Remote Line TEACH

### General Notes

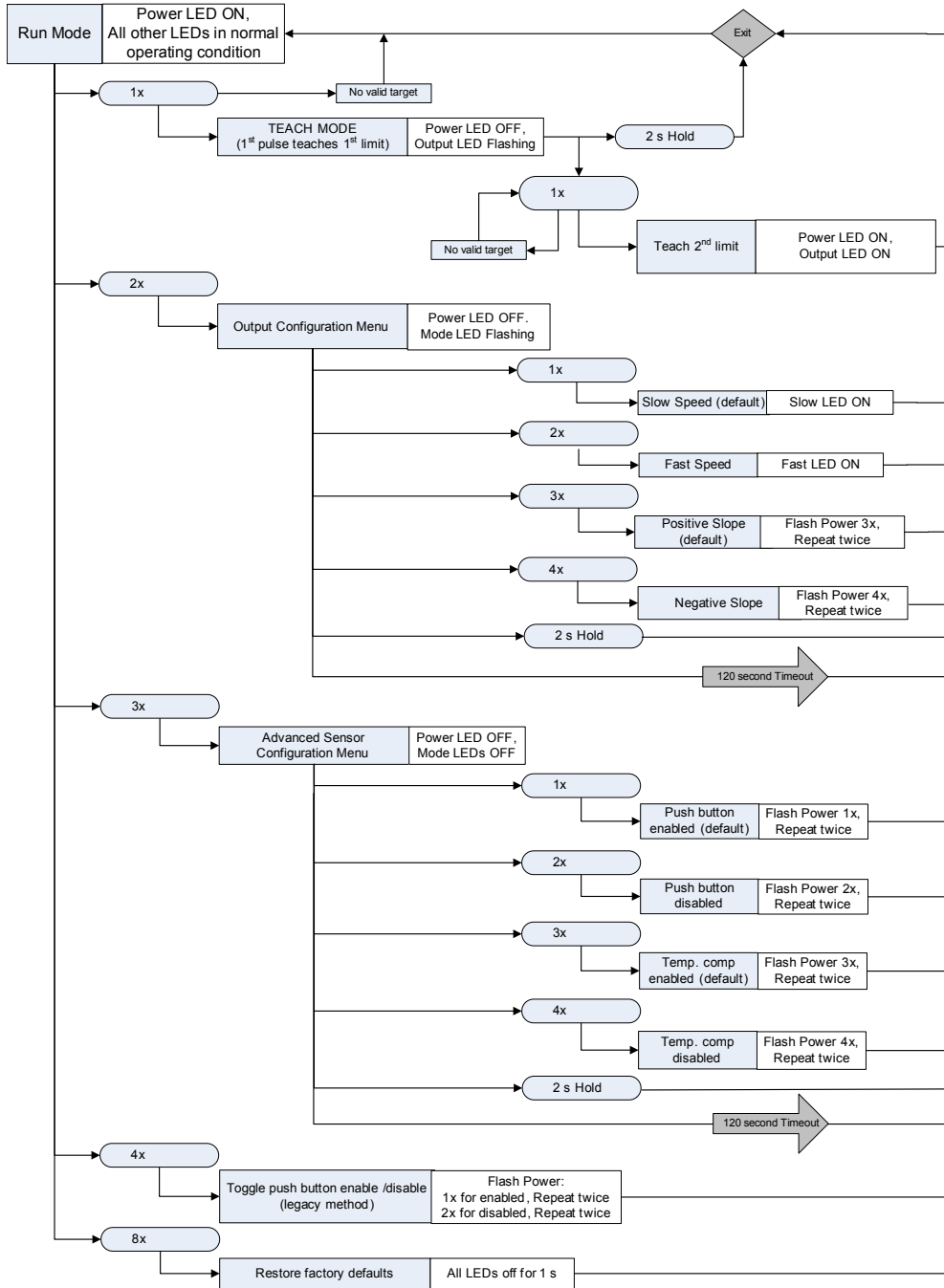
- Run Mode is the sensor's normal operating condition
- The duration of each Pulse is defined as "T":  $0.04 < T < 0.8\text{ s}$



- A Hold will exit TEACH MODE and return to Run Mode with previously saved changes. The duration of a Hold is:  $T > 2\text{ s}$
- A Timeout will occur if a condition is not registered within 120 seconds, causing the sensor to return to Run Mode (during sensor configuration only)
- Sensor configuration user feedback shown on Green LED. See flowchart.

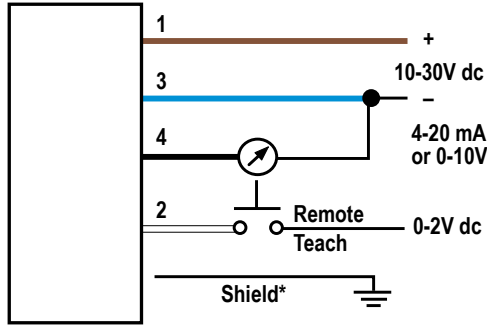
<sup>4</sup> Sensor will not Teach or indicate "Teach Not Accepted" when there is no signal present (Signal LED Red or Flashing Red)

- The Red Signal LED will be ON whenever the target is in view.





## Wiring



### Wiring Key

- 1 = Brown
- 2 = White
- 3 = Blue
- 4 = Black

Cable and QD hookups are functionally identical. It is recommended that the shield wire be connected to earth ground. Shielded cordsets are recommended for all QD models.

