MEASUREMENT AND VERIFICATION PLAN

FOR

BURKE REHABILITATION HOSPITAL CHP PROJECT

As-Built

July 31, 2008

Submitted to:

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1. Introduction

Siemens Building Technologies, Inc. has submitted an application to the NYSERDA CIPP program (PON 984) to install a CHP system at Burke Rehabilitation Hospital in White Plains, New York. The Hospital consists of 17 buildings with a total floor space of 257,000 ft^2. In-patient capacity is 140 beds.

The CHP system includes eight (8) Tecogen 75 kW units. The total gross power output is 600 kW. Thermal output from the units will be used to meet various hot water loads in the facility. Dump radiators will reject any unused heat from the engines. The heat recovery system can nominally provide 4080 MBtu/h of heat to the facility loads (according to the drawings).

The generators are 480 VAC, 3-phase (wye) induction generators. The electrical service for the 8 generators combined is 1200 amps. The facility electrical service is 480 VAC, 3-phase at 3000 amps. The generator power is fed into the main facility panel. A protective relay monitors generator output as well as the utility status to satisfy the Consolidated Edison inter-connection requirements.

Heat from the engine loop can be used to meet thermal loads in the facility via five heat exchangers (see Figure 2). The thermal loads include:

- Terminal Reheating – Loop P-4 (summer, 2550 MBtu/h)
- Perimeter Space Heating - Loops P-5 and P-40 (winter, 5550 & 5550 MBtu/h)
- Makeup water pre-heating for DHW (year-round, 260 MBtu/h)
- Makeup water pre-heating for Laundry (year-round, 60 MBtu/h)

At full load the generators will consume approximately 7,000 std cubic feet (cf) of natural gas per hour.

2. Instrumentation

Siemens will supply the instrumentation listed Table 1 below. A single power meter will measure the gross power produced by the 8 generator units. One gas meter will measure the natural gas supplied to the units. A separate facility meter will be installed.

Table 1. Instrumentation Supplied By Siemens

Point	Instrument	Output Type	Sensor Location	Notes
Facility Power	Wattnode WNB-3Y-480P (2000 amp CTs) FCL-2000:0.333V-18	Pulse output (4 hz @ full scale or 0.11542 kWh/p)	In the main disconnect (see Figure 3)	
Generator Power Output	Wattnode WNB-3Y-480P (2000 amp CTs) CTB-5.0X5.0-2000	Pulse output (4 hz @ full scale or 0.11542 kWh/p)	In or near "B9S-1" disconnect (see Figure 3)	
Generator Gas Input (**FG**)	Roots B3 Series Model #7M175	Solid State Pulse (SSP) output, 1000 cf/pulse (temp-compensated)	On gas line serving all 8 engines	Roots "TS" pulser option Pulse rate: 6 p/hr
Panel H-CHP Power (**WH**)	Wattnode WNB-3Y-480P (200 amp CTs) CTS-2000-200	Pulse output (4 hz @ full scale or 0.011542 kWh/p)	In H-CHP Panel (see Figure 3)	This panel should include all parasitics on the engine skid as well pumps and fans for heat rejection
Non-Parasitic Power (**WL**)	Wattnode WNB-3Y-480P (100 amp CTs) CTS-2000-100	Pulse output (4 hz @ full scale or 0.00571 kWh/p)	Near L-CHP Panel; all non-CHP, non-parasitic loads from H-CHP (e.g. lights, plug loads, HVAC)	WP = WH - WL
fluid loop flow rate (**FL**)	Onicon F-1110 Flow Meter	4-20mA output Full Scale: 400 gpm	In fluid loop as shown Figure 1. With 4 feet of straight pipe before and after meter.	4" diam pipe, nom. flow: 176 gpm nom. Q: 4080 MBtu/h ΔT: ~46°F

The temperature sensors in Table 2 will be supplied by the NYSERDA Monitoring Agent. Siemens will provide ¼ inch thermo-wells for the three temperature sensors shown in Figure 1.

Table 2. Summary of Temperature Measurements

Point	Instrument	Output Type	Sensor Location
Hot Water Supply (**T1**)	Watlow /Gordon Thermocouple, Type-T,	Thermocouple signal	In fluid loop as shown Figure 1
Hot Water Return – to Radiator (**T2**)	Watlow / Gordon Thermocouple, Type-T	Thermocouple signal	In fluid loop as shown Figure 1
Hot Water Return – to engine (**T3**)	Watlow / Gordon Thermocouple, Type-T	Thermocouple signal	In fluid loop as shown Figure 1

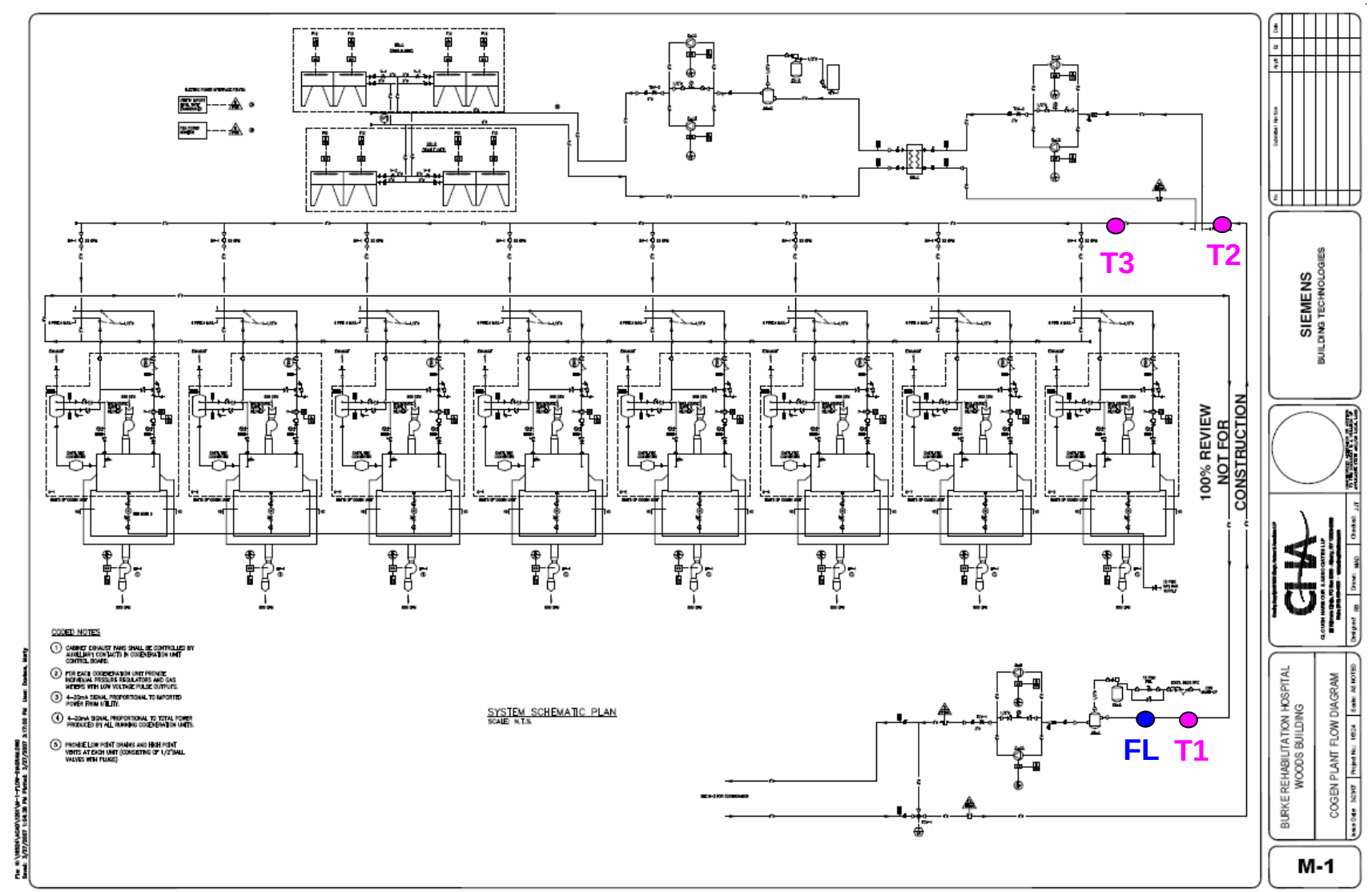


Figure 1. Schematic (Drawing M-1) Showing the Location of Temperature Sensors and Flow Meters

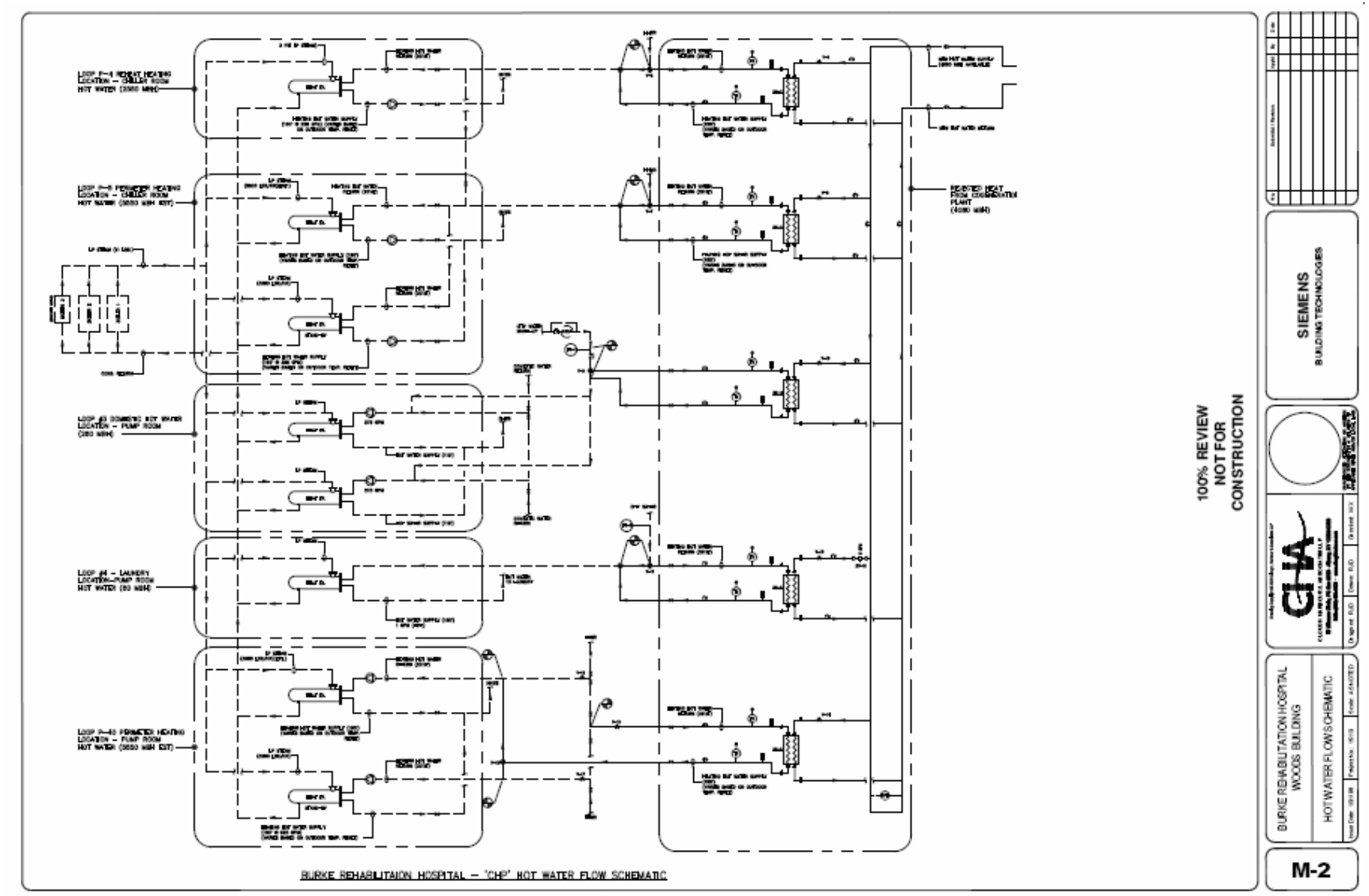


Figure 2. Schematic (Drawing M-2) Showing the Location of Heat Exchangers Serving Thermal Loads in the Facility

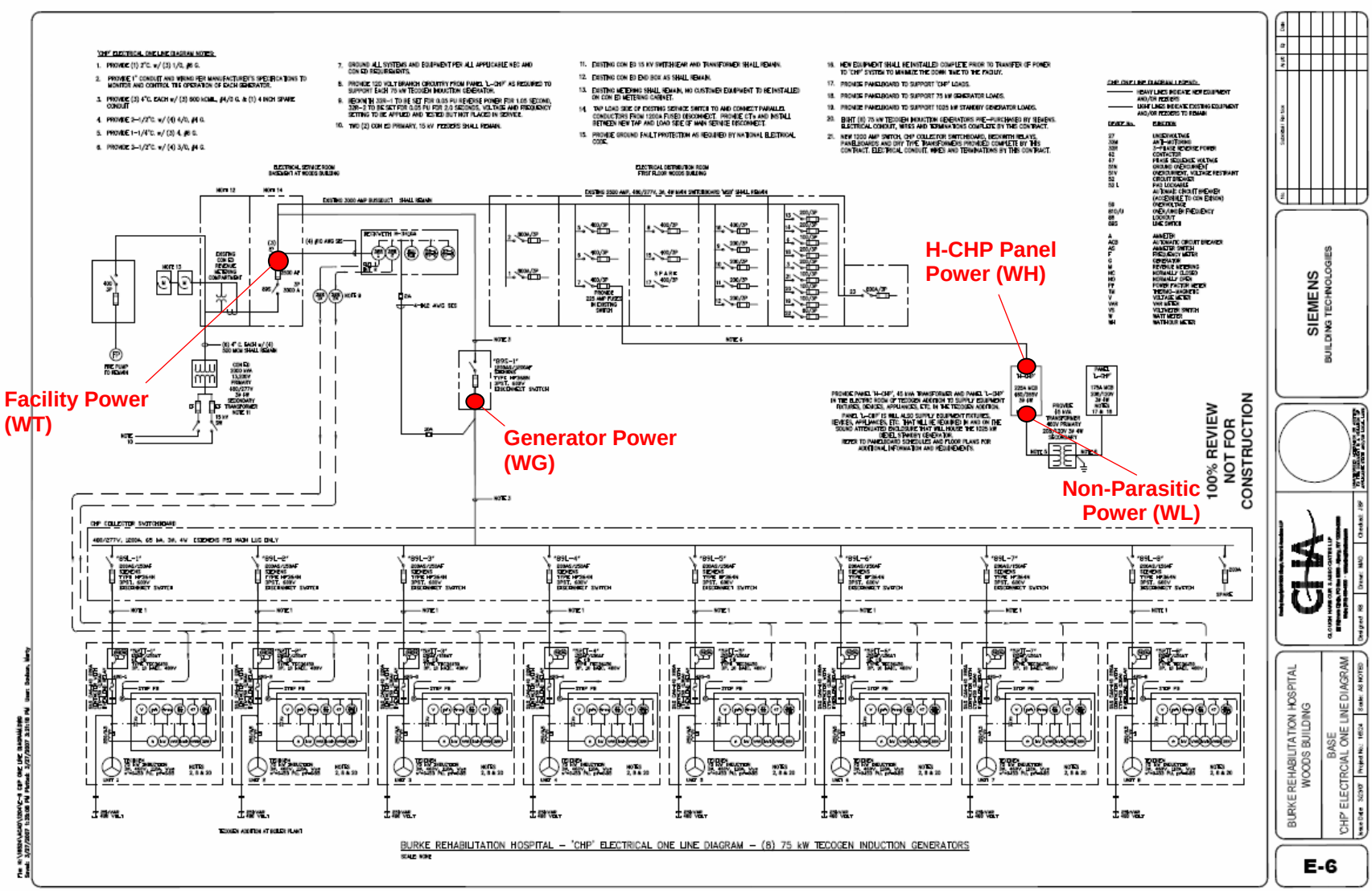


Figure 3. One-Line Schematic (Drawing E-6) Showing Locations of Power Measurement Points

Datalogger

An Obvius Acquisuite 8812 datalogger was installed to record the required data. The sensors will be sampled or scanned at 3 second intervals. All readings will be averaged, summed or calculated for each 15-minute interval. The datalogger will be able to hold more than 100 days of recorded 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

The NYSERDA monitoring agent 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 in a suitable area of the cogeneration room after structure erection. The monitoring agent can provide a phone sharing module so the device can be used by facility staff and/or other devices that may need a phone-modem connection.

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 3. Summary of Monitored Data Points

Point	Description	Engineering Units
WT	Facility Power / Purchased Utility Power	kWh per interval
WG	Generator Power Output	kWh per interval
FG	Generator Gas Consumption	Standard CF per interval
WP	Parasitic Power (calculated; see below)	kWh per interval
WH	H-CHP Panel Power	kWh per interval
WL	L-CHP Panel Power	kWh per interval
FL	Fluid Loop Flow Rate	gpm
T1	Hot Water Supply Temperature	°F
T2	Hot Water Return to Radiator	°F
T3	Hot Water Return to Engines	°F

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

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

Heat Recovery Rates

The heat recovery rates will be calculated from the recorded data after each 15-minute interval. The piping arrangement at this site allows for multiple heat rates to be determined with 3 temperature sensors and one flow reading:

Total Useful heat recovery (**QHU**) = $K \cdot FL \cdot (T1-T2)$

Rejected (unused) heat recovery (**QR**) = $K \cdot FL \cdot (T2-T3)$

Total heat recovery (**QT**) = $K \cdot FL \cdot (T1-T3)$

The loop fluid is expected to be water. The factor K is 487 Btu/h-gpm-°F for pure water at 180ºF (the nominal temperature expected in the heat recovery loop).

Calculated Quantities

The net power output from the CHP system will be defined as the gross power from the engine generators (WG) minus the parasitic power (WP). The H-CHP Panel includes all parasitic loads plus the transformer feed for the L-CHP panel, that contains all non-parasitic loads. The parasitic power will be determined using the two power readings:

$$WP = WH - WL$$

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

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

where:

QHU	-	Useful heat recovery (Btu/h)
WG	-	generator gross output (kWh)
WP	-	Parasitic power use (kWh)
FG	-	Generator gas consumption (Std CF)
Δt	-	0.25 for 15-minute data
HHV_{gas}	-	Lower heating value for natural gas (~1030 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:

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

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

Appendix

Cut Sheets for Key Sensors and Instruments

Obvius Acquisuite Datalogger
Wattnode Power Transducers
Flex-Core CTs
Roots Gas Meter
Onicon Flow Meter
Mamac Temperature Sensors

Instrumentation, Wiring Schematic, and Installation Details

Site Visits

December 6, 2007	Initial Visit (Hugh Henderson, Deodat Jamna)
April 7-8, 2008	Datalogger and sensors installation. DAS system operational but incomplete (Hugh Henderson, Kendra Scott, Brian Hawkins, Deodat Jamna)
June 5, 2008	All sensors connected, partially verified sensor readings (Hugh Henderson, Kendra Scott, Deodat Jamna)
July 24, 2008	Investigated problems with facility and generator power transducer readings, no resolution achieved for either sensor (Kendra Scott, Jeff Cosgrove, Deodat Jamna, Fred Nguyen)
July 30, 2008	Installed new facility and generator power transducers, corrected wiring, verified readings (Hugh Henderson, Kendra Scott, Deodat Jamna, Fred Nguyen)

Description of Monitored Data Points and Schematics

Table A-1 lists the monitored points installed at the site. The wiring Schematics are shown in Table A-2 and Table A-3.

Table A-1. Monitored Data Point List

Pt Name	Data Logger Channel	Description	Units	Sensor	Notes
TLS	ACQ-IN1	Loop Supply Temperature	F	Mamac TE-211Z	40 to 140 F Range
TLRBC	ACQ-IN2	Loop Return Temperature Before Cooler	F	Mamac TE-211Z	30 to 180 F Range
TLR	ACQ-IN3	Loop Return Temperature After Cooler	F	Mamac TE-211Z	30 to 180 F Range
FL	ACQ-IN4	Loop Water Flow Rate	gpm	Onicon F-1110	0 to 250 gpm Range
FG	ACQ-IN7	Generator Gas Use	cuft	Roots B3 Series Model #7M175	1000 cubic feet / Pulse
WH	ACQ-IN8	HCHP Panel Power	kWh	Wattnode WNB-3Y-208-P, 200 Amp CTs	200 Amp CTs (11.542 Wh/Pulse)
WL	EXP-D1	LCHP Panel Power	kWh	Wattnode WNB-3Y-208-P, 100 Amp CTs	100 Amp CTs (5.771 Wh/Pulse)
WG	EXP-D2	Generator Power	kWh	Wattnode WNB-3Y-208-P, 2000 Amp CTs	2000 Amp CTs (115.42 Wh/Pulse)
WT	EXP-D3	Facility Power	kWh	Wattnode WNB-3Y-208-P, 2000 Amp CTs	2000 Amp CTs (115.42 Wh/Pulse)

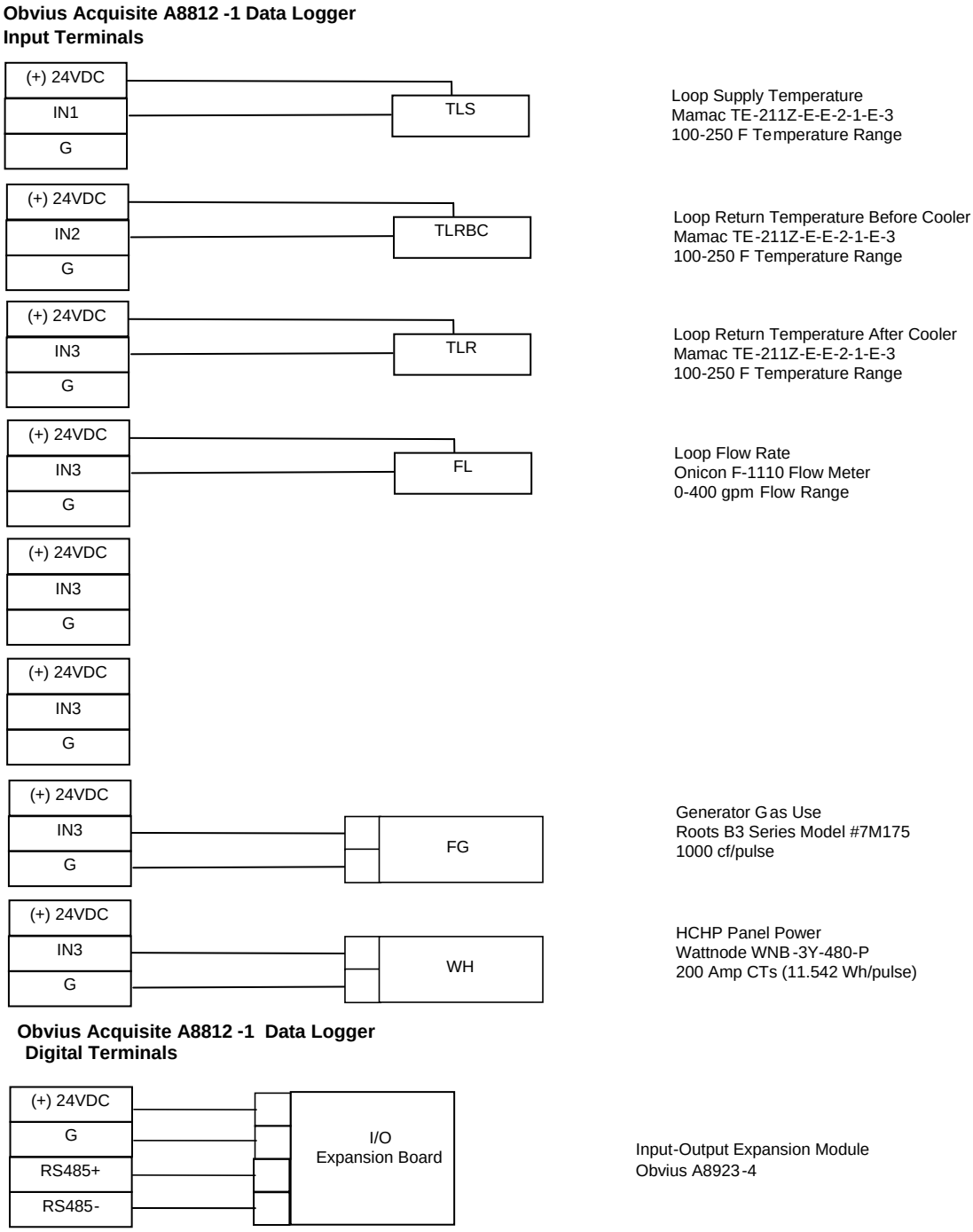
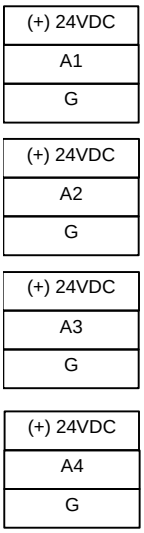
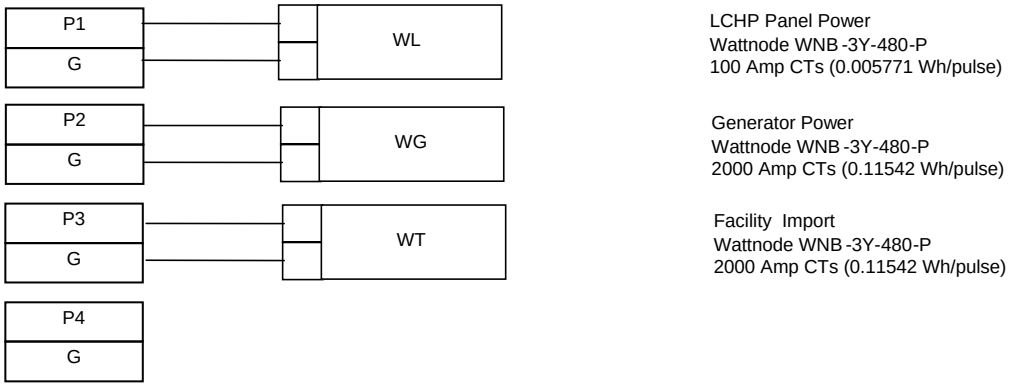


