

# MEASUREMENT AND VERIFICATION PLAN

FOR

## ARKER COMPANIES 231 STEUBEN STREET CHP SYSTEM

*March, 2015*

*Submitted to:*

**New York State Energy Research and Development Authority**  
17 Columbia Circle  
Albany, NY 12203-6399

*Submitted by:*

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**Project Team:**

**Applicant:**

Allan Arker  
The Arker Companies  
15 Verbena Avenue, Suite #100  
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**Facilities:**

Terrace Gardens #2  
231 Steuben Street  
Staten Island, NY 10304

**CHP Developer/Installer:**

Gregg Gimpaolo  
All Systems Cogeneration Inc.  
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**Monitoring Contractor:**

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## 1. Introduction

All Systems Cogeneration Inc. (ASC) is installing a cogen system at Terrace Gardens #2 at 231 Steuben Street, an affordable housing complex owned and operated by Arker Companies. The system is based around one (1) INV-100 100 kW InVerde 100 cogen unit provided by Tecogen. The InVerde unit includes a natural gas-fired reciprocating V8 engine, water cooled permanent magnet generator, jacket water and exhaust heat recovery systems, and self-contained inverter in a sound attenuating enclosure. The unit can provide 100 kW of continuous power, 125 kW of peak power, and 700 MBtu/h of thermal output as hot water.

The CHP system contains three (3) separate water loops; a low temperature loop for DHW heating, a high temperature loop for boiler heating, and an inverter cooling loop. The low temperature loop includes a HX for DHW loads and a dump radiator to remove excess heat. The high temperature loop feeds the boilers directly and is possible because the boilers at this facility are low pressure boilers (8-10 lbs steam). The generator cooling loop flows directly to a cooling radiator.

## 2. Monitoring System

A monitoring system is installed, to measure the performance of the CHP system. The system is based around an Obvius AcquiSuite data logger. ASC will provide the flow meters and has been subcontracted to install the metering and CDH Energy will provide the temperature sensors and install the monitoring system. The critical monitored points to quantify system performance are listed in Table 1.

**Table 1. Monitored Data Points**

| Logger Channel | Data Point | Description   | Eng Units | Instrument / Transducer          | Output     |
|----------------|------------|---|-----------|----------------------------------|------------|
| MB-001         | WT         | Gross Power Output                                  | kWh       | INVERDE Modbus Output            | Modbus RTU |
| MB-002         | WP         | Parasitic Loads                                     | kWh       | Continental Controls Wattnode    | Modbus RTU |
| -              | WG         | Net Power Output                                    | kWh       | -                                | Calculated |
| 1              | FG         | Cogen Gas Consumption                               | cf        | NGrid Utility Meter Pulse Output | Pulse      |
| 2              | FL         | Low Temp Loop - Flow                                | gpm       | Onicon F-1111                    | 4 - 20 ma  |
| 3              | TLS        | Low Temp Loop - Supply Temp                         | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| 4              | TLR1       | Low Temp Loop - DHW HX Return Temp (after DHW HX)   | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| 5              | TLR2       | Low Temp Loop - Dump HX Return Temp (after Dump HX) | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| 6              | FH         | High Temp Loop - Flow                               | gpm       | Nice Titan                       | 4 - 20 ma  |
| 7              | THS        | High Temp Loop - Supply Temp                        | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| 8              | THR        | High Temp Loop - Return Temp (After Boiler HX)      | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| -              | QU         | Total Useful Heat Recovery                          | MBtu      | -                                | Calculated |
| -              | QR         | Rejected Heat Recovery                              | MBtu      | -                                | Calculated |
| -              | QSH        | Boiler Heat Recovery                                | MBtu      | -                                | Calculated |
| -              | QDHW       | DHW Heat Recovery                                   | MBtu      | -                                | Calculated |

The total useful thermal output of the system (**QU**) will be calculated using the measured temperatures (across the useful HX's) and flows provided by the flow meters (**FL, TLS, TLR1, TLR2, FH, THS, THR**). Heat rejected by a dump radiator will also be calculated using the flow and temperatures measured across the dump radiator (**FL, TLR1, TLR2**).

The generator gross power output (**WT**) will be read directly from the cogen unit. The parasitic power (**WP**) will be measured with a WattNode power transducer. The parasitic loads typically include: cogen loop pumps, steam/boiler pump, and fans. The systems total parasitic loads will be subtracted from the gross power (**WT**) output to calculate the unit's net power (**WG**). Natural gas to the cogen unit (**FG**) will be measured on the pipe directly in line with the cogen unit.

### Sensor Details

- **Temperature.**
  - Veris Industries – 2 ½” Remote Probe 10K Type II Thermistor
- **Water Flow.**
  - Onicon – F-1111 Insertion Style Impeller Flow Meter
  - NICE – Titan Insertion Style Vortex Shedding Flow Meter
- **Gas Flow.**
  - National Grid Utility Pulse Meter
- **Power.**
  - Continental Controls Systems - WattNode

### Data Logging System

CDH Energy provides, installs, and wires an Obvius AcquiSuite data logger, power meter, and temperature sensors. ASC will provide and install an Onicon flow meter for the low temperature loop and a Nice Titan flow meter for the high temperature loop. The data logger will be provided a static IP address. The Obvius will upload data to CDH, who will serve it up to the NYSERDA Data Integrator web site

## 3. Data Analysis

### Heat Recovery Rates

The heat recovery rates will be calculated using the 1-minute average data from the logger.

#### Total useful heat recovery

$$QU_{avg} = k \cdot \frac{1}{N} \sum_{j=1}^N FH \cdot THS_j - THR_j + FL \cdot TLS_j - TLR1_j$$

#### Rejected heat recovery

$$QR_{avg} = k \cdot \frac{1}{N} \sum_{j=1}^N FL \cdot TLR1_j - TLR2_j$$

Depending on the site configuration additional heat recovery calculations may be made using additional temperature sensors on the main recovered heat loop and the measured flow.

Where  $N = 60$  when converting from 1-minute to hourly data.  $K$  is the product of density and specific heat. The loop fluid is a water glycol mixture.

$$30\% \text{ glycol: } k_{gly} = 480 \text{ Btu/h}\cdot\text{gpm}$$

### Other Calculated Quantities

Net generator output will be calculated by subtracting the parasitic loads from the gross generator output.

$$WG = WT - WP$$

The net total efficiency of the CHP system, based on the higher heating value of the fuel, will be defined as:

$$TE_{net} = \frac{QU \cdot \Delta t + 3.412 \cdot (WG)}{HHV_{gas} \cdot FG}$$

where:

|             |   |  |
|-------------|---|--|
| $QU_{avg}$  | - | Useful heat recovery (MBtu/h)  |
| $WG$        | - | Net Generator output (kWh)   |
| $FG$        | - | Generator gas consumption (Std CF)                                     |
| $\Delta t$  | - | 0.250 hour for 15-minute data  |
| $HHV_{gas}$ | - | Higher heating value for natural gas (1.032 MBtu per CF <sup>1</sup> ) |

The total efficiency (TE) can be calculated for any time interval. Other efficiency metrics are also of interest.

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<sup>1</sup> HHV from [www.eia.doe.gov](http://www.eia.doe.gov)

Table 2 below summarizes the other efficiency metrics that will be determined:

**Table 2. Summary of Efficiency Calculations**

|                            | <b>NET<br/>(using net power)</b>   | <b>GROSS<br/>(using generator output)</b>                                |
|----------------------------|--|--|
| Electrical Efficiency (EE) | $\frac{3.412 \cdot (WG)}{HHV_{gas} \cdot FG}$                            | $\frac{3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$                            |
| Thermal Efficiency (THE)   | $\frac{QU \cdot \Delta t}{HHV_{gas} \cdot FG}$                           |  |
| Total Efficiency (TE)      | $\frac{QU \cdot \Delta t + 3.412 \cdot (WG)}{HHV_{gas} \cdot FG}$        | $\frac{QU \cdot \Delta t + 3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$        |
| Unit Efficiency (UE)       | $\frac{(QU + QR) \cdot \Delta t + 3.412 \cdot (WG)}{HHV_{gas} \cdot FG}$ | $\frac{(QU + QR) \cdot \Delta t + 3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$ |

Notes: 1) All values must be over same time interval.

2) The difference between net and gross efficiency can also be related by a factor of:  $1 - f_{para}$

## **Appendix A**

### **Site Addendum**

## Addendum – 231 Steuben Street

Terrace Gardens #2  
231 Steuben Street  
Staten Island, NY 10069

### Site Contacts

Michael Grew  
Progressive Management  
917-282-8604  
[MGrew@progressivemgmt.net](mailto:MGrew@progressivemgmt.net)

Joe Gilligan  
All Systems Cogen  
631-891-8123

- CDH was on site November 3, 2014 for the initial site visit to scout out sensor locations and communications, leave enclosure and backplane for mounting by facility staff, and rough-in wiring where possible.
- CDH was on site December 4, 2014 and December 5, 2014 to install the data logger, install the parasitic power transducers, install flowmeters, terminate sensor wiring, configure and verify metering, set up communications, and begin data collection.
- CDH was in site December 19, 2014 to install the high temperature flowmeters, set up communications, and begin data collection.
- All Systems Cogen was on site on January 21, 2015 to terminate the wires for the gas pulse meter.

### Summary

CDH provided and installed the data logger, temperature sensors and parasitic power meter. All Systems Cogen provided the flowmeters and were installed by CDH Energy. CDH performed all of the necessary wire pulls and terminated wiring to the data logger and sensors.

### IP Info

|                |                 |
|----------------|-----------------|
| Datalogger IP: | 50.74.102.109   |
| Netmask:       | 255.255.255.248 |
| Gateway:       | 50.74.102.105   |
| Primary DNS:   | 24.29.99.35     |
| Secondary DNS: | 24.29.99.36     |



## Monitored Data Points

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| 7              | THS        | High Temp Loop - Supply Temp                        | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| 8              | THR        | High Temp Loop - Return Temp (After Boiler HX)      | °F        | Veris 10k Type 2 Thermistor      | Resistance |
| -              | QU         | Total Useful Heat Recovery                          | MBtu      | -                                | Calculated |
| -              | QR         | Rejected Heat Recovery                              | MBtu      | -                                | Calculated |
| -              | QSH        | Boiler Heat Recovery                                | MBtu      | -                                | Calculated |
| -              | QDHW       | DHW Heat Recovery                                   | MBtu      | -                                | Calculated |

## Procedure

- Temperature sensors were calibrated in-house, therefore field verification was not necessary.
- Hot water loop flows were verified by comparing the flow meter readings on the Obvius to measurements taken using a portable Portaflow ultrasonic flowmeter.
- The gas pulse meter has not been installed as of January 9, 2015. Once the pulse meter is installed by National Grid, CDH will return to terminate the wiring and verify the gas use by comparing the calculated electrical efficiency from the measured gas flow from the gas meter to the specifications for the Inverde INV-100.

