MEASUREMENT AND VERIFICATION PLAN

FOR

DG/CHP SYSTEM AT 666 5TH AVE – OFFICE POWER

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Submitted to:

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1. Introduction

The CHP system at 666 5th Ave consists of ten 100-kW Eliot microturbines. The turbines have roughly a 105-kW gross output to cover the operation of the onboard gas compressor and controls, resulting in a net output of 1 MW for the entire turbine array.

The turbines have integrated hot water heat recovery, with a parallel piping arrangement. Each turbine pulls hot water from a return header and injects heated hot water to a supply header. There is a dump radiator for system stability and heat rejection.

The turbines are electrically connected into one group of four turbines, and one group of six turbines. These two groups are connected to two of the four utility feeds into the building. The other two feeds are unaffected by the operation of the CHP system. The grouping of turbines and selection of associated utility feed was performed to maximize the opportunity for electrical operation. The turbine groups are sized to be very close to the continuous baseload for these services.

Heat from the turbine heat recovery loop can be used to meet thermal loads in the facility via a heat exchanger (for heating season operation), or directly used by absorption chiller (see Figure 3). The thermal loads include:

- Space heating to the building dual temperature loop (isolated by HX) (winter, approx 5.4 MMBtu/h)
- Direct hot water use by absorption chiller (summer, approx 4.3 MMBtu/h)

Heat not recovered (typically at startup, or low load conditions) will be wasted, first by a bypass exhaust damper in each turbine, then by heat rejection by a dump radiator located on the heat recovery loop.

The loop will typically operate between 120°F - 205°F supply temperature, and return to the microturbine arrays at between 120°F - 180°F. The loop flow rate will be 350 gpm, and the heat recovery loop will contain a 30/70 mixture of propylene glycol and water.

At full load the generators will consume approximately 13,500 std cubic feet (cf) of natural gas per hour.

2. Instrumentation

Office Power's primary revenue stream at this application will be to sell electricity and thermal energy at the prevailing utility rates before the CHP system was installed. This results in a high degree of metering required by Office Power to ensure that all energy flows are accounted.

Office Power will supply the instrumentation listed Table 1 below for use in meeting the NYSERDA CHP program monitoring requirements. These sensors are only a subset of the total sensor array used to track system performance for Office Power's purposes.

Table 1. Instrumentation Supplied By Office Power

Point	Instrument	Output Type	Sensor Location	Notes
Facility Power	(4) Power Logic ION7350 3ϕ, 277 L-N, 4000:5 A CTs	Full data stream (kW, kWh used) Modbus RTU (COM2)	Utility feed disconnects, cellar level (see Figure 1)	• Data points WT1, WT2, WT3, WT4
Generator Power Output	(2) Power Logic ION7350 3ϕ, 277 L-N, 1200:5 A CTs (TA1) 800:5 A CTs (TA2)	Full data stream (kW, kWh used) Modbus RTU (COM2)	Combined turbine array disconnects, 15 floor rooftop (see Figure 1)	• Data points WTA1, WTA2
System Parasitic (Combined)	(1) Power Logic ION7350 3ϕ, 277 L-N, 200:5 A CTs	Full data stream (kW, kWh used) Modbus RTU (COM2)	Parasitic Load Panel, 15-floor rooftop	• Data point WTPLP • Includes absorption chiller, tower and pumps
System Parasitic (Abs Chiller Only)	(1) Power Logic ION7350 3ϕ, 277 L-N, 200:5 A CTs	Full data stream (kW, kWh used) Modbus RTU (COM2)	Parasitic Load Panel, 15-floor rooftop	• Data point WTCHM • Includes absorption chiller, tower and pumps
Generator Gas Input	(2) Roots B3 Series Model #16M1751	Solid State Pulse (1TWPS) output, 1 cf/pulse (temp-compensated)	At gas service entrance, cellar level (see Figure 2)	• Data points FGM1, FGM2 • Meter and rate selection subject to Con-Ed discretion
Heat recovery loop flow rate	Micrometer V-Cone & Foxboro DP differential pressure transmitter	4-20 mA output 0 – 500 GPM 10:1 turndown (Flow < 50 GPM = 0 GPM)	On heat recovery loop piping, between abs. chiller and dump radiator (see Figure 3)	• Data point FGL • 6" OD pipe diameter • 350 GPM nominal flow
Heat recovery loop temperatures	ACI 10k Ω thermistor	Direct read to ALC SCADA system using 5 VDC half bridge	In thermowells installed on heat recovery loop piping, (see Figure 3)	• TLS, TLR1, TLR

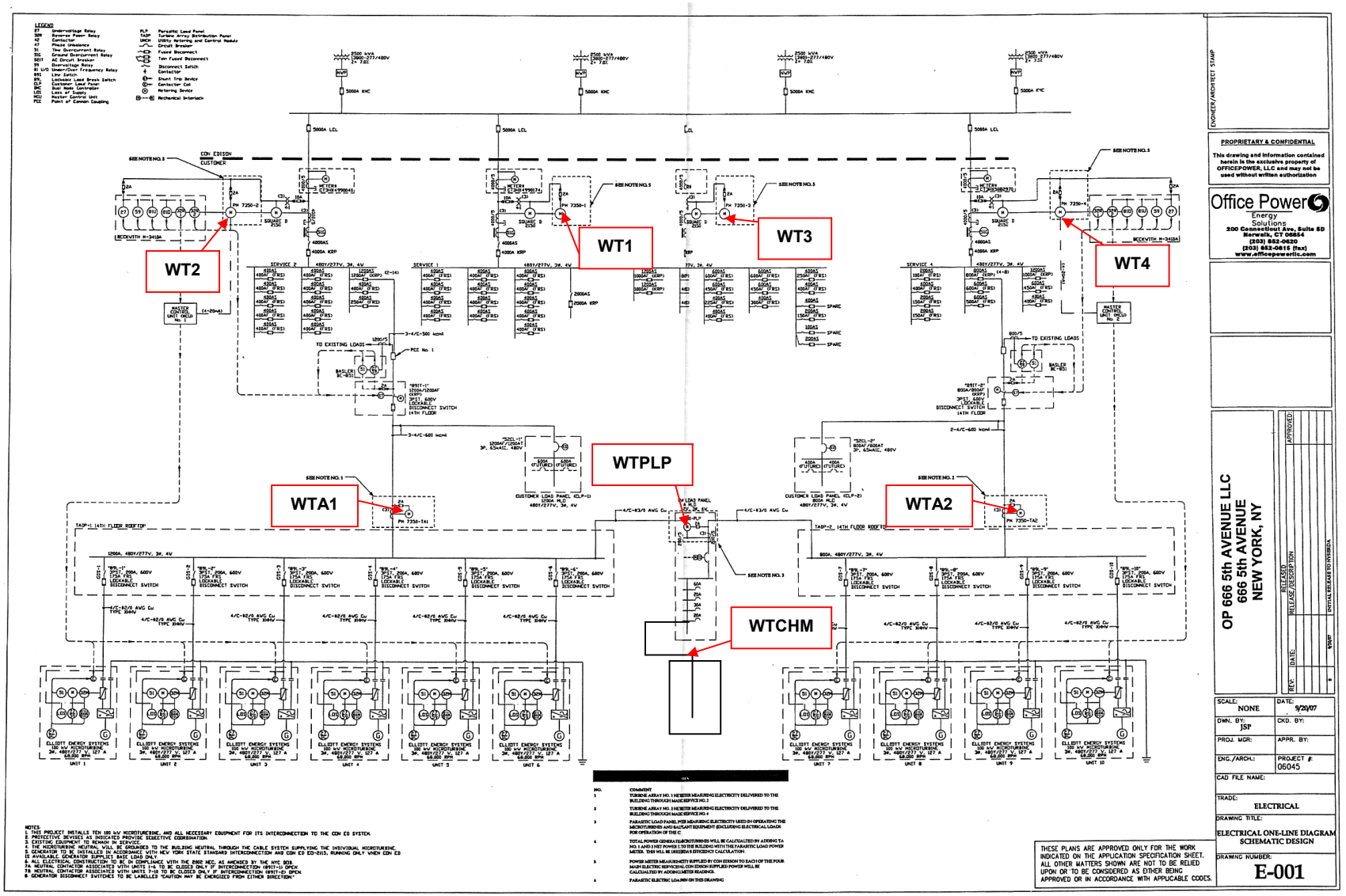

Figure 1. Power Transducer Locations

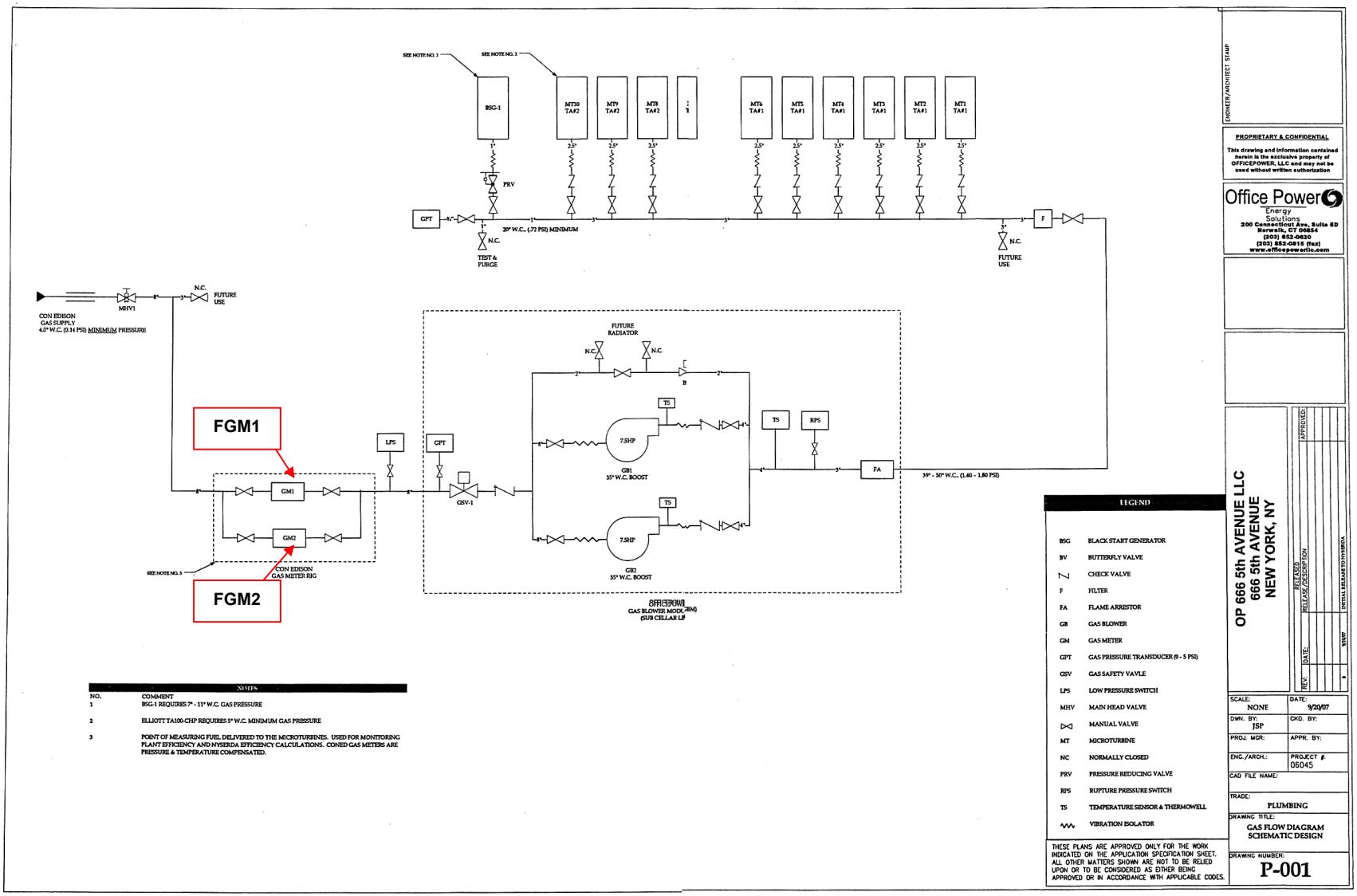

Figure 2. Gas Meter Locations (Con Ed Billing Meters)

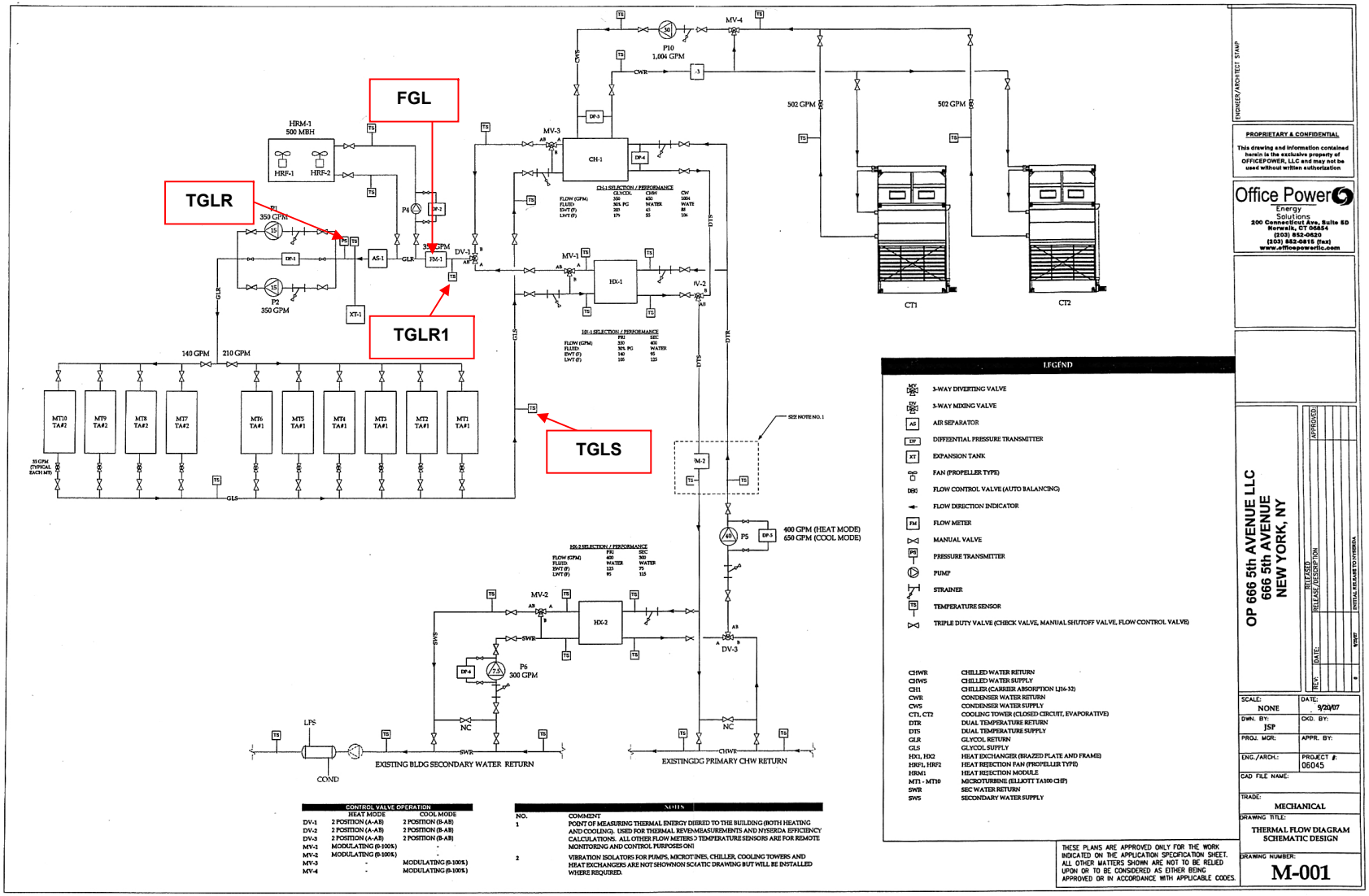

Figure 3. Heat Recovery Temperature and Flow Sensor Locations

Office Power is installing an Automated Logic based SCADA system as the basis for monitoring the system performance. The SCADA system will also act as the conduit for data to be transferred to the data logger installed by CDH Energy. Figure 4 in the Office Power Instrumentation Plan (Appendix B) displays the overall hierarchy of the data collection system at the site.

Sensor readings from this system will be conveyed to the CDH Energy data logger via a MODBUS RTU connection. The CDH Energy data logger will conform to the communication specification defined in the Instrumentation Plan Table 1 (Appendix B).

Datalogger

A CR1000 Campbell Scientific datalogger will be installed to record the required data. The logger will interface with Office Power's Automated Logic SCADA controller via a two wire twisted pair MODBUS RTU connection. The CDH data logger will act as the MODBUS master in this arrangement, polling the SCADA system for the required registers every 30-seconds. It is assumed that each polling of the registers from the SCADA system will provide the data logger with the most current "real-time" data reading. The scanned data will then be averaged or totaled (depending on the type of data point measured) into 15-minute data and stored on the data logger. Based on the number of points monitored (14 points), the logger will have enough storage capacity to hold 180-days of data if communications are lost.

The datalogger will continue to log data for a few hours in the event of a power outage at the site. The data will be downloaded from the datalogger twice a day by a phone-modem connection and loaded into a database. The data will be checked for validity and posted on the NYSERDA web site.

Onsite Installation

CDH Energy will install a datalogger panel at a location in the cogeneration room agreeable to the site and developer. The monitoring system panel will be approximately 2 ft x 2 ft x 1 ft. The panel will be mounted near a 120 VAC power receptacle (it will require 1 amp or less). The panel should be conveniently located relative to the sensors listed above as well as the communications line provided by the site.

Communications

Phone line will be supplied by the site or developer. The phone line will only receive calls to the logger, the data logger will not be initiating any outside communication.

On Site Support

As the monitoring arrangement at this site will involve utilizing sensors foreign to the data logger, it is expected that Office Power will provide on site support for CDH Energy during the

monitoring system installation and configuration. There will be a need to support in diagnosing and debugging communications between the data logger and Office Power's SCADA system.

Also, it will be necessary to have on-site support from Office Power when the readings collected by the data logger are verified using handheld measurements. It may be necessary to perform such actions during verification as removing temperature sensors from the thermowells and expose them to ambient conditions – without disrupting system operations or tripping system alarms. By removing temperature sensors (one at a time) from the thermowells, a step change in temperature will be observed both at the SCADA system, and at the CDH data logger. This will help in verifying that the proper temperature measurement is being placed in the proper holding register on the SCADA system, and that the data logger logs this register properly.

3. Data Analysis

The collected data will be used to determine the net power output of the system as well as the fuel conversion efficiency (FCE).

Table 2. Summary of Monitored Data Points

No.	Data Point	Description	Engineering Unit
1	WT1	Building Main Service #1 Energy Import	kWh
2	WT2	Building Main Service #2 Energy Import	kWh
3	WT3	Building Main Service #3 Energy Import	kWh
4	WT4	Building Main Service #4 Energy Import	kWh
5	WTA1	Turbine Array #1 (6 Turbines) Energy Production	kWh
6	WTA2	Turbine Array #2 (4 Turbines) Energy Production	kWh
7	WT1_kW	Building Main Service #1 Demand Import	kW
8	WT2_kW	Building Main Service #2 Demand Import	kW
9	WT3_kW	Building Main Service #3 Demand Import	kW
10	WT4_kW	Building Main Service #4 Demand Import	kW
11	WTA1_kW	Turbine Array #1 (6 Turbines) Demand Production	kW
12	WTA2_kW	Turbine Array #2 (2 Turbines) Demand Production	kW
13	WTPLP	Parasitic Panel Energy Consumption	kWh
14	WTPLP_kW	Parasitic Panel Demand Consumption	kW
15	WTCHM	Absorption Chiller Component Electric Consumption	kWh
16	WTCHM_kW	Absorption Chiller Component Demand Consumption	kW
17	FGM1	Microturbine Array Gas Consumption Meter 1	cu ft
18	FGM2	Microturbine Array Gas Consumption Meter 2	cu ft
19	TGLR	Glycol Return Temperature to Microturbine Array	F
20	TGLR1	Glycol Temperature after HX and Abs. Chiller	F
21	TGLS	Glycol Supply Temperature from Microturbine Array	F
22	FGL	Glycol Flow (Flow Meter FM-2)	gpm

Peak Demand or Peak kW

The peak electric output or demand for each power reading will be taken as the average kW in a 15-minute interval, or

$$kW = \frac{kWh}{\Delta t} = \frac{kWh\ per\ interval}{0.25\ h}$$

Heat Recovery Rates

The heat recovery rates will be calculated in the datalogger at each scan interval and averaged for each 15-minute recording interval. The piping arrangement at this site allows for multiple heat rates to be determined with 3 temperature sensors and one flow reading:

Useful heat recovery (**QU**) = $K \cdot \Sigma\ [FL \cdot (TGLS-TGLR1)] / n$

Rejected (unused) heat recovery (**QR**) = $K \cdot \Sigma\ [FL \cdot (TGLR-TGLR1)] / n$

The loop fluid is expected to be a glycol-water mixture. The factor K will be determined based on a periodic reading of the fluid properties with a refractometer to determine the glycol concentration. (K ~ 500 Btu/h-gpm-°F for pure water; ~474 for 20% glycol). 'n' is the number of scan intervals included in each recording interval (e.g., with 30 sec scans and 15-minute data, n=30)

Calculated Quantities

The net power output from the CHP system will be defined as the gross power from the microturbines (WTA1+WTA2) minus the parasitic power (WTPLP-WTCHM). The parasitic power is the total load in panel PLP minus those loads dedicated to operation of the absorption chiller.

The fuel conversion efficiency of the CHP system, based on the lower heating value of the fuel, will be defined as:

$$FCE = \frac{QU \cdot \Delta t + 3.412 \cdot (WG - WP)}{0.9 \cdot LHV_{gas} \cdot FG}$$

where:

QU	-	Useful heat recovery (Btu/h)
WG	-	microtubine gross output (kWh) (WTA1+WTA2)
WP	-	Parasitic power use (kWh) (WTPLP – WTCHM)
FG	-	Generator gas consumption (Std CF)
Δt	-	0.25 for 15-minute data
LHV_{gas}	-	Lower heating value for natural gas (~905 Btu per CF). Where 0.9 is the conversion factor between HHV and LHV

The FCE can be calculated for any time interval. When converting to daily, monthly, or annual values, the each value is summed and then the formula is applied:

$$FCE = \frac{\sum^{N} QU \cdot \Delta t + 3.412 \cdot \sum^{N} (WG - WP)}{0.9 \cdot HHV_{gas} \cdot \sum^{N} FG}$$

Where N is equal to the number of intervals in the period of interest.

Appendix A

Cut Sheets for Key Sensors and Instruments

CR1000 Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; non-condensing environment required. To maintain electrical specifications, Campbell Scientific recommends recalibrating dataloggers every two years. We recommend that the system configuration and critical specifications are confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE

10 ms to 30 min. @ 10 ms increments

ANALOG INPUTS

8 differential (DF) or 16 single-ended (SE) individually configured. Channel expansion provided by AM16/32 and AM25T multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single conversion. **Resolution of DF measurements with input reversal is half the Basic Res.**

	Input Referred Noise Voltage	
Input Range (mV)[1]	*DF Res (µV)*[2]	*Basic Res (µV)*
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

[1]Range overhead of ~9% exists on all ranges to guarantee that full-scale values will not cause over-range.

[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset), -55° to 85°C

[3]The sensor and measurement noise are not included and the offsets are the following:

Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range; digital resolution dominates for higher ranges.

250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

MINIMUM TIME BETWEEN VOLTAGE MEASUREMENTS: Includes the measurement time and conversion to engineering units. For voltage measurements, the CR1000 integrates the input signal for 0.25 ms or a full 16.66 ms or 20 ms line cycle for 50/60 Hz noise rejection. DF measurements with input reversal incorporate two integrations with reversed input polarities to reduce thermal offset and common mode errors and therefore take twice as long.

250 µs Analog Integration: ~1 ms SE
1/60 Hz Analog Integration: ~20 ms SE
1/50 Hz Analog Integration: ~25 ms SE

COMMON MODE RANGE: ±5 V

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

ANALOG OUTPUTS

3 switched voltage, active only during measurement, one at a time.

RANGE AND RESOLUTION: Voltage outputs programmable between ±2.5 V with 0.67 mV resolution.

ACCURACY: ±(0.06% of setting + 0.8 mV), 0° to 40°C
±(0.12% of setting + 0.8 mV), -25° to 50°C
±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

CURRENT SOURCING/SINKING: ±25 mA

RESISTANCE MEASUREMENTS

MEASUREMENT TYPES: The CR1000 provides ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation using any of the 3 switched voltage excitations eliminates dc errors.

RATIO ACCURACY[3]: Assuming excitation voltage of at least 1000 mV, not including bridge resistor error.

$\pm(0.04\%$ of voltage reading + offset$)/V_x$

[3]The sensor and measurement noise are not included and the offsets are the following:

Offset for DF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

Offset values are reduced by a factor of 2 when excitation reversal is used.

PERIOD AVERAGING MEASUREMENTS

The average period for a single cycle is determined by measuring the average duration of a specified number of cycles. The period resolution is 192 ns divided by the specified number of cycles to be measured; the period accuracy is ±(0.01% of reading + resolution). Any of the 16 SE analog inputs can be used for period averaging. Signal limiting are typically required for the SE analog channel.

INPUT FREQUENCY RANGE:

Input	*Signal (peak to peak)*[4]		*Min.*	*Max*[5]
Range	*Min*	*Max*	*Pulse W.*	*Freq.*
±2500 mV	500 mV	10 V	2.5 µs	200 kHz
±250 mV	10 mV	2 V	10 µs	50 kHz
±25 mV	5 mV	2 V	62 µs	8 kHz
±2.5 mV	2 mV	2 V	100 µs	5 kHz

[4]The signal is centered at the datalogger ground.

[5]The maximum frequency = 1/(Twice Minimum Pulse Width) for 50% of duty cycle signals.

PULSE COUNTERS

Two 24-bit inputs selectable for switch closure, high frequency pulse, or low-level ac.

MAXIMUM COUNTS PER SCAN: 16.7×10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW LEVEL AC MODE: Internal ac coupling removes dc offsets up to ±0.5 V.

Input Hysteresis: 16 mV @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine wave (mV RMS)	*Range (Hz)*
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS

8 ports software selectable, as binary inputs or control outputs. C1-C8 also provide edge timing, subroutine interrupts/wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UART), SDI-12 communications, and SDM communications.