Table A-2. Wiring Schematic for Obvius Internal I/O Connections (Modbus Address 250)

Obvius A8923-4 Input/Output Module
Analog Terminals



Obvius A8923-4 Input-Output Module
Pulse Terminals

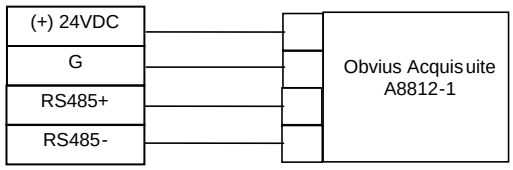


LCHP Panel Power
Wattnode WNB-3Y-480-P
100 Amp CTs (0.005771 Wh/pulse)

Generator Power
Wattnode WNB-3Y-480-P
2000 Amp CTs (0.11542 Wh/pulse)

Facility Import
Wattnode WNB-3Y-480-P
2000 Amp CTs (0.11542 Wh/pulse)

Obvius A8923-4 Input-Output Module
Digital Terminals

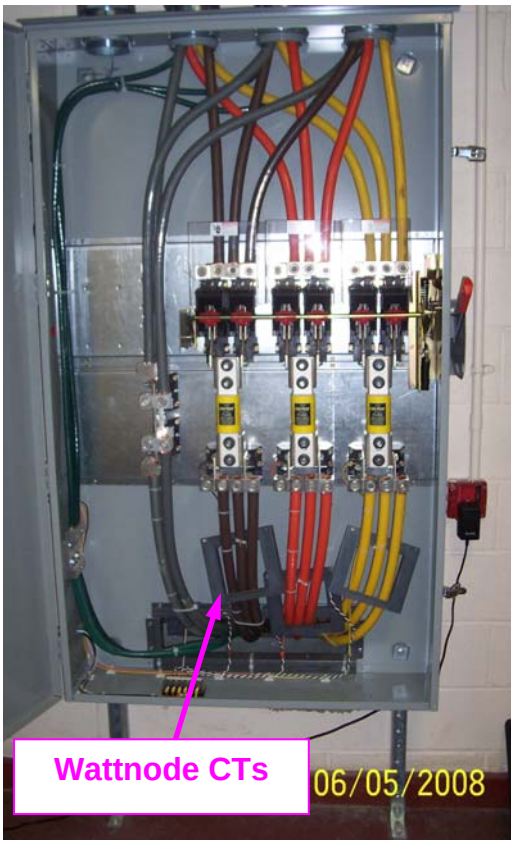


Connection to Obvius Datalogger
Obvius Acquisite A8812 -1

Table A-3. Wiring Schematic for Obvius Expansion Board (Modbus Address 001)

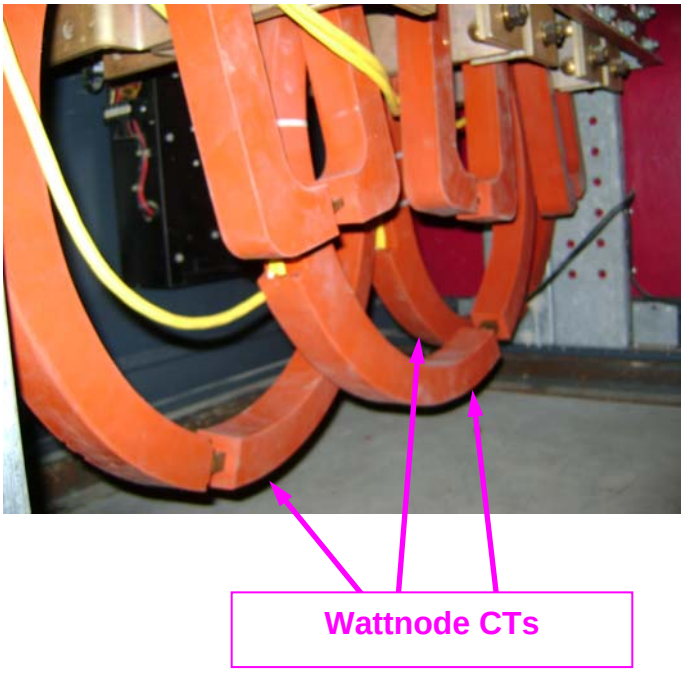
Photos of Installed Sensors

Generator Power Transducer (Red LEDs for Negative Power)

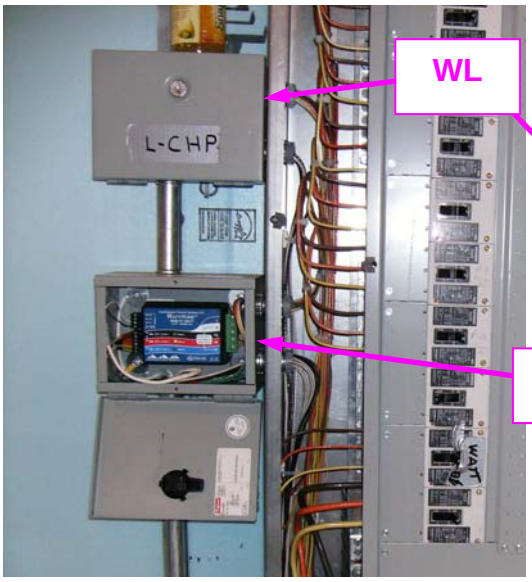


Generator Power CTs in Generator Disconnect

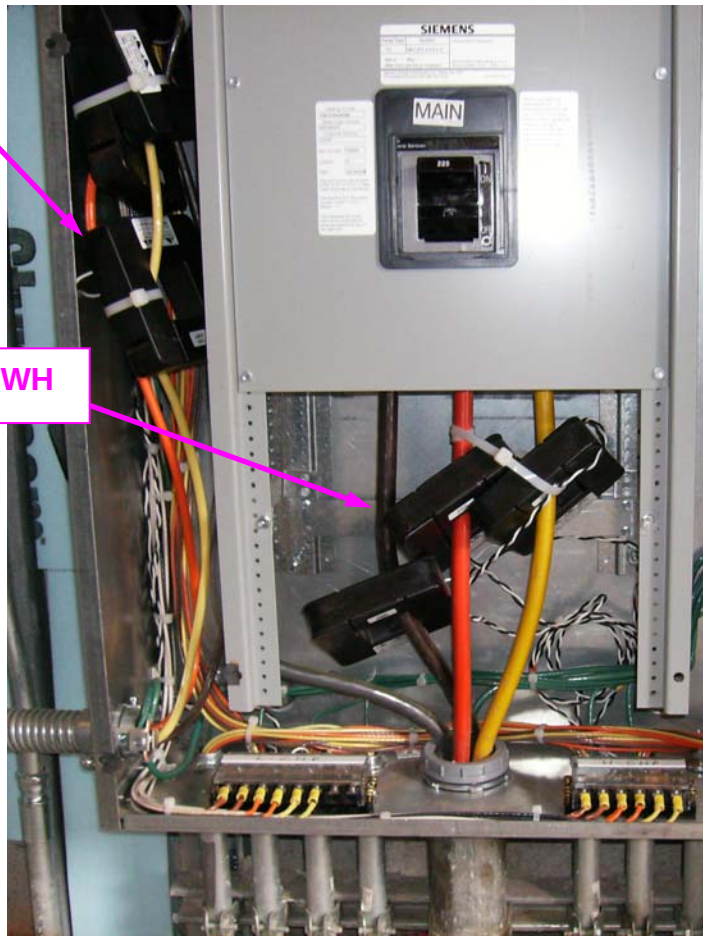
Facility Power Transducer (Yellow and Red LEDs for Negative Power with Low Power Factor)



Facility Power CTs in Facility Disconnect



Parasitic Power Transducers (WL and WH)



Parasitic Power Current Transducers (WL and WH)

Loop Return Temperature After Cooler (TLR)

Loop Return Temperature Before Cooler (TLRBC)

Loop Flow Meter (FL)

Loop Supply Temperature (TLS)

Gas Meter (FG)

One-time Readings

Hand-held power and amp readings were taken on the H-CHP and L-CHP loads during the two site visits. They are summarized in the tables below.

Table A-4. Hand-held Power and Current Readings for the L-CHP Panel During the April Site Visit

April 8, 2008 10:51 AM

Label	Circuit	Current (Amps)	Power (kW)
EF-1	2	6	0.5
EF-2	4	Off	Off
EF-3	6	6	0.5
EF-4	8	Off	Off
EF-5	10	6.2	0.52
EF-6	12	Off	Off
EF-7	14	Off	Off
EF-8	16	6.2	0.52
EF-9	34	4.5	0.28
Tecogen 1	18	11	0.93
Tecogen 2	20	11.2	0.94
Tecogen 3	22	11.1	0.94
Tecogen 4	24	11.2	0.93
Tecogen 5	26	11.2	0.92
Tecogen 6	28	11	0.9
Tecogen 7	30	11	0.93
Tecogen 8	32	11.3	0.96

Table A-5. Hand-held Power and Current Readings for the L-CHP Panel During the June Site Visit

June 5, 2008 10:45 AM

Label	Circuit	Current (Amps)
EF-1	2	5.22
EF-2	4	5.95
EF-3	6	5.4
EF-4	8	5.2
EF-5	10	5.35
EF-6	12	5.26
EF-7	14	5.21
EF-8	16	5.18
EF-9	34	4.47
Tecogen 1	18	N/A[1]
Tecogen 2	20	10.11
Tecogen 3	22	10.19
Tecogen 4	24	10.25
Tecogen 5	26	10.09
Tecogen 6	28	10.36
Tecogen 7	30	10.36
Tecogen 8	32	10.36

Notes: [1] - There was no connection from this breaker during the June site visit

Table A-6. Hand-held Power and Current Readings for the H-CHP Panel During the April Site Visit

June 5, 2008 11:30 AM	
Label	**Power (kW)**
DC-1	1.39
DC-2	1.26
DC-3	1.39
DC-4	1.35
DC-5	1.39
DC-6	1.26
DC-7	1.33
DC-8	1.32
P-13	Off
P-14	0.88
P-9	5
P-10	Off
Transformer	14.9

Table A-7. Hand-held Power and Current Readings for the H-CHP Panel During the June Site Visit

April 8, 2008 10:46 AM	
Label	**Current (Amps)**
DC-1	2.5
DC-2	2.5
DC-3	2.5
DC-4	2.5
DC-5	2.5
DC-6	2.5
DC-7	2.5
DC-8	2.5
P-13	Off
P-14	8.9
P-9	5.6
P-10	Off

Sensor Calibration

The Mamac Temperatures sensors (TLS, TLRBC and TLR) were extensively bench tested prior to installation. The sensors were connected to a datalogger and placed in an insulated hot water bath. A NIST-traceable glass thermometer was used to record the "true" or "actual" temperature. A series of several test runs were completed. For each run the temperature readings from each sensor was compared to the actual temperature. Four runs were conducted for TLS and TLRBC. After seeing little variation in the results for TLS and TLRBC, only two runs were conducted for TLR. A regression analysis was used to estimate the linear correction that would convert the actual reading to the true reading. Table A8 shows the resulting slope and off-set used for each sensor to correct the sensor reading to the true temperature. Also shown in Table A8, corrected temperature ranges for each sensor were then calculated and entered into the Obvius datalogger. Table A9, Table A-10 and **Table A-11** show the data recorded for each sensor compared to the true temperature and the resultant curve fit models.

Table A8. Datalogger Settings for Analog Sensors

Channel	Description	Calibration Results Slope	Calibration Results Offset	Obvius Ranges Min (F)	Obvius Ranges Max (F)
TLS	Loop Supply Temperature	1.005	-4.336	103.777	252.917
TLRBC	Loop Return Temperature Before Cooler	0.998	-3.911	104.150	254.461
TLR	Loop Return Temperature After Cooler	1.017	-3.110	100.602	249.777

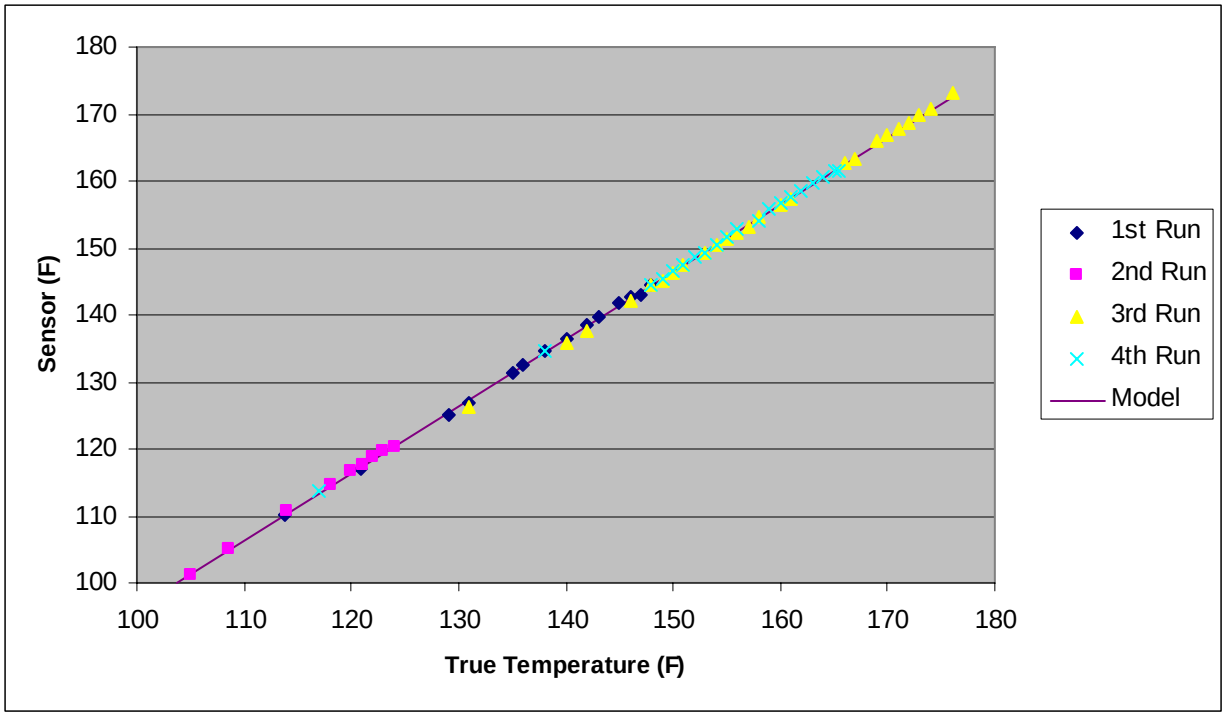


Table A9. Loop Supply Temperature (TLS) Calibration

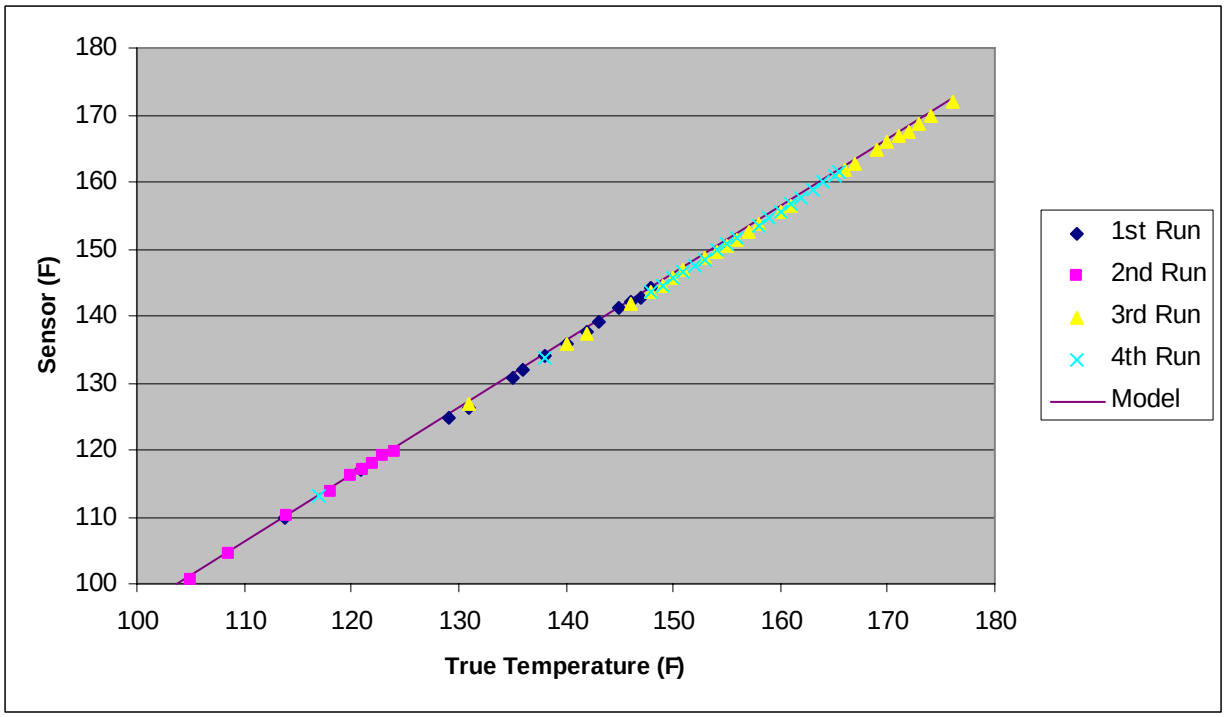


Table A-10. Loop Return Temperature Before Cooler (TLRBC) Calibration

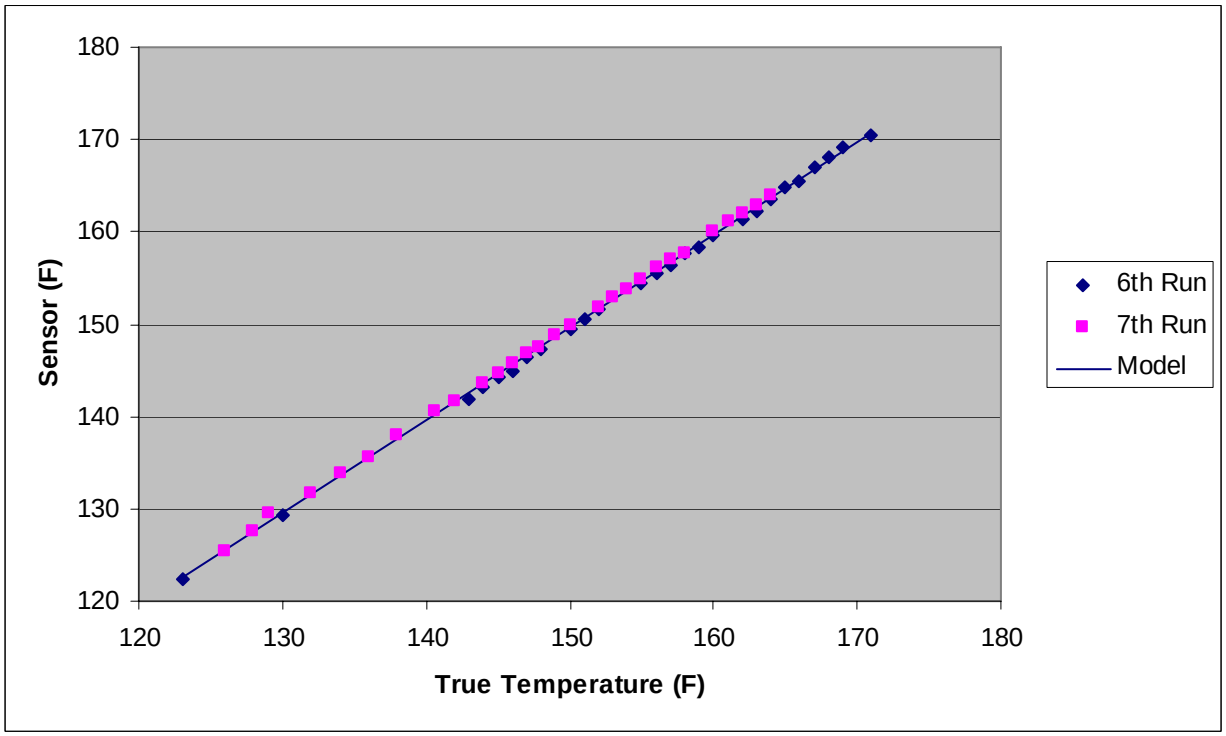


Table A-11. Loop Return Temperature After Cooler (TLR) Calibration

Field Verification

Field measurements were taken using an independent handheld meter to verify the sensors installed at the site yield a proper reading.

For verification of the WH and WL power transducers, a Fluke 39 power meter was used to take readings, which were then compared to the corresponding readings from the Obvius datalogger. Two sets of readings were taken for the HCHP transducer and three were taken for the LCHP. Neither transducer showed a large difference between the instantaneous hand-held readings and the one-minute average readings from the datalogger.

Table A-12. Verification Readings for HCHP Power Transducer (Scaling Factor: 11.542 Wh/pulse)

Time	Handheld Power Readings	Datalogger Power Readings	Difference (kW)
10:20 AM	32.1	31.2	0.9
11:10 AM	30.2	29.8	0.4

Table A-13. Verification Readings for LCHP Power Transducer (Scaling Factor: 5.771 Wh/pulse)

Time	Handheld Power Readings	Datalogger Power Readings	Difference (kW)
10:36 AM	12	11.4	0.6
10:41 AM	11.3	11.1	0.2
11:11 AM	10	9.7	0.3

On June 5, verification readings were taken for the generator power transducers. The power meter could not be verified using the Fluke power meter in the same manner as the HCHP and LCHP. For these transducers, the voltage readings across the three CTs were measured. The CT voltage compared to 0.333 V is proportional to the amperage through the CT compared to its size. The voltage on all three phases was also measured and the apparent power (kVA) was calculated. The apparent power was then compared to the real power recorded by the Obvius and the resultant power factor was calculated. The power factor was reasonable for the generator power.

Table A-14. Verification Data for Generator Power Transducer (Scaling Factor: 115.42Wh/pulse)

Generator Power	0.333	**VAC CTs**
	2000	**Amps**

1:10 PM				
Phase	**CT Volts**	**Voltage**	**Generator Amps**	**Generator kVA**
A	0.128	270	769	208
B	0.127	269	763	205
C	0.125	270	751	203
Total				615
			Obvius kW	598
			Power Factor	0.97

The facility power also could not be measured directly and was compared to the Tecogen system reading a Beckwith meter. During one site visit, we verified the secondary amp CTs for the Beckwith were reading the same primary amperage as the Wattnode CTs. Then the power readings from the two meters were compared on a subsequent visit with the new facility Wattnode meter installed. There was good agreement between the two meters.