## Specifications

### Sensing Range

- "A" suffix models: 100 mm to 1 m (3.9 in to 39 in)
- "B" suffix models: 200 mm to 2 m (7.8 in to 78 in)
- "C" suffix models: 300 mm to 3 m (11.8 in to 118 in)

### Ultrasonic Frequency

- "A" suffix models: 224 kHz
- "B" suffix models: 174 kHz
- "C" suffix models: 114 kHz

### Supply Voltage

10 to 30 V dc (10% maximum ripple) at 40 mA, exclusive of load

### Supply Protection Circuitry

Protected against reverse polarity and transient voltages

### Output Configuration

**Analog Output:** 0 to 10V dc or 4 to 20 mA, depending on model

### Output Rating

**Analog Voltage Output:** 2.5 k $\Omega$  min. load resistance; Minimum supply for a full 10V output is 12V dc (for supply voltages between 10 and 12, V out max. is at least V supply -2)

**Analog Current Output:** 1 k $\Omega$  max. at 24V input; max. load resistance =  $(V_{cc}-4)/0.02\Omega$

**For current output (4-20 mA) models,** ideal results are achieved when the total load resistance  $R = [(V_{in} - 4)/0.020]\Omega$ . Example, at  $V_{in} = 24V$  dc,  $R \approx 1$  k $\Omega$  (1 watt)

### Output Protection Circuitry

Protected against short circuit conditions

### Linearity

0.25% of distance

### Resolution

- "A" suffix models: 0.1% of distance (0.5 mm min.)
- "B" suffix models: 0.1% of distance (1.0 mm min.)
- "C" suffix models: 0.1% of distance (1.5 mm min.)

### Minimum Window Size

10 mm (0.4 in)

### Adjustments

**Sensing window limits:** TEACH-Mode of near and far window limits may be set using the push button or remotely via TEACH input.

**Response speed selection:** Fast or Slow (see [Mode Setup - Response Speed](#) on page 2 or [Remote Line TEACH](#) on page 5)

**Advanced configuration options:** Analog output slope, push button enabled/disabled, temperature compensation enabled/disabled (see [Remote Line TEACH](#) on page 5)

### Indicators

See [Figure 1](#) on page 1

### Loss of Signal Indication

**0 to 10V dc models:** Analog output goes to 0V

**4 to 20 mA models:** Analog output goes to 3.6 mA

### Construction

**Housing:** PBT polyester

**Push buttons:** polyester

**Transducer:** epoxy /ceramic composite

### Environmental Rating

Leakproof design, rated IEC IP67 (NEMA 6)

### Connections

2 m (6.5 ft) or 9 m (30 ft) shielded 4-conductor (with drain) PVC cable, 150 mm (6 in) PUR Euro-style pigtail (QPMA), or 4-pin integral Euro-style connector (Q8)

### Temperature Effect

0.02% of distance/°C

### Delay at Power-up

500 ms

### Output Response Time

"A" suffix models: 45 ms (fast); 105 ms (slow)

"B" suffix models: 92 ms (fast); 222 ms (slow)

"C" suffix models: 135 ms (fast); 318 ms (slow)

**Operating Conditions**

**Temperature:** -40 °C to +70 °C (-40 °F to +158 °F)  
**Humidity:** 95% at +50 °C maximum relative humidity (non-condensing)

**Vibration and Mechanical Shock**

All models meet Mil. Std. 202F requirements method 201A (vibration: 10 to 60 Hz max., double amplitude 0.06 in, max acceleration 10G). Also meets IEC 947-5-2; 30G 11 ms duration, half sine wave

**Certifications**



**Application Note**

The temperature warmup drift upon power-up is less than 1% of the sensing distance.

**Required Overcurrent Protection**



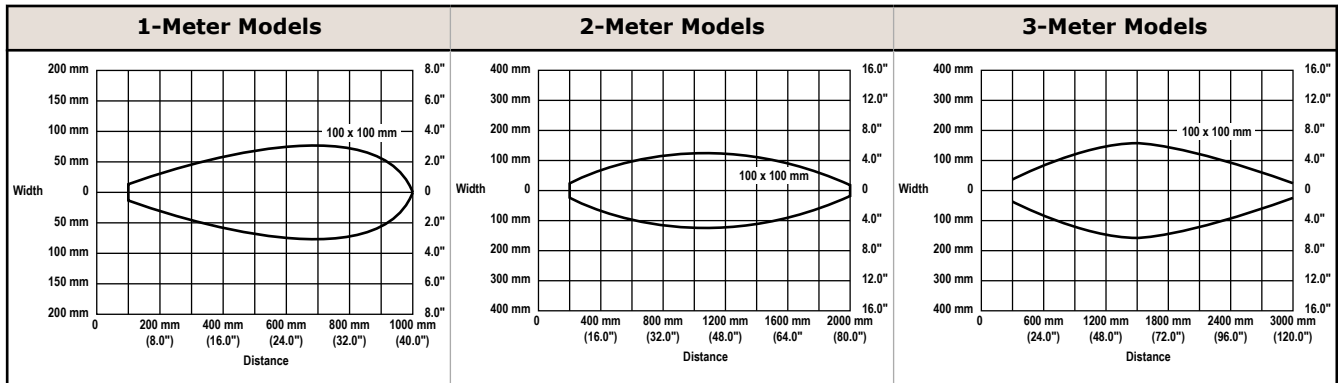
**WARNING:** Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.  
 Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.  
 Supply wiring leads < 24 AWG shall not be spliced.  
 For additional product support, go to <http://www.bannerengineering.com>.

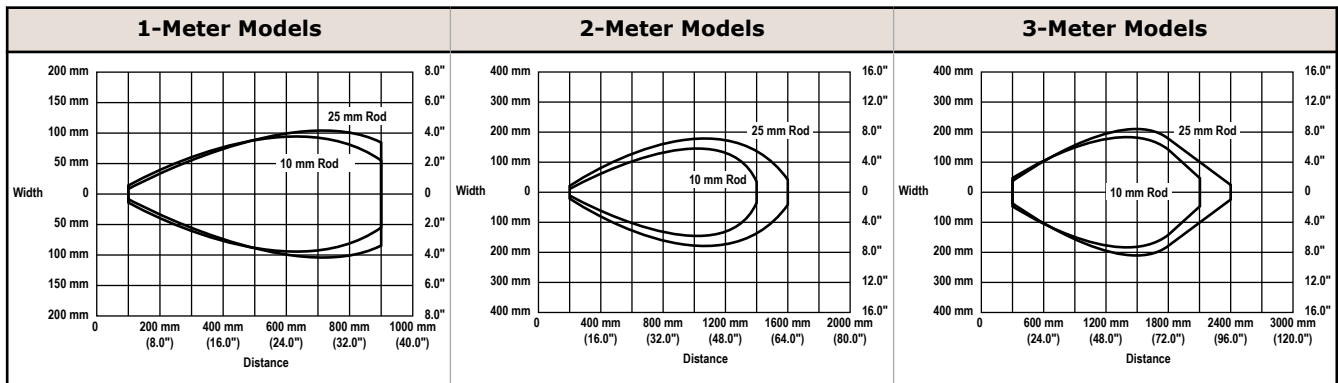
| Supply Wiring (AWG) | Required Overcurrent Protection (Amps) |
|---------------------|--|
| 20                  | 5.0                                    |
| 22                  | 3.0                                    |
| 24                  | 2.0                                    |
| 26                  | 1.0                                    |
| 28                  | 0.8                                    |
| 30                  | 0.5                                    |

