Prepared on Behalf of:

Connecticut Airport Authority
Administration Office – Terminal A – 3rd Floor
Windsor Locks, CT 06096

Prepared for:

Connecticut Department of Energy and Environmental Protection
Public Utilities Regulatory Authority
Ten Franklin Square
New Britain, Connecticut 06051

MEASUREMENT AND VERIFICATION PLAN

Bradley International Airport CHP System #2
Bradley Energy Center
Schoephoester Road
Windsor Locks, CT 06096

Prepared by

980 Ciprianna Drive
Unit A1 PMB 302
Myrtle Beach, SC 29572-4629

October 26, 2026

Green Harbor energy

Combined Heat and Power Plant

Bradley Airport Energy Center

Schoephoester Road

Windsor Locks, CT 06096

Pursuant to

State of Connecticut

Renewable Generator Qualification

Class III Resource – Efficient CHP

Prepared by:

Darrell Sandlin, CEM

Green Harbor Energy

October 26, 2026

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SECTION 1.0 – INTRODUCTION

This Measurement and Verification Plan, hereinafter referred to as the "M&V plan" for Bradley International Airport CHP System #2 and CHP System #3 in the Combined Heat and Power Plant at Bradley International Airport, has been developed and submitted along with the application for Connecticut Renewable Generator Qualification, pursuant to the Renewable Portfolio Standards of Connecticut Statutes § 16-1 (26) (27) & 16-245a.

The Connecticut Airport Authority confirms that Green Harbor Energy will represent CHP System #2 and CHP System #3 through the application process and remain in place as the Authority's Authorized Representative after the two new CHP systems are approved as Connecticut Class III renewable energy generators. Green Harbor Energy will be responsible for the marketing of all class III credits generated from operations of these generators. Attestation to this is included in Appendix A of this plan.

The performance data published in this M&V plan are based upon projected performance data for CHP System # 2 and CHP System #3 both of which were added to the Bradley Airport Energy Center in Calendar year 2024. The projections are computed based on the 2025 operating sequence as explained to Green Harbor Energy by Ameresco. Ameresco has responsibility and authority for the day-to-day operations and control of the energy center for the Connecticut Airport Authority.

William H. Smith (State of Connecticut, Professional Engineer, License Number #PEN.0030531))

Clean Energy Associates
3546 Jefferson Township Parkway
Marietta, GA 30066
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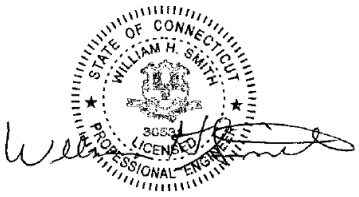

Darrell Sandlin, CEM
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SECTION 2.0 – PROJECT DESCRIPTION

Bradley International Airport opened for commercial air traffic in 1947. In 2001 the Connecticut Department of Transportation, Bureau of Aviation and Ports, seeking ways to lower its operating costs while improving the certainty of energy supply to the airport, began construction of a new Energy Center (EC). Scope of the final design included three combined heat and power (CHP) natural gas reciprocating engines providing 3.8 MW of onsite electric generation and 13,000 MBTU of engine heat recovery. One (1) 500-ton absorption chiller, two (2) 750-ton electric drive centrifugal chillers and two (2) 12,000 MBTU dual fuel hot water boilers were included in the original project. The EC was completed and began operation in November 2002.

In 2010 the EC capacity was expanded with the addition of "CHP System #4" an 1,860 kW genset to meet increasing loads from the continued growth at Bradley Airport. That CHP system is currently an approved CT Class 3 source under Docket # 15-12-34.

The Connecticut Airport Authority (CAA) was established in 2011 to develop, improve, and operate Bradley International Airport and the state's five general aviation airports The services previously provided by Terminal B have now been transferred to unified Terminal A along with the corresponding energy loads. These loads are being met by generation from the EC.

In 2022 Ameresco notified CAA that 2 of the 3 original CHP systems were at end of life and no longer reliable. A plan was put in motion to fully replace CHP system #2 and CHP System #3 with new Waukesha rich burn reciprocating engines. Each of the replacement generators are water cooled, rich burn turbocharged reciprocating engine generators with a max electric output of 1,350 kW. These engine generators will be restricted to 88% of their max electric rating, therefore held to gross electric output of 1,200 kW.

The new CHP System #2 began commercial operations in October 2024.
The new CHP System #3 began commercial operations in January 2025.

Calendar year 2025, the average monthly energy consumption at the airport was 1,455 MWH. The EC operates in parallel with the utility grid. On average, 10% of the electricity supply is imported from Eversource Energy, leaving an average balance of 1,310 MWH per month to be supplied from the EC. CHP System #4, with net capacity of 1.77 MW, an average load factor of 70%, 90% availability, and positioned as the "lead" generator in the sequence stack, is capable of generating approximately 842 MWH per month. CHP System #4 typically produces about 65% of the MWH generated by the EC. The balance of the average monthly load (468 MWH) is split equally between CHP System #2 and CHP System #3. Mentioned earlier, each of the two new CHP Systems has a net capacity of 1.2 MW, an average load factor of 70% and 90% availability. CHP System #2 and CHP System #3 share duty as "following" generators in

the sequence behind CHP System #4. While each of these units can generate an average of 544 MWH per month, only a balance of 468 MWH is required, and since they are duty-cycled, each unit will produce half of that or about 234 MWH per month. (18% of the average load per month supplied by the EC).

Ameresco points out that energy reliability is the number one priority for Bradley Airport. The operating sequence for the CHP engines is based on a load sharing approach. In this way, multiple generators will operate between 65 and 70% of their individual full load capacity. If any one of the operating machines fails, there is sufficient time to start the next available generator while the operating machines pick up the load immediately. The electric circuit is shown in the electrical one-line diagram in figure 3.1, below.

Thermal recovery from each of CHP systems is achieved from a series water flow first through a Tranter "Superchanger®" plate and frame heat exchanger, recovering high temperature engine jacket water, and then to a Kickham Boiler, heat recovery generator positioned in each of the engine exhausts. Collectively, these heat exchangers increase the incoming hot water temperature from 160°F to about 215°F, yielding a maximum of 5.5 MMBTUH of hot water production from a full-load run hour, by each of the CHP engines. Thermal recovery from each CHP system is piped to the existing hot water heating circuit supporting the airport. CHP thermal recovery offsets fuel consumption of two (2) industrial hot water boilers in the EC. The CHP recovered thermal can also provide useful energy input to the absorption chiller to offset summer cooling loads. The thermal circuit is shown in the piping and instrument diagram M402 in Figure 3.2, below.

To maximize the certainty of electric power to the airport, the sequence of operation for the EC is set for electric load following. As mentioned earlier, CHP System #4 is typically set in the lead position. Once CHP #4 reaches a load factor near or just above 70%, either CHP System #2 or CHP System #3 will be started and that generator will load share up to approximately 70% of it's individual maximum electric generation capacity. If either of those two generators are unable to satisfy the airport electric load, a third CHP System will be started, and so on, until all 4 of CHP units in the EC are running. As the airport electric load decreases CHP units are shut down in a reverse sequence.

It is well worth mentioning again that operating the EC under the aforementioned sequence is not with energy efficiency as a priority, but with energy certainty as the highest priority. Running multiple engines at part-load conditions will result in a lower overall fuel efficiency. However, we are confident that all CHP generators will average monthly and quarterly fuel efficiency greater than 50%, a key requirement to maintain eligibility under the Connecticut RPS rules.

SECTION 3.0 – MEASUREMENT AND VERIFICATION PLAN

3.1 Purpose

This M&V plan will be used to verify and report the electric generation and overall energy efficiency of the CHP plant in accordance with the key performance criteria mandated by the Connecticut Department of Public Utilities Regulatory Authority. Further, the M&V plan will define the methodology followed when preparing reports for quarterly fuel conversion efficiency and percentages of electric and thermal energy production.

3.2 Measurement Boundary

The CHP plant operating efficiency and production output will be determined from a measurement boundary that includes CHP System #2 and CHP System #3, Waukesha natural gas fired engine generators, the engine high temp engine jacket water heat exchanger, and the engine exhaust gas heat exchanger. The measurement boundary also includes the revenue metering equipment. Performance specifications for the engine generators are included in Appendix E of this plan.

3.3 CHP Plant Overview

Electrical interconnection and revenue metering of each CHP generator at the EC is defined by the Electrical One-Line diagram (E102) shown in Figure 3.1, below.

Thermal energy recovery and engine fuel metering for each CHP generator are defined by the Piping and Instrument Diagram (M402) shown in Figure 3.2, below.

