MEASUREMENT AND VERIFICATION PLAN

FOR

CHP SYSTEM AT
BIRCHWOOD APARTMENTS – THE TOLEDO

April 2015

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1. Introduction

The Toledo is one of three (3) high rise apartment buildings that make up the Birchwood Towers. All together the three towers house a total of 798 one, two and three bedroom apartments. The CHP system being installed includes one 75-kW Aegen TP-75LE unit provided by Aegis Energy Services Inc. The Aegen unit includes a natural gas fired reciprocating engine, a 480 VAC induction generator, and a jacket water and exhaust heat recovery system all housed in a sound attenuating enclosure. The system includes the protective relay built into the panel. The unit is capable of providing 523 MBtu/h of thermal output in the form of hot water, and serves the facilities DHW, space heating, and pool heating loads. The system does include a dump radiator.

Figure 1. Birchwood Apartments – The Toledo Cogen Unit

PUMP SCHEDULE

PUMP NO.	SERVICE	FLOW	HEAD	H.P	PHASE	MODEL
P-1	COGEN MODULE	25 GPM	70 FT	3/4	3	BELL & GOSSETT SERIES 1535 3S3T
P-2	DHW LOOP	30 GPM	15 FT	1/6	1	BELL & GOSSETT PL-45B
P-3	BUILDING LOOP	30 GPM	33 FT	3/4	3	BELL & GOSSETT SERIES 60 6I3T
P-4	GLYCOL LOOP	30 GPM	33 FT	3/4	3	BELL & GOSSETT SERIES 60 6I3T
P-9	POOL LOOP	15 GPM	23 FT	1/6	1	BELL & GOSSETT PL-45

CONTROL VALVE SCHEDULE

VALVE NO.	SERVICE	FLOW TYPE	SIZE	VOLTAGE	VALVE MODEL	ACTUATOR
V-1	COGEN DHW	MIXING	1 1/2"	24 V	TAC VS2313-526-9-54	MS40-7043M MODULATING
V-2	TANK BYPASS	MIXING	2"	24 V	TAC VA2213-528-9-67	MA40-7043 ON/OFF
V-3	BUILDING HEAT	MIXING	1 1/2"	24 V	TAC VS2313-526-9-54	MS40-7043M MODULATING
V-9	POOL HEAT	MIXING	1 1/2"	24 V	TAC VS2313-526-9-54	MS40-7043M MODULATING

NOTES:

1. ALL EXISTING DHW SYSTEM & PIPING TO REMAIN.
2. EXISTING STEAM SYSTEM TO REMAIN UNCHANGED.

HEAT EXCHANGER HX-1

DESIGN MANUFACTURER	API HEAT TRANSFER
MODEL	SBM7M-40
TYPE	BRAZED PLATE
MATERIAL	COPPER
SERVICE	DHW

SIDE	HOT	COLD
FLUID TYPE	WATER	WATER
FLUID FLOW	22 GPM	30 GPM
TEMPERATURE IN	225 DEG F	172 DEG F
TEMPERATURE OUT	176 DEG F	207 DEG F
PRESSURE DROP	0.91 PSI	1.55 PSI
INLET SIZE	2" NPT	2" NPT

HEAT EXCHANGER HX-2

DESIGN MANUFACTURER	API HEAT TRANSFER
MODEL	SBM7M-40
TYPE	BRAZED PLATE
MATERIAL	COPPER
SERVICE	BOILER HEAT

SIDE	HOT	COLD
FLUID TYPE	WATER	WATER
FLUID FLOW	22 GPM	30 GPM
TEMPERATURE IN	225 DEG F	165 DEG F
TEMPERATURE OUT	176 DEG F	190 DEG F
PRESSURE DROP	0.77 PSI	2.71 PSI
INLET SIZE	2" NPT	2" NPT

HEAT EXCHANGERS HX-3

DESIGN MANUFACTURER	API HEAT TRANSFER
MODEL	SBM7M-40
TYPE	BRAZED PLATE
MATERIAL	COPPER
SERVICE	DUMP RADIATOR

SIDE	HOT	COLD
FLUID TYPE	WATER	WATER
FLUID FLOW	22 GPM	30 GPM
TEMPERATURE IN	225 DEG F	172 DEG F
TEMPERATURE OUT	179 DEG F	207 DEG F
PRESSURE DROP	0.91 PSI	1.71 PSI
INLET SIZE	2" NPT	2" NPT

DUMP RADIATOR HX-4

DESIGN MANUFACTURER	IEA OR EQUAL
FLOW RATE	30 GPM
GROSS HEAT LOAD	523,000 BTU/HR
INLET LIQUID TEMP	196 DEG F
OUTLET LIQUID TEMP	160 DEG F
BLOWER FAN POWER	2 HP PER MOTOR
NUMBER FANS	1
MODEL NUMBER	HCR-M-14-02-08-S02
FAN SPEED	1160 RPM
LIQUID MEDIUM	40% PROP. GLYCOL
DRY WEIGHT	575 LBS

TEMPERATURE SENSOR SCHEDULE

TS NO.	SERVICE	MODEL	WELL TYPE
TS-1	COGEN SUPPLY	MAMAC TE-703-C-5A	AT-225
TS-1N	COGEN SUPPLY (CDH ONLY)	BADGER 380	AT-225
TS-2	DHW TO POOL	MAMAC TE-703-C-5A	AT-225
TS-9	POOL SUPPLY	MAMAC TE-703-C-5A	AT-225
TS-3	POOL TO DUMP	MAMAC TE-703-C-5A	AT-225
TS-3N	POOL TO DUMP (CDH ONLY)	BADGER 380	AT-225
TS-4	COGEN RETURN	MAMAC TE-703-C-5A	AT-225
TS-4N	COGEN RETURN (CDH ONLY)	VERIS TIDB1DO	AT-225
TS-11	DHW TANK TO HX1	MAMAC TE-703-C-5A	AT-225
TS-12	DHW HX1 TO TANK	MAMAC TE-703-C-5A	AT-225
TS-13	DHW TANK SUPPLY TEMP	MAMAC TE-703-C-5A	AT-225
TS-21	SPACE TO HX2	MAMAC TE-703-C-5A	AT-225
TS-22	HX2 TO SPACE	MAMAC TE-703-C-5A	AT-225
TS-91	POOL TO HX-9	MAMAC TE-703-C-5A	AT-225
TS-92	HX-9 TO POOL	MAMAC TE-703-C-5A	AT-225
TS-31	RADIATOR TO HX3	MAMAC TE-703-C-5A	AT-225
TS-32	HX3 TO RADIATOR	MAMAC TE-703-C-5A	AT-225
TS-10	OUTSIDE AIR	MAMAC TE-205-F-5	

COGENERATION SCHEDULE

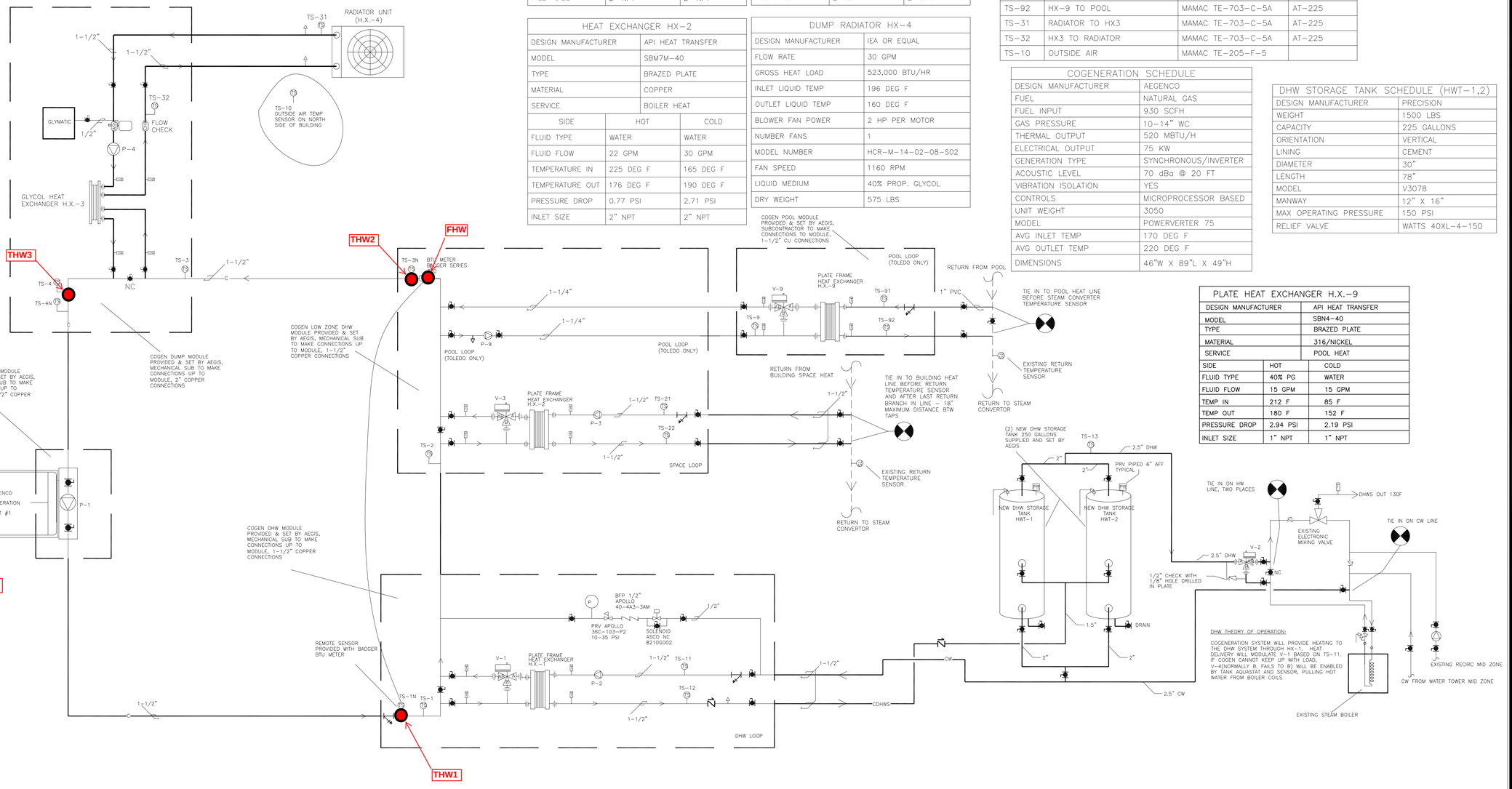
DESIGN MANUFACTURER	AEGENCO
FUEL	NATURAL GAS
FUEL INPUT	930 SCFH
GAS PRESSURE	10-14" WC
THERMAL OUTPUT	520 MBTU/H
ELECTRICAL OUTPUT	75 KW
GENERATION TYPE	SYNCHRONOUS/INVERTER
ACOUSTIC LEVEL	70 dBa @ 20 FT
VIBRATION ISOLATION	YES
CONTROLS	MICROPROCESSOR BASED
UNIT WEIGHT	3050
MODEL	POWERVERTER 75
AVG INLET TEMP	170 DEG F
AVG OUTLET TEMP	220 DEG F
DIMENSIONS	46"W X 89"L X 49"H

DHW STORAGE TANK SCHEDULE (HWT-1,2)

DESIGN MANUFACTURER	PRECISION
WEIGHT	1500 LBS
CAPACITY	225 GALLONS
ORIENTATION	VERTICAL
LINING	CEMENT
DIAMETER	30"
LENGTH	78"
MODEL	V3078
MANWAY	12" X 16"
MAX OPERATING PRESSURE	150 PSI
RELIEF VALVE	WATTS 40XL-4-150

PLATE HEAT EXCHANGER H.X.-9

DESIGN MANUFACTURER		API HEAT TRANSFER
MODEL		SBN4-40
TYPE		BRAZED PLATE
MATERIAL		316/NICKEL
SERVICE		POOL HEAT
SIDE	HOT	COLD
FLUID TYPE	40% PG	WATER
FLUID FLOW	15 GPM	15 GPM
TEMP IN	212 F	85 F
TEMP OUT	180 F	152 F
PRESSURE DROP	2.94 PSI	2.19 PSI
INLET SIZE	1" NPT	1" NPT



1 M-001

COGENERATION MECHANICAL FLOW DIAGRAM (TYPICAL TOLEDO & KYOTO)

SCALE: NTS

NO.	DATE	REVISION DESCRIPTION
1	11-19-13	MINOR REVISIONS, ADDED POOL HT

PROJECT LOCATION MAP

TRUE NORTH — PROJECT NORTH

CLIENT:

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FAX: 413-536-1104
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ALL DRAWINGS ARE TO BE READ NOT SCALED.