Table A-15. Comparison of Wattnode CT readings to Beckwith CTs

July 24, 2008 12:45 PM				
	Wattnode CTs (2000:0)		**Beckwith CTs (2000:5)**	
Phase	**CT Volts**	**Pri Amps**	**Sec Amps**	**Pri Amps**
A	0.188	1,129	2.750	1,100
B	0.193	1,159	2.580	1,032
C	0.190	1,141	2.620	1,048
Total		3,429		3,180
			Difference (Amps)	249
			Difference (%)	8%

Table A-16. Verification Data for Facility Power Transducer (Scaling Factor: 115.42Wh/pulse)

July 30 12:45	**Power Reading (kW)**
Tecogen (Beckwith Meter)	320
Obvius Datalogger (Wattnode Meter)	312.3
Difference	7.7 (2.4 %)

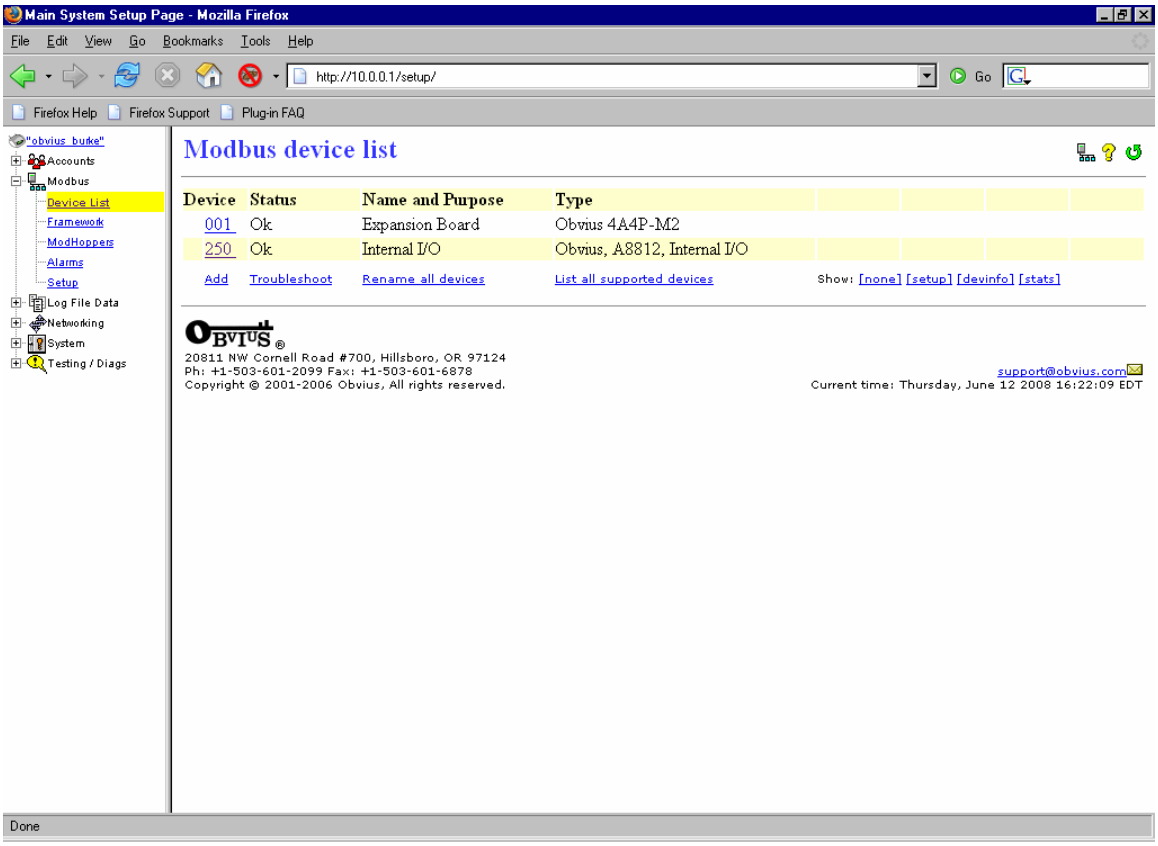
The Roots gas meter contains two accumulator readouts for gas use: an odometer-style analog readout and a digital readout. The digital readout is on the pulser unit and is expected to correspond to the pulses it puts. A set of readings was taken, approximately 1.5 hours apart, and the difference between was digital readings was compared to the Obvius datalogger. The difference was also calculated for the analog readout and the analog-digital multiplier was calculated. There was no difference between the digital readout and the Obvius reading.

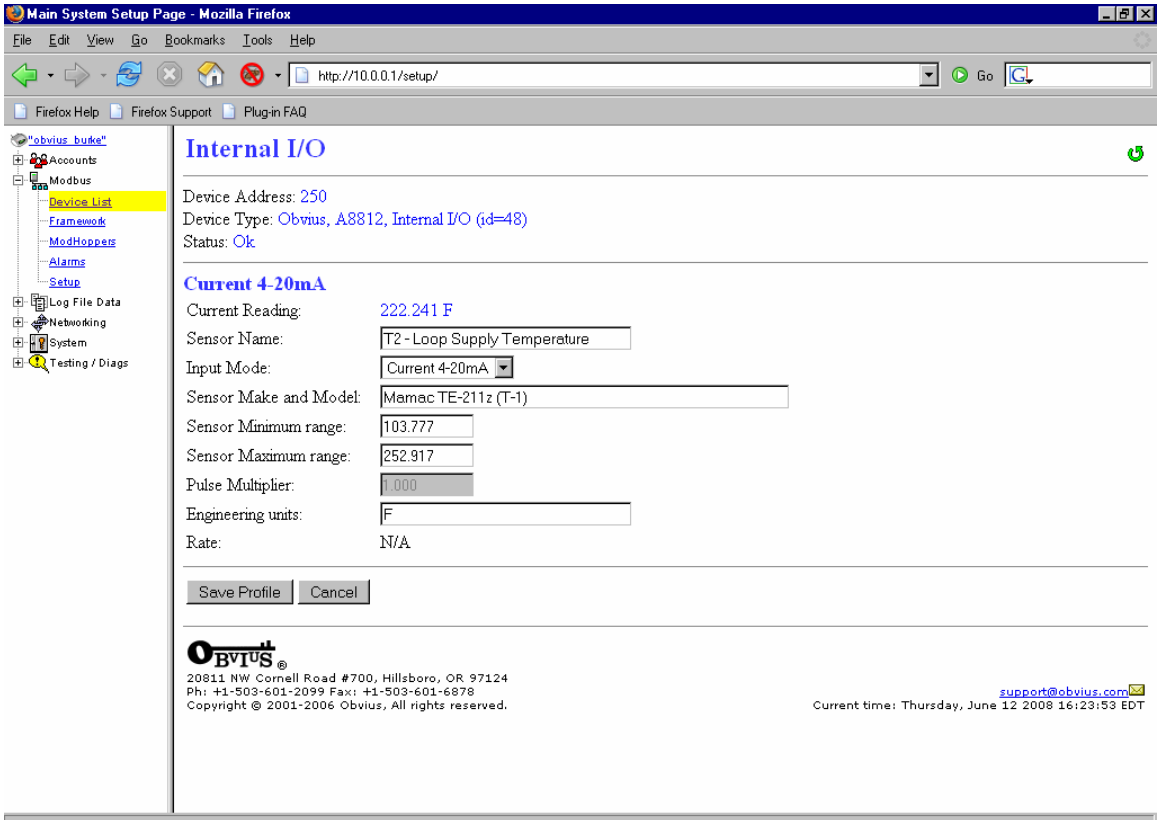
Table A-17. Gas Meter Verification Readings

Time	Digital Reading (MCF)	Analog (CCF)
10:15 AM	5,147	63,362
11:33 AM	5,156	63,517
Difference (cuft)	9,000	15,489
Analog-Digital Multiplier		0.581
Obvius Reading (cuft)	9,000	
Digital-Obvius (cuft)	-	

Data Logging Equipment

An Obvius Acquisuite 8812 datalogger was installed to collect the data. The sensors are sampled or scanned at 5-second intervals. Screen captures of the datalogger settings are shown below.




Main System Setup Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://10.0.0.1/setup/
Go
Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok
Current 4-20mA
Current Reading: 222.241 F
Sensor Name: T2 - Loop Supply Temperature
Input Mode: Current 4-20mA
Sensor Make and Model: Mamac TE-211z (T-1)
Sensor Minimum range: 103.777
Sensor Maximum range: 252.917
Pulse Multiplier: 1.000
Engineering units: F
Rate: N/A
Save Profile Cancel
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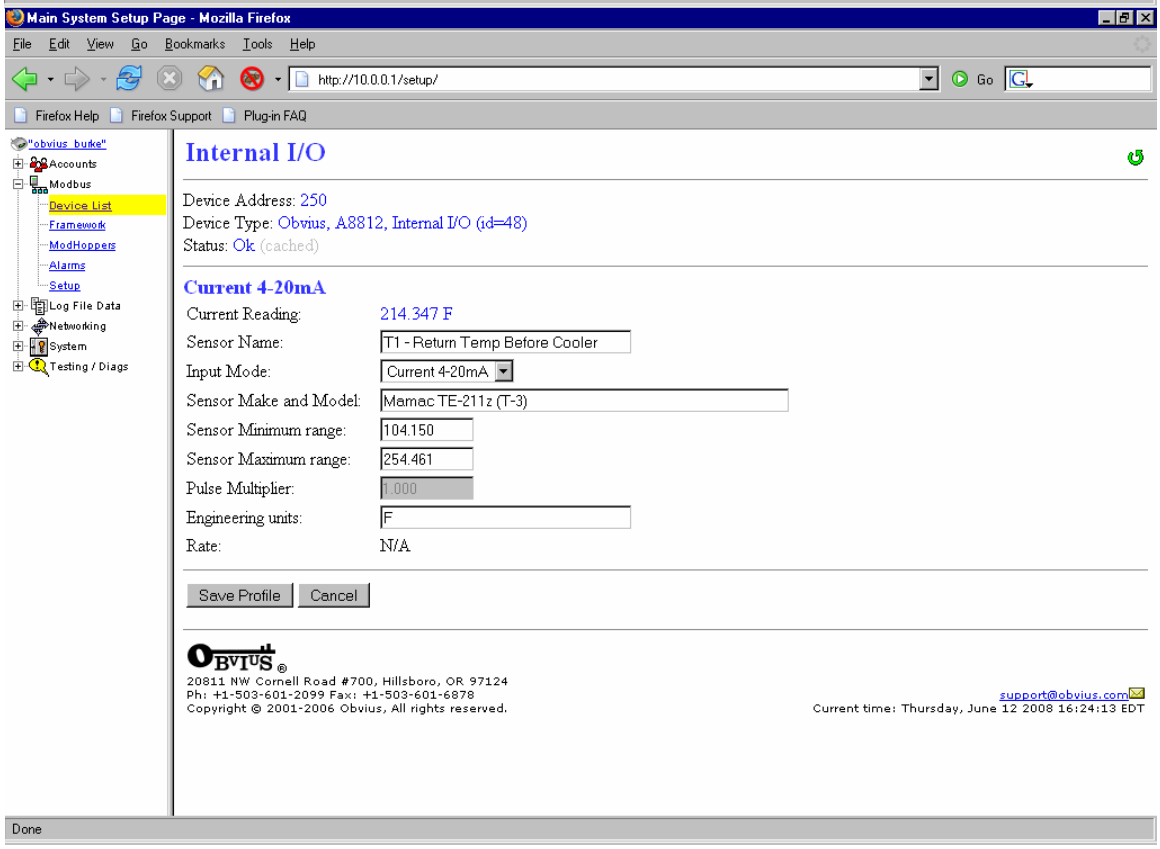
Current time: Thursday, June 12 2008 16:23:53 EDT
Done


Main System Setup Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://10.0.0.1/setup/
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"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok (cached)
Current 4-20mA
Current Reading: 214.347 F
Sensor Name: T1 - Return Temp Before Cooler
Input Mode: Current 4-20mA
Sensor Make and Model: Mamac TE-211z (T-3)
Sensor Minimum range: 104.150
Sensor Maximum range: 254.461
Pulse Multiplier: 1.000
Engineering units: F
Rate: N/A
Save Profile Cancel
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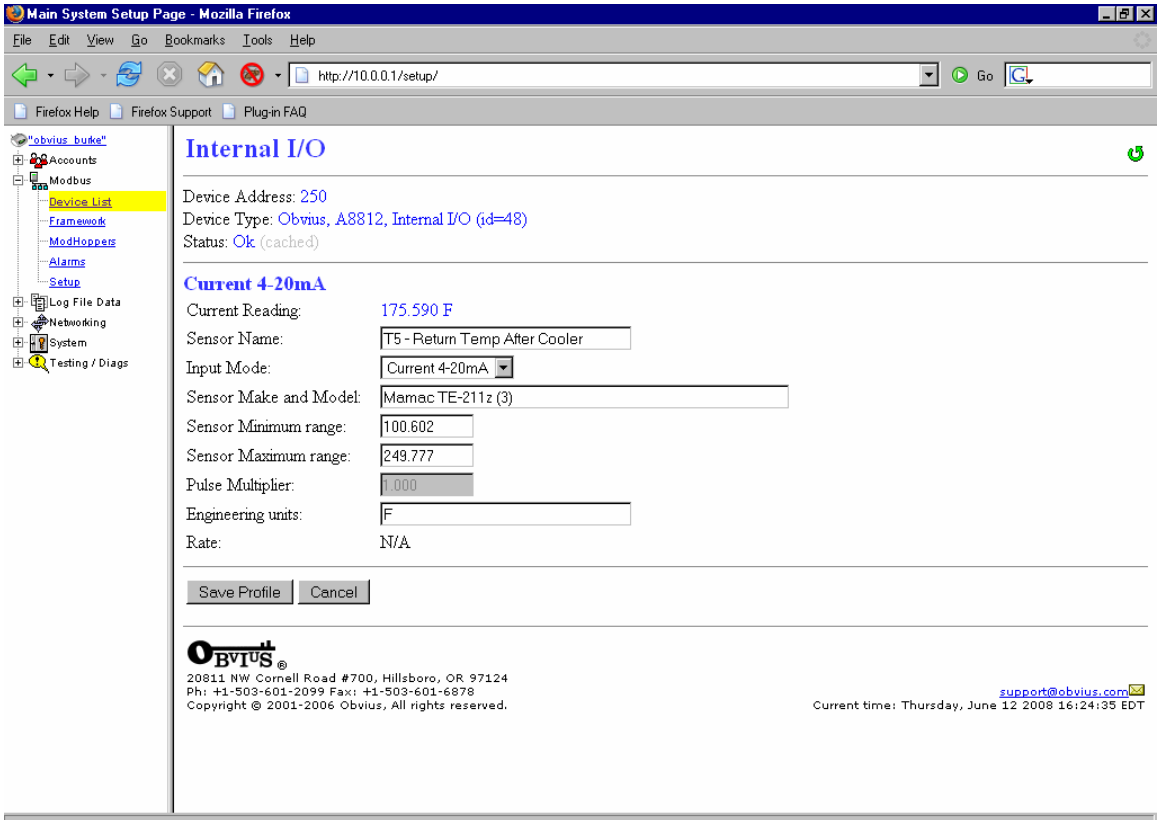
Done


Main System Setup Page - Mozilla Firefox
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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok (cached)
Current 4-20mA
Current Reading: 175.590 F
Sensor Name: T5 - Return Temp After Cooler
Input Mode: Current 4-20mA
Sensor Make and Model: Mamac TE-211z (3)
Sensor Minimum range: 100.602
Sensor Maximum range: 249.777
Pulse Multiplier: 1.000
Engineering units: F
Rate: N/A
Save Profile Cancel
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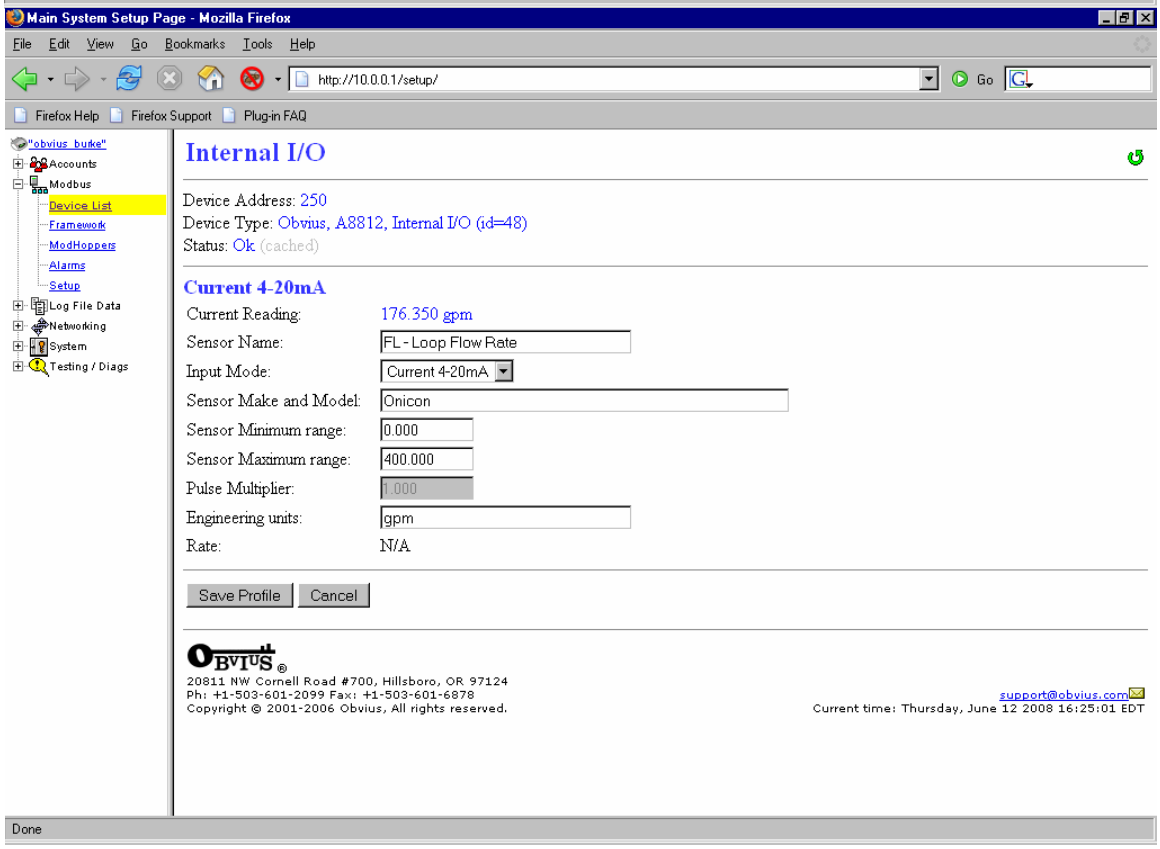
Current time: Thursday, June 12 2008 16:24:35 EDT
Done


Main System Setup Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://10.0.0.1/setup/
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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok (cached)
Current 4-20mA
Current Reading: 176.350 gpm
Sensor Name: FL - Loop Flow Rate
Input Mode: Current 4-20mA
Sensor Make and Model: Onicon
Sensor Minimum range: 0.000
Sensor Maximum range: 400.000
Pulse Multiplier: 1.000
Engineering units: gpm
Rate: N/A
Save Profile Cancel
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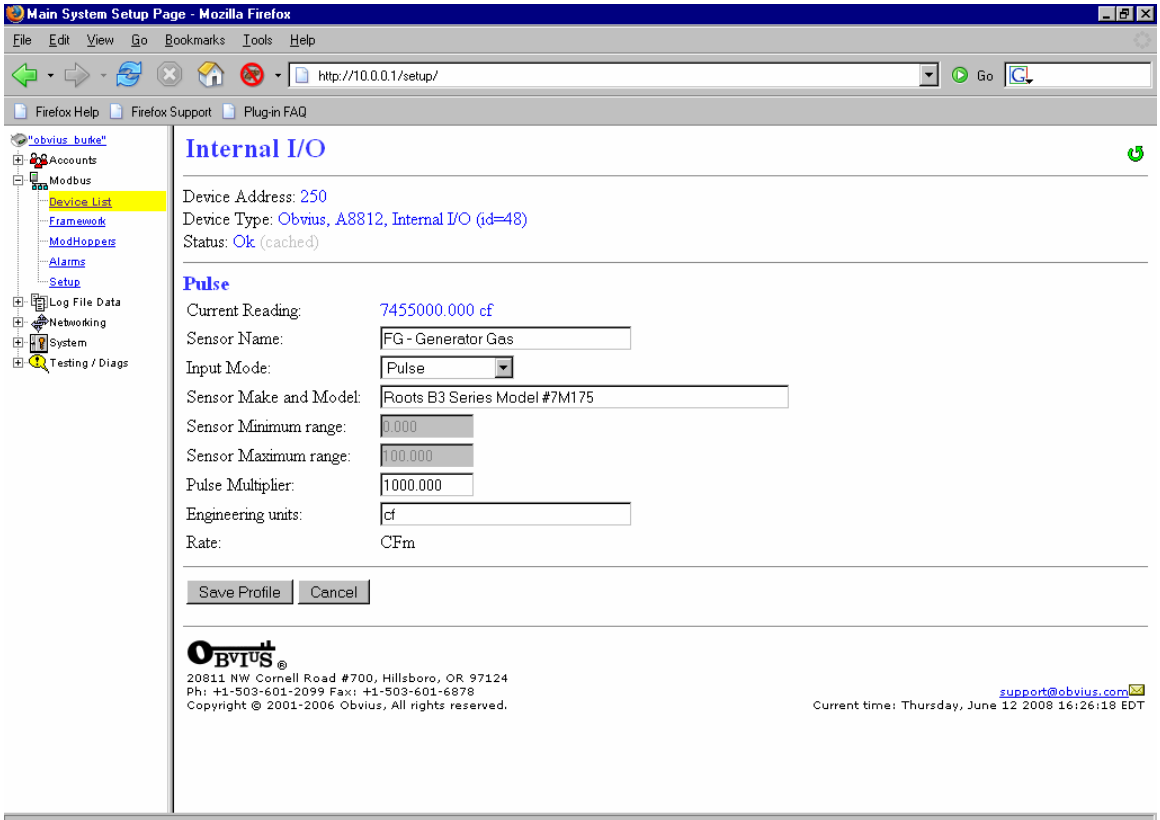
Current time: Thursday, June 12 2008 16:25:01 EDT
Done