HIGH FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 ohms

INPUT STATE: high 3.8 to 5.3 V; low -0.3 to 1.2 V

INPUT HYSTERISIS: 1.4 V

INPUT RESISTANCE: 100 kohms

SWITCHED 12 V

One independent 12 V unregulated sources switched on and off under program control. Thermal fuse hold current = 900 mA @ 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

SDI-12 INTERFACE SUPPORT

Control ports 1, 3, 5, and 7 may be configured for SDI-12 asynchronous communications. Up to ten SDI-12 sensors are supported per port. It meets SDI-12 Standard version 1.3 for datalogger mode.

CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

CPU AND INTERFACE

PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core)

MEMORY: 2 Mbytes of Flash for operating system; 4 Mbytes of battery-backed SRAM for CPU usage, program storage and data storage.

SERIAL INTERFACES: CS I/O port is used to interface with Campbell Scientific peripherals; RS-232 port is for computer or non-CSI modem connection.

PARALLEL INTERFACE: 40-pin interface for attaching data storage or communication peripherals such as the CFM100 module

BAUD RATES: Selectable from 300 bps to 115.2 kbps. ASCII protocol is one start bit, one stop bit, eight data bits, and no parity.

CLOCK ACCURACY: ±3 min. per year

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc

TYPICAL CURRENT DRAIN:
Sleep Mode: ~0.6 mA
1 Hz Scan (8 diff. meas., 60 Hz rej., 2 pulse meas.)
w/RS-232 communication: 19 mA
w/o RS-232 communication: 4.2 mA
1 Hz Scan (8 diff. meas., 250 µs integ., 2 pulse meas.)
w/RS-232 communication: 16.7 mA
w/o RS-232 communication: 1 mA
100 Hz Scan (4 diff. meas., 250 µs integ.)
w/RS-232 communication: 27.6 mA
w/o RS-232 communication: 16.2 mA

CR1000KD CURRENT DRAIN:
Inactive: negligible
Active w/o backlight: 7 mA
Active w/backlight: 100 mA

EXTERNAL BATTERIES: 12 Vdc nominal; reverse polarity protected.

PHYSICAL SPECIFICATIONS

MEASUREMENT & CONTROL MODULE SIZE: 8.5" x 3.9" x 0.85" (21.6 x 9.9 x 2.2 cm)

CR1000WP WIRING PANEL SIZE: 9.4" x 4" x 2.4" (23.9 x 10.2 x 6.1 cm); additional clearance required for serial cable and sensor leads.

WEIGHT: 2.1 lbs (1 kg)

WARRANTY

Three years against defects in materials and workmanship.

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Datasheet: ION® 7300 | 7330 | 7350

Switchboard Case option

Integrated display model

Intelligent Metering and Control Devices

Used in enterprise energy management applications such as feeder monitoring and sub-metering, ION® 7300 series meters offer unmatched value, functionality, and ease of use. ION 7300 series meters interface to ION Enterprise® software or other automation systems for fast information sharing and analysis.

The ION® 7300 meters are an ideal analog meter replacement with a multitude of power and energy measurements, analog and digital I/O, communication ports, and industry-standard protocols. The ION® 7330 meter adds on-board data storage, emails of logged data, and an optional modem. The ION® 7350 meter is further augmented by more sophisticated power quality analysis, alarms and a call-back-on-alarm feature.

Patented ION® technology also lets you customize metering or analysis functions at your workstation, without any hard wiring. Just graphically link a few drag-and-drop icons, or select default setups, and you're ready to go.

Not all features listed are available with every model. Please refer to the detailed descriptions within for a complete list of feature availability.

Applications Summary

Power and Energy Metering
Each meter in the versatile ION 7300 series gives you hundreds of high-accuracy power, energy, demand and harmonics measurements. Use the revenue-certified models for billing, bill verification, and sub-metering applications.

Power Quality Analysis
You can use meter data to help uncover the sources of harmonics and voltage sags/swells. Analyze problems and avoid repeat interruptions.

Cost Allocation and Billing
Determine cost centers, identify opportunities for demand control, and check energy consumption patterns.

Demand and Power Factor Control
Avoid penalties with automated load shedding, scheduling, peak shaving or capacitor bank control.

Load Studies and Circuit Optimization
Determine the capacity of your electric network and run at peak efficiency. Perform load trending.

Equipment Monitoring and Control
Improve process yields and extend equipment life. Meter all your utilities including gas, steam, water and more.

Preventative Maintenance
Set up alarms to warn of pending problems. Log events and alarms for all critical conditions.

Features Summary

Measurements
- Energy: bi-directional, absolute and net
- Demand: rolling block, predicted, and thermal
- Harmonics: individual and total harmonic distortion up to the 15th or 31st
- Advanced logic and mathematical functions

Internet-Enabled Communications
- Two RS-485 ports
- Optional built-in modem with ModemGate™ allows modem access for 31 other devices
- Optional Ethernet port with EtherGate™ allows direct Ethernet-to-RS-485 data transfer to 31 other devices
- Infrared data port standard
- Modbus™ RTU, Modbus TCP, DNP 3.0, and PROFIBUS DP
- Call-back feature offers fast alarm response
- Web server, MeterM@il® allow distribution of metered data and alarms over the Internet

On-Board Data Logging
- Scheduled or event-driven logging of up to 96 parameters
- Sequence-of-events and min/max logging

Setpoints for Control and Alarms
- Setpoint on any parameter or condition
- 1 second operation

Inputs and Outputs
- 4 digital inputs for status/counter functions
- 4 digital outputs for control/pulse functions
- Optional analog inputs and outputs

Example Display Formats

Front Panel Display

The ION 7300 series front panel supports local data display and basic setup:

- Easy-to-read LCD with back lighting
- Adjustable contrast
- Remote display option up to 1.8m (6ft.) from base unit
- 8 data display screens that can be customized through the communications port, to show the parameters of your choice and scrolled manually or automatically
- Four display formats: 4-parameter, to single-parameter large character displays
- Custom parameter labels (programmable via communications)

Metering

The ION 7300 series meters provide fully bi-directional, 4-quadrant, revenue-accurate or revenue-certified energy metering. They can replace discrete energy meters, demand meters and pulse initiators, and perform a wide range of other metering and instrumentation functions.

4-Quadrant Energy

The meters are fully bi-directional and monitor energy in all four quadrants. They provide all traditional active, reactive and apparent energy parameters and can provide measurements like Volt-Hours, Amp-Hours, etc.

- kWh, imported, exported, net (imported and exported), and total (imported and exported)
- kVARh imported, exported, net (imported and exported), and total (imported and exported)
- kVAh total
- kVAh, imported, exported, net (ION 7330 and ION 7350 meters only)
- Volt-hours and amp-hours
- Integration of any instantaneous measurement

Demand

The ION 7300 series meters support rolling block, thermal, and predicted demand. The meters calculate demand on any instantaneous measurement and record peak (maximum) and minimum demand. Peak demand registers can be reset manually (password protected) from the front panel or via communications. Default setup:

- kW demand and min/max
- kVAR demand and min/max
- kVA demand and min/max
- Amps demand and min/max
- Volts demand and min/max
- Demand on any instantaneous measurement

Instantaneous

The ION 7300 series meters offer the most comprehensive array of instantaneous (real-time) measurements available in the industry. Measurements include true RMS, per phase and total for:

- Voltage and current
- kW, kVAR and kVA
- Power factor
- Frequency
- Voltage and current unbalance

Time of Use

The ION 7330 and ION 7350 meters provide:

- 2 year internal calendar
- Up to 15 daily tariff profiles
- Programmable triggers
- Separate energy and demand accumulators

Harmonics

The ION 7300 series meters feature harmonic distortion metering.

- Total Harmonic Distortion and individual harmonics to the 15th, (31st on the ION 7350 meter) on voltage and current inputs
- K-factor for current inputs

Universal Metering

The ION 7300 series meters can be equipped with a variety of digital and analog I/O combinations, for universal metering. You can replace PLCs and RTUs (monitoring pressure, temperature and power transducers), as well as traditional power transducers. The ION 7330 and ION 7350 meters can accept input pulses from gas, water, steam, or other metering equipment and convert pulses into actual consumption values.

Residual Current

When set to 4-Wire Wye, any of the meters can calculate neutral or ground current based on three phase current measurements.

Min/Max Recording

The ION 7300 meter will record each new minimum and new maximum value with date and time-stamp for the following parameters.

- Voltage and current min/max
- kW, kVAR, and kVA min/max
- Power factor
- Frequency
- Voltage unbalance
- Plus any measured value

Logging and Recording

The ION 7330 and ION 7350 meters provide data and event logs. Non-volatile memory ensures that valuable information can be preserved between intervals when the logs are retrieved via communications.

Historical Logging

Any combination of measurements can be recorded at scheduled intervals by setpoints or logic conditions. ION 7300 series meters can be configured for up to 30 days of recording capacity at 15 minute intervals.

- The ION 7350 meter offers a maximum of 6 data logs, each recording up to 16 user defined parameters concurrently, for a total of 96 parameters
- The ION 7330 meter offers a maximum of 2 data logs, each recording up to 16 user defined parameters concurrently, for a total of 32 parameters

For more detail, refer to the ***ION 7300 Series User's Guide.***

Min/Max Logging

- Perform min/max logging on any parameter, over any time interval (e.g. daily, monthly)
- Easily record other values coinciding with the new minimum or maximum
- Defaults: Min and max for all basic power parameters. Voltage (L-L/L-N) per phase, Current per phase, kW, kVAR, kVA, Power Factor, Frequency, and Rolling Block Demand for kW, kVAR and kVA.

Event Logging and Alarming

Configurable event priorities allow you to define alarm conditions.

- Sequence-of-events timestamped to ±10ms accuracy
- Time-stamped record of all configuration changes, setpoint and min/max events

Waveform Recording

The ION 7350 meter simultaneously captures events on all channels, up to 48 cycles each:

- Resolution: 64 samples per cycle
- The maximum number of cycles for contiguous waveform capture is 6,900 (based on 16 samples/cycle x 48 cycles)

Sag/Swell Monitoring

- Detect sags or swells on any voltage channel and record instantaneous values and waveforms with the ION 7350 meter

Logic, Math and Control

The ION 7330 and ION 7350 meters offer sophisticated logic and mathematical functions to perform on-board calculations on any measured value. You can calculate true quantities from pulse inputs (e.g. BTU calculations) or use the math functions to calculate other values.

Mathematical Functions

Define custom formulas using:

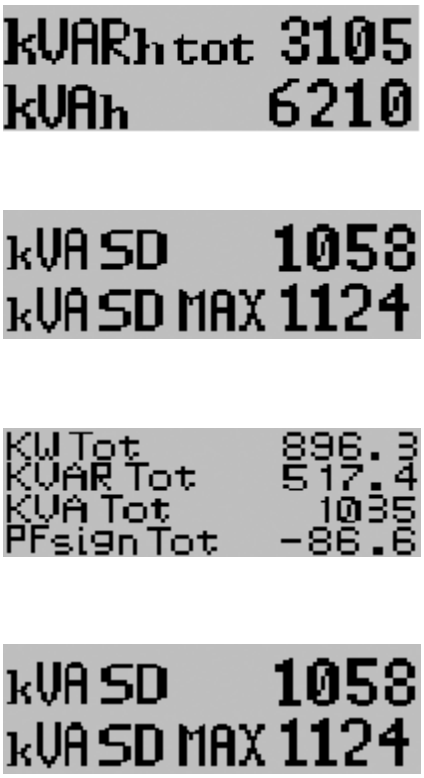
- Arithmetic (+, x, -, ÷)
- Comparison (>, <, =, ≥, ≤, ≠)
- Logical (AND, OR, NOT, TRUE, FALSE, IF)
- Trigonometric (SIN, COS, TAN, ASIN, ACOS, ATAN)
- Math (PI, SQRT, POWER, SUM, SUMSQ, AVG, RMS, LOG10, LN, MAX, MIN)

Programmable Logic and Setpoints

The ION 7330 and ION 7350 meters can use logical operators and setpoints to set alarms, define basic control algorithms for capacitor and demand control, and implement advanced back-up protection for equipment. 12 setpoints are configurable for 1-second operation. Each setpoint can be triggered for the over- or under-conditions you specify. Use setpoints to trigger:

- Data logging
- Digital outputs
- Clearing and reset functions
- Pulse outputs
- Call-back (ION 7350)

Example Display Formats



An ION 7300 with remote display

Software Integration

The meters can be easily integrated within an energy management or SCADA system to provide remote display of all measured parameters at a PC workstation, as well as remote configuration and manual control capabilities.

ION Enterprise™

The meters are compatible with our Windows 2000-based ION Enterprise power monitoring software. ION Enterprise web-enabled software displays real-time and logged data, and offers control/configuration capabilities. It provides enterprise-wide data sharing in a secure networked environment.

ION Setup™ Software

The meters are further enhanced by ION Setup for Windows, a software solution that displays real-time data from your power monitoring devices and provides device configuration capabilities.

ION Setup lets you create a network of sites and devices, so that the meters are easy to find and the communication links are ready whenever you want to make changes to your meters or network.

Internet Connectivity

MeterM@il®

When equipped with an Ethernet port, the ION 7330 and ION 7350 meters can automatically send data logs via e-mail. The ION 7350 can also send alarm notifications via e-mail. MeterM@il messages can be received like any e-mail message, at a workstation, cell phone, pager or PDA. Data logs can also be sent on an event-driven or scheduled basis via e-mail, while conveniently accommodating firewall restrictions.

WebMeter™

An on-board Web server combined with an Ethernet port offers quick and easy access to real-time energy and basic power quality information without special software. Built-in web pages display a range of energy and basic power quality information through any web-enabled device, and even support basic meter configuration tasks.

Communications

Serial Ports

The ION 7300 meter is equipped with a single RS-485 port, while the ION 7330 and ION 7350 meters can have two RS-485 ports, depending on the communications options selected.

- Optically isolated
- Baud rates up to 19,200bps
- Compatible with power monitoring software that supports Modbus RTU or ION
- The ION 7330 meter and ION 7350 meter also support DNP 3.0

Infrared Data Port

A front panel optical port is offered on all models in the ION 7300 series.

- Compatible with an ANSI Type 2 magnetic optical communications coupler and can operate at baud rates up to 19,200bps
- Can be used for infrared energy pulsing or communication with Power Measurement software

Ethernet Port (optional)

All meters in the ION 7300 series can be ordered with an optional 10Base-T port for direct access to metering information via an Ethernet LAN/WAN.

- Protocol: ION, Modbus TCP
- Data rate: 10 Mbps
- Ping and Telnet diagnostic services
- EtherGate™ allows the ION 7330 and ION 7350 to act as a gateway, allowing the direct transfer of data between an Ethernet network and up to 31 RS-485 devices
  Note: The meter COM2 port functions as a dedicated EtherGate port (RS-485 Master) on ION 7330 and ION 7350 meters with the Ethernet option

PROFIBUS Port (optional)

PROFIBUS DP standard protocol support via sub-D 9 pin female connector is offered exclusively on the ION 7300.

Internal Modem

The ION 7330 and ION 7350 offer an optional, space saving, internal modem which helps reduce cost and improve reliability by replacing external modems and RS-485 to RS-232 converters.

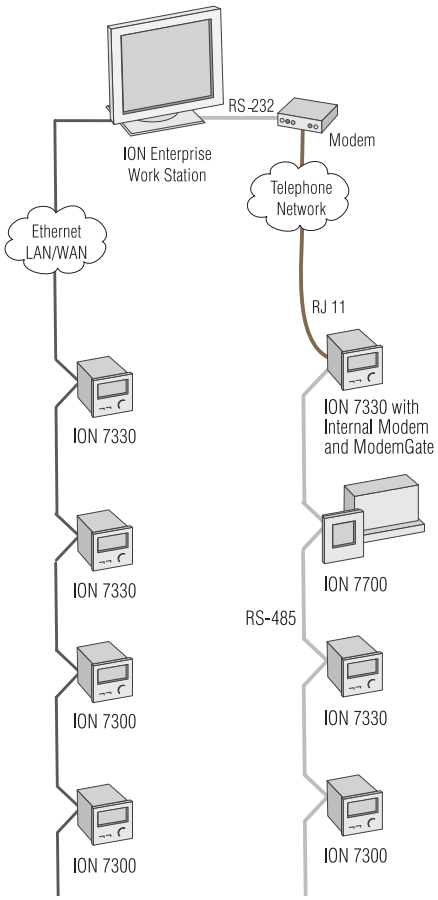
- Baud rates from 300bps to 33,600bps
- The ModemGate feature lets the remote master station access the meter and up to 31 other devices connected to the RS-485 loop through a single internal modem
  Note: The meter COM1 port functions as a dedicated ModemGate port (RS-485 Master) on ION 7330 and ION 7350 meters with the internal modem option
- Compatible with power monitoring software that supports Modbus RTU, ION or DNP 3.0
- RJ-11 or a captured wire connector (CWC)
- The ION 7350 meter is offered with a call-back feature for quick alarm response

Interoperability

The ION 7330 and ION 7350 meters can concurrently communicate via multiple protocols so you can use their advanced features to extend an existing Modbus, DNP or ION Enterprise network. Logs and real time values are also available through Modbus. In addition, the meters are fully supported by UTS MV-90® through serial and Ethernet.

Connection to Infrared Data Port

Example 7330 ION Communication Connections



The Power of ION

The ION 7300 series meters are based on our patented ION technology which ensures the longevity of your metering solution because it can adapt as your needs change. The measurements and other functions of the meters are provided by ION modules. You can quickly add or rearrange functions with drag-and-drop icons and a few clicks of a mouse. Imagine new features and build them with ION.

*Inputs/Outputs**

The ION 7300 series meters offer a variety of analog and digital I/O combinations. The analog I/O option can be specified for any ION 7300 series meter, allowing you to monitor a wide range of conditions, such as flow rates, device cycles (RPM), fuel levels, oil pressures and transformer temperatures. You can output energy pulses to an RTU or perform equipment control operations.

Status Inputs

Four optically isolated digital inputs on the ION 7330 and ION 7350 meters can monitor status, count transducer pulses, breaker trips and pulses from any external "volts free" dry contact.

Digital Outputs

ION 7300 series meters are equipped with 4 fully programmable digital output ports, suitable for pulsing or controlling relays. The Infrared Data Port and/or a rear panel LED can also be used for energy pulsing.

Relay Extension Board

An optional Digital Output Extension Board extends the meter's output capabilities with additional relay options. ***(Please contact Power Measurement for details.)***

Analog Inputs/Outputs

Any meter in the ION 7300 series can be equipped with an optional analog I/O card featuring:

- 4 analog inputs accepting 0 to 1mA or 0 to 20mA, (scalable from 4 to 20mA)
- 4 analog outputs providing 0 to 1mA or 0 to 20mA, (scalable from 4 to 20mA)

When equipped with analog I/O, TRAN base meters cannot be ordered with a remote display (RMD).

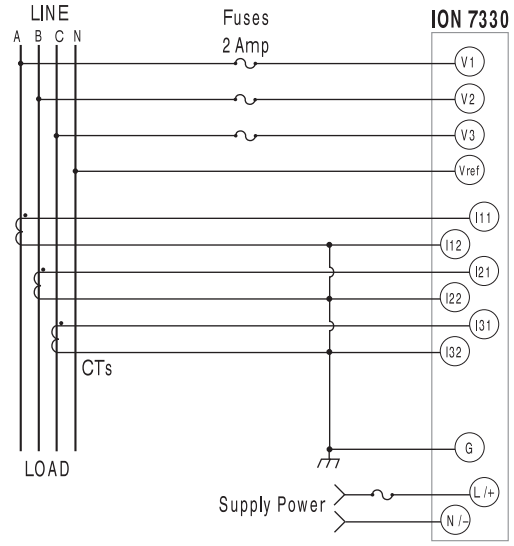
Connections and LEDs

The meters support 4-Wire Wye, Delta, 3-Wire Wye, Direct Delta and single phase systems. They have 3 voltage and 3 current inputs.

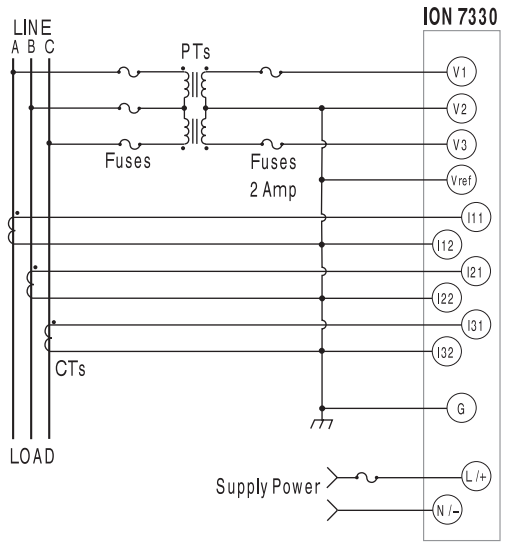
- No PTs required on the voltage inputs for Wye systems up to 347/600VAC and Delta systems up to 600VAC
- Accept CTs with 5A nominal/10A full scale outputs
- Captured-wire connector (CWC) option
- Inputs pass the ANSI/IEEE C37.90.1-1989 surge withstand and fast transient test

Example Connections

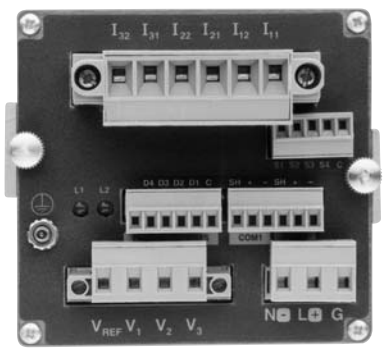
4-Wire Wye (Direct Connection)



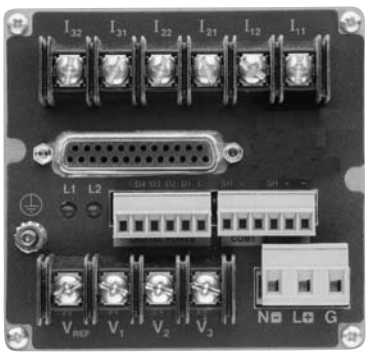
3-Wire Delta (2 PTS and 3 CTs)



ION 7330 Basic Model Rear Panel - CWC Option



ION 7300 Tran Model Rear Panel



* Analog I/O is not available with all form factors and communications configurations. Please check our on-line order forms for supported combinations.

Mounting

- Basic models have an integrated display and fit in a DIN standard 3.6 in. x 3.6 in. (92 mm x 92 mm) panel cutout, secured by sliding clamps tightened by thumbscrews.
- TRAN models have no integrated display and can be flush-mounted against any flat surface. Optional DIN rail mount is also available.
- The RMD (Remote Display Module), fits a DIN standard cutout up to 6 ft. (1.8 m) from the base meter. Off-the-shelf panel punches can be purchased. Contact us for sources.
- An adapter plate is available to facilitate the conversion from our 3000 series meters to ION 7300 series meters. Contact us for more information.
- Meters weigh approx. 4 lbs / 1.8 kg. Box dimensions are 15x11x7 in / 38x28x18 cm.

Switchboard Draw-out Cases

ION 7300 series meters can be ordered with switchboard hardware, which is offered as a complete kit (internal cage with external casing) and as a "retro-fit" kit designed to fit into existing GE S1 or ABB FT21 switchboard cases. The FT21 implementation supports type D4B-7F (in Delta volts mode) and type D4B-3F (in 4-wire Wye volts mode).