**Performance Curves**

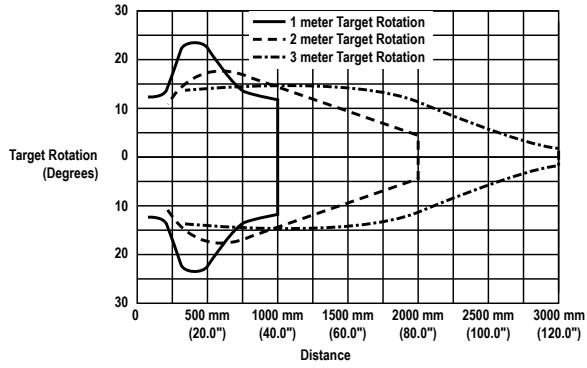
**With Plate Target (Typical)**



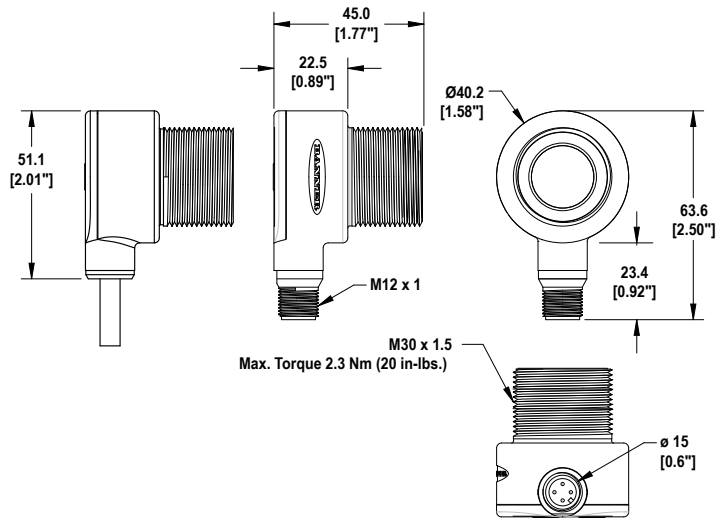
**With Rod Target (Typical)**



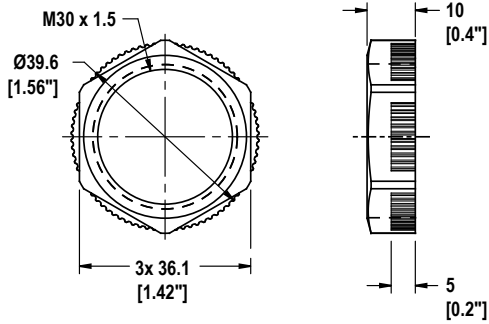
## Maximum Target Rotation Angle



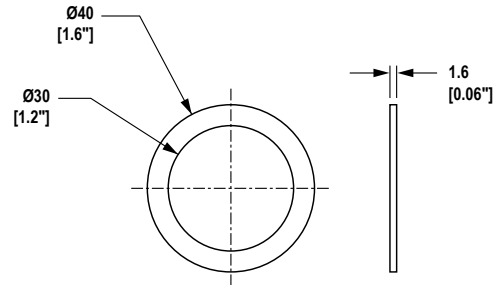
## Dimensions



### Locknut (included with all models)

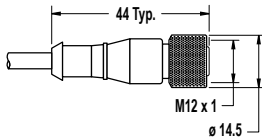

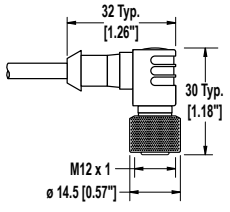


### Washer (included with all models)



## Accessories

### Quick-Disconnect Cables

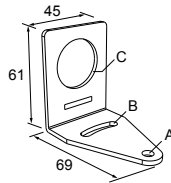
| 4-Pin Threaded M12/Euro-Style Cordsets with Shield |                |             |   |   |
|--|----------------|-------------|---|---|
| Model  | Length         | Style       | Dimensions  | Pinout (Female)   |
| MQDEC2-406   | 1.83 m (6 ft)  | Straight    |   |  <p>1 = Brown<br/>2 = White<br/>3 = Blue<br/>4 = Black</p> |
| MQDEC2-415   | 4.57 m (15 ft) |             |   |   |
| MQDEC2-430   | 9.14 m (30 ft) |             |   |   |
| MQDEC2-406RA                                       | 1.83 m (6 ft)  | Right-Angle |  |   |
| MQDEC2-415RA                                       | 4.57 m (15 ft) |             |   |   |
| MQDEC2-430RA                                       | 9.14 m (30 ft) |             |   |   |

## Brackets

All measurements are in mm.