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PROJECT

BIRCHWOOD APARTMENTS
COGENERATION PROJECT
102-10 & 102-30 66TH RD
NEW YORK, NY 11375

DRAWING TITLE:

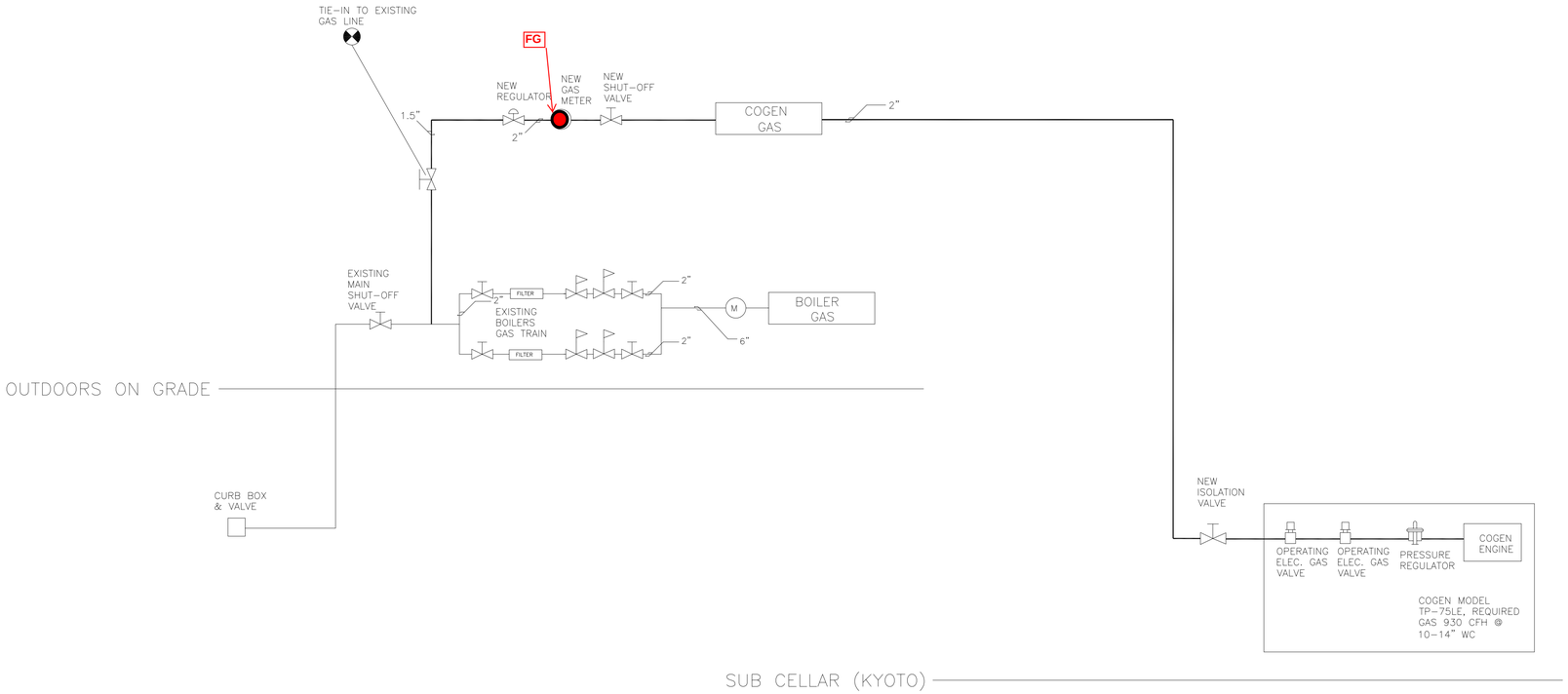
HVAC SCHEDULES/ FLOW DIAGRAM

DESIGN BY:	SP	DATE:	6/25/13
DRN BY:	SP	DATE:	10/7/13
CKD BY:		DATE:	
FINAL CKD BY:		DATE:	
SCALE:	AS NOTED	DATE:	
DWG No.	PAGE 3 OF 16		

M-001.01

PROJECT NO. 60-008

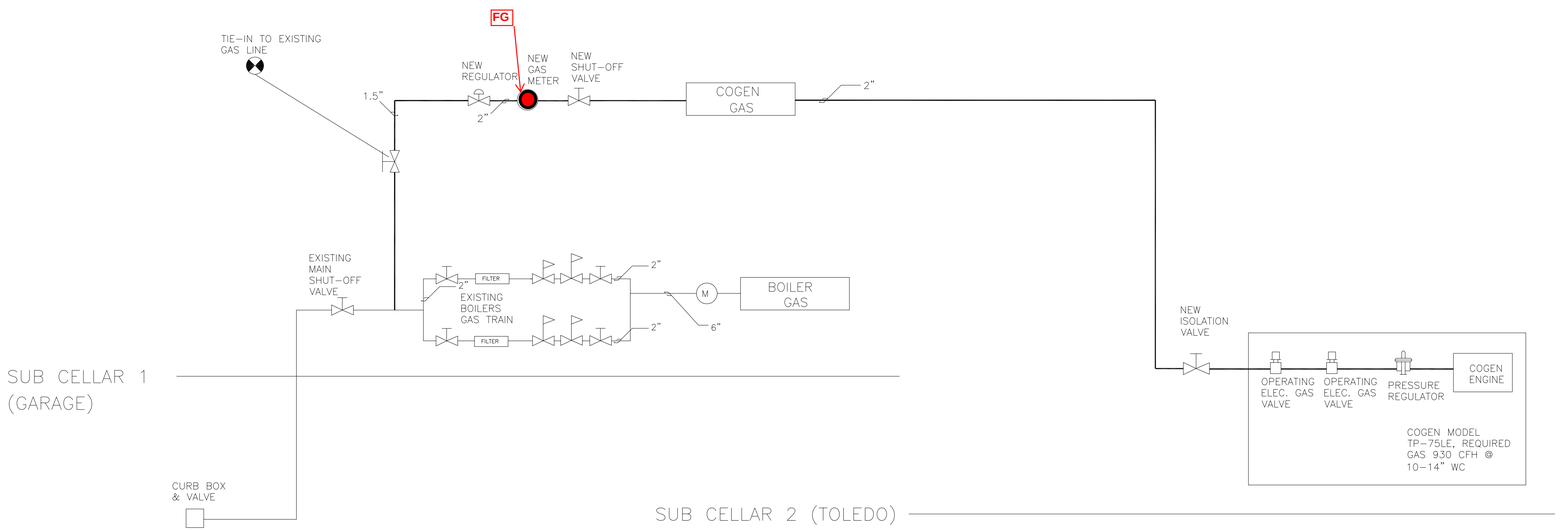
B-SCAN:



1 P-003

COGENERATION GAS RISER - KYOTO PARTIAL PLAN

SCALE: NTS



2 P-003

COGENERATION GAS RISER - TOLEDO PARTIAL PLAN

SCALE: NTS

NO.	DATE	REVISION DESCRIPTION
1	11-19-13	MINOR REVISIONS, ADDED POOL HT

PROJECT LOCATION MAP

TRUE NORTH

PROJECT NORTH

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B E P C

STATE OF NEW YORK · JOHN C. BECKER · LICENSED PROFESSIONAL ENGINEER · KYOTO

PROJECT

BIRCHWOOD APARTMENTS
COGENERATION PROJECT
102-10 & 102-30 66TH RD
NEW YORK, NY 11375

DRAWING TITLE:

PLUMBING RISER DIAGRAMS, KYOTO & TOLEDO

DESIGN BY:	SP	DATE:	6/25/13
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FINAL CKD BY:		DATE:	
SCALE:	AS NOTED	DATE:	
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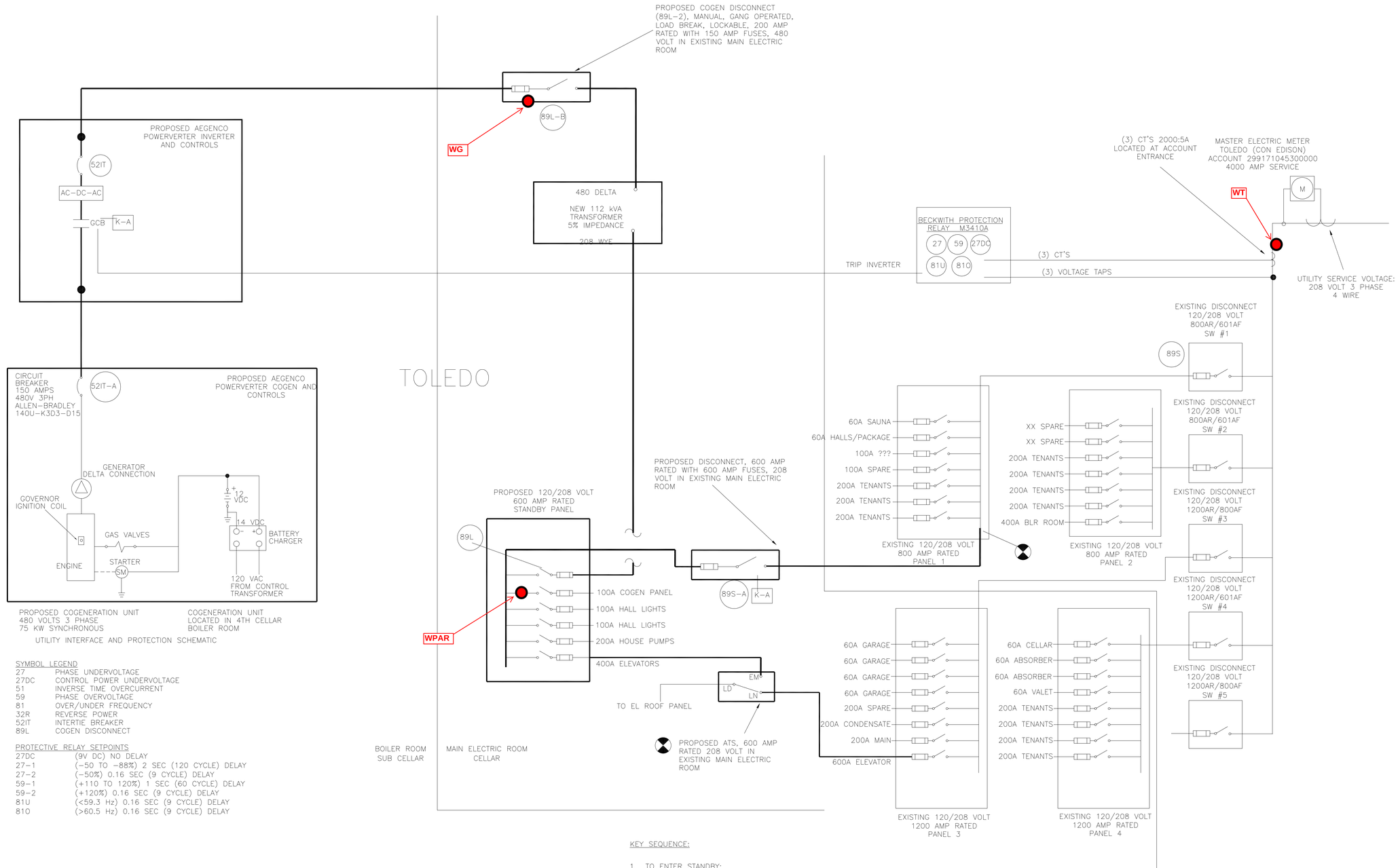
P-003.01