Ratings

Voltage Inputs

- 50 to 347 VAC L-N (277 VAC for CWC option)
- 25% overrange
- CWC option: Pluggable captured-wire connectors (max. 277 VAC on voltage inputs)
- All options: Overload withstand for 1500 VAC continuous, 3250 VAC for 1 second non recurring. Input impedance: > 2 M Ohms/phase (phase-Vref)

Current Inputs

- 5A nominal / 10 A full scale
- Starting current: 20 mA
- Overload withstand: 20 A continuous, 500A for 1 second non-recurring
- Worst case burden (at10A): 0.0625 VA
- 20% Overrange full accuracy

Power Supply

- Basic: 95 to 240 VAC (±10%), (47 to 440 Hz) 120 to 310 VDC (±10%), 0.2 A worst case loading (12 W) at 100 VAC at 25°C (77°F)
- P24 option: 20 to 60 VDC (±10%), 0.6 A worst case loading (12 W)

Environmental Conditions

- Operation: -20°C to +60°C (-4°F to +140°F) ambient air
- Storage: -30°C to +85°C (-22°F to +185°F)
- Humidity: 5% to 95% non-condensing

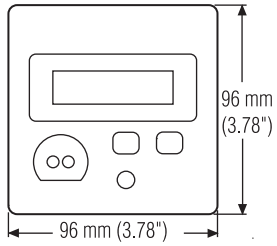
Digital Outputs

- 4 optically isolated digital outputs
- Maximum forward current: 80 mA
- Maximum voltage: 30 V

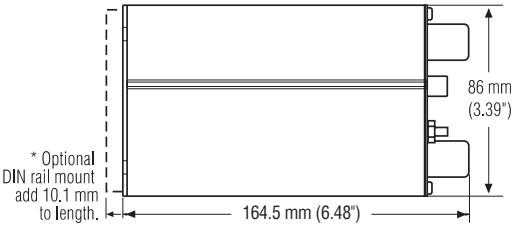
Dimensions

ION 7300 Series Panel Meter Configurations

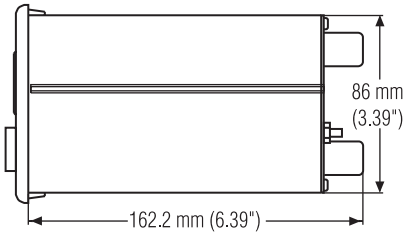
Front View of Basic, Display and RMD Models



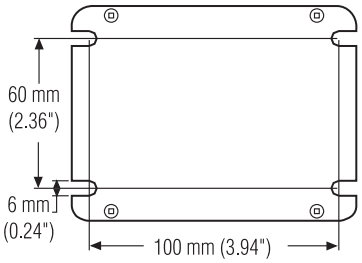
Side View of TRAN Base Unit with optional DIN rail mount



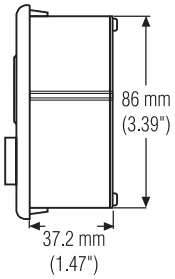
Side View of Basic and Display Models



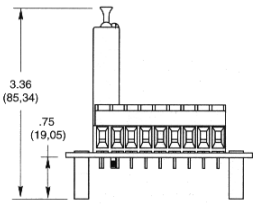
Front View of TRAN Base Unit



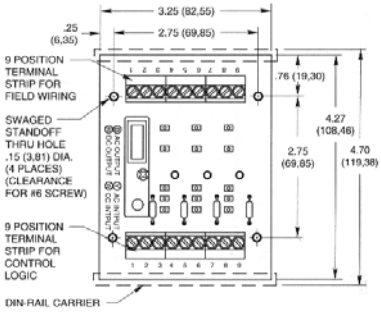
Side View RMD Display



End View of Relay Board

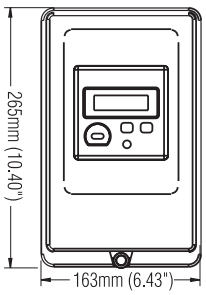


Top View of Relay Board

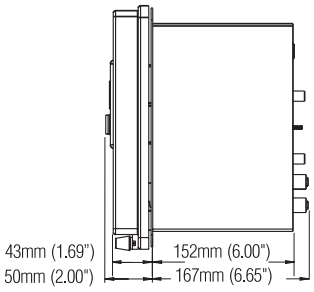


ION 7300 Series Switchboard Drawout Case Configurations

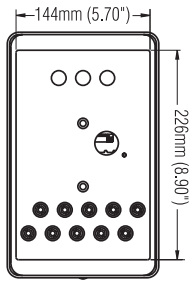
Front View of ABB FT21 Case



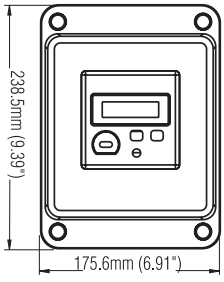
Side View of ABB FT21 Case



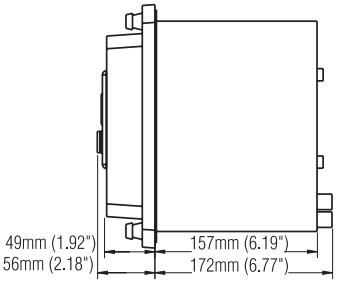
Rear View of ABB FT21 Case



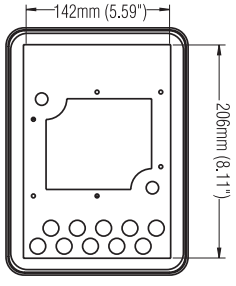
Front View of GE S1 Switchboard Case



Side View of GE S1 Switchboard Case



Rear View of GE S1 Switchboard Case



Measurement Specifications† (at 50.0Hz and 60.0Hz at 25ºC / 77ºF)

Parameter	Accuracy ±(%rdg + %FS*)
Voltage	0.25% + 0.05%
Frequency	±0.01Hz
Current	0.25% + 0.05%
kVA	0.5% + 0.1%
kVAR (>5% F.S.)	1.5% reading
kVAh	1.0% reading
kVARh	1.5% reading
Power Factor	1.5% reading
Total Harmonic Distortion (THD)	1.0% Full Scale
I4 Derivation	1.0% reading + 0.2% unbalanced
K Factor	5.0% Full Scale

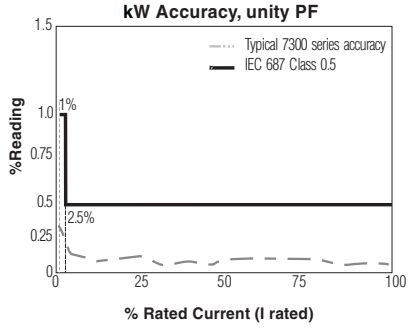
* *%Full scale voltage and current* † *50VAC to 347VAC +25%*

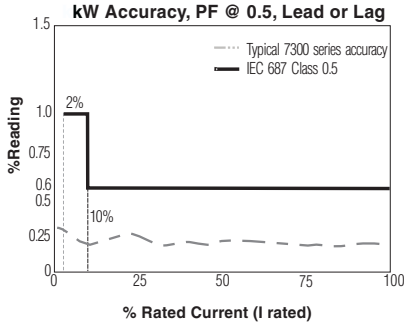
Display resolution meets or exceeds accuracy.

kW and kWh Measurements

	Accuracy*	Register Bounds	
		kW	kWh
ANSI 12.20 Class 0.5	0.5% reading	0 to ± $3.3x10^7$	0 to ± 10^{38}
IEC 60687 Class 0.5	0.5% reading	0 to ± $3.3x10^7$	0 to ± 10^{38}

**Accuracy specifications comply with IEC 687 Class 0.5 specification and ANSI 12.20 Class 0.5 at 25°C (77°F)*





User Programmable Log Capacity

Example Configurations:

			Waveform Recording Settings				
	Event	Data	Channel	Samples per cycle	Cycles	Record depth	# of days
ION 7330	500	A	-	-	-	-	29
	500	B	-	-	-	-	118
	500	C	-	-	-	-	96
	500	D	-	-	-	-	383
ION 7350	500	A	6	32	12	3	28
	500	B	6	32	12	3	111
	500	A	6	16	48	3	26
	500	D	6	64	16	3	331

A *16 parameters recorded every 15 minutes*
B *16 parameters recorded hourly*
C *4 parameters recorded every 15 minutes*
D *4 parameters recorded every hour*

Ratings (continued)

Status Inputs (ION 7330 and ION 7350 meters)

- Self-excited, dry contact, no external voltage source required
- +30VDC differential SCOM output to S1 through S4 inputs
- Minimum pulse width: 25msec

Analog Inputs

- Accuracy: <+-0.3% of full scale
- Update rate: 1s
- Input impedance: 24.3 Ω, 475 Ω (0 to 20mA, 0 to 1mA)
- Maximum source impedance (Ω): 500 Ω, 10k Ohms (0 to 20mA, 0 to 1mA)
- Channel to channel isolation: None
- Maximum common mode voltage: 30V

Analog Outputs

- Accuracy: <+-0.3% of full scale
- Maximum load drive capability: 500 Ω (0 to 20mA), 10k Ω (0 to 1mA)
- Channel to channel isolation: None
- Maximum common mode voltage: 30V

Standards Compliance

- UL: Certified to UL 3111
- CAN/CSA C22.2 No.1010-1
- CE marked
- EMC compliant to:

  EN 55014-1:1993 for Radiated and Conducted Emissions

  Electrical Fast Transient/burst Immunity – EN 61000-4-4

  EN 60687:1993 for Immunity to Electromagnetic HF Fields

  EN 60687:1993 for Immunity to Electrostatic Discharges
- IEC 1010-1
- Measurement Canada AE-0788
- OFGEM approved (UK)
- Surge withstand: All inputs pass ANSI/IEEE C37.90-1989 surge withstand and fast transient tests
- FCC: Part15, FCC Rules for Class A Digital Device
- Analog I/O: Each analog I/O pin passes IEC 61000-4-4 fast transient test with capacitive clamp (4kVp-p @ 2.5kHz for 1 min)

Datasheet: ION® 7300 | 7330 | 7350

Some features are optional.
To identify standard and optional features, please see the 'Product Order Forms' at www.pwrm.com.

Features and Options List	ION 7300	ION 7330	ION 7350
Power, Energy, and Demand			
Voltage/current per phase, average, unbalance	■	■	■
Power: real, reactive, apparent, power factor, frequency	■	■	■
Energy: bi-directional, total, import, export, net	■	■	■
Demand: block, rolling block, thermal	■	■	■
Power Quality			
Sag/Swell monitoring			■
Harmonics: individual, even, odd, total up to	15th	15th	31st
Sampling rate, maximum samples per cycle	32	32	64
Logging and Recording			
Standard memory capacity		300 kB	300 kB
Min/max logging for any parameter	■	■	■
Historical logs, maximum # of channels		32	96
Waveform logs, maximum # of cycles			48
Timestamp resolution in seconds		0.001	0.001
Communications and I/O (maximum #)			
RS-485 ports	1	2	2
Ethernet ports	1	1	1
Infrared optical port	1	1	1
Internal modem		1	1
PROFIBUS DP port	1		
DNP 3.0 through serial, modem and I/R ports		■	■
Modbus RTU slave on serial, modem and I/R ports	■	■	■
Modbus TCP through Ethernet port	■	■	■
EtherGate, data transfer between Ethernet and RS-485		■	■
ModemGate, data transfer between internal modem and RS-485		■	■
MeterM@il, logged data and alarms via e-mail*		■	■
WebMeter, onboard web server	■	■	■
Analog inputs	4	4	4
Analog outputs	4	4	4
Digital status inputs/counter		4	4
Digital relay outputs	4	4	4
Setpoints, Alarming, and Control			
Setpoints, minimum response time		1 second	1 second
Math, logic, trig, log, linearization formulas		■	■
Single and multi-condition alarms		■	■
Call-out on alarms			■
Revenue Metering and Standards			
ANSI C12.16 accuracy compliant	■	■	■
IEC 60687 accuracy class 0.5S compliant	■	■	■
ANSI class 10, (5A nominal, 10A max)	■	■	■
MV-90 on serial, Ethernet ports		■	■
Multi-year scheduling: hourly activity profiles		■	■

* The ION 7330 meter cannot send email alert messages because it does not have an Alert module.

LISTED Digital Power Monitor 20SJ

Certificate No. 002188

Meet the World Leader

Power Measurement is the leading provider of enterprise energy management systems for energy suppliers and consumers worldwide. Our ION® web-ready software and intelligent electronic devices comprise a complete, real-time information and control network that supports billing for complex energy contracts and helps improve power quality, reduce energy costs and keep operations running enterprise-wide, 24 hours a day. Our reputation for unparalleled value, quality and service is based on over two decades of innovation and experience.

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Revision Date: October 2007

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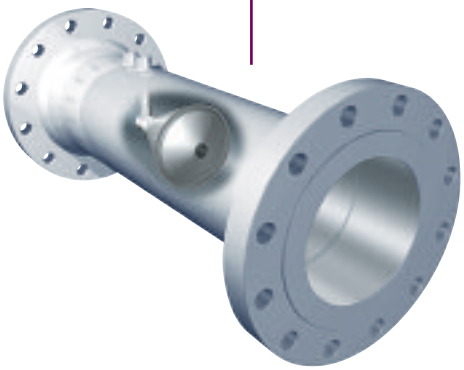
Technology

VCONE®



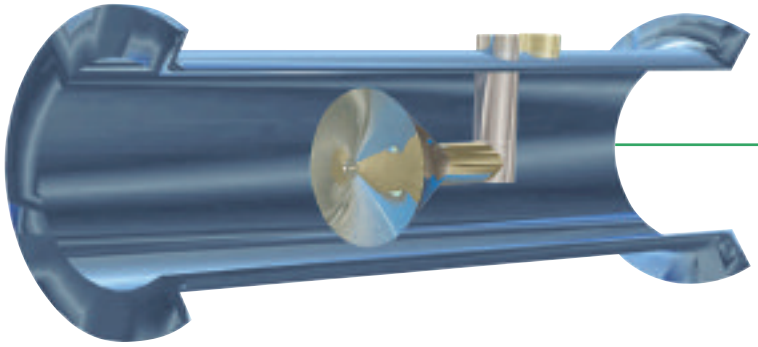
For the Real World.

McCROMETER
The Flow Measurement Specialists

50TH ANNIVERSARY
McCROMETER • 1955 • 2005

V-Cone – A New DP Technology

Designed f



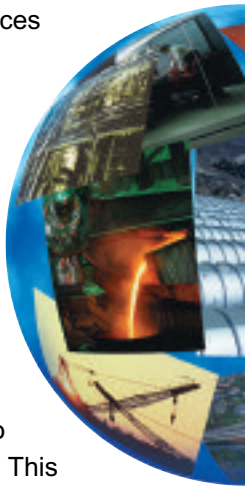
Cut away view of centrally-located cone.

High Performance in "Real World" Applications

MccCrometer's V-Cone is an innovative flowmeter that takes differential pressure-type flow measurement to another level. Designed for the harshest operating environments and for the widest variety of fluids, this advanced flowmeter consistently outperforms traditional DP devices and other major flow technologies. The V-Cone offers better accuracy and repeatability, wider rangeability, installation flexibility and reduced maintenance. Its performance is so outstanding, some users say it deserves a technology name all its own.

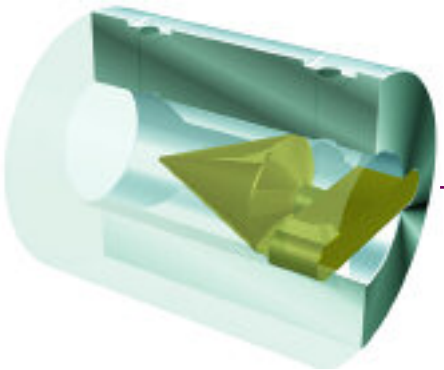
Accuracy You Can Count On

The key benefit to the V-Cone's unique design is its ability to provide repeatable accuracy of up to ±0.5% of rate under even the most difficult flow conditions, and over a wide range of Reynolds numbers. Whether measuring swirling fluids or low pressure flows, the V-Cone delivers the accuracy and reliability other devices only achieve under lab conditions.



Acts as own flow conditioner

The V-Cone's enhanced performance is due to the shape and position of the cone in relation to the measurement ports. This allows the V-Cone to act as its own flow conditioner, fully conditioning



The Wafer-Cone® can be fitted between two flanges for more compact installation. It is available in a variety of materials and the cone can be easily replaced to accomodate changing flow conditions.

for Difficult-to-Measure Applications

and mixing the flow prior to measurement. The result is a low amplitude, high frequency signal with little "signal bounce." Readings are always precise and reliable, including in low pressure flow situations.

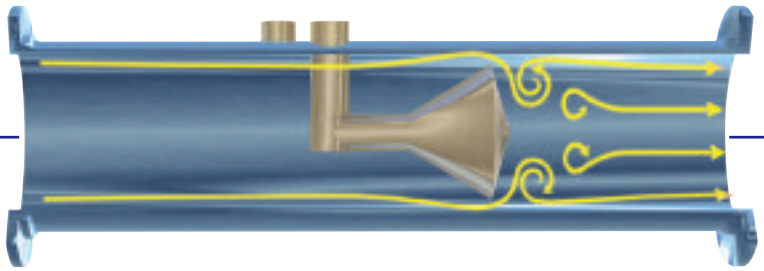
Maximum Installation Flexibility

The V-Cone's ability to condition the flow prior to measurement results in another significant benefit: installation flexibility. Because the V-Cone can accurately measure disturbed flow, it doesn't require the upstream or downstream straight pipe runs of many other flowmeters. This key feature means the V-Cone can be installed virtually anywhere in a piping system or easily retrofit into an existing piping layout. The result can be significant cost savings. It also means the V-Cone can fit where other flowmeters can't due to limited-space or weight requirements.

Low-to-No Operating Costs

The V-Cone assures long-term performance. It has no moving parts to replace and maintain. In addition, the contoured shape of the cone directs the flow without impacting it against an abrupt surface. Instead, a boundary layer forms along the cone, directing fluid away from the beta edge. Because the beta edge remains unchanged, the calibration of the meter is accurate for a much longer time, possibly indefinitely.

The V-Cone forms very short vortices as the flow passes the cone. These short vortices create a low amplitude, high frequency signal for excellent signal stability.



The V-Cone's contour-shaped cone also directs the flow without impacting it against an abrupt surface. As a result, the beta edge of the cone is not subject to wear by dirty fluids. Because it remains unchanged, V-Cones rarely, if ever, require recalibration.

Pipe flow is rarely ideal. Practically any change to the piping can disturb even a well-developed flow. The contoured shape and location of a suspended cone in the V-Cone Flowmeter overcomes this by reshaping the velocity profile upstream. As the flow approaches the cone, the flow profile "flattens" toward the shape of a well-developed profile – even in extreme flow conditions.

Flexible Design Meets Range of Needs

The V-Cone Flowmeter offers exceptional sizing flexibility. It can be sized for line diameters of 1/2" to over 120". It also comes in two standard configurations: a precision flow tube or insertion weld-on saddle meter. A variety of construction materials is also available.

McCrometer Application Support

At McCrometer, all we make are flowmeters. We have 50 years of flow measurement experience in municipal, industrial and agricultural markets.

Our knowledgeable staff can accurately evaluate your flow application and specify the best metering technology for your specific flow condition. For a free evaluation of your flow application or to find out about our other flowmeter products, contact your McCrometer representative today.

VCONE®

V-Cone Performance Advantages

high accuracy

•

high repeatability

•

conditions flow before measuring

•

minimum straight pipe requirements

•

broad rangeability

•

low headloss

•

clean or dirty liquids, wet gases, slurries

•

low signal noise

•

self cleaning

Difficult-to-Measure Applications

Ideal for Tough Applications

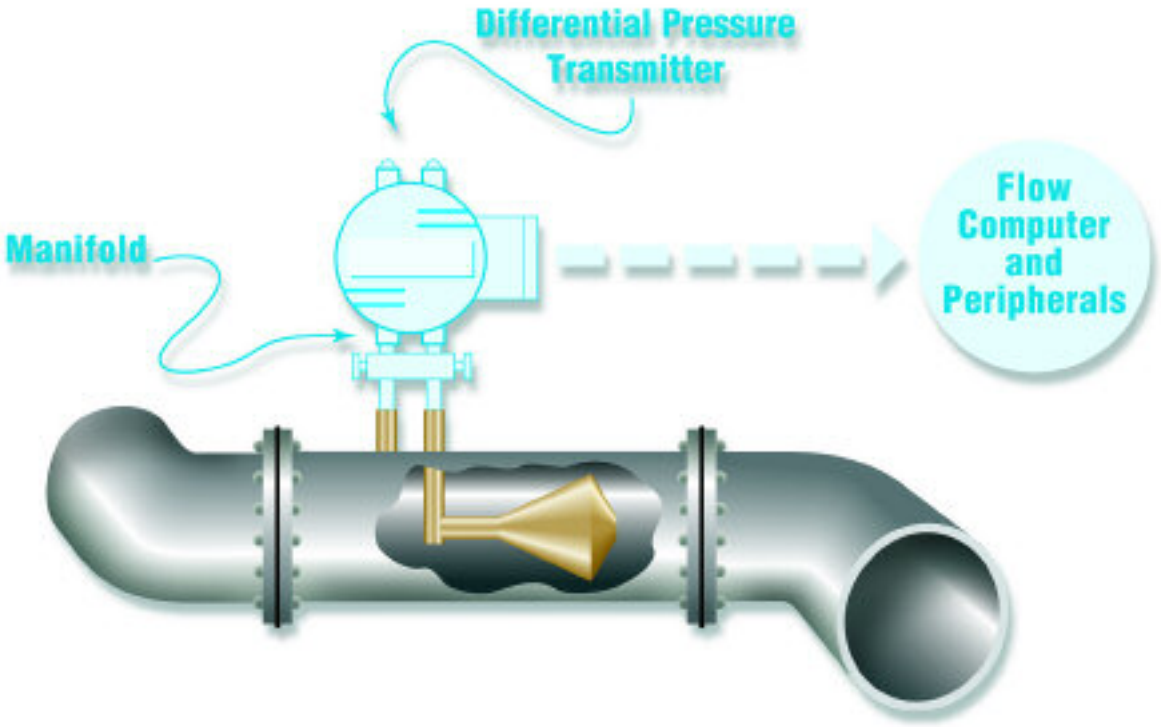
- oil & gas production and delivery
- petroleum refining
- municipal water & wastewater
- chemical/ pharmaceutical processing
- power/co-generation
- mining
- pulp & paper
- industrial manufacturing
- food & beverage

The McCrometer V-Cone Flowmeter is a patented technology that accurately measures flow over a wide range of Reynolds numbers, under all kinds of conditions and for a variety of fluids. It operates on the same physical principle as other differential pressure-type flowmeters, using the theorem of conservation of energy in fluid flow through a pipe.

Advanced DP Technology: Principles of Operation

The V-Cone's remarkable performance characteristics, however, are the result of its unique design. It features a centrally-located cone inside the tube. The cone interacts with the fluid flow, reshaping the fluid's velocity profile and creating a region of lower pressure immediately downstream of itself. The pressure difference, exhibited between the static line pressure and the low pressure created downstream of the cone, can be measured via two pressure sensing taps. One tap is placed slightly upstream of the cone, the other is located in the downstream face of the cone itself. The pressure difference can then be incorporated into a derivation of the Bernoulli equation to determine the fluid flow rate.

The cone's central position in the line optimizes the velocity of the flow at the point of measurement, assuring highly accurate, reliable flow measurement regardless of the condition of the flow upstream of the meter.



Standard Accuracy:	From ±0.5% of actual flow (certain fluids and Reynolds number applications require special calibrations to achieve this value).
Repeatability:	±0.1% or better.
Flow Ranges:	10:1 and greater.
Standard Beta Ratios:	0.45 through 0.80, special betas available.
Head Loss:	Varies with beta ratio and DP.
Installation Piping Requirements:	Typically 0-3 diameters upstream and 0-1 diameters downstream of the cone are required, depending on fittings or valves in the adjacent pipeline.
Materials of Construction Include:	Duplex 2205, 304, or 316 stainless steel, Hastelloy C-276, 254, SMO, carbon steels. Special materials on request.
Line Sizes:	0.5″ to 120″ or larger.
End Fittings:	Flanged, threaded, hub or weld-end standard. Others on request.
Configurations:	Precision flow tube and wafer-type. • Calibrated for customer application. • ASME B31.3 construction available.
Approvals for the V-Cone:	• Canadian custody transfer approved. • Meters in compliance with PED97/23/EC are available upon request. • The V-Cone is manufactured under a quality management system that is certified to ISO 9001:2000.

McCROMETER
The Flow Specialists for 50 Years

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I/A Series® Electronic Pressure Transmitters Model IDP10 with 4 to 20 mA Analog Output for Differential Pressure Measurement

IDP10
LOW PROFILE
STRUCTURE LP1

IDP10
TRADITIONAL
STRUCTURE

IDP10
LOW PROFILE
STRUCTURE LP2

This analog output, two-wire d/p Cell® Transmitter provides precise, reliable, measurement of differential pressure, and transmits a 4 to 20 mA analog output signal.

HIGH DEPENDABILITY AND VALUE

- Available with traditional or low profile structures.
- Superior Performance and long term stability from micoprocessor-based technology.
- Industry standard 316L ss, Co-Ni-Cr, Hastelloy C, Monel, or Tantalum sensor materials, depending on transmitter structure.
- Durable aluminum or 316 ss housing available; both meet NEMA 4X and IEC IP66.
- Optional mounting bracket sets allow pipe, surface, or manifold mounting of transmitter.
- CE marked; complies with applicable EMC, ATEX, and PED European Directives.
- Designed for hazardous area installations. Versions available to meet Agency flameproof and zone requirements.
- Standard 5-year warranty.

INTELLIGENT TRANSMITTER FEATURES AT AN ECONOMICAL PRICE

When you want the flexibility and performance of a configurable, intelligent transmitter but you don't need a digital output signal, these transmitters provide exceptional benefits at a very affordable price:

- Liquid Crystal Display (LCD) digital indicator with on-board pushbuttons
- Pushbutton configuration and calibration:
  - Linear or square root output
  - Adjustable damping
  - Forward or reverse output
  - Failsafe output; upscale or downscale
  - Reranging without applying pressure
- Easily upgradeable to fully intelligent version (FoxCom™, HART, FOUNDATION Fieldbus, or PROFIBUS)

invensys®
FOXBORO®

I/A Series PRESSURE TRANSMITTER FAMILY

This complete family of d/p Cell®, gauge, absolute, multirange, multivariable, and premium performance transmitters, as well as transmitters with remote or direct connect pressure seals, all using field-proven silicon strain gauge sensors and common topworks.

MODULAR ELECTRONICS

Select the electronics module you need to provide just the right level of intelligence for your application and budget. If your needs change, the modular design allows easy migration to other protocols — including FoxCom, HART FOUNDATION Fieldbus, PROFIBUS, and 1 to 5 V dc versions.

ELECTRONICS VERSION -A TRANSMITTER

This transmitter uses the -A electronics module. It is a very economical analog output transmitter that provides full configuration capability. It represents an Invensys Foxboro advancement in providing the greatest functionality for the largest number of applications at the least possible cost to you. It even provides the ability to rerange to new calibrated ranges, using the standard LCD Indicator, without the need to apply calibration pressure.

It is designed for use in Division 1 hazardous areas, and complies with Division 2 requirements. Also versions are available to meet Agency flameproof and zone requirements. See Electrical Safety Specifications section.

WIDE MEASUREMENT RANGE WITH A MINIMUM OF SENSORS

Five sensors are provided to cover measurement spans from 0.12 to 21 000 kPa (0.018 to 3000 psi). The high turndown capability of the transmitter means that nearly all applications can be satisfied with only these five ranges, greatly simplifying your spare transmitter and spare parts requirements.

STANDARD LCD DIGITAL INDICATOR

A two-line digital indicator, shown in Figure 17, is provided as standard with this transmitter. The indicator displays the measurement with a choice of units. Two on-board pushbuttons allow zero and span adjustments, as well as local configuration, without the need for a PC-Based Configurator.

SENSOR CORROSION PROTECTION

For traditional structure, choice of 316L ss, Co-Ni-Cr, Hastelloy C, Monel, Gold-Plated 316L ss, and Tantalum materials. High corrosion resistance of Co-Ni-Cr (TI 037-078) means long service life in many difficult applications without the extra cost for exotic materials. See TI 037-75b for process applicability with Co-Ni-Cr and other process wetted materials.

For low profile structures LP1 and LP2, 316L ss and Hastelloy C are offered as sensor materials. Refer to Transmitter Structures section that follows for description and application of traditional and low profile (LP1 and LP2) structures.

HIGH PERFORMANCE

These transmitters utilize microprocessor-based correction to achieve both excellent accuracy and ambient temperature compensation.

EASE OF INSTALLATION

Rotatable Topworks allows transmitter installation in tight places, allows indicator to be positioned in preferred direction, and eases field retrofit.

Two Conduit Entrances offer a choice of entry positions for ease of installation and self-draining of condensation regardless of mounting position and topworks rotation.

Wiring Guides and Terminations provide ease of wire entry and support, plenty of space to work and store excess wire, and large, rugged screw terminals for easy wire termination.

PROCESS CONNECTORS

Removable, gasketed process connectors allow a wide range of selections, including 1/4 NPT, 1/2 NPT, Rc 1/4, Rc 1/2, and weld neck connections. For highly corrosive chemical processes when a traditional structure is used, two 1/2 NPT pvdf inserts (Figure 1) are installed in both 316 ss covers and are used as the process connectors. In these applications, tantalum is used as the sensor diaphragm material.

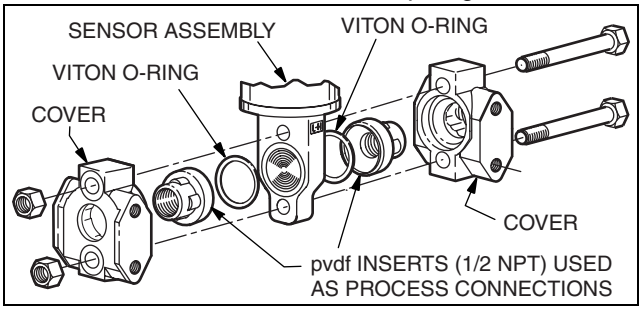


Figure 1. Bottomworks Shown with 1/2 NPT pvdf Inserts Installed in HI- and LO-Side Covers with Traditional Structure

OPTIONAL MOUNTING BRACKET SETS

In addition to the standard style mounting bracket sets optionally offered with these transmitters, a unique universal style mounting bracket has been developed to allow wide flexibility in transmitter mounting configurations consistent with installation requirements. All mounting bracket sets allow mounting to a surface, pipe, or manifold. Refer to Dimensions - Nominal section.