### SMB30A

- Right-angle bracket with curved slot for versatile orientation
- Clearance for M6 (¼ in) hardware
- Mounting hole for 30 mm sensor
- 12-ga. stainless steel

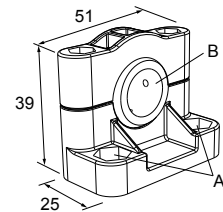


**Hole center spacing:** A to B=40

**Hole size:** A=ø 6.3, B= 27.1 x 6.3, C=ø 30.5

### SMB1815SF

- Swivel with set screws for mounting sensors by the cable hub
- Black reinforced thermoplastic polyester
- Stainless steel swivel locking hardware and hex wrench included

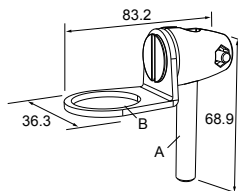


**Hole center spacing:** A = 36.0

**Hole size:** A = ø 5.0, B = ø 15.0

### SMB30FA

- Swivel bracket with tilt and pan movement for precise adjustment
- Mounting hole for 30 mm sensor
- 12-ga. 304 stainless steel
- Easy sensor mounting to extrude rail T-slot
- Metric and inch size bolt available

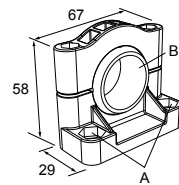


**Bolt thread:** SMB30FA, A= 3/8 - 16 x 2 in; SMB30FAM10, A= M10 - 1.5 x 50

**Hole size:** B= ø 30.1

### SMB30SC

- Swivel bracket with 30 mm mounting hole for sensor
- Black reinforced thermoplastic polyester
- Stainless steel mounting and swivel locking hardware included



**Hole center spacing:** A=ø 50.8

**Hole size:** A=ø 7.0, B=ø 30.0

## Banner Engineering Corp. Limited Warranty

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Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

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# PD765

Trident Series Process & Temperature Meters

 **TRIDENT**



**PROCESS & TEMP**

- 4-20 mA,  $\pm 10$  V, TC & RTD Inputs
- 4-Digit Display, 0.56" (14.2 mm) or 1.20" (30.5 mm)
- Type 4X, NEMA 4X, IP65 Front
- 1/8 DIN Shallow Depth Case 3.6" Behind Panel
- Operating Temperature Range of  $-40^{\circ}\text{C}$  to  $65^{\circ}\text{C}$
- Free MeterView<sup>®</sup> Software - Configuration & Data Acquisition
- Sunlight Readable Display
- Universal Power Supply 85-265 VAC
- 12-36 VDC/12-24 VAC Power Option
- 24 VDC @ 200 mA Transmitter Power Supply Options
- 2 Relays + 4-20 mA Output Options
- Pump Alternation Capability
- USB, RS-232, & RS-485 Serial Communication Options
- Free Modbus<sup>®</sup> RTU with Serial Adapter Option
- Copy Meter Settings to Other Meters
- Max/Min Display
- High & Low Alarms with Multiple Reset Actions

**PRECISION DIGITAL CORPORATION**

**PRECISION  
DIGITAL** 

[www.predig.com](http://www.predig.com)

# PD765 Trident Series Process & Temperature Meters

## Trident & Trident X2 Displays



UV Resistant  
Sunlight Readable Models



Front Panel  
NEMA 4X Rated



**TRIDENT**

(Actual Size Digits)

**TRIDENT X2**



0.56" (14.2 mm) Display



1.2" (30.5 mm) Display

## FEATURE RICH & SIMPLE TO USE

The PD765 Trident digital panel meter is one of the most versatile digital panel meters on the market and will satisfy a wide variety of process applications. The Trident can be field programmed to accept process voltage (0-5V, 1-5V, etc) and current (4-20 mA) inputs, 100 Ohm RTDs, and the four most common thermocouples. It is housed in a shallow-depth, 1/8 DIN enclosure that features a NEMA 4X front panel and convenient mounting hardware. There are two power options for the Trident: 85 to 265 VAC or 12-36 VDC and it can provide 24 VDC to power the transmitter if needed. Programming and setup can be performed with the four front panel pushbuttons, free MeterView software, or using the Copy function.

## TWO DISPLAY SIZES

The display height on the standard Trident meter is 0.56" (14.2 mm) and on the Trident X2 the display height is an astounding 1.2" (30.5 mm). The Trident X2 can be read easily from distances of up to 30 feet! Both meters are available with all Trident features.

The intensity of the display on both versions of the Trident can be adjusted to compensate for various lighting conditions, including direct sunlight.

## VERSATILE OPERATION

Look to the Trident meter for the key features and options you want and don't worry about getting bogged down in a confusing array of things you don't need. The Trident's Max/Min function, 2 relays + 4-20 mA output, serial communication, and Modbus RTU options provide all the utility you need to handle all the common applications.

### Maximum/Minimum

To display the maximum and minimum readings since the last reset/power-up, use the Up arrow/Max button

## Powerful Relay Functionality

All relay functions are set up from the front panel or from a PC running MeterView® software.

- Automatic reset only
- Automatic or manual reset
- Latching or non-latching relays
- Pump alternation control
- On and off time delays from 0 to 199 seconds
- Fail-safe operation is user selectable

## Isolated 4-20 mA Transmitter Output

The Trident's Isolated 4-20 mA output option converts the Trident into a transmitter with a digital display; perfect for temperature applications!

## Serial Communication Adapters & Converters

A wide variety of serial communication adapters and converters are available for the Trident meter. A serial adapter and Precision Digital's free MeterView software allows the Trident to be programmed from a computer and to connect to a PC for data acquisition. Adapters are available for USB, RS-232, and RS-485 communications. Converters are available for isolated and non-isolated RS-232 to RS-422/485 and USB to RS-422/485.