PROJECT NO.
60-008

B-SCAN:



UTILITY INTERFACE AND PROTECTION SCHEMATIC

SYMBOL LEGEND

27	PHASE UNDERVOLTAGE
27DC	CONTROL POWER UNDERVOLTAGE
51	INVERSE TIME OVERCURRENT
59	PHASE OVERVOLTAGE
81	OVER/UNDER FREQUENCY
32R	REVERSE POWER
52IT	INTERTIE BREAKER
89L	COGEN DISCONNECT

PROTECTIVE RELAY SETPOINTS

27DC	(9V DC) NO DELAY
27-1	(-50 TO -88%) 2 SEC (120 CYCLE) DELAY
27-2	(-50%) 0.16 SEC (9 CYCLE) DELAY
59-1	(+110 TO 120%) 1 SEC (60 CYCLE) DELAY
59-2	(+120%) 0.16 SEC (9 CYCLE) DELAY
81U	(<59.3 Hz) 0.16 SEC (9 CYCLE) DELAY
81O	(>60.5 Hz) 0.16 SEC (9 CYCLE) DELAY

KEY SEQUENCE:

1. TO ENTER STANDBY:
   - 1.1. OPEN BREAKER 89S-2, TURN K-A TO LOCK 89S-B OPEN & REMOVE K-A.
   - 1.2. INSERT K-A INTO LOCK ON INVERTER AND TURN TO ENABLE STANDBY OPERATION. K-A IS NOW CAPTURED.
   - 1.3. USE THE "ALARM RESET" BUTTON TO CLEAR THE ALARM ON THE INVERTER.
   - 1.4. THE MACHINE WILL START AUTOMATICALLY
2. TO RETURN TO PARALLEL OPERATION:
   - 2.1. TURN K-A ON INVERTER AND REMOVE KEY TO DISABLE STANDBY OPERATION.
   - 2.2. INSERT K-A INTO LOCK HOLDING 89S-2 OPEN AND TURN KEY TO WITHDRAW BOLT.
   - 2.3. CLOSE 89S-B. K-A IS NOW CAPTURED
   - 2.4. GENERATOR WILL CONNECT AFTER A 300 SECOND DELAY.

1 / E-006 SITE ELECTRICAL ONE-LINE DIAGRAM - TOLEDO

SCALE: NTS

NO.	DATE	REVISION DESCRIPTION
1	11-19-13	MINOR REVISIONS, ADDED POOL HT

PROJECT LOCATION MAP

TRUE NORTH / PROJECT NORTH

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PROJECT

BIRCHWOOD APARTMENTS
COGENERATION PROJECT
102-10 & 102-30 66TH RD
NEW YORK, NY 11375

DRAWING TITLE:

ELECTRICAL ONELINE DIAGRAM - TOLEDO

DESIGN BY:	SP	DATE:	6/25/13
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FINAL CKD BY:		DATE:	
SCALE: AS NOTED		DATE:	
DWG No.	PAGE 15 OF 16		

E-006.01

PROJECT NO. 60-008

B-SCAN:

2. Monitoring System

A monitoring system will be installed to measure the performance of the CHP system. The system will be based around an Obvius AquiSuite data logger. Aegis is installing the majority of the metering and contracted CDH Energy to provide and install the monitoring system. The cogen unit, controls, metering equipment, and data logger are all located in the sub-basement boiler room. The monitored points recommended to quantify performance are listed in Table 1.

Table 1. Monitored Data Points

No.	Input	Data Point	Description	Units	Sensor
1	MB-002	WT	Total Facility Power	kW/kWh	Veris E50 C2 with MV Rope CTs
2	MB-001	WG	Gross Generator Power	kW/kWh	Veris H8035-0300-3
3	MB-003	WPAR	Parasitic Power	kW/kWh	Veris H8035-0100-2
4	IN1	FG	Generator Gas Use	CF	Utility pulse output from billing meter
5	IN2	THW1	Supply Temperature from Cogen Unit	deg F	Veris TID B1 D0 10k Type II thermisor
6	MB-004	QU_METER	Useful Heat Recovery - BTU Meter Calculated	Mbtu	Badger 380 BTU meter
7	MB-004	THW2	Temperature Between Useful HXs and Dump HX	deg F	
8	MB-004	THW3	Return Temperature to Cogen Unit	deg F	
9	MB-004	FHW	Flowrate CHP Loop	GPM	
10	-	QU	Useful Heat Recovery	Mbtu	Calculated Point
11	-	QR	Heat Rejection to Cooling Tower	Mbtu	Calculated Point
12	-	TAO	Ambient Temperature	deg F	NWS Station

The rejected heat recovery from the system **(QR)** is calculated by the temperature and flow measurements provided by the BTU Meter **(FHW, THW2, and THW3)**. The temperature sensors for the BTU Meter are being installed before and after the dump radiator HX. The useful heat recovery (space heating, DHW, and pool heating) can be calculated using one of the BTU meters temperature sensors, the BTU meter flow, and the additional temperature sensor (**FHW, THW1, and THW2)**.

The generator gross power output **(WT)** will be measured inside the 208 V panel located on the opposite side of the boiler room of the cogen unit. The systems parasitic loads will be measured with a dedicated power meter **(WP)** in the 208 V panel located on the back side of the pillar the CDH enclosure is mounted. The total facility power will also be monitored by a third power meter (**WT**), located up a level in the basement electrical room. Natural gas to the system **(FG)** is measured on the pipe directly in line with the cogen unit. The meter is located in the parking garage on the basement level.

Sensor Details

- ***BTU Meter.*** Badger Series 380 BTU Meter
- ***Temperature***. Two (2) RTD's and one (1) 10K Type II Thermistor
- ***Water Flow***. Badger Series 380 BTU Meter

- ***Gas Flow***. Utility Gas Meter
- ***Power***
    - *Gross Generator* – Veris H8035-0300 Power Meter
    - *Parasitic* – Veris H8035-0100 Power Meter
    - *Total Facility* – Veris E50 Power Meter

Data Logging System

CDH Energy will provide, install, and wire an Obvius AcquiSuite data logger. All field sensors will be terminated to the AcquiSuite. The AcquiSuite will utilize a port on a router or switch (DHCP or Static IP, to be provided by Aegis) to send data nightly to the CDH server. 110 VAC power and CAT 5 cable to be provided to the data logger enclosure by Aegis.

3. Data Analysis

Heat Recovery Rates

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

QU – Useful Heat Recovery $$QU_{avg} = k \cdot \frac{1}{N} \sum_{j=1}^{N} FHW \cdot (THW1_j - THW2_j)$$

QR – Rejected Heat Recovery $$QR_{avg} = k \cdot \frac{1}{N} \sum_{j=1}^{N} FHW \cdot (THW2_j - THW3_j)$$

Where N = 15 when converting from 1-minute to 15-minute data. K is the product of density and specific heat. The loop fluid is expected to be water or water with some glycol. For instance the factor *k* is equal to:

30% glycol: k_{gly} = 466.6 Btu/h·gpm·°F at 180ºF
pure water: k_{water} = 487.8 Btu/h·gpm·°F at 180ºF

Other Calculated Quantities

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

WNET = WG - WP

The fraction of parasitic losses (which is typically 3-5%) is defined as

$$f_{para} = \frac{WP}{WG}$$

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

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

where:

QU_{avg}	-	Useful heat recovery (MBtu/h)
WNET	-	Net Generator output (kWh)
FG	-	Generator gas consumption (Std CF)
Δt	-	0.25 hour for 15-minute data
HHV_{gas}	-	Higher heating value for natural gas (1.032 MBtu per CF [1])

[1] HHV from www.eia.doe.gov : Heat Content of Natural Gas for Massachusetts

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

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

Table 2. Summary of Efficiency Calculations

	NET (using net power)	**GROSS (using generator output)**
Electrical Efficiency (EE)	$\frac{3.412 \cdot (WNET)}{HHV_{gas} \cdot FG}$	$\frac{3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$
Thermal Efficiency (THE)	$\frac{QU \cdot \Delta t}{HHV_{gas} \cdot FG}$	
Total Efficiency (TE)	$\frac{QU \cdot \Delta t + 3.412 \cdot (WNET)}{HHV_{gas} \cdot FG}$	$\frac{QU \cdot \Delta t + 3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$
Unit Efficiency (UE)	$\frac{(QU + QR) \cdot \Delta t + 3.412 \cdot (WNET)}{HHV_{gas} \cdot FG}$	$\frac{(QU + QR) \cdot \Delta t + 3.412 \cdot (WT)}{HHV_{gas} \cdot FG}$