UNIQUE PROCESS COVER AND CELL BODY DESIGN

Biplanar Construction (Figure 2) maintains the traditional horizontal process connections and vertical mounting by providing a cell body contained between two process covers, while still achieving light weight, small size, and high standard static pressure rating of 25 MPa (3625 psi). This provides easy retrofit of any conventional differential pressure transmitter, and also is easily mounted in the horizontal position with vertical process connections, when required.

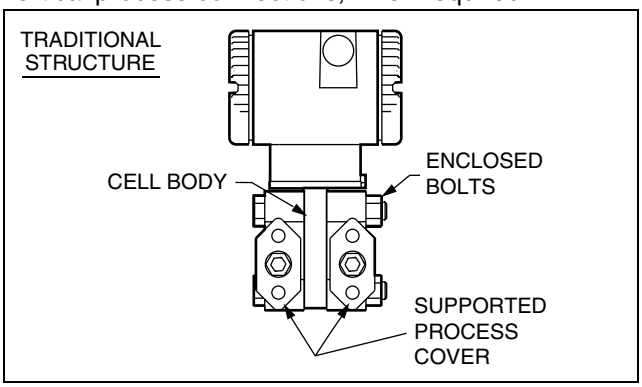


Figure 2. Biplanar Construction Shown with Traditional Horizontal Process Connections

Process Covers (Figure 2) are fully supported by the cell body over their entire height. This prevents bending and results in a highly reliable seal. Also, this provides dimensional stability to the process covers, ensuring that they will always mate properly with 3-valve bypass manifolds.

Process Cover Bolts (Figure 2) are enclosed to minimize corrosion and to minimize early elongation with rapid temperature increases. The design makes it less likely for the transmitter to release process liquid during a fire.

Process Cover Gaskets are ptfe as standard; ptfe provides nearly universal corrosion resistance, and eliminates the need to select and stock various elastomers to assure process compatibility.

Light Weight provides ease of handling, installation, and direct mounting without requiring costly pipe stands.

TRANSMITTER STRUCTURES

Traditional and low profile structures (LP1 and LP2) are offered to accommodate and to provide flexibility in transmitter installations. See paragraphs below.

Traditional Structure

The traditional structure (Figure 3) utilizes the right angle design common to most DP transmitters in use throughout the world. Process connections are oriented 90 degrees from the transmitter centerline. This traditional structure makes it easy to retrofit any transmitters of similar design.

Sensor cavity venting and draining is provided for both vertical and horizontal transmitter installation, using innovative tangential connections to the sensor cavity (Figures 4 and 5). Optional side vents are offered for sensor cavity venting in the upright position (Figure 6).

An extensive variety of process-wetted materials are available for the process covers on this highly versatile and widely used transmitter.

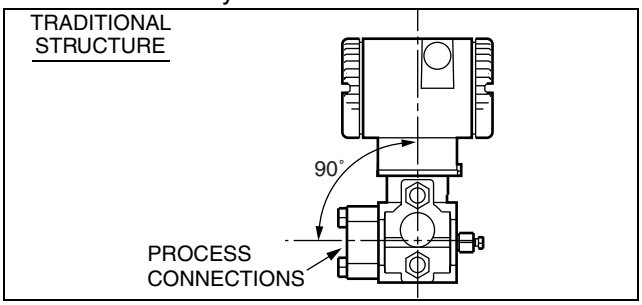


Figure 3. Vertical Mounting Showing Process Connections at 90 degrees

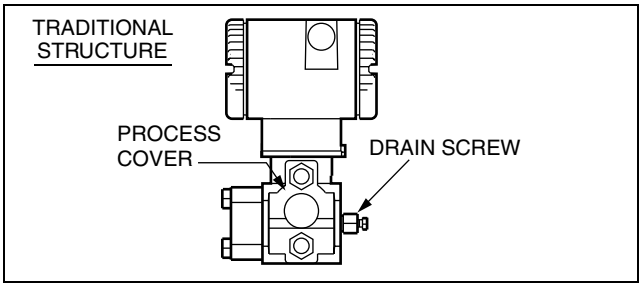


Figure 4. Vertical Mounting - Cavity Draining

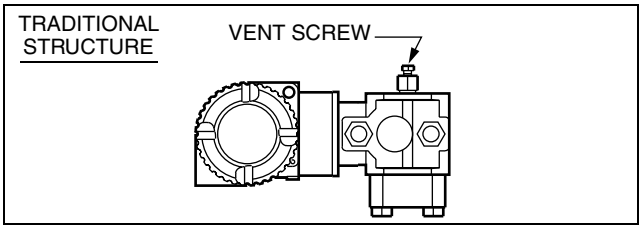


Figure 5. Horizontal Mounting - Cavity Venting, and Self-Draining into Process Line

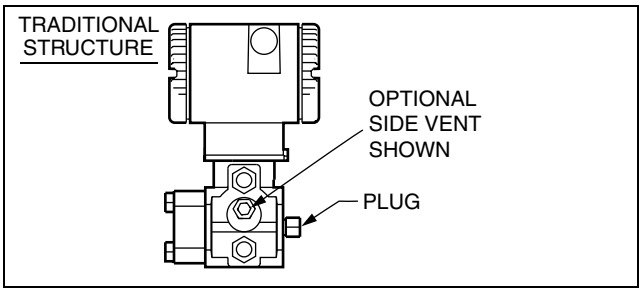


Figure 6. Vertical Mounting - Cavity Venting, and Self-Draining into Process Line

Low Profile Structures

The low profile structures utilize an in-line design, placing the process connections in line with the transmitter centerline (Figures 7 and 8). This allows mounting of the transmitter in the upright position with the process connections facing downward, for connection to vertical process piping or for mounting directly to a three- or five-valve manifold.

The low profile structures provide a mounting style similar to that used by competitive Coplanar™ transmitters. This makes it easy to select Foxboro transmitters for both retrofit and new applications where this type of installation is desired.

Transmitters with the low profile structure can be attached directly to existing, installed Coplanar manifolds, such as the Rosemount Model 305RC or Anderson Greenwood Models MC3, MC5G, MC5P, and MT3 by use of an optional adapter plate (Figure 9). Also, when assembled to the same process piping or manifold as a Coplanar transmitter, one of the electrical conduit connections is located within ± one inch of the similar conduit connection on the competitive transmitter, assuring ease of retrofit or conformance with installation design drawings.

All parts making up the low profile versions are identical to the parts in the traditional version except for the process covers and the external shape of the sensor cell body.

For user convenience, two types of low profile structures are offered, type LP1 and LP2. The process covers are the only transmitter parts that differ between structure types LP1 and LP2.

Refer to the sections that follow for further descriptions of low profile structures LP1 and LP2.

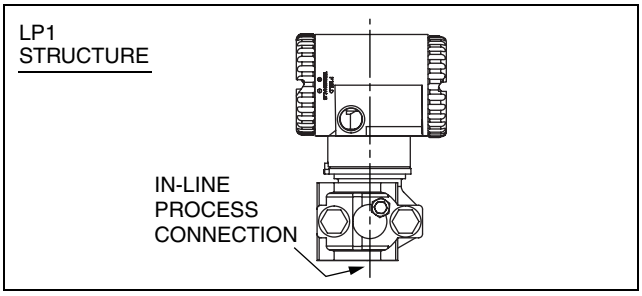


Figure 7. Low Profile Structure - LP1 Shown

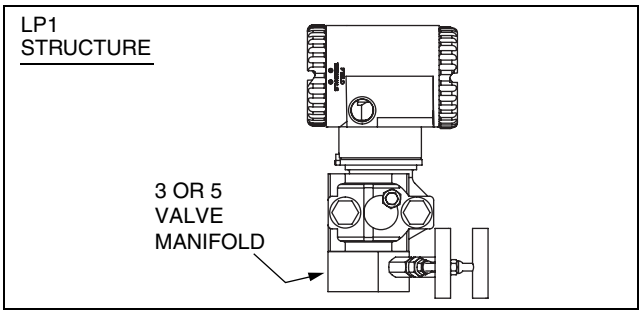


Figure 8. LP1 Shown Directly Mounted to Manifold

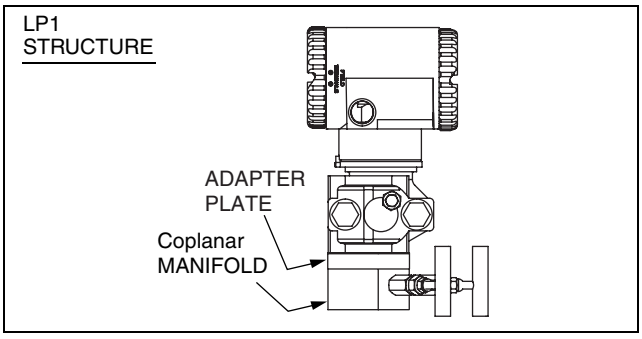


Figure 9. LP1 Shown Mounted to a Coplanar Manifold using an Optional Intermediate Adapter Plate

Low Profile Structure LP1 – Direct Mount

Low Profile Structure LP1 is a compact, inexpensive, lightweight design for direct mounting to a separately mounted manifold or process piping. These transmitters are not typically bracket-mounted.

They are supplied as standard with a single vent/drain screw in the side of each process cover. In conjunction with the standard tangential venting and draining design, they are suitable for mounting either vertically (Figure 10) or horizontally, and are suitable for nearly all applications, including liquids, gases, and steam. For horizontal installation, they can simply be “turned over” (rotated 180 degrees - Figures 11 and 12) to orient the high and low pressure sides in the preferred locations. There is no need to unbolt process covers. The topworks housing can also be rotated, as shown, to orient the conduit connections in the desired position.

In the vertical, upright position, they are also self-draining and are ideal for gas flow rate service, when directly mounted to a manifold located above the horizontal pipeline. The vent screw can be omitted for this or other applications, if desired.

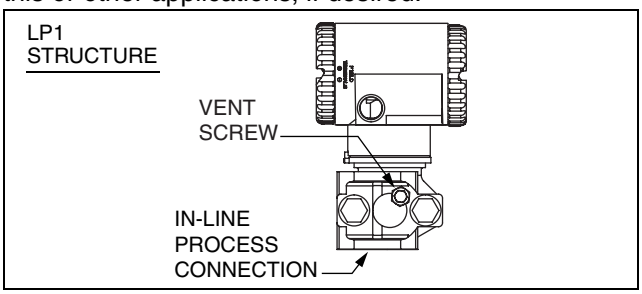


Figure 10. Upright Mounting

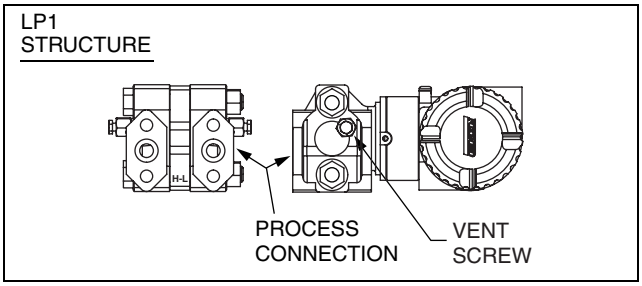


Figure 11. Horizontal Mounting with Vent Screw

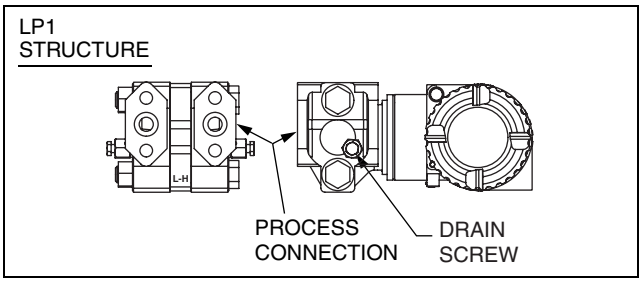


Figure 12. Horizontal Mounting with Drain Screw

Low Profile Structure LP2 - Bracket or Direct Mount

Low Profile Structure LP2 is a universal design for either bracket or direct mounting. Drilled and tapped mounting holes facilitate mounting to either new or existing Foxboro brackets (Options -M1, -M2, and -M3), as well as standard brackets supplied with existing Coplanar transmitters. See Figures 13 and 14.

These transmitters can also be directly mounted to manifolds or process piping and are available with the same optional adapter used with low profile structure LP1 to fit existing Coplanar manifolds (Figure 15).

For extra convenience, they use a full-featured vent and drain design, with separate vent and drain screws positioned in each cover for complete venting or draining directly from the sensor cavity. They are normally recommended for upright, vertical installation.

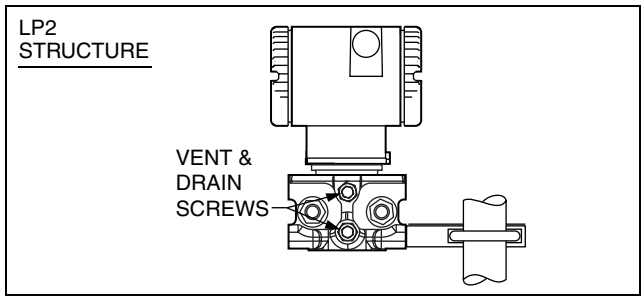


Figure 13. Shown on Foxboro Universal Bracket

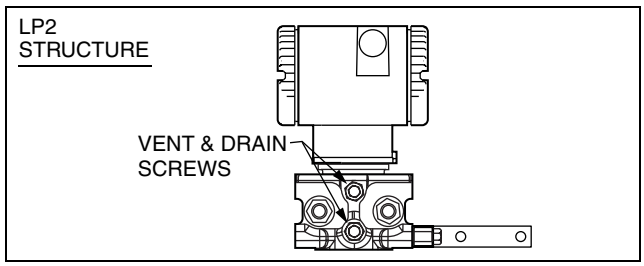


Figure 14. Shown on Coplanar Bracket

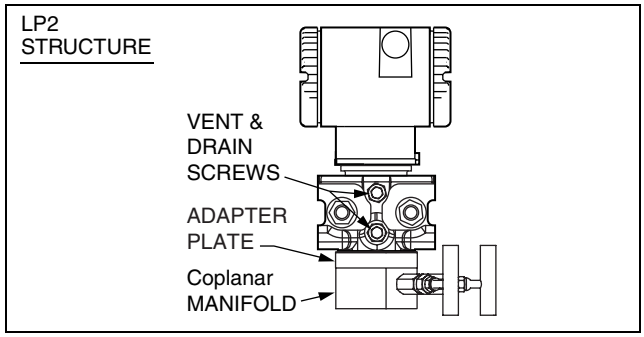


Figure 15. Adapter Mount to Existing Coplanar Manifold

PRESSURE SEALS

Pressure seals are used with transmitters having a traditional structure (see Transmitter Structures section above) when it is necessary to keep the transmitter isolated from the process. A sealed system is used for a process fluid that may be corrosive, viscous, subject to temperature extremes, toxic, sanitary, or tend to collect and solidify.

Table 1 lists the various pressure seals that can be used with an IDP10 Transmitter. To order a transmitter with seals, both a Transmitter Model Number and Seal Model Number are required. For a complete listing of pressure seal models and specifications, see PSS 2A-1Z11 A. Also see Figure 16 for typical pressure seal configurations.

Table 1. Pressure Seals Used with IDP10 Transmitters

Direct Connect Pressure Seal Assemblies		
Seal Model	**Seal Description**	**Process Connections**
PSFLT	Flanged, Direct Connect (Flanged Level), Flush or Extended Diaphragm	ANSI Class 150/300/600 flanges and BS/DIN PN 10/40, 10/16, 25/40 flanges
PSSCT	Sanitary, Direct Connect (Level Seal), Flush Diaphragm	Process Connection to Sanitary Piping with 2- or 3-inch Tri-Clamp
PSSST	Sanitary, Direct Connect (Level Seal), Extended Diaphragm	Process Connection to 2-in Mini Spud or 4-in Standard Spud; Tri-Clamp
Remote Mount, Capillary-Connected Pressure Seal Assemblies		
Seal Model	**Seal Description**	**Process Connections**
PSFPS	Flanged, Remote Mount, Flush Diaphragm	ANSI Class 150/300/600 flanges and BS/DIN PN 10/40 flanges
PSFES	Flanged, Remote Mount, Extended Diaphragm	ANSI Class 150/300/600 flanges and BS/DIN PN 10/40, 10/16, 25/40 flanges
PSFAR	Flanged, Remote Mount, Recessed Diaphragm	ANSI Class 150/300/600/1500 flanges
PSTAR	Threaded, Remote Mount, Recessed Diaphragm	1/4, 1/2, 3/4, 1, or 1 1/2 NPT internal thread
PSISR	In-Line Saddle Weld, Remote Mount, Recessed Diaphragm	Lower housing of seal is in-line saddle welded to nominal 3- or 4-inch (and larger) Pipe
PSSCR	Sanitary, Remote Mount, Flush Diaphragm	Process Connection secured with a Tri-Clamp to a 2- or 3-inch pipe
PSSSR	Sanitary, Remote Mount, Extended Diaphragm	Process Connection to 2-in Mini Spud or 4-in Standard Spud; Tri-Clamp

Figure 16. Typical IDP10 Pressure Seals

FUNCTIONAL SPECIFICATIONS

Span Limits for IDP10 d/p Cell Transmitters

Code	kPa	psi	mbar	mmHg	mmH_2O	inH_2O
A (a)	0.12 and 7.5	0.018 and 1.1	1.2 and 75	0.93 and 56	12 and 750	0.5 and 30
B	0.87 and 50	0.125 and 7.2	8.7 and 500	6.5 and 375	87 and 5000	3.5 and 200
C	7 and 210	1 and 30	70 and 2100	50 and 1500	700 and 21 000	28 and 840
Code	**MPa**	**psi**	**bar or kg/cm^2**	**mHg**	**mH_2O**	**ftH_2O**
D	0.07 and 2.1	10 and 300	0.7 and 21	0.5 and 15	7 and 210	23 and 690
E (b)	0.7 and 21(b)	100 and 3000 (b)	7 and 210 (b)	5 and 150 (b)	70 and 2100 (b)	230 and 6900 (b)

(a) Span Limit Code "A" not available when pressure seals are selected.
(b) When certain options are specified, the upper span and range limits are reduced as shown in the "Options Impact" table below.

Range Limits for IDP10 d/p Cell Transmitters (a)

Code	kPa	psi	mbar	mmHg	mmH_2O	inH_2O
A (b)	-7.5 and +7.5	-1.1 and +1.1	-75 and +75	-56 and +56	-750 and +750	-30 and +30
B	-50 and +50	-7.2 and +7.2	-500 and +500	-375 and +375	-5000 and +5000	-200 and +200
C	-210 and +210	-30 and +30	-2100 and +2100	-150 and +150	-21 000 and +21 000	-840 and +840
Code	**MPa**	**psi**	**bar or kg/cm^2**	**mHg**	**mH_2O**	**ftH_2O**
D	-0.21 and +2.1	-30 and +300	-2.1 and +21	-1.5 and +15	-21 and +210	-69 and +690
E (c)	-0.21 and 21 (c)	-30 and +3000 (c)	-2.1 and +210 (c)	-1.5 and +150 (c)	-21 and +2100 (c)	-69 and +6900 (c)

(a) Positive values indicate HI side of sensor at the high pressure, and negative values indicate LO side of sensor at the high pressure.
(b) Span Limit Code "A" not available when pressure seals are selected.
(c) When certain options are specified, the upper span and range limits are reduced as shown in the "Options Impact" table below.

Impact of Certain Options on Span and Range Limits (a)

Option	Description (Also see Model Code)	Span and Range Limits Derated to:
-B3	B7M Bolts and Nuts (NACE)	20 MPa (2900 psi, 200 bar, or kg/cm^2)
-D1	DIN Construction	16 MPa (2320 psi, 160 bar or kg/cm^2)
-D5 or -B1	DIN Construction or 316 ss Bolting	15 MPa (2175 psi, 150 bar or kg/cm^2)
-D2, -D4, -D6, or -D8 (a)	DIN Construction (a)	10 MPa (1500 psi, 100 bar or kg/cm^2) (a)

(a) Refer to Model Code section for application and restrictions related to the items listed in the table.

Maximum Static and Proof Pressure Ratings for IDP10 d/p Cell Transmitters (a)

Transmitter Configuration (See Model Code for Description of Options)	Static Pressure Rating			Proof Pressure Rating (b)		
	MPa	psi	bar or kg/cm^2	MPa	psi	bar or kg/cm^2
With Option -D9 or -Y	40	5800	400	100	14500	1000
Standard or with Option -B2, -D3, or -D7	25	3625	250	100	14500	1000
With Option -B3	20	2900	200	70	11150	700
With Option -D1	16	2320	160	64	9280	640
With Option -B1 or -D5	15	2175	150	60	8700	600
With Option -D2, -D4, -D6, or -D8	10	1500	100	40	6000	400
With Structure Codes 78 and 79 (pvdf insert)	2.1	300	21	8.4	1200	84

(a) Refer to Model Code section for application and restrictions related to the items listed in the table.
(b) Proof pressure ratings meet ANSI/ISA Standard S82.03-1988. Unit may become nonfunctional after application of proof pressure.

Output Signal
4 to 20 mA, Linear or Square Root (Configurable)

Electrically Adjustable Damping
Response time is normally 0.75 s, or setting of 0 (none), 2, 4, or 8 seconds, whichever is greater, for a 90% recovery from an 80% input step per ANSI/ISA S51.1. (For 63.2% recovery, 0.50 s with sensors B to E, and 0.60 s with sensor A.)

Suppressed Zero and Elevated Zero
Suppressed or elevated zero ranges are acceptable as long as Span and Range limits are not exceeded.

Field Wiring Reversal
No transmitter damage.

Zero and Span Adjustments (Figure 17)
Zero and span adjustments can be accomplished using the pushbuttons on the LCD indicator.

FUNCTIONAL SPECIFICATIONS (Cont.)

Standard Liquid Crystal Display (LCD) Indicator with On-Board Pushbuttons (Figure 17)

Indicator Provides:

- Two Lines; four numeric characters on top line and seven alphanumeric characters on bottom line.
- Measurement Readout; value on top line and units label on bottom line.
- Configuration and Calibration Prompts.

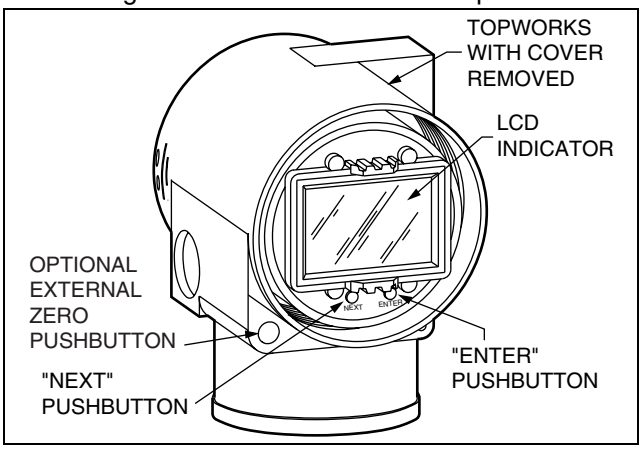


Figure 17. LCD Indicator with Pushbuttons

Optional External Zero Adjustment (Figure 17)

An external pushbutton mechanism is isolated from the electronics compartment and activates (magnetically) an internal reed switch through the housing. This eliminates a potential leak path for moisture or contaminants to get into the electronics compartment. The optional external zero adjustment can be disabled by a configuration selection.

European Union Directives

- Complies with Electromagnetic Compatibility Requirements of European EMC Directive 89/336/EEC by conforming to the following CENELEC and IEC Standards: EN 50081-2, EN 50082-2, and IEC 801-2 through 801-6.
- Complies with NAMUR Part 1 Interference Immunity Requirement.
- Conforms to Applicable European Union Directives (“CE” Logo marked on product).

Square Root Low Flow Cutoff

User configurable to provide:

- Cutoff to zero at flows <10% of maximum flow (1% of maximum differential pressure).
- Or active point-to-point line between zero and 20% of maximum flow (4% of maximum differential pressure).

Supply Voltage Requirements and External Loop Load Limitations (Figure 18)

Nominal minimum voltage shown in Figure 18 is 11.5 V dc. This can be reduced to 11 V dc using a plug-in jumper across the test receptacles in the field wiring compartment terminal block. An optional plug-in shorting bar (Figure 21) is offered for this purpose.

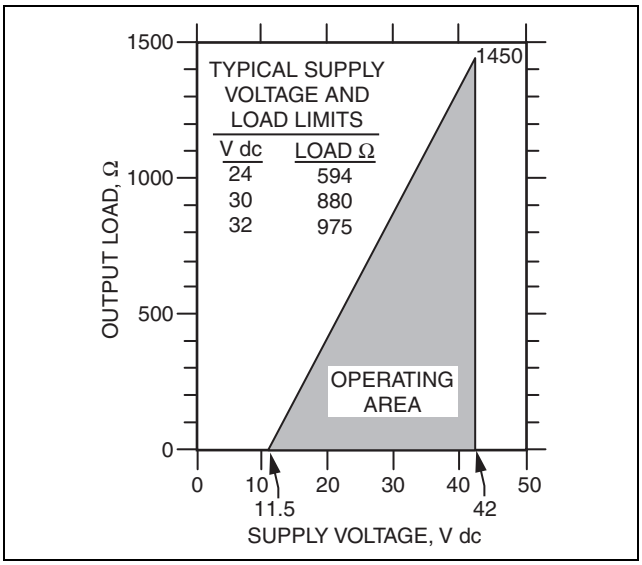


Figure 18. Supply Voltage vs. Output Load

Minimum Allowable Absolute Pressure vs. Transmitter Temperature

WITH SILICONE FILL FLUID

Full vacuum: up to 121°C (250°F)

WITH FLUORINERT FILL FLUID

Refer to Figure 19.