## Verification Data – December 19, 2014

### Generator Power and Gas:

Generator power and gas was not verified for Terrace Gardens #2, because the cogen unit was not running during the verification site visit. The Terrace Gardens #2 cogen unit performance is assumed to be similar to Terrace Gardens #1.

### Parasitic Loads:

Parasitics are continuously measured with a WattNode power transducer. The loads measured include:

- DHW Pump
- Steam Pump
- Heat Dump Fan #1
- Heat Dump Fan #2

### Temperatures:

Field verification not performed, because sensors were lab calibrated.

**Flow:**

| FL   | Portaflow (gpm) | Onicon (gpm) |
|------|-----------------|--------------|
|      | 23.7            | 22.3         |
|      | 23.7            | 22.2         |
|      | 23.2            | 22.8         |
|      | 23.5            | 22.5         |
|      | 24.1            | 22.3         |
|      | 21.0            | 19.7         |
|      | 20.8            | 19.3         |
|      | 20.7            | 19.2         |
|      | 22.7            | 21.4         |
|      | 24.0            | 22.3         |
|      | 20.7            | 19.2         |
| Avg: | 22.6            | 21.2         |

|                   |               |
|-------------------|---------------|
| Pipe Material:    | Copper Type L |
| Nominal Size:     | 1.5"          |
| Outside Diameter: | 1.625"        |
| Wall Thickness:   | 0.0600"       |
| Sensor Spacing:   | 0.735"        |

**Geometric Correction for High Temperature Flow Meter**

The NICE flow meter for the high temperature water loop for the boiler feed water pre-heat was ordered for a 2 inch schedule 40 steel pipe and was installed in a 1.5 inch type L copper pipe. The geometric correction multiplier is shown below.

Pipe Dimensions

|                         | 1.5 in<br>Sched 40 | 2 in<br>Sched 40 | 1.5 in<br>Type L |
|-------------------------|--------------------|------------------|------------------|
| OD (in)                 | 1.9                | 2.375            | 1.625            |
| Wall Thickness (in)     | 0.145              | 0.154            | 0.06             |
| ID (in)                 | 1.61               | 2.067            | 1.505            |
| Area (in <sup>2</sup> ) | 2.0358             | 3.3556           | 1.7789           |
| Area (ft <sup>2</sup> ) | 0.0141             | 0.0233           | 0.0124           |

Ratio for 231 Steuben  
set for 2 inch sched 40  
have 1.5 inch type L  
**0.530**

Ratio for 195 Steuben  
set for 1.5 sched 40  
have 1.5 inch type L  
**0.874**

|             | NICE Face | NICE corrected | All-Systems Meter |
|-------------|-----------|----------------|-------------------|
| 195 Steuben | 23.0      | 20.1           | 21.0              |
| 231 Steuben | 33.0      | 17.5           | 19.0              |

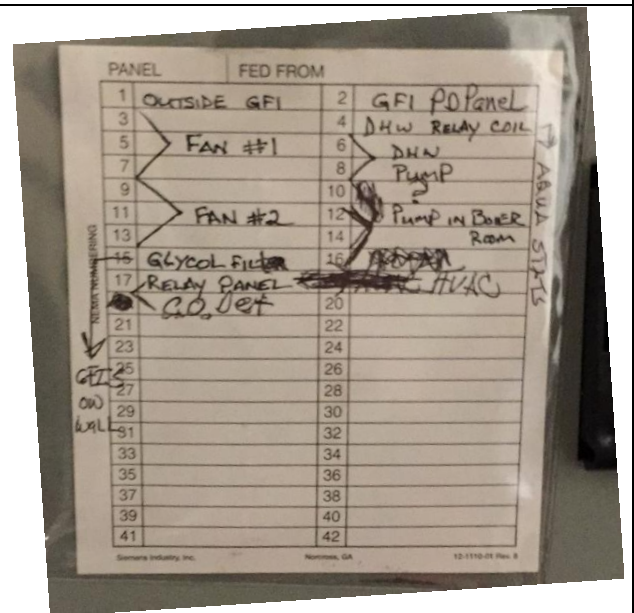
Site Photos



InVerde 100kW cogen unit at 195 Steuben Street



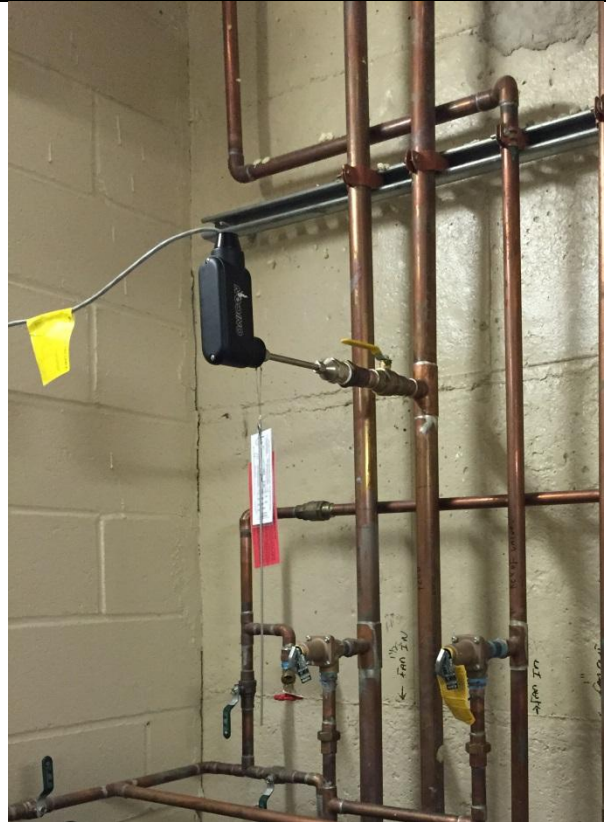
Nameplate for 231 Steuben Street



Electrical panel with parasitic loads (left).  
 Electrical panel door card (above)



Power transducer below electrical panel with parasitic loads



DHW loop flow meter

## **Appendix B**

### **Data Sheets**

## AcquiSuite

### Data Acquisition Server



#### ACQUISUITE A8812-1 AND A8812-GSM

Obvius' AcquiSuite is an intelligent, flexible data acquisition server allowing users to collect energy data from meters and environmental sensors. Designed to connect to IP-based applications such as enterprise energy management, demand response and smart grid programs, the AcquiSuite server lets you connect thousands of energy points, benchmark energy usage and reduce energy costs.

#### DATA COLLECTION

The AcquiSuite collects and logs data from connected (wired or wireless) devices based on user selected intervals. Data from downstream devices is time stamped and stored locally in non-volatile memory until the next scheduled upload or manual download. Using an integrated modem or Ethernet (LAN) connection you can push or pull data via HTTP, XML, FTP or any custom protocol utilizing our AcquiSuite Module to build your own application, including integrated cellular communication options.

#### INSTALLATION & FEATURES

No software is required. Easily access information through ANY web browser. The AcquiSuite has eight integrated flex I/O inputs. Each field selectable input can measure resistive, analog (4/20mA / 0-10V) and standard pulse / KYZ pulse output devices. This simplifies installation for basic projects monitoring electric, gas or water meters. There are several additional features including alarming, SNMP Traps, network configuration, wireless diagnostics, security provisions, alarm relays and backlit LCD. Our integrated meter driver library is designed to speed up installation and lower integration costs through "plug-and-play" connectivity.

#### COMPATIBILITY

The AcquiSuite is compatible with nearly any front-end software platform allowing customers to use a variety of reporting tools; whether it's a local server or an enterprise wide reporting suite. Obvius offers a free utility for automated .CSV file downloads or an affordable hosted solution for \$195.00 annually (unlimited data storage).

#### PARTNERS

Obvius' outstanding integration and software partners supplement our products and services to ensure you receive the very best energy monitoring solution.

#### APPLICATIONS

- Utility submetering (electricity, gas, water, etc.)
- Measurement and verification (M&V)
- Reduce energy costs
- Access energy information from local or remote sites
- Benchmark building energy usage
- View "real time" performance data
- Track energy use and peak demand for Demand Response programs
- Monitor performance of critical systems (lighting, HVAC, PDUs, inverters, etc.)
- Alarm notification for data points above or below target levels (including SNMP Traps)
- Monitor renewable energy performance and production
- Create load profiles for energy purchases
- Push or pull meter data to energy dashboards, kiosks and software applications
- LEED / Energy Star certification

#### ABOUT OBVIUS

Obvius manufactures data acquisition and wireless connectivity products specifically for energy management. We deliver cost-effective, reliable hardware designed to speed up installation. Our products are based on an open architecture allowing our customers to collect and log energy information from virtually any meter or sensor. The ability to support multiple communication options provides remote access to all your energy information. Founded in 2003, Obvius is located in Tualatin, Oregon. We serve a global clientele and continue to drive innovation by simplifying data collection.

#### SOLUTIONS

- Data Acquisition
- Wireless Communication
- Meters & Sensors
- Custom Packaged Solutions
- Integration & Software Partners

#### HEADQUARTERS

Tualatin, Oregon

#### CONTACT US

[sales@obvius.com](mailto:sales@obvius.com)

## AcquiSuite A8812

Obvius helps customers collect and distribute energy information. Users can begin with one best-of-breed product that satisfies a requirement, or incorporate several products and services for a complete energy management solution.