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

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

Appendix A - Data Sheets

Obvius Aquisuite A8810

Veris E50 C2 Power Meter

Veris H8035-XXX

Badger Series 380 BTU Meter

MAMAC 10k Type 2 Thermistor

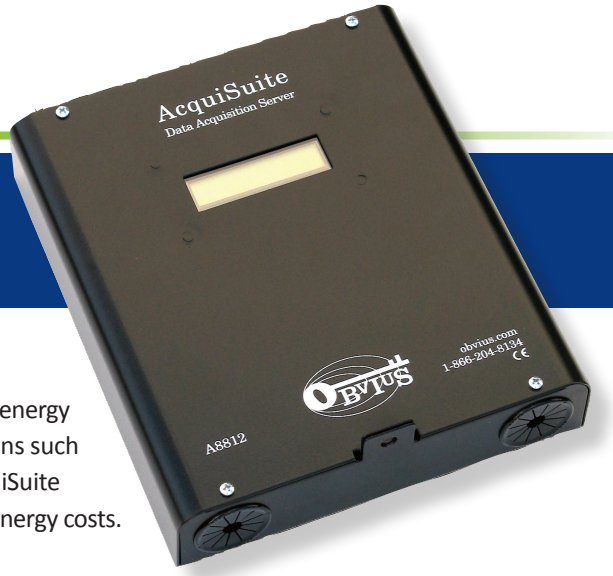
PRODUCT DATASHEET

obvius

Energy Information Made Obvius

AcquiSuite

Data Acquisition Server



ACQUISUITE A8812-1 AND A8812-GSM

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

DATA COLLECTION

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

INSTALLATION & FEATURES

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

COMPATIBILITY

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

PARTNERS

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

APPLICATIONS

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

ABOUT OBVIUS

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

SOLUTIONS

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

HEADQUARTERS

Tualatin, Oregon

CONTACT US

sales@obvius.com

AcquiSuite A8812

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

Specifications	
Processor	ARM9 embedded CPU, ARM7 IO co-processor
Operating System	Linux 2.6
Memory	32 MB RAM
Flash ROM	16 MB NOR Flash (expandable with USB memory device)
Interval Recording	1 to 60 minutes, user selectable
LEDs	8x input, 4 modem activity, Modbus TX/RX, power, system, IO status
Console	2 x 16 LCD character, two push buttons
Power	
North America	110-120VAC, 60Hz, primary
CE/Europe	100-240VAC, 50-60Hz, primary (interchangeable plug adapters optional)
Power Supply	24VDC, 1A, class 2 wall brick transformer included
Communication	
Protocols	Modbus/RTU, Modbus/TCP, TCP/IP, PPP, HTTP/HTML, FTP, NTP, XML, SNMP-Trap
LAN	RJ45 10/100 Ethernet, full half duplex, auto polarity
Modem	V.34 bis, 33,600 bps (A8812-1 only)
Cellular	GSM/GPRS Cellular (A8812-GSM only)
USB	USB expansion port
Inputs	
Serial Port	RS-485 Modbus, supports up to 32 external devices (expandable)
I/O	8x Flex IO inputs with user selectable modes: voltage, current, resistance, pulse and status
Outputs	
Relays	2x, dry contact 30 VDC, 150 mA max
Physical	
Weight	5lbs (2.3kg)
Size	8" x 9.25" x 2.5" (203mm x 235mm x 64mm)
Environment	
North America	0 to 50C, 0-90% RH, non-condensing
CE/Europe	5 to 40C, 0-90% RH, non-condensing
Codes and Standards	
FCC CFR 47 Part 15, Class A, EN 61000, EN 61326, CE	
Additional Notes	
NEMA enclosures available upon request	
Manufactured in the USA	

CE

obvius

Obvius
20497 SW Teton Avenue
Tualatin, OR 97062

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

Power Monitoring Single-circuit

Enercept® Networked Power Transducers (Modbus® RTU)

H8035 & H8036 Series

H8035/H8036

BACnet Connectivity Via New E8951 Gateway

U.S. Patent No. 6,373,238

SPECIFICATIONS

5 Year Warranty

Agency Approvals	UL508
INPUTS	
Voltage Input	208 to 480VAC, 50/60 Hz RMS [1, 2, 3]
Current Input	Up to 2400A continuous per phase [2, 3]
ACCURACY	
System Accuracy	±1% of reading from 10% to 100% of the rated current of the CTs, accomplished by matching the CTs with electronics & calibrating them as a system
OUTPUTS	
Type	Modbus RTU [4, 5]
Baud Rate	9600, 8N1 format
Connection	RS-485, 2-wire + shield
ENVIRONMENTAL	
Operating Temp Range	0° to 60°C (32° F to 140°F), 50°C (122°F) for 2400A
Humidity Range	0 - 95% noncondensing; indoor use only

Approved for California CSI Solar applications (check the CSI website for model numbers).

1. Do not install on the line or load side of a VFD unit, or on any other equipment generating harmonics. For line side applications, use the E5x Series meters.

2. Contact factory to interface for voltages above 480VAC or current above 2400 Amps.

3. Do not apply 600V Class current transformers to circuits having a phase-to-phase voltage greater than 600V, unless adequate additional insulation is applied between the primary conductor and the current transformers. Veris assumes no responsibility for damage of equipment or personal injury caused by products operated on circuits above their published ratings.

4. Detailed protocol specifications are available at: http://www.veris.com/modbus

5. Modbus TCP, BACnet MS/TP, BACnet IP and LON TP/FT-10 protocols available via accessories.

Integral Monitoring Solution Eliminates the Need for Separate Enclosures

FEATURES

- *Revenue Grade measurements*
- *Precision electronics and current transformers in a single package...reduces the number of installed components... creating significant labor savings*
- *Monitor energy parameters (kW, kWh, kVAR, PF, Amps, Volts) at up to 63 locations on a single RS-485 network...greatly reduces wiring time and cost*
- *Fast split-core installation virtually eliminates the need to remove conductors...saves time and labor*
- *Smart electronics virtually eliminate CT orientation concerns...fast trouble-free installation*
- *CSI approved...eases submission process for California Solar Initiative*

APPLICATIONS

- *Energy managment and performance contracting*
- *Monitoring for commercial tenants*
- *Activity-based costing in commercial and industrial facilities*
- *Real-time power monitoring*
- *Load shedding*

DESCRIPTION

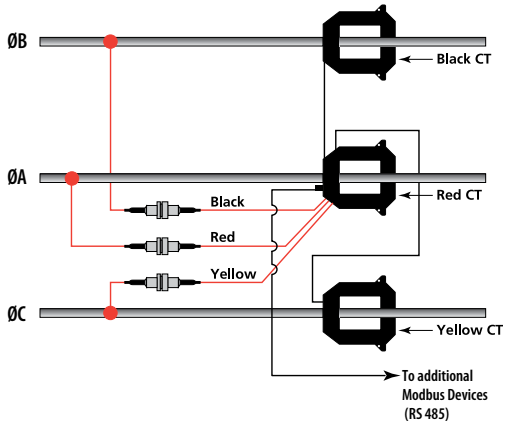
The **Enercept H8035 and H8036 Series** are innovative three-phase networked (Modbus RTU) power transducers that combine measurement electronics and high accuracy industrial grade CTs in a single package. The need for external electrical enclosures is eliminated, greatly reducing installation time and cost.

There are two application-specific platforms to choose from. The Basic Enercept energy transducers (H8035) are ideal for applications where only kW and kWh are required. The Enercept Enhanced power transducers (H8036) output 26 variables including kW, kWh, volts, amps, and power factor, making them ideal for monitoring and diagnostics.

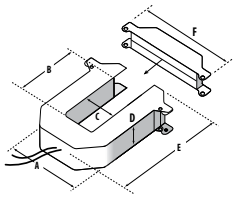
Color-coordination between voltage leads and CTs makes phase matching easy. Additionally, the Enercept automatically detects and compensates for phase reversal, virtually eliminating the concern of CT load orientation. Up to 63 Enercepts can be daisy-chained on a single RS-485 network.

WIRING DIAGRAMS

208 or 480VAC 3Ø, Installation

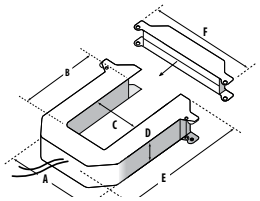


240VAC 1Ø, 3-Wire Installation



SMALL
100/300 Amp

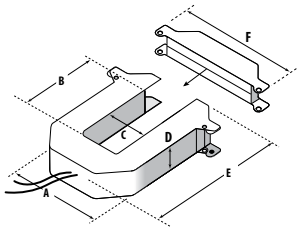
A =	3.8"	(96 mm)
B =	1.2"	(30 mm)
C =	1.3"	(31 mm)
D =	1.2"	(30 mm)
E =	4.0"	(100 mm)
F =	4.8"	(121 mm)



MEDIUM
400/800 Amp

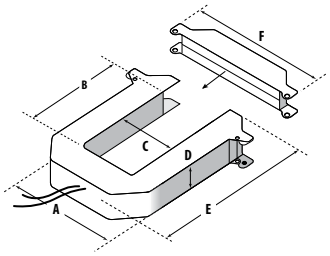
A =	4.9"	(125 mm)
B =	2.9"	(73 mm)
C =	2.5"	(62 mm)
D =	1.2"	(30 mm)
E =	5.2"	(132 mm)
F =	6.0"	(151 mm)

DIMENSIONAL DRAWINGS



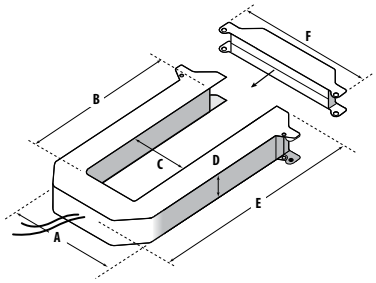
SMALL
100/300 Amp

A =	3.8"	(96 mm)
B =	1.2"	(30 mm)
C =	1.3"	(31 mm)
D =	1.2"	(30 mm)
E =	4.0"	(100 mm)
F =	4.8"	(121 mm)



MEDIUM
400/800 Amp

A =	4.9"	(125 mm)
B =	2.9"	(73 mm)
C =	2.5"	(62 mm)
D =	1.2"	(30 mm)
E =	5.2"	(132 mm)
F =	6.0"	(151 mm)



LARGE
800/1600/2400 Amp

A =	4.9"	(125 mm)
B =	5.5"	(139 mm)
C =	2.5"	(62 mm)
D =	1.2"	(30 mm)
E =	7.9"	(201 mm)
F =	6.0"	(151 mm)

DATA OUTPUTS

H8035	*H8036*
kWh	*kWh, Consumption*
kW	*kW, Real Power*
	kVAR, Reactive Power
	kVA, Apparent Power
	Power Factor
	Average Real Power
	Minimum Real Power
	Maximum Real Power
	Voltage, L-L
	*Voltage, L-N**
	Amps, Average Current

**Based on derived neutral voltage.*

ORDERING INFORMATION

c UL us LISTED

*Modbus Basic Power Transducers**

MODEL	MAX. AMPS	CT SIZE
H8035-0100-2	100	SMALL
H8035-0300-2	300	SMALL
H8035-0400-3	400	MEDIUM
H8035-0800-3	800	MEDIUM
H8035-0800-4	800	LARGE
H8035-1600-4	1600	LARGE
H8035-2400-4	2400	LARGE

**H8035 models work with H8920-5 LON nodes*

*Modbus Enhanced Data Stream Power Transducers**

MODEL	MAX. AMPS	CT SIZE
H8036-0100-2	100	SMALL
H8036-0300-2	300	SMALL
H8036-0400-3	400	MEDIUM
H8036-0800-3	800	MEDIUM
H8036-0800-4	800	LARGE
H8036-1600-4	1600	LARGE
H8036-2400-4	2400	LARGE

**H8036 models work with H8920-1 LON nodes*

ACCESSORIES

LON Gateway (H8920)
CT Mounting brackets (AH06)
Modbus-to-BACnet Converter (E8951)
Modbus TCP Gateway (U013-0013 or U013-0015)