PDA8006

PDA7232

PDA7422



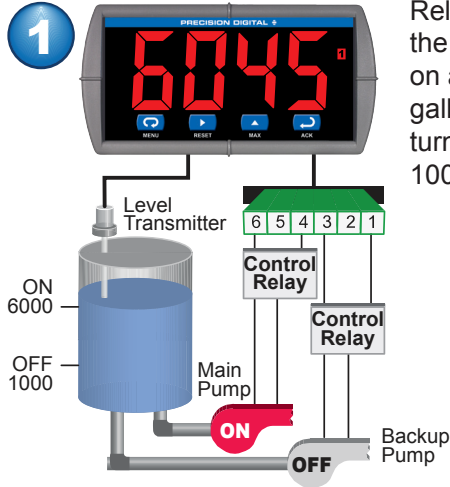
# PD765 Trident Series Process & Temperature Meters

## Modbus RTU

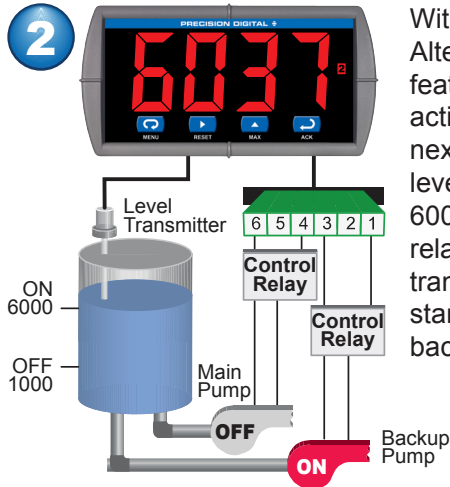
Use the Trident's Modbus RTU communications to connect the Trident to a PLC, SCADA system or other digital device. It is a standard feature on all Trident models.

## Pump Alternation

The Trident, in pump alternation mode, will automatically alternate two pumps:



Relay #1 turns the main pump on at 6000 gallons and turns it off at 1000 gallons.



With the Pump Alternation feature activated, the next time the level reaches 6000 gallons, relay #2 transfers and starts the backup pump.

## EASY SETUP AND PROGRAMMING

The Trident is easily setup and programmed using the simple four-button programming method. The meter can also be programmed using a PC and Precision Digital's free MeterView software or "cloned" with the Copy function. There is only one switch on the entire meter, no jumpers, and no need to ever open the case.

## Programming with Four Front Panel Buttons

The Trident's four front panel buttons keep the user in control of the programming process. To see how simple it is to program the Trident, check out the Virtual Meter at [www.predig.com](http://www.predig.com).

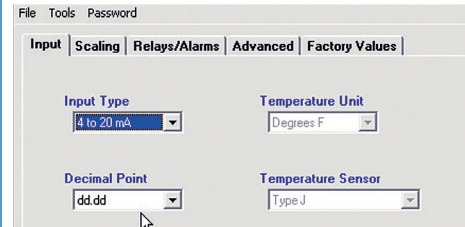
## Meter Copy

The Copy function is used to copy (or clone) all the settings from one Trident meter to other Trident meters in less than 10 seconds. The Copy function is a standard feature on all meters. The Copy feature does not require a serial communication adapter, it only requires the optional cable assembly (PDA7420).



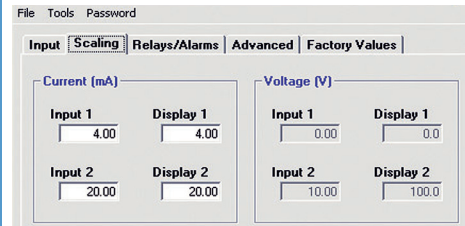
## Programming From a PC with MeterView®

Precision Digital's free MeterView® software allows all PD765 Trident setup parameters to be programmed from a PC and to save the configuration settings to a file for reporting or programming other meters. And since the serial adapter is an external device, one serial adapter can program an infinite number of meters!



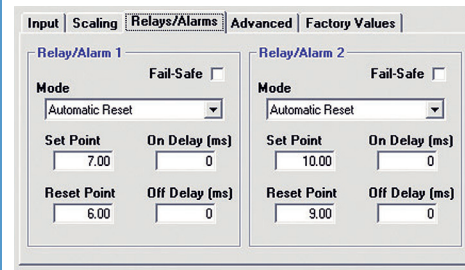
### Configure Input

- Input type
- Decimal point
- Temp units
- Sensor type



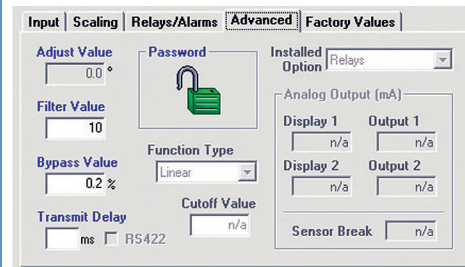
### Meter Scaling

- Scale input
- No cryptic codes
- Simple to use



### Set Relays/Alarms

- Select mode
- Set/reset points
- Fail-safe operation
- On & off delays



### Advanced Settings

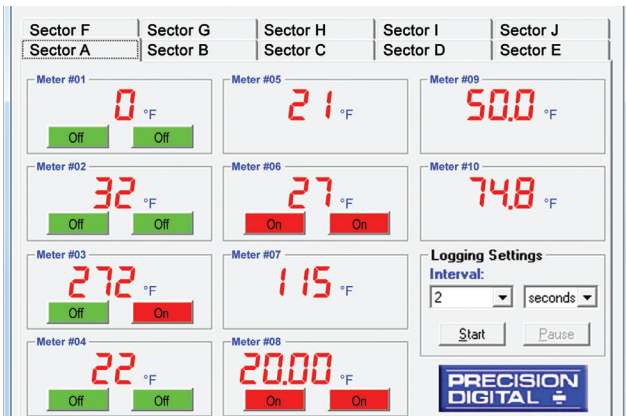
- Password
- Filter & bypass
- Transmit delay
- Function type
- Cutoff value

# PD765 Trident Series Process & Temperature Meters

## DATA ACQUISITION

Digital panel meters make a great front end to a PC-based data acquisition system. They are easy to set up, can be used for a wide range of inputs, will power the transmitter, and best of all provide a local display of the process. Precision Digital has the perfect package with its Trident Digital Panel Meters, a wide selection of serial adapters and converters and free MeterView software. Data is displayed on the PC and written to a file that could then be imported into a spreadsheet or other application.