### Specifications

|                    |  |
|--------------------|--|
| Processor          | ARM9 embedded CPU, ARM7 IO co-processor                            |
| Operating System   | Linux 2.6  |
| Memory             | 32 MB RAM  |
| Flash ROM          | 16 MB NOR Flash (expandable with USB memory device)                |
| Interval Recording | 1 to 60 minutes, user selectable                                   |
| LEDs               | 8x input, 4 modem activity, Modbus TX/RX, power, system, IO status |
| Console            | 2 x 16 LCD character, two push buttons                             |

### Power

|               |   |
|---------------|---|
| North America | 110-120VAC, 60Hz, primary   |
| CE/Europe     | 100-240VAC, 50-60Hz, primary (interchangeable plug adapters optional) |
| Power Supply  | 24VDC, 1A, class 2 wall brick transformer included                    |

### Communication

|           |  |
|-----------|--|
| Protocols | Modbus/RTU, Modbus/TCP, TCP/IP, PPP, HTTP/HTML, FTP, NTP, XML, SNMP-Trap |
| LAN       | RJ45 10/100 Ethernet, full half duplex, auto polarity                    |
| Modem     | V.34 bis, 33,600 bps (A8812-1 only)                                      |
| Cellular  | GSM/GPRS Cellular (A8812-GSM only)                                       |
| USB       | USB expansion port   |

### Inputs

|             |  |
|-------------|--|
| Serial Port | RS-485 Modbus, supports up to 32 external devices (expandable)                               |
| I/O         | 8x Flex IO inputs with user selectable modes: voltage, current, resistance, pulse and status |

### Outputs

|        |                                    |
|--------|------------------------------------|
| Relays | 2x, dry contact 30 VDC, 150 mA max |
|--------|------------------------------------|

### Physical

|        |  |
|--------|--|
| Weight | 5lbs (2.3kg)                             |
| Size   | 8" x 9.25" x 2.5" (203mm x 235mm x 64mm) |

### Environment

|               |                                    |
|---------------|------------------------------------|
| North America | 0 to 50C, 0-90% RH, non-condensing |
| CE/Europe     | 5 to 40C, 0-90% RH, non-condensing |

### Codes and Standards

FCC CFR 47 Part 15, Class A, EN 61000, EN 61326, CE

### Additional Notes

NEMA enclosures available upon request

Manufactured in the USA



Obvius  
20497 SW Teton Avenue  
Tualatin, OR 97062

503 601 2099  
866 204 8134 (USA only)  
sales@obvius.com

# TITAN BTU Insertion Vortex

## Product Features

- Complete BTU, water, gas or steam measurement solutions.
- Standardize on an insertion bar that can measure line sizes 1.5" – 36"
- Heavy Duty & Maintenance Free Design
- All parts are welded stainless steel construction
- No moving parts, No holes to clog
- Life-time repeatability
- 1" NPT Connection
- Dual Piezo Sensors never contact fluid
- Dual Thermistor Sensors  $\pm .1$  Deg °C accuracy
- No pins or screws to corrode and rust
- Can handle process pressure over 500 psig
- Can handle process temperature up to 450 °F
- Simultaneous 4-20 mA, programmable Pulse output..

## Model TITAN BTU General Specification



The **TITAN** vortex sensing element is CNC machined out of one piece of solid stainless steel. The ceramic ISO Piezo electric sensors are bonded inside the vortex element which is press fit to the stainless steel insertion bar and completely welded together. There are NO internal o-rings or seals of any kind and absolutely NO leak paths into the sensors or electronics. Our sensors NEVER touch the process fluid giving them an almost unlimited life span. Our elements are ONE-PIECE technology and geometry will NEVER change.

With over 100 years of combined CNC machining experience our solid stainless steel **TITAN** vortex element has no pins, screws or gaskets of any kind. The bluff body and tail piece are CNC machined from the body of the element. Since there are no holes to clog and no moving parts, there are no mechanical limitations due to frequency or velocities. Our machined elements will never wear or move out of place, giving the same steady frequency from the first day to year thirty.

Each **TITAN** comes with its own seal assembly that rides along the shaft of the insertion bar. This stainless steel seal assembly has a 1" NPT connection for easy connect and disconnect with any valve, thread-o-let or any ANSI class flange. The **TITAN** can be installed or removed during flow with a 1" fully ported ball valve during higher pressure applications.

The unique design of the **TITAN** can be used in BTU measurement calculations for LIQUID lines. The same **TITAN** design can measure water as low as slow as 1feet per second to excess of 30 feet per second.

The **TITAN** has no moving or wearing parts making certain that the K Factor, pulses per foot – per second, will not change over time and long term accuracy is always constant. This allows all of our insertion instruments to achieve an accuracy of  $\pm 1\%$  of reading with  $\pm .25\%$  repeatability.

The **TITAN** has dual Thermistors for temperature measurement with accuracies of  $\pm .1$  °C. All Thermistors are epoxy coated, precision matched to 5 standardized resistance curves. Maximum working temperature is 150°C.

Where Flow Measurement Meets Innovation...

tel: 732.952.5324  
fax: 732.727.8911  
[sales@niceinstrumentation.com](mailto:sales@niceinstrumentation.com)  
[www.niceinstrumentation.com](http://www.niceinstrumentation.com)

**NICE**  
Instrumentation, Inc.



## Application Guide

| Model | Liquid | Gas | Steam | Hot Tap | Temperature Range |             | Maximum Pressure |     | Line Sizes |           |
|-------|--------|-----|-------|---------|-------------------|-------------|------------------|-----|------------|-----------|
|       |        |     |       |         | °F                | °C          | PSI              | Bar | in         | mm        |
| TITAN | Yes    | Yes | Yes   | Yes     | -250 to 450       | -250 to 218 | 500              | 34  | 1.5 to 36  | 36 to 900 |

NOTE: The same meter can be used in Steam, Gas and Liquids. The insertion bar and sensors are universal among all process fluid types.

## Performance Specifications

### Accuracy (linear ranges)

#### Liquid.....± 1.0% of flow rate

Test conditions: Water at 65 °F (18.3 °C), 50 psig (3.4 bar)  
with 10 pipe diameters upstream and 5 pipe diameters downstream

#### Gas.....± 1.0% of flow rate

Test conditions: Air at 65 °F (18.3 °C), 25 psig (1.7 bar)  
with 10 pipe diameters upstream and 5 pipe diameters downstream

#### Repeatability.....± .25% of flow rate

#### BTU/Flow Rate

Adjustable from:  
1 second  
1 minute  
1 hour  
1 day

#### Response Time

1 – 1000 seconds

#### Analog Output

Calibrated to .001mA of reading

## Operating Specifications

### Linear Range

Reynolds number from 10,000 to 7,000,000  
*Measurement Range may vary depending on density*

### Measurable Flow Velocities

| Liquid Flow       | English  | Metric  |
|-------------------|--|---|
| V <sub>min.</sub> | .985 ft/s                                      | .300 m/s                                      |
| V <sub>max.</sub> | 32 ft/s  | 9 m/s   |
| Gas Flow          | English  | Metric  |
| V <sub>min.</sub> | $\sqrt[3]{\left(\frac{140}{\rho}\right)}$ ft/s | $\sqrt[3]{\left(\frac{143}{\rho}\right)}$ m/s |
| V <sub>max.</sub> | 300 ft/s                                       | 91 m/s  |
| Where:            | $\rho$ = density (lb/ft <sup>3</sup> )         | $\rho$ = density (kg/m <sup>3</sup> )         |

Where Flow Measurement Meets Innovation...

tel: 732.952.5324  
fax: 732.727.8911  
[sales@niceinstrumentation.com](mailto:sales@niceinstrumentation.com)  
[www.niceinstrumentation.com](http://www.niceinstrumentation.com)



## Operating Specifications & Functions

### Ambient Temperature Limit

32 to 145 °F (0 to 61 °C)

### Ambient Humidity Limit

5 to 100% relative humidity non-condensing

### Power Requirements

#### Standard

Isolated 14 – 36 VDC

#### Optional

110 / 220 VAC

*Note: All power supplies come standard with NEMA 4X explosion proof enclosures and watertight multipole power connectors.*

### Output Signals

#### Analog

4 – 20 mA, 2 – wire system, auto digitally adjusted span, Pulse, Fractional Pulse, MODBUS.

#### Display

6 Digits of Rate w/ Floating Decimal  
Available in all Engineering Units

8 Digits of Total  
Available in all Engineering Units

#### Serial Port

For Reading and Loading Operating Parameters

### Microtel Smart TX (Local & Remote)

#### Operator Interface

Continuously displays both BTU rate and total including all engineering units

2 lines, 16 characters each line, alphanumeric, reflective L.C.D. display

Field calibration with local keypad

Electronics are universal among all Nice vortex meter types

#### Diagnostics & Setup

Serial communication for computer Interface

Alphanumeric error messages displayed  
For turbulent or erratic flow, flow above or below the calibrated range, and high flow or low flow cut off points



## Physical Specifications

### Materials

#### Wetted Parts of Meter

304L or 316L C&C Machined  
Stainless Steel.

#### External Parts

304L or 316L C&C Machined  
Stainless Steel.

#### Electrical Enclosure Specifications

Aluminum double sided  
standard enclosure

(OPTIONAL)

NEMA 4X explosion, dust,  
and water proof requirements.

FM Approved  
UL Classified  
CSA Approved  
ATEX for use in;

Class I, Groups B,C & D,  
Class II, Groups E,F & G and  
Class III hazardous locations as  
defined by the National Electrical Codes  
and Canadian Electrical Code.

#### Process Connection

TITAN ...1" NPT or Flange ANSI

#### Seal Assembly

Screws down into a 1" NPT connection.  
Slides along shaft of insertion bar for a  
leak free installation.

Seal assembly allows the insertion bar to  
slide into the process. An arrow is CNC  
machined into the top of the insertion bar  
which must point down stream allowing for  
precise vortex shedding and signal  
generation.

Comes standard in 304L Stainless Steel.

#### Remote Mountable Electronics (Standard)

Available up to 300 ft (90.144m) from meter.  
Uses genuine TURCK plugs and cord sets.



Includes 383 Aluminum Enclosure

(OPTIONAL)

Approved for NEMA 4X watertight and  
explosion proof requirements.

## Measurable Flow Rates

| Water Minimum and Maximum Flow Rates <sup>1</sup> |            |             |              |              |               |               |                 |                 |                 |
|---|------------|-------------|--------------|--------------|---------------|---------------|-----------------|-----------------|-----------------|
| in.<br>(mm)                                       | 2<br>(50)  | 3<br>(80)   | 4<br>(100)   | 6<br>(150)   | 8<br>(200)    | 12<br>(300)   | 16<br>(400)     | 24<br>(600)     | 36<br>(900)     |
| gpm   | 9.1<br>315 | 22.4<br>700 | 35.7<br>1210 | 80.5<br>2750 | 143.5<br>4700 | 322<br>11,166 | 507.5<br>16,625 | 1,155<br>38,500 | 2,618<br>88,046 |
| m <sup>3</sup> /h                                 | 3<br>70    | 4.5<br>160  | 10<br>270    | 19<br>625    | 39<br>1,065   | 98<br>2,380   | 150<br>3,775    | 355<br>8,570    | 855<br>20,052   |

1. Standard conditions of 68 °F (20 °C) in schedule 40 pipe

Where Flow Measurement Meets Innovation...