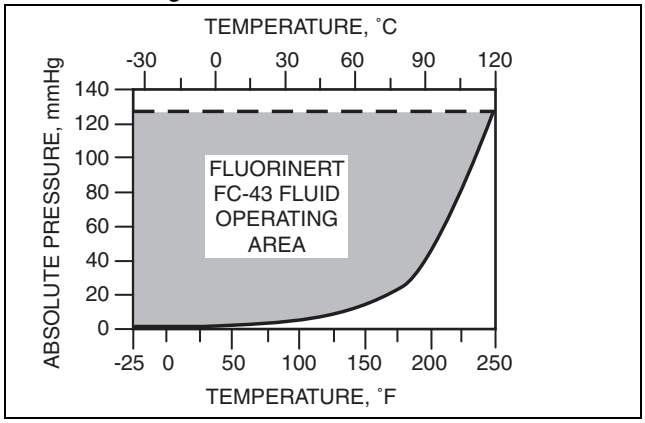


Figure 19. Minimum Allowable Absolute Pressure vs. Transmitter Temperature, Fluorinert FC-43, 2.6 cSt at 25°C (77°F)

Configuration and Calibration Data, and Electronics Upgradeability

Factory characterization, user configuration, and calibration data are stored in the sensor (see Figure 20). Therefore the electronics module can be replaced or changed from one type to another.

A module may be replaced without the need for reconfiguration or recalibration. Although module replacement can affect accuracy up to 0.20% of span, this error can be removed by an mA trim without application of pressure.

Changing module types may require reconfiguration and recalibration, as well as a different terminal block, if applicable, but all factory characterization data is retained.

Optional Custom Configuration (Option -C2)

For the transmitter to be custom configured by the factory, the user must fill out a data form. If this option is not selected, a standard (default) configuration will be provided; see Table 2 for allowable pressure units, and Table 3 for an example of Configuration Option -C2.

Table 2. Allowable Pressure Units for Calibrated Range (a)

inH_2O	psi	Pa	atm	g/cm^2
ftH_2O	inHg	kPa	bar	kg/cm^2
mmH_2O	mmHg	MPa	mbar	torr

(a) Displayed in upper case only on transmitter.

Table 3. Example of Configuration Option -C2

Parameter	Standard (Default) Configuration	Example of Configuration Option -C2
Calibrated Range		
• Pressure Units	per S.O.(a)	INH2O (a)
• LRV	per S.O.	0
• URV	per S.O.	100
Output Mode	Linear	Square Root
Output Direction	Forward	Forward
Damping	None	2
Failsafe Action	Upscale	Downscale
Ext. Zero Option	Enabled	Disabled
Other:		
If Linear:		
• Label (2nd line)	(b)	INH2O (b)
• Display LRV	(c)	0 (c)
• Display URV	(c)	100 (c)
If Square Root:		
• Label (2nd line)	%	GPM (d)
• Display LRV	0	0
• Display URV	100	500 (e)

(a) Select from list in Table 2.
(b) Same as units selected for calibrated range, or percent.
(c) Same as calibrated range, or 0 and 100 for percent.
(d) Up to 7 letters (upper case), numbers, or available symbols.
(e) Any value between and including -9999 and 9999.

NOTE: There is a maximum of 4 digits for entering range values.

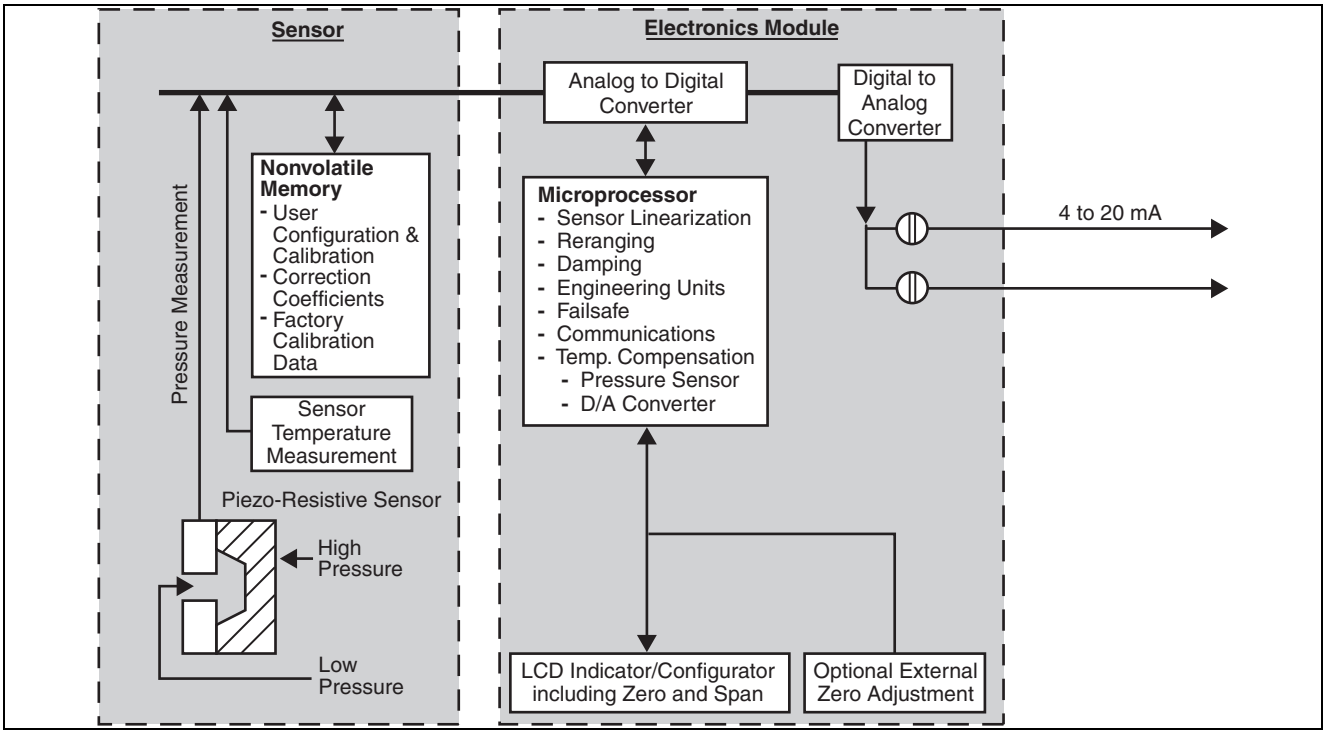


Figure 20. Transmitter Functional Block Diagram

OPERATING, STORAGE, AND TRANSPORTATION CONDITIONS

Influence	Reference Conditions	Normal Operating Conditions (a)	Operative Limits (a)	Transportation/ Storage Limits
Process Connection Temp. • with Silicone Fill Fluid • with Fluorinert Fill Fluid	• 24 ±2°C (75 ±3°F) • 24 ±2°C (75 ±3°F)	• -29 to + 82°C (-20 to +180°F) • -29 to + 82°C (-20 to +180°F)	• -46 and +121°C (b) (-50 and +250°F) (b) • -29 and +121°C (-20 and +250°F)	• Not Applicable • Not Applicable
Electronics Temperature (c)	• 24 ±2°C (75 ±3°F)	• -29 to + 82 °C (g) (-20 to +180 °F) (g)	• -40 and +85°C (b)(g) (-40 and +185°F) (b)(g)	• -54 and +85°C (-65 and +185°F)
Relative Humidity (d)	50 ±10%	0 to 100%	0 and 100%	0 and 100% Noncondensing
Supply Voltage – mA Output	30 ±0.5 V dc	11.5 to 42 V dc (e)	11.5 and 42 V dc (e)	Not Applicable
Output Load – mA Output	650 Ω	0 to 1450 Ω	0 and 1450 Ω	Not Applicable
Vibration	1 m/s^2 (0.1 “g”)	6.3 mm (0.25 in) Double Amplitude: from 5 to 15 Hz with Aluminum Housing and from 5 to 9 Hz with 316 ss Housing		11 m/s^2 (1.1 “g”) from 2.5 to 5 Hz (in Shipping Package)
		0 to 30 m/s^2 (0 to 3 “g”) from 15 to 500 Hz with Aluminum Housing; and 0 to 10 m/s^2 (0 to 1 “g”) from 9 to 500 Hz with 316 ss Housing		
Mounting Position	Upright or Horizontal (f)		No Limit	Not Applicable

(a) When Structure Codes 78/79 (pvdf inserts in Hi- and Lo-side process covers) are used, maximum overrange is 2.1 MPa (300 psi), and temperature limits are -7 and +82°C (20 and 180°F); when DIN Construction Options D2/D4/D6/D8 are used, temperature limits are 0 and 60°C (32 and 140°F).

(b) Selection of Option -J extends the low temperature operative limit of transmitters with silicone filled sensors down to -50°C (-58°F).

(c) The operative limits of the standard LCD Indicator are -29 and +85°C (-20 and +185°F), and the normal operating conditions are -20 to +82°C (-4 to +180°F). Although the LCD Indicator will not be damaged at any temperature within the “Storage and Transportation Limits”, updates will be slowed and readability decreased at temperatures outside the “Normal Operating Conditions”.

(d) With topworks cover on and conduit entrances sealed.

(e) 11.5 V dc can be reduced to 11 V dc by using a plug-in shorting bar; see “Supply Voltage Requirements” section and Figure 18.

(f) Sensor process wetted diaphragms in a vertical plane.

(g) Refer to the Electrical Safety Specifications section for a restriction in ambient temperature with certain electrical certifications.

PERFORMANCE SPECIFICATIONS

(Zero-Based Calibrations; Co-Ni-Cr or 316L ss Sensor with Silicone Fluid; Under Reference Operating Conditions unless otherwise specified; URL = Upper Range Limit; Span = Calibrated Span.)

Accuracy (includes Linearity, Hysteresis, and Repeatability)

±0.20% of Span. See Table 4 for Small Span Accuracy.

Table 4. Accuracy with Small Spans

For Span Code	If Span is:	Then Small Span Accuracy in % of Span is:
B	<5% of URL	$\pm\left[(0.10) + (0.005)\left(\frac{\text{URL}}{\text{Span}}\right)\right]$
A, C, D, E	<6.7% of URL	$\pm\left[(0.10) + (0.0067)\left(\frac{\text{URL}}{\text{Span}}\right)\right]$

Stability

Long term drift is less than ±0.05% of URL per year over a 5-year period.

Calibration Frequency

The calibration frequency is five years. The five years is derived using the values of allowable error (% span), TPE (% span), performance margin (% span), and stability (% span/month); where:

$$\text{Calibration Frequency} = \frac{\text{Performance Margin}}{\text{Stability}} = \text{Months}$$

RFI Effect

The output error is less than 0.1% of span for radio frequencies in the range of 27 to 1000 MHz and field intensity of 30 V/m when the transmitter is properly installed with shielded conduit and grounding, and housing covers are in place. (Per IEC Std. 61000-4-3.)

Vibration Effect

Total effect is ±0.2% of URL per “g” for vibrations in the frequency range of 5 to 500 Hz; with a double amplitude (DA) of 6.3 mm (0.25 in) in the range of 5 to 15 Hz, or accelerations of 3 “g” in the range of 15 to 500 Hz, whichever is smaller, for transmitter with aluminum housing; and with a DA of 6.3 mm (0.25 in) in the range of 5 to 9 Hz, or accelerations of 1 “g” in the range of 9 to 500 Hz, whichever is smaller, for transmitter with 316 ss housing.

Supply Voltage Effect

The output changes less than 0.005% of calibrated span for each 1 V change within the specified supply voltage requirements.

Position Effect

The transmitter may be mounted in any position. Any zero effect caused by the mounting position can be eliminated by rezeroing. There is no span effect.

Static Pressure Effect

The zero and span shift for a 7 MPa, 1000 psi change in static pressure is:

ZERO SHIFT (a)

Span Code	Zero Shift-Static Pressure Effect
A	±0.30% URL (b)
B and C	±0.10% URL
D	±0.50% URL (b)
E	±0.50% URL

(a) Can be calibrated out by zeroing at nominal line pressure.

(b) Per 3.5 MPa (500 psi) for Span Codes A and D.

SPAN SHIFT

±0.25% of Reading (±0.30% for Span Code A)

Switching and Indirect Lightning Transients

The transmitter can withstand a transient surge up to 2000 V common mode or 1000 V normal mode without permanent damage. The output shift is less than 1.0%. (Per ANSI/IEEE C62.41-1980 and IEC Std. 61000-4-5.)

Ambient Temperature Effect

Total effect for a 28°C (50°F) change within Normal Operating Condition limits is:

Span Code	Specification
A (a)	±(0.18% URL + 0.15% Span)
B and C	±(0.03% URL + 0.20% Span)
D	±(0.05% URL + 0.18% Span)
E	±(0.08% URL + 0.15% Span)

(a) Span Code A specifications apply to a transmitter with a stainless steel sensor only.

NOTE

For additional ambient temperature effect when pressure seals are used, see PSS 2A-1Z11 A.

PHYSICAL SPECIFICATIONS

Process Cover and Connector Material (Process Wetted)
Carbon Steel, 316 ss, Monel, Hastelloy C, or pvdf (Kynar) inserts in 316 ss covers for transmitter traditional structure; and 316 ss for transmitter low profile structures. For exceptional value and corrosion resistance, 316 ss is the least expensive material.

Process Cover and Process Connection Gaskets
Glass filled ptfe, or Viton when Structure Codes 78/79 (pvdf inserts) are used.

Process Cover Bolts and Nuts
ASTM A193, Grade B7 high strength alloy steel for bolts, and ASTM A194 Grade 2H high strength alloy steel for nuts are standard. Options include NACE Class B7M bolting, 17-4 ss bolting, and 316 ss bolting.

Sensor Material (Process Wetted)
Co-Ni-Cr, 316 L ss, Gold-Plated 316L ss, Monel, Hastelloy C, or Tantalum for transmitter traditional structure; and 316L ss or Hastelloy C for transmitter low profile structures. For exceptional value and corrosion resistance, 316L ss is the least expensive material. Refer to TI 037-078 and TI 37-75b for information regarding the corrosion resistance of Co-Ni-Cr and other sensor materials.

Sensor Fill Fluids
Silicone Oil or Fluorinert (FC-43)

Environmental Protection
Transmitter is dusttight and weatherproof per IEC IP66 and provides the environmental and corrosion resistant protection of NEMA Type 4X.

Electronics Housing and Housing Covers
Housing has two compartments to separate the electronics from the field connections. The housing and covers are made from low copper, die-cast aluminum alloy with an epoxy finish, or from 316 ss. Buna-N O-ring seals are used to seal the threaded housing covers, housing neck, and terminal block.

Electrical Connections
Field and RTD sensor wires enter through 1/2 NPT, PG 13.5, or M20 threaded entrances, as specified, on either side of the electronics housing. Wires terminate under screw terminals and washers on terminal block in the field terminal compartment. Unused entrance is plugged to insure moisture and RFI/EMI protection. See Figure 23.

Electronics Module
Printed wiring assemblies are conformally coated for moisture and dust protection.

Mounting Position
The transmitter may be mounted in any orientation.

Approximate Mass (with Process Connectors)
4.2 kg (9.2 lb) – with Traditional Structure
Add 0.1 kg (0.2 lb) – with Low Profile Structure LP1
Add 0.8 kg (1.8 lb) – with Low Profile Structure LP2
Add 1.1 kg (2.4 lb) – with 316 ss Housing
Add 0.2 kg (0.4 lb) – with LCD Indicator Option

Dimensions
See “Dimensions - Nominal” section and Dimensional Print DP 020-446.

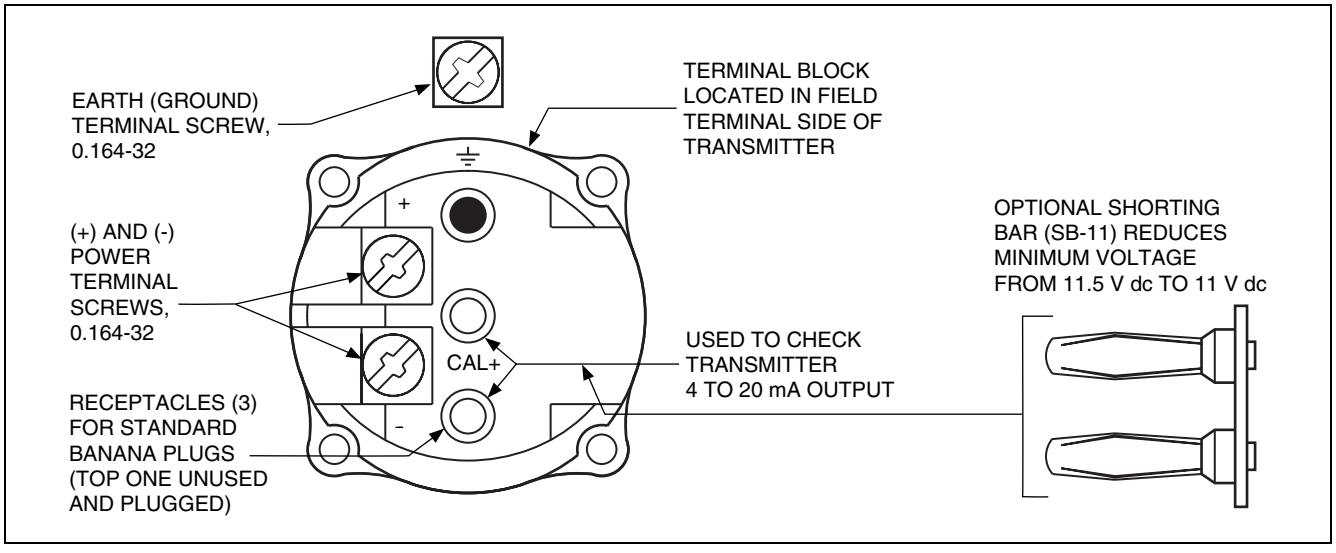


Figure 21. Field Terminal Block

ELECTRICAL SAFETY SPECIFICATIONS

Testing Laboratory, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
ATEX flameproof: II 2 GD, EEx d IIC, Zone 1.	Temperature Class T6, Ta = -40 to +80°C.	D
CSA explosionproof for Class I, Division 1, Groups B, C, and D; dust-ignitionproof for Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Maximum Ambient Temperature 85°C.	C
CSA for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Temperature Class T6 at 40°C and T4A at 85°C maximum ambient.	
CSA field device zone certified flameproof Ex d IIC. Also, all certifications of Code C above.	Maximum Ambient Temperature 85°C.	B
FM explosionproof for Class I, Division 1, Groups B, C, and D; dust-ignitionproof for Class II, Division 1, Groups E, F, and G; Class III, Division 1.	Temperature Class T6 at 80°C and T5 at 85°C maximum ambient.	F
FM nonincendive for Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.	Temperature Class T4A at 40°C and T4 at 85°C maximum ambient.	
FM field device zone approved flameproof AEx d IIC. Also, all certifications of Code F above.	Temperature Class T6 at 80°C and T5 at 85°C maximum ambient.	G
IECEx flameproof: Ex d IIC.	T6, Ta = 80°C; T5, Ta = 85°C; Ambient Temperature -20 to +85°C.	V

MODEL CODE

Description	Covers	Sensor	Fill Fluid	Model
I/A Series, Electronic d/p Cell Transmitter for Differential Pressure Measurement				IDP10
Electronics Versions and Output Signal				
Analog; 4 to 20 mA dc (Version -A)				-A
Structure Code - Select from one of the following six groups:				
1. Transmitter with Traditional Structure				
	Covers	**Sensor**	**Fill Fluid**	
	Steel	Co-Ni-Cr	Silicone	10
	Steel	Co-Ni-Cr	Fluorinert	11
	Steel	316L ss	Silicone	12
	Steel	316L ss	Fluorinert	13
	Steel	Hastelloy C	Silicone	16
	Steel	Hastelloy C	Fluorinert	17
	316 ss	Co-Ni-Cr	Silicone	20
	316 ss	Co-Ni-Cr	Fluorinert	21
	316 ss	316L ss	Silicone	22
	316 ss	316L ss	Fluorinert	23
	316 ss	316L ss, Gold Plated	Silicone	2G
	316ss	Monel	Silicone	24
	316 ss	Monel	Fluorinert	25
	316 ss	Hastelloy C	Silicone	26
	316 ss	Hastelloy C	Fluorinert	27
	Monel	Monel	Silicone	34
	Monel	Monel	Fluorinert	35
	Hastelloy C	Hastelloy C	Silicone	46
	Hastelloy C	Hastelloy C	Fluorinert	47
	Hastelloy C	Tantalum	Silicone	48
	Hastelloy C	Tantalum	Fluorinert	49
	pvdf Insert (Kynar)	Tantalum	Silicone (Used w/Process Connector Type 7)	78 (a)
	pvdf Insert (Kynar)	Tantalum	Fluorinert (Used w/Process Connector Type 7)	79 (a)
2. Transmitter with Low Profile Structure LP1 (Not available with Pressure Seals)				
	Covers	**Sensor**	**Fill Fluid**	
	316 ss	316L ss	Silicone	LL
	316 ss	316L ss	Fluorinert	LM
	316 ss	Hastelloy C	Silicone	LC
	316 ss	Hastelloy C	Fluorinert	LD
3. Transmitter with Low Profile Structure LP2 (Not available with Pressure Seals)				
	Covers	**Sensor**	**Fill Fluid**	
	316 ss	316L ss	Silicone	52
	316 ss	316L ss	Fluorinert	53
	316 ss	Hastelloy C	Silicone	56
	316 ss	Hastelloy C	Fluorinert	57
4. Transmitter prepared for Foxboro Model Coded Remote Mount Seals (b)(c)				
Transmitter prepared for Remote Seals on Both HI and LO Sides, Silicone Fill in Sensor				S1
Transmitter prepared for Remote Seals on Both HI and LO Sides, Fluorinert Fill in Sensor				S2
Transmitter prepared for Remote Seal HI Side, 1/2 NPT Connector LO Side, Silicone Fill in Sensor				S3
Transmitter prepared for Remote Seal HI Side, 1/2 NPT Connector LO Side, Fluorinert Fill in Sensor				S4
Transmitter prepared for Remote Seal LO Side, 1/2 NPT Connector HI Side, Silicone Fill in Sensor				S5
Transmitter prepared for Remote Seal LO Side, 1/2 NPT Connector HI Side, Fluorinert Fill in Sensor				S6

Model Code continued on next page

IDP10 DIFFERENTIAL PRESSURE TRANSMITTERS (Cont.)

MODEL CODE (Cont.)

5. Transmitter Prepared for Foxboro Model Coded Direct Connect Seals (b)	
PSFLT, PSSCT, or PSSST Direct Connect Seal on HI Side; 1/2 NPT Process Connector LO Side; Silicone Fill	F1
PSFLT, PSSCT, or PSSST Direct Connect Seal on HI Side; 1/2 NPT Process Connector LO Side; Fluorinert Fill	F2
PSFLT, PSSCT, or PSSST Direct Connect Seal on HI Side; Remote Seal with Capillary LO Side; Silicone Fill	F3
PSFLT, PSSCT, or PSSST Direct Connect Seal on HI Side; Remote Seal with Capillary LO Side; Fluorinert Fill	F4
6. Transmitter Prepared for non-Foxboro Seals	
Remote Seals on High and Low Sides; Silicone Fill in Sensor	SA
Remote Seals on High and Low Sides; Inert Fill in Sensor	SB
Remote Seal on High Side and 1/2 NPT Connector on Low Side, Silicone Fill in Sensor	SC
Remote Seal on High Side and 1/2 NPT Connector on Low Side, Inert Fill in Sensor	SD
Remote Seal on Low Side and 1/2 NPT Connector on High Side, Silicone Fill in Sensor	SE
Remote Seal on Low Side and 1/2 NPT Connector on High Side, Inert Fill in Sensor	SF
Span Limits (Differential Pressure Units)	
kPa / **inH_2O** / **mbar**	
0.12 and 7.5 / 0.5 and 30 / 1.2 and 75	A (e)
0.87 and 50 / 3.5 and 200 / 8.7 and 500	B
7 and 210 / 28 and 840 / 70 and 2100	C
MPa / **psi** / **bar or kg/cm^2**	
0.07 and 2.1 / 10 and 300 / 0.7 and 21	D
0.7 and 21 / 100 and 3000 / 7 and 210	E (f)
Process Connector Type (Material Same as Process Cover Material) (g)	
See below: • For d/p: No connectors; both covers tapped for 1/4 NPT (316 ss only, no side vents) • Flange Mount Hi Side: 1/2 NPT, 316 ss Process Connector on Lo Side (F1 and F2 only) • Flange Mount Hi Side: No connectors; both sides prepared for seals (F3 and F4 only) • Two Remote Seals: No connectors; both covers tapped for capillary connection (S1, S2, SA, SB only) • One Remote Seal: 1/2 NPT, 316 ss Process Connector on side opposite seal (S3 to S6, SC to SF only)	0
1/4 NPT, Not with Structure Codes 46 to 49, 78, 79; or pressure seals	1
1/2 NPT, Not with Structure Codes 78 or 79, or pressure seals	2
Rc 1/4, Not with Structure Codes 46 to 49, 78, 79; or pressure seals	3
Rc 1/2, Not with Structure Codes 78 or 79, or pressure seals	4
1/2 Schedule 80 Welding Neck, Not with Structure Codes 46 to 49, 78, 79; or pressure seals	6
None; pvdf Insert tapped for 1/2 NPT/Process Inlet on Side of 316 ss Process Covers (only with 78/79 above)	7
Conduit Connection and Housing Material	
1/2 NPT Conduit Connection, Aluminum Housing	1
PG 13.5 Conduit Connection, Aluminum Housing (With Electrical Safety Code D only)	2
1/2 NPT Conduit Connection, 316 ss Housing	3
PG 13.5 Conduit Connection, 316 ss Housing (With Electrical Safety Code D only)	4
M20 Conduit Connection, Both Sides, Aluminum Housing (With Electrical Safety Code D only)	5
M20 Conduit Connection, Both Sides, 316 ss Housing (With Electrical Safety Code D only)	6
Electrical Safety (Also see Electrical Safety Specifications section)	
ATEX II 2 GD, EEx d IIC, Zone 1 (d)	D
CSA Certified Division 1 explosionproof, dust-ignitionproof; and Division 2, Classes I, II, and III	C
CSA zone certified Ex d IIC; also all certifications of Code C above (d)	B
FM approved, Division 1 explosionproof, dust-ignitionproof; and Division 2 nonincendive	F
FM zone approved AEx d IIC; also all approvals of Code F above (d)	G
IECEx flameproof: Ex d IIC	V

Model Code continued on next page

IDP10 DIFFERENTIAL PRESSURE TRANSMITTERS (Cont.)

MODEL CODE (Cont.)