Main System Setup Page - Mozilla Firefox
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Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok (cached)
Pulse
Current Reading: 7455000.000 cf
Sensor Name: FG - Generator Gas
Input Mode: Pulse
Sensor Make and Model: Roots B3 Series Model #7M175
Sensor Minimum range: 0.000
Sensor Maximum range: 100.000
Pulse Multiplier: 1000.000
Engineering units: cf
Rate: CFm
Save Profile Cancel
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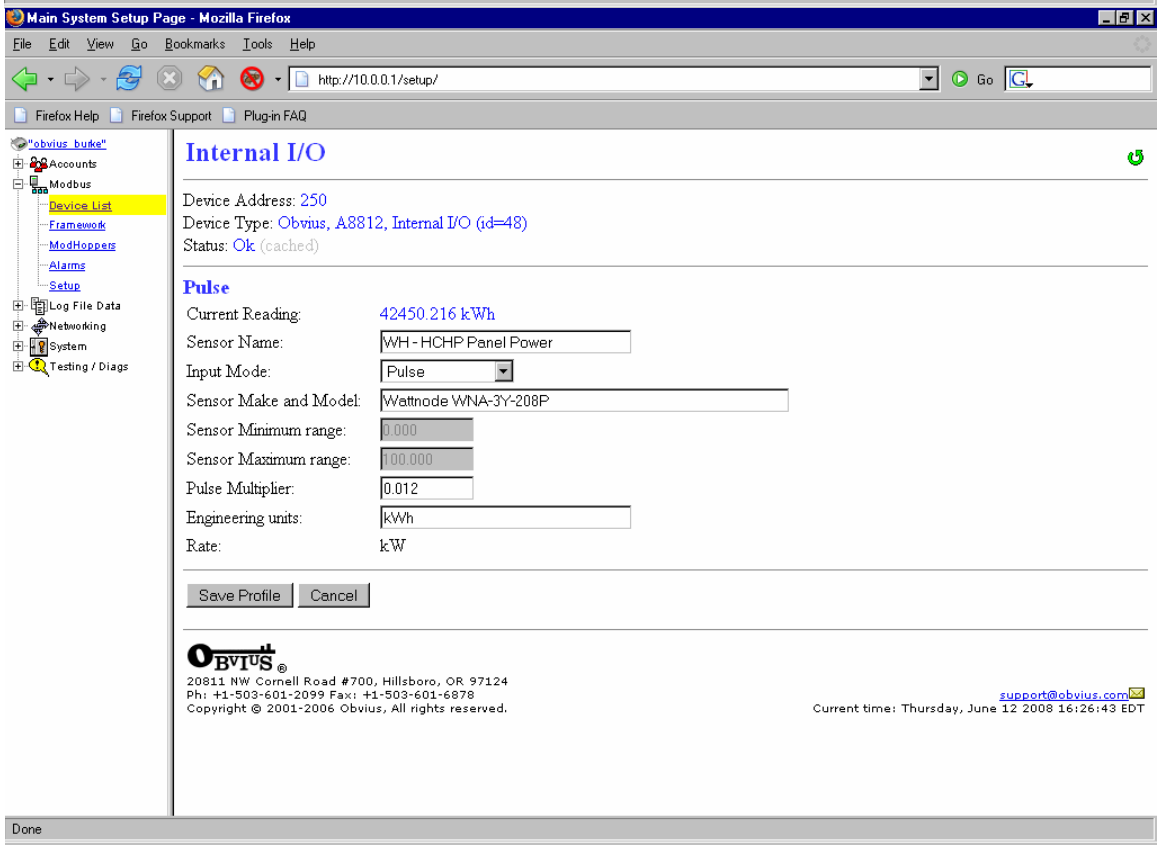
Current time: Thursday, June 12 2008 16:26:18 EDT
Done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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Internal I/O
Device Address: 250
Device Type: Obvius, A8812, Internal I/O (id=48)
Status: Ok (cached)
Pulse
Current Reading: 42450.216 kWh
Sensor Name: WH - HCHP Panel Power
Input Mode: Pulse
Sensor Make and Model: Wattnode WNA-3Y-208P
Sensor Minimum range: 0.000
Sensor Maximum range: 100.000
Pulse Multiplier: 0.012
Engineering units: kWh
Rate: kW
Save Profile Cancel
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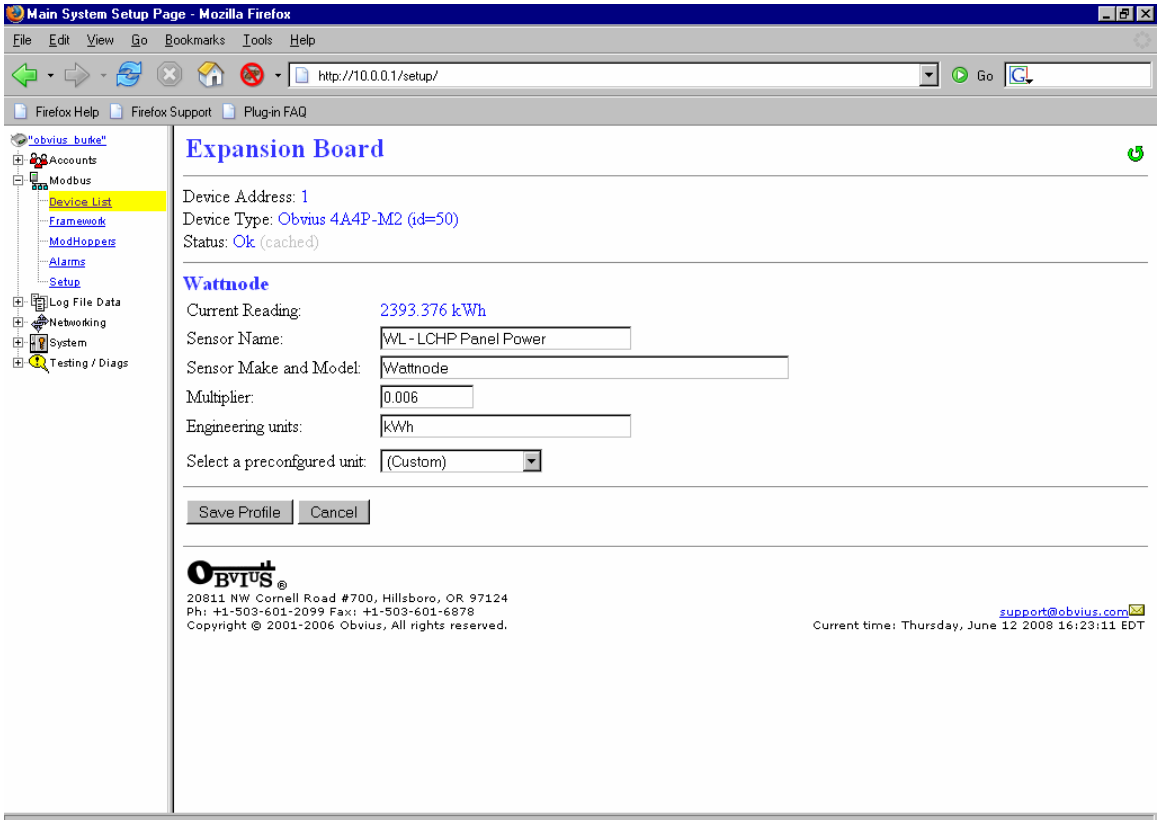
Main System Setup Page - Mozilla Firefox
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http://10.0.0.1/setup/
Go
Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Expansion Board
Device Address: 1
Device Type: Obvius 4A4P-M2 (id=50)
Status: Ok (cached)
Wattnode
Current Reading: 2393.376 kWh
Sensor Name: WL - LCHP Panel Power
Sensor Make and Model: Wattnode
Multiplier: 0.006
Engineering units: kWh
Select a preconfgured unit: (Custom)
Save Profile Cancel
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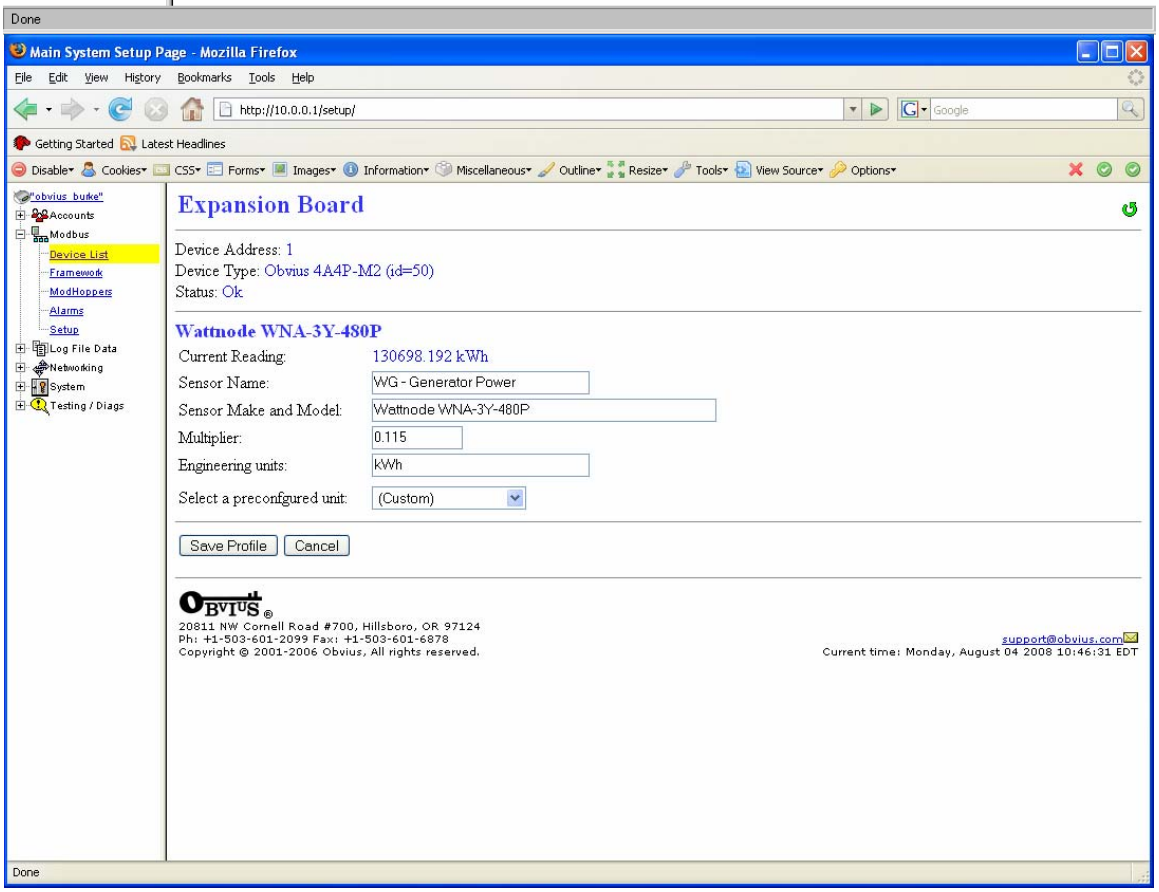
Current time: Thursday, June 12 2008 16:23:11 EDT
Done


Main System Setup Page - Mozilla Firefox
File Edit View History Bookmarks Tools Help
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Google
Getting Started Latest Headlines
Disable Cookies CSS Forms Images Information Miscellaneous Outline Resize Tools View Source Options
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Expansion Board
Device Address: 1
Device Type: Obvius 4A4P-M2 (id=50)
Status: Ok
Wattnode WNA-3Y-480P
Current Reading: 130698.192 kWh
Sensor Name: WG - Generator Power
Sensor Make and Model: Wattnode WNA-3Y-480P
Multiplier: 0.115
Engineering units: kWh
Select a preconfgured unit: (Custom)
Save Profile Cancel
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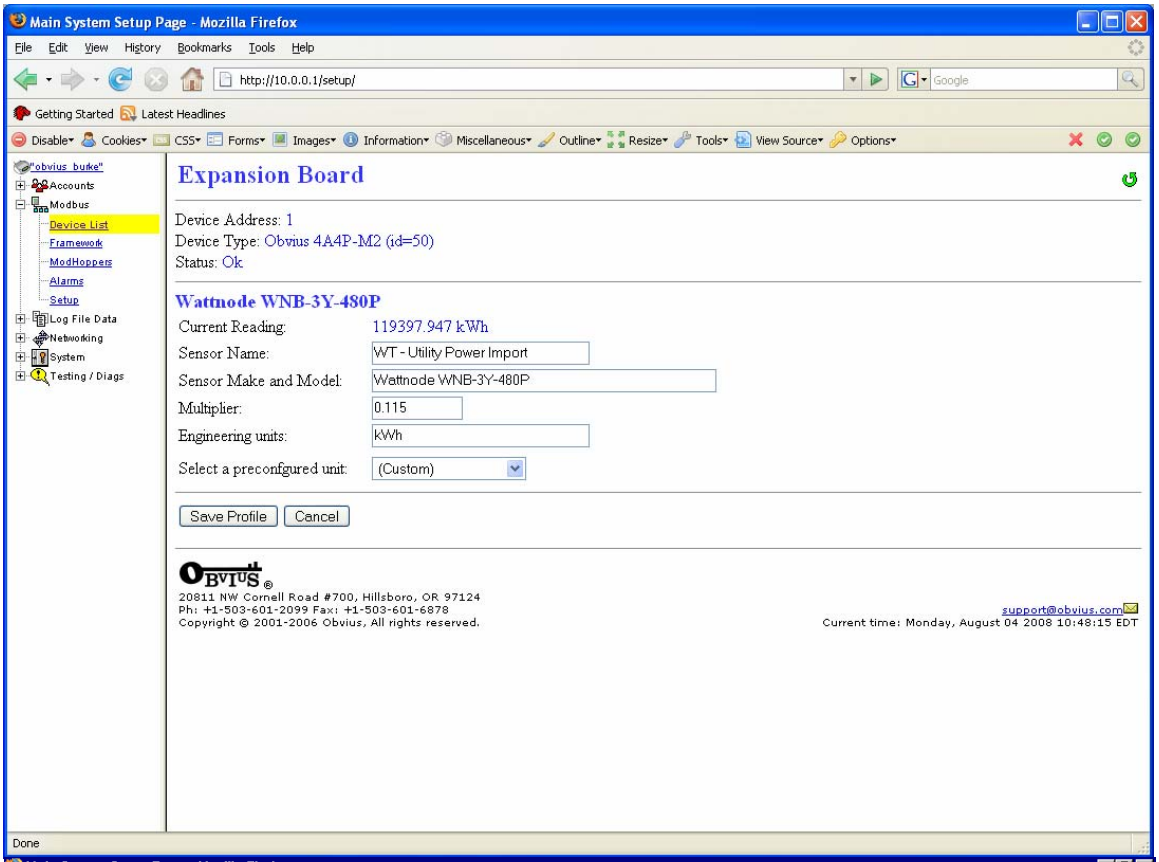
support@obvius.com
Current time: Monday, August 04 2008 10:46:31 EDT
Done


Main System Setup Page - Mozilla Firefox
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http://10.0.0.1/setup/
Getting Started Latest Headlines
Disable Cookies CSS Forms Images Information Miscellaneous Outline Resize Tools View Source Options
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Expansion Board
Device Address: 1
Device Type: Obvius 4A4P-M2 (id=50)
Status: Ok
Wattnode WNB-3Y-480P
Current Reading: 119397.947 kWh
Sensor Name: WT - Utility Power Import
Sensor Make and Model: Wattnode WNB-3Y-480P
Multiplier: 0.115
Engineering units: kWh
Select a preconfigured unit: (Custom)
Save Profile Cancel
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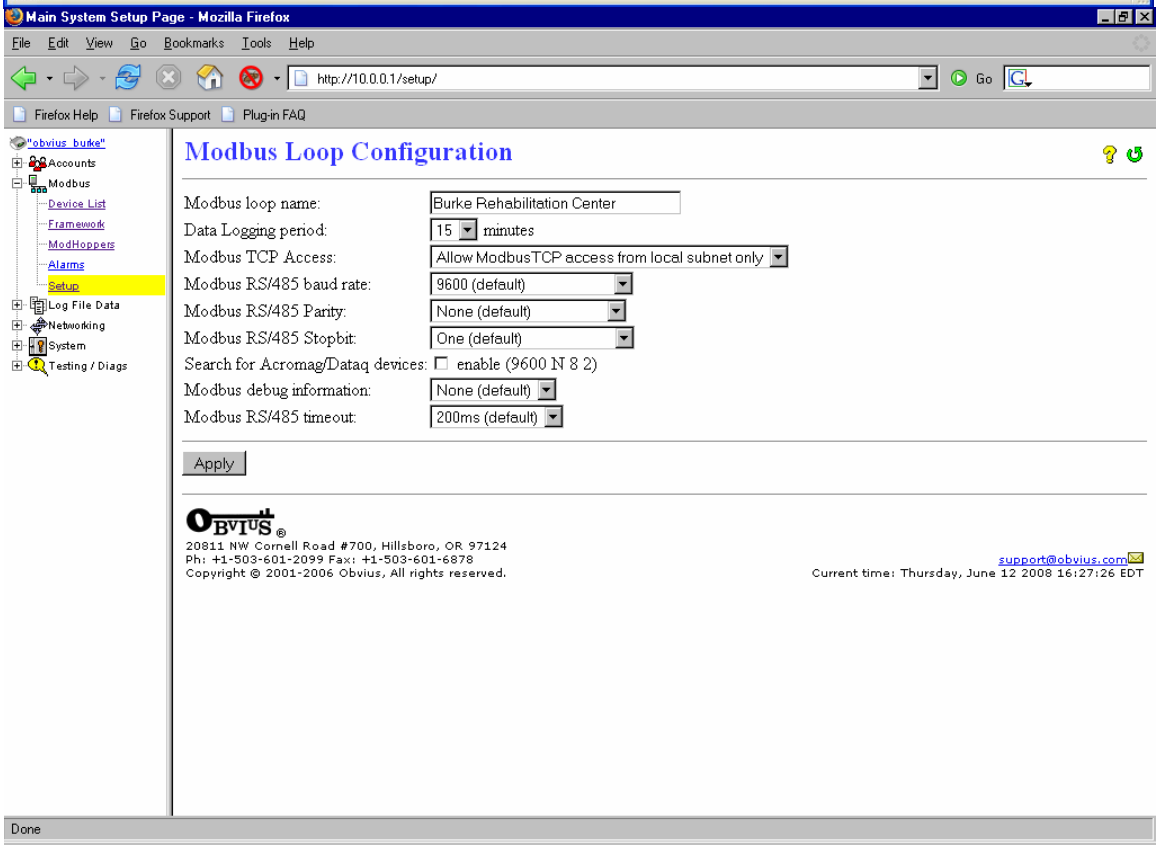
Current time: Monday, August 04 2008 10:48:15 EDT
Done


Main System Setup Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://10.0.0.1/setup/
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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Networking
System
Testing / Diags
Modbus Loop Configuration
Modbus loop name: Burke Rehabilitation Center
Data Logging period: 15 minutes
Modbus TCP Access: Allow ModbusTCP access from local subnet only
Modbus RS/485 baud rate: 9600 (default)
Modbus RS/485 Parity: None (default)
Modbus RS/485 Stopbit: One (default)
Search for Acromag/Dataq devices: enable (9600 N 8 2)
Modbus debug information: None (default)
Modbus RS/485 timeout: 200ms (default)
Apply
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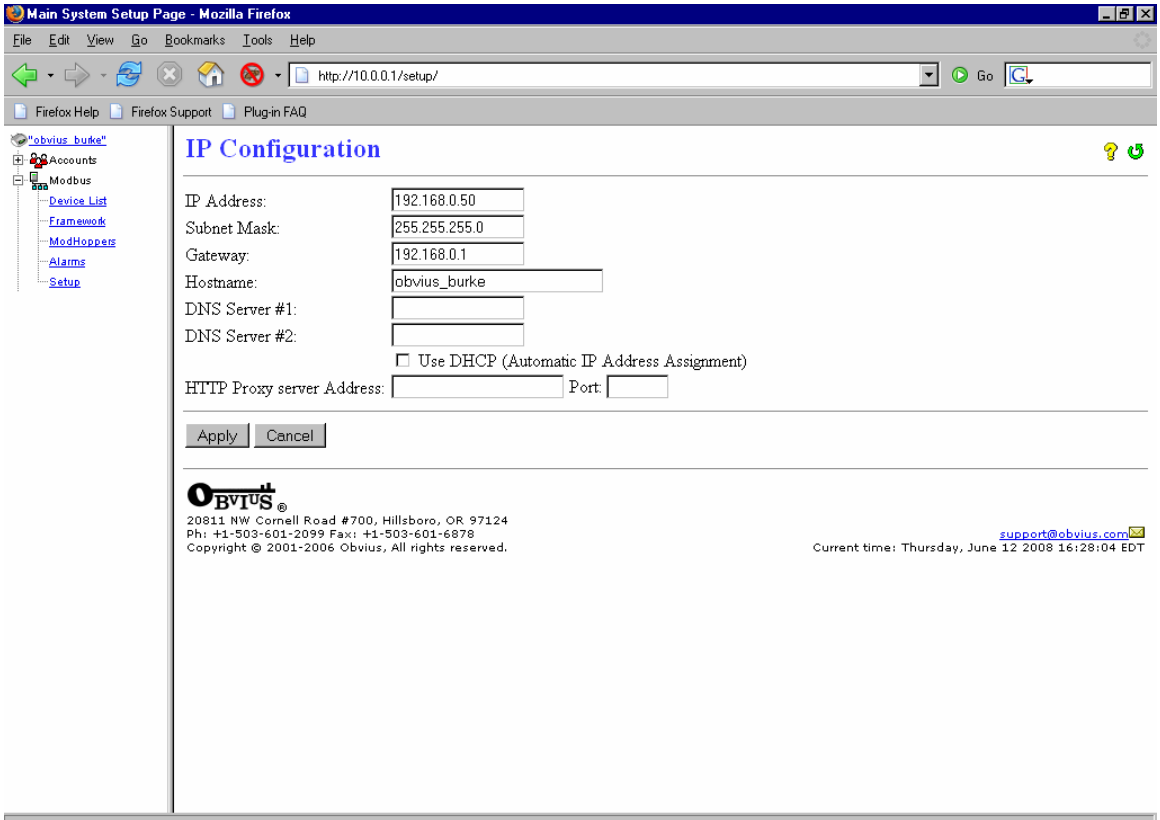
Current time: Thursday, June 12 2008 16:27:26 EDT
Done


Main System Setup Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://10.0.0.1/setup/
Go
Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
IP Configuration
IP Address: 192.168.0.50
Subnet Mask: 255.255.255.0
Gateway: 192.168.0.1
Hostname: obvius_burke
DNS Server #1:
DNS Server #2:
Use DHCP (Automatic IP Address Assignment)
HTTP Proxy server Address: Port:
Apply Cancel
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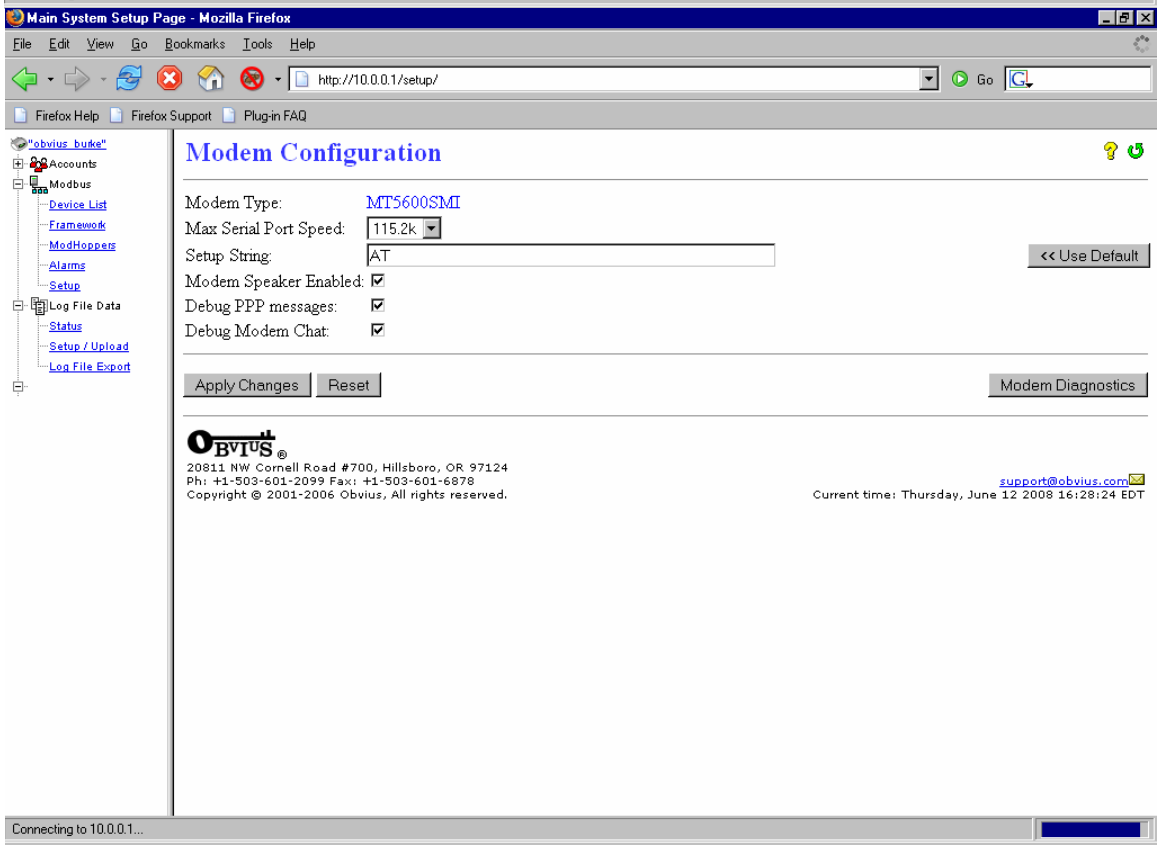
Current time: Thursday, June 12 2008 16:28:04 EDT
Transferring data from 10.0.0.1...