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fax: 732.727.8911  
[sales@niceinstrumentation.com](mailto:sales@niceinstrumentation.com)  
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## Straight Run Piping Requirements

| Straight Run Piping Requirements                 | Upstream | Downstream |
|--|----------|------------|
| One 90° elbow before the meter                   | 10 D     | 5 D        |
| Two 90° elbows before the meter                  | 15 D     | 5 D        |
| Two 90° elbows out of plane before the meter     | 30 D     | 5 D        |
| Reduction before meter                           | 10 D     | 5 D        |
| Regulator or Valve partially closed before meter | 30 D     | 5 D        |
| Tee Connection before meter                      | 30 D     | 5 D        |

*D is equal to the internal diameter of the pipe.*

## Other Installation Considerations

### Mounting Position

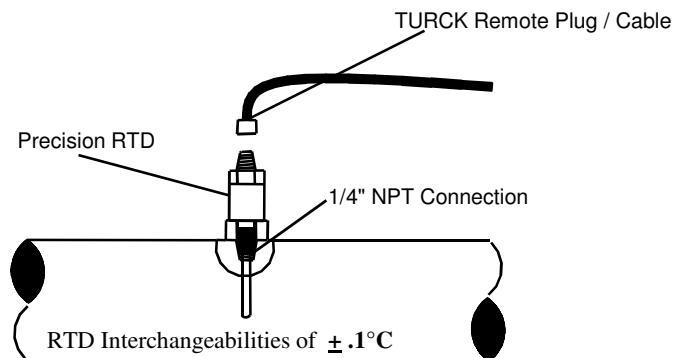
The TITAN can be installed in almost any orientation around the pipe. Vertically, horizontally or angled pipe sections are a good spot to install the TITAN. The mounting assembly will insure that the meter is attached perpendicular to the axis of the pipe. The TITAN should not be installed “upside-down”. For liquid applications, the fluid must completely fill the pipe

### Site Selection

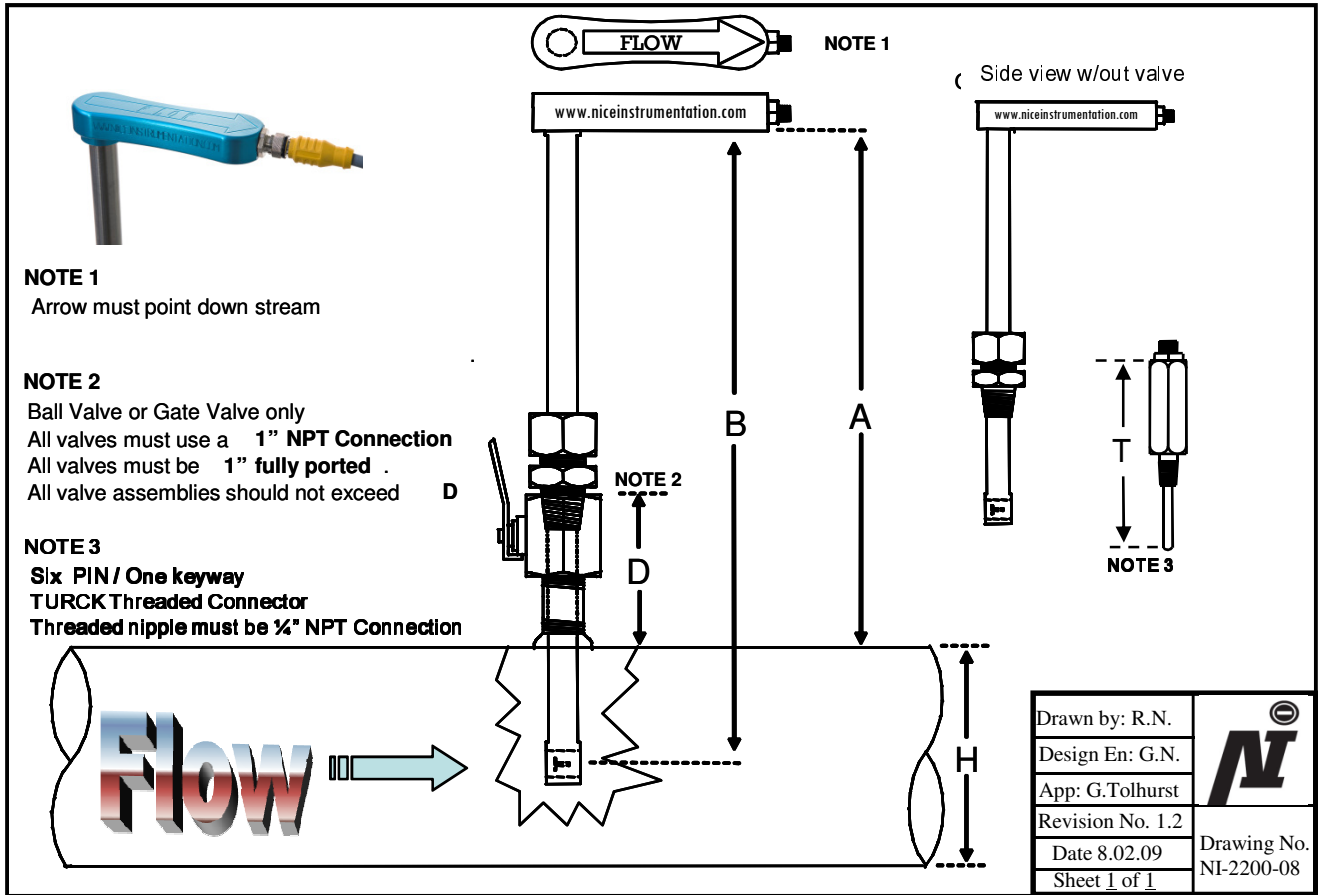
The flow measurement location should be selected to minimize turbulence and swirl. The more laminar the flow profile the better the site location. The extent of the flow turbulence depends on what type of piping is upstream and downstream from the meter. (Please see straight run piping requirements above) Valves, elbows, regulators, pumps, tee connections, and other piping components may add disturbances to the flow.

### RTD Probe

The RTD probe can be inserted in any line size through a 1/4” NPT connection. Assembly off pipe cannot be any higher than 1” to ensure proper insertion depth.



# Dimensions and Weights



## Dimension Tables

| Model | Connection | H   |     | A     |       | B   |     | (should not exceed) D |     | T   |     |
|-------|------------|-----|-----|-------|-------|-----|-----|-----------------------|-----|-----|-----|
|       |            | in. | mm  | in.   | mm    | in. | mm  | in.                   | mm  | in. | mm  |
| TITAN | 1" NPT     | 1.5 | 36  | 11.25 | 281.3 | 12  | 300 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 2   | 50  | 11    | 275   | 12  | 300 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 4   | 100 | 10    | 250   | 12  | 300 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 6   | 150 | 9     | 225   | 12  | 300 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 8   | 200 | 14    | 350   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 10  | 250 | 13    | 325   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 12  | 300 | 12    | 300   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 14  | 350 | 11    | 275   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 16  | 400 | 10    | 250   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 18  | 450 | 9     | 225   | 18  | 450 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 20  | 500 | 14    | 350   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 22  | 550 | 13    | 325   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 24  | 600 | 12    | 300   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 26  | 650 | 11    | 275   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 28  | 700 | 10    | 250   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 30  | 750 | 9     | 225   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 32  | 800 | 8     | 200   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 34  | 850 | 7     | 175   | 24  | 600 | 6                     | 150 | 4.6 | 115 |
| TITAN | 1" NPT     | 36  | 900 | 6     | 150   | 24  | 600 | 6                     | 150 | 4.6 | 115 |

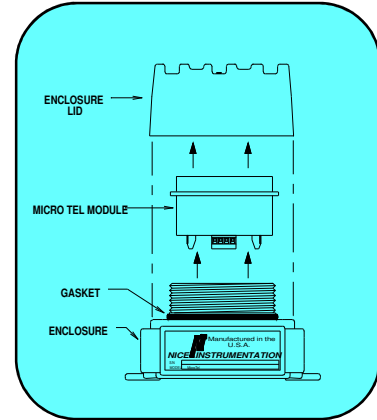
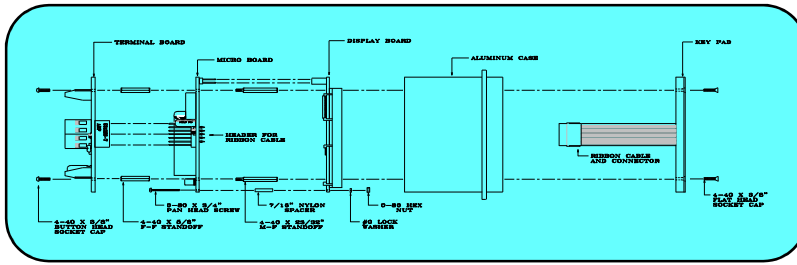
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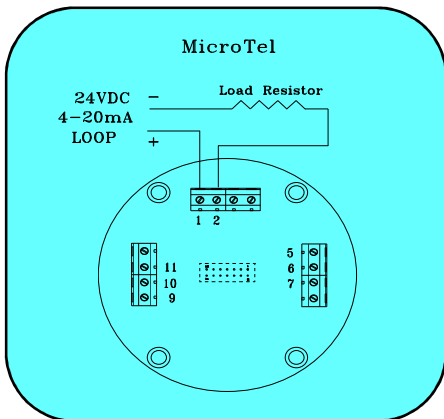
# Dimensions and Weights

## Microtel Assembly

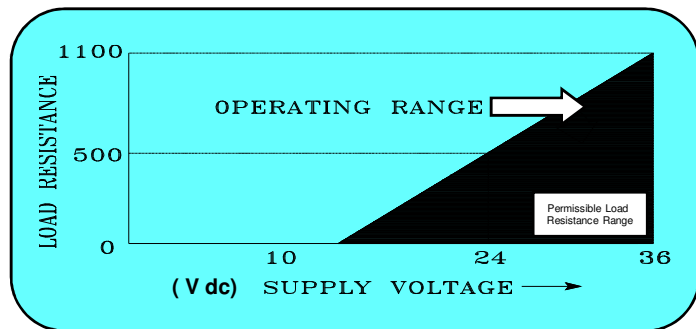


# Internal Wiring Diagrams

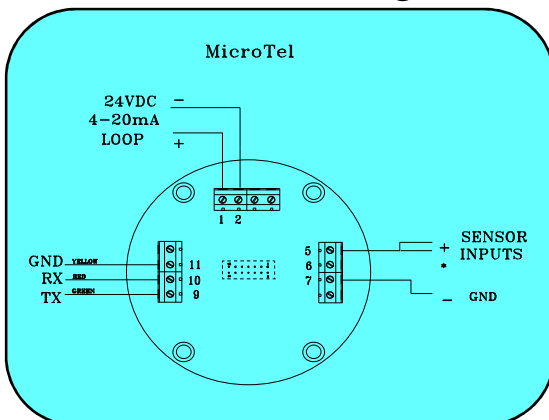
## Microtel Load Resistance



With Microtel powered on



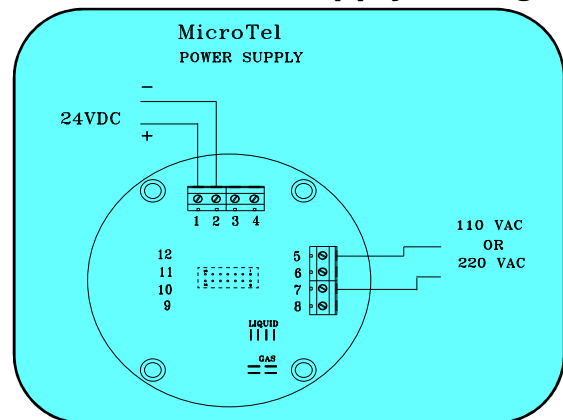
## Microtel Internal Wiring



### VDC Power: Analog Output

Scalable 4-20mA output, complete 2 wire device. Load resistor may be installed on supply or return line.  $V_s = 14-36$  VDC. See graph above.