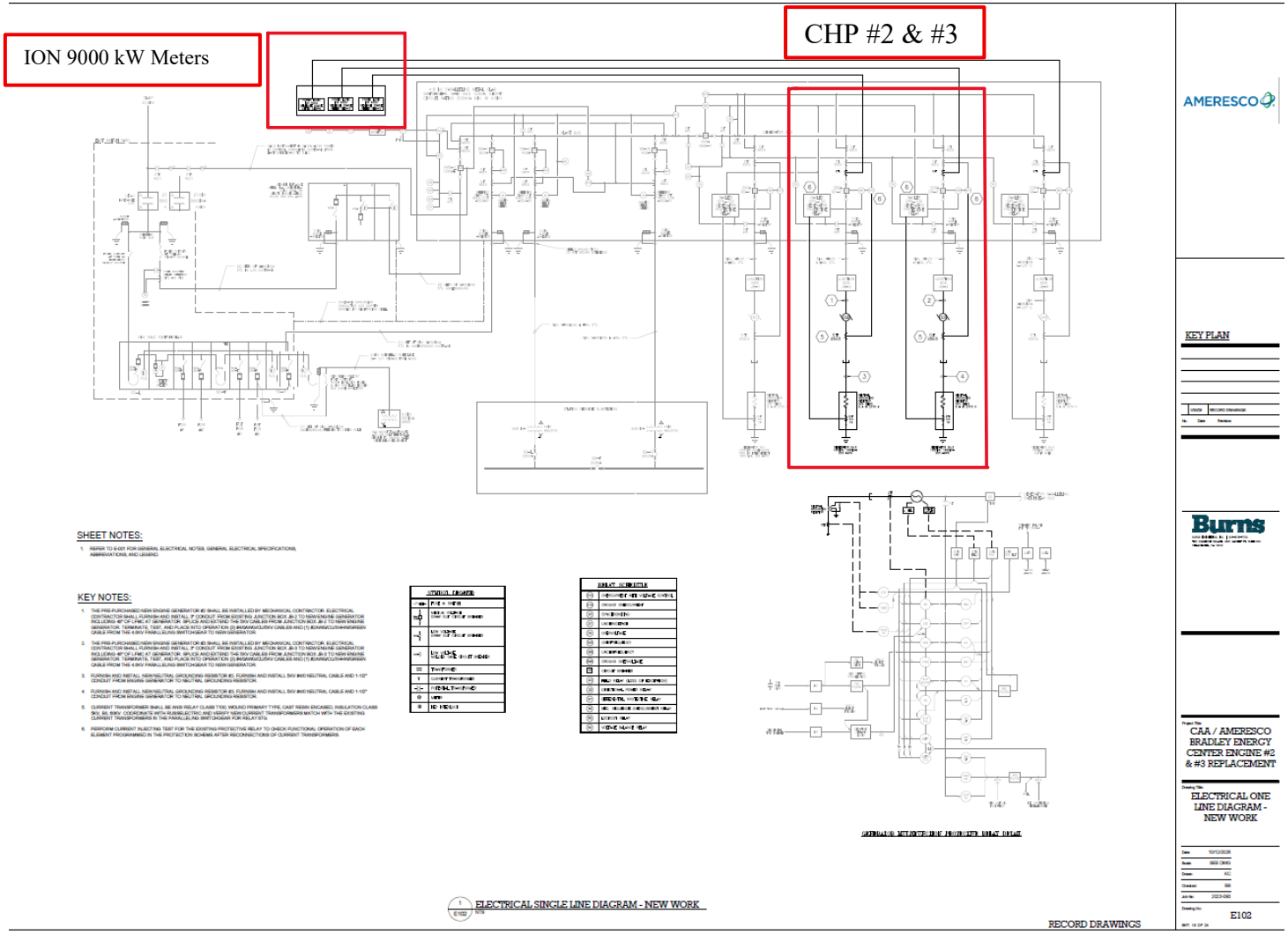

Figure 3.1 Electric One Line diagram

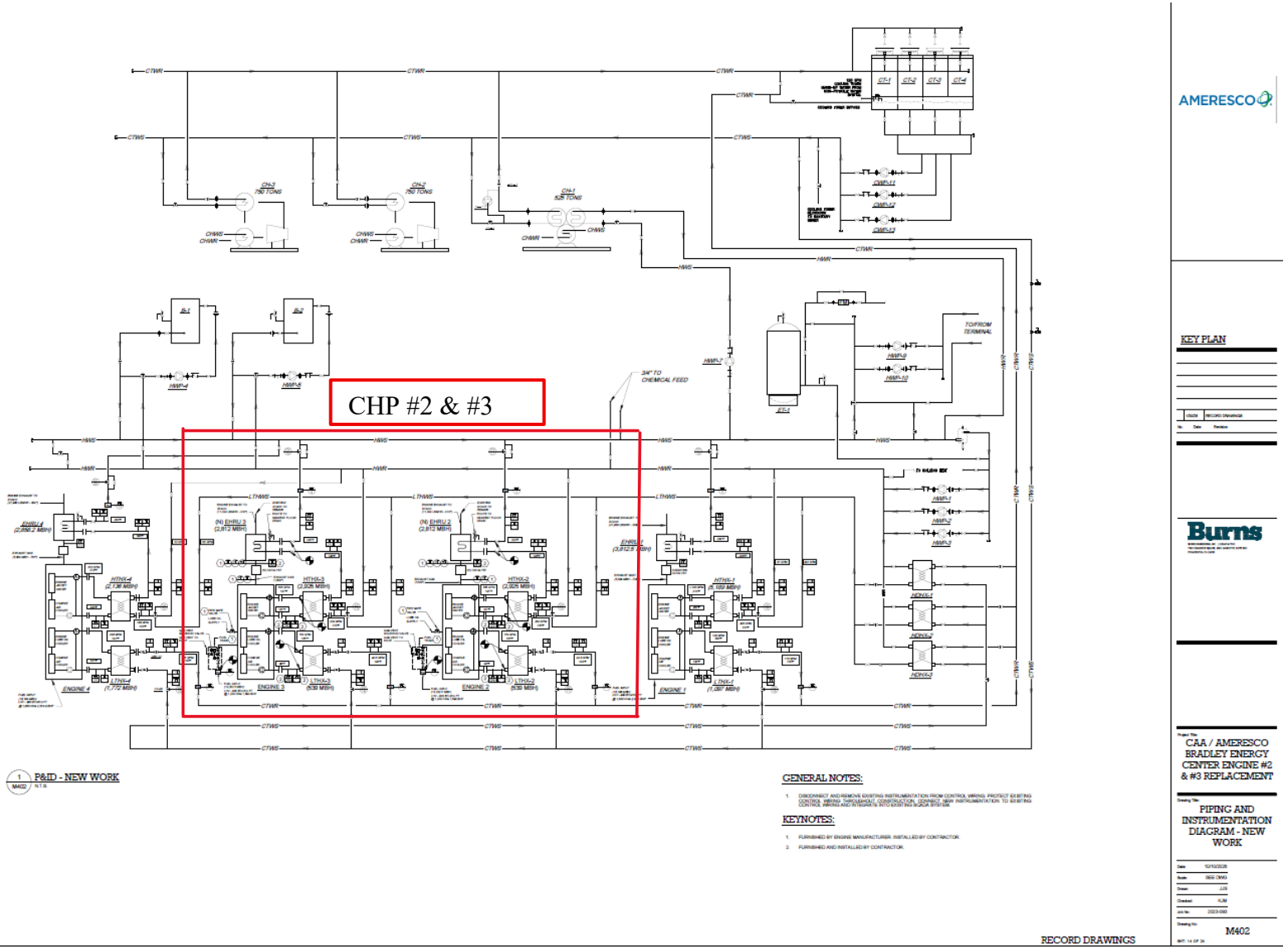

Figure 3.2 Cogen Flow diagram

3.4 Data Collection – Measurement Interval Period and Management

Electric generation from CHP System #2 and CHP System #3 are metered by a Schneider Electric Power Logic ION9000T power meter. The ION 9000T provides revenue quality accuracy and speed and meets ANSI C 12.20 class 0.2 standards. Metered data from the ION 9000T is captured and stored by a custom SCADA system designed, installed and programmed by TVC systems. Technical data sheets for the revenue electric meter are included in Appendix F.

Natural Gas consumption by each CHP generator is metered by a Dresser Roots series B3 positive displacement rotary gas meter. The 3M175 meter is a revenue quality meter and includes a Honeywell pressure and temperature corrector. Natural gas consumption data is conveyed by a pulse output. The pulse output signal is totalized and stored by the on-site SCADA system. Technical Datasheets for the fuel meter are included in Appendix F.

Useful thermal energy is metered and calculated from flow rate and temperature measurements. The Dynasonic TFX series ultrasonic flow meter determines fluid flow, while (3) "matched" Pyromation RTDs determine temperature change of the water before and after a series of two heat exchangers. Flow and temperature data is collected real time and BTUH computed by the SCADA system. Technical data sheets for the flow meter and temperature sensors are included in Appendix F.

Interval data from the revenue electric, fuel and thermal metering systems is collected and stored at hourly interval periods by the on-site SCADA system. Every 24 hours the SCADA system will automatically export kWh electric generation, SCF natural gas consumption, GPM hot water flow, heat recovery outlet temperature, heat recovery inlet temperature and the heat recovery calculated MMBTUH all on hourly intervals, to a cloud-based FTP server, provided by Green Harbor Energy. At the end of each quarter Green Harbor Energy will download this interval data and prepare the hourly, monthly and quarterly generation efficiency reports following the calculation methodology provided in section 3.6 of this plan. The monthly to quarterly computations will be reviewed and compared against the M&V plan, by a Professional Engineer licensed in the state of Connecticut.

P.E. approved quarterly performance results will identify final net electric generation eligible for Connecticut Class III credits, the overall fuel efficiency for each of the CHP systems as well as the percent contribution from electricity and useful thermal energy to Bradley Airport. The final quarterly performance reports will be filed with Connecticut PURA as required.

3.5 Measurement Equipment Specifications

Following lists meter type(s) and model number(s). Technical Data Sheets for each are listed in Appendix F.

- Electricity Generation (kW) – Schnieder Electric, Power Logic ION 9000T
- Engine Parasitic Loads (kW) – Stipulated as 12.6 kW per full load run hour of 1,200 kW
- Engine Fuel Consumption (FM) – Dresser Series B3 rotary meter, Model 3M175 + Honeywell EC 350 PTZ Gas Volume Corrector
- Hot Water Flow (FE 5 and FE 6) – Badger Meter, Dynasonics TFX Ultrasonic Flow Meter, Model DTFXD2A1NA-NN
- Hot Water Temperature Sensors (TT-20, 21, 22, 25, 26 & 27) – Pyromation Inc., RTD's Model (R1T185L483-S4DO6092-SL-8HN31-440-385D-S)
- Data Acquisition Server – TVC custom SCADA solution for Bradley Energy Center

3.6 Calculation Methodology

The following information provides clarification for the methodology applied to calculate monthly data and energy values, ultimately applied to calculate the CHP plant fuel conversion efficiency. Meter data below will be collected and stored electronically on hourly time intervals:

Fuel Conversion Efficiency

[Net Electric Energy Generation (MWH) + Total Useful Thermal Energy Recovered (MWH)] ÷ [LHV Total Fuel Input (MWH)] = % Fuel Conversion Efficiency

Where;

Net Electrical Energy Generation (MWH) = [Gross Metered Electric Out (kWh) – Stipulated Parasitic Load of 12.4 kW per full load run hour] ÷ 1,000

And;

Total Useful Thermal Energy Recovered (MWH) = BTUH Metered Hot Water production ÷ 3,413,000

From;

Hot Water production = [Flow in GPM from (FE-5) x Delta T (TT20 – TT22) x 500 (8.333 Lbs./Gal. x 60 min/hr.)] = BTUH

And;

MWH Total Fuel Input (LHV) = Natural Gas Flow (SCF) x 935 BTU/SCF (Listed in the Generator Performance Specifications, Appendix E) ÷ 3,413,000

3.7 Operating Air Permit:

Specific to the new CHP System #2 and CHP System #3, Connecticut Department of Energy and Environmental Protection (DEEP) issued New Source Review Permit to construct and operate a Stationary Source. A copy from the title page of each permit is included here to provide identification of the permit numbers.

Connecticut
Department of Energy &
Environmental Protection

portal.ct.gov/DEEP

BUREAU OF AIR MANAGEMENT
NEW SOURCE REVIEW PERMIT
TO CONSTRUCT AND OPERATE A STATIONARY SOURCE

Issued pursuant to Title 22a of the Connecticut General Statutes (CGS) and Section 22a-174-3a of the Regulations of Connecticut State Agencies (RCSA).

Operator	Ameresco Select, Inc.
Operator Address	3 Schoephoester Road, Windsor Locks, CT 06096
Owner	Connecticut Airport Authority
Owner Address	334 Ella Grasso Turnpike, Suite 160, Windsor Locks CT 06096
Equipment Location	130 Schoephoester Road, Windsor Locks, CT 06096
Equipment Description	Waukesha Model VHP-L7044GSI S5 4-stroke Rich Burn Reciprocating Engine with Miratech Model IQ2S-34-16 three-way Catalyst Device
Town-Permit Numbers	213-0118
Premises Number	009
Stack Number	7
Permit Issue Date	April 30, 2024
Expiration Date	None

Emma Cimino
Emma Cimino
Deputy Commissioner

April 30, 2024
Date

Connecticut
Department of Energy &
Environmental Protection

portal.ct.gov/DEEP

BUREAU OF AIR MANAGEMENT
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Owner	Connecticut Airport Authority
Owner Address	334 Ella Grasso Turnpike, Suite 160, Windsor Locks CT 06096
Equipment Location	130 Schoephoester Road, Windsor Locks, CT 06096
Equipment Description	Waukesha Model VHP-L7044GSI S5 4-stroke Rich Burn Reciprocating Engine with Miratech Model IQ2S-34-16 three-way Catalyst Device
Town-Permit Numbers	213-0119
Premises Number	009
Stack Number	8
Permit Issue Date	April 30, 2024
Expiration Date	None

Emma Cimino

Emma Cimino
Deputy Commissioner

April 30, 2024
Date

79 Elm Street, Hartford, CT 06106-5127
www.ct.gov/deep
Affirmative Action/Equal Opportunity Employer

3.8 Overall Operating Performance of the Efficient CHP Plant:

Using the calculation methodology described above, the table below contains projected monthly performance data for CHP System #2 and CHP System #3. The projections have been verified using a subset of the 2025 calendar year metered observations, provided by Ameresco.