## Data Logging up to 100 Trident Meters



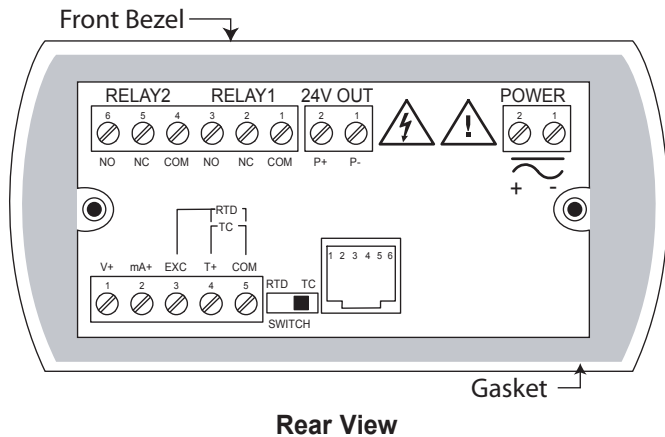
## Sample File Generated by MeterView®

**PD765 Log File**

Name: C:\MV3logfile.htm      Created: 1/7/2011 5:34:12 PM  
 Serial Port: COM 1      Connection speed: 2400 Baud      Logging rate: 1 update every 10 seconds

| Date & Time         | Tag Number   | Address | Display | Units | Relay 1 | Relay 2 |
|---------------------|--------------|---------|---------|-------|---------|---------|
| 1/7/2011 5:34:12 PM | Tank 1 Level | 06      | 17.70   | Feet  | P1 On   | P2 Off  |
| 1/7/2011 5:34:12 PM | Tank 2 Level | 07      | 18.18   | Feet  | P3 Off  | P4 Off  |
| 1/7/2011 5:34:12 PM | Tank 3 Level | 08      | 20.54   | Feet  | P5 On   | P6 Off  |
| 1/7/2011 5:34:12 PM | Tank 1 Temp  | 09      | 74      | °F    | Off     | Off     |
| 1/7/2011 5:34:12 PM | Tank 2 Temp  | 10      | 72      | °F    | Off     | Off     |
| 1/7/2011 5:34:12 PM | Tank 3 Temp  | 11      | 72      | °F    | Off     | Off     |
| 1/7/2011 5:34:22 PM | Tank 1 Level | 06      | 17.58   | Feet  | P1 On   | P2 Off  |
| 1/7/2011 5:34:22 PM | Tank 2 Level | 07      | 18.04   | Feet  | P3 Off  | P4 Off  |
| 1/7/2011 5:34:22 PM | Tank 3 Level | 08      | 19.79   | Feet  | P5 Off  | P6 Off  |
| 1/7/2011 5:34:22 PM | Tank 1 Temp  | 09      | 74      | °F    | Off     | Off     |
| 1/7/2011 5:34:22 PM | Tank 2 Temp  | 10      | 72      | °F    | Off     | Off     |

## CONNECTIONS

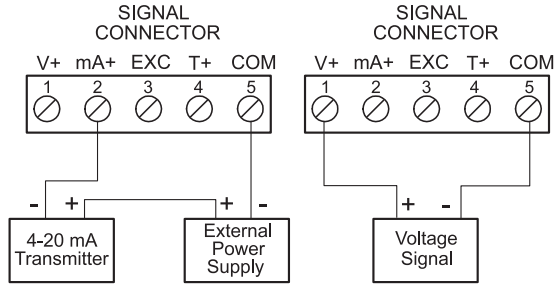


## PROCESS & TEMPERATURE INPUTS

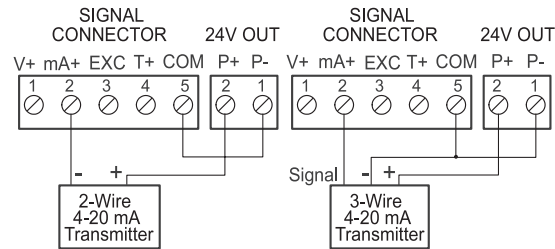
The Trident is factory calibrated to accept 4-20 mA, ±10 VDC, type J, K, T, or E thermocouples and 100 Ω platinum RTDs. Process inputs can be scaled with or without applying an input for virtually any engineering units. Temperature inputs can be programmed to display in degrees Fahrenheit or Celsius and the type K thermocouple can display up to 2300 °F.

### Current & Voltage Inputs

Setting up the meter to accept a current or voltage input could not be easier. All setup is performed with the front panel buttons and there are no switches or jumpers to deal with.



Transmitter Powered by External Supply



Transmitter Powered by Internal Supply (optional)

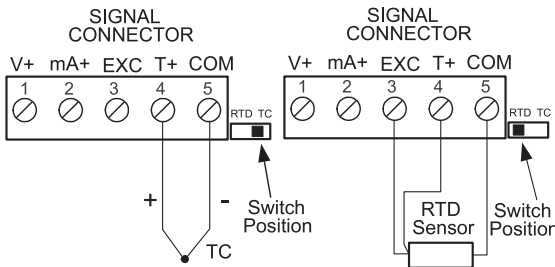
### Current Overload Protection

To protect the instrument from unexpected current overload, the current input circuit contains a resettable fuse. The fuse limits the current to a safe level when it detects a fault condition, and automatically resets itself when the fault condition is removed.

### Thermocouple & RTD inputs

Setting up the Trident to accept a thermocouple or RTD input is simply a matter of setting a switch at the rear of the case and selecting the input type from the menu.

The meter accepts J, K, T, or E type thermocouples as well as two, three, or four-wire 100 Ω platinum RTDs.



## NEMA 4 & 4X ENCLOSURES

Thermoplastic and stainless steel NEMA 4X, and painted steel NEMA 4 enclosures for up to 10 Trident meters are available. Please visit our Enclosure Selection Utility at [www.predig.com/esu](http://www.predig.com/esu) for an easy way to find the right enclosure.