## Microtel Power Supply Wiring



### VAC Power: Analog Output

Scalable 4-20mA output, complete 2 wire device. Load resistor may be installed on supply or return line.

# Ordering Information and Suffix Codes

## Model # TITAN-XX-X(XX)-XX-XX

| Category                     | Description   | Suffix Codes |             |             |              |              |
|------------------------------|---|--------------|-------------|-------------|--------------|--------------|
| TITAN IV<br>TITAN IV/BTU     | Insertion Vortex Flow Meter<br>Insertion Vortex Flow Meter with BTU calculation.  | TITAN        | —           | —           | —            | —            |
| Line Sizes                   | Standard line sizes 1.5" to 36"   | —<br>—       | 1.5<br>36   | —<br>—      | —<br>—       | —<br>—       |
| Microtel Transmitter Display | Volumetric Flow Only<br>Total BTU calculations<br>(1 external Temperature sensor) | —<br>—       | —<br>—      | V<br>BTU    | —<br>—       | —<br>—       |
| Power Supply                 | Standard 24 V dc input  | —<br>—<br>—  | —<br>—<br>— | —<br>—<br>— | 24<br>—<br>— | —<br>—<br>—  |
| -250 to 450 °F<br>-          | Standard Temperature -250 to 450 °F   | —<br>—       | —<br>—      | —<br>—      | —<br>—       | LT<br>—<br>— |

### Notes:

- Your registered representative will use Nice Instrumentation Vortex Sizing Application to determine precise scaling factor for your application.
- The Standard remote option comes with 10 feet from meter.
- Unit has 4-20mA output
- OPTIONAL Enclosure for remote display is NEMA 4X watertight and explosion proof requirements.

FM Approved  
UL Classified  
CSA Approved  
ATEX for use in;  
Class I, Groups B,C & D,  
Class II, Groups E,F & G and  
Class III hazardous locations as defined by the National Electrical Codes and Canadian Electrical Code.

### Nice Vortex Sizing Program for precise application sizing

Please specify the following information with your order:

- Fluid Type
- Min – Max operating flow rate
- Operating Temperature
- Operating Pressure

## Other Products from...



**Remote Vortex Plate**



Nice Instrumentation, Inc.  
999 Route 9  
Parlin, NJ 08859

Phone: 1-732-952-5324  
Fax: 1-732-727-8911

[sales@niceinstrumentation.com](mailto:sales@niceinstrumentation.com)  
[www.niceinstrumentation.com](http://www.niceinstrumentation.com)

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### Vortex Plate

- World's only 3/4" thin vortex plate
- Solid stainless steel construction



### Flanged Vortex Plate

- Measures two times lower than any other vortex flow meter.



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





THE WATTNODE MODBUS is a multi-function networked energy meter. The WattNode MODBUS offers true RMS power, energy and demand metering, plus individual phase measurements of voltage, current, power factor, reactive power and energy, and line frequency. Typical applications include energy monitoring, sub-metering, demand management, power factor control and phase-load monitoring.

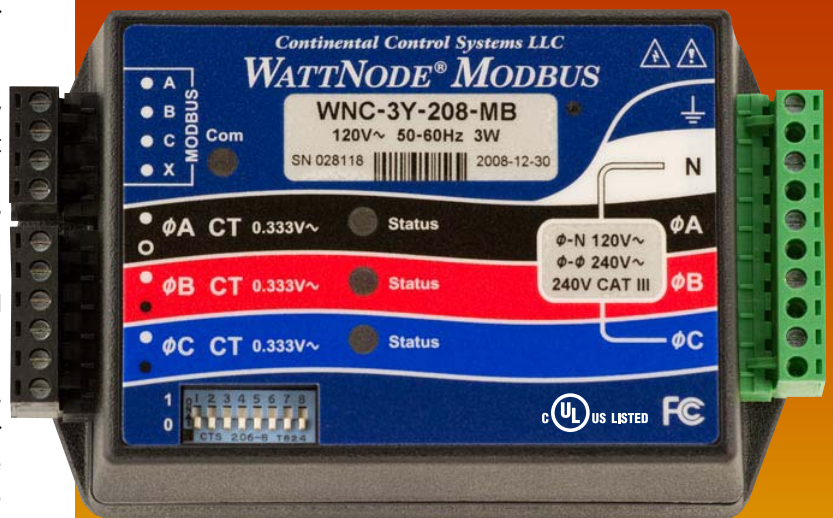
NETWORKING the WattNode MODBUS is easy. The WATTNODE communicates over a half-duplex EIA RS-485 interface. Standard baud rates are 9,600 and 19,200 baud. The WattNode uses the industry standard MODBUS RTU (binary) communication protocol, allowing up to 127 WattNodes per RS-485 subnet.

EASE OF USE and economy of installation were key design criteria. The WattNode MODBUS' compact size permits installation inside of most electrical service panels and junction boxes. Diagnostic LEDs help insure fast, easy, and correct installation. Detachable screw terminals make wiring a snap. The WattNode MODBUS is line-powered and requires no separate power source.

ACCURACY of the WattNode MODBUS is 0.5% nominal (see manual for details). Even with leading or lagging power factor and chopped or distorted wave forms, the WattNode MODBUS measures true RMS power. This makes it ideal for monitoring motors and pumps controlled by variable speed drives or loads with switching power supplies.

THE COMPLETE LINE of WattNode MODBUS models measures 1, 2, or 3 phases in 2, 3, or 4 wire configurations with nominal voltages from 120 to 600 VAC at 50/60 Hz. Operation from 5 to 5000 Amps is possible by selecting from our line of safe, low-voltage output, current transformers.

**kWh** **kVAR** **VOLTS**  
**DEMAND** **PEAK DEMAND** **kW**



**FREQUENCY** **PF** **AMPS**



**Continental Control Systems LLC**  
 3131 Indian Road, Suite A  
 Boulder, CO 80301 USA  
 (303) 444-7422 Fax (303) 444-2903  
 sales@ccontrolsys.com  
 www.ccontrolsys.com

**Toll-Free**  
**(888) 928-8663**

- **Multiple Measurements**  
kW, kWh, Demand, kVAR, kVARh, PF, Amps, Volts, Frequency
- **MODBUS Network Ready**  
Communicates over a half-duplex EIA RS-485 interface
- **Compact Size**  
Fits inside of standard electrical panels and junction boxes
- **Auto-Correcting Polarity**  
Auto-detects RS-485 A/B polarity on properly biased networks, simplifying installation.
- **Measures 1φ, 2φ, 3φ Circuits**  
Flexible, field configurable
- **Line Powered**  
No external power supply required
- **Two Baud Rates**  
9,600 and 19,200 baud
- **Full RS-485 Subnet**  
127 WattNode's per RS-485 subnet.

# Specifications

# WATTNODE<sup>®</sup> MODBUS

## AC Power Measurement for MODBUS

### Quantities Measured

- True RMS Power - Watts (Phase A, B, C, Sum)
- Reactive Power - VARs (Phase A, B, C, Sum)
- Power Factor (Phase A, B, C, Average)
- True RMS Energy - Watthours (Phase A, B, C, Sum)
- Reactive Energy - VAR-hours (Sum)
- AC Frequency
- RMS Voltage (Phase A, Phase B, Phase C)
- RMS Current (Phase A, Phase B, Phase C)
- Demand and Peak Demand

### Measurement Configuration

- Three phase: 3-wire or 4-wire
- Single phase: 2-wire or 3-wire

### User Controlled Inputs

- Set CT size in amps
- Set demand window type and period
- Reset peak demand to zero

### Accuracy

0.5% nominal (see manual for details).

### Electrical

Operating Voltage Range: 80% - 115% of nominal  
Power Line Frequency Range: 50 to 60 Hz

### Environmental

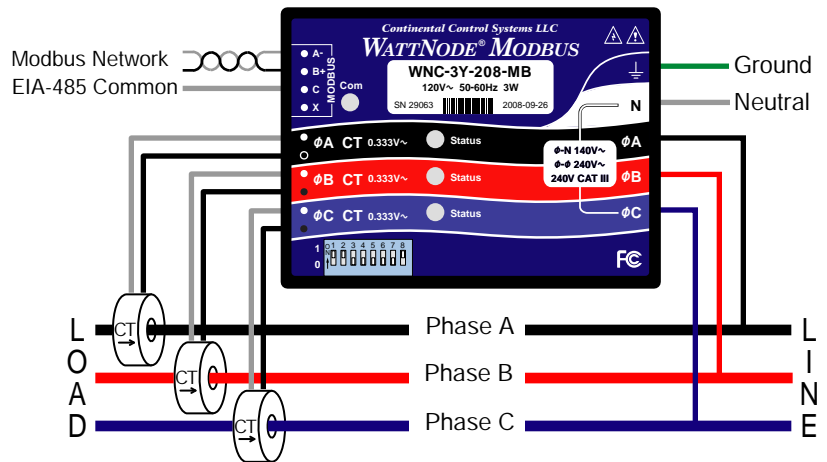
-30°C to +55°C (-22°F to 131°F)  
Humidity: 5 to 90% RH (noncondensing)

### Mechanical

Enclosure: High impact, ABS plastic  
Flame Resistance Rating: 94V-0, IEC FV-0  
Size: 5.63" x 3.34" x 1.5" (143mm x 85mm x 38mm)  
Weight: 10.8 oz (305 gm)  
Connectors: Euroblock style pluggable terminal blocks

### MODBUS Communication

EIA RS-485 Interface  
Baud Rates: 9,600 and 19,200  
Duplex: Half (two-wire plus common)  
Parity: N81 (no parity, eight data bits, one stop bit)  
MODBUS Buffer: 256 bytes  
Response Time: 5 - 300 milliseconds



### MODELS

| Model         | VAC             | VAC          | Phases | Wires |
|---------------|-----------------|--------------|--------|-------|
|               | Line To Neutral | Line To Line |        |       |
| WNC-3Y-208-MB | 120             | 208-240      | 3*     | 4     |
| WNC-3Y-400-MB | 230             | 400          | 3*     | 4     |
| WNC-3Y-480-MB | 277             | 480          | 3*     | 4     |
| WNC-3Y-600-MB | 347             | 600          | 3*     | 4     |
| WNC-3D-240-MB | N/A             | 208-240      | 3      | 3     |
| WNC-3D-400-MB | N/A             | 400          | 3      | 3     |
| WNC-3D-480-MB | N/A             | 480          | 3      | 3     |

\*Can be used to measure 1, 2 or 3 phase circuits.