Bradley International Airport CHP (System #2 and System #3)

Location: Schoephoester Road, Windsor Locks, CT

Data: 2026 M&V Plan Energy Projections

System Overview 2026

Prime Mover Type:	Natural Gas Recip Engine
Max Rated Electric Output (KW):	1,350
Scheduled Electric Output (KW):	1,200
Total Fuel Input (MWH)	8,461
Net Electric Output (MWH)	2,840
Thermal Energy Transfered (MWH)	4,021
Fuel Conversion Efficiency (%)	81%

Fuel Conversion Efficiency = [Net Electric Output + Thermal Energy Transferred] / Fuel Input

Projected System Performance Data

Month	Full Load Equivalent Operating Hours	Total Fuel Input (MWH)	Net Electric Output (MWH)	Thermal Energy Transfered (MWH)	Fuel Conversion Efficiency (%)	Electric Contribution (%)	Thermal Contribution (%)
Jan	203	719	241	342	81.1%	41.4%	58.6%
Feb	183	649	218	308	81.1%	41.4%	58.6%
Mar	203	719	241	342	81.1%	41.4%	58.6%
Apr	197	695	233	330	81.1%	41.4%	58.6%
May	203	719	241	342	81.1%	41.4%	58.6%
Jun	197	695	233	330	81.1%	41.4%	58.6%
Jul	203	719	241	342	81.1%	41.4%	58.6%
Aug	203	719	241	342	81.1%	41.4%	58.6%
Sep	197	695	233	330	81.1%	41.4%	58.6%
Oct	203	719	241	342	81.1%	41.4%	58.6%
Nov	197	695	233	330	81.1%	41.4%	58.6%
Dec	203	719	241	342	81.1%	41.4%	58.6%
Annual	2,391	8,461	2,840	4,021	81.1%	41.4%	58.6%

Airport use of Recovered Thermal Energy

Month	Process Heating (MMBTU)	Process Cooling (MMBTU)	Space Heating (MMBTU)	Space Cooling (MMBTU)	Domestic Hot Water (MMBTU)	Other (MMBTU)	Total Energy Transfered (MMBTU)
Jan	0	0	1,049	0	117	0	1,165
Feb	0	0	947	0	105	0	1,052
Mar	0	0	1,049	0	117	0	1,165
Apr	0	0	677	338	113	0	1,128
May	0	0	466	583	117	0	1,165
Jun	0	0	0	1,015	113	0	1,128
Jul	0	0	0	1,049	117	0	1,165
Aug	0	0	0	1,049	117	0	1,165
Sep	0	0	0	1,015	113	0	1,128
Oct	0	0	350	699	117	0	1,165
Nov	0	0	789	226	113	0	1,128
Dec	0	0	1,049	0	117	0	1,165

SECTION 4.0 – APPENDICES A - F

Appendix A: Owner Authorization to Represent

CERTIFICATION OF AUTHORIZED REPRESENTATIVE

October 16, 2026

Connecticut Public Utilities Regulatory Authority
Attn: RPS Applications
10 Franklin Square
New Britain, CT 06051

I, Michael W. Shea as Executive Director & CEO for Connecticut Airport Authority certify that **Darrell Sandlin**, representing Green Harbor Energy, is the Authorized Representative named in this Application for Connecticut Renewable Generator Qualification, pursuant to the Renewable Portfolio Standards Connecticut General Statutes § 16-1 (26)(27) & 16-245a ("the Application") and is authorized to execute the Application on our behalf.

Print: Michael W. Shea

Signature: Michael W. Shea

Date: 10/16/2026

Title: Executive Director & CEO

Appendix B: Authorized Representative's Attestation of Performance

By way of declaration I certify that I have prepared and agree with the information as presented in this M&V plan. I hereby confirm the performance data, interconnection with the local public utility and the system descriptions, including figures, diagrams, equipment & instrument specifications, quantities and other parameters pertinent to the energy performance of the combined heat & power plant descried above are accurate to the best of my knowledge and experience.

Furthermore I hereby affirm the data sets are available for inspection upon request. The information provided in the accompanying M&V plan is true and accurate to the best of my knowledge. I understand that Connecticut class 3 RPS credits will be created from the energy generation as documented in this plan. I certify that I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that based on reasonable investigation, including my inquiry of the individuals responsible for supplying the information is true, accurate and complete to the best of my knowledge and belief.

PRINT Darrell Sandlin

SIGNATURE 

DATE October 26, 2026

TITLE Director, Engineering Services

FOR Green Harbor Energy

Appendix C: Authorized Representative's Certification for Application

Owner's Certification for the Application for Connecticut Renewable Generator Qualification Pursuant to the Renewable Portfolio Standards Connecticut General Statutes § 16-1 (26) (27) & 16-245a, for Qualification as a Glass III Resource.

I, **Darrell Sandlin**, representing the **Connecticut Airport Authority,** certify the following information concerning the CHP system installed in the Energy Center at Bradley International Airport, Windsor Locks, Connecticut is true and accurate to the best of my ability. Further, we seek qualification as a CT RPS Class III generator through this application:

1. The CHP system complies with the manufacturer's instructions.

2. The CHP system complies with the interconnection and protection requirements of the local electric distribution company and the Department.

3. The CHP system complies with the provisions of the National Electrical Code and all other applicable local, state, and federal codes of practice.

4. The CHP system has obtained and posted all required permits, as needed

5. That the CHP system has had all required inspections preformed.

6. That the CHP system uses metering technology in accordance with ISO-NE Operating (OP) 18.

7. That "efficiency" is defined as the sum of the total net electrical and useful thermal energy output, divided by LHV of fuel energy input.

PRINT Darrell Sandlin

SIGNATURE 

DATE October 26, 2026

TITLE Director, Engineering Services

FOR Green Harbor Energy

Appendix D: Owner Attestation of CL&M Funding

Owner Attestation of CL&M Funding

I, Michael Shea, as Executive Director & CEO for the Connecticut Airport Authority hereby confirm the Connecticut Airport Authority did not apply for and has not utilized any funding from the Connecticut "Conservation and Load Management Fund", (CL&M fund), in the purchase, install or operation of the combined heat and power plant identified by this M&V Plan.

Print: Michael Shea

Signed: Michael Shea

Date: 10/16/2026

Title: Executive Director & CEO

Appendix E: Generator Performance Specifications for CHP #2 and CHP #3

KRAFTPOWER
The power of performance

Waukesha
INNIO

Bradley Energy Center - Ameresco 0.8PF - Windsor Locks, CT

VHP - L7044GSI S5

Kraft Power Corporation David Barstow dbarstow@kraftpower.com

Power Generation

ENGINE SPEED (rpm):	1200	NOx SELECTION (g/bhp-hr):	Customer Catalyst
DISPLACEMENT (in3):	7040	COOLING SYSTEM:	JW, IC + OC
COMPRESSION RATIO:	9.7:1	INTERCOOLER WATER INLET (°F):	130
IGNITION SYSTEM:	ESM2	JACKET WATER OUTLET (°F):	180
EXHAUST MANIFOLD:	Water Cooled	JACKET WATER CAPACITY (gal):	100
COMBUSTION:	Rich Burn, Turbocharged	AUXILIARY WATER CAPACITY (gal):	11
ENGINE DRY WEIGHT (lbs):	24250	LUBE OIL CAPACITY (gal):	190
AIR/FUEL RATIO SETTING:	0.38% CO	MAX. EXHAUST BACKPRESSURE (in. H2O):	20
ENGINE SOUND LEVEL (dBA)	105	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	ESM2 Controlled	EXHAUST SOUND LEVEL (dBA)	113
FREQUENCY (Hz):	60	PHASE:	3
GENERATOR TYPE:	Synchronous	PHASE ROTATION:	T1-T2-T3

SITE CONDITIONS:

FUEL:	Natural Gas	ALTITUDE (ft):	250
FUEL PRESSURE RANGE (psig):	40 - 60	MAXIMUM INLET AIR TEMPERATURE (°F):	100
FUEL HHV (BTU/ft3):	1,035.2	FUEL WKI:	91.8
FUEL LHV (BTU/ft3):	935.8		

SITE SPECIFIC TECHNICAL DATA

POWER RATING	UNITS		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 100 °F 100%	75%	50%
CONTINUOUS ENGINE POWER	BHP		1900	1900	1425	950
OVERLOAD	% 2/24 hr		0	0	-	-
ELECTRICAL EFFICIENCY (LHV)	%		33.9	33.9	33.2	31.3
GENERATOR OUTPUT	kWe		1350	1350	1013	675
GENERATOR kVA	kVA		1688	1688	1266	844
based on 96.3% generator efficiency at 0.8 PF, no auxiliary engine driven equipment						
FUEL CONSUMPTION						
FUEL CONSUMPTION (LHV)	BTU/kWe-hr		10070	10070	10273	10901
FUEL CONSUMPTION (HHV)	BTU/kWe-hr		11139	11139	11364	12059
FUEL FLOW *based on fuel analysis LHV*	SCFM		242	242	185	131
HEAT REJECTION						
JACKET WATER (JW)	BTU/hr x 1000		3715	3715	2925	2147
LUBE OIL (OC)	BTU/hr x 1000		480	480	443	394
INTERCOOLER (IC)	BTU/hr x 1000		670	670	372	149
EXHAUST	BTU/hr x 1000		3591	3591	2697	1872
RADIATION	BTU/hr x 1000		567	567	545	523
EMISSIONS (ENGINE OUT):						
NOx (NO + NO2)	g/bhp-hr		11.2	11.2	12.3	12.6
CO	g/bhp-hr		9.0	9.0	9.1	9.5
THC	g/bhp-hr		0.5	0.5	0.7	0.9
NMHC	g/bhp-hr		0.052	0.052	0.070	0.091
NM,NEHC (VOC)	g/bhp-hr		0.014	0.014	0.019	0.024
CO2	g/bhp-hr		443	443	452	480
CO2e (Methane GWP: 25)	g/bhp-hr		455	455	468	500
CH2O	g/bhp-hr		0.050	0.050	0.050	0.050
CH4	g/bhp-hr		0.47	0.47	0.63	0.83
AIR INTAKE / EXHAUST GAS						
INDUCTION AIR FLOW	SCFM		2544	2544	1948	1378
EXHAUST GAS MASS FLOW	lb/hr		11828	11828	9055	6405
EXHAUST GAS FLOW *at exhaust temp, 14.6 psia*	ACFM		8201	8201	6190	4316
EXHAUST TEMPERATURE	°F		1100	1100	1078	1056

HEAT EXCHANGER SIZING[12]			
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000		4213
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000		1305

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	450
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	16
AUX WATER PUMP MIN. DESIGN FLOW	GPM	79
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	36

All data provided per the conditions listed in the notes section on page three.
Data Generated by EngCalc Program Version 4.3 INNIO Waukesha Gas Engines, Inc.
2/14/2023 12:30 PM

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KRAFTPOWER
The power of performance

Waukesha
INNIO

Bradley Energy Center - Ameresco 0.8PF - Windsor Locks, CT

VHP - L7044GSI S5

Kraft Power Corporation David Barstow dbarstow@kraftpower.com

Power Generation

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	93
Ethane	C2H6	4
Propane	C3H8	1
Iso-Butane	I-C4H10	0
Normal Butane	N-C4H10	0
Iso-Pentane	I-C5H12	0
Normal Pentane	N-C5H12	0
Hexane	C6H14	0
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	98
NON-HYDROCARBONS:		
Nitrogen	N2	0
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	2
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100

FUEL:	Natural Gas
FUEL PRESSURE RANGE (psig):	40 - 60
FUEL WKI:	91.8
FUEL SLHV (BTU/ft3):	919.50
FUEL SLHV (MJ/Nm3):	36.16
FUEL LHV (BTU/ft3):	935.78
FUEL LHV (MJ/Nm3):	36.80
FUEL HHV (BTU/ft3):	1035.15
FUEL HHV (MJ/Nm3):	40.71
FUEL DENSITY (SG):	0.60