H8920 Series

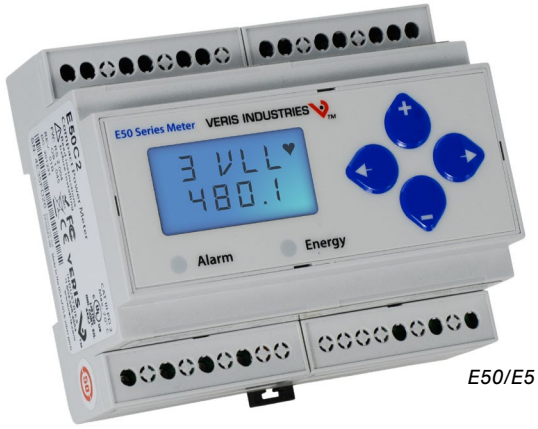
U013-0012

AH06

E8951

Enhanced Power and Energy Meter

E5x Series



E50/E51

Versatile Energy Monitoring Solution

FEATURES

- *Revenue Grade measurements*
- *High reliability with ANSI C12.20 0.2% accuracy, IEC 62053-22 Class 0.2S on E5xxx*
- *DIN rail or screw mounting options...easy installation*
- *Real energy output and phase loss alarm output on E50Bx and E5xCx models...one device serves multiple applications*
- *90-600VAC...application versatility with fewer models to stock*
- *Data logging capability (E5xC3 and E5xx5)... ensures long term data retrieval and safeguards during power failures*
- *Compatible with CTs from 5A to 32000A...wide range of service types*
- *User-enabled password protection...protect from tampering*
- *System integration via Modbus (E5xCx), BACnet MS/TP (E5xHx), or Lonmark-certified LON FT (E50Fx)...convenient compatibility with existing systems*
- *Native BACnet MS/TP support (no gateway) with serial rates up to 115.2 kbaud (E5xHx)*
- *BTL-certified (E5xH2)*
- *E51 models: Bi-directional metering (4-quadrant), an essential solution for solar and other renewable energy applications, measures Import, Export and net energy transfer*
- *CSI approved...eases submission process for California Solar Initiative*
- *E51Cx includes SunSpec compliant common and meter register blocks*

APPLICATIONS

- *Energy monitoring in building automation systems*
- *Renewable energy*
- *Energy management*
- *Commercial submetering*
- *Industrial monitoring*
- *Cost allocation*

SPECIFICATIONS

5 Year Warranty

Agency Approvals	UL508 (Open Type Device), EN61010-1, California CSI Solar, ANSI C12.20, Cat III, pollution degree 2
INPUTS	
Control Power, AC	50/60 Hz; 5VA max.; 90V min.; UL Maximums: 600V L-L (347V L-N); CE Maximum: 300V L-N
Control Power, DC	3W max.; UL and CE: 125 to 300VDC (external DC current limiting required)
Voltage Input	UL: 90V L-N to 600V L-L ; CE: 90V L-N to 300V L-N
CURRENT INPUT	
Scaling	5A to 32,000A
Input Range	0 to 0.333V or 0 to 1V (selectable) CTs must be rated for use with Class 1 voltage inputs
Pulse Inputs *E5xHx & E50Fx only*	Contact inputs to pulse accumulators (one set with E5xH2 and E50F2; two sets with E5xH5 and E51F5)*
ACCURACY	
Real Power & Energy	0.2% (ANSI C12.20, IEC 62053-22 Class 0.2S)
OUTPUTS	
E50B1 & E5xCx	Real Energy Pulse: N.O. static**; Alarm contacts: N.C. static**
E50Bx	Reactive energy pulse 30VAC**
E5xCx	RS-485 2-wire Modbus RTU (1200 baud to 38.4 kbaud)
E5xHx	RS-485 2-wire BACnet MS/TP (9600 baud to 115.2 kbaud)
E50Fx	2-wire LON FT
MECHANICAL	
Mounting	DIN Rail or 3-point screw mount
ENVIRONMENTAL	
Altitude of Operation	3000 m
Operating Temp Range	-30° to 70°C (-22° to 158°F)
Storage Temp Range	-40° to 85°C (-40° to 185°F)
Humidity Range	<95% RH noncondensing; indoor use only

**10kΩ VAC/DC to 4-10VDC*
***30VAC/DC, 100mA max. (AC: 50/60Hz)*

DESCRIPTION

The **E5x Series** DIN Rail Meter combines exceptional performance and easy installation to deliver a cost-effective solution for power monitoring applications. The E5x can be installed on standard DIN rail or surface mounted as needed. The Modbus, LON, and BACnet output models offer added flexibility for system integration. The data logging capability (E5xC3 and E5xx5) protects data in the event of a communications or power failure elsewhere in the system. Combinations of serial communication, pulse output, and phase alarms are provided to suit a wide variety of applications. Additional pulse inputs on E5xHx and E50Fx provide an easy way to incorporate simple flow sensors to track gas, water, steam, or other energy forms using a BACnet or LON system.

The E51 models add a bi-directional monitoring feature designed expressly for renewable energy applications, allowing measurement of power imported from the utility grid as well as power exported from the renewable energy source (e.g. solar panels). In this way, a facility administrator can track all energy data, ensuring accuracy in billing and crediting. They are also useful for monitoring loads that use regenerative braking.

ORDERING INFORMATION

E51Cx only

E5xH2 only

E50Fx only

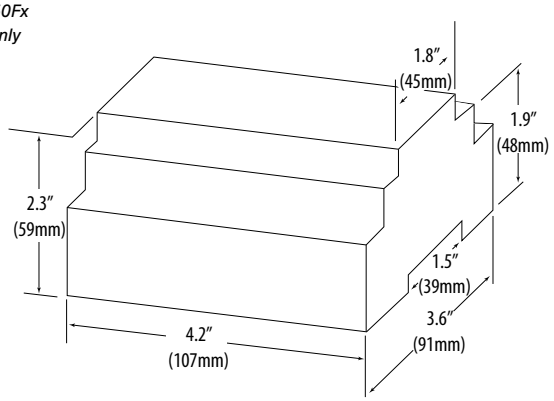
	E50B1	E50C2	E50C3	E50F2	E50F5	E50H2	E50H5	E51C2	E51C3	E51H2	E51H5
MEASUREMENT CAPABILITY - FULL DATA SET											
Bi-directional Energy Measurements								●	●	●	●
Power (3-phase total and per phase): Real (kW) Reactive (kVAR), and Apparent (kVA)	●	●	●	●	●	●	●	●	●	●	●
Power Factor: 3-phase average & per phase	●	●	●	●	●	●	●	●	●	●	●
Present Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)	●	●	●	●	●	●	●	●	●	●	●
Import and Export totals of Present Power Demand: Real (kW), Reactive (kVAR), & Apparent (kVA)								●	●	●	●
Peak Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)	●	●	●	●	●	●	●	●	●	●	●
Current (3-phase average and per phase)	●	●	●	●	●	●	●	●	●	●	●
Voltage: Line-Line and Line-Neutral (3-phase average and per phase)	●	●	●	●	●	●	●	●	●	●	●
Frequency	●	●	●	●	●	●	●	●	●	●	●
ANSI C12.20 0.2% accuracy, IEC 62053-22 Class 0.2S	●	●	●	●	●	●	●	●	●	●	●
Accumulated Net Energy: Real (kWh), Reactive (kVARh), and Apparent (kVAh)	●	●	●	●	●	●	●	●	●	●	●
Accumulated Real Energy by phase (kWh)	●	●	●	●	●	●	●	●	●	●	●
Import and Export Accumulators of Real and Apparent Energy								●	●	●	●
Reactive Energy Accumulators by Quadrant (3-phase total & per phase)								●	●	●	●
Demand Interval Configuration: Fixed or Rolling Block	●	●	●	●	●	●	●	●	●	●	●
Demand Interval Configuration: External Sync to Comms		●	●	●	●	●	●	●	●	●	●
DATA LOGGING											
Data Logging: 10 16-Bit Configurable (can include Date/Time) Data Buffers			●						●		
Data Logging: 3 Timestamped 32-Bit Configurable Data Buffers					●		●				●
Store up to 60 days of readings at 15-minute intervals			●		●		●		●		●
OUTPUTS											
Alarm Output (N.C.)	●	●	●	●		●		●	●	●	
1 Pulse Output (N.O.)		●	●					●	●		
2 Pulse Outputs (N.O.)	●										
RS-485 Serial (Modbus RTU Protocol)		●	●					●	●		
RS-485 Serial (BACnet MS/TP Protocol)						●	●			●	●
LON FT Serial (LonTalk Protocol)				●	●						
INPUTS											
2 Pulse Contact Accumulator Inputs					●		●				●
1 Pulse Contact Accumulator Input				●		●				●	

ACCESSORIES

NEMA4 enclosure (AE010) and locking mechanism (AE011)
Fuse Kits with hi-interrupt capability AC Fuses (AH02, AH03, AH04)
Split-core and solid-core CTs (H681x, E68xx)
Replacement mounting clips (AE004)

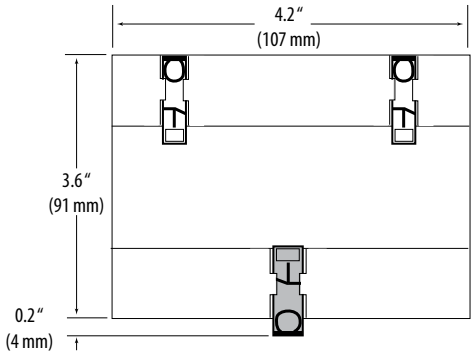
DIN Rail (AV01), DIN Rail Stop Clips (AV02)
Modbus TCP Gateway (U013-0012)
BACnet IP Router (U013-0013 or U013-0015)
Modbus to BACnet Converter (E8951)
Network Display (H8932, H8936)

DIMENSIONAL DRAWINGS

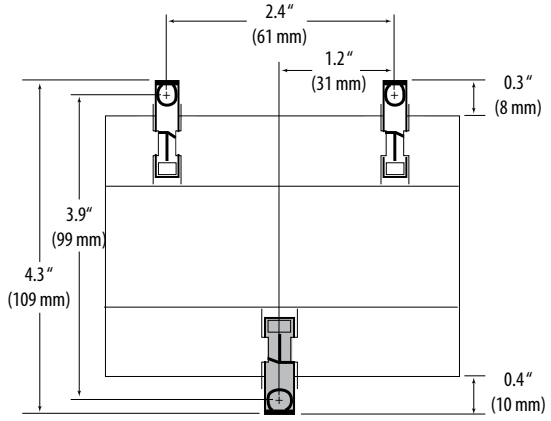


MOUNTING DIAGRAMS

DIN Mount Configuration



Screw Mount Configuration




U013-0012


U013-0013

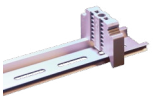

U013-0015


AH04


AE010


AE012


H681x


AV01/AV02

Badger Meter

Series 380 Impeller

380CS/HS

OVERVIEW

The Badger Meter Series 380 Btu Systems provide a low cost system for metering cold or hot systems. The 380CS/HS can accurately measure flow and temperature differential to compute energy. Utilizing either BACnet or Modbus RS-485 communications protocols or a scaled pulse output, the Btu Meter can interface with many existing control systems.

The rugged design incorporates an impeller flow sensor and two temperature probes. One temperature probe is conveniently mounted directly in the flow sensor tee. The second temperature probe is placed on either the supply or the return line depending on ease of installation for the application. These minimal connections help simplify installation and save time.

The main advantage of the Series 380 Btu meters is the cost savings over other systems offered on the market today. The integration of flow and temperature sensors provide a single solution for metering. With this system it will be possible to meter energy where it hasn't been cost effective before.

Commissioning of this meter can be completed in the field via a computer connection. Setup includes energy measurement units, measurement method, communication protocol, pulse output control, fluid density, and specific heat parameters.