Main System Setup Page - Mozilla Firefox
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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Status
Setup / Upload
Log File Export
Modem Configuration
Modem Type: MT5600SMI
Max Serial Port Speed: 115.2k
Setup String: AT
<< Use Default
Modem Speaker Enabled:
Debug PPP messages:
Debug Modem Chat:
Apply Changes Reset
Modem Diagnostics
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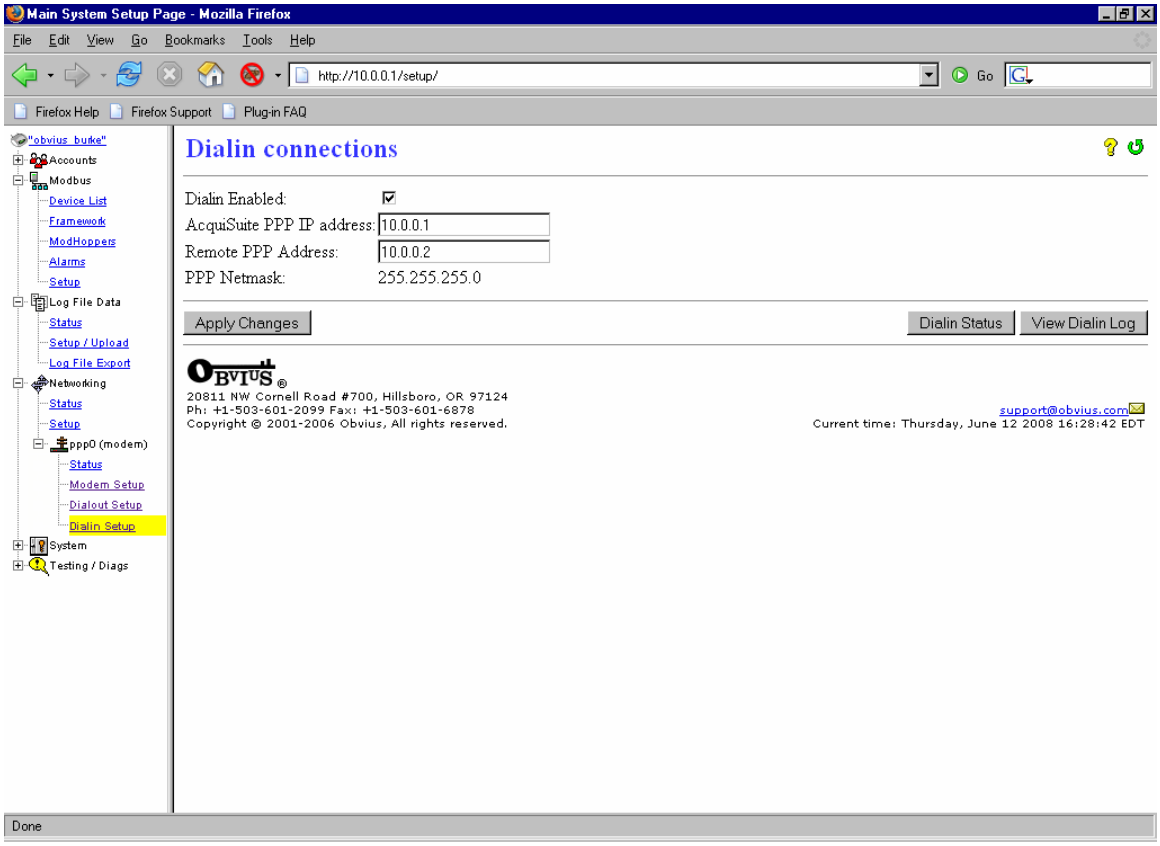
Current time: Thursday, June 12 2008 16:28:24 EDT
Connecting to 10.0.0.1...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Firefox Help Firefox Support Plug-in FAQ
"obvius_burke"
Accounts
Modbus
Device List
Framework
ModHoppers
Alarms
Setup
Log File Data
Status
Setup / Upload
Log File Export
Networking
Status
Setup
ppp0 (modem)
Status
Modem Setup
Dialout Setup
Dialin Setup
System
Testing / Diags
Dialin connections
Dialin Enabled:
AcquiSuite PPP IP address: 10.0.0.1
Remote PPP Address: 10.0.0.2
PPP Netmask: 255.255.255.0
Apply Changes
Dialin Status
View Dialin Log
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Done

A8812 AcquiSuite DR™ Data Acquisition Server

Description

Obvius, the leader in cost effective data acquisition and wireless metering solutions introduces the all-new A8812-x AcquiSuite DR™ data acquisition server, providing high performance and low cost for:

- Demand response programs
- Benchmarking building operations performance
- Verification of energy savings and utility costs
- Cost allocation to departments or tenants
- Internet based supervisory control outputs

The system combines the flexibility of choosing LAN, modem or cellular communication paths with the lowest total installed cost for logging building data such as:

- Electrical, gas and water usage and costs
- Indoor and outdoor temperatures
- Pressure, humidity, CO2
- Industry standard pulse or analog inputs

AcquiSuite™ brings "plug and play" capability to the data acquisition market, dramatically reducing the time and training required to put a typical building on line. In most applications, the installation can be done by the building engineer or contractor in less than 2 hours. The system automatically detects and configures Modbus devices in just seconds reducing installation time and costs.

Applications

- Demand response program control and reporting
- Cost allocation to tenants and third parties
- Measurement & verification of energy savings
- Data center branch circuit monitoring
- Monitoring performance of building systems (e.g., chillers, boilers, fans)

Easy installation saves time and money

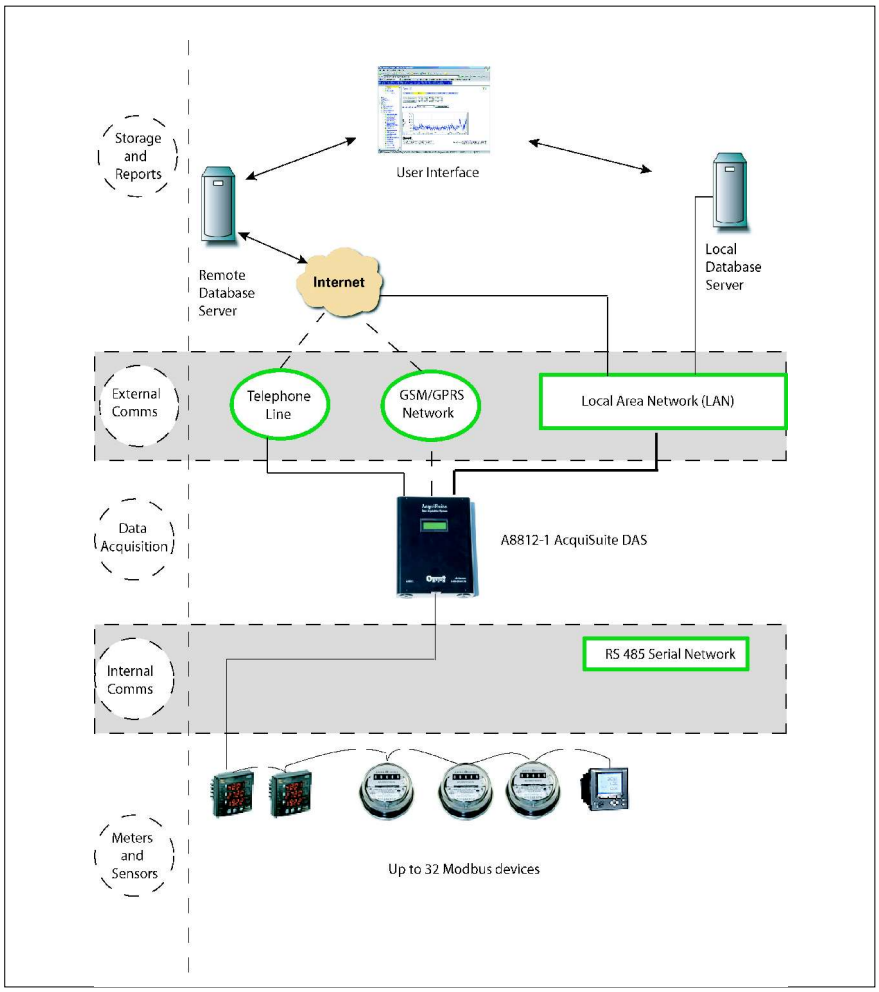
- Simple "plug and play" connectivity to standard Modbus meters minimizes installation time and costs
- "Flex" I/O inputs provide easy connections for analog, pulse and resistance sensors
- Acquisuite hardware and software is designed to provide data in flexible, industry standard formats for databases, spreadsheets, etc.
- A8812 provides onboard plug in for R9120 ModHopper to allow wireless RS 485 communications
- Integrated relay outputs allow supervisory control from any location for load shedding or local generation
- Integrated web server provides setup and configuration using any industry standard web browser (i.e., Netscape™ or Internet Explorer™)

Internet display of key building parameters

- Buildingmanageronline.com™ allows authorized users to see building performance data in an easy to use graphical format
- BMO site provides storage, display and downloads of historical data in a secure SQL database
- Users can be notified of alarm conditions in any or all monitored points
- Open protocols provide connectivity to any energy management or building automation software

Flexible communications and wireless connectivity

- All data is stored at the site in nonvolatile memory, insuring protection of valuable information in the event of power loss
- Optional on-board ModHopper (R9120-x) for wireless RS 485 communications (consult factory)
- A8812-1 provides two communication options: Local Area Network (LAN) or phone line
- A8812-GSM replaces the standard phone modem with a GSM/GPRS modem for cellular data transfer



SPECIFICATIONS

Processor	Main processor: ARM 9 ; I/O co-processor: ARM 7
Operating System	Linux 2.6
Flash ROM	16 MB NOR Flash (expandable with USB memory device)
Memory	32 MB RAM
LED	8x pulse input, 4 modem activity, Modbus TX/RX, power status
Console	2 x 16 LCD character, two buttons
LAN	10/100, Auto crossover detection
Modem (phone)	V.34 bis, 33,600 bps **(Part number A8812-1)**
Modem (cellular)	GSM/GPRS Class10, 85 kbps **(Part number A8812-GSM)**
Protocols	Modbus/RTU, Modbus/TCP, TCP/IP, PPP, HTTP/HTML, FTP,SNMP, SMTP, XML
Power Supply	24 VDC, included
Serial Port	RS-485 Modbus
Approvals	CE; FCC Part 15, Class A
USB port	USB memory expansion port
Power Requirement	110-120VAC
Interval recording	User selectable 1-60 minutes. Default 15 minute interval.
Outputs	2x, Dry contact 30 VDC, 150 mA max
Inputs	8x, user selectable:

- 0-10 V - Min/Max/Ave/Instantaneous
- 4-20 mA - Min/Max/Ave/Instantaneous
- Pulse - Consumption, Rate
- Resistance - Min/Max/Ave/Instantaneous
- Runtime - Runtime, Status

CE

Continental Control Systems

WattNode®

Advanced Pulse Output AC Power Measurement

277/480 VAC

120/240

The WattNode is a true RMS AC watt-hour transducer with pulse output (solid state relay closure) proportional to kWH consumed. The WattNode provides accurate measurement at low cost to meet your needs for sub-metering, energy management and performance contract applications.

Easy Installation saves you time and money. The WattNode is small enough to fit entirely within a standard electrical panel and the screw terminals unplug for easy wiring.

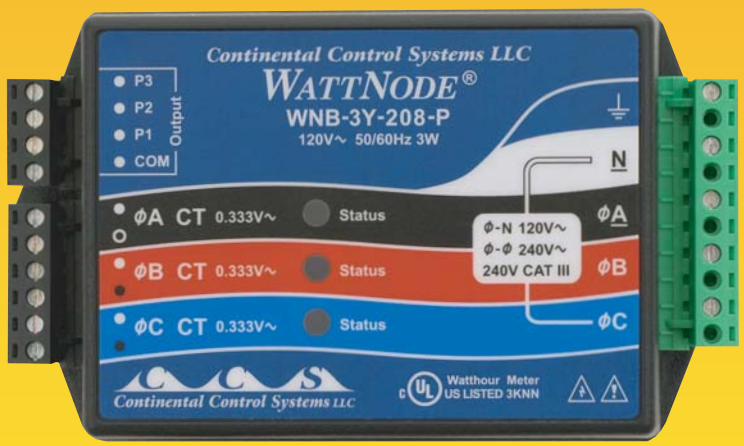
The Advanced Output includes separate pulse channels for positive and negative power, for net metering and PV metering. Optional models are available with one pulse output channel per measurement phase, which can be used to monitor each phase independently or to monitor three separate single-phase circuits with one WattNode.

Our Diagnostic LEDs provide a per-phase indication of power (green flashing), negative power (red flashing), and advanced diagnostics (yellow flashing) to help troubleshoot connection problems, like swapped CTs, or excessive line voltage. See the User's Guide for a full description.

The Pulse Series family measures 1, 2, or 3 phases in 2, 3 or 4 wire configurations. With voltage ratings from 120 to 600 VAC and current transformer (CT) rating from 5 to 4000 amps, there is a WattNode combination to meet your AC power measurement requirements.

Accuracy of the WattNode is is 0.5% of reading over a wide range of power factors and harmonic content. You get true kWH measurements even with switching power supplies and variable speed drives.

Our Safe CTs, with internal burden resistors produce a voltage proportional to the load current. At rated current voltage is only 0.333 VAC. Split-core CTs quickly install on existing wiring and solid-core CTs cost less for new wiring.



c UL us LISTED

(888) 928-8663

Continental Control Systems LLC
3131 Indian Road, Suite A
Boulder, CO 80301 USA
(888) 928-8663 Fax (303) 444-2903
sales@ccontrolsys.com

www.ccontrolsys.com

- **Advanced Pulse Output**
  Separate pulse channels for positive and negative power. Optional models are available with one pulse output channel per measurement phase.
- **Small Size**
  Can be installed in existing service panels or junction boxes.
- **Uses Safe CTs**
  Output limited to one volt.
- **Line Powered**
  No external power supply required.
- **Digital Signal Processing**
  Accurate kWH measurement over a wide harmonic range.
- **Detachable Terminal Blocks**
  Easy to install and remove.

SPECIFICATIONS

WATTNODE®

Advanced Pulse Output AC Power Measurement

Measurement Configurations

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

Electrical

Line Powered
Operating Voltage Range: +15%, -20% of nominal
Power Line Frequency: 50/60 Hz
CT Input: 0.333 VAC

Pulse Output

Optoisolated, solid state relay closures handle up to maximum 60 VDC & to 5mA
Standard: 4.00 Hz Bidirectional Output
Optional: 0.01 Hz to 600 Hz Bidirectional Output Models
Optional: Per-Phase Output Models 0.01 Hz to 150 Hz available

Accuracy

Normal Operation: Line voltage: 80% - 115% of nominal
Power factor: 1.0
Frequency: 48 - 62 Hz
Ambient Temperature: 25˚C
Current: 5% - 100% of rated current
Accuracy: ±0.5% of reading

Environmental

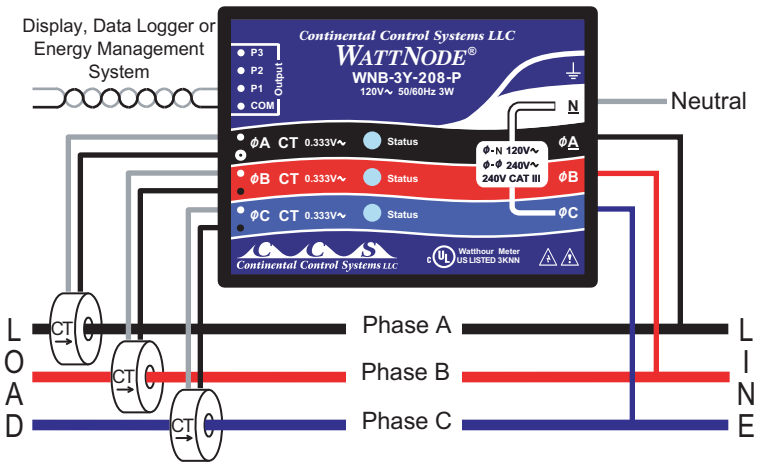
Operating Temperature: -30˚C to +55˚C (-22˚F to 131˚F)
Operating Humidity: 5 to 90% (RH)

Mechanical

Enclosure: High impact, UL rated, ABS plastic
Size: 3.3” x 5.6” x 1.25”
Connectors: UL, CSA recognized, detachable, screw terminals (14AWG), 600V

Optional LCD Display

Display: Eight digits, each 0.43" high
Reset: Wired remote and configurable front panel button
Enclosure: Panel mount box, 2.95" x 1.52"
Battery: Lithium 2/3A, replace every four years



MODELS

Model	VAC Line To Neutral	VAC Line To Line	Phases	Wires
WNB-3Y-208-P	120	208-240	3	4
WNB-3Y-400-P	230	400	3	4
WNB-3Y-480-P	277	480	3	4
WNB-3Y-600-P	347	600	3	4
WNB-3D-240-P	120	208-240	3	3
WNB-3D-400-P	230	400	3	3
WNB-3D-480-P	277	480	3	3

LCD Displays

Model	Displays	Units
LCDA-E	Energy	WH, kWH, or MWH
LCDA-P	Power	W or kW
LCDA-EP	Energy & Power	WH, kWH, or MWH & W or kW

OPENING CURRENT TRANSFORMERS (SPLIT-CORE)

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

TOROIDAL CURRENT TRANSFORMERS (SOLID-CORE)

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

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

MADE IN THE USA

(888) 928-8663

Continental Control Systems
3131 Indian Road, Suite A
Boulder, CO 80301
(888) 928-8663 Fax (303) 444-2903
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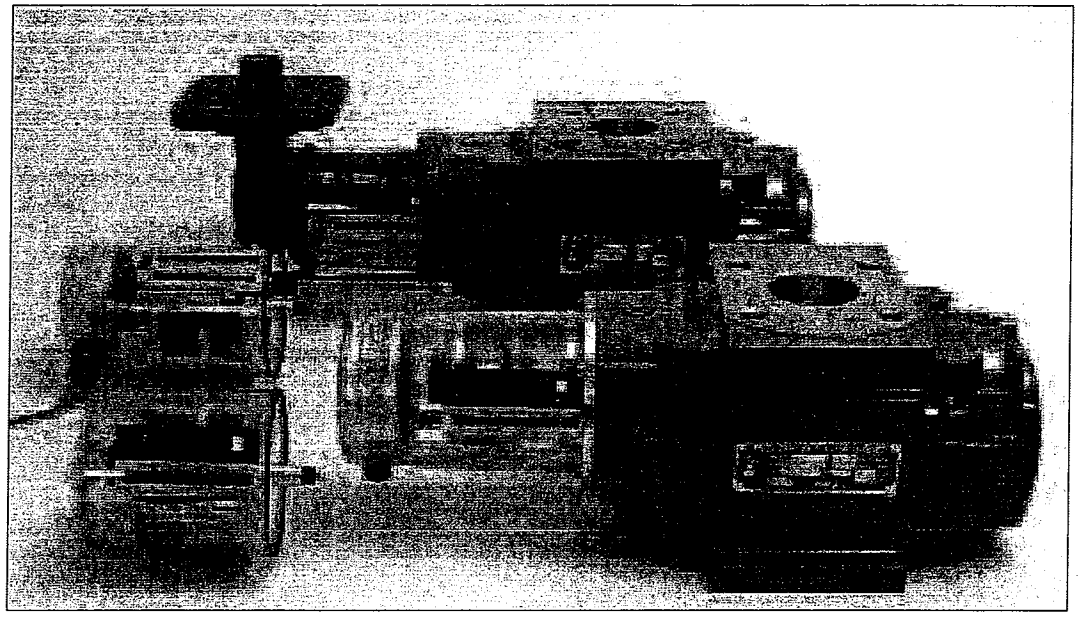
DRESSER

ROOTS® Meter Series B3

Featuring Series 3 Accessory Units



Series B3 version ROOTS® meters are designed to provide accurate gas measurement over a wide range of flow, pressure and temperature conditions.

Available Types Include:

- CTR – Non-Compensated Counter
- CD – Non-Compensated Counter with Instrument Drive
- TC – Temperature Compensated Counter
- TD – Temperature Compensated Counter with Instrument Drive
- CTR or TC with Solid State Pulser – Low Frequency pulse output
- CTR or TC with AMR Adapter
- CEX – Counter (CTR) with High Frequency Transmitter/Pulser

Series B meter bodies are also available with the integral electronic ROOTS® IMC/C2 or IMC/W2 volume, pressure and temperature corrector, or the ROOTS® IMC/W2-T for a "temperature only" corrected reading.

SERIES B3: 7M175 ROOTS® Meter

	UNITS	Imperial	UNITS	Metric
Temperature Range	deg. F	-40 to +140	deg. C	-40 to +60
Base Rating (Q Max.)	acfh	7000	m^3/h	200,0
Max. Operating Pressure (MAOP)	psig	175	kPa	1200
Leak Test (125% MAOP)	psig	219	kPa	1510
Static Test (2 x MAOP)	psig	350	kPa	2400
Rangeability +/- 1%	ratio	67:1	ratio	67:1
Rangeability +/- 2%	ratio	115:1	ratio	115:1
Start Rate	cfh	5.33	m^3/h	0,1509
Stop Rate	cfh	3.39	m^3/h	0,0960
Flow Rate @ 0.5" w.c., Gas	cfh	5400	m^3/h	152,9
Avg. Differential, 100% Flow	in. w.c.	1.6	mbar	4,0
Max. Pressurization Rate	psig/sec	5	kPa/sec	35
Max. Operating Speed	rpm	1867	rpm	1867
Gear Ratio	ratio	160:1	ratio	564,9038:1
Displaced Volume/Revolution	cf	0.0625	m^3	0,001770
Drive Rate, CD	cf/rev	10	m^3/rev	1
Drive Rate, TD	cf/rev	100	m^3/rev	10
Temp. Compensating Range (TC, TD)	deg. F	-20 to +120	deg. C	-29 to +49
Min. Odometer Reading	cf	0.2	m^3	0,02
Odometer Turnover	yrs.	1.63	yrs.	5,77
Nominal Pipe Size	in.	3	mm	80
Flange-to-Flange	in.	9-1/2	mm	241,3
Flange Connection	ANSI	150#FF	ANSI	150#FF
Bolts per Flange	qty.	4	qty.	4
Bolt Size[1]	in.	5/8 - 11	in.	5/8 - 11
Flange Bolt Hole Depth	in.	15/16	mm	23,8
Bolt Torque: Lubricated/Non-Lub.	ft.-lb.	55/60	N-m	74/81
Restricting Orifice (120%)	in.	13/16	mm	20,638
Oil Capacity – Side Inlet	oz.	3	ml	89
Oil Capacity – Top Inlet	oz.	21.9	ml	648
Counter Version (CTR)[2]				
Net Weight	lbs.	52	kg	23,6
Shipping Weight	lbs.	58	kg	26,3
Carton Size	in.	34x 13 x 12	cm	86 x 33 x 31
Counter with Instrument Drive (CD)[2]				
Net Weight	lbs.	58	kg	26,3
Shipping Weight	lbs.	64	kg	29,0
Carton Size	in.	38 x 15 x 16	cm	97 x 38 x 41

NOTES:

[1] Bolt Length varies by application.

[2] Weights and dimensions available for CPS, TC, TD, TPS upon request.

ROOTS® Series B3

Meter Specifications

SERIES B3	Units	8C175	11C175	15C175	2M175	3M175	5M175	7M175	11M175	16M175	23M175	23M232	38M175	56M175
Base Rating	acfh	800	1100	1500	2000	3000	5000	7000	11000	16000	23000	23000	38000	56000
Max. Operating Pressure	psig	175*	175*	175*	175	175	175	175	175	175	175	175	175	175
Rangeability +/-1%	ratio	26:1	31:1	40:1	100:1	76:1	120:1	67:1	124:1	116:1	40:1	169:1	90:1	53:1
Rangeability +/-2%	ratio	46:1	58:1	78:1	200:1	139:1	215:1	115:1	227:1	223:1	60:1	278:1	110:1	109:1
Start Rate	acfh	2.79	2.30	1.94	1.01	2.1	1.2	5.3	3.9	3.2	23	10.33	27	40
Stop Rate	acfh	2.03	1.74	1.57	0.82	1.8	0.8	3.4	3.2	1.9	18	5.75	20	29
Flow Rate, 0.5" w.c.,Gas	acfh	800	1100	1500	2000	2580	3975	5400	7300	9950	14800	10948	20600	23000
Differential, 100% Flow	in.w.c.	0.45	0.6	0.75	0.65	1.1	1.1	1.6	1.06	2.1	1.3	2.08	1.9	2.2
Drive Rate, CD/TD	cf/rev	10/100	10/100	10/100	10/100	10/100	10/100	10/100	10/100	100/1000	100/NA	100/NA	100/NA	100/NA
Min. CTR Reading	cf	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2	2	2	2	2
Nominal Pipe Size	in.	2	2	2	2	2	3	3	4	4	6	4	6	8
Flange/Flange Dim.	in.	6-3/4	6-3/4	6-3/4	6-3/4	6-3/4	6-3/4	9-1/2	9-1/2	9-1/2	16	15/16	18	21
Oil Capacity: Side Inlet	oz.	0.8	0.8	0.8	1.3	1.3	1.3	3	3	3	40	3.4	40	40
Oil Capacity: Top Inlet	oz.	3	3	3	7.6	7.6	7.6	21.9	21.9	21.9	154	21.8	154	154

Meter Sizing

Model	8C175*	11C175*	15C175*	2M175*	3M175*	5M175*	7M175	11M175	16M175	23M175	23M232	38M175	56M175
Base Rating (acfh)	**800**	**1100**	**1500**	**2000**	**3000**	**5000**	**7000**	**11000**	**16000**	**23000**	**23000**	**38000**	**56000**
Meter Pressure (psig)	Corrected Capacity at Metering Pressure - MSCFH												
1	0.84	1.2	1.6	2.1	3.1	5.2	7.3	11.5	16.7	24	24	39.7	58.5
5	1.1	1.5	2	2.6	4	6.6	9.2	14.5	21.1	30.3	30.3	50	73.8
25	2.1	2.9	4	5.4	8	13.4	18.7	29.4	42.8	61.5	61.5	101.7	149.8
60	4	5.6	7.6	10.1	15.2	25.3	35.4	55.6	80.8	116.2	116.2	191.9	282.9
100	6.2	8.5	11.7	15.5	23.3	38.8	54.4	85.4	124.3	178.6	178.6	295.1	434.9
150	8.9	12.3	17	22.3	33	56	78	123	179	256.7	256.7	424.1	625
175	10.3	14.1	19	25.7	39	64	90	141	206	295.7	295.7	488.6	721.5
200	11.7	16	21.9	29.1	43.7	72.8					334.8		
232											384.7		

*Available with 200 psig Rating.