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI* calculations.
* Trademark of INNIO Waukesha Gas Engines Inc.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Chloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Chlori	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes (as Si)	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.
2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.
3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with a tolerance of -0/+5 %. For sizing piping and fuel equipment, it is recommended to include the 5% tolerance.
4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.
5. Emission levels for engines with Waukesha supplied 3-way catalyst are given at catalyst outlet flange. For all other engine models, emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Catalyst out emission levels represent emission levels the catalyst is sized to achieve. Manual adjustment may be necessary to achieve compliance as catalyst/engine age. Catalyst-out emission levels are valid for the duration of the engine warranty. Emissions are at an absolute humidity of 75 grains H2O/lb (10.71 g H2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.
6. Air flow is based on undried air with a tolerance of ± 7%.
7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 50°F (28°C).
8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.
9. Inlet air restrictions based on full rated engine load. Exhaust backpressure based on 178.1 PSI BMEP and 1200 RPM. Refer to the engine specification section of Waukesha's standard technical data for more information.
10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.
11. Fuel must conform to Waukesha's "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.
12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.
13. Fuel volume flow calculation in english units is based on 100% relative humidity of the fuel gas at standard conditions of 60°F and 14.696 psia (29.92 inches of mercury, 101.325 kPa).
14. Fuel volume flow calculation in metric units is based on 100% relative humidity of the fuel gas at a combustion temperature of 25°C and metering conditions of 0°C and 101.325 kPa (14.696 psia; 29.92 inches of mercury). This is expressed as [25, V(0;101.325)].
15. Engine sound data taken with the microphone at 1 m (3.3 ft) from the side of the engine at the approximate front-to-back centerline. Microphone height was at intake manifold level. Engine sound pressure data may be different at front, back and opposite side locations. Exhaust sound data taken with microphone 1 meter (3.3 ft) away and 1 meter (3.3 ft) to the side of the exhaust outlet.
16. Due to variation between test conditions and final site conditions, such as exhaust configuration and background sound level, sound pressure levels under site conditions may be different than those tabulated above.
17. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow.
18. Continuous Power Rating: The highest load and speed that can be applied 24 hours per day, seven days per week, 365 days per year except for normal maintenance at indicated ambient reference conditions and fuel. No engine overload power rating is available.
19. emPact emission compliance available for entire range of operable fuels; however, fuel system and/or O2 set point may need to be adjusted in order to maintain compliance.
20. In cold ambient temperatures, heating of the engine jacket water, lube oil and combustion air may be required. See Waukesha Technical Data.
21. Available Turndown Speed Range refers to the constant torque speed range available. Reduced power may be available at speeds outside of this range. Contact application engineering.

SPECIAL REQUIREMENTS

KPC The power of performance

Appendix F: Metering Instrument Specifications

Natural Gas Meter & Corrector

S:B3

DRESSER
Measurement

ROOTS® Meter Series B3
Featuring Life-Lubed Accessory Units



ROOTS® meter Series B3 are designed to provide accurate gas measurement over widely fluctuating flow, pressure and temperature conditions.

Series 3 and Series 2(TQM) accessory units are interchangeable with Series B basic meter bodies.

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
- CEX - Counter (CTR) with High Frequency Transmitter/Pulser

Series B meter bodies are also available with the integral electronic ROOTS® VTC temperature compensator or the ROOTS® IMC volume, pressure and temperature corrector.

PRODUCT DATA

ROOTS Meters & Instruments

DRESSER

ROOTS® SERIES B3

Full Range of Sizes:
12 meter sizes offer a complete 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 5M have a 6-3/4" (171 mm.) flange-to-flange dimension for standardization in the meter set design. As loads change, meter sizes can be easily interchanged, saving the cost of re-piping.

Accurate Low Flow Performance:
Low start/stop rates extend the rangeability (gas measured) over 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 optional 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.

Solid State Pulser Installation Is A Snap:
ROOTS® meters with factory installed Solid State Pulsers are the low cost solution for your AMR requirements. With magnets installed, the pulser assembly literally snaps onto the cover without removing the meter from service. Pulser-ready meters are an economical factory option.



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

General Information

The ROOTS® meter Series B3 is a positive displacement, rotary type gas meter designed for continuously measuring and indicating the accurate measurement of gas in a pipeline. 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 directly 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 B meters may be used satisfactorily for pressure ranging from a few ounces to full MAOP. Displaced volume measurement is completely independent of the gas specific gravity, temperature, and pressure.

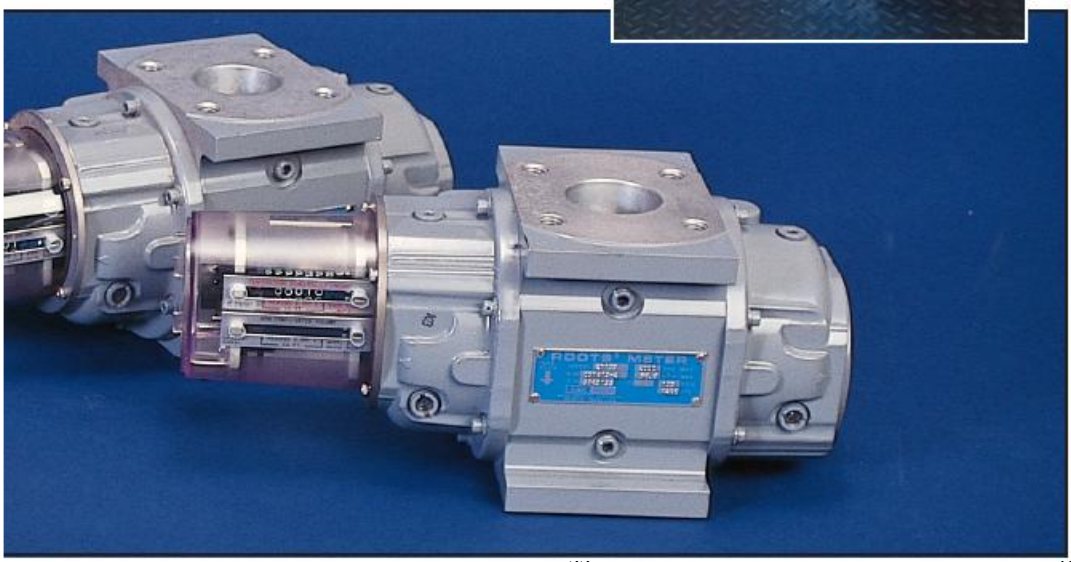
ROOTS® meters are manufactured in accordance with ANSI/ASC-B109.3 for Rotary Type Gas Displacement Meters. ROOTS® meter series B sizes 8C through 56M have flanged inlet and outlet connections conforming dimensionally with ANSI/ASME standards. Sizes 8C through 2M are available with 1-1/2" NPT connections, upon special request. The meter operating temperature range is from -40°F to +140°F (-40°C to +60°C).

ROOTS® meters series B have a Maximum Allowable Operating Pressure (MAOP) rating of 175 psig (1200 kPa). 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® Series B meter bodies accept a wide range of Series 3 accessories for all metering applications.



Counter Pulser & TC Versions



ROOTS® SERIES B3

Meter Specifications

SERIES B3	Units	8C175	11C175	15C175	2M175	3M175	5M175	7M175	11M175	16M175	23M175	38M175	56M175
Base Rating	acfh	800	1100	1500	2000	3000	5000	7000	11000	16000	23000	38000	56000
Max. Operating Pressure	psig	175	175	175	175	175	175	175	175	175	175	175	175
Rangeability +/- 1%		26:1	31:1	40:1	68:1	76:1	120:1	67:1	124:1	116:1	40:1	90:1	53:1
Rangeability +/- 2%		46:1	58:1	78:1	126:1	139:1	215:1	115:1	227:1	223:1	60:1	110:1	109:1
Start Rate	cfh	2.79	2.3	1.94	1.9	2.1	1.2	5.33	3.88	3.24	23	27	40
Stop Rate	cfh	2.03	1.74	1.57	1.1	1.8	0.8	3.39	3.23	1.89	18	20	29
Flow Rate, 0.5" w.c., Gas	cfh	800	1100	1500	2000	2580	3975	5400	7300	9950	14800	20600	23000
Differential, 100% Flow	in.w.c.	0.26	0.356	0.459	0.495	0.64	0.733	0.984	1.07	1.27	1	1.5	1.8
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
Min. CTR Reading	cf	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2	2	2	2
Nominal Pipe Size	in.	2	2	2	2	2	3	3	4	4	6	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	18	21
Oil Capacity: Side Inlet	oz.	0.8	0.8	0.8	1.25	1.25	1.25	3.4	3.4	3.4	40.2	40.2	40.2
Oil Capacity: Top Inlet	oz.	3	3	3	7.6	7.6	7.6	21.85	21.8	21.8	154	154	154

Meter Sizing

Model	8C175*	11C175*	15C175*	2M175	3M175	5M175	7M175	11M175	16M175	23M175	38M175	56M175
Base Rating (ACFH)	800	1100	1500	2000	3000	5000	7000	11000	16000	23000	38000	56000
Metering Pressure (PSIG)	Corrected Capacity at Metering Pressure - MSCFH											
1	0.8	1.2	1.6	2.1	3.1	5.2	7.3	11.5	16.7	24	39.7	58.5
5	1.1	1.5	2	2.6	4	6.6	9.2	14.5	21.1	30.3	50	73.8
25	2.1	2.9	4	5.4	8	13.4	18.7	29.4	42.8	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	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	295.1	434.9
150	8.9	12.3	17	22.3	33	56	78	123	179	256.7	424.1	625
175	10.3	14.1	19	25.7	39	64	90	141	206	295.7	488.6	721.5
200	11.7	16	21.9									

*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 Measurement

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Houston, Texas, USA TX 77077
Email: DMD_Roots@dresser.com

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Website: www.dresser.com

ROOTS BLOWERS & COMPRESSORS ROOTS METERS & INSTRUMENTS DRESSER PIPING SPECIALTIES MOONEY CONTROLS FLOSYSTEMS

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WINDOWS® is a registered trademark of Microsoft Corporation.

S:B3
Rev. 6/01

Honeywell



EC 350 PTZ Gas Volume Correctors
Enabling Precision Gas Measurement

Proven Technology. Superior Performance.

Local gas distribution companies supplying commercial and industrial customers require gas measurement solutions that are accurate, easy to maintain and reliable over extended operation. A PTZ gas volume corrector converts gas volume from operating conditions to reference pressure and temperature conditions. Thus, it is a key element in the gas value chain, from the meter to billing data.

Honeywell's EC 350 PTZ gas volume correctors are purpose-built, UMB- and rotary-mount devices, which are intended to simplify and optimize custody transfer and industrial measurement. This new electronic corrector platform offers best-in-class features such as improved accuracy, expanded memory, advanced diagnostics nd integrated cellular communications. The EC 350 also reduces maintenance requirements and is intuitive and simple to use.





Modern & Reliable

With the EC 350 family of PTZ gas volume correctors, gas distribution firms are assured of robust performance in standard meter applications. The basic design of these correctors allows for very precise measurements and long-term reliability. They are fully field-programmable and easy to use through a multi-line keypad interface. The EC 350 also ensures users of a low total cost of ownership and reduced operating expenses.