RS-485 Configuration

All Series 380 Btu meters are equipped with BACnet and Modbus protocols as a standard feature. The protocol of choice can be selected and setup in the field at the users discretion. These common protocols allow for quick and easy commissioning while gaining valuable application data beyond energy total. Information such as Flow Rate, Flow Total, Energy Rate, Energy Total, Temp 1, Temp 2, and Delta T can all be transmitted on the RS-485 connection.

Scaled Pulse Output

If the RS-485 is not required for the application, a simple scaled pulse output is available. This output would represent energy total and can be set in various units of measure. This output is an open drain scaled pulse output that is compatible with a variety of PLCs, counters and also the Badger Meter 350 wireless system. This ensures the unit is easily compatible with most inputs.

MECHANICAL

Mass — Less than 13 lbs.

ELECTRICAL

Inputs

Power — 12-35 VDC
12-28 VAC

Communication — Modbus RTU
BACnet MSTP

Output

Scaled Pulse — Open drain
0.01 Hz min. to 100 Hz max.

MATERIALS

Housing	Polycarbonate
Flow Sensor	PEEK
Potting Material	Polyurethane
Tee Material	Brass

SENSOR BODY SIZES

Tee Sizes 3/4", 1", 1 1/4", 1 1/2", and 2"

ENVIRONMENTAL

Fluid Temp. — -4°F to 140°F (-20°C to 60°C) - chilled
40°F to 260°F (4°C to 125°C) - hot

Ambient Temp. — -4°F to 149°F (-20°C to 65°C)

ACCURACY

± 2% of flow rate within flow range
± 0.5% repeatability
RTD meets IEC751 Class B

FLOW RANGE

1 - 15ft./sec

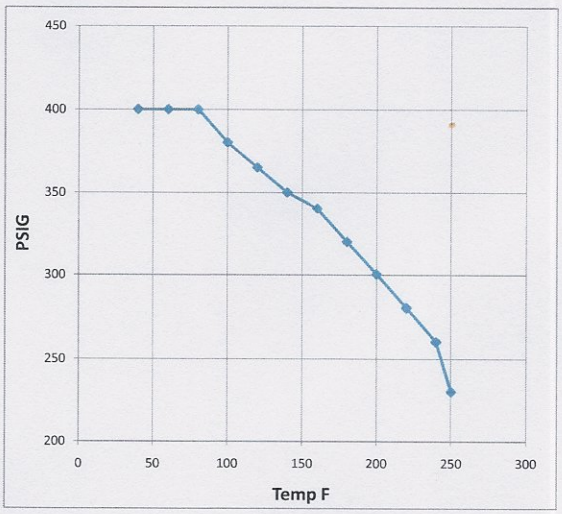
Diameter (Inches)	380 Btu Meter Flow Range (GPM)		
0.75	1.65	to	24.69
1	2.70	to	40.48
1.25	4.66	to	69.93
1.5	6.35	to	95.18
2	10.49	to	157.34

This chart is based on ASME/ANSI B36.10 Welded and Seamless Wrought Steel Pipe and ASME/ANSI B36.19 Stainless Steel Pipe

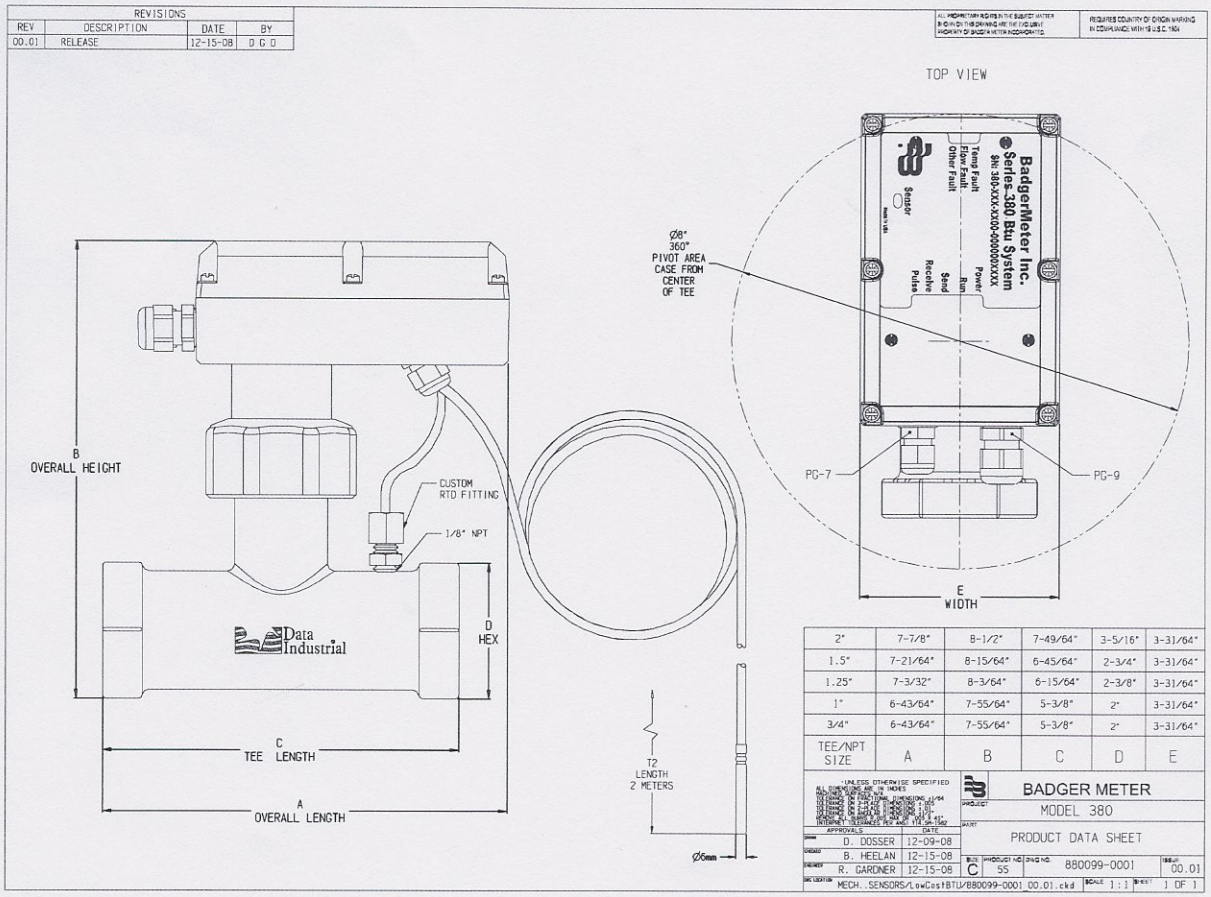
Technical Brief

Badger® Series 380 BTU System Ordering Matrix

	380	0	7	0	0	0	-	1	2	0	0
Type											
CS - Cold Service		0									
HS - Hot Service		1									
Size											
0.75"			07								
1"			10								
1.25"			12								
1.5"			15								
2"			20								
Electronic Housing											
Polycarbonate				0							
Output											
Scaled Pulse and RS-485 (Modbus and BACnet)					0						
Display											
N/A						0					
O-Ring											
EPDM (CS - Cold Service)								1			
Aflas® (HS - Hot Service)								2			
Shaft											
Tungsten Carbide [Standard]									2		
Impeller											
Stainless Steel										0	
Bearing											
Torlon® (CS - Cold Service)											0
Ketron® (HS - Hot Service)											2



*Max. Temp. 250ºF 230 PSIG
Unit can be used to -20ºF @ 400 PSIG



TEE/NPT SIZE	A	B	C	D	E
2"	7-7/8"	8-1/2"	7-49/64"	3-5/16"	3-31/64"
1.5"	7-21/64"	8-15/64"	6-45/64"	2-3/4"	3-31/64"
1.25"	7-3/32"	8-3/64"	6-15/64"	2-3/8"	3-31/64"
1"	6-43/64"	7-55/64"	5-3/8"	2"	3-31/64"
3/4"	6-43/64"	7-55/64"	5-3/8"	2"	3-31/64"

Data Industrial®

Please see our website at www.badgermeter.com
for specific contacts.

Due to continuous research, product improvements and enhancements, Badger Meter reserves the right to change product or system specifications without notice, except to the extent an outstanding contractual obligation exists.

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800-876-3837 | infocentral@badgermeter.com | www.badgermeter.com

MAMAC SYSTEMS®
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sales@mamacsys.com • www.mamacsys.com

CE
RoHS

Model TE-701/702
Technical Information
TI.701/702-01

DUCT TEMPERATURE SENSORS

For Additional Information See TE-701/702 Data Sheet

SPECIFICATIONS

Platinum RTD Sensors:
±0.1% @ 32°F (0°C), Alpha: 385 per DIN 43760

Nickel RTD Sensors (#2):
±0.5°C @ 0°C (32°F), 5,000 PPM/K T.C.R.

Nickel RTD Sensors (#4):
±0.5°F @ 70°F (21.1°C), 6,000 PPM/K T.C.R.

Balco RTD Sensors:
±0.5°F @ 70°F (21.1°C), 4,300 PPM/K T.C.R.

Thermistor Sensors:
±0.2°C interchangeability @ 77°F (25°C)

Operating Temperature:
-40°F to 210°F (-40°C to 100°C)

Ambient Temperature:
-40°F to 160°F (-40°C to 70°C)

Probe Material:
1/4" (6.3 mm) O.D., 0.020" (0.5 mm) wall, 304 Stainless Steel

Flange Material:
Galvanized Steel

Bulkhead Fitting:
Brass with poly compression sleeve

Plastic Enclosure:
Polycarbonate 30% glass filled, rated UL 94V-5-0

Steel NEMA-1 (IP-30):
18 Ga. Galvanized Steel

Steel NEMA-4 (IP-65):
18 Ga. Cold Rolled Steel, Powder coated

Warranty:
Five Years (Lifetime on Moisture Migration)

EMC Conformance:
EN 55022, 55024, 61000-3-3, 61000-4-2, 61000-4-3, 61000-4-4, 61000-4-5, 61000-4-6 & 61000-4-11

U.S. PATENT NO. 6457857, 6555748, 7036224

ORDERING INFORMATION: TE-701-

INSTALLATION	TEMP SENSOR	PROBE LENGTH
A Flange mount 3" (175 mm) wire leads	1 100-Ohm Platinum RTD	A 4" (100 mm)
B Flange mount 6' (1.8 m) plenum cable	2 1,000-Ohm Nickel RTD (5,000 PPM)	B 6" (150 mm)
C Bulkhead mount 3" (175 mm) wire leads	3 1,000-Ohm Platinum RTD	C 8" (200 mm)
D Bulkhead mount 6' (1.8 m) plenum cable	4 1,000-Ohm Nickel RTD (6,000 PPM)	D 12" (300 mm)
	5 1,000-Ohm Balco RTD	
	7 10,000-Ohm NTC Thermistor (Type III)	
	8 10,000-Ohm NTC Thermistor (Carel)	
	10 3,000-Ohm NTC Thermistor	
	12 10,000-Ohm NTC Thermistor (Type II)	
	13 5,000-Ohm NTC Thermistor	
	14 1,035-Ohm Silicon PTC	
	15 100,000-Ohm NTC Thermistor	
	17 20,000-Ohm NTC Thermistor	
	18 2,252-Ohm NTC Thermistor	
	21 1,800-Ohm NTC Thermistor	

Example: TE-701-B-10-A: *Flange mount with 6' cable, 3K ohm thermistor and 4" probe.*

ORDERING INFORMATION: TE-702-

INSTALLATION	TEMP SENSOR	PROBE LENGTH
A Polycarb Plastic Enclosure (IP-54)	1 100-Ohm Platinum RTD	A 4" (100 mm)
B Galvanized Steel Enclosure (NEMA-1 / IP-30)	2 1,000-Ohm Nickel RTD (5,000 PPM)	B 6" (150 mm)
C Painted Steel Enclosure (NEMA-4 / IP-65)	3 1,000-Ohm Platinum RTD	C 8" (200 mm)
	4 1,000-Ohm Nickel RTD (6,000 PPM)	D 12" (300 mm)
	5 1,000-Ohm Balco RTD	
	7 10,000-Ohm NTC Thermistor (Type III)	
	8 10,000-Ohm NTC Thermistor (Carel)	
	10 3,000-Ohm NTC Thermistor	
	12 10,000-Ohm NTC Thermistor (Type II)	
	13 5,000-Ohm NTC Thermistor	
	14 1,035-Ohm Silicon PTC	
	15 100,000-Ohm NTC Thermistor	
	17 20,000-Ohm NTC Thermistor	
	18 2,252-Ohm NTC Thermistor	
	21 1,800-Ohm NTC Thermistor	

Example: TE-702-A-3-D: *Polycarb plastic enclosure with 1K ohm Platinum RTD and 12" probe.*

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INSTALLATION

Inspection Inspect the package for damage. If damaged, notify the appropriate carrier immediately. If undamaged, open the package and inspect the device for obvious damage. Return damaged products.