### OPENING CURRENT TRANSFORMERS (SPLIT CORE)

| Model    | Inside Diameter | Rated Amps                            |
|----------|-----------------|---------------------------------------|
| CTS-0750 | 0.75"           | 5, 15, 30, 50, 70, 100, 150, 200      |
| CTS-1250 | 1.25"           | 70, 100, 150, 200, 250, 300, 400, 600 |
| CTS-2000 | 2.00"           | 600, 800, 1000, 1200, 1500            |
| CTB      | Bus Bar         | 600, 800, 1200, 2000, 3000 (custom)   |

### TOROIDAL CURRENT TRANSFORMERS (SOLID CORE)

| Model    | Inside Diameter | Rated Amps                       |
|----------|-----------------|----------------------------------|
| CTT-0300 | 0.30"           | 5, 15, 20, 30                    |
| CTT-0500 | 0.50"           | 15, 20, 30, 50, 60               |
| CTT-0750 | 0.75"           | 30, 50, 70, 100                  |
| CTT-1000 | 1.00"           | 50, 70, 100, 150, 200            |
| CTT-1250 | 1.25"           | 70, 100, 150, 200, 250, 300, 400 |

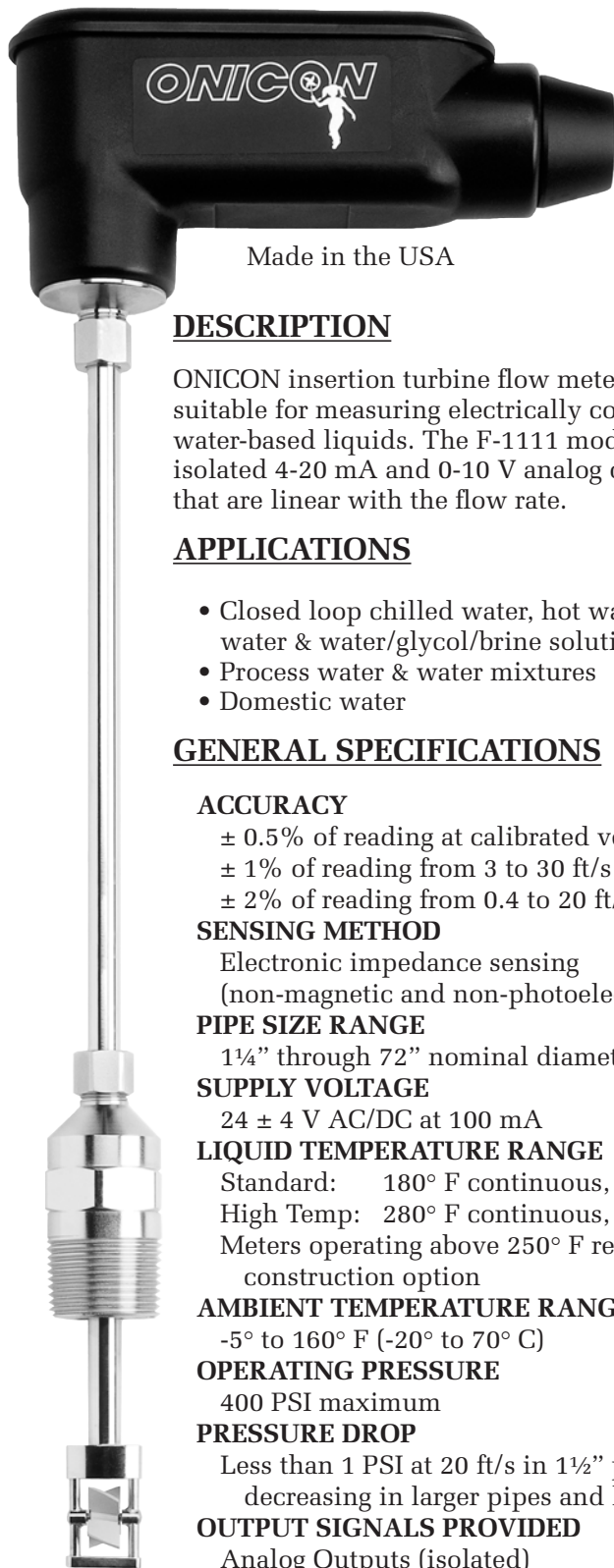
Current Transformer Output Voltage: 0 - 0.333 VAC @ rated current

**MADE IN THE USA**

**(888) 928-8663**



Continental Control Systems  
3131 Indian Road, Suite A  
Boulder, CO 80301  
(303) 444-7422 Fax (303) 444-2903  
sales@ccontrolsys.com  
www.ccontrolsys.com



• **F-1111 SINGLE TURBINE •**  
**INSERTION FLOW METER**  
**ISOLATED ANALOG OUTPUT**



Made in the USA

**DESCRIPTION**

ONICON insertion turbine flow meters are suitable for measuring electrically conductive water-based liquids. The F-1111 model provides isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

**APPLICATIONS**

- Closed loop chilled water, hot water, condenser water & water/glycol/brine solutions for HVAC
- Process water & water mixtures
- Domestic water

**GENERAL SPECIFICATIONS**

**ACCURACY**

- ± 0.5% of reading at calibrated velocity
- ± 1% of reading from 3 to 30 ft/s (10:1 range)
- ± 2% of reading from 0.4 to 20 ft/s (50:1 range)

**SENSING METHOD**

Electronic impedance sensing  
 (non-magnetic and non-photoelectric)

**PIPE SIZE RANGE**

1¼" through 72" nominal diameter

**SUPPLY VOLTAGE**

24 ± 4 V AC/DC at 100 mA

**LIQUID TEMPERATURE RANGE**

Standard: 180° F continuous, 200° F peak  
 High Temp: 280° F continuous, 300° F peak  
 Meters operating above 250° F require 316 SS construction option

**AMBIENT TEMPERATURE RANGE**

-5° to 160° F (-20° to 70° C)

**OPERATING PRESSURE**

400 PSI maximum

**PRESSURE DROP**

Less than 1 PSI at 20 ft/s in 1½" pipe,  
 decreasing in larger pipes and lower velocities

**OUTPUT SIGNALS PROVIDED**

Analog Outputs (isolated)  
 Voltage output: 0-10 V (0-5 V available)  
 Current output: 4-20 mA  
 Frequency Output  
 0 – 15 V peak pulse, typically less than 300 Hz

(continued on back)

**CALIBRATION**

Every ONICON flow meter is wet calibrated in our flow laboratory against primary volumetric standards that are directly traceable to N.I.S.T. A certificate of calibration accompanies every meter.

**FEATURES**

**Unmatched Price vs. Performance** - Custom calibrated, highly accurate instrumentation at very competitive prices.

**Excellent Long-term Reliability** - Patented electronic sensing is resistant to scale and particulate matter. Low mass turbines with engineered jewel bearing systems provide a mechanical system that virtually does not wear.

**Industry Leading Two-year "No-fault" Warranty** - Reduces start-up costs with extended coverage to include accidental installation damage (miswiring, etc.) Certain exclusions apply. See our complete warranty statement for details.

**Simplified Hot Tap Insertion Design** - Standard on every insertion flow meter. Allows for insertion and removal by hand without system shutdown.

**OPERATING RANGE FOR  
 COMMON PIPE SIZES  
 0.17 TO 20 ft/s**

±2% accuracy begins at 0.4 ft/s

| Pipe Size (Inches) | Flow Rate (GPM) |
|--------------------|-----------------|
| 1 ¼                | 0.8 - 95        |
| 1 ½                | 1 - 130         |
| 2                  | 2 - 210         |
| 2½                 | 2.5 - 230       |
| 3                  | 4 - 460         |
| 4                  | 8 - 800         |
| 6                  | 15 - 1,800      |
| 8                  | 26 - 3,100      |
| 10                 | 42 - 4,900      |
| 12                 | 60 - 7,050      |
| 14                 | 72 - 8,600      |
| 16                 | 98 - 11,400     |
| 18                 | 120 - 14,600    |
| 20                 | 150 - 18,100    |
| 24                 | 230 - 26,500    |
| 30                 | 360 - 41,900    |
| 36                 | 510 - 60,900    |

## F-1111 SPECIFICATIONS (cont.)

### MATERIAL

Wetted metal components:

Standard: Electroless nickel plated brass

Optional: 316 stainless steel

### ELECTRONICS ENCLOSURE

Standard: Weathertight aluminum enclosure

Optional: Submersible enclosure

### ELECTRICAL CONNECTIONS

4-wire minimum for 4-20 mA or 0-10 V output

Second analog output and/or frequency output requires additional wires

Standard: 10' of cable with 1/2" NPT conduit connection

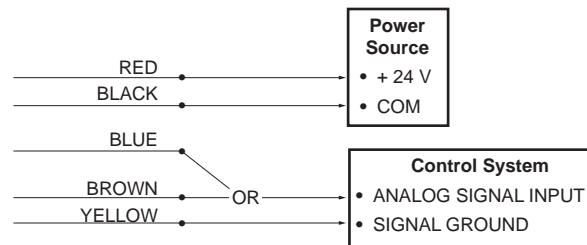
Optional: Indoor DIN connector with 10' of plenum rated cable

## F-1111 WIRING INFORMATION

| WIRE COLOR | DESCRIPTION                                    | NOTES   |
|------------|--|---|
| RED        | (+) 24 V AC/DC supply voltage, 100 mA          | Connect to power supply positive  |
| BLACK      | (-) Common ground (Common with pipe ground)    | Connect to power supply negative  |
| GREEN      | (+) Frequency output signal: 0-15 V peak pulse | Required when meter is connected to local display or Btu meter                    |
| BLUE       | (+) Analog signal: 4-20 mA (isolated)          | Use yellow wire as (-) for these signals. Both signals may be used independently. |
| BROWN      | (+) Analog signal: 0-10 V (isolated)           |   |
| YELLOW     | (-) Isolated ground                            | Use for analog signals only   |

## F-1111 WIRING DIAGRAM

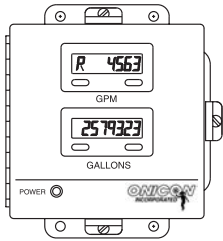
Flow meter into control system (no display or Btu meter)



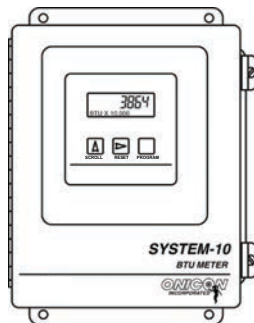
### NOTE:

1. Black wire is common with the pipe ground (typically earth ground).
2. Frequency output required for ONICON display module or Btu meter, refer to wiring diagram for peripheral device.