With the EC 350 Platform, Users Benefit from:

- Greater flexibility in gas volume correction
- Intuitive operation for all corrector applications
- Versatile UMB, rotary and wall-mount options
- Expanded communication options via internal cellular modem
- IR port allowing for easy configuration
- Advanced audit trail
- Robust diagnostics to reduce maintenance
- Extended 10-year battery life
- Low ownership and operating costs





When it comes to gas volume correction, the EC 350 line provides many operational advantages. These flexible devices have a common look and feel, and utilize state-of-the-art technology such as a reverse flow capability. The volume correctors incorporate a highly accurate, plug-and-play digital pressure transducer and an enclosure optimized for serviceability. Featuring long-term stability and extended battery life, the EC 350 minimizes the need for site visits and simplifies field repairs.

State-of-the-Art Technology

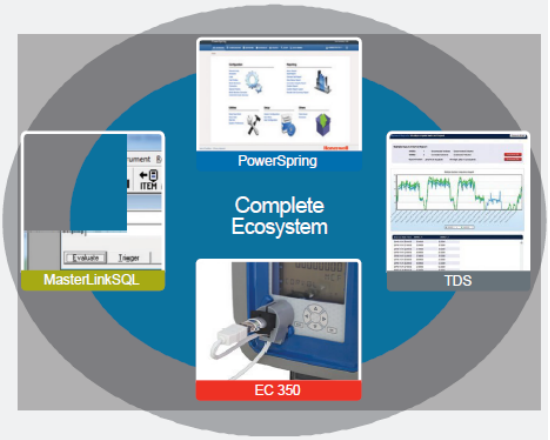
A Simple Move

The EC 350 is the first member of a new family of Electronic Volume Correctors and Dataloggers. This new platform comprises:

- EC 350 Electronic Volume Corrector
- TC 350 Turbo Corrector (not yet available)
- TM 350 Turbo Monitor (not yet available)
- ER 350 Electronic Recorder (not yet available)

This New Evc Platform Leverages 40 Years of Experience and Reuses Some Important Design Characteristics of the Successful Mini-Max and Mini-AT Product Lines:

- Same UMB—The Mini-Max and Mini-AT pulse input subsystem has been improved over time to make it the most reliable pulsing assembly available in the market. The EC 350 inherits this superiority by using the same field-proven UMB and pulse-sensing mechanism as the Mini-Max.
- Similar door lock and latch mechanism—The EC 350 uses a robust latching and locking mechanism similar to the Mini-Max standard for ruggedness and reliability
- Alkaline battery pack—The Mini-Max battery pack is easy to open/close and snap in place. Using low-cost and easily disposable alkaline batteries is a very popular feature of the existing Mini-Max and Mini-AT grade products.
- Rotary interface
- Messenger modem
- MasterLink—The MasterLink software is widely used and recognized by most operators. The EC 350 simply appears as a new selection in the list of supported products.



EC350 is Part of an Integrated Ecosystem That Also Comprises:

- PowerSpring—Aggregates large volumes of granular interval meter data, and then pre-processes it smartly and efficiently before such data is commercially processed by various other enterprise utility applications. PowerSpring MDM uses state-of-the-art technology to ensure compliance to stringent IT data security standards and user policies without compromising human factors and ease to use.
- Total Data Services (TDS)—TDS delivers the interval meter data (load profile) and optionally device alarms and gas system pressure data, directly to your desktop through a secure, customizable web portal.
- MasterLink SQL—MasterLink was designed to offer a single software package to interact with Honeywell Mercury Instruments. MasterLink is a single software package to provide the ability to configure, calibrate, download data, create reports and graphs, diagnostic tools, communicate via serial, modem, ISP, wireless...and more.

Best-in-Class Features

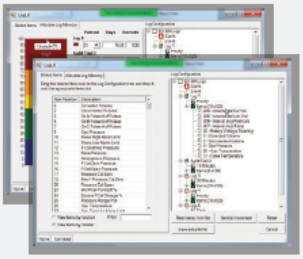
- Field-proven Mini-Max UMB configuration
- Meter, rotary or wall-mount
- Corrected volume calculation according to AGA-7, AGA-8 gross method 1 & 2, AGA-8 Detailed and NX-19
- Multi-line dynamic contrast (LCD display)
- Easy navigation with intuitive menus
- Reverse flow measurement capability
  - Avoid potential fines for overbilling customers
- Optional cellular radio or landline modem
  - Compatible with cellular devices for remote data transmission



- Plug-and-play digital pressure transducer
  - Eliminates specialized training for field replacement
  - Better accuracy: 4 times more accurate than a MiniMax, therefore fewer units to stock



- Backwards compatibility with existing rotary meters
- Up to 10-year battery life
  - Significantly reduces cost-of-ownership
- Long-term stability and accuracy
  - Increases cycle time between recalibrations
- AMR/AMI support with serial interface and pulse output
- AMR-ready and compatible with Itron, Sensus, Aclara and other AMR devices
- Configurable and mappable audit trail
  - Includes options for multiple audit trail logs



- Outputs: 4 opto-couplers (3 pulse + 1 alarm)
- Embedded Modbus communication
  - Eliminates need for PT board
  - Supports Modbus ASCII, RTU and Enron (BSAP: future)
- Multiple, independent communication ports
  - Allows simultaneous access (multi-tasking) from all ports
  - IrDA interface operates at the same time as an RS port
- RS232/485 communication port
- Optional 4-20 mA (requires external loop power), additional RS232/485, Mux DI/DO board (future)
- IrDA port for configuration, item file or audit trail download
- Mercury MasterLink programming software
- Redundant uncorrected meter data reading
- Remote firmware upgradeability
  - Minimizes need to send technicians to the site
- Easy addition of I/O
  - Enables easy upgrades and retrofits in the field
- Flexible power supply options
  - Easily adapts to installation environment
- Universal AMR mounting
  - Does away with tampering
- CSA/MC/ATEX/IEC Ex/MID/EN12405 approvals

The Easy Choice

Honeywell is more than just a gas measurement hardware provider—we deliver a complete solution for meter data collection and management. Our Total Data Services (TDS) provide a fully secured outsourcing alternative for data acquisition, remote monitoring, remote control and event notification applications. With TDS, Honeywell hosts the customer's metering data and makes it accessible via a secure web portal.

In addition to the instruments, software (MasterLink, PowerSpring) and web-based services (TDS) that Honeywell Mercury Instruments provides, the EC 350 volume correctors can be delivered pre-configured with cellular radio provisioned, activated and tested, ready to be integrated with TDS, Honeywell's PowerSpring Meter Data Management software or your favorite data collection software to ease IT integration in your Advanced Metering or Smart Metering infrastructure.

This ensures each installation is a success and limits the risks inherent to properly configuring the different elements of the puzzle.

Make the Right Choice

Honeywell offers industry-leading gas control, measurement and analysis equipment to gas utilities and other users around the world. We have expertise along the entire gas supply chain, with products and systems that enable you to exercise full control over your regulating and measuring needs.

Honeywell is recognized for long-term reliability and performance; lowest total cost of ownership and installation; and outstanding technical training, field support and customer service.

We are committed to the gas measurement field, with a track record of providing backwards compatibility and a path forward for our customers.

Wherever you are, you can count on Honeywell's commitment to product quality, reliability, safety and performance.

Today, no other electronic volume corrector manufacturer offers more products and services for the gas industry than Honeywell. With the most complete line of gas volume correctors and global service and support capabilities, we have the products you need, ready for immediate delivery.

Technical Specifications

Accuracy

- Maximum error over the full temperature range -40°C to 65°C (-40°F to 149°F) including linearity, repeatability and hysteresis:
  - Pressure: ±0.1% of full scale
  - Temperature: ±0.1% of reading
- Maximum error at reference conditions:
  - Pressure: ±0.04% of full scale
  - Temperature: ±0.1% of reading
- Long term drift:
  - Pressure: ±0.4% of full scale over 10 years
- Recommended calibration time: 10 years

Environmental Conditions

- Ambient temperature range: -40°C to 65°C (-40°F to 149°F)
- Ambient humidity range: 0 to 95% non-condensing

Power Supply Options

- Alkaline receptacle (5-7 years)
- Lithium batteries (10 years)
- DC power

Certifications

- CSA C/US Class I, Div 2, Groups C&D, T3C
- CSA C/US Class I, Div 1, Groups C&D
- Class I, Zone 0, AEx ia IIB T4 Ga
- IECEx Ex ia IIB T4 Ga

Metrological Approvals

- Measurement Canada

Technical data is subject to change without notice.

For More Information

To learn more about Honeywell's EC 350 PTZ Gas Volume Correctors, visit https://process.honeywell.com or contact your Honeywell account manager.

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United States & Canada: 855-251-7065
Outside the United States: 302-669-4253
https://process.honeywell.com

BR-15-13-ENG
April 2024
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Honeywell

Electric Metering

ION9000 series Technical Datasheet

The PowerLogic™ ION9000 is your 24/7 power quality expert, providing information, not just data.

With a comprehensive, industry-leading Power Quality Instrument (PQI) performance designation according to IEC 62586-1/-2, the PowerLogic™ ION9000 is third-party certified ANSI C12.20 Class 0.1 and IEC 62053-22 Class 0.1S accurate, the most accurate power meter available today. Lab-verified power quality and safety ensure reliable, precision performance that is perfect for supply- or demand-side applications. Its patented Disturbance Direction Detection also helps you pinpoint the source of power quality issues faster. Capable of sampling at 10 MHz, the ION9000T captures extremely fast voltage events that are missed by most other power meters, enabling advanced diagnostics and high-resolution event associations for fast, conclusive diagnosis and resolution to transient voltages.

Highly customizable and modular, the ION9000's field programmability can adapt to satisfy any solution, protecting your investment now and in the future. All designed to align with your comprehensive grid cybersecurity policies and backed by Schneider Electric's global services and support.

Applications

Ideal for critical power and large energy users who cannot afford to be shut down, the ION9000T has High-Speed Transient Capture (HSTC) to detect and record transient events that exceed the voltage withstand of sensitive equipment.



METSEION92040

ION9000 series

The market solution for

Markets that benefit from a solution that includes PowerLogic™ ION9000 series meters:

- Data centers
- Healthcare facilities
- Semiconductor
- Pharmaceutical & chemical
- Energy industries
- Mining, Minerals, & Metals
- Renewable energy interconnects
- Medium voltage distribution & energy automation

Benefits

- Makes understanding power quality simple which helps operations personnel avoid downtime and increase productivity and equipment life
- Makes energy and power quality data immediately actionable and relevant to operational and sustainability goals

Competitive advantages

- Modular, flexible, patented ION™ programmable technology
- Utility grade energy accuracy
- Patented Disturbance Direction Detection
- Third-party, lab-verified compliance to the latest PQ standards
- Onboard pass/fail PQ characterization and assessment according to EN50160 and IEEE519
- Cybersecurity event logging, Syslog protocol, HTTPS, SFTP, and full control of each communication port
- High-speed impulsive and oscillatory transient detection

Power management solutions

Schneider Electric provides innovative power management solutions to increase your energy efficiency and cost savings. Maximize electrical network reliability and availability, and optimize electrical asset performance.