To select proper meter size, use Minimum Operating Pressure and Maximum Instantaneous Hourly Flow Rate.
Complete Data Sheets are available for each meter size. Request Data Sheet by meter model.

DRESSER
Roots Meters & Instruments

Dresser Roots Meters & Instruments — **Dresser, Inc.**

P. O. Box 42176
Houston, TX 77242-2176
website: www.dresser.com

Inside US Ph: 800.521.1114
Outside US Ph: 832.590.2303

Fax: 800.335.5224
Fax: 832.590.2494
www.rootsmeters.com

PRODUCT DATA

Full Range of Sizes:

13 meter sizes offer a competitive range of rotary meters for commercial and industrial metering applications. Select the correct meter size for cost effectiveness and accurate measurement.

Standardized Flanges:

Sizes 8C through 3M have a 6-3/4" (171mm) flange-to-flange dimension for standardization in the meter set design. As loads change, meter sizes are easily interchanged, saving the cost of re-piping.

Accurate Low Flow Performance:

Low start/stop rates extend the rangeability (gas measured) over a wider range of flow conditions.

Low Pressure Differentials:

Reducing the maximum operating speed provides lower pressure differentials for low pressure applications, as well as extending the meter's life-expectancy.

SERIES 3 ACCESSORY UNITS

Oil-free Design:

Series 3 accessories feature high quality and long-term reliability with an oil-free permanently lubricated design. Oil is not required for the Polymer bushings and pre-lubricated, shielded ball bearings. Permanent lubrication equates to easier installation and less maintenance.

Durable, Weather Resistant Cover:

Optical Quality Lexan® covers on Series 3 accessories offer exceptional Ultraviolet protection while the cylindrical design allows the unit to easily shed rain, snow, ice and dirt. The single piece cover design provides added protection against leakage under extreme conditions.

High and Low Frequency Pulser Options:

The Counter with Electronic Transmitter (ICEX) provides a high frequency non-compensated pulse output for applications requiring information on the gas flow rate while the low frequency solid state pulsers are a lower cost option for both non-compensated (ICPWX) and temperature compensated (ITPWX) volume accumulation applications.

Non-Moving Odometer Masking System:

A unique and versatile odometer masking design using opaque or semi-transparent covers offers configurable, trouble-free masking.

Universal Instrument Drive (ID) Assembly:

One size fits all with the Series 3 Instrument Drive Assembly. Inventory costs are reduced by stocking one ID Assembly.

AMR Adapter:

The new direct drive AMR Adapter offers you a low cost solution for Series B3 CTR or TC meters in applications that require the adaptation of a Residential ERT or Cellnet AMR. The AMR Adapter is available as a conversion kit for field installation or factory installed on new meters.

General Information

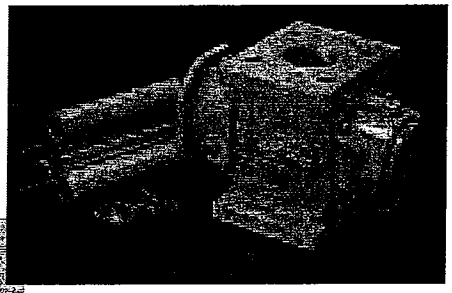
The Series B3 ROOTS® meter is a positive displacement, rotary type gas meter designed for continuously measuring and indicating the accurate measurement of gas. ROOTS® meters are suitable for handling most types of clean, dry, common gases at either constant or varying flow rates. Meters of standard construction are not directly suitable for handling acetylene, biogas or sewage gas. Contact the factory for information on specially constructed meters made of materials more compatible with these and other gases.

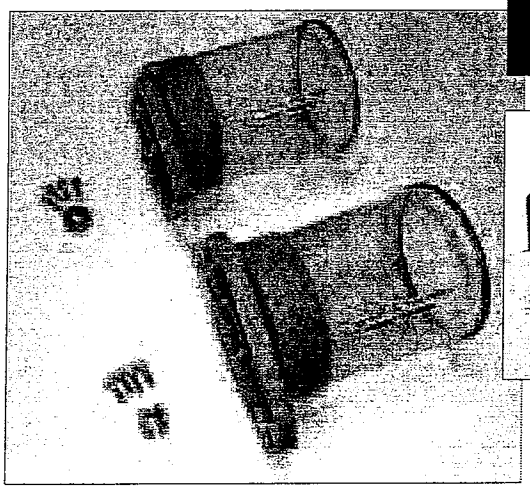
Volumetric accuracy of the ROOTS® meter is permanent, non-adjustable, and is not affected by low or varying line pressure. Series B3 meters may be used satisfactorily for pressures ranging from a few ounces to full Maximum Allowable Operating Pressure (MAOP). Displaced volume measurement is completely independent of the gas specific gravity, temperature, and pressure.

Series B ROOTS® meters have a MAOP rating of 175 psig (1200kPa). Every meter is static pressure tested at the factory at twice its MAOP and leak tested at 125 percent of MAOP in accordance with ASME Boiler Pressure Vessel Codes. Other pressure ratings are available. Consult Factory.

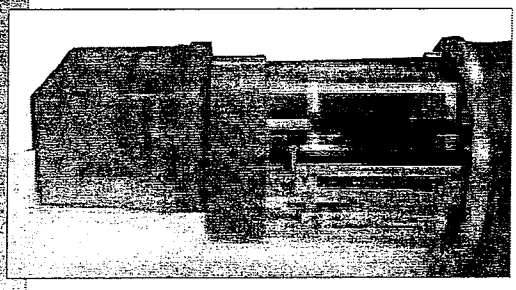
ROOTS® meters are manufactured in accordance with ANSI B109.3 for Rotary Type Gas Displacement Meters. Series B3 ROOTS® meter sizes 8C through 56M, have flanged inlet and outlet connections conforming dimensionally with ANSI/ASME standards. Sizes 8C through 2M are available with 1-1/2" NPT connections, upon special request. The meter operating temperature range is from -40°F to +140°F (-40°C to +60°C) while the temperature compensating mechanism of the TC accessory provides a corrected reading for temperatures ranging from -20°F to +120°F (-29°C to +49°C).

Series B ROOTS® meter bodies accept a wide range of Series 3 accessories for all metering applications.

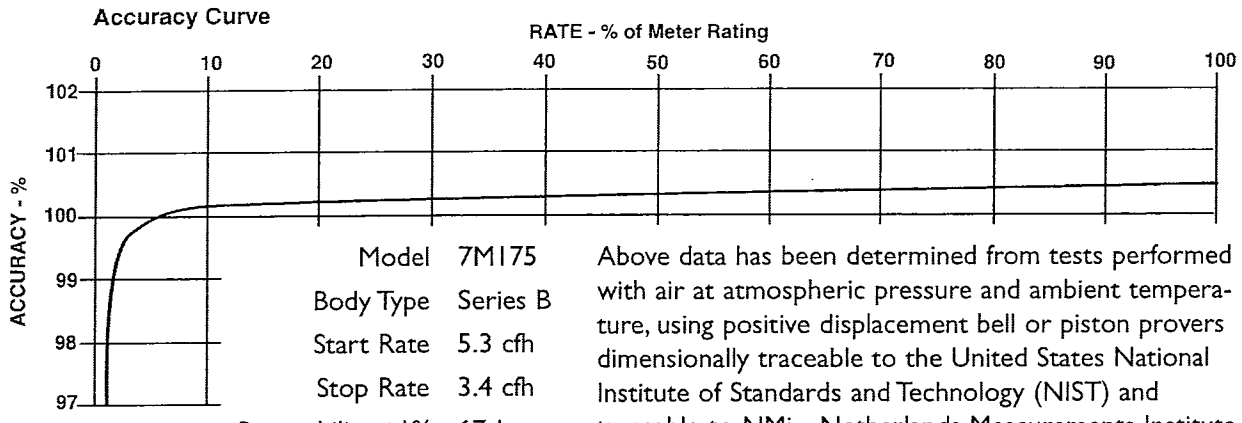




AMR Adapters for Series B3 ROOTS Meter.

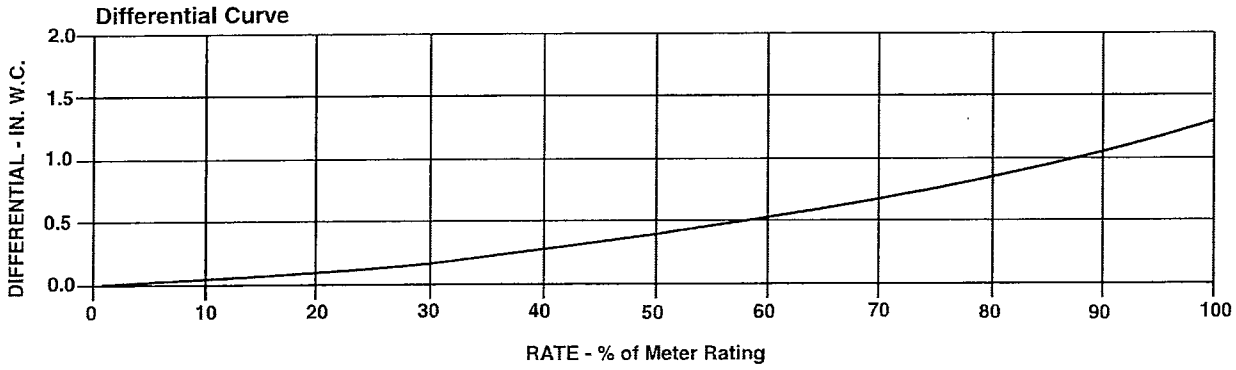


AMR Adapter and ERT installed on a ROOTS Meter (top inlet meter installation shown)

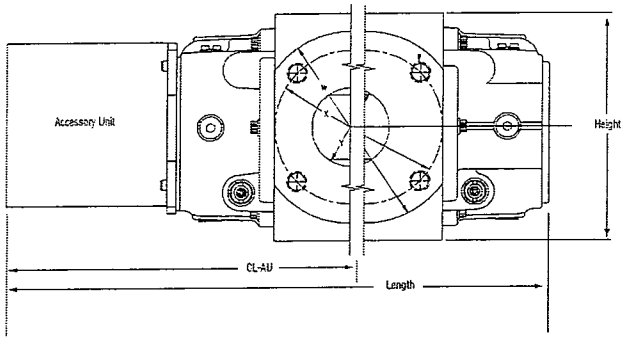


Model	7M175
Body Type	Series B
Start Rate	5.3 cfh
Stop Rate	3.4 cfh
Rangeability ±1%	67:1
Rangeability ±2%	115:1

Above data has been determined from tests performed with air at atmospheric pressure and ambient temperature, using positive displacement bell or piston provers dimensionally traceable to the United States National Institute of Standards and Technology (NIST) and traceable to NMi - Netherlands Measurements Institute for volumetric flow rate.



7M175 Series B3	Overall Length inches	mm	Overall Height inches	mm	Width (Flange/Flange) inches	mm	Centerline to Accessory End (CL-AU) inches	mm	Request Detailed Drawing Number
CTR / TC	17-13/16	452	8-7/8	225	9-1/2	241	11-5/16	273	D054518-000
CD / TD	21-19/32	548	8-7/8	225	9-1/2	241	15-3/32	383	D054432-000
CPS / TPS	19-15/16	506	8-7/8	225	9-1/2	241	13-7/16	341	D054671-000
IMC/C	23-3/16	589	8-7/8	225	9-1/2	241	14-15/16	379	D056487-000
IMC/W	24-3/16	614	8-7/8	225	9-1/2	241	17-11/16	449	D056703-000



To order

Specify: Meter Series, Size and Type (i.e., ROOTS Meter Series B3 7M175 CD).

For CD or TD, specify Inlet (Top or Side) and ID Rotation (CW-B or CCW-A).

For Pulser, specify Single or Dual Connectors and Connector Type (MS Circular, Conduit or Cable Gland).

For more specific ordering information on the electronic products, request: TS:SSP, TS:IMC/C or S:IMC/W.

Contact the factory for other available information, options, or special requests.

DRESSER
Roots Meters & Instruments

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P. O. Box 42176
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Fax: 832.590.2494
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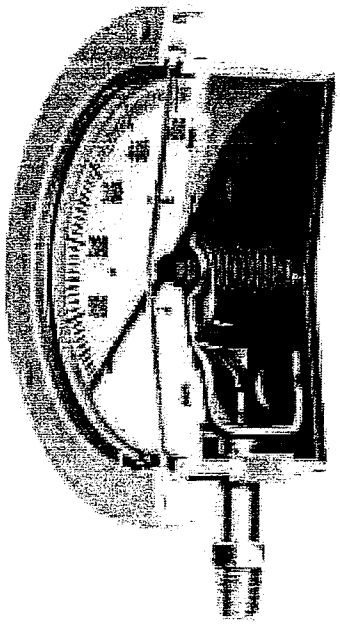
Mini-Map

PERMA-CAL® INDUSTRIES, INC.

HAVING ONLY ONE MOVING PART MINIMIZES THE EFFECTS OF SHOCK, VIBRATION PULSATION AND WEAR



DIRECT DRIVE BOURDON TUBE

The advantage of Perma-Cal® *direct drive* over conventional C- tube gauges is simple, there is only one moving part **No gears, linkages, or springs** to wear or break. Perma-Cal® gauges have a unique helical-wound elastic element that is attached directly to the pointer shaft. This eliminates the need for any movement-amplifying gears or linkages (the parts of a C-tube that fail most frequently). Perma-Cal® gauges maintain their structural integrity and accurate calibration in the most demanding environments, even during prolonged and rugged use. Perma-Cal® *direct drive* pressure gauges provide the lowest cost of ownership by giving the best value in durability, reliability, and accuracy.

NO LIQUID FILL

Perma-Cal® gauges have more **durability** and **longevity** than liquid-filled gauges, without the mess or problems of liquid fill. Perma-Cal® gauges do not have any of the problems filling solves. There are **no gears or linkages** to lubricate, and Perma-Cal® gauges are internally dampened with a small application of heavy (600,000 centistokes) silicone grease that eliminates pointer flutter. Perma-Cal® provides a longer life gauge than liquid filled gauges without the leaking or discoloring problems of liquid fill.

SAFETY FEATURES

Perma-Cal® gauges have a very **low volume** elastic element and **solid front** case that provide the safest gauge possible. C-tube gauges have a relatively large volume elastic element that in cases of catastrophic failure could spill large amounts of process. Not all direct drive gauges offer the industry standard **solid front** for case safety. The Perma-Cal® configuration of **solid front** and rear blowout features provides the customer with the safest possible case style. Perma-Cal® furnishes the safest, most durable gauge in the industry.

CERTIFIED ACCURACY

All Perma-Cal® gauges have a high repeatable accuracy, instantaneous action, and are available as Grade 3A (±.25% full scale), Grade 2A (±.5% full scale), or ±.5% mid-scale/ ± 1% full scale. The full scale accuracy rating is applicable in both ascending and descending modes on all gauges, except for gauges rated 8,000 PSI and above , where the descending accuracy is ±1% of full scale. Test gauges (Grade 3A) come with a calibration certificate traceable to the National Institute of Standards and Technology (NIST) included in the price. Perma-

PERMA-CAL®
INDUSTRIES, INC.

HOW TO ORDER A PERMA-CAL® *DIRECT DRIVE* GAUGE WITH THE EXACT SPECIFICATIONS YOU REQUIRE

Go through the eleven blocks of options listed below and select an option code for each specific feature you need:

Option >	A	B	C	D	E	F	G	H	I	J	-	K*
Part Number >											-	

OPTION	CODE	FEATURES
A **Product Type**	**1**	Pressure Gauges
	2	Seawater Depth Gauges (FSW Ranges)
B **Accuracy**	**0**	¼% Full Scale (8½", 6", 4½" and 2½" dials; Calibration Certification included)
	1	½% Full Scale (6", 4½", 3½" and 2½" dials)
	2	1% Full Scale, ½% Mid Scale (6", 4½", 3½" and 2½" dials)
C **Dial Size**	**0**	6" (External zero adjust included)
	1	4½" (External zero adjust included on test gauges, optional on process gauges)
	2	3½" (External zero adjust not available; zero adjust pointer included)
	3	2½" (External zero adjust included on test gauges, optional on process gauges)
	8	8½" (External zero adjust included)
	F	Front Flange (8½", 6", 4½" and 2½" only)
	M	No Flange Metalic (4½" only; Flange Kit available)

D **Case Type**		(Product Bulletin)
	N	No Flange (6", 4½" and 2½" only)
	R	Rear Flange (6", 4½" and 2½" only)
	S	No Flange Stainless Steel (4½" only; Flange Kit available) (Product Bulletin)
	T	Turret (4½" and 3½")
E **Pointer Type**	**I**	Process (bold, easy-reading)
	T	Test (knife-edged, precision reading)

		Dial Size	**Mirror Band ?**	**Dampening ?**	**External Zero Adj. ?**
F **Dial Trim**	**A**	2½", 4½", 6"	No	No	Yes
	B	2½", 4½", 6"	No	Yes	Yes
	D	2½", 3½", 4½"	No	Yes	No
	M	2½", 4½", 6", 8½"	Yes	Yes	Yes
	N	2½", 3½", 4½"	No	No	No
	R	3½", 4½", 6", 8½"	No	Yes	No
	S	3½", 4½", 6", 8½"	No	No	No
	W	2½", 4½", 6", 8½"	Yes	No	Yes
	Note: Trim codes A,B,M,R,S & W have stainless steel dials except for 2½" size.				

G **Pressure Range**	**XX**	A two character code specifies pressure range and units of measurement, i.e., psi, kPa, Bar, kgcm², FSW, etc. See Bulletin T-103 for available ranges and their corresponding codes.

	A	Black	**G**	Green	**W**	White

H **Case Color**	**B**	Blue	**R**	Red	**Y**	Yellow
	H	High Temp (Glass-filled nylon, 4½" yellow turret only)				
	U	Unpainted (M, S and -Z case types only)				
I **Fitting Position**	**0**	Rear				
	2	Bottom (6 o'clock position)				
	4	Top (12 o'clock position)				
J **Fitting Type**	**1**	¼ NPT	**6**	MS 33649E4		
	2	Not Assigned	**7**	Not Assigned		
	3	½ NPT	**8**	9/16-18 O-ring union (MIL-G-18997)		
	4	MS 33514E4	**9**	¼ BSP		
	5	AS 4395E4 (MS 33656E4)	**X**	Customer Specified (VCR Style, etc.)		
K **Misc. Options** *** You may select zero to as many options as you need.**	**C**	Calibration Certificate (not apropos on ¼%)				
	E	EPDM Isolator Installed				
	H	Helium leak test				
	L	Tempered glass				
	N	Nicrobraze				
	O	Cleaned for Oxygen service				
	P	Pointer stop pin				
	T	Stainless steel tag				
	V	Viton™ Isolator installed				
	Z	Aluminum case (2½" NF;, 4½" RF;, 8½" RF, case types only)				

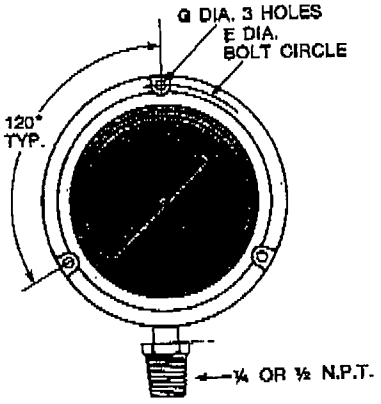
Specifications

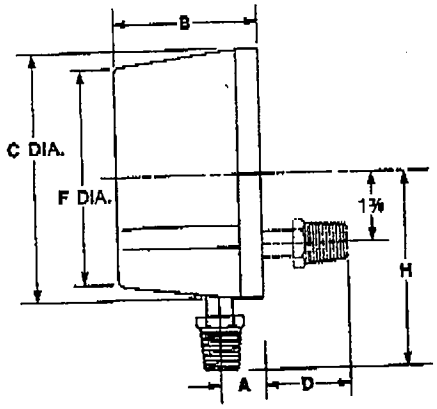
Proof Pressure without calibration shift	150% of F.S. pressure[1]
Burst Pressure	500% of F.S. pressure[2]
Wetted Parts	Inconel X-750, 316SS, and silver braze. For other options, consult factory.
Media Temperature	−65° to +250°F
Ambient Temperature	−65° to +190°F
Response Time	Approx. 100 msec to F.S.[3]
Life	250,000 cycles min. at 80% F.S.
Accuracy:[4]	
1/4% F.S.	±.25% full scale[5]
1/2% F.S.	±.5% full scale
1/2% M.S.	±1% full scale, ±.5% mid scale
Repeatability & Sensitivity	±.25% full scale
Calibration	Vertical mounting standard[6]

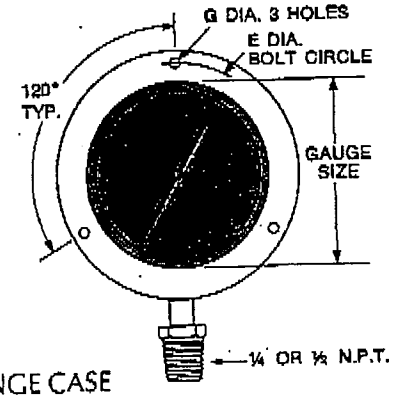
NOTES:

[1]125% of F.S. pressure, 8,000 PSI and above.
[2]250% of F.S. pressure, 8,000 PSI and above.*
[3]Gas operation with no coil dampening.
[4]Specified accuracy includes all friction error, hysteresis and linearity variations.
[5]F.S. accuracy ascending. ±1% F.S. accuracy descending on 8,000 PSI and above.
[6]Calibration in other mounting positions available upon request.

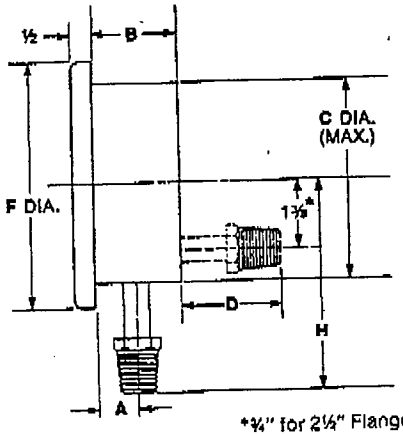
*Or 25,000 PSI, whichever is less.







FLANGE CASE

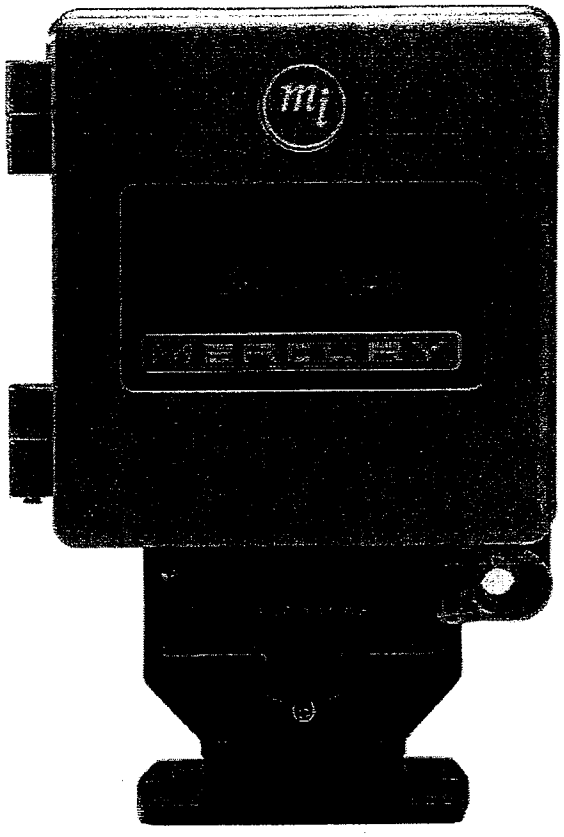


*¾" for 2½" Flange.

GAUGE SIZE	A	B	C	D	E	F	G	H	PANEL OPENING (REF.)	WRENCH SIZE (HEX) ¼"	½"
8½" Flange	1⅛	2 1/32	6 5/16	1 7/16	9⅝	10⅜	9/32	5 1/16	9	⅝	⅞
6" Flange	1⅛	2 1/32	6 5/16	1 7/16	7	7¾	9/32	5 1/16	6½	⅝	⅞
4½" Flange	1⅛	2 1/32	4⅞	1 7/16	5⅜	6	7/32	4⅛	4 15/16	⅝	⅞
4½" Turret	1 1/16	2 11/16	5 13/16	1 7/16	5⅜	5¼	7/32	4⅛	N.A.	⅝	⅞
3½" Turret	1 1/16	2 11/16	4¾	1 7/16	4¼	3⅞	7/32	4⅛	N.A.	⅝	⅞
2½" Flange	1 9/16	2 1/16	2¼	2 1/16	3⅛	3⅝	5/32	3⅜	2 13/16	⅝	N.A.