Requirements
- Tools (*not provided*)
  - Digital Volt-ohm Meter (DVM)
  - Appropriate screwdriver for mounting screws
  - Appropriate drill and drill bit for mounting screws
- Appropriate accessories
- Two #8 self-tapping mounting screws (*not provided*)
- Training: *Installer must be a qualified, experienced technician.*

Warning:
- Do not use on oxygen service, in an explosive/hazardous environment, or with flammable/combustible media.
- Disconnect power supply before installation to prevent electrical shock and equipment damage.
- Make all connections in accordance with the job wiring diagram and in accordance with national and local electrical codes. Use copper conductors only.

Caution:
- Use electrostatic discharge precautions (e.g., use of wrist straps) during installation and wiring to prevent equipment damage.
- Avoid locations where severe shock or vibration, excessive moisture or corrosive fumes are present. NEMA-4 housings are intended for outdoor use primarily to provide a degree of protection against wind-blown dust, rain, and hose-directed water.
- Do not exceed ratings of the device.

Mounting

Location: *Install the sensor in a location where it will sample the average air temperature in a duct. Avoid areas where the air is stratified because these areas can cause sensing errors.*

TE-701-A or B: Refer to ***Figure 4*** for mounting dimensions.

1. Drill a 3/8-inch (9 mm) hole into the duct or plenum where the sensor will be installed.
2. Insert the sensor probe into the duct or plenum until the flange rests against the duct or plenum wall.
3. Use the flange as a template to mark and drill holes for two #8 self-tapping sheet metal screws *(not provided)*.
4. Fasten the sensor to the duct or plenum wall with the sheet metal screws.
5. Make the wiring connections. Refer to ***Figure 1***.

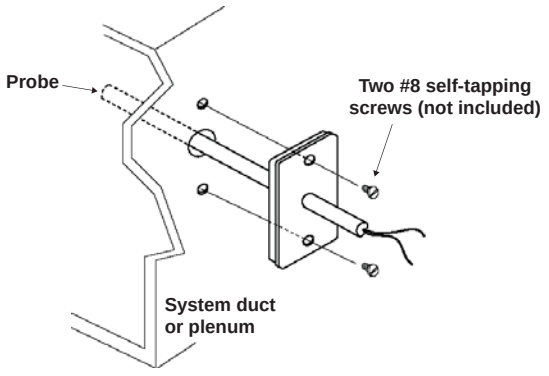

Figure 1 *- Installing the TE-701-A or TE-701-B Sensor*

TE-701-C or D: Refer to ***Figure 5*** for mounting dimensions.

1. Drill a 3/8-inch (9 mm) hole into the duct or plenum where the sensor will be installed.
2. Remove the mounting nut from the bulkhead fitting.
3. Insert the sensor probe into the duct or plenum until the bulkhead fitting rests against the duct or plenum wall.
4. Guide the nut along the probe and tighten against the duct or plenum.
5. Make the wiring connections. Refer to ***Figure 2***.

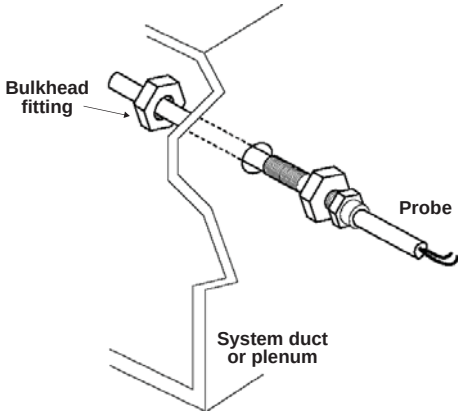

Figure 2 *- Installing the TE-701-C or TE-701-D Sensor*

TE-702-A, B, or C: Refer to ***Figures 6 & 7*** for mounting dimensions.

1. Drill a 3/8-inch (9 mm) hole into the duct or plenum where the sensor will be installed.
2. Insert the sensor probe into the duct or plenum until the mounting bracket rests against the duct or plenum wall.
3. Use the mounting bracket as a template to mark and drill holes for two #8 self-tapping sheet metal screws *(not provided)*.
4. Fasten the sensor to the duct or plenum wall with the sheet metal screws.
5. Loosen the cover screws and rotate the cover out of the way.
6. Make the wiring connections. Rotate and screw the cover back into place. Refer to ***Figure 3***.

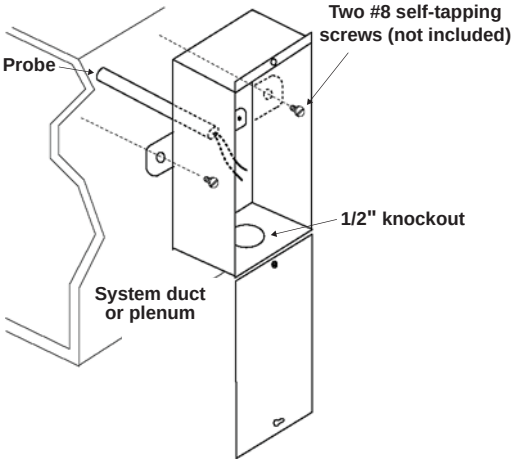

Figure 3 *- Installing the TE-702-A, TE-702-B, or TE-702-C Sensor*

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CHECKOUT

Allow the sensor to stabilize in the duct air stream for a minimum of five minutes before taking a resistance measurement.

1. Disconnect the sensor lead wires from the controller.
2. Connect an ohmmeter across the lead wires.
3. Ensure that nominal resistance measurements are in accordance with the resistance/temperature curves. (Refer to ***Tables 1 & 2***. For complete ***Resistance vs. Temperature*** tables, please refer to **TI.700-11** - Temperature Sensor section.)
4. Reconnect sensor lead wires to the controller.
5. Check operation of the complete control system.

MAINTENANCE Regular maintenance of the total system is recommended to assure sustained optimum performance.

FIELD REPAIR None. Replace with a functional unit.

DIMENSIONAL DATA

TE-701/702 Duct Temperature Sensor dimensions shown in inches and millimeters (mm).

Figure 4
TE-701-A & TE-701-B

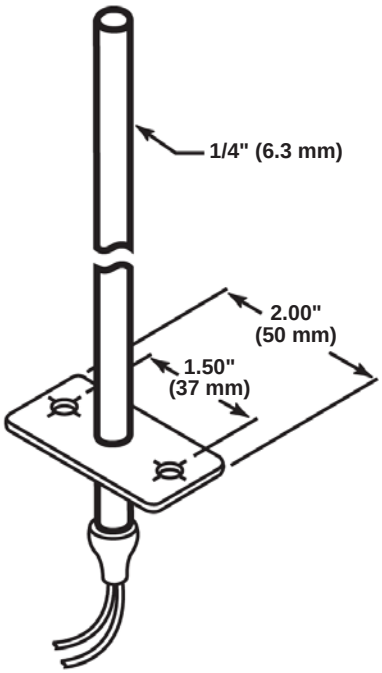

Figure 5
TE-701-C & TE-701-D

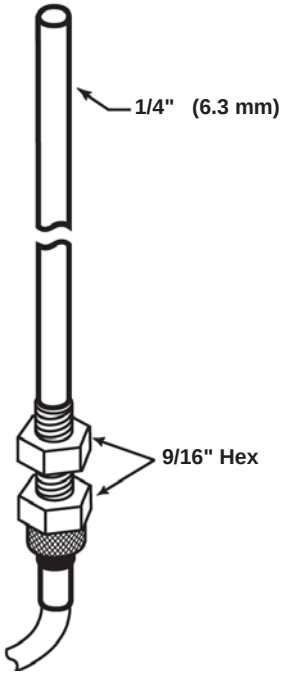

Figure 6
TE-702-A

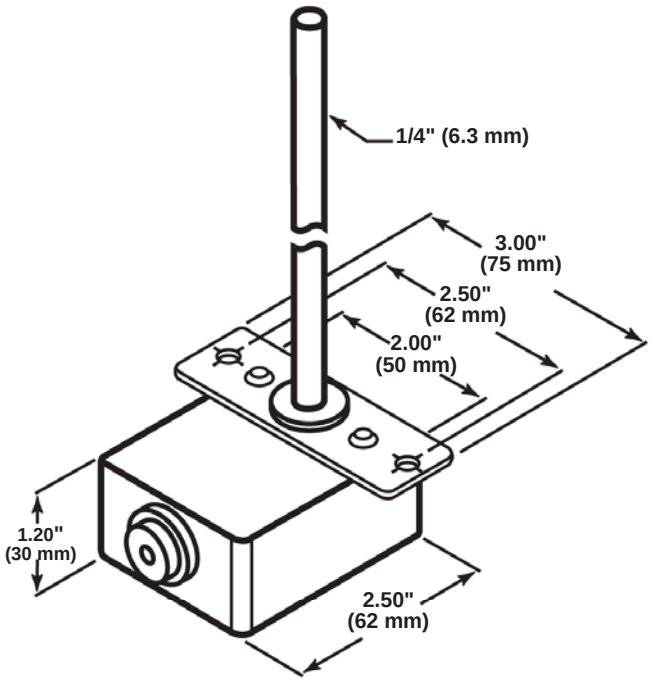

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Figure 7
TE-702-B & TE-702-C