Optional Selections	
Refer to Optional Selections below.	
Mounting Bracket Set (h)	
Standard Style Painted Steel Bracket with Plated Steel Bolts	-M1
Standard Style Stainless Steel Bracket with Stainless Steel Bolts	-M2
Universal Style Stainless Steel Bracket with Stainless Steel Bolts (not with Structure Codes LL, LM, LC, or LD)	-M3
Blind (Solid) Cover over Standard LCD Indicator	
Blind (Solid) Cover replaces Window Cover	-L2
DIN 19213 Construction used with Process Connector Code 0 and 316 ss Covers with no side vents (not available when remote or direct connect seals are specified)	
Single Ended Process Cover with M10, B7 Steel Bolting (j)(s)	-D1
Double Ended Process Cover with M10, B7 Steel Bolting (Blind Kidney Flange on Back) (j)(k)(l)	-D2
Single Ended Process Cover with 7/16 in, B7 Steel Bolting; standard pressure rating 25 MPa (3625 psi) (s)	-D3
Double Ended Process Cover with 7/16 in, B7 Steel Bolting (Blind Kidney Flange on Back) (j)(k)(l)	-D4
Single Ended Process Cover with 7/16 in, 316 ss Bolting (j)(s)	-D5
Double Ended Process Cover with 7/16 in, 316 ss Bolting (Blind Kidney Flange on Back) (j)(k)(l)	-D6
Single Ended Process Cover with 7/16 in, 17-4 ss Bolting; standard pressure rating 25 MPa (3625 psi) (s)	-D7
Double Ended Process Cover with 7/16 in, 17-4 ss Bolting (Blind Kidney Flange on Back) (j)(k)(l)	-D8
Single Ended Process Cover with 7/16 in, 17-4 ss Bolting; pressure rating 40 MPa (5800 psi) (s) Not available with Span Codes A, D, or E; or Option Codes -V, -B1, -B2, -B3, or -Y	-D9
Cleaning and Preparation - Not Available with Gold-Plated Sensor, Structure 2G or Pressure Seals	
Unit Degreased - for Silicone Filled Sensors Only (Not for Oxygen/Chlorine/Other Fluids that may react with Silicone)	-X1
Cleaned and Prepared for Oxygen Service - for Fluorinert Filled Sensors Only (Not Available with Carbon Steel Covers or with Silicone Filled Sensors)	-X2
Cleaned and Prepared for Chlorine Service - for Fluorinert Filled Sensors Only (m) (Not Available with Carbon Steel Covers or with Silicone Filled Sensors)	-X3
Bolting for Process Covers/Connectors - Not with DIN 19213 Construction or Structure Codes 78 and 79 (n)	-B1
316 ss Bolts and Nuts (Pressure Derated; Not Available with -Y Option) (j)	-B2
17-4 ss Bolts and Nuts (m)	-B3
B7-M Bolts and Nuts (NACE)(Pressure Derated) (j)	
Conduit Thread Adapters (Not available with Conduit Connection Codes 5 and 6)	
Hawke-Type 1/2 NPT Cable Gland for use with Conduit Connection Codes 1 and 3 (p)	-A1
M20 Conduit Thread Adapter for use with Conduit Connection Codes 1 and 3 (p)	-A3
Electronics Housing Features	
External Zero Adjustment	-Z1
Custody Transfer Lock and Seal	-Z2
External Zero Adjustment and Custody Transfer Lock/Seal	-Z3
Custom Factory Configuration	
Full Factory Configuration (Requires Configuration Form to be Filled Out)	-C2
Tubing Connectors - Not available with Structure Codes 78 and 79; also not with Pressure Seals	
Steel, Connecting 6 mm Tubing to 1/4 NPT Process Connector Only with Structure Codes 10 to 13; and Process Connector Codes 0 and 1	-E1
Steel, Connecting 12 mm Tubing to 1/2 NPT Process Connector Only with Structure Codes 10 to 13; and Process Connector Code 2	-E2
316 ss, Connecting 6 mm Tubing to 1/4 NPT Process Connector Only with Structure Codes 10 to 13 and 20 to 23; and Process Connector Codes 0 and 1	-E3
316 ss, Connecting 12 mm Tubing to 1/2 NPT Process Connector Only with Structure Codes 10 to 13 and 20 to 23; and Process Connector Code 2	-E4
Vent Screw in Process Cover	
Supply Vent Screw in Side of Each Process Cover (Available only on Traditional Process Cover Structure Codes 22 to 47)	-V
Omit Vent Screw in Side of Each Process Cover (Available only on Type LP1 Low Profile Process Cover Structures Codes LL, LM, LC, and LD)	-V1

Model Code continued on next page

MODEL CODE (Cont.)

Adapter Plate, Bolts, and Gaskets for Direct Mount to Competitive Manifolds (t)	
See inside pages for manifold compatibility.	
Adapter Set for MC Coplanar Manifolds, B7 Bolts (not with options -B1, -B2, or -B3)	-P1
Adapter Set for MC Coplanar Manifolds, 316 ss Bolts (requires -B1 option)	-P2
Adapter Set for MC Coplanar Manifolds, 17-4 ss Bolts (requires -B2 option)	-P3
Adapter Set for MC Coplanar Manifolds, B7M Bolts (requires -B3 option)	-P4
Adapter Set for MT3 Coplanar Manifolds, Traditional Flange, B7 Bolts (not with options -B1, -B2, or -B3)	-P5
Adapter Set for MT3 Coplanar Manifolds, Traditional Flange, 316 ss Bolts (requires -B1 option)	-P6
Adapter Set for MT3 Coplanar Manifolds, Traditional Flange, 17-4 ss Bolts (requires -B2 option)	-P7
Adapter Set for MT3 Coplanar Manifolds, Traditional Flange, B7M Bolts (requires -B3 option)	-P8
Gaskets	
Gasket for Vacuum Service with Pressure Seals (r)	-G1
Instruction Books (Common MI, Brochure, and Full Documentation Set on CD-ROM is Standard)	
Without Instruction Book and CD; only "Getting Started" brochure is supplied.	-K1
Miscellaneous Optional Selections	
Low Temperature Operative Limit of Electronics Housing Extended Down to -50°C (-58°F) Not available with sensors and seals with fluorinert fill; Structure Codes 78 and 79; and DIN Options -D2, -D4, -D6, and -D8	-J
Supplemental Customer Tag (Stainless Steel Tag wired onto Transmitter)	-T
Static Pressure Rating to 40 MPa (5800 psi); Only with Span Codes B and C Not available with: – Options -B1, -B2, and -B3 (q) – Options -D1 to -D9 – Structure Codes 34, 35, 78, 79, S1 to S6, SA to SF, F1 to F4	-Y

(a) Maximum static pressure rating is 2.1 MPa (300 psi); temperature limits are -7 and +82°C (20 and 180°F).
(b) Both Transmitter and Pressure Seal Model Numbers are required. See PSS 2A-1Z11 A for the various pressure seal Model Codes.
(c) Remote Seal Models that may be specified are PSFPS, PSFES, PSFAR, PSTAR, PSISR, PSSCR, and PSSSR.
(d) Cover lock provided as standard with Electrical Safety Codes D, B, and G.
(e) Span Limit Code A is not available with pressure seals, except for Sanitary Spud Seals Models PSSSR-.4 and PSSST-.4.
(f) Span Limit Code E is not available with Structure Codes 78 and 79 above (pvdf insert in HI side cover).
(g) Select Code "0" if a pressure seal is specified. Otherwise select Codes 1 through 7.
(h) Mounting sets not offered with direct connect (flange mount) seals.
(j) See Functional Specifications section for pressure deratings when certain DIN 19213 versions and Bolting Options -B1 and -B3 are specified.
(k) Temperature limits derated to 0 and 60°C (32 and 140°F). Also not available with Structure Codes 52 to 57, and LL, LM, LC, and LD.
(l) Mounting Bracket Set options are not available with Options -D2, -D4, -D6, and -D8.
(m) When -X3 is specified, the standard bolting is replaced with 17-4 ss bolts and nuts. Therefore, there is no need to specify Option -B2 when selecting the Chlorine Service Option -X3.
(n) Not available with DIN construction options. For stainless steel bolts with DIN construction, specify -D5 to -D9, as required.
(p) Available with Electric Safety Code D only.
(q) -B2 Bolt Option (17-4 ss) is not available with the -Y option because 17-4 ss bolts and nuts are supplied as part of the -Y option.
(r) -G1 is a required option when pressure seal will be used in vacuum applications. This option substitutes vacuum service metal gasket for standard ptfe process cover gasket.
(s) Not available with Low Profile Structure Codes 52 to 67.
(t) Adapter plate options -P1 to -P8 are not available with:
– Pressure Seal Structure Codes.
– Process Connector Codes 1-7.
– DIN Construction Options -D1, -D2, -D4, -D5, -D6, -D7, -D8, -D9.

SUGGESTED RFQ SPECIFICATIONS

The manufacturer shall provide two-wire, 4 to 20 mA dc analog output, differential pressure transmitter(s) suitable for field mounting. They are offered with traditional or low profile structures. Transmitters with a traditional structure can also be provided (as required) with direct connect seals, or remote capillary connected seals. The specifications for these transmitters are:

Accuracy: ±0.20% of calibrated span.

Linear or Square Root Output: Pushbutton configurable to set linear or square root output.

Static Pressure Rating: 25 MPa (3625 psi) for standard transmitter.

Ambient Temperature Effect: For transmitter only (without pressure seals). Total effect for a 55°C (100°F) change within normal operating conditions is less than ±0.5% of calibrated span at maximum span (less than ±0.7% with 30 inH_2O URL sensor).

Damping: Settable for a range of none to 8 seconds.

Proof Pressure: 14 500 psi for standard transmitter

Span Limits: 0.5 and 30 inH_2O, 3.5 and 200 inH_2O, 28 and 840 inH_2O, 10 and 300 psi, or 100 and 3000 psi, as specified; or SI and metric equivalents.

LCD Indicator: Standard Liquid Crystal Display (LCD) Indicator with on-board pushbuttons for calibration and configuration.

Mounting: On process piping, on a manifold, or optional mounting bracket

Input Connection: With process connectors to accept 1/4 NPT, 1/2 NPT, Rc 1/4 or Rc 1/2, 1/2 Schedule 80 welding neck; or 1/2 NPT pvdf inserts installed in 316 ss covers; or prepared for a direct connect seal; or prepared for a single remote capillary connected seal, or two remote capillary connected seals.

Electronics Housing: 316 ss, or aluminum housing with epoxy finish

Modular Electronics: Easily replaceable modular electronics in a NEMA 4X (IEC IP66) housing sealed with O-rings for protection against moisture or other contaminants.

Process Cover: Traditional Structures:
Steel, 316 ss, Monel, Hastelloy C, or pvdf insert
Low Profile Structures:
316 ss

Sensor Materials: Traditional Structure:
316L ss, Hastelloy C, Co-Ni-Cr, Monel, Tantalum, or Gold-Plated 316L ss
Low Profile Structures:
316L ss or Hastelloy C

Approvals and Certifications: Must be suitable for Division 1 hazardous locations, and conform to all applicable European Union Directives. Also versions available to meet Agency flameproof and zone requirements.

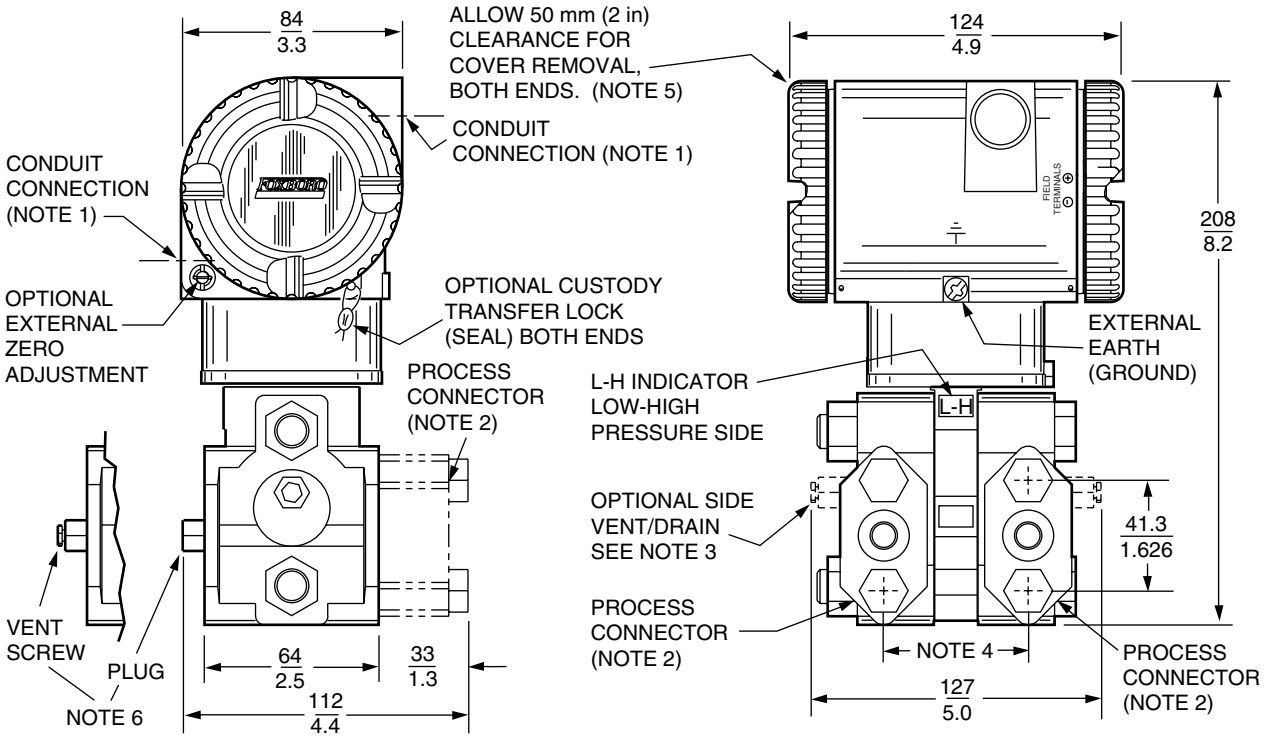
Approximate Mass: (with Process Connectors) 4.2 kg (9.2 lb), with Traditional Structures;
Add 0.1 kg (0.2 lb) with Low Profile Structure LP1;
Add 0.8 kg (1.8 lb) with Low Profile Structure LP2;
Add 1.1 kg (2.4 lb) with 316 ss housing;
Add 0.2 kg (0.4 lb) with optional LCD indicator.

Model Codes: I/A Series IDP10-A Electronic d/p Cell Transmitter, with or without pressure seals, or equivalent.

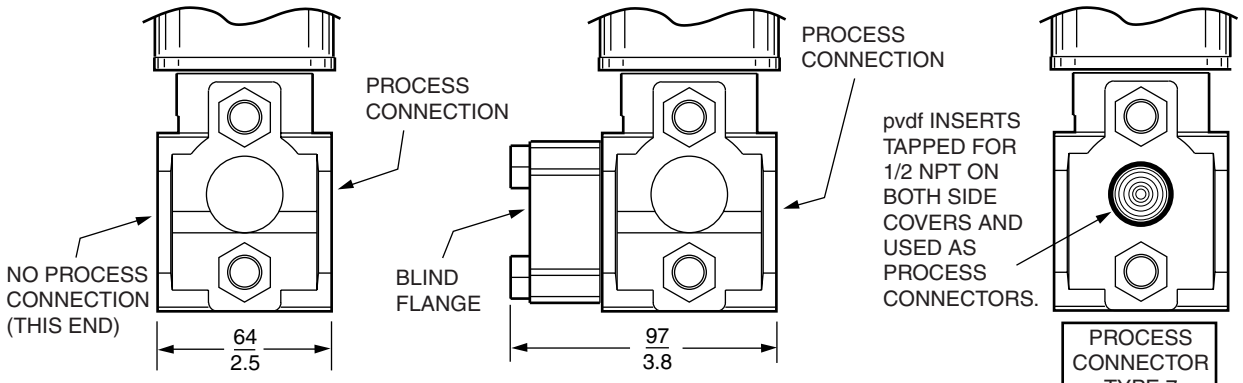
DIMENSIONS-NOMINAL

mm
in

TRANSMITTER WITH TRADITIONAL STRUCTURE



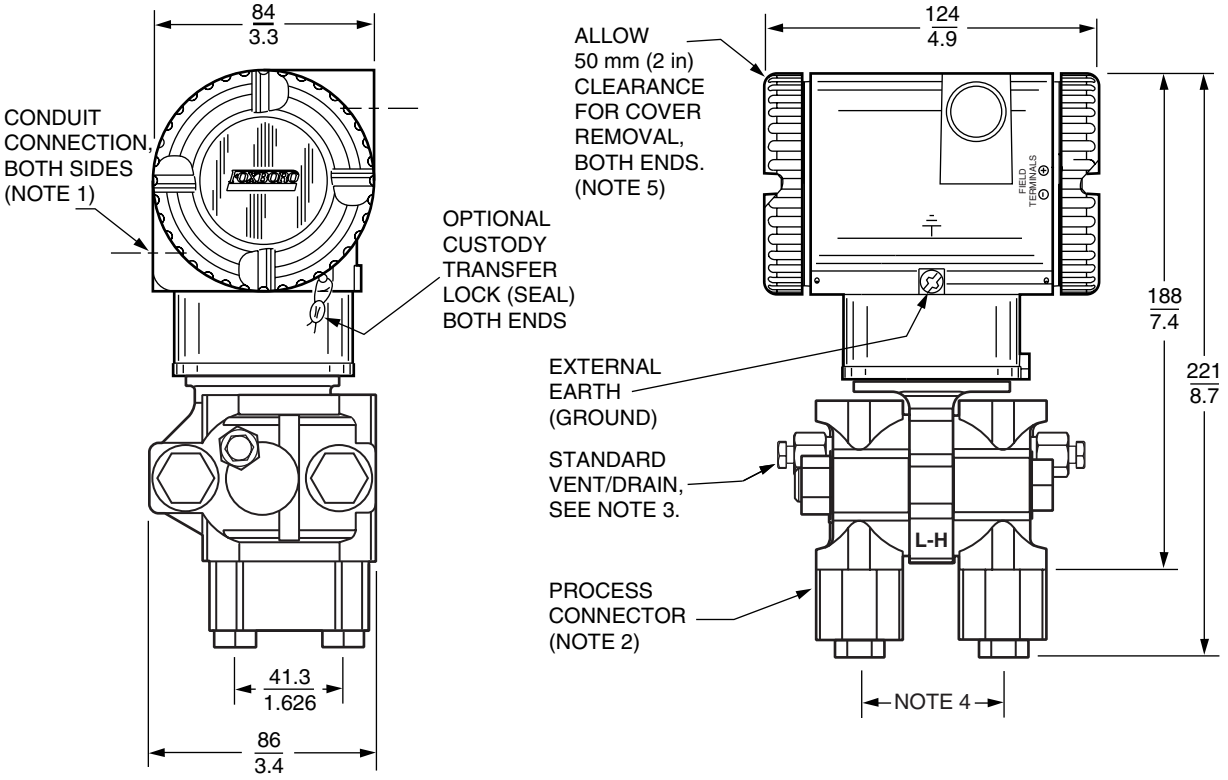
NOTES:
1. CONDUIT CONNECTION 1/2 NPT OR PG 13.5, BOTH SIDES: PLUG UNUSED CONNECTION WITH METAL PLUG (SUPPLIED).
2. PROCESS CONNECTORS MAY BE REMOVED AND TRANSMITTER MOUNTED DIRECTLY ON A MANIFOLD, OR CONNECTIONS MADE DIRECTLY TO PROCESS COVER USING 1/4 NPT INTERNAL THREAD IN PROCESS COVER.
3. PROCESS COVER CAN BE INVERTED MAKING OPTIONAL SIDE VENTS OR SIDE DRAINS
4. PROCESS CONNECTORS CAN BE INVERTED TO GIVE EITHER 51, 54, OR 57 mm (2.0, 2.125, OR 2.25 in) CENTER-TO-CENTER DISTANCE BETWEEN HIGH AND LOW PRESSURE CONNECTIONS.
5. TOPWORKS CAN BE ROTATED TO ANY POSITION WITHIN ONE TURN COUNTERCLOCKWISE OF THE FULLY TIGHTENED POSITION.
6. PROCESS COVER END PLUGS ARE SUBSTITUTED FOR VENT SCREWS WHEN OPTIONAL SIDE VENTS (NOTE 3) ARE SPECIFIED.



DIMENSIONS-NOMINAL (Cont.)

mm
in

TRANSMITTER WITH LOW PROFILE STRUCTURE LP1

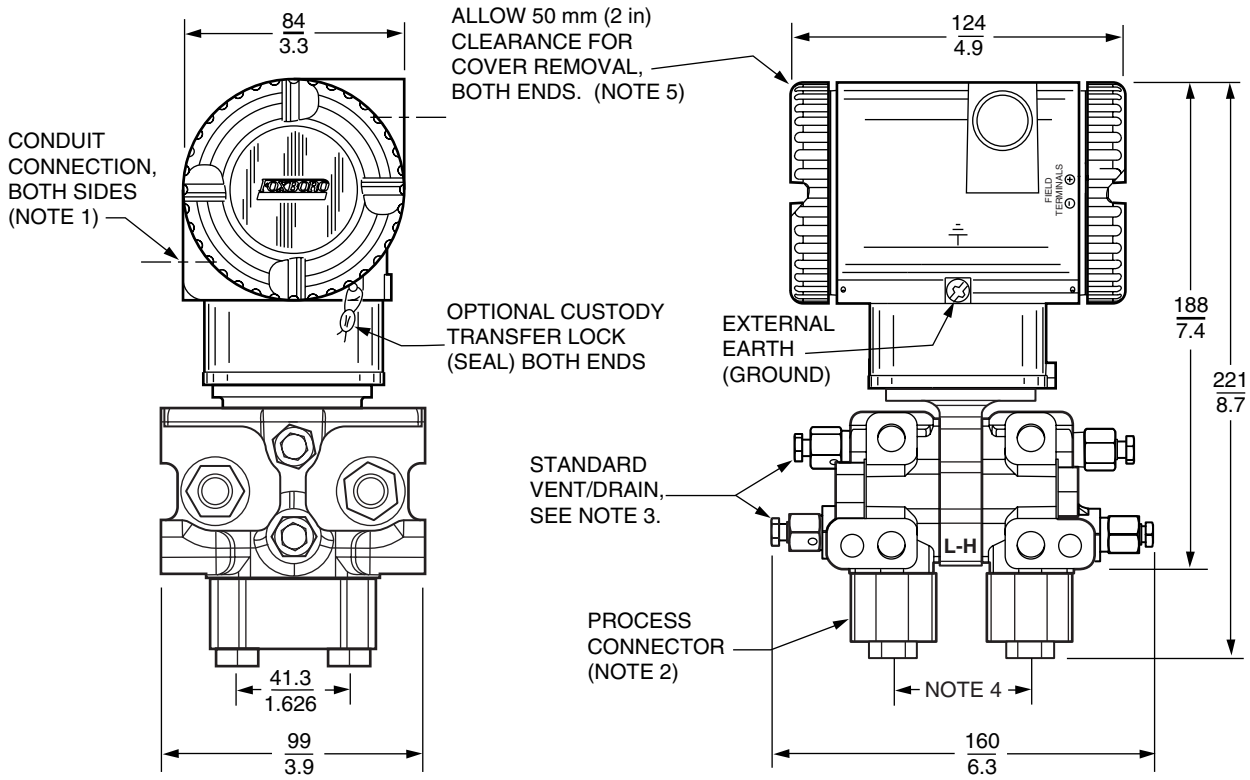


NOTES:
1. CONDUIT CONNECTION 1/2 NPT, PG 13.5, OR M20, BOTH SIDES: PLUG UNUSED CONNECTION WITH METAL PLUG (SUPPLIED).
2. PROCESS CONNECTORS MAY BE REMOVED AND TRANSMITTER MOUNTED DIRECTLY ON A MANIFOLD, OR CONNECTIONS MADE DIRECTLY TO PROCESS COVER USING 1/4 NPT INTERNAL THREAD IN PROCESS COVER.
3. THE TRANSMITTER'S LOW PROFILE STRUCTURE LP1 IS SHOWN IN THE VERTICALLY UPRIGHT POSITION. NOTE THE LOCATION OF THE STANDARD VENT/DRAIN SCREW. IN THIS CONFIGURATION THE TRANSMITTER CAN BE VENTED OR IS SELF-DRAINING. ALSO RECOMMENDED IS A HORIZONTAL INSTALLATION WHERE THE INSTALLED ORIENTATION CAN BE SET TO ALLOW FOR VENTING OR DRAINING.
4. PROCESS CONNECTORS CAN BE INVERTED TO GIVE EITHER 51, 54, OR 57 mm (2.0, 2.125, OR 2.25 in) CENTER-TO-CENTER DISTANCE BETWEEN HIGH AND LOW PRESSURE CONNECTIONS.
5. TOPWORKS CAN BE ROTATED TO ANY POSITION WITHIN ONE TURN COUNTERCLOCKWISE OF THE FULLY TIGHTENED POSITION.

DIMENSIONS-NOMINAL (Cont.)

mm
in

TRANSMITTER WITH LOW PROFILE STRUCTURE LP2



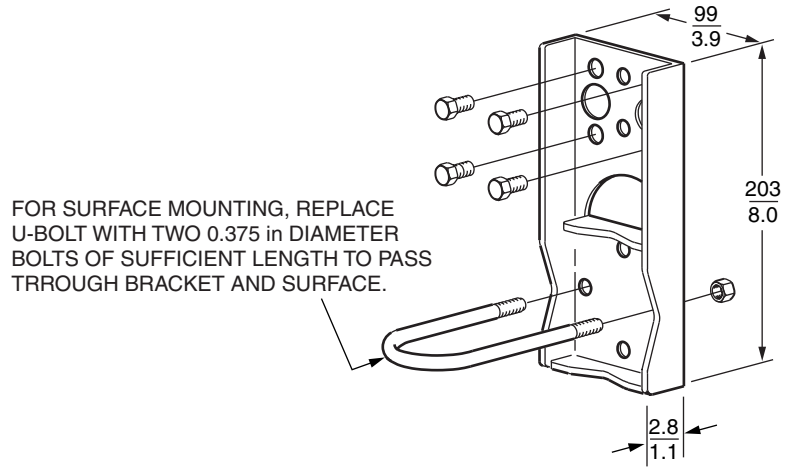
NOTES:

1. CONDUIT CONNECTION 1/2 NPT, PG 13.5, OR M20, BOTH SIDES: PLUG UNUSED CONNECTION WITH METAL PLUG (SUPPLIED).
2. PROCESS CONNECTORS MAY BE REMOVED AND TRANSMITTER MOUNTED DIRECTLY ON A MANIFOLD, OR CONNECTIONS MADE DIRECTLY TO PROCESS COVER USING 1/4 NPT INTERNAL THREAD IN PROCESS COVER.
3. THE TRANSMITTER'S LOW PROFILE STRUCTURE LP2 IS SHOWN IN THE RECOMMENDED VERTICAL UPRIGHT POSITION. NOTE THE STANDARD VENT OR DRAIN SCREWS. HORIZONTAL INSTALLATIONS ARE NOT RECOMMENDED.
4. PROCESS CONNECTORS CAN BE INVERTED TO GIVE EITHER 51, 54, OR 57 mm (2.0, 2.125, OR 2.25 in) CENTER-TO-CENTER DISTANCE BETWEEN HIGH AND LOW PRESSURE CONNECTIONS.
5. TOPWORKS CAN BE ROTATED TO ANY POSITION WITHIN ONE TURN COUNTERCLOCKWISE OF THE FULLY TIGHTENED POSITION.