Conformity of standards

- ANSI C12.20
- ANSI C37.90.1
- IEC 61000-4-7
- IEC 61000-4-15
- IEC 61000-4-30
- IEC 61010-1
- IEC 61326-1
- IEC 61557-12
- IEC 61850
- IEC 62052-11
- IEC 62052-31
- IEC 62053-22
- IEC 62053-23
- IEC 62053-24
- IEC 62586
- UL 61010-1



PowerLogic™ ION9000 front view



PowerLogic™ ION9000 with panel mounting adapter

ION9000 series



PowerLogic™ ION9000 series meter with RD192 display



PowerLogic™ ION9000 RD192 remote display



PowerLogic™ ION9000 Harmonics display

Main characteristics

- PQ compliance reporting and basic PQ analysis:
  - Recognized as a Power Quality Instrument Class A to IEC62586-1 and IE62586-2
  - Monitors and logs parameters according to IEC 61000-4-30 Class A international PQ standards (test methods as per IEC 62586-2).
  - High resolution waveform capture: triggered manually or by event. Captured waveforms available directly from the meter via SFTP in a COMTRADE format, and viewable in the meter's web interface.
  - Generates onboard PQ compliance reports accessible via onboard web pages:
    - Pass/fail report for IEEE 519 for voltage and current harmonic limits.
    - ITIC (CBEMA) and SEMI curves, with alarm categorization to support further analyses.
    - NEMA Motor Derating curve.
  - Harmonic analysis:
    - THD and TDD per phase, min/max, custom alarming.
    - Individual harmonic magnitudes and angles on voltage and current, up to the 63rd harmonic.
  - Disturbance detection and capture: sag/swell on any current and voltage channel, alarm on disturbance event, and waveform capture.
  - Patented Disturbance Direction Detection: provides indication of the captured disturbance occurring upstream or downstream of the meter; timestamped results provided in the event log, with degree of certainty of disturbance direction.
- Transient detection and capture: events 20 microseconds or longer in duration on any voltage channel with alarm, event log, and waveform capture.
- PowerLogic™ ION9000T also provides High-Speed Transient Capture (HSTC) of voltage events 100 nanoseconds or longer in duration and up to 10,000 V in magnitude with high-speed and disturbance waveform captures, as well as per-event statistics on each transient.

- Metering precision:
  - IEC 61557-12 PMD/SD/K70/0.2 and PMD/SS/K70/0.2 3000m (Performance Measuring and Monitoring devices (PMD)).
  - Industry leading Class 0.1S accuracy IEC 62053-22, ANSI C12.20 Class 0.1 (active energy).
  - Class 0.5S accuracy for reactive energy (IEC 62053-24).
  - Cycle-by-cycle RMS measurements updated every ½ cycle.
  - Full 'multi-utility' WAGES metering support.
  - Net metering.
  - Anti-tamper protection seals and hardware metrology lock.

- Cybersecurity:
  - Security events logging with Syslog protocol support.
  - HTTPS and SFTP secure protocols.
  - Ability to enable or disable any communication port and any protocol per port.
  - Anti-tamper protection seals and hardware metrology lock.
  - User accounts with strong passwords.

- Used with Schneider Electric's advanced software tools, provides detailed PQ reporting across entire network:
  - EN 50160 compliance report.
  - IEEE 519 harmonic compliance report.
  - IEC 61000-4-30 report.
  - Power quality compliance summary.
  - Energy reports for consumption analysis and cost management.
  - WAGES dashboards and reports.
  - Display of waveforms and PQ data from all connected meters.
  - Onboard web-based waveform viewer.
  - EcoStruxure™ Power Events Analysis, including alarm management, sequence of events, and root cause analysis.

ION9000 series

Feature guide

General	ION9000	ION9000T
Use on LV, MV, and HV systems	■	■
Current accuracy: 0.1 % reading	■	■
Voltage accuracy: 0.1 % reading	■	■
Active energy accuracy: 0.1 Class	■	■
Number of samples/cycle or sample frequency: 1024	■	■
High-Speed Transient Capture: 10 MHz (200 k for 50 Hz, 167 k for 60 Hz)	-	■
Instantaneous rms values		
Current, voltage, frequency	■	■
Active, reactive, apparent power: Total and per phase	■	■
Power factor: Total and per phase	■	■
Energy values		
Active, reactive, apparent energy	■	■
Settable accumulation modes	■	■
Demand values		
Current: Present and max. values	■	■
Active, reactive, apparent power: Present and max. values	■	■
Predicted active, reactive, apparent power	■	■
Synchronization of the measurement window	■	■
Setting of calculation mode: Block, sliding	■	■
Power Quality measurements		
Harmonic distortion: Current and voltage	■	■
Individual harmonics: via front panel and web page: 63 via EcoStruxure™ software: 511	■	■
Waveform capture	■	■
Detection of voltage swells and sags	■	■
Fast acquisition: 1/2 cycle data	■	■
EN 50160 compliance checking	■	■
Customizable data outputs (using logic and math functions)	■	■
IEEE 519 compliance checking	■	■
Data recording		
Min/max of instantaneous values	■	■
Data logs	■	■
Event logs	■	■
Trending/forecasting	■	■
SER (Sequence of event recording)	■	■
Time stamping	■	■
GPS synchronization (± 1ms)	■	■
Memory: 2000 MB	■	■
Display and I/O		
Front panel display, 2 options: 96 mm & 192 mm	■	■
Pulse output: 2	■	■
Digital or analog inputs(max): 32 digital, 16 analog	■	■
Digital or analog outputs (max, including pulse output): 4 digital, 10 relay, 8 analog	■	■
Communication		
2-Wire RS-485 port	■	■
Ethernet port(s): 2x 10/100BASE-TX, RJ45 connector, CAT5/5a/6/6a cable	■	■
Serial port protocols (Modbus, ION, DNP3, DLMS/COSEM)	■	■
Ethernet port protocols (Modbus, ION, DNP3, DLMS/COSEM, IEC 61850)	■	■
Ethernet gateway	■	■
Alarm notification via email	■	■
HTTP/HTTPS web server with waveform viewer	■	■
SNMP with custom MIB and traps for alarms	■	■
SMTP email	■	■
PTP and NTP time synchronization	■	■
SFTP file transfer	■	■
Option module with 4-Wire RS-485 port	■	■
Option module with Fiber-Ethernet port	■	■

ION9000 series

Technical specifications

Electrical characteristics			ION9000	ION9000T
Type of measurement	True rms to 1,024 samples per cycle		■	■
	High-speed transient detection, 10 MHz, 10 kV		-	■
Measurement accuracy	Current & voltage	Class 0.1 as per IEC 61557-12	■	■
	Active Power	Class 0.1 as per IEC 61557-12	■	■
	Power factor	Class 0.5 as per IEC 61557-12	■	■
	Frequency	Class 0.02 as per IEC 61557-12	■	■
	Active energy	Class 0.1S IEC 62053-22 Class 0.1 IEC 61557-12 Class 0.1 ANSI C12.20	■	■
	Reactive Energy	Class 0.5S IEC 62053-24	■	■
Display refresh rate		HMI display updated once per second; data refresh rate 1/2 cycle or 1 second	■	■
Input-voltage characteristics	Specified accuracy voltage	57 - 400 V L-N / 100 - 690 V L-L	■	■
	Impedance	5 MΩ per phase	■	■
	Specified accuracy frequency	42 to 69 Hz (50/60 Hz nominal)	■	■
	Limit range of operation - frequency	20 to 450 Hz	■	■
Input-current characteristics	Rated nominal current	1 A (0.1S), 5 A (0.1S); current class 2, 10, 20 A (0.1 ANSI)	■	■
	Specified accuracy current range	Starting Current: 1 mA (no accuracy) Accurate Range: 10 mA - 20 A	■	■
	Permissible overload	500 A rms for 1.0s	■	■
	Impedance	0.0003 Ω per phase	■	■
	Burden	0.01 VA max at 5 A	■	■
LV Input-current characteristics	Input voltage range	±5.5 V pk	■ [1-3]	-
	Minimum signal	1 mV	■ [1-3]	-
	Withstand	30 V pk continuous	■ [1-3]	-
	Input impedance	200 k Ω	■ [1-3]	-
	Safety	For use with listed Energy Monitoring current transformers	■ [1-3]	-
Power supply AC/DC	AC	90-480 V AC ±10 % (50/60 Hz ±10 %) 90-120 V AC ±10% (400 Hz)	■	■
	DC	110-480 V DC ±10 %	■	■
	Ride-through time (Values for meters with no optional accessories)	100 ms (5 cycles at 50/60 Hz) typ., 120 V AC 400 ms (20 cycles at 50/60 Hz) typ., 240 V AC 1,200 ms (60 cycles at 50/60 Hz) typ., 480 V AC	■	■
	Burden	Typical: 16.5 W / 38 VA at 480 V (50/60 Hz) Fully optioned: max. 40 W / 80 VA at 480 V (50/60 Hz).	■	■
Power supply LV DC	DC	20 to 60 V DC ±10 %	■	-
	Burden	Typical: 15 W at 20 to 60 V DC Fully optioned: 38 W at 20 to 60 V DC	■	-
Input/outputs	Meter base Only	8 digital inputs (30 V AC/60 V DC) 4 Form A (KY) solid state digital output (30 V AC/60 V DC, 75 mA) 2 Form C relays (8 A at 250 V AC, 5 A at 24 V DC)	■	■
	Optional	Digital - 6 digital inputs (30 V AC / 60 V DC) wetted + 2 Form C relay outputs (250 V AC, 8 A)	■	■
		Analog - 4 analog inputs (0-20 mA, 4-20 mA, 0-30 V DC) + 2 analog outputs (0-20 mA, 4-20 mA, 0-10 V DC).	■	■

[1-3] The LV Input-current option replaces standard CT inputs

ION9000 series

Mechanical characteristics			ION9000	ION9000T
Weight	DIN rail mount meter 1.5 kg IO modules 0.140 kg Touchscreen display 0.300 kg		■	■
IP degree of protection	IP 65, UL type 12: Panel mount and touchscreen display, front. IP 30: Panel mount rear, DIN rail mount, I/O modules.		■	■
Excellent quality		ISO 9001 and ISO 14000 certified manufacturing.	■	■
Dimensions	Panel mount	160 x 160 x 135.3 mm	■	■
	DIN rail mount meter	160 x 160 x 135.3 mm	■	■
	Color remote display (2 options)	197 x 175 x 27.5 mm touchscreen	■	■
	I/O modules	90.5 x 90.5 x 22 mm	■	■
	Touchscreen display(s)	192 mm and 96 mm	■	■
Environmental conditions				
Operating temperature	-25 to 70 °C		■	■
Remote Display Unit	-25 to 60 °C		■	■
Storage temperature	-40 to 85 °C		■	■
Humidity rating	5 to 95 % non-condensing		■	■
Installation category	III		■	■
Operating altitude (maximum)	3,000 m above sea-level		■	■
Electromagnetic compatibility				
EMC standards	IEC 62052-11, IEC 61326-1, IEC 61000-6-5		■	■
Immunity to electrostatic discharge	IEC 61000-4-2		■	■
Immunity to radiated fields	IEC 61000-4-3		■	■
Immunity to fast transients	IEC 61000-4-4		■	■
Immunity to surges	IEC 61000-4-5		■	■
Immunity to conducted disturbances	IEC 61000-4-6		■	■
Immunity to power frequency magnetic fields	IEC 61000-4-8		■	■
Immunity to conducted disturbances, 2-150kHz	CLC/TR 50579		■	■
Immunity to voltage dips & interruptions	IEC 61000-4-11		■	■
Immunity to ring waves	IEC 61000-4-12		■	■
Conducted and radiated emissions	EN 55011 and EN 55032 Class B, FCC part 15 Class B, ICES-003 Class B		■	■
Surge withstand Capability (SWC)	IEEE/ANSI C37.90.1		■	■
Safety				
Safety Construction	IEC/EN 61010-1 ed.3, CAT III, 400 V L-N / 690 V L-L, UL 61010-1 ed.3 and CSA-C22.2 No 61010-1 ed.3, CAT III, 347 V L-N / 600 V L-L, IEC/EN 62052-31, protective class II		■	■
Communication				
Ethernet to serial line gateway	Communicates directly with up to 31 serial devices		■	■
Web server	Customizable pages, new page creation capabilities, HTML/XML compatible		■	■
Serial port RS-485	2x, Baud rates of 2,400 to 115,200, pluggable screw terminal connector		■	■
Ethernet port(s)	2x 10/100BASE-TX, RJ45 connector, CAT5/5e/6/6a cable		■	■
Protocol	HTTPS, SFTP, SNMP, SMTP, DPWS, RSTP, PTP, NTP/SNTP, GPS, Syslog, DHCP, IPv4, IPv6		■	■
Communication option module				
Optional port 4-Wire RS-485	Baud rates of 2400 to 115200, pluggable screw terminal connector		■	■
Optional Fiber-Ethernet port	Ethernet patch cable from base meter, multi-mode 100Base-FX, SC duplex connector		■	■