MERCURY INSTRUMENTS, INC.

Manufacturer of Precision Instruments



Mini-Max, Mini-Max-AT and Mini-Max-ATX User Guide

Revision List

1.00	Initial Release	May 2006

Copyrights and Trademarks

Introduction

Note: There are many references throughout this manual to the Mini-Max instrument. The same information also applies to Mini-Max-AT and Mini-Max-ATX instruments. Exceptions will be noted where applicable.

The Mini-Max is a stand alone, electronic gas volume corrector. Its standard mounting is on rotary, turbine, and diaphragm gas meters that have a rotating shaft (instrument drive) output. The Mini-Max is also compatible with meters that provide low frequency pulses. The purpose of this Operator's Guide is to provide the information necessary to install and use the Mini-Max corrector.

The Mini-Max is a smaller, more compact corrector than the Mercury Instrument's Mercor Mini-AT volume corrector and provides the user with simplified operation. There are three different versions offered; **Mini-Max**, **Mini-Max-AT** and **Mini-Max-ATX**. The main difference between the three is the amount of memory for audit trail logging. The table below provides the amount of memory storage for each version.

Mini-Max Audit Trail Memory Capacity				
	4-items Hourly	4-items Daily	10-items Hourly	10-items Daily
Mini-Max	1.7 days	41 days	n/a	n/a
Mini-Max-AT	41 days	2.7 years	n/a	n/a
Mini-Max-ATX	1.1 years	26 years	6 months	11 years

A PC (desktop or laptop computer) is needed to configure and download the Mini-Max using Mini-Max Link or MasterLink32 software. Detailed information regarding the software is available through the Mini-Max Link Software Users Manual, or through the Mini-Max Link help screens.

In addition to its small, sturdy case, the Mini-Max offers these and other features:

- Durable, anti-corrosive enclosure
- High-performance, low power microprocessor
- Extended battery life
- Audit Trail memory (see table above for capacities)
- Field programmable firmware updates via serial cable
- Audit trail, configuration and calibration data stored in nonvolatile memory
- Two Form-A outputs for Volume
- One Form-A output for Alarm signal or for external Power Control
- Software selectable Pulse Widths for volume pulses
- Serial port with autobaud (default)
- High-speed data transfers (up to 38.4 kbaud)
- On-board surge protection for serial & pulse data
- Alphanumeric LCD display
- Built-in membrane push-button for scroll list
- User-programmable scroll list
- Double-latch bar door closure w/ padlock hasp
- Field replaceable Alkaline batteries
- Easy-release, easy open battery receptacle

Specifications

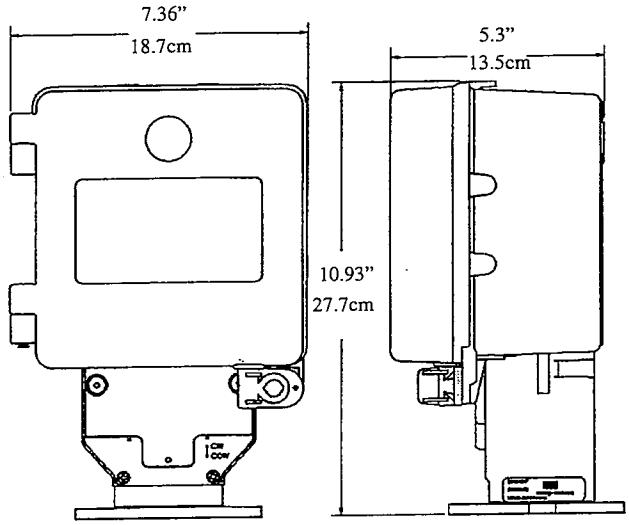
Input Volume

- Dual Dry-reed switches, one pulse per each meter revolution
- Uncorrected volume totalized on mechanical index, also displayable on LCD (Liquid Crystal Display)
- Input pulse counting continues for one half hour without main battery

Input Pressure

- Precision strain gauge pressure transducer compensated to minimize ambient temperature effects
- Live display of input pressure on LCD
- Standard Transducer Ranges:

Pressure Range		Transducer Type
PSI	BAR	
0-1	0.07	Gauge only
0-3	0.2	Gauge only
0-6	0.4	Gauge only
0-15	1.0	Gauge only
0-30	2.0	Gauge or Absolute
0-60	4.0	Gauge or Absolute
0-100	7.0	Gauge or Absolute
0-300	20	Gauge or Absolute
0-600	41	Gauge or Absolute
0-1000	70	Gauge or Absolute



Input Temperature

- Highly stable, solid state temperature sensor in a sealed ¼" diameter, 6" long stainless steel probe with 6' shielded conductor and ½" NPT slip-along fitting to match thermowell
- Range: -40°F. to 150°F. (-40°C. to 65.5°C.)
- Live display of input temperature on LCD

Corrected Volume

- Corrected to desired Base Pressure & Base Temperature
- Corrected for Supercompressibility (NX-19 or AGA8)
- Selectable volume units, both Metric & Imperial
- Displayed continuously on 8-digit x ½" LCD

Power

- 3.8 to 15.0 VDC (maximum 6VDC for Ex installations)
- Battery life: 4 years+ (with standard Alkaline Disposable Batteries)
- Half hour operation with batteries removed
- 2 Month low battery warning with 1 month additional reserve (LCD will display HELP)
- Main battery voltage and alarms displayable on LCD

Output Volume for data collection systems

- Two Form-A for Volume and one Form-A for Alarms
- Software selectable pulse width (default = 62.5 msec.)
- Optional mechanical uncorrected volume switch

Memory

- Audit Trail: **Mini-Max:** 41 days of Daily
  Mini-Max-AT: 41 days of Hourly
  Mini-Max-ATX; 400 days of Hourly (4-items)
  Mini-Max-ATX; 180 days of Hourly (10-items)
- Flash: Resident firmware (upgradable via laptop)
- E^2PROM: Resident pressure compensation coefficients, calibration items, configuration items and audit trail data

Accuracy

(Maximum error at reference conditions including linearity, repeatability and hysteresis.)

- Computation: ±0.3% of corrected volume reading
- Pressure transducer: ±0.4% of full scale
- Temperature Sensor: ±1.0°F.
- Combined computation: ±0.5% of full scale
(pressure & temperature)

Ambient Temperature Effects

From –40°F to 150°F (-40C to 65.5°C)

- Total: ±0.1% of corrected volume per 100°F.

Long Term Stability

- Total: ±0.5% of corrected volume per year.

Environmental Conditions

- Ambient Temperature -40°F. to 150°F. (-40°C. to 65.5°C.)
- Ambient Humidity: 0 to 100% Non-condensing.

Enclosure

- Composite case and door with double-latch bar
- Lexan viewing windows for uncorrected mechanical index, corrected volume LCD
- Mounting plate with gasket and bolts to accommodate most meters

Certifications

- CSA listed for Class I, Division 1 & 2, Groups C & D

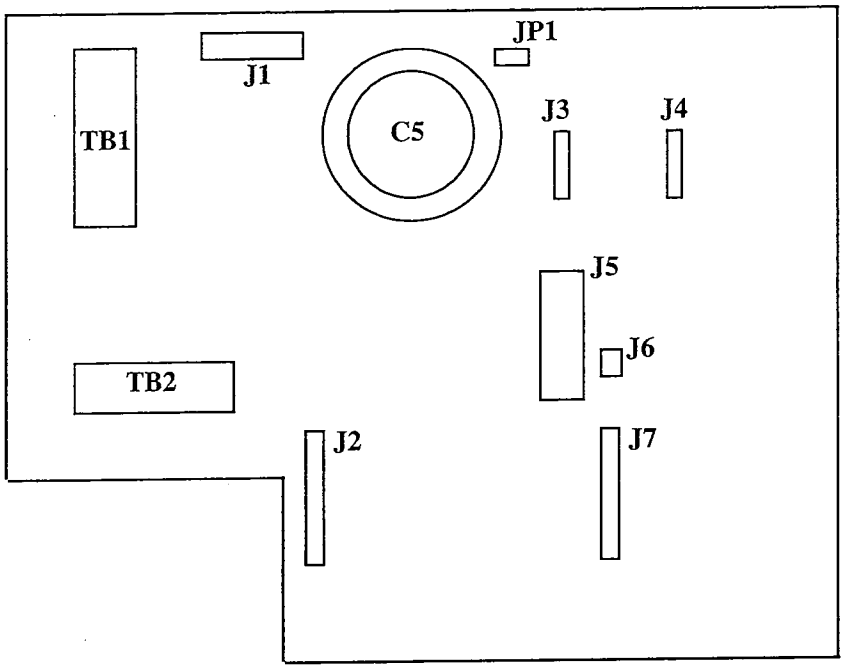


Fig. 1
Diagram of the Mini-Max Board
(Actual Size)

Connector / Jumper	Purpose
J1	Connection for LCD Display
J2	Connection for Input Switch Board
J3, J4	Connection for main battery
J5	Connection for serial port, modem
J6	Connection for temperature input
J7	Connection for pressure input
TB1	Surge protected output for Volume Pulse A,B, and Alarm Pulse
TB2	Connection for Remote UncVol switch input
C5	Super Cap
JP1	Super Cap disconnection Jumper

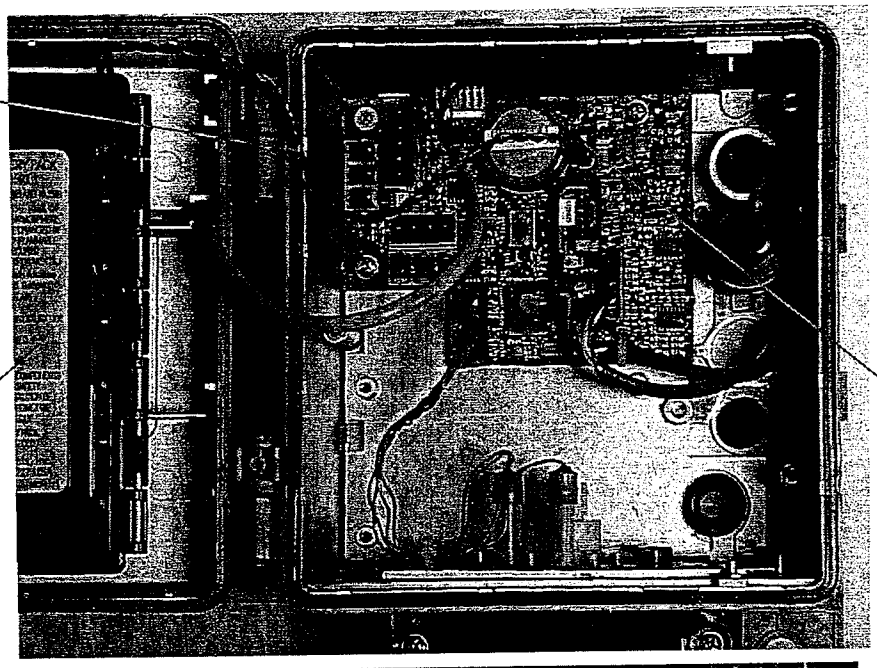
Quick Start Guide

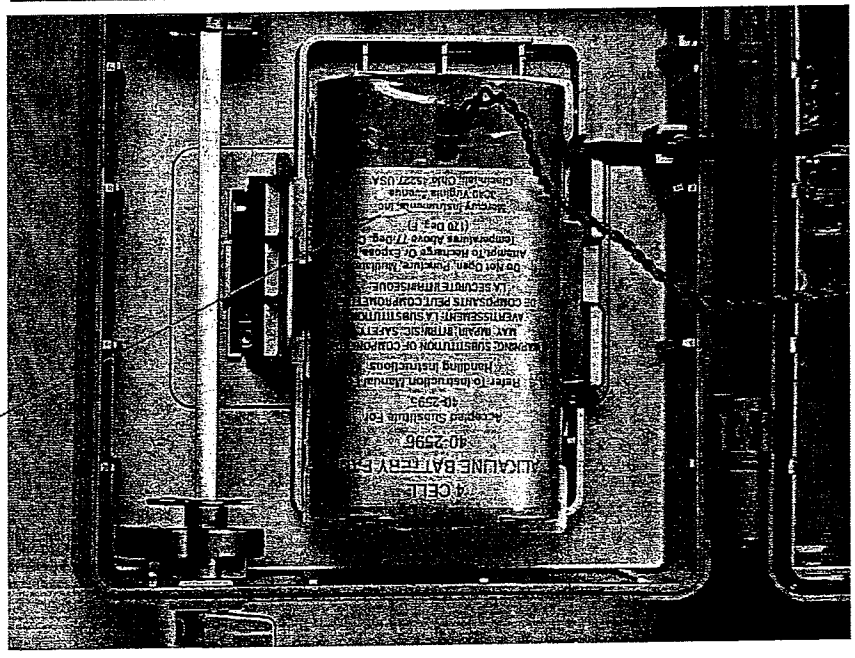
The following steps will guide you to getting the Mini-Max instrument installed and operational.

1. Carefully unpack the instrument and verify that there is no shipping damage. Also verify that there are no missing items in the shipment.

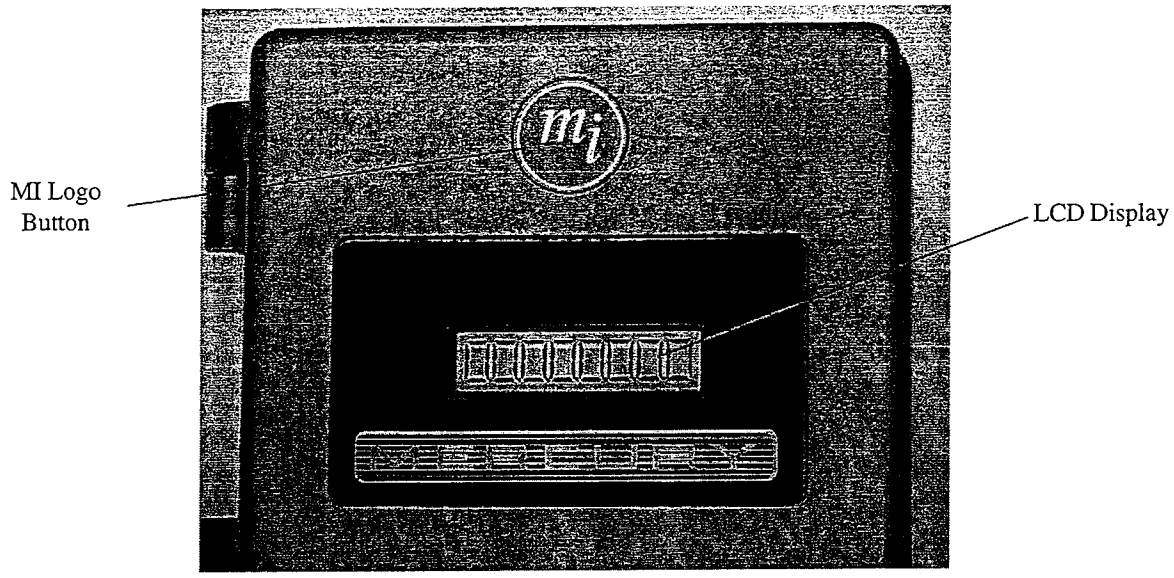
2. Rotate the door closure tab at the bottom of the double-latch assembly to open the case door. Make sure there are no loose connections or loose hardware.

3. Install four new D-cell batteries if using the Alkaline Receptacle Pack. Snap the battery pack into the battery bracket located on the inside of the door. Plug the battery cable connector into either J3 or J4.

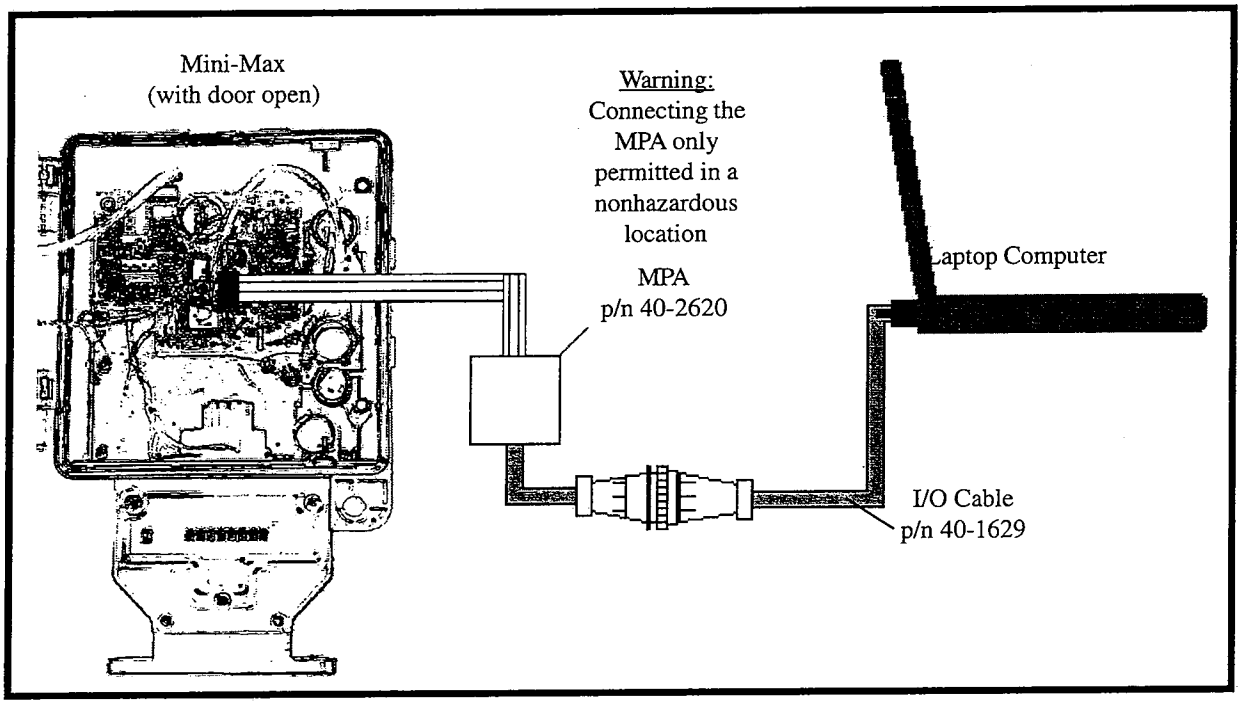




4. Verify that digits appear in the LCD display (usually all zeroes). Scroll through the meter reader list by pressing "MI" logo button to verify the instrument is operating.



5. Connect the MPA ribbon cable into the serial port (J5), and connect a standard serial cable from the MPA to a computer serial port.



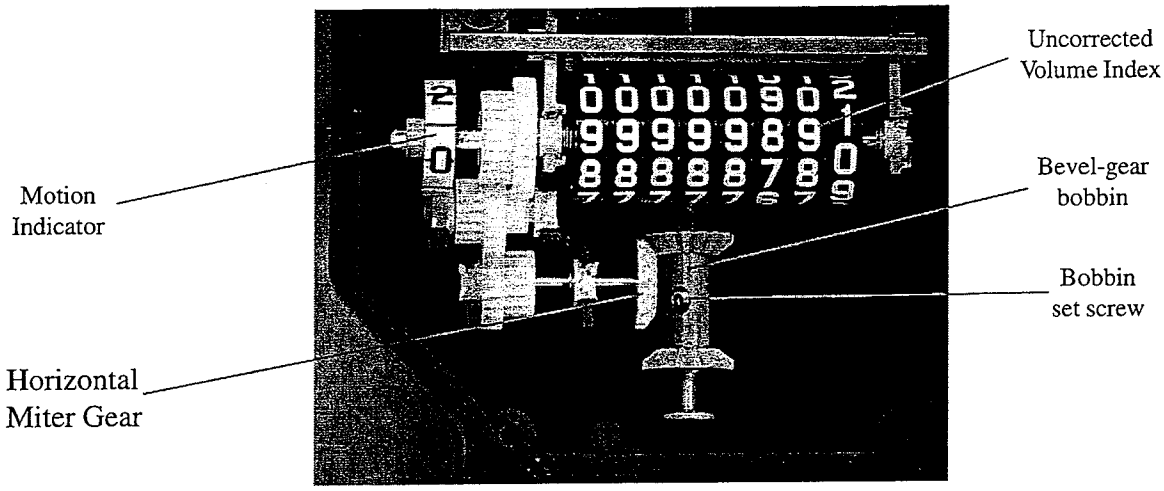
6. Run MasterLink software and use the "Set Instr. Date/Time via Computer" selection in the Instrument Menu to set the date and time in the instrument.

7. Use MasterLink software to verify that company and site specific items are set properly, especially item 098 (Meter Index Code).

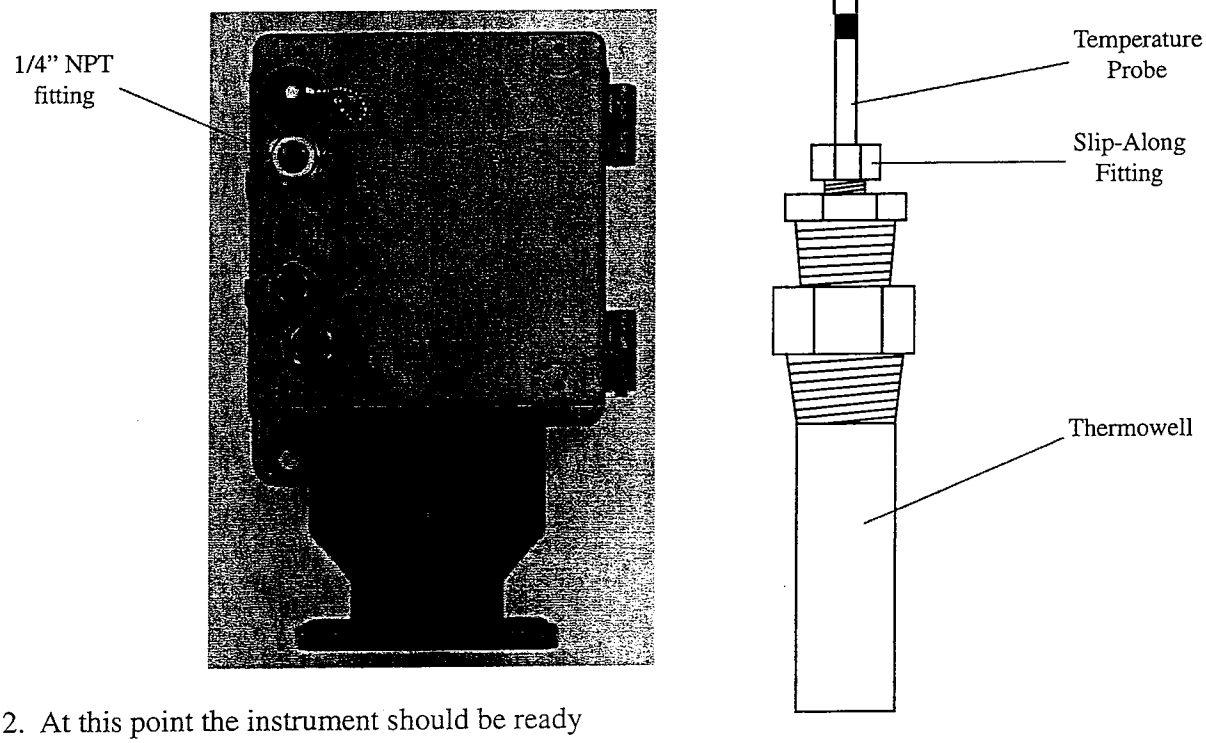
8. Use the "Disconnect Link" function in the Instrument menu to return the Mini-Max back to corrector mode. Remove the MPA connector from J5.

9. Place the Mini-Max on the meter, making sure that the wriggler is aligned properly. Bolt the Mini-Max to the meter.

10. Verify the uncorrected volume reading rotates in the proper direction. If not, remove the clear index cover. Loosen the set screw on the Bevel-gear Bobbin. Shift the bobbin **Up** for CW meters or **Down** for CCW meters. Retighten the set screw after the bobbin is properly positioned and fully meshes with the miter gear on the horizontal shaft..