## ALSO AVAILABLE



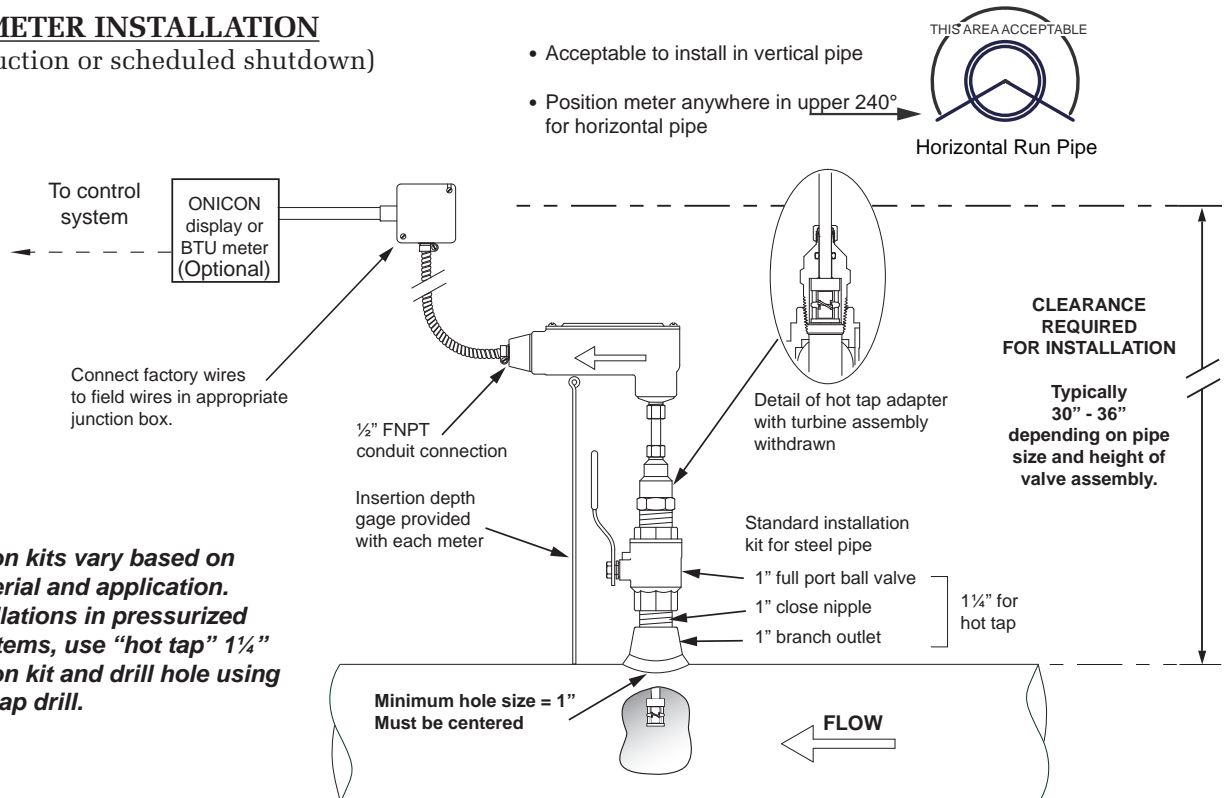
Display Modules



Btu Measurement Systems

## TYPICAL METER INSTALLATION

(New construction or scheduled shutdown)



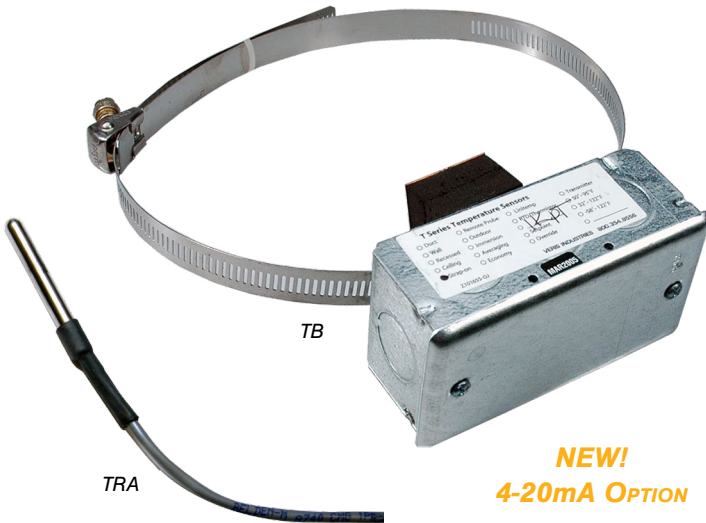
### NOTE:

Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use "hot tap" 1 1/4" installation kit and drill hole using a 1" wet tap drill.

# Specialty Temperature Sensors



## TB & TRA Series



### SPECIFICATIONS

|                                       |  |
|---------------------------------------|--|
| <b>Wiring</b>                         | 22 AWG; 2-wire: RTD/Thermistor   |
| <b>TEMPERATURE TRANSMITTER OPTION</b> |  |
| <b>Input Power</b>                    | 4-20mA models: Loop powered Class 2, 12-30VDC only, 30mA max;<br>0-5/0-10V models: Class 2, 12-30VDC/24VAC, 50/60Hz, 15mA max  |
| <b>Temp Output</b>                    | 2-wire, loop powered 4-20mA  |
| <b>Sensor Type</b>                    | Thermistor/RTD   |
| <b>Accuracy</b>                       | ±1.0°C*  |
| <b>Ranges</b>                         | -25° to 105°C (available ranges; model number specifies exact range)   |
| <b>LINITEMP OPTION</b>                |  |
| <b>Input Power</b>                    | Class 2; 5 to 30VDC  |
| <b>Output</b>                         | 10mV/°C  |
| <b>Calibration Error</b>              | 1.5°C (2.7°F) typical; 2.5°C (4.5°F) max. at 25°C (77°F)*  |
| <b>Error over Temp</b>                | 1.8°C (3.24°F) typical; 3.0°C (5.4°F) max. over 0° to 70°C (32° to 158°F) range;<br>2.0°C (3.6°F) typical, 3.5°C (6.3°F) max. over -25° to 105°C (-13° to 221°F) range |
| <b>Operating Temp</b>                 | TB -25° to 105°C (-13° to 221°F)<br>TRA Probe -25° to 105°C (-13° to 221°F), Wiring -20° to 80°C (-4° to 176°F)  |

\* Add the transmitter accuracy to the RTD/thermistor accuracy to get the total product accuracy. For RTD and thermistor accuracies and ranges, see the table below.

\*\*Room temperature error documented on each unit.

To compute Linitemp temperature:  
mV reading/10 - 273.15 = Temperature in °C

### High Accuracy Specialty Sensors

#### FEATURES

##### TB Pipe Surface Sensor

- Secondary measurement of water temperature...ideal for retrofit applications
- Pipe clamps allow for easy installation on pipes up to 12" in diameter

##### TRA Probe Sensor

- Durable stainless steel sensing probe for long sensor life
- Multiple cable lengths for application flexibility

#### DESCRIPTION

The **TB** strap-on sensor uses a clamp to secure the unit to a pipe and a copper sensing plate for fast temperature response. The TB is perfect for secondary measurement of water temperature typical in retrofit applications. It includes a steel mounting box for wire termination and easy conduit connection.

The **TRA Series** stainless steel remote probe is designed for high accuracy in remote temperature sensing applications. The TRA can be used in numerous refrigeration applications or can be mounted on pipes for chilled or heated water temperature sensing. It is easily installed and includes a durable stainless steel sensing probe and a two-wire twisted pair wire with strain relief. Multiple cable lengths are available for added flexibility.

| Class                  | Pt RTD                  |                         | Balco RTD | THERMISTOR       |                  |                     |                  |                    |                  |                  |         |         |         |                |                  |
|------------------------|-------------------------|-------------------------|-----------|------------------|------------------|---------------------|------------------|--------------------|------------------|------------------|---------|---------|---------|----------------|------------------|
|                        | 100 Ohm                 | 1000 Ohm                | 1000 Ohm  | 2.2k             | 3k               | 10k Type 2          | 10k Type 3       | 10k Dale           | 10k 3A221        | 10k "G" US       | 20k     | 20k "D" | 100k    | 10k Type 2     | 10k Type 3       |
| <b>Accuracy</b>        | ±0.3°C<br>0.00385 curve | ±0.3°C<br>0.00385 curve | ±1% @70°C | ±0.2°C<br>0/70°C | ±0.2°C<br>0/70°C | ±1.0°C<br>-50/150°C | ±0.2°C<br>0/70°C | ±0.2°C<br>-20/70°C | ±1.1°C<br>0/70°C | ±0.2°C<br>0/70°C | Consult | Consult | Consult | ±0.1°C 20/70°C | ±0.1°C<br>0/70°C |
| <b>Temp. Response*</b> | PTC                     | PTC                     | PTC       | NTC              | NTC              | NTC                 | NTC              | NTC                | NTC              | NTC              | NTC     | NTC     | NTC     | NTC            | NTC              |