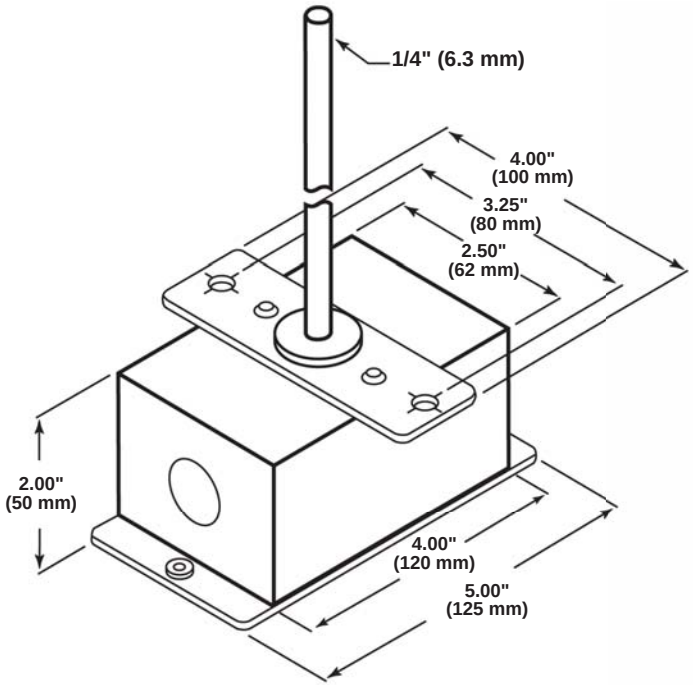

Table 1. Resistance Versus Temperature

°F	°C	Type 1 RTD	Type 3 RTD	Type 4 RTD	Type 5 RTD	Type 7 thermistor	Type 10 thermistor
72	22.2	108.66	1,086.6	1,006.0	1,004.4	11,194	3,392
72.5	22.5	108.76	1,087.6	1,007.5	1,005.5	11,068	3,350
73	22.8	108.87	1,088.7	1,009.0	1,006.6	10,943	3,309
73.5	23	108.98	1,089.8	1,010.5	1,007.6	10,820	3,269
74	23.3	109.09	1,090.9	1,012.0	1,008.7	10,698	3,229
74.5	23.6	109.19	1,091.9	1,013.5	1,009.8	10,578	3,189
75	23.9	109.30	1,093.0	1,015.1	1,011.0	10,459	3,150
75.5	24.1	109.41	1,094.1	1,016.6	1,012.1	10,343	3,112
76	24.4	109.52	1,095.2	1,018.1	1,013.2	10,227	3,074
76.5	24.7	109.62	1,096.2	1,019.6	1,014.3	10,113	3,037
77	25	109.73	1,097.3	1,021.1	1,015.4	10,000	3,000
77.5	25.3	109.84	1,098.4	1,022.6	1,016.5	9,889	2,964
78	25.5	109.95	1,099.5	1,024.1	1,017.6	9,779	2,928
78.5	25.8	110.06	1,100.1	1,025.6	1,018.7	9,671	2,890
79	26.1	110.17	1,101.7	1,027.2	1,019.8	9,563	2,858
79.5	26.4	110.27	1,102.7	1,028.7	1,020.9	9,458	2,823
80	26.7	110.38	1,103.8	1,030.2	1,022.1	9,353	2,789
80.5	27	110.49	1,104.9	1,031.7	1,023.2	9,250	2,756
81	27.2	110.60	1,106.0	1,033.3	1,024.3	9,148	2,723
81.5	27.5	110.70	1,107.0	1,034.8	1,025.4	9,045	2,690
82	27.8	110.81	1,108.1	1,036.3	1,026.5	8,943	2,658

Table 2. Resistance Versus Temperature

°F	°C	Type 12 thermistor	Type 13 thermistor	Type 15 thermistor	Type 17 thermistor	Type 18 thermistor	Type 21 thermistor
72	22.2	11,307	5,654	113,080	22,825	2,546	2,005
72.5	22.5	11,169	5,584	111,680	22,525	2,515	1,983
73	22.8	11,031	5,515	110,300	22,226	2,484	1,962
73.5	23	10,896	5,448	108,960	21,935	2,454	1,941
74	23.3	10,762	5,381	107,620	21,645	2,424	1,920
74.5	23.6	10,631	5,316	106,320	21,362	2,394	1,899
75	23.9	10,501	5,251	105,020	21,080	2,365	1,879
75.5	24.1	10,374	5,188	103,760	20,806	2,336	1,859
76	24.4	10,247	5,124	102,480	20,532	2,308	1,839
76.5	24.7	10,123	5,062	101,240	20,266	2,280	1,819
77	25	10,000	5,000	100,000	20,000	2,252	1,800
77.5	25.3	9,880	4,940	98,800	19,741	2,225	1,791
78	25.5	9,760	4,880	97,600	19,483	2,198	1,762
78.5	25.8	9,643	4,821	96,420	19,232	2,171	1,743
79	26.1	9,526	4,763	95,260	18,981	2,145	1,725
79.5	26.4	9,412	4,706	94,120	18,737	2,119	1,707
80	26.7	9,298	4,649	92,980	18,494	2,094	1,689
80.5	27	9,187	4,616	92,320	18,257	2,069	1,671
81	27.2	9,077	4,583	91,660	18,020	2,044	1,653
81.5	27.5	8,969	4,507	90,140	17,790	2,020	1,636
82	27.8	8,861	4,431	88,620	17,560	1,996	1,619

For complete ***Resistance Versus Temperature*** tables, please refer to TI.700-11.

For Technical / Application Assistance call your nearest office

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08-8395-4333 • Fax 08-8395-4433

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656-3927273 • Fax 656-3927276

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155 McIntosh Drive, Unit 5
Markham • Ontario • L3R 0N6
Canada
905-474-9215 • Fax 905-474-0876

Appendix B – Verification Notes

Birchwood Towers – The Toledo

102-10 66th Rd.
New York, NY 11375

Site Contact
Sean Pringle
Aegis Energy Services Inc.
55 Jackson St.
Holyoke, MA 01040
springle@aegisenergyservices.com
413-536-1156
413-896-1622 cell

- CDH was on site to install data logger and terminate sensors on September 9, 2014.
- Unit began running December 4, 2014.
- CDH was on site March 30, 2015 to verify metering.

CDH To Do –

1. Terminate / configure power readings from Beckwith protective relay
2. Terminate gas meter (once pulse output is added)

Summary

Aegis provided and installed the power, gas and BTU meter. CDH provided the data logger and one temperature sensor. An electrician did the majority of the wire pulls while CDH terminated wiring and verified metering.

Monitored Data Points

No.	Input	Data Point	Description	Units	Sensor
1	MB-002	WT	Total Facility Power	kW/kWh	Veris E50 C2 with MV Rope CTs
2	MB-001	WG	Gross Generator Power	kW/kWh	Veris H8035-0300-3
3	MB-003	WPAR	Parasitic Power	kW/kWh	Veris H8035-0100-2
4	IN1	FG	Generator Gas Use	CF	Utility pulse output from billing meter
5	IN2	THW1	Supply Temperature from Cogen Unit	deg F	Veris TID B1 D0 10k Type II thermisor
6	MB-004	QU_METER	Useful Heat Recovery - BTU Meter Calculated	Mbtu	Badger 380 BTU meter
7	MB-004	THW2	Temperature Between Useful HXs and Dump HX	deg F	
8	MB-004	THW3	Return Temperature to Cogen Unit	deg F	
9	MB-004	FHW	Flowrate CHP Loop	GPM	
10	-	QU	Useful Heat Recovery	Mbtu	Calculated Point
11	-	QR	Heat Rejection to Cooling Tower	Mbtu	Calculated Point
12	-	TAO	Ambient Temperature	deg F	NWS Station

IP Info

External BWT IP:	207.237.134.35
Netmask:	255.255.255.248
Gateway:	207.237.134.33
Primary DNS:	207.172.3.8
Secondary DNS:	207.172.3.9

Procedure

- Power (generator and parasitic) was verified by comparing the Veris H8035 power meter reading on the Obvius to the measured power using a handheld Fluke-39.

- Temperatures were measured using a Fluke 51-II and a surface probe.
    - All temperatures were measured from the surface of the copper piping.

- Hot water loop flows were not able to be verified due to too much noise in the ultrasonic flowmeter reading.

Verification Data – March 30, 2015

Generator Power:

WG	Obvius (kW)	Fluke (kW)
	57.9	58

Parasitic Loads:

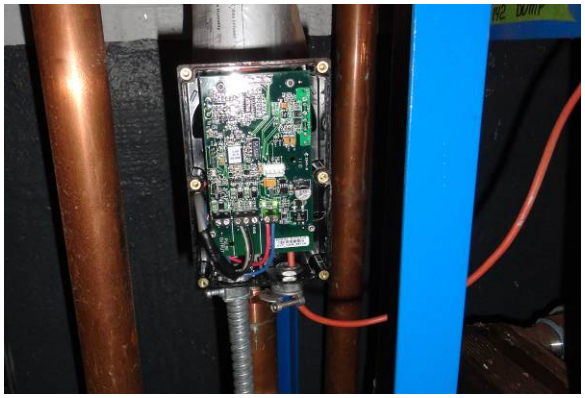
WPAR	Obvius (kW)	Fluke (kW)
	2.7	2.72

Temperatures:

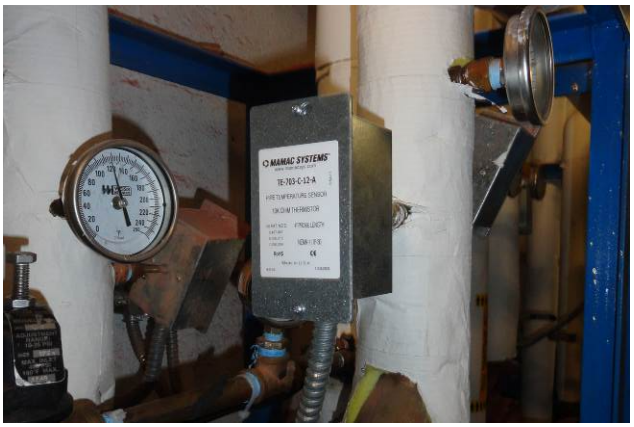
	Obvius (°F)	Gauge (°F)	Fluke (°F)
THW1	186.2	185	181.5
	185.8	184	180.9
Avg:	*186.0*	*184.5*	*181.2*
THW2	106.7	105	104.7
	106.6	104	104.6
Avg:	*106.7*	*104.5*	*104.7*
THW3	106.15	105	105
	106.1	107	105.3
Avg:	*106.1*	*106.0*	*105.2*

Site Photos

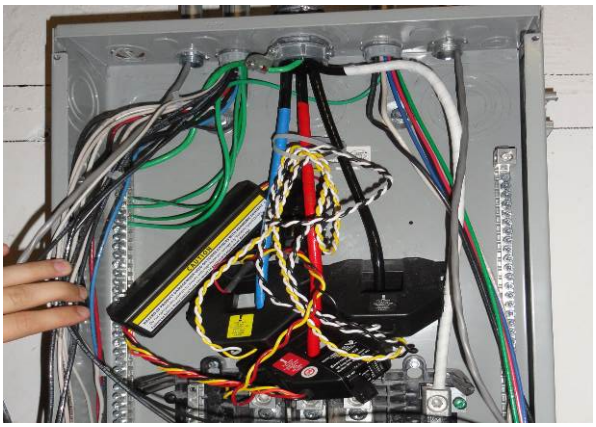
CDH enclosure and Obvius datalogger



Badger 380 BTU meter (FHW, THW2, THW3)



Mamac 10k Type 2 Thermistor (THW1)



Veris H8035 Power meter (WPAR)

Utility gas meter, located in parking garage (FG)

Location of cogen power meter (WG)