## PROTEX-MAX



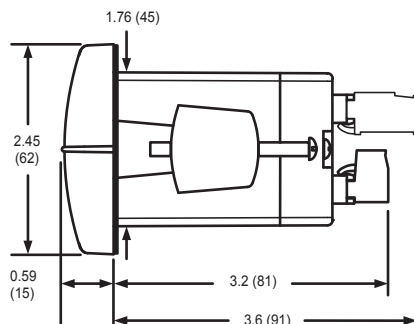
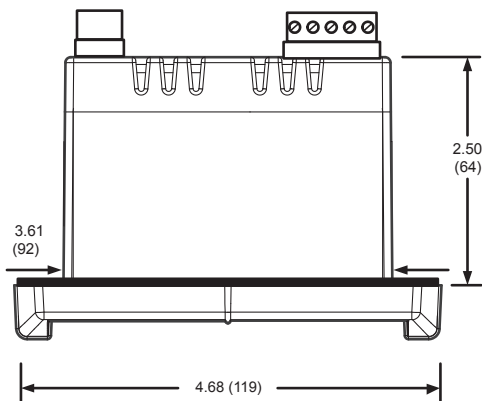
**PD8-765**  
Process & Temperature

The Trident X2 can now go anywhere as the ProtEX-MAX! The same huge, bright display and features of the Trident X2 are provided in an approved ProtEX-MAX explosion proof enclosure. In addition, RS-485 serial communications for Modbus or MeterView software is standard. All ProtEX-MAX products also come with SafeTouch® through glass buttons, for easy programming and operation in your hazardous area.

## QUICK INSTALLATION

The Trident is housed in a shallow-depth case that is designed for easy installation and servicing. The extra large front bezel is rated Type 4X, IP65. The mounting brackets are locked in place to make it easy to mount the meter in the panel. Removable screw terminal connectors make for easy and convenient wiring.

## Mounting Dimensions



Notes:

1. Panel cutout required: 1.772 x 3.622 (45 x 92)
2. Panel thickness: 0.040 – 0.250 (1.0 – 6.4)
3. Mounting brackets lock in place for easy mounting

## SPECIFICATIONS

Except where noted all specifications apply to operation at +25°C.

### General

**Display:** Trident: 0.56" (14.2 mm); Trident X2: 1.20" (30.5 mm) red LED, 4 digits (-1999 to 9999)  
**Display Intensity:** Eight user selectable levels  
**Front Panel:** NEMA 4X, IP65; panel gasket provided  
**Programming Methods:** Four front panel buttons, cloning with Copy feature, PC with MeterView software, and Modbus registers.  
**Noise Filter:** Programmable 2 to 199 (0 will disable filter)  
**Display Update Rate:** Process/RTD: 3.7-5/sec; TC: 1.8-2.5/sec  
**Overrange:** Display flashes 9999  
**Underrange:** Display flashes -1999  
**Recalibration:** All inputs are calibrated at the factory; recalibration is recommended at least every 12 months.  
**Max/Min Display:** Stored until reset by user or meter is turned off.  
**Password:** Restricts modification of programmed settings.  
**Non-Volatile Memory:** Settings stored for a minimum of 10 years.  
**Power Options:** 85-265 VAC, 50/60 Hz; 90-265 VDC, 20 W max or 12-36 VDC; 12-24 VAC, 6 W max.  
**Required Fuse:** UL Recognized, 5 A max, slow-blow; up to 6 meters may share one fuse.  
**Normal Mode Rejection:** 64 dB at 50/60 Hz  
**Isolation:** 4 kV input/output-to-power line; 500 V input-to-output or output-to-24 VDC supplies. -6R5 & -6X5 models only: 100 V output-to-24 VDC supply  
**Operating Temperature:** -40 to 65°C (-40 to 149°F)  
**Storage Temperature:** -40 to 85°C (-40 to 185°F)  
**Relative Humidity:** 0 to 90% non-condensing  
**Connections:** Power & Signal: removable screw terminal blocks accept 12 to 22 AWG. Serial: RJ11 header, standard on all meters.  
**Enclosure:** 1/8 DIN, high impact plastic, 94V-0, color; gray  
**Weight:** 9.5 oz (269 g) (including options)  
**UL File Number:** E160849; 508 Industrial Control Equipment  
**Warranty:** 3 years parts & labor

### Process Inputs

**Inputs:** 0-20 mA, 4-20 mA, 1-5 V, ±10 V  
**Accuracy:** ±0.05% FS ±1 count; square root: ±0.1% FS ±2 counts  
**Function:** Linear or square root  
**Low-Flow Cutoff:** 0 to 9999 (0 disables cutoff function)  
**Decimal Point:** Up to 3 decimals.  
**Calibration:** Scale without signal or calibrate with signal source  
**Calibration Range:** User programmable over entire range of meter  
**Input Impedance:** Voltage range: greater than 1 MΩ, Current range: 50-100 Ω, varies with resettable fuse impedance  
**Input Overload:** Protected by automatically resettable fuse  
**Temperature Drift:**

|                | 0 to 65° C ambient     | -40 to 0° C ambient |
|----------------|------------------------|---------------------|
| <b>Current</b> | ±0.20% FS (50 PPM/°C)  | ±0.80% FS           |
| <b>Voltage</b> | ±0.02% FS (1.7 PPM/°C) | ±0.06% FS           |

**Transmitter Supply:** Isolated, one or two transmitter supplies  
P1: 24 VDC ±10% @ 200 mA max (-10 option)  
P1 & P2: 24 VDC ±10% @ 200 mA & 40 mA max (-20 option)

### Temperature Inputs

**Inputs:** Factory calibrated, field selectable: type J, K, T, or E thermocouples and 100 Ω platinum RTD (0.00385 or 0.00392 curve)  
**Resolution:** 1°; type TC & RTD: 1° or 0.1°  
**Cold Junction Reference:** Automatic  
**Temperature Drift:** ±2°C maximum  
**Offset Adjustment:** Programmable to ±19.9°. This parameter allows the user to apply an offset value to the temperature being displayed.  
**Input Impedance:** Greater than 100 kΩ  
**Sensor Break:** All relays and alarm status LEDs go to alarm state.