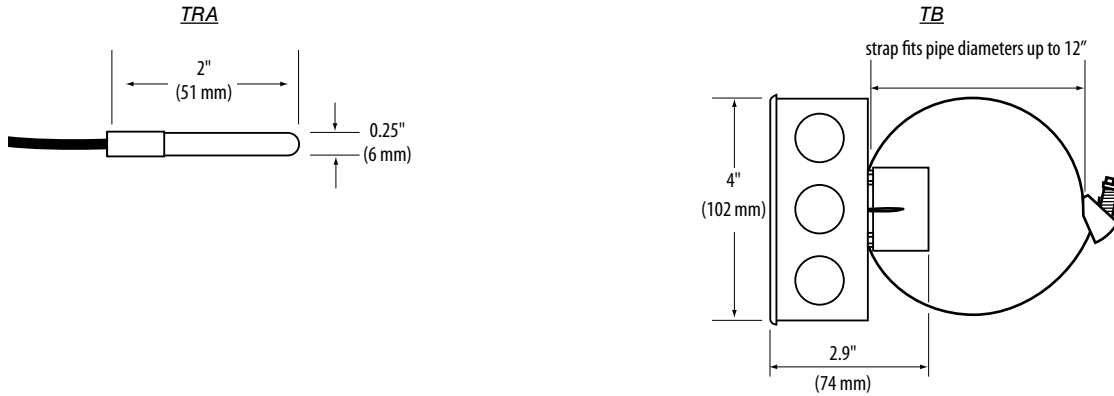
\*PTC: Positive Temperature Coefficient  
\*NTC: Negative Temperature Coefficient

High Accuracy

#### STANDARD RTD AND THERMISTOR VALUES (Ohms Ω)

| °C                  | °F  | 100 Ohm  | 1000 Ohm | 1000 Ohm | 2.2k     | 3k       | 10k Type 2 | 10k Type 3 | 10k Dale | 10k 3A221 | 10k "G" US | 20k NTC   | 20k "D"  | 100k      | 10k Type 2 | 10k Type 3 |
|---------------------|-----|----------|----------|----------|----------|----------|------------|------------|----------|-----------|------------|-----------|----------|-----------|------------|------------|
| -50                 | -58 | 80.306   | 803.06   | 740.46   | 154,464  | 205,800  | 692,700    | 454,910    | 672,300  | -         | 441,200    | 1,267,600 | -        | -         | 692,700    | 454,910    |
| -40                 | -40 | 84.271   | 842.71   | 773.99   | 77,081   | 102,690  | 344,700    | 245,089    | 337,200  | 333,562   | 239,700    | 643,800   | 803,200  | 3,366,000 | 344,700    | 245,089    |
| -30                 | -22 | 88.222   | 882.22   | 806.02   | 40,330   | 53,730   | 180,100    | 137,307    | 177,200  | 176,081   | 135,300    | 342,000   | 412,800  | 1,770,000 | 180,100    | 137,307    |
| -20                 | -4  | 92.160   | 921.60   | 841.00   | 22,032   | 29,346   | 98,320     | 79,729     | 97,130   | 96,807    | 78,910     | 189,080   | 220,600  | 971,200   | 98,320     | 79,729     |
| -10                 | 14  | 96.086   | 960.86   | 877.46   | 12,519   | 16,674   | 55,790     | 47,843     | 55,340   | 55,252    | 47,540     | 108,380   | 122,400  | 553,400   | 55,790     | 47,843     |
| 0                   | 32  | 100.000  | 1,000.00 | 913.66   | 7,373    | 9,822    | 32,770     | 29,588     | 32,660   | 32,639    | 29,490     | 64,160    | 70,200   | 326,600   | 32,770     | 29,588     |
| 10                  | 50  | 103.903  | 1,039.03 | 952.25   | 4,487    | 5,976    | 19,930     | 18,813     | 19,900   | 19,901    | 18,780     | 39,440    | 41,600   | 199,000   | 19,930     | 18,813     |
| 20                  | 68  | 107.794  | 1,077.94 | 991.82   | 2,814    | 3,750    | 12,500     | 12,272     | 12,490   | 12,493    | 12,260     | 24,920    | 25,340   | 124,900   | 12,500     | 12,272     |
| 25                  | 77  | 109.735  | 1,097.35 | 1,013.50 | 2,252    | 3,000    | 10,000     | 10,000     | 10,000   | 10,000    | 10,000     | 20,000    | 20,000   | 100,000   | 10,000     | 10,000     |
| 30                  | 86  | 111.673  | 1,116.73 | 1,035.18 | 1,814    | 2,417    | 8,055      | 8,195      | 8,056    | 8,055     | 8,194      | 16,144    | 15,884   | 80,580    | 8,055      | 8,195      |
| 40                  | 104 | 115.541  | 1,155.41 | 1,077.68 | 1,199    | 1,598    | 5,323      | 5,593      | 5,326    | 5,324     | 5,592      | 10,696    | 10,210   | 53,260    | 5,323      | 5,593      |
| 50                  | 122 | 119.397  | 1,193.97 | 1,120.52 | 811.5    | 1,081    | 3,599      | 3,894      | 3,602    | 3,600     | 3,893      | 7,234     | 6,718    | 36,020    | 3,599      | 3,894      |
| 60                  | 140 | 123.242  | 1,232.42 | 1,166.13 | 561.0    | 747      | 2,486      | 2,763      | 2,489    | 2,486     | 2,760      | 4,992     | 4,518    | 24,880    | 2,486      | 2,763      |
| 70                  | 158 | 127.075  | 1,270.75 | 1,210.75 | 395.5    | 527      | 1,753      | 1,994      | 1,753    | 1,751     | 1,990      | 3,512     | 3,100    | 17,510    | 1,753      | 1,994      |
| 80                  | 176 | 130.897  | 1,308.97 | 1,254.55 | 284.0    | 378      | 1,258      | 1,462      | 1,258    | 1,255     | 1,458      | 2,516     | 2,168    | 12,560    | 1,258      | 1,462      |
| 90                  | 194 | 134.707  | 1,347.07 | 1,301.17 | 207.4    | -        | 919        | 1,088      | 917      | 915       | 1,084      | 1,833     | 1,542    | 9,164     | 919        | 1,088      |
| 100                 | 212 | 138.506  | 1,385.06 | 1,348.38 | 153.8    | -        | 682        | 821        | 679      | 678       | 816.8      | 1,356     | 1,134    | 6,792     | 682        | 821        |
| 110                 | 230 | 142.293  | 1,422.93 | 1,397.13 | 115.8    | -        | 513        | 628        | 511      | 509       | 623.6      | 1,016     | 816      | 5,108     | 513        | 628        |
| 120                 | 248 | 146.068  | 1,460.68 | 1,447.44 | 88.3     | -        | 392        | 486        | 389      | 388       | 481.8      | 770       | 606      | 3,894     | 392        | 486        |
| 130                 | 266 | 149.832  | 1,498.32 | 1,496.28 | 68.3     | -        | 303        | 380        | 301      | 299       | 376.4      | 591       | 456      | 3,006     | 303        | 380        |
| <b>Sensor Codes</b> |     | <b>B</b> | <b>C</b> | <b>I</b> | <b>E</b> | <b>F</b> | <b>D</b>   | <b>H</b>   | <b>J</b> | <b>S</b>  | <b>R</b>   | <b>M</b>  | <b>U</b> | <b>T</b>  | <b>W</b>   | <b>Y</b>   |

**DIMENSIONAL DRAWINGS**



**ORDERING INFORMATION**

Strap-on Bracket

Diameter



- A = 2 1/2" (6.4 cm) max.
- D = 8" (20 cm) max.
- E = 12" (31 cm) max.

Sensor Type



- B = 100R platinum, RTD
- C = 1k platinum, RTD
- D = 10k T2, Thermistor
- E = 2.2k, Thermistor
- F = 3k, Thermistor
- G = 10k CPC, Thermistor
- H = 10k T3, Thermistor
- I = 1k Balco (Nickel-Iron) RTD
- J = 10k Dale, Thermistor
- K = 10k w/11k shunt, Thermistor
- M = 20k NTC, Thermistor
- N = 1800 ohm, Thermistor
- P = 10mV/°C, Linitemp
- R = 10k US, Thermistor
- S = 10k 3A221, Thermistor
- T = 100k, Thermistor
- U = 20k "D", Thermistor
- W = 10k T2 high accuracy, Thermistor
- Y = 10k T3 high accuracy, Thermistor
- Z = 10k E1, Thermistor
- CC = 15k, Thermistor

Cal Certificate



- 0 = None
- 1 = 1 point Cal validation
- 2 = 2 point Cal validation

Resistive Output Option (Stop here)

4-20mA Temp. Transmitter Option Option†

Bottom Range

Temp.††

= (choose a valid temp value†)

Temp Scale

Temp.†

C = Celsius  
F = Fahrenheit

Top Range

Temp.†

= (choose a valid temp value)

† Available only with B, C, D, H, W, and Y sensors

†† Value must be a whole number between -25°C and 105°C (-13°C and 221°F) and must be lower than the Top Range Value.

‡ Value must be a whole number between -25°C and 105°C (-13°C and 221°F) and must be higher than the Bottom Range Value.

Remote Probe

Sensor Type



- B = 100R platinum, RTD
- C = 1k platinum, RTD
- D = 10k T2, Thermistor
- E = 2.2k, Thermistor
- F = 3k, Thermistor
- G = 10k CPC, Thermistor
- H = 10k T3, Thermistor
- I = 1k Balco (Nickel-Iron) RTD
- J = 10k Dale, Thermistor
- K = 10k w/11k shunt, Thermistor
- M = 20k NTC, Thermistor
- N = 1800 ohm, Thermistor
- P = 10mV/°C, Linitemp
- R = 10k US, Thermistor
- S = 10k 3A221, Thermistor
- T = 100k, Thermistor
- U = 20k "D", Thermistor
- W = 10k T2 high accuracy, Thermistor
- Y = 10k T3 high accuracy, Thermistor
- Z = 10k E1, Thermistor
- CC = 15k, Thermistor

Cal Certificate



- 0 = None
- 1 = 1 point Cal validation
- 2 = 2 point Cal validation

Cable Length

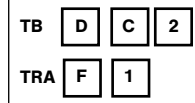


- None = 3 ft (0.9 m)
- A = 6 ft (1.8 m)\*
- B = 10 ft (3.1 m)\*
- C = 20 ft (6.1 m)\*\*
- D = 25 ft (7.6 m)\*\*
- E = 50 ft (15 m)\*\*
- F = 100 ft (30 m)\*\*

\*Not available for sensor types B, C & P.

\*\*Not available for sensor types B, C, E, F, N & P

Examples:



**ACCESSORIES**

Klipet mounting clip for TRA probe (AA64)

Temperature range converter, resistive to 4-20mA (AA10xxxx)



AA64



AA10xxxx