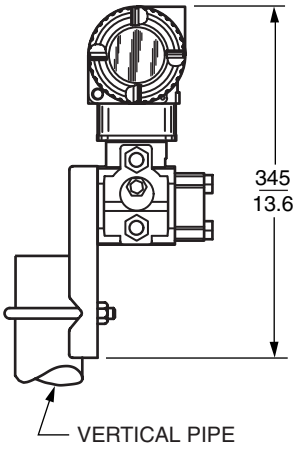
DIMENSIONS-NOMINAL (Cont.)

mm
in

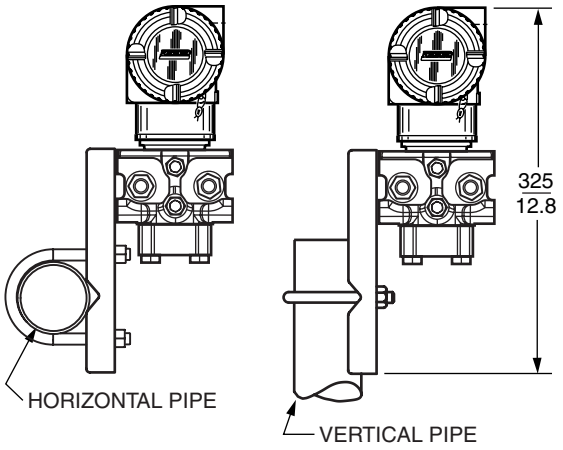
TRANSMITTER WITH STANDARD STYLE MOUNTING BRACKET KIT (Options -M1 and -M2)



TRANSMITTER WITH TRADITIONAL STRUCTURE



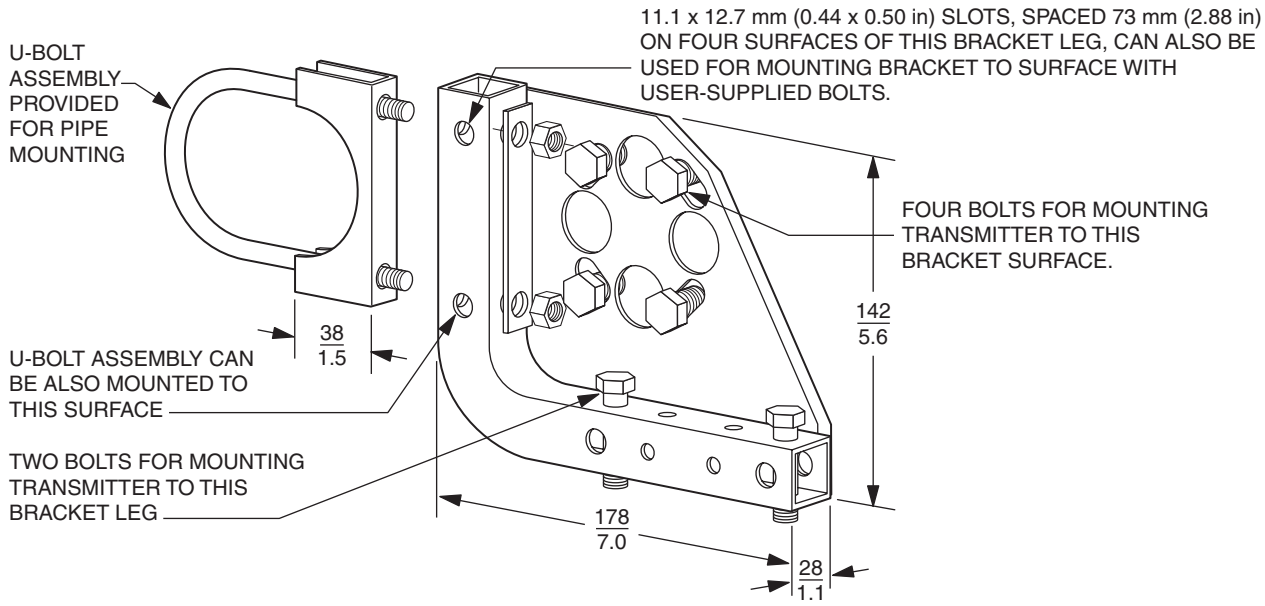
TRANSMITTER WITH LOW PROFILE STRUCTURE LP2



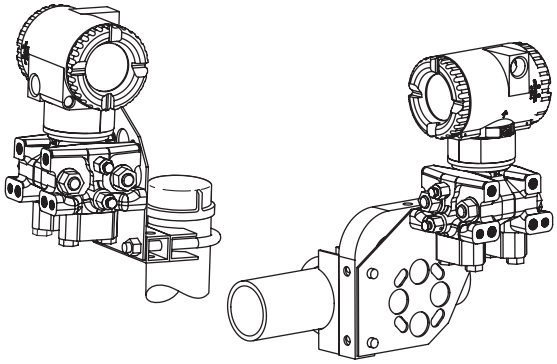
DIMENSIONS-NOMINAL (Cont.)

mm
in

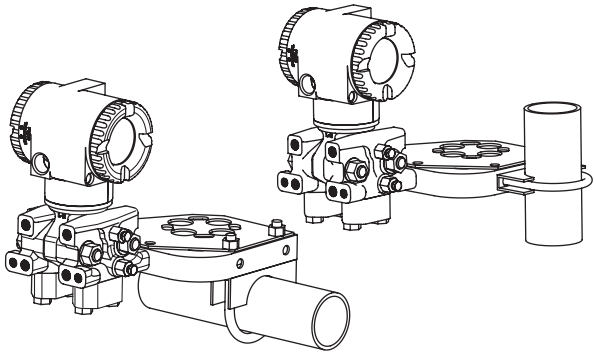
TRANSMITTER WITH UNIVERSAL STYLE MOUNTING BRACKET KIT (Option -M3)



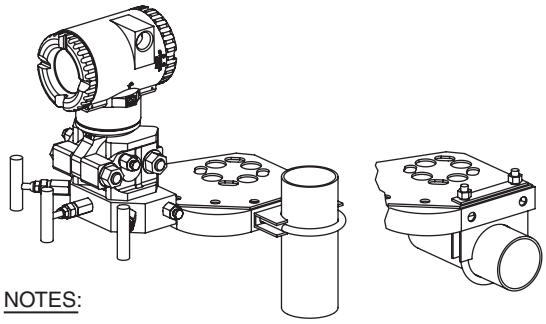
TYPICAL PIPE MOUNTING WITH LOW PROFILE STRUCTURE LP2

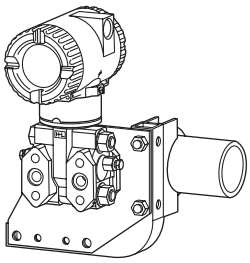


TYPICAL PIPE MOUNTING
LOW PROFILE STRUCTURE LP1



TYPICAL PIPE MOUNTING
WITH TRADITIONAL STRUCTURE





NOTES:

1. FOR SURFACE MOUNTING CONFIGURATIONS, USE THE U-BOLT MOUNTING HOLES FOR ATTACHING THE BRACKET TO A SURFACE RATHER THAN TO THE U-BOLT ASSEMBLY. SURFACE MOUNTING BOLTS FOR ATTACHING THE BRACKET TO A SURFACE ARE USER SUPPLIED.
2. REFER TO DIMENSIONAL PRINT DP 020-446 FOR FURTHER IPD10 MOUNTING CONFIGURATIONS, INCLUDING MOUNTING WITH -P OPTIONAL MOUNTING PLATES.

ORDERING INSTRUCTIONS

1. Model Number(s) as follows:
   - Transmitter only if pressure seals are not selected
   - Both transmitter and pressure seals if pressure seals are selected with traditional structure. See PSS 2A-1Z11 A.
2. Calibrated Pressure Range (using Allowable Pressure Units from the table below).
3. Configuration Data Form when Factory Calibration Option -C2 is specified.
4. Options and Accessories not in Model Code (see PSS 2A-1Z9 E).
5. User Tag Data - Data Plate; 32 characters maximum. For additional tag data, specify Optional Supplemental Tag -T.

Allowable Pressure Units for Calibrated Range (a)

inH_2O	psi	Pa	atm	g/cm^2
ftH_2O	inHg	kPa	bar	kg/cm^2
mmH_2O	mmHg	MPa	mbar	torr

(a) Displayed in upper case only on transmitter.

OTHER M&I PRODUCTS

Invensys Foxboro provides a broad range of measurement and instrument products, including solutions for pressure, flow, analytical, positioners, temperature, controlling and recording. For a listing of these offerings, visit the Invensys Foxboro web site at:

www.foxboro.com/instrumentation

33 Commercial Street
Foxboro, MA 02035-2099
United States of America
www.foxboro.com
Inside U.S.: 1-866-746-6477
Outside U.S.: 1-508-549-2424
or contact your local Foxboro representative.
Facsimile: 1-508-549-4999

MB 010 Printed in U.S.A. 0507

ACI
Automation Components Inc.

Product Data

Thermistor Temperature Sensors

ACI/2252 Series
ACI/3K Series
ACI/5K Series
ACI/10K-AN (Type III)
ACI/10K-CP (Type II)

Product Description

The ACI/2252, ACI/3K, ACI/5K, ACI/10K-AN (Type III), and ACI/10K-CP (Type II) Series temperature sensors are thermistor type sensors. These sensors provide a predictable output over a specified temperature range to meet each manufacturers required input values.

Thermistors offer high accuracy and interchangeability over a wide temperature range.

The thermistors higher resistance relative to Platinum RTD's, creates a larger signal with the same measuring current, negating most lead wire resistance problems and eliminating the need for signal conditioners.

These units are offered in Room, Room with Set Point, Room with Override, Room with Setpoint and Override, and Room w/ Setpoint, Override, and RJ11 Jack, Stainless Steel Duct and Duct without Box, Immersion, Stainless Plate, Raw, Bendable Copper and Stainless Steel Rigid Averaging, Strap-On, Bullet Probe, Button Sensor, and Outdoor Air Configurations.

Setpoint options include a linear 400 Ohm, 1K, 2K, 3K, 5K, 8.5K, 10K, 20K, or 100K slide potentiometer. An optional series resistor allows for any offset of the setpoint potentiometer. These may be either Direct or Reverse Acting.

Indication stickers for setpoint include Cool|Warm, 55 to 85, and 10 to 30°C. Others are available upon request.

Override options include a N/O switch in parallel with the sensor or a separate 2 pole terminal block for Tenant override.

All ACI sensors can be ordered with an optional 4 pin RJ11 or 6 pin RJ12 or 1/8" RS232 Stereo communication jack with terminal blocks for remote programming.

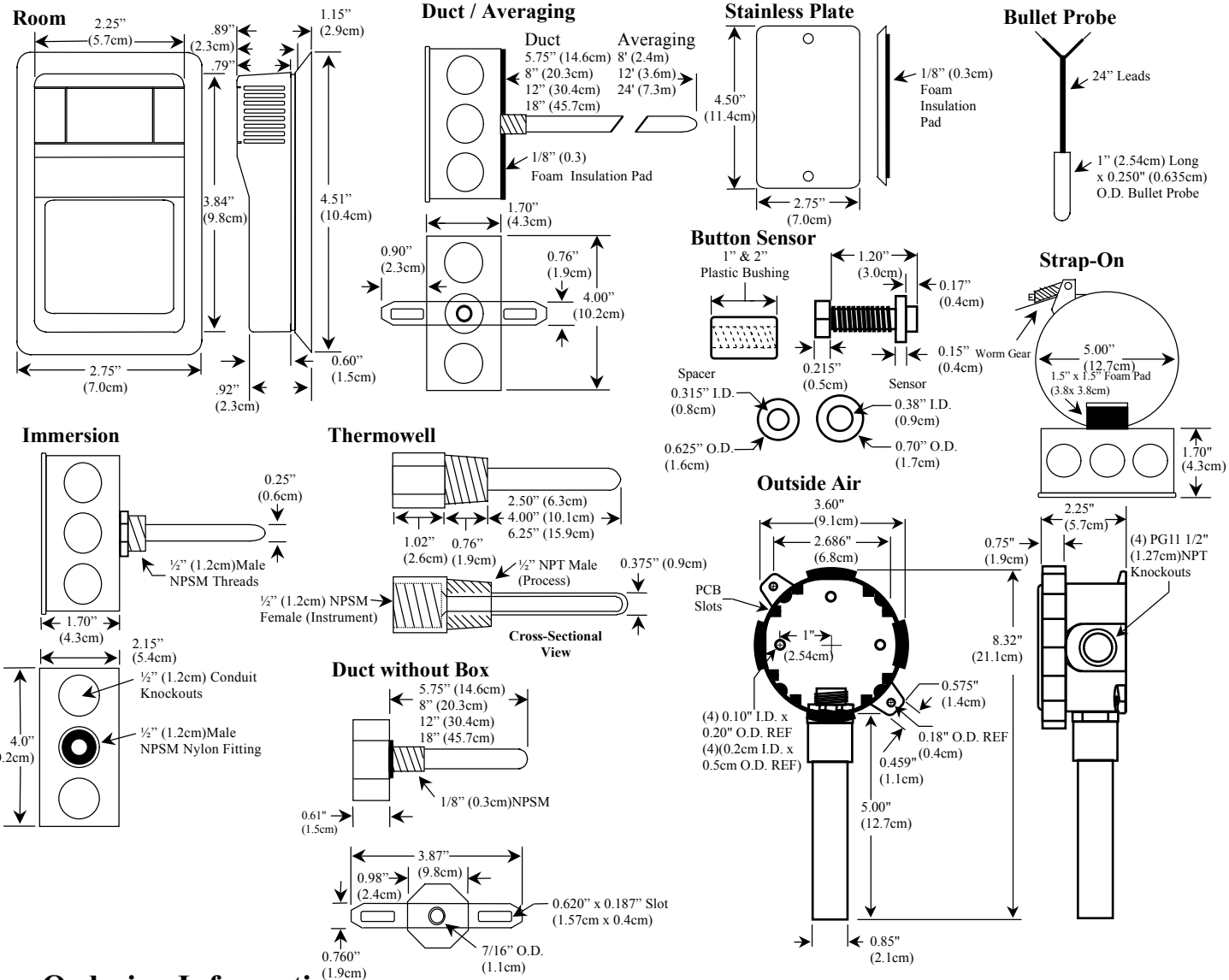
All units come with a two year factory warranty. Please contact ACI for more information regarding these products.

Product Specifications

Output	2,252 Ohms @ 77°F(25°C) 3,000 Ohms @ 77°F(25°C) 5,000 Ohms @ 77°F(25°C) 10K Ohms @ 77°F(25°C) Type II 10K Ohms @ 77°F(25°C) Type III	**Dissipation Constant**	3 mW / °C
		Stability	+/-0.13°C
Temperature Range	-40 to 302°F (-40 to 150°C)	**Accuracy**	+/- 0.2°C (0 to 70°C)
Interchangeability	+/- 0.2°C (0 to 70°C)	**Operating Humidity**	0 to 90% RH non-condensing

2305 Pleasant View Rd. Middleton Industrial Park Middleton, WI 53562
PH: (608) 831-2585 FAX: (608) 831-7407

Dimensions



Ordering Information

A/ [ ] -[ ] -[ ] -[ ] -[ ] -[ ]

Sensor	Configuration	Communication Jack	Pot Value	Setpoint Indication	Pot Action
2252	**R -** Room	**RJ4** (4 Pin RJ11)	**400 Ohm**	**Cool | Warm**	**DA** (Direct)
3K	**RS -** Room w/Setpoint	**RJ6** (6 Pin RJ12)	**1K**	**55 to 85**	**RA** (Reverse)
5K	**RO -** Room w/Override	**232** (1/8" Stereo Jack)	**2K**	**10 to 30°C**	
AN (10K-AN)	**RSO -** Room w/Setpoint & Override		**3K**	**Specify**	
CP (10K-CP)	**D -** Duct 4", 8", 12", 18"		**5K**		
	DO - Duct without Box 4", 8", 12", 18"		**8.5K**		
	I - Immersion 2.5", 4", 8"		**10K**		
	A - Averaging 8', 12', 24'		**20K**		
	RA - Rigid Averaging 18", 24", 36"		**100K**		
	S - Strap - On				
	O - Outdoor Air				
	BP - 1" Bullet Probe				
	RP - Remote Probe 6' Lead wire				
	SP - Stainless Plate				
	W - Raw w/18" Leads				
	BBS - Brass Button Sensor				
	SBS - Stainless Button Sensor				

CE

For CE compliance, sensor leads must be no longer than 3 meters in length. Additionally, certain product variations may not be CE compliant.
Contact ACI for further details

Example: A/AN -RSO -RJ6 -20K -55 to 85 -DA or A/3K -D -8" or A/AN -RSO -232 -20K -RA -Cool/Warm

2305 Pleasant View Rd. Middleton Industrial Park Middleton, WI 53562

T-16 **PH: (608) 831-2585 FAX: (608) 831-7407**

Appendix B

Office Power Instrumentation Plan (November 8, 2007 revision)

INSTRUMENTATION PLAN

FOR

DISTRIBUTED GENERATION / COMBINED HEAT AND POWER
(DG/CHP) SYSTEM

AT

666 5TH AVENUE, NEW YORK

NOVEMBER 8, 2007

SUBMITTED TO:

New York State Energy Research and
Development Authority
7 Columbia Circle
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METERING OVERVIEW:

OfficePower will install a collection of meters as part of the DG/CHP plant's construction to measure and record (1) the electricity supplied from both the incumbent electric utility (Con Edison) and from each Turbine Array (DG/CHP plant), (2) the thermal energy recovered and delivered to the building and (3) the natural gas used by the microturbines to generate the on-site power. OfficePower will use the data collected by these meters to measure the plant's overall monthly and annual performance and operating efficiency, and will serve as the basis for making the calculations necessary to qualify for NYSERDA's incentive payments for installing and operating of the planned DG/CHP plant.

ELECTRICAL ENERGY AND POWER MEASUREMENTS:

The plant at 666 5th Avenue will use PowerLogic ION7350 meters which provide fully bi-directional, 4-quadrant, revenue accurate energy and demand data. (See Appendix B for a copy of the PowerLogic ION7350 Datasheet.) The meters are wired 277 VAC L-N directly, eliminating the need for potential transformers. Metering and relaying current transformers will be installed to provide three-phase current inputs to each meter. All current transformers (CT) will have a 5A secondary output. The CT size will be determined based on the electrical bus size on which each CT is measuring current, as shown below. Figure 1 details the locations within the building of the ION7350 meters.

ELECTRIC METER	BUS (A)	CT RATIO
Building Main Electric Services	4,000A	4000:5A
Turbine Array #1 Net Power	1,200A	1200:5A
Turbine Array #2 Net Power	800A	800:5A
Parasitic Load Panel	200A	200:5A
Chiller Module Parasitic Load Panel	200A	200:5A

A certificate of accuracy will be provided for each ION7350 meter installed. If additional on-site testing is required, a 2-conductor longitudinal switch disconnect terminal block is installed for each voltage and current input to provide a connection point for electrical testing equipment.

Each meter internally converts voltage and current inputs to the meter to digital values. In addition, each meter has a remote display for viewing measured and

calculated electrical values, as well as memory for storing the digital electrical data.

Utility power (kW) and energy (kWh) delivered to the building is calculated by:

EQ. 1 $$WT_{Utility(gross)}[kW, kWh] = \sum WT_{1-4}[kW, kWh]$$

Electrical power (kW) and energy (kWh) delivered to the building from the DG/CHP plant is calculated by:

EQ. 2 $$WT_{DG/CHP(net)}[kW, kWh] = \sum WT_{TA1-TA2}[kW, kWh]$$

The building's total demand and consumption of electricity is therefore calculated by:

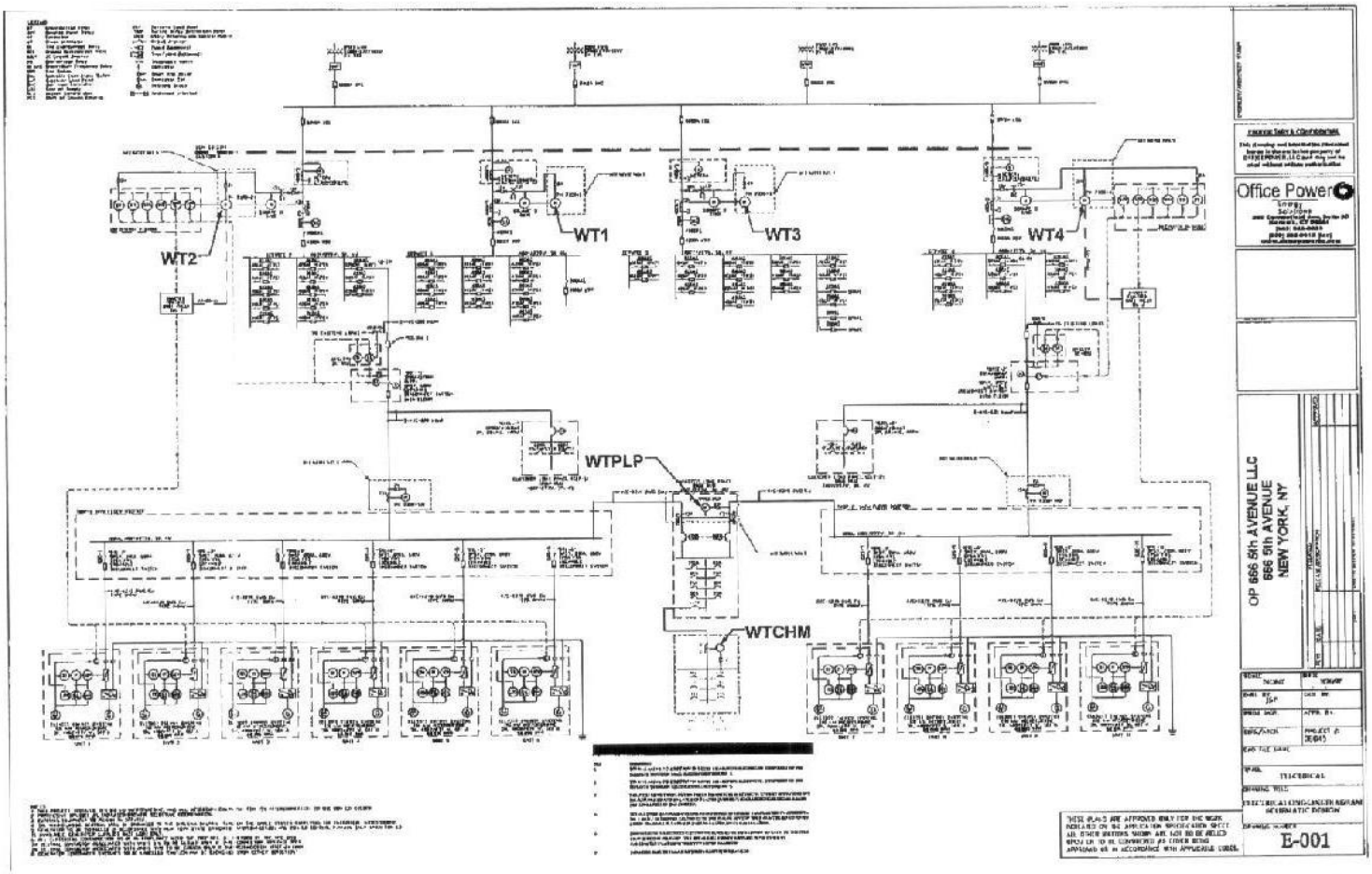
EQ. 3 $$WT_{Building}[kW, kWh] = WT_{Utility(Gross)}[kW, kWh] + WT_{DG/CHP(net)}[kW.kWh]$$

Each ION7350 meter will have two RS485 communication ports. COM1 port will be programmed to communicate and upload data to OfficePower's remote metering database using the ION communication protocol. COM2 port will be programmed to transmit data to OfficePower's SCADA system using Modbus RTU communication protocol. The SCADA system is the Modbus master device and each ION7350 meter is programmed as a Modbus slave device.