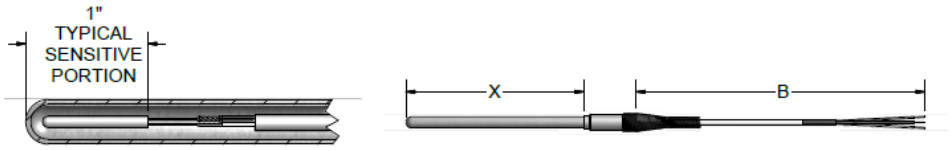
ION9000 series

Firmware characteristics		ION9000	ION9000T
High-speed data recording	Down to 1/2 cycle interval recording, stores detailed characteristics of disturbances or outages. Trigger recording by a user-defined setpoint, or from external equipment	■	■
Harmonic distortion	Up to 63rd harmonic (511th via Schneider Electric EcoStruxure™ software) for all voltage and current inputs	■	■
Sag/swell detection	Analyze severity/potential impact of sags and swells: magnitude and duration data suitable for plotting on voltage tolerance curves per phase triggers for waveform recording	■	■
Disturbance direction detection	Determine the location of a disturbance more quickly and accurately by determining the direction of the disturbance relative to the meter. Results are captured in the event log, along with a timestamp and confidence level indicating level of certainty	■	■
Detection & capture of transients	As short as 20 µs at 50 Hz (17 µs at 60 Hz)	■	■
High-speed transient capture	Detection and capture of high-speed impulsive and oscillatory transients as short as 100 ns in duration and up to 10 kV in magnitude	-	■
Instantaneous	High accuracy of standard speed (1s) and high-speed (1/2 cycle) measurements, including true rms per phase and total for: voltage, current, active power (kW),reactive power (kvar), apparent power (kVA), power factor, frequency, voltage and current unbalance, phase reversal	■	■
Load profiling	Channel assignments (1600 channels via 100 recorders) configurable for any measurable parameter, including historical trend recording of energy, demand, voltage, current, power quality, or any measured parameter. Trigger recorders based on time interval, calendar schedule, alarm/event condition, or manually	■	■
Trend curves	Historical trends and future forecasts to better manage demand, circuit loading, and other parameters. Provides average, min, max, and standard deviation every hour for last 24 hours, every day for last month, every week for last 8 weeks and every month for last 12 months	■	■
Waveform captures	Simultaneous capture of voltage and current channels, sub-cycle disturbance captures of 180-cycles @ 1,024 samples/cycle to 7,200-cycles @ 16 sample/cycle, retriggerable	■	■
High-speed transient waveform captures	Simultaneous capture of voltage channels, impulsive and oscillatory transient capture of up to 1-cycle @ 200 k samples per cycle (50 Hz) along with coincidence disturbance waveform capture	-	■
Alarms	Threshold alarms: adjustable pickup and dropout setpoints and time delays, numerous activation levels possible for a given type of alarm, user-defined or automatic alarm threshold settings, user-defined priority levels (optional automatic alarm setting)	■	■
Advanced Time of Use (TOU)	4 seasons; 5 different day types: weekend, weekday, and holiday; up to 4 tariffs per day type	■	■
Advanced network security	Up to 50 users with unique access rights. Perform resets, time sync, or meter configurations based on user privileges	■	■
Memory	2,000 MB	■	■
Firmware update	Update via the communication ports	■	■
Display characteristics			
96 mm pushbutton display	320 x 240 (1/4 VGA) color LCD, configurable screens, 5 buttons and 2 LED indicators (alarm and meter status)	■	■
192 mm touchscreen display	800 x 480 pixels, 177.8 mm (7") Color LCD, +/- 85 degree view angle, sunlight readable, dual capacitive touch, usable when wet or through Class 0 lineman gloves, impact resistant to 5 joules, IP65 rating	■	■
Languages	English, French, Spanish, Russian, Portugese, German, Italian, Chinese	■	■
Notations	IEC, IEEE	■	■

RTD

Configuration Code RT01
RTD Assemblies with Extension Leadwire
Configuration Code RT02
RTD Assemblies with Sheath Terminations

The RTD elements illustrated and described on this page are designed to measure temperature in a variety of process and laboratory applications. These RTDs are specifically designed for use in two different process temperature ranges and will provide accurate and repeatable temperature measurement through a broad range. Low range RTDs are constructed using fluoropolymer-insulated, silver-plated copper internal leads with potting compounds to resist moisture penetration. High range RTDs are constructed with nickel internal leads inside swaged MgO insulated cable to allow higher temperature measurements at the RTD element and provide higher temperature lead protection along the sheath. The following tables allow customer selection of standard element materials, tolerances, sheath diameters, mounting fittings and terminations. Custom-built assemblies with non-standard specifications are available upon request.



ORDER CODES

Example Order Number: **R5T185L** (1-1) **48** (1-2(A)) **3** (1-3) - **006** (1-4) - Page RTD-2 - Page RTD-3 - Page RTD-4 - Page RTD-5

1-1 Single Platinum RTD Elements

CODE	TOLERANCE[1]	BASE RESISTANCE @ 0 °C (R_0)	TEMPERATURE COEFFICIENT	CODE			
				1/8" O.D.	3/16" O.D.	1/4" O.D.	3/8" O.D.
LOW RANGE WIRE WOUND (-200 to 200) °C [-328 to 392] °F							
R1T185L	Grade B	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
R3T185L	Class AA	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
R5T185L	(1/5) Class B	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
R1T192L	Grade B	100 Ω	α = 0.003 92 °C^{-1}	28	38	48	68
R3T192L	Class AA	100 Ω	α = 0.003 92 °C^{-1}	28	38	48	68
LOW RANGE THIN FILM (-50 to 200) °C [-58 to 392] °F							
RBF185L	Class B	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
RAF185L	Class A	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
RBF195L	Class B	1000 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
HIGH RANGE WIRE WOUND (-200 to 600) °C [-328 to 1112] °F							
R1T185H	Grade B	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
RAT185H	Class A	100 Ω	α = 0.003 85 °C^{-1}	28	38	48	68
R1T192H	Grade B	100 Ω	α = 0.003 92 °C^{-1}	28	38	48	68
[1] Refer to RTD tolerance information in the general information section for calculations to determine specific tolerance at temperature.							

1-1 Duplex Platinum RTD Elements

CODE	TOLERANCE[1]	BASE RESISTANCE @ 0 °C (R_0)	TEMPERATURE COEFFICIENT	CODE		
				3/16" O.D.	1/4" O.D.	3/8" O.D.
LOW RANGE WIRE WOUND (-200 to 200) °C [-328 to 392] °F						
R1T285L	Grade B	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
R3T285L	Class AA	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
R5T285L	(1/5) Class B	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
R1T292L	Grade B	100 Ω	α = 0.003 92 °C^{-1}	38	48	68
R3T292L	Class AA	100 Ω	α = 0.003 92 °C^{-1}	38	48	68
LOW RANGE THIN FILM (-50 to 200) °C [-58 to 392] °F						
RBF285L	Class B	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
RAF285L	Class A	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
RBF295L	Class B	1000 Ω	α = 0.003 85 °C^{-1}	38	48	68
HIGH RANGE WIRE WOUND (-200 to 600) °C [-328 to 1112] °F						
R1T285H	Class B	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
RAT285H	Class A	100 Ω	α = 0.003 85 °C^{-1}	38	48	68
R1T292H	Grade B	100 Ω	α = 0.003 92 °C^{-1}	38	48	68
[1] Refer to RTD tolerance information in the general information section for calculations to determine specific tolerance at temperature.						

1-2 Available Sheath Diameters 316SS

1-4 Length

CODE
3 Digit 'X' Length

1-3 Element Connection

CODE	DESCRIPTION
2	2-wire
3	3-wire
4[1]	4-wire
[1] Not available in duplex	

1-2A

CODE	NOMINAL SHEATH DIAMETER (inches)	TIP DIA. O.D. (inches)	TIP LENGTH (inches)
88R48	1/2	1/4	1 1/4
68R38	3/8	3/16	1 1/4
48R28	1/4	1/8	1 1/4

REDUCED-TIP RTD's

Table 1-2A lists RTD elements with reduced tip sheaths. To order, use order code numbers from Tbl. 1-2A in place of straight sheath order code numbers from Tbl. 1-2. Other reduced tips are available upon request. EXAMPLE: R1T185L**88R483**-006.

Dynasonics
Ultrasonic Flow Meters

Transit Time Flow Meters

TFXL Ultrasonic

DESCRIPTION

The TFXL ultrasonic transit time flow meter measures most clean liquids and liquids with small amounts of suspended solids or aeration, such as surface water or sewage.

FEATURES

- Bi-directional flow measurement system.
- Totalizer options include forward, reverse and net total.
- ULTRALINK software utility enables in-field flow meter configuration, calibration and troubleshooting, via laptop PC.
- Compact enclosure uses large, easy-to-read digital display.

BENEFITS

- Reduced material costs: clamp-on sensor eliminates the need for in-line flanges, pipe fittings, strainers, and filters.
- Reduced installation time: may be installed and fully operational within minutes. No need to break into pipelines.
- Reduced maintenance costs: with no moving parts, there is nothing on the TFXL to wear down — no repair kits or replacement parts are needed.
- Easy retrofit: with three standard outputs (4…20 mA, TTL pulse and simulated turbine frequency), the TFXL drops easily into existing DCS and flow monitoring systems.
- Reduced downtime: installation may be performed on full pipes. No need to shut the process down for installation or maintenance.

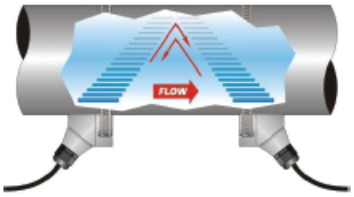
APPLICATION

The TFXL ultrasonic flow meter clamps onto the outside of a pipe and does not contact the internal liquid. This advanced product provides instantaneous rate and accumulated flows along with 4…20 mA and pulse outputs. Compact integral mount systems can accommodate pipes/tubing two inches and smaller. Remote mount systems are also available for pipe/tubing sizes 1/2 in. (DN 15) and higher.



OPERATION

Transit time flow meters use two transducers that function as both ultrasonic transmitters and receivers. The flow meters operate by alternately transmitting and receiving a frequency-modulated burst of sound energy between the two transducers. The burst is first transmitted in the direction of fluid flow and then against fluid flow. Since sound energy in a moving liquid is carried faster when it travels in the direction of fluid flow (downstream) than it does when it travels against fluid flow (upstream), a differential in the times of flight will occur. The sound's time-of-flight is accurately measured in both directions and the difference in time-of-flight calculated.