11. Connect the pressure line to the 1/4" NPT fitting at the back of the instrument. Also insert the slip-along fitting into the thermowell, and place the temperature probe into the slip-along fitting, sliding the probe down until it bottoms out in the thermowell before tightening the slip-along nut



12. At this point the instrument should be ready

Correction Factors to Metered Volume

Ideal or perfect gases follow the relationship of Boyle's Law for pressure effect and Charles' Law for temperature effect, which can be stated: The volume of any definite weight of a perfect gas varies inversely with change in absolute pressure and directly with change in absolute temperature. The equation for this relationship of the two laws is expressed as follows:

$$\frac{V1*P1}{T1} = \frac{V2*P2}{T2}$$

The Symbols V1, P1 and T1 refer to the original volume, pressure and temperature while V2, P2 and T2 refer to the volume, pressure and temperature of the new or changed conditions. Rearranging the equation and rewriting subscripts, we can express it as follows:

$$Vb = Vm * \frac{(Pm * Tb)}{(Pb * Tm)}$$

Where: Vb = gas volume (cu. Ft.) at base condition corrected
Pb = absolute base pressure (psia)
Tb = absolute base temperature (deg. R)
Vm = gas volume metered (cu. Ft.) uncorrected
Pm = absolute meter pressure (psia)
Tm = absolute meter temperature (deg. R)

Pressure Factor Fp

The pressure factor (Fp) to apply to metered volume is expressed by the Boyle's Law relationship as follows:

$$Fp = \frac{Pm}{Pb} = \frac{\text{Meter Pressure (PSIG) + Atmospheric Pressure (PSIA)}}{\text{Base Pressure (PSIA)}}$$

Each increment of meter pressure represents a different pressure factor. As the flowing gas pressure (Pm) changes, the Mini-Max automatically applies the pressure factor (Fp) to the metered volume (Vm).

Temperature Factor Ft

The temperature factor (Ft) to apply to metered volume is expressed by the Charles' Law relationship as follows:

$$Ft = \frac{Tb}{Tm} = \frac{\text{Base Temperature, deg F + 459.67}}{\text{Meter Temperature, deg F + 459.67}}$$

Each increment of meter temperature represents a different temperature factor. Therefore, as the flowing gas temperature changes, the Mini-Max automatically applies the temperature factor (Ft) to the metered volume.

Supercompressibility Factor Fpv

Gases actually behave slightly different than what the ideal gas laws indicate. This deviation depends on the molecular composition of the gas and the specific gravity as well as the pressure and temperature. Natural gas, for instance, compresses by a greater amount than that computed by Boyle's law and hence the term "supercompressibility" is used for this deviation. It is small at very low pressure, but becomes substantial as the pressure increases. The Mini-Max automatically applies the supercompressibility factor and therefore the equation for total volume correction that the Mini-Max applies to metered volume, is expressed as:

$$Vb = Vm * Fp * Ft * (Fpv)^2$$

Where:
Vb = gas volume (cu. Ft.) at base condition corrected
Vm = metered volume read from meter index
Fp = pressure factor
Ft = temperature factor
Fpv = supercompressibility determined from NX-19 or AGA-8

The Mini-Max automatically squares the supercompressibility factor displayed, which is based on the pressure and temperature sensed at the meter. The resulting volume readout is corrected for pressure, temperature, and supercompressibility.

NX-19 vs AGA-8 Supercompressibility

The Mini-Max calculates the supercompressibility factor every meter revolution using one of two different methods. The first (default) method is NX-19 which uses a table built into the Mini-Max firmware. The second, newer method is AGA-8 (either Gross or Detail) which is a table generated by MasterLink32 software and sent to the Mini-Max using MasterLink32's Transfer | Send AGA-8 Factors. Determining which method to use, if supercompressibility is to be used at all, is usually a personal or corporate choice.

How the Mini-Max Works

The Mini-Max is a dedicated microcomputer that uses precision sensors to measure gas pressure and temperature to correct the metered volume. The electronic circuits are powered by the battery pack located on inside of door. The battery voltage is regulated to the various voltages required by the remaining circuits. While in the Corrector Mode, most of the electronic circuitry is in an 'unpowered' (sleep) state. When the magnet disc rotates and actuates the input switches, the electronics are energized and begin the correction cycle. The input switches not only 'wake-up' the electronics, but are also the input for uncorrected volume. The volume that each input closure represents is defined by Item Code 098 multiplied by the value at Item Code 114.

Once the instrument 'wakes-up', the computer program in firmware instructs the CPU (microprocessor) to obtain analog measurements. At least four analog signals: gas pressure, gas temperature, main battery voltage and case temperature, are multiplexed through the A/D converter and sent to the microprocessor for processing.

The microprocessor converts the digitized analog signals to an equivalent numeric value and stores this information in memory. Gas Pressure is stored at Item Code 008, Gas Temperature is stored at Item Code 026, Main Battery Voltage is stored at Item Code 048, and Case Temperature is stored at Item Code 031. After all measurements are obtained, the microprocessor compares the measured values to the parameter limits already saved in memory, i.e., pressure low limit, temperature high limit, battery low limits, etc. If any of the measured parameters are out of range, the microprocessor jumps to an alarm subroutine. Except for battery Shutdown Voltage limit exceeded, the alarm subroutine activates the appropriate alarm item code, turns on the alarm indicator and transmits an alarm pulse out the alarm channel. After the alarm sequence is complete, the microprocessor returns to its normal functions.

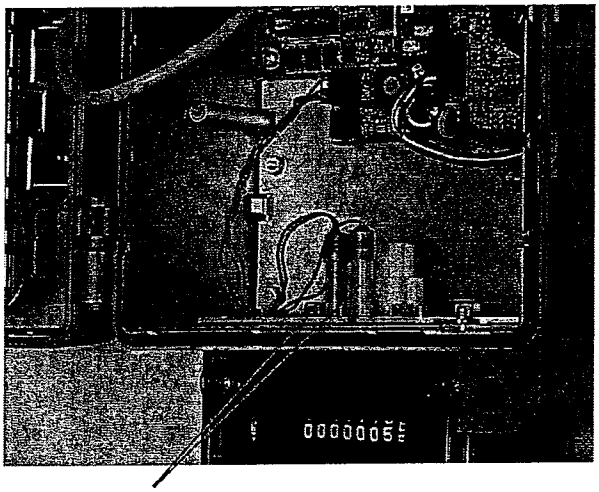
At the time of a full 'wake-up', if the battery Shutdown Voltage low-limit (Item Code 50) is exceeded, the microprocessor activates the alarm indicator (all seven LCD decimal points are turned-on), transmits an alarm pulse on the alarm channel, spells out the word "HELP" on the LCD. Under these conditions, the "HELP" message is displayed for as long as there is enough battery voltage to maintain the display. The Mini-Max is still correcting the gas volume, however, the user has no access until the batteries are replaced. The mechanical index is still functional. To restore normal instrument operation, remove the dead batteries and replace them with fresh ones. When the LCD goes blank, the configuration, calculated, and logged data are all safe in nonvolatile memory.

After the alarm subroutine is complete, or if no alarm conditions are present, the microprocessor computes new correction factors based on the new measurements and parameters already in memory. Parameters in memory are items such as: Base Pressure, Base Temperature, Specific Gravity, etc. The new correction factors are then applied to the uncorrected volume input to obtain the corrected volume. The amount of corrected volume just calculated is then added to the totalized corrected volume stored at Item Code 000. The uncorrected volume just received is also added to the totalized uncorrected volume stored at Item Code 002. When the microprocessor has completed the updating of its memory registers and item codes, it will update the LCD with the new corrected volume information. The microprocessor will then power down most of the main board circuits and transmit corrected volume pulses if Item Codes 093 and 094 were configured for 'pulse outputs'. Otherwise, the main board will go back into the 'sleep' mode waiting for the next uncorrected volume input pulse.

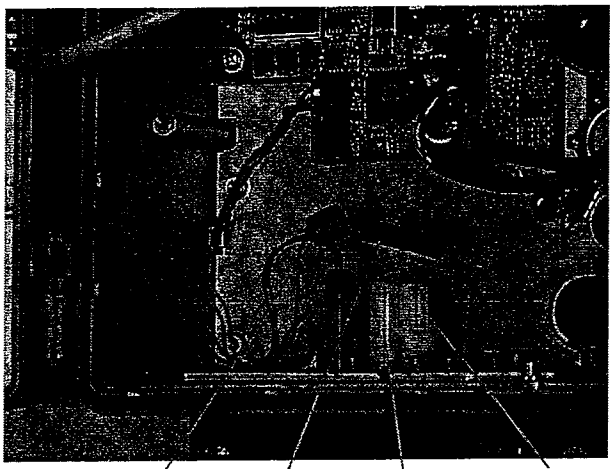
Three other conditions can cause the Mini-Max to 'wake-up' while in Corrector Mode. They are: a Display Button Input, a Serial Communication Link or a scheduled Audit Trail Log entry. A Display Button Input is caused by pressing the MI logo above the LCD. It can take up to two seconds for the Mini-Max to wake up. A Display Button Input will cause the microprocessor to initiate the Meter Reader Mode. A 'wake-up' caused by a Serial Communication Link will allow the instrument to 'talk' to serial devices connected to the serial port (local or modem). An Audit Trail wake-up occurs either hourly or daily. In all three cases, the microprocessor will initiate a full correction cycle as described above. Except for Audit Trail wake-ups, after the completion of the correction cycle, most main board circuits will remain energized while the instrument is performing the user requested tasks.

Drive Input and Switches

A universal mounting bracket, containing a digital index for indicating uncorrected volume, is used to mount the Mini-Max to a meter. A reversing gear mechanism permits changing the index rotation to match meter rotation. The input signal (pulses) for uncorrected volume is produced by magnetically actuated reed switches. A magnet is located at the top shaft (inside the main enclosure) and is rotated by the meter output shaft. There is very little torque loading on the meter. The two input switches allow continued operation if one switch should fail. If a switch failure is detected, an alarm is displayed. The switches can be replaced.

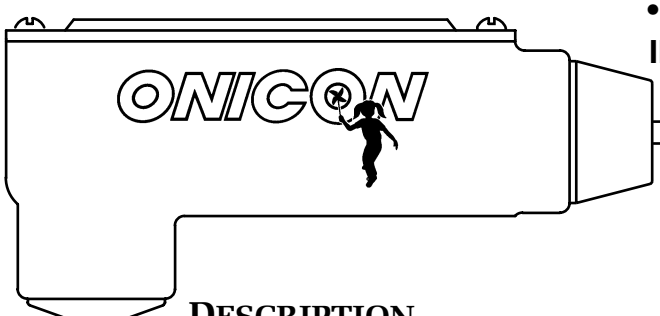


Input Switches (2)



Pressure System

The pressure sensing system incorporates a precision strain gage pressure transducer located inside the Mini-Max enclosure. A ¼" NPT female case connection protrudes through the back of the case for the attachment of the pressure line. A valve kit with shut-off valve, tubing, and fittings is optionally available to make the pressure connection to the meter/pipeline. A plug-in cable is used to make the electrical connection from the pressure transducer to the main circuit board.



• F-1110 SINGLE TURBINE • INSERTION FLOW METER ANALOG OUTPUT

ONICON INCORPORATED

Made in the USA

DESCRIPTION

ONICON insertion turbine flow meters are suitable for measuring electrically conductive water-based liquids. The F-1110 model provides non-isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

APPLICATIONS

- Chilled water, hot water, condenser water, and water/glycol/brine for HVAC
- Process water and water mixtures
- Domestic water

GENERAL SPECIFICATIONS

ACCURACY

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

SENSING METHOD

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

PIPE SIZE RANGE

1¼" through 72" nominal

SUPPLY VOLTAGE

24±4 V AC/DC at 50 mA

LIQUID TEMPERATURE RANGE

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

AMBIENT TEMPERATURE RANGE

-5 to 160˚ F (-20 to 70˚ C)

OPERATING PRESSURE

400 PSI maximum

PRESSURE DROP

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

OUTPUT SIGNALS PROVIDED:

ANALOG OUTPUTS (NON-ISOLATED)

Voltage output: 0-10 V (0-5 V available)
Current output: 4-20 mA

FREQUENCY OUTPUT

0-15 V peak pulse, typically less than 300 Hz

(continued on back)

CALIBRATION

Every ONICON flow meter is wet-calibrated in our flow laboratory against primary volumetric standards directly traceable to NIST. Certification of calibration is included with every meter.

FEATURES

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

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

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

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

OPERATING RANGE FOR COMMON PIPE SIZES
0.17 TO 20 ft/s
± 2% accuracy begins at 0.4 ft/s

Pipe Size (Inches)	Flow Rate (GPM)
1¼	0.8 - 95
1½	1 - 130
2	2 - 210
2½	2.5 - 230
3	4 - 460
4	8 - 800
6	15 - 1800
8	26 - 3100
10	42 - 4900
12	60 - 7050
14	72 - 8600
16	98 - 11,400
18	120 - 14,600
20	150 - 18,100
24	230 - 26,500
30	360 - 41,900
36	510 - 60,900

1500 North Belcher Road, Clearwater, Florida 33765 Tel (727) 447-6140 Fax (727) 442-5699
www.onicon.com E-mail: sales@onicon.com

F-1110 SPECIFICATIONS cont.

MATERIAL

Wetted metal components
Standard: Electroless nickel plated brass
Optional: 316 stainless steel

ELECTRONICS ENCLOSURE

Standard: Weathertight aluminum enclosure
Optional: Submersible enclosure

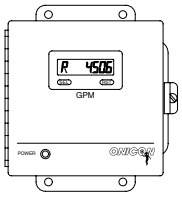
ELECTRICAL CONNECTIONS

3-wire minimum for 4-20 mA or 0-10 V output
Second analog output and/or frequency output requires additional wires
Standard: 10' of cable with ½" NPT conduit connection
Optional: Indoor DIN connector with 10' of plenum rated cable

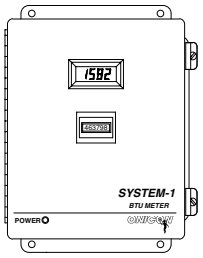
F-1110 Wiring Information

WIRE COLOR CODE		NOTES
RED	(+) 24 V AC/DC supply voltage, 50 mA	Connect to power supply positive
BLACK	(–) Common ground (Common with pipe ground)	Connect to power supply negative & analog input ground
GREEN	(+) Frequency output signal: 0-15 V peak pulse	Required when meter is connected to local display or BTU meter
BLUE	(+) Analog signal: 4-20 mA (Non-isolated)	Both signals may be used independently
BROWN	(+) Analog signal: 0-10 V (Non-isolated)	

ALSO AVAILABLE



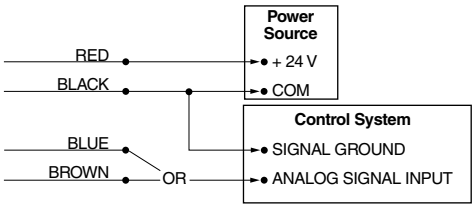
Display Modules



BTU Measurement Systems

F-1110 Wiring Diagram

Flow Meter into Control System (No Display or BTU Meter)

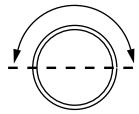


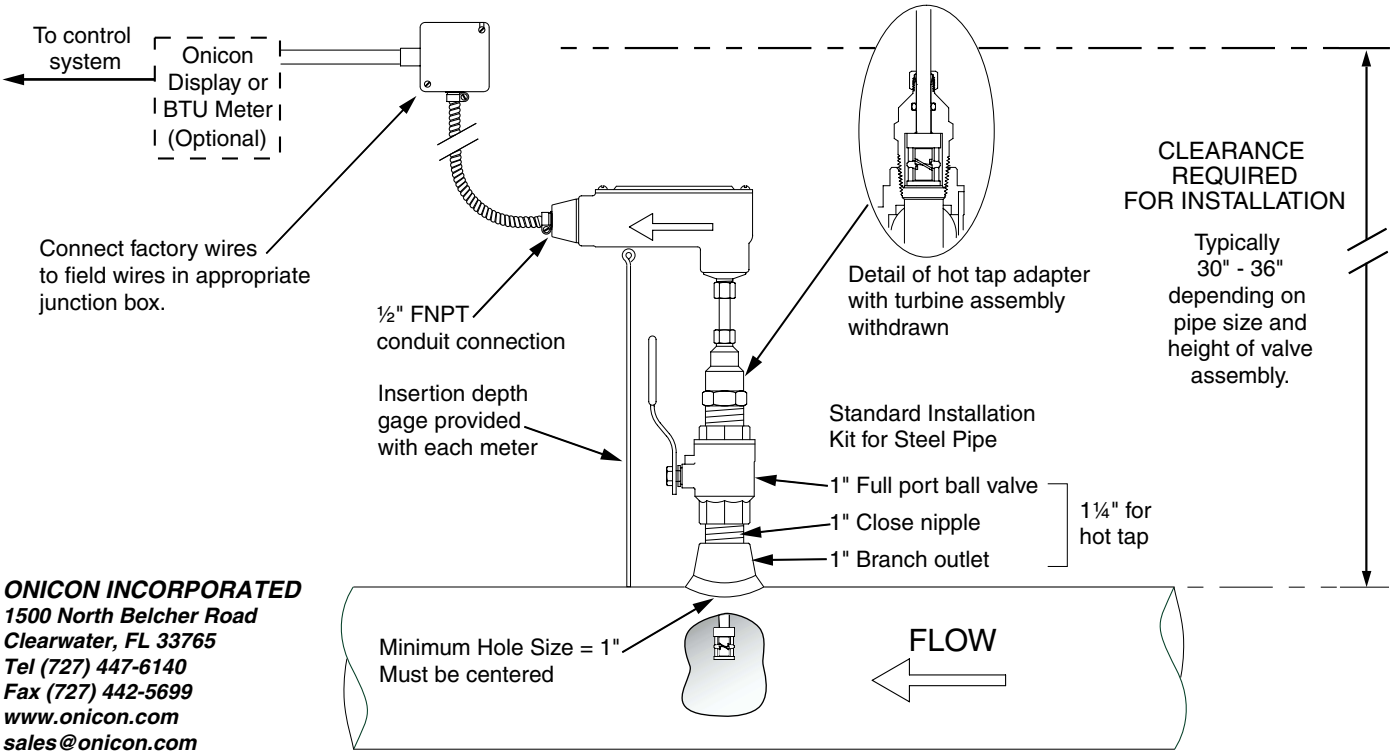
NOTE: 1. Black wire is common with the pipe ground (typically earth ground).
2. Frequency output required for ONICON display module or BTU meter, refer to wiring diagram for peripheral device.

Typical Meter Installation

(New construction or scheduled shutdown)

- Acceptable to install in vertical pipe
- Position meter anywhere in upper 180˚ for horizontal pipe





ONICON INCORPORATED
1500 North Belcher Road
Clearwater, FL 33765
Tel (727) 447-6140
Fax (727) 442-5699
www.onicon.com
sales@onicon.com

Note: Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use "Hot tap" 1¼ inch installation kit and drill hole using a 1 inch wet tap drill.

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Temperature Transducer

Model TE-211/213

FEATURES:

- 4 to 20mA, 0-1VDC, 0-5VDC, 0-10VDC, or 1-50KHz AFCP, and custom output options
- Transducers are available in different housing for space, duct, immersion, duct averaging, remote strap-on probe and outside air applications
- -50°F to +500°F wide operating range
- Custom calibration of temperature range is available

APPLICATIONS:

- Air Ducts
- Outside Air
- Clean Rooms
- Air Handlers
- Computer Centers
- Laboratories
- Office Buildings
- Paper Storage Rooms
- Grain Silos
- Food Processing Plants
- Green Houses
- Environmental Chambers
- Process Control
- Hydraulic Systems

DESCRIPTION:

Signal conditioning is performed by industrial quality integrated circuits to provide a true linear output. The circuit is factory calibrated but zero and span trimmers are provided to adjust the output if necessary. Output accuracy is not affected by long wire runs or electrical noise. The transducer can operate over a wide supply voltage range.

The TE-210 is available in many different housings to cover all applications. For space temperature sensing, the transducer is available in a unique plastic enclosure that has two separate compartments divided by a solid partition. Each compartment is ventilated individually from three sides. One chamber incorporates the electronics and the other the sensing element. In this way there is total isolation between the electronics and the sensor to assure accuracy. For air duct temperature, the sensor is encapsulated in a 1/4 inch OD aluminum or stainless steel probe. The probe protrudes from the bottom of the die cast aluminum transducer housing minimizing lead length error. The probe can be inserted directly into the duct and mounting holes are provided to rigidly support the assembly. TE-210 is also available in a bendable aluminum 3/8 inch OD extra long probe for averaging duct air temperature. The probe incorporates numerous sensors encapsulated at equal distances across the length of the probe. The complete assembly acts as a single sensor and any temperature change is averaged across the sensors. The probe can be easily bent to fit any size duct.

For monitoring water temperature, the TE-210 is available in a die cast aluminum enclosure with a 1/4 inch OD, probe with a brass fitting that can be screwed directly into any thermowell providing a rigid support to the transducer. The TE-210 is also available with a remote probe to be strapped on a pipe or any other application in which high temperatures are encountered. For monitoring outside air temperature the TE-210 is also available in a weather proof enclosure with a suitable sun shield to be mounted outside.

TE-210 is also available with 100 ohm or 1000 ohm precision thin film platinum RTD (±. 1% @0°C), For 100 ohm specify TE-211Y and 1000 ohm specify TE-211Z. Remaining options are the same as TE-210.

ORDERING INFORMATION: TE-210-

ENCLOSURE	PROBE LENGTH	PROBE MATERIAL	THERMOWELL FITTING	SUPPLY VOLTAGE	OUTPUT	RANGE
A) Space	A) 4 inches	1) Aluminum	A) Brass 1/4" NPT	1) 24VDC	A)O-1VDC	1)+50°F-+85°F
B) Duct	B) 6 inches	2) Stainless Steel	B) Brass 1/2" NPT	2) 24VAC	B)0-5VDC	2)+ 40°F-+140 °F
C) Immersion	C) 8 inches	3) Custom	D) Custom	3) 115VAC	C)0-10VDC	3)-30°F-+130°F
D) Duct Avg	D)12 inches			4) 12VDC	D)4-20mA	4)0°F- +100°F
E) RP/SO*	E) 2 inches			5) Custom	E)4-20mA	5)100°F-+250°F
F) OAWP**	F) 6 feet				(2-wire)	6)0°F-+250°F
G) Custom	G) 12 feet				F) 1-50KHz	7)Custom
	H) 24 feet	Note: TE-211Y/TE-2l1Z available for			AFCP	
	1) Custom	24VDC 4-20mA 2-wire loop only.			G) Custom	

*Remote probe or strap-on
**Outside air weather proof

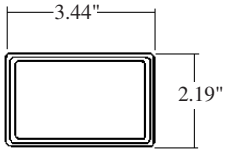
Model TE-210

SPECIFICATIONS:

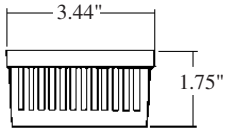
Range:
-50°F - +500°F

Accuracy:
±0.5°F

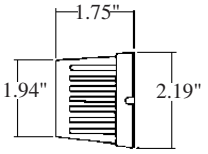
Ambient Temperature:
0-70°C



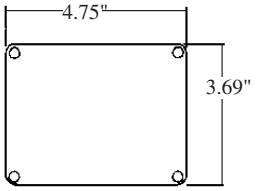
Front View



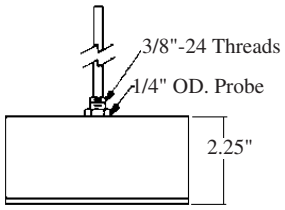
Top View



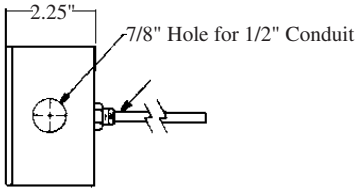
Side View



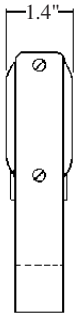
Front View



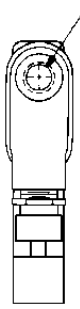
Top View



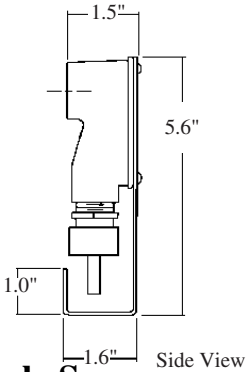
Side View



Front View



Back View



Side View

A Complete Line of Transducers From a Single Source

Space Temperature
Duct Temperature
Outside Temperature
DuctAvg Temp
Strap-On Temp
Remote Temperature
Space Avg Temp
Differential Temp
Space Humidity
Duct Humidity
Outside Humidity

Remote Humidity
Temp & Humidity
Motor Current
Voltage
Pneumatic Pressure
Steam Pressure
Water Pressure
Air Pressure
Duct Static Pres
Bldg Static Pres
Filter Pres Drop

Compressor Head Pres
Compressor Suction
Pres Chiller Head Pres
Chiller Suction Pres
CW Flow
HWFlow
Steam Flow
Gas Flow
Tank Level
Rainfall
Windspeed

Wind Direction
Air Flow
Water Alert
Ambient Light
Outside Light
Damper Control
Mixing Valve Ctrl
Vane Control
Soil Moisture
Local Indication
Setpoint Control

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Advanced Micro Systems
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Allan Bradley
American Auto-Matrix
Andover Controls
AT&T
Atlantic Energy Tech
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Eagle Signal
EDA Sims
Elemco Prime Energy
Encon Systems
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General Electric
Hewlett Packard
Honeywell
HSQ Technology
Hypertek
Johnson Controls
Leviton
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