# PD765 Trident Series Process & Temperature Meters

| Type | Range                             | Acc. (0-65°C) | Acc. (-40-0°C) |
|------|-----------------------------------|---------------|----------------|
| J    | -58° to 1382°F<br>-50° to 750°C   | ±2°F<br>±1°C  | ±5°F<br>±3°C   |
| K    | -58° to 2300°F<br>-50° to 1260°C  | ±2°F<br>±1°C  | ±4°F<br>±2°C   |
| T    | -292° to 700°F<br>-180° to 371°C  | ±2°F<br>±1°C  | ±13°F<br>±7°C  |
| E    | -58° to 1700°F<br>-50° to 927°C   | ±2°F<br>±1°C  | ±11°F<br>±6°C  |
| RTD  | -328° to 1382°F<br>-200° to 750°C | ±1°F<br>±1°C  | ±5°F<br>±3°C   |

## Relays

**Rating:** 2 Form C (SPDT); rated 3 A @ 30 VDC or 3 A @ 250 VAC resistive load; 1/14 HP

(≈ 50 watts) @ 125/250 VAC for inductive loads such as contactors, solenoids, etc.

**Deadband:** 0-100% FS, user selectable

**High or Low Alarm:** User may program any alarm for high or low

**Relay Operation:**

1. Automatic (non-latching) 2. Latching 3. Pump alternation control

**Relay Reset:** User selectable via front panel buttons or PC

1. Automatic reset only (non-latching)

2. Automatic plus manual reset at any time (non-latching)

3. Manual reset only, at any time (latching)

4. Manual reset only after alarm condition has cleared (latching)

**Automatic Reset:** Relays reset when input passes the reset point

**Manual Reset:** Front panel button, MeterView, Modbus registers

**Time Delay:** 0 to 199 seconds, on and off delays; programmable

**Fail-Safe Operation:** Programmable, independent for each relay. Relay coils are energized in non-alarm condition. In case of power failure, relays will go to alarm state.

**Auto Initialization:** When power is applied to the meter, relays will reflect the state of the input to the meter.

## Isolated 4-20 mA Transmitter Output

**Scaling Range:** 1.00 to 23.00 mA; reverse scaling allowed.

**Calibration:** Factory calibrated 4.00 to 20.00 mA

**Accuracy:** ±0.1% FS ±0.004 mA

**Temperature Drift:** 50 PPM/°C

*Note: Analog output drift is separate from input drift*

**Isolation:** 500 V input-to-output or output-to-24 VDC supplies; 4 kV output-to-power line

**External Power:** 35 VDC maximum

**Output Loop Resistance:** Loop Resistance

| Power Supply      | Minimum | Maximum |
|-------------------|---------|---------|
| 24 VDC            | 10 Ω    | 700 Ω   |
| 35 VDC (external) | 100 Ω   | 1200 Ω  |

## Serial Communications

**Compatibility:** EIA-232, and EIA-485 with PDA7232 and PDA7422 Trident adapters.

**Protocol:** PDC and Modbus RTU

**Meter Address:** PDC protocol: 0 to 99, Modbus protocol: 1 to 247

**Baud Rate:** 300 to 19,200 bps

**Transmit Time Delay:** Programmable 0 to 199 ms

**Data:** 8 bit (1 start bit, 1 stop bit)

**Parity:** None (2 stop bits), even, or odd

(Modbus only; PDC protocol does not use parity)

Byte-to-Byte Timeout: 0.01 to 2.54 seconds (Modbus only)

**Turn Around Delay:** Less than 2 ms (fixed)

Refer to PDC and Modbus Serial Communications Protocol manuals for details.

## ORDERING INFORMATION

| Trident X2 PD765 • Large Display Models |                 |   |
|---|-----------------|---|
| 85-265 VAC Model                        | 12-36 VDC Model | Options Installed                         |
| PD765-6X0-00                            | PD765-7X0-00    | None                                      |
| PD765-6X0-10                            |                 | 24 VDC Supply                             |
| PD765-6X2-00                            | PD765-7X2-00    | 2 Relays                                  |
| PD765-6X2-10                            |                 | 2 Relays + 24 VDC Supply                  |
| PD765-6X3-00                            | PD765-7X3-00    | 4-20 mA Output                            |
| PD765-6X3-10                            |                 | 4-20 mA Out + 24 VDC Supply               |
| PD765-6X3-20                            |                 | 4-20 mA Out + Dual 24 VDC Supplies        |
|   | PD765-7X5-00    | 2 Relays + 4-20 mA Output                 |
| PD765-6X5-10                            |                 | 2 Relays + 4-20 mA Output + 24 VDC Supply |

| Trident PD765 • Standard Display Models |                 |   |
|---|-----------------|---|
| 85-265 VAC Model                        | 12-36 VDC Model | Options Installed                         |
| PD765-6R0-00                            | PD765-7R0-00    | None                                      |
| PD765-6R0-10                            |                 | 24 VDC Supply                             |
| PD765-6R2-00                            | PD765-7R2-00    | 2 Relays                                  |
| PD765-6R2-10                            |                 | 2 Relays + 24 VDC Supply                  |
| PD765-6R3-00                            | PD765-7R3-00    | 4-20 mA Output                            |
| PD765-6R3-10                            |                 | 4-20 mA Out + 24 VDC Supply               |
| PD765-6R3-20                            |                 | 4-20 mA Out + Dual 24 VDC Supplies        |
|   | PD765-7R5-00    | 2 Relays + 4-20 mA Output                 |
| PD765-6R5-10                            |                 | 2 Relays + 4-20 mA Output + 24 VDC Supply |

| Accessories |  |
|-------------|--|
| Model       | Description                                  |
| PDA7420     | Trident Meter Copy Cable, 7' (2.1 m)         |
| PDA7422     | Trident RS-485 Serial Adapter                |
| PDA7232     | Trident RS-232 Serial Adapter                |
| PDA7485-I   | RS-232 to RS-422/485 Isolated Converter      |
| PDA7485-N   | RS-232 to RS-422/485 Non-Isolated Converter  |
| PDA8006     | USB Serial Adapter                           |
| PDA8232-N   | USB to RS-232 Non-Isolated Converter         |
| PDA8485-I   | USB to RS-422/485 Isolated Converter         |
| PDA8485-N   | USB to RS-422/485 Non-Isolated Converter     |
| PDX6901     | Suppressor (snubber): 0.01 μF/470 Ω, 250 VAC |

## Your Local Distributor is:

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