The energy and demand of all electrical loads used in the operation of the distributed generation plant (including the absorption chiller) and those connected to the parasitic load panel will be measured using a Power Measurement PML7350 meter (designated PML7350-PLP). A second PML7530 meter (designated PML7350-CHM) will sub-meter the electrical loads used to operate the absorption chiller and ancillary equipment, consisting of the following equipment:

Absorption chiller
Cooling towers (fans and spray pumps)
Pump P5 (chilled water)
Pump P10 (condenser water)
Chiller Module exhaust fan & heater
Chiller Module controls

FIGURE 1
ELECTRICAL INTERCONENCT ONE-LINE DIAGRAM



When operating in the power and heating modes, the parasitic electric load for the DG/CHP plant is calculated as:

EQ. 4 $$WT_{Parasitic(heat)}[kW, kWh] = WT_{PLP}[kW, kWh]$$

When operating in the cooling mode, the parasitic electric load for the DG/CHP plant is calculated by subtracting PML7350-CHM from PLP7350-PLP:

EQ. 5 $$WT_{Parasitic(cool)}[kW, kWh] = WT_{PLP}[kW, kWh] - WT_{CHM}[kW, kWh]$$

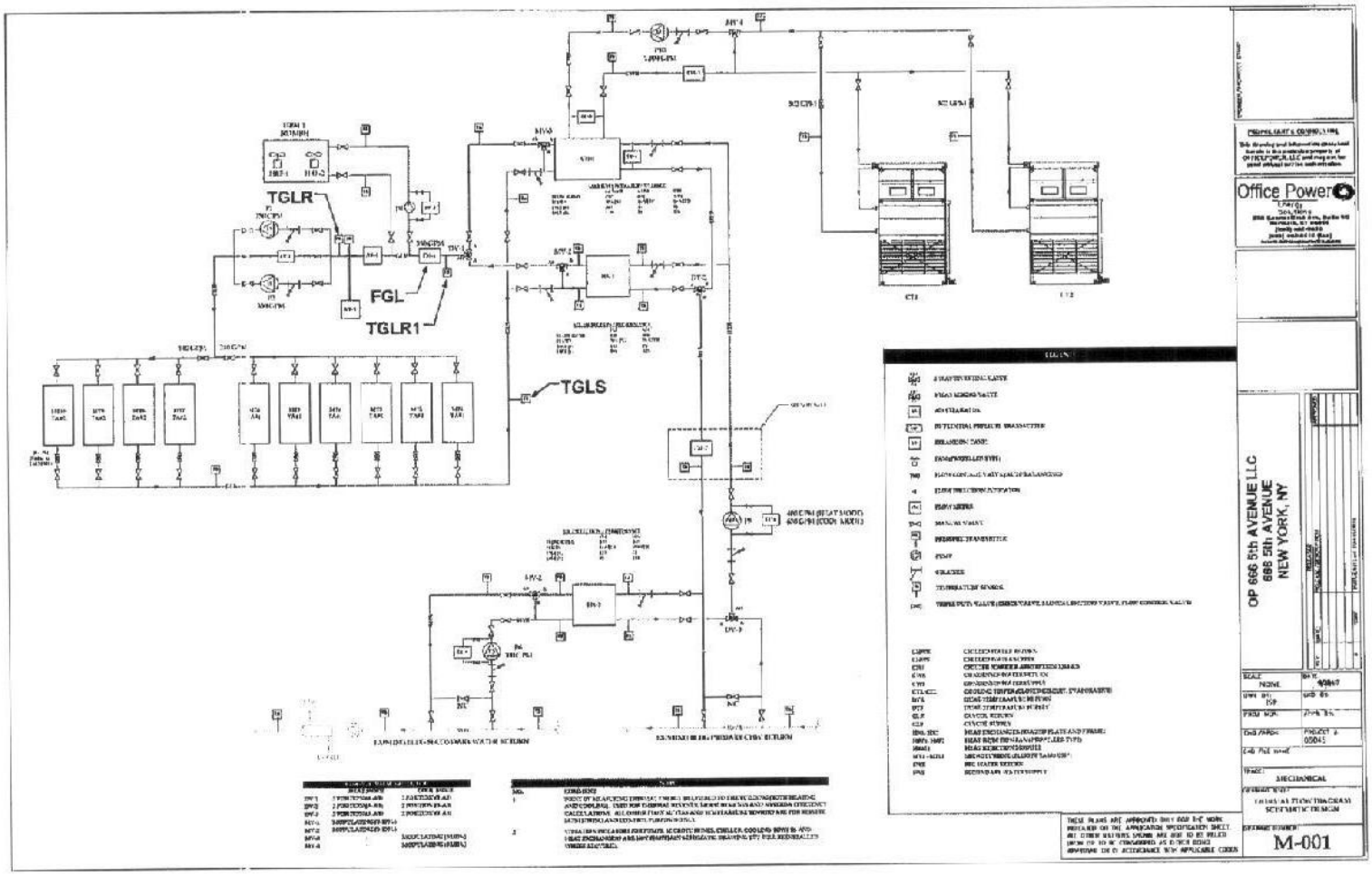
TEMPERATURE MEASUREMENTS:

To calculate the thermal energy delivered to the building from the DG/CHP plant, the heat recovery system's supply and return temperatures are measured. Glycol temperatures (TGLR, TGLR1, TGLS) are measured using 10K Ohm thermistor temperature sensors. Sensors will be installed in ½" threaded stainless steel wells. Figure 2 displays the locations where these three temperature sensors are located. (See Appendix E for ACI Temperature Sensor Datasheet.)

The SCADA control module supplies 5 VDC power to each sensor, and measures the return current to determine resistance in the circuit. Using a 12 bit A/D converter and a resistance/temperature curve table, OfficePower's SCADA control module generates a digital temperature value. An offset is used to calibrate each temperature reading with field measurements. Temperature sensors are used to monitor and control the heat recovery piping system in addition to providing information for NYSERDA's measurement and verification.

OfficePower will install a Pete's Plug (P/N 110XL) adjacent to each temperature sensor. A test thermometer can be inserted in the Pete's Plug for verification and calibration of temperature sensor measurements. (See Appendix G for Pete's Plug Datasheet.)

FIGURE 2
THERMAL PIPING ONE-LINE DIAGRAM



FLOW MEASUREMENT AND CALCULATION:

To calculate the thermal energy delivered to the building from the DG/CHP plant, the heat recovery system flow also needs to be measured. A McCrometer V-Cone flow meter is used to measure the differential pressure generated by the flow of the glycol/water fluid in the microturbine heat recovery piping. (See Appendix C for McCrometer V-Cone Flow Datasheet.) The flow meter's unique design eliminates or reduces the need for up/down stream straight pipe diameters, under even the most difficult flow conditions.

The nominal flow rate in the heat recovery piping system is 350 GPM (35 GPM per microturbine). Each microturbine will be fitted with a pressure independent flow control valve to regulate the maximum flow through each turbine at 35 GPM. The FM-1-VC flow meter is rated for 500 GPM maximum with a 10:1 turndown ratio. Figure 2 shows the location of the flow meter in the common supply header of the heat recovery piping so that total flow, regardless of the operating mode (heating or cooling) is measured.

A Foxboro DP transmitter is used to measure differential gage pressure (inWC) of flow across the V-Cone flow meter. The Foxboro DP transmitter outputs a 4-20 mA current signal in linear proportion to the differential pressure measured from the flow meter. (See Appendix D for Foxboro DP Transmitter Datasheet.) The SCADA control module measures the current input, and using a 12 bit A/D converter, generates a digital differential pressure value. An offset is used to calibrate the control module input with the DP transmitter output.

Heat recovery flow as measured by the flow meter FM-1-VC is calculated using the following formula:

EQ. 6 $$FGL_{(gallons/\min)} = \sqrt{\frac{DP_{ACTUAL[inWC]}}{DP_{MAX[inWC]}}} \times FGL_{MAX[gallons/\min]}$$

Where: DP_{MAX} = 49.99 inWC[1]
FCL_{MAX} = 500 GPM

OfficePower's SCADA system will use flow measurements to monitor and control its heat recovery piping system in addition to providing data to meet NYSERDA's measurement and verification requirements. All differential

[1] Data taken from the FM-1-VC McCrometer V-Cone preliminary sizing and is subject to change based on final factory testing of the flow meter. See McCrometer V-Cone preliminary sizing in Appendix B.

pressure readings of less than 0.5 inWC (50 GPM) will be interpreted and recorded as no flow (0 GPM flow rate).

OfficePower will mount the Foxboro DP transmitter on a stainless steel manifold block equipped with spare test ports for connection of a test pressure gauge(s).

THERMAL (BTU) CALCULATIONS:

The working fluid in the heat recovery piping system is a 30/70 mixture of propylene glycol and water. This brine solution has a specific heat of 0.935 Btu/ lbm-^{0}F and an equation factor of 480 Btu/gallon-^{0}F-h.

Gross heat recovered from the DG/CHP system is calculated as:

EQ. 7 $$Q_{CHP(gross)}\left[\frac{Btu}{h}\right] = 480\left[\frac{Btu\,\min}{gallon°Fh}\right] xFGL\left[\frac{gallon}{\min}\right] x(TGLS - TGLR)[°F]$$

Net useful heat recovered from the DG/CHP system is calculated as:

EQ. 8 $$Q_{CHP(net)}\left[\frac{Btu}{h}\right] = 480\left[\frac{Btu\,\min}{gallon°Fh}\right] xFGL\left[\frac{gallon}{\min}\right] x(TGLS - TGLR1)[°F]$$

During normal operation, the Heat Rejection Module will not operate. When there is no thermal demand (heating or cooling), each microturbine's integral heat exchanger damper will modulate to the full bypass position, rejecting the hot turbine exhaust is rejected directly to ambient. Each microturbine controls the modulating of the bypass damper to maintain a pre-set desired temperature setpoint.

The plant's Heat Rejection Module (HRM), consisting of a P4 pump and fans, will only operate when the glycol return temperature (TGLR) to the microturbines exceeds 205F. The HRM is sized to reject the full heat output of one microturbine (~400 MBH) when operating at full power output. In the event the glycol return temperature continues to rise to 210F, the SCADA system will automatically shut down the microturbine whose bypass damper is not functioning.

The thermal energy rejected to ambient by the Heat Rejection Module is calculated as:

EQ. 9 $$Q_{DumpRad}\left[\frac{Btu}{h}\right] = 480\left[\frac{Btu\,\min}{gallon°Fh}\right] xFGL\left[\frac{gallon}{\min}\right] x(TGLR1 - TGLR)[°F]$$

GAS MEASUREMENTS:

Con Edison will install a new 8" gas service dedicated to the distributed generation plant. OfficePower will request Con Edison install solid-state pulsers on each of their revenue gas meters to provide a compensated pulse output from each meter. The pulse output(s) will be wired as a digital input to OfficePower's SCADA control module. The SCADA will be programmed to count the pulses and calculate the gas flow (cubic feet) measured by each meter. OfficePower will use the gas meter pulses to monitor the distributed generation plant efficiency as well as for NYSERDA measurement and verification. Figure 3 shows the location of the utility gas meters in the overall fuel delivery piping to the DG/CHP system.

Energy consumed to operate the DG/CHP plant is calculated as:

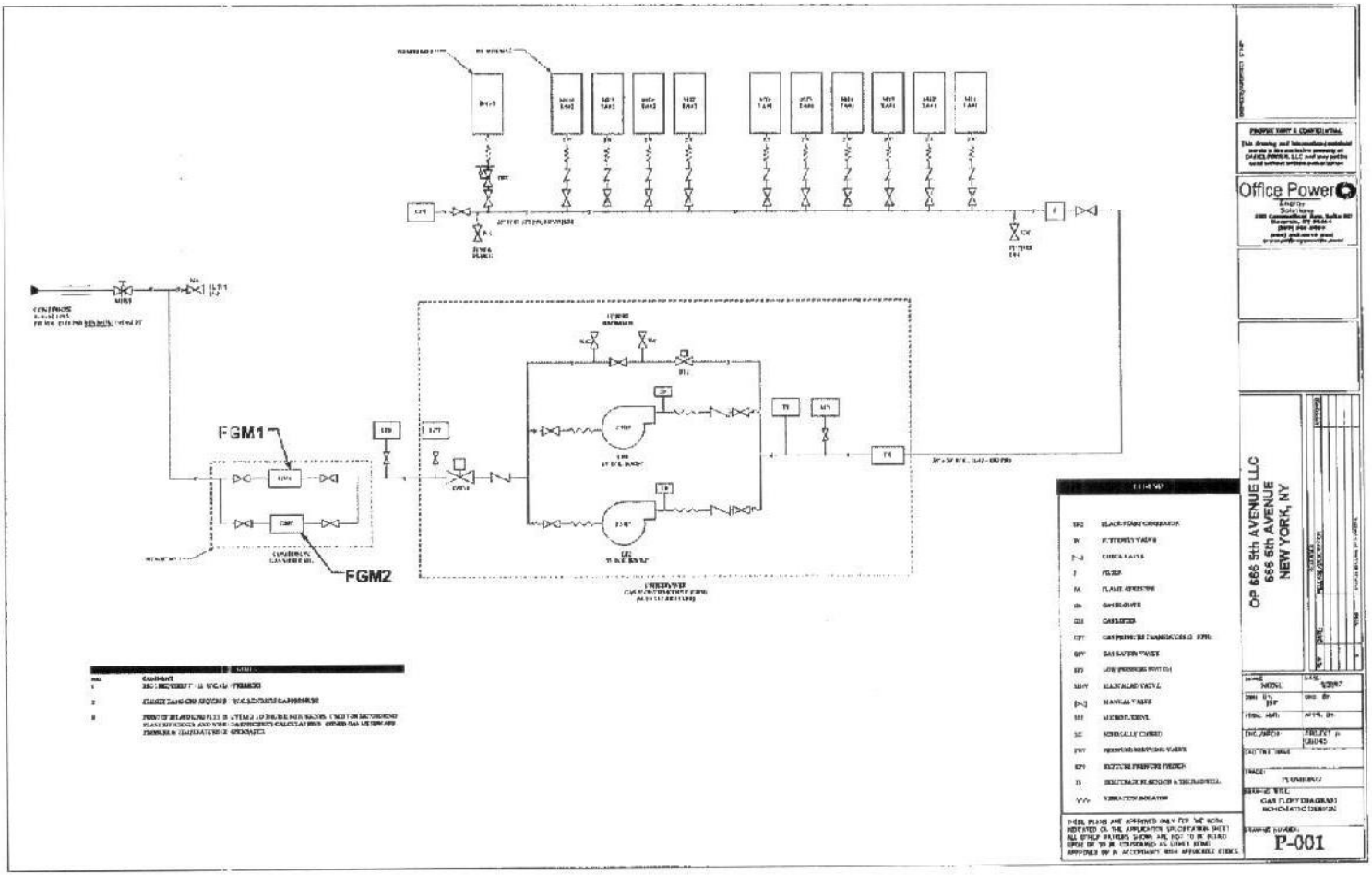
EQ. 10 $$FGM_{Utility(LHV)}[Btu] = \sum FGM1 \div 2[CuFt] xHHV\left[\frac{Btu}{CuFt}\right] x0.9\left[\frac{Btu_{LHV}}{Btu_{HHV}}\right]$$

Where:

HHV = Higher heating value of natural gas, typically between 950 and 1,020 Btu/Cu Ft.

0.9 = Ratio of lower heating value to higher heating value for natural gas (approximate)

FIGURE 3
FUEL DELIVERY ONE-LINE DIAGRAM



OPERATING MODE:

Thermal energy recovered from the Elliott microturbines will be used to heat and cool the building during winter and summer respectively using the same heat recovery piping. The SCADA system will be programmed to provide two binary outputs (1=ON, 0=OFF) signals indicating if thermal energy from the microturbines is being used for heating or cooling of the building.

DG/CHP PLANT EFFICIENCY CALCULATIONS:

The DG/CHP plant efficiency is therefore calculated as:

In the heating mode,

EQ. 11

$$\eta DG/CHP_{(Heat,\ LHV)} = \frac{Q_{CHP(net)}[Btu] + 3{,}412\left[\frac{Btu}{kW}\right] x\left(WT_{DG/CHP(net)}[kW] - WT_{Parasitic(Heat)}[kW]\right)}{FGM_{Utility(LHV)}[Btu]}$$

In the cooling mode,

EQ. 12

$$\eta DG/CHP_{(Cool,\ LHV)} = \frac{Q_{CHP(net)}[Btu] + 3{,}412\left[\frac{Btu}{kW}\right] x\left(WT_{DG/CHP(net)}[kW] - WT_{Parasitic(Cool)}[kW]\right)}{FGM_{Utility(LHV)}[Btu]}$$

DATA DELIVERY TO NYSERDA DATA COLLECTING EQUIPMENT:

OfficePower will utilize its Automated Logic Supervisory Control and Data Acquisition (SCADA) system as the platform for aggregating and distributing metering and sensor data to NYSERDA's data collection equipment. As described previously, electrical, thermal and gas meter/sensor readings are delivered as analog and digital inputs to control modules within SCADA system. Wiring connections are made to the control module physically closest to the meter/sensor devices. The control modules are connected to an ARC156 network which is used to broadcast information between SCADA control and

communication modules using the BACnet communication protocol. Required meter/sensor data will be written to Modbus registers for reading by NYSERDA data collection equipment. The Modbus registers will be updated at a minimum every thirty (30) seconds[2]. All metering/sensor data sent to NYSERDA's data collector is also used by OfficePower for its monitoring and control of the microturbines and distributed generation plant.

OfficePower will install a high speed LGR communication module to serve as the portal through which meter/sensor data can be read from the SCADA system by NYSERDA's data collector. The NYSERDA data collector will serve as Modbus Master to poll data from the SCADA communication module, which will be programmed as the Modbus slave device.

Figure 4 provides a hierarchal view of the data delivery system. Table 1 provides specifications for the communication wiring and suggested Modbus communication protocol. Table 2 provides a list of required data points and Modbus register information for use in programming the data logger.

TABLE 1
COMMUNICATION SPECIFICATION

CABLE TYPE	2-WIRE
CABLE SPECIFICATION	18-AWG, SHIELDED PAIR
MAX LENGTH	1,000 FEET
COMMUNICATION TYPE	EIA-485 MODBUS RTU
BAUD	9600 BPS[3]
DATA BITS	8 DATA BITS
PARITY	NO PARITY
STOP BIT(S)	1
MODBUS SLAVE DEVICE NO.	1[4]

[2] Faster update of the Modbus registers may be possible but will require field testing and verification for reliability of data transmission.
[3] Faster Modbus communication speeds available but will require testing to verify data transmission accuracy.
[4] Slave device number to be determined by NYSERDA technical consultant programming the data logger.

FIGURE 4
HIERARICAL VIEW OF DATA DELIVERY SYSTEM

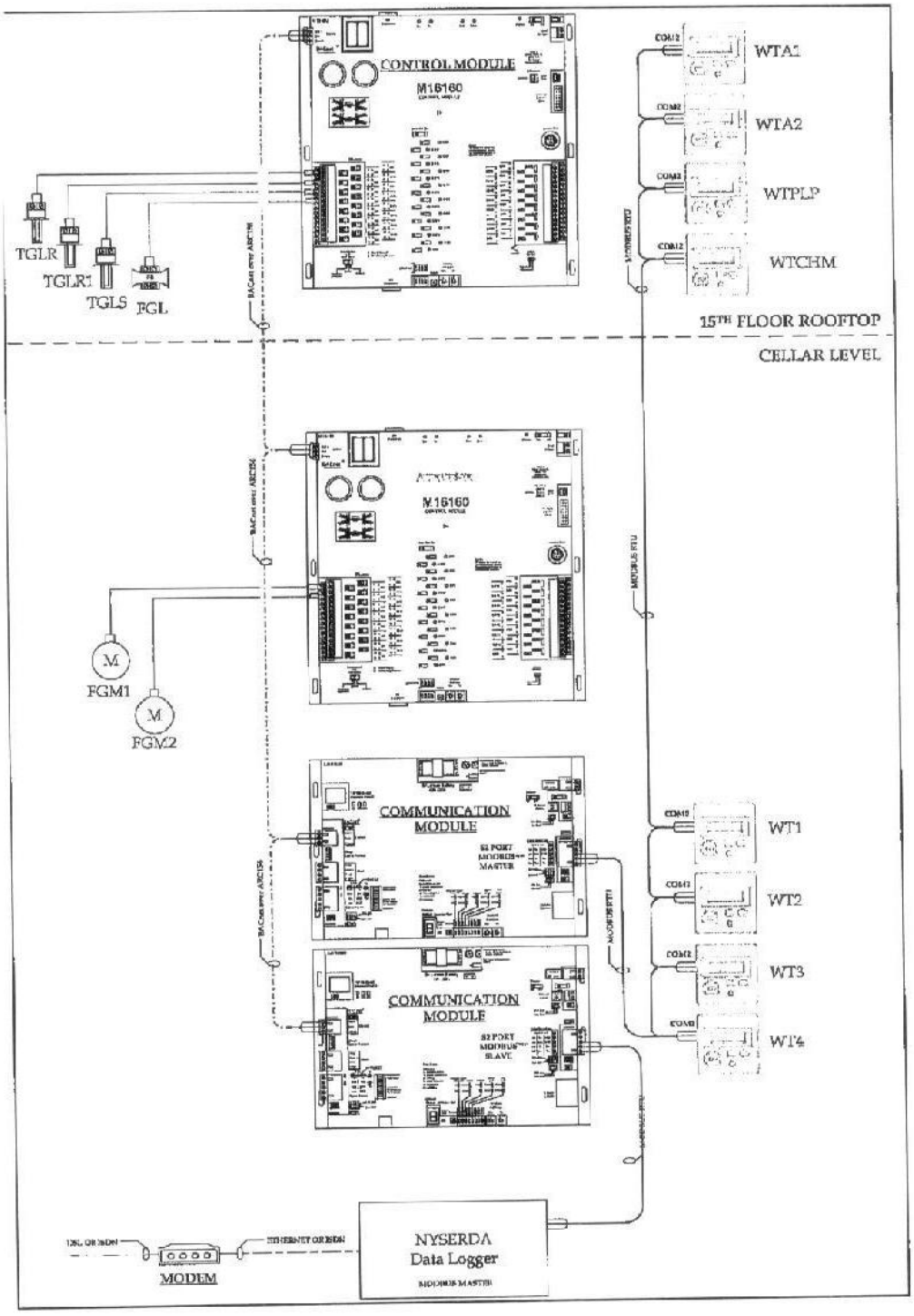


TABLE 2
MODBUS REGISTER LIST

MODBUS ADDRESS	TAG	DESCRIPTION	FORMAT[1]	R/W
	WT1	BUILDING MAIN ELECTRIC SERVICE #1 ENERGY IMPORT (KWH)	SINT32	READ
	WT2	BUILDING MAIN ELECTRIC SERVICE #2 ENERGY IMPORT (KWH)	SINT32	READ
	WT3	BUILDING MAIN ELECTRIC SERVICE #3 ENERGY IMPORT (KWH)	SINT32	READ
	WT4	BUILDING MAIN ELECTRIC SERVICE #4 ENERGY IMPORT (KWH)	SINT32	READ
	WTA1	TURBINE ARRAY #1 NET ENERGY EXPORT (KWH)	SINT32	READ
	WTA2	TURBINE ARRAY #2 NET ENERGY EXPORT (KWH)	SINT32	READ
	WT1KW	BUILDING MAIN ELECTRIC SERVICE #1 DEMAND IMPORT (KW)	SINT	READ
	WT2KW	BUILDING MAIN ELECTRIC SERVICE #2 DEMAND IMPORT (KW)	SINT	READ
	WT3KW	BUILDING MAIN ELECTRIC SERVICE #3 DEMAND IMPORT (KW)	SINT	READ
	WT4KW	BUILDING MAIN ELECTRIC SERVICE #4 DEMAND IMPORT (KW)	SINT	READ
	WTA1KW	TURBINE ARRAY #1 DEMAND EXPORT (KW)	SINT	READ
	WTA2KW	TURBINE ARRAY #2 DEMAND EXPORT (KW)	SINT	READ
	WTAPLP	PARASITIC LOAD PANEL ENERGY (KWH)	SINT32	READ
	WTAPLPKW	PARASITIC LOAD PANEL DEMAND (KW)	SINT	READ
	WCHMPLP	CHILLER MODULE PARASITIC LOAD PANEL ENERGY (KWH)	SINT32	READ
	WCHMPLPKW	CHILLER MODULE PARASITIC LOAD PANEL DEMAND (KW)	SINT	READ
	FGM1	GAS METER #1 (CF)	SINT32	READ
	FGM2	GAS METER #2 (CF)	SINT32	READ
	TGLR	GLYCOL RETURN TEMPERATURE POST RADIATOR (^{0}F)	SINT	READ
	TGLR1	GLYCOL RETURN TEMPERATURE PRE RADIATOR (^{0}F)	SINT	READ
	TGLS	GLYCOL SUPPLY TERMPERATURE (^{0}F)	SINT	READ
	FGL	FM-1 GLYCOL FLOW METER (GPM)	SINT	READ
	HEAT	OPERATING MODE – HEATING	BIT	READ
	COOL	OPERATING MODE – COOLING	BIT	READ

NOTE 1 SINT = SIGNED 16-BIT INTEGER (-32,768 TO +32,767)
SINT32= SIGNED 32-BIT INTEGER (-2,147,483,648 TO +2,147,483,647)
BIT = DISCRETE (BINARY) 0 OR 1

DATA PROCESSING AND TRANSFER TO NYSERDA DATABASE

NYSERDA's technical consultant is responsible for furnishing, installing, programming and maintaining a data collector that reads data from OfficePower's SCADA system and for uploading of the data to a remote database.

APPENDIX A – INSTRUMENTATION SPECIFICATIONS

TABLE A1 – POWER AND ENERGY METERS

OP TAG	PML7350-MES1, PML7350-MES2, PML7350-MES3, PML7350-MES4, PML7350-TA1, PML7350-TA2, PML7350-PLP, PML7350-CHM
NYSERDA DATA POINT	WT1, WT2, WT3, WT4, WTA1, WTA2, WTPLP,WTCHM
MANUFACTURER	SCHNEIDER ELECTRIC POWER LOGIC
MODEL	ION 7350
PART NUMBER	P7350R0B0B0A0A0A
TYPE	BIDIRECTIONAL THREE PHASE POWER AND ENERGY METER
SIZE (MEMORY)	300 KB
ACCURACY	VOLTAGE 0.25% RDG + 0.05% FS, FREQUENCY ±0.01% RDG , CURRENT 0.25% RDG +0.05% FS
RANGE	50 TO 347 VAC L-N, 5A NOMINAL / 10A FULL SCALE
OUTPUT SIGNAL	SERIAL RS485 MODBUS RTU
POTENTIAL TRANSFORMER	N/A. METERS WIRED DIRECT 277 L-N, 4-WIRE
CURRENT TRANSFORMER TYPE	RELAY & METER CLASS TRANSFORMER.' FINAL SELECTION TBD.
CURRENT TRANSFORMER SIZE	CURRENT TRANSFORMERS WILL BE SIZED BASED ON CURRENT RATING OF THE ELECTRICAL BUS
NOTES	TRAN UNIT WITH REMOTE DISPLAY, -4F TO +140F OPERATING TEMPERATURE. TIMESTAMP RESOLUTION 0.001 SECONDS. SEE ATTACH DOCMENTS FOR ADDITIONAL DETAILS ON ELECTRIC METER AND CURRENT TRANSFORMERS.

TABLE A2 - DIFFERENTIAL PRESSURE FLOW METER

OP TAG	FM-1-VC
NYSERDA DATA POINT	FGL
MANUFACTURER	McCROMETER
MODEL	V-CONE
TYPE	DIFFERENTIAL PRESSURE FLOW METER
PART NUMBER	VS06QE03S
SIZE	6" FLANGED
ACCURACY	± 0.5% OF ACTUAL FLOW
REPEATABILITY	± 0.1% OR BETTER
RANGE	0.5" W.C. TO 50" W.C.
FLOW RATE (MAX)	500 GPM @ 50" W.C. DP
FLOW RANGE	10:1 OR GREATER
STRAIGHT PIPE REQUIREMENTS	0D UP AND DOWN STREAM
NOTES	SEE ATTACHED V-CONE DOCUMENTS & PRELIMINARY SELECTION

TABLE A3 - DIFFERENTIAL PRESSURE (DP) TRANSMITTER

OP TAG	FM-1-DT
NYSERDA DATA POINT	FGL
MANUFACTURER	FOXBORO
MODEL	IGP10
PART NUMBER	IGP10-A22C1F-V3
TYPE	GAUGE PRESSURE
SIZE	½" THREADED
ACCURACY	± 0.20% OF SPAN
RANGE	0 – 30 PSI
AMBIENT TEMPERATURE	-20 TO +180F OPERATING
OUTPUT SIGNAL	4 TO 20 mA LINEAR
NOTES	INCLUDES MANIFOLD BLOCK WITH TEST PORTS & ISOLATION VALVES & LCD INDICATOR. SEE ATTACHED FOXBORO TRANSMITTER PRODUCT SPECIFICATION.