Badger Meter

TTM-DS-00960-EN-02 (September 2014)

Product Data Sheet

SPECIFICATIONS

System

Liquid Types	Most clean liquids or liquids containing small amounts of suspended solids or gas bubbles	
Velocity Range	0.1…40 FPS (0.03…012, MPS)	
Flow Accuracy	DTTR/DTTN/DTTH DTTS/DTTC	±1% of reading at rates > 1 FPS (0.3 MPS), ±0.01 FPS (±0.003 MPS) at rates lower than 1 FPS 1 in. (25 mm) and larger – ±1% of reading from 10…100% of measuring range, or ±0.01 FPS (0.003 MPS) at rates lower than 10% of measuring range; 3/4 in. (19 mm) and smaller – ±1% of full scale
Ambient Temperature	General purpose Hazardous locations integral mount Hazardous locations DTTN	–40…185° F (–40…85° C) 0…105° F (–17…40° C) –40…185° F (–40…85° C)
Repeatability	±0.5% of reading	
Transducer Type	Clamp-on, uses time-of-flight ultrasonics	
Protection	Reverse polarity, surge suppression	
Certifications	Remote mount transmitter and integral mount transmitter with transducers	General purpose standards: UL 61010-1 and CSA C22.2 No. 61010-1 Hazardous location designation and standards: Class I, Division 2, Groups C and D UL1604, CSA C22.2 No. 213
	Hazardous location transducers (DTTN with I.S. option)	Hazardous location designation and standards: Class I, Division 1, Groups C and D, T5 UL913:2002, UL916 CAN/CSA C22.2 No. 0-10, C22.2 No. 142-M1987, C22.2 No. 157-92 Install with I.S. barrier D070-1010-002

Transmitter

Power Requirements	12…28V DC @ 0.25A	
Display	Type Rate Total	2 line x 8 character LCD 8 maximum digits with lead zero blanking 8 maximum digits with exponential multipliers from –1…6
Enclosure Rating	NEMA Type 3 (Type 3) ABS, PVC and Ultem (integral system), brass or SS hardware	
Units of Measure	Engineering units Rate	Feet, US gallons, cubic feet, million gallons, barrels (liquid and oil), acre-feet, lbs, meters, cubic meters, liters, million liters, kilograms Second, minute, hour, day
Outputs	Analog and TTL Frequency (Output option 1)	4…20 mA: 900 ohms max, internally powered, 12-bit resolution
		Selectable turbine meter simulation or square wave 0…1000 Hz, duty cycle 50% +/- 10% Square wave: 5V DC Turbine meter simulation: 500 mVpp minimum
	Totalizer pulse (Output option 3)	Source or sink, 5V DC, 2 mA maximum, pulse duration 30 ms, external resistor Normal state high with pulses low

Transducers

Transducer Construction	DTTR	NEMA 6*/IP67	PBT glass filled, Ultem, Nylon cord grip PVC cable jacket; –40…250° F (–40…121° C)
	DTTC	NEMA 6*/IP67	CPVC, Ultem, Nylon cord grip Polyethylene cable jacket; –40…185° F (–40…85° C)
	DTTN I.S.	NEMA 6P*/IP68	CPVC, Ultem, Nylon cord grip Polyethylene cable jacket; –40…185° F (–40…85° C)
	DTTH	NEMA 6*/IP67	PTFE, Vespel, Nickel-plated brass cord grip PFA cable jacket; –40…350° F (–40…176° C)
	DTTS	NEMA 6*/IP67	PVC, Ultem, Nylon cord grip PVC cable jacket; –40…140° F (–40…60° C)
	*NEMA 6 units: to a depth of 3 ft (1 m) for 30 days max. NEMA 6P units: to a depth of 100 ft (30 m) seawater equivalent density indefinitely.		
Cable Length	990 ft (300 meter) max. in 10 ft (3 m) increments; Submersible Conduit limited to 100 ft (30 m)		
Pipe/Tubing Sizes	1/2 in. (12mm) and larger		
Pipe/Tubing Materials	Carbon steel, stainless steel, copper, and plastic		

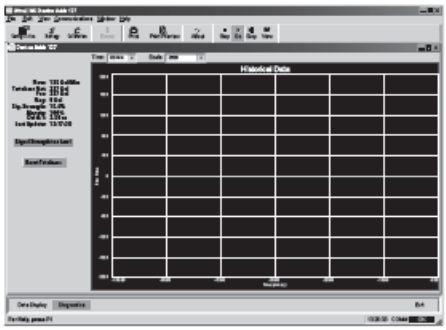
Software Utilities

ULTRALINK	Used to configure, calibrate and troubleshoot flow and energy meters. Connection via USB A/B cable; software is compatible with Windows 2000, Windows XP, Windows Vista and Windows 7

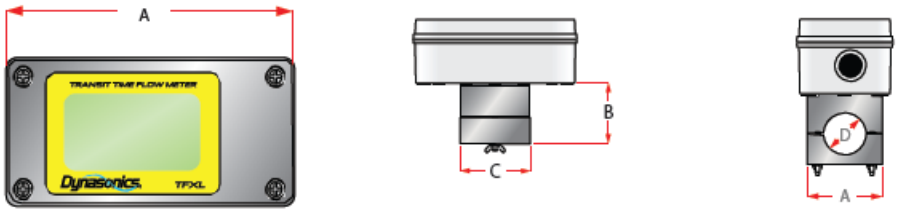
ULTRALINK SOFTWARE UTILITY

In addition to, or as a replacement for, the keypad entry programming, the flow meter can be used with the ULTRALINK software utility. The software is used to configure, calibrate and communicate with TFXL Ultra flow meters. Additionally, it has numerous troubleshooting tools to make diagnosing and correcting installation problems easier.

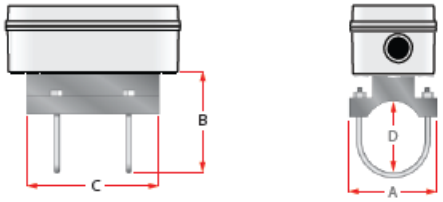
A PC can be hard-wired to the TFXL Ultra through a standard USB connection found on most current computers.



Integral System



U-Bolt Connections (ANSI and Copper 2 in Models)

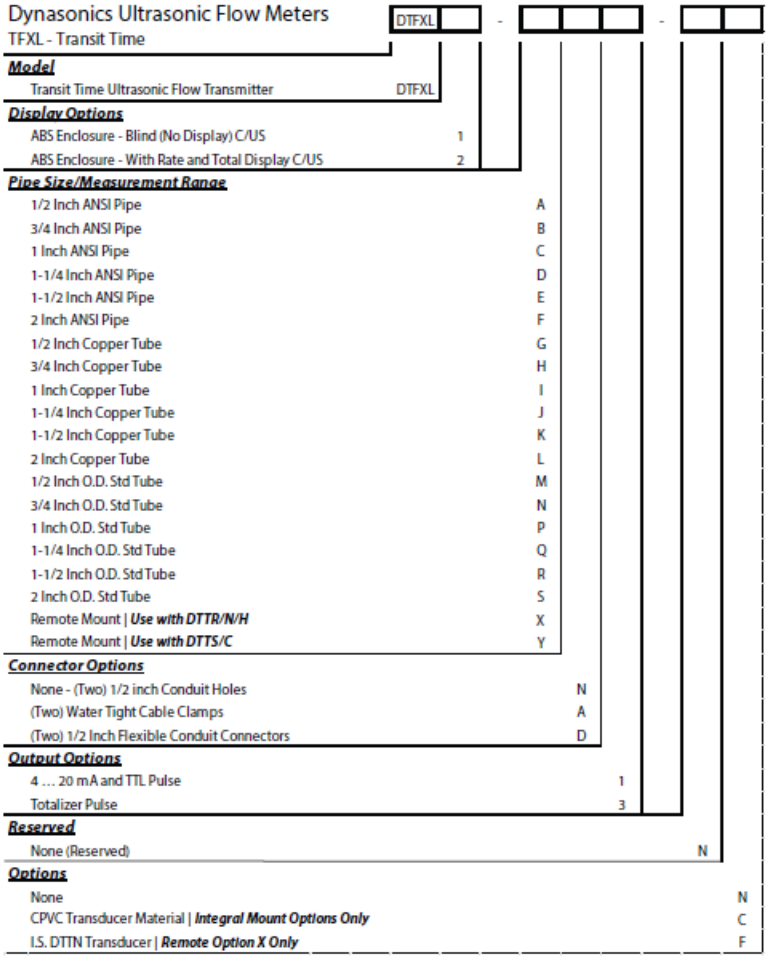


DTTS/DTTC Transducers

Pipe Size	Pipe Material	A	B	C	D	Measuring Range
1/2 in.	ANSI/DN	2.46 in. (62.5 mm)	2.36 in. (59.9 mm)	2.66 in. (67.6 mm)	0.84 in. (21.3 mm)	2.0…38 gpm (8…144 lpm)
	Copper	2.46 in. (62.5 mm)	2.36 in. (59.9 mm)	3.33 in. (84.6 mm)	0.63 in. (15.9 mm)	1.8…27 gpm (7…102 lpm)
	Tubing	2.46 in. (62.5 mm)	2.28 in. (57.9 mm)	3.72 in. (94.5 mm)	0.50 in. (12.7 mm)	1.5…18 gpm (6…68 lpm)
3/4 in.	ANSI/DN	2.46 in. (62.5 mm)	2.57 in. (65.3 mm)	2.66 in. (67.6 mm)	1.05 in. (26.7 mm)	2.75…66 gpm (10…250 lpm)
	Copper	2.46 in. (62.5 mm)	2.50 in. (63.5 mm)	3.56 in. (90.4 mm)	0.88 in. (22.2 mm)	2.5…54 gpm (10…204 lpm)
	Tubing	2.46 in. (62.5 mm)	2.50 in. (63.5 mm)	3.56 in. (90.4 mm)	0.75 in. (19.0 mm)	2.5…45 gpm (10…170 lpm)
1 in.	ANSI/DN	2.46 in. (62.5 mm)	2.92 in. (74.2 mm)	2.86 in. (72.6 mm)	1.32 in. (33.4 mm)	3.5…108 gpm (13…409 lpm)
	Copper	2.46 in. (62.5 mm)	2.87 in. (72.9 mm)	3.80 in. (96.5 mm)	1.13 in. (28.6 mm)	3.5…95 gpm (13…320 lpm)
	Tubing	2.46 in. (62.5 mm)	2.75 in. (69.9 mm)	3.80 in. (96.5 mm)	1.00 in. (25.4 mm)	3.5…85 gpm (13…320 lpm)
1-1/4 in.	ANSI/DN	2.80 in. (71.0 mm)	3.18 in. (80.8 mm)	3.14 in. (79.8 mm)	1.66 in. (42.2 mm)	5.0…186 gpm (19…704 lpm)
	Copper	2.46 in. (62.5 mm)	3.00 in. (76.2 mm)	4.04 in. (102.6 mm)	1.38 in. (34.9 mm)	4.5…152 gpm (17…575 lpm)
	Tubing	2.46 in. (62.5 mm)	3.00 in. (76.2 mm)	4.04 in. (102.6 mm)	1.25 in. (31.8 mm)	4.0…136 gpm (15…514 lpm)
1-1/2 in.	ANSI/DN	3.02 in. (76.7 mm)	3.40 in. (86.9 mm)	3.33 in. (84.6 mm)	1.90 in. (48.3 mm)	6.0…250 gpm (23…946 lpm)
	Copper	2.71 in. (68.8 mm)	2.86 in. (72.6 mm)	4.28 in. (108.7 mm)	1.63 in. (41.3 mm)	5.0…215 gpm (19…814 lpm)
	Tubing	2.71 in. (68.8 mm)	3.31 in. (84.1 mm)	4.28 in. (108.7 mm)	1.50 in. (38.1 mm)	5.0 …200 gpm (19…757 lpm)
2 in.	ANSI/DN	3.70 in. (94.0 mm)	3.42 in. (86.9 mm)*	5.50 in. (139.7 mm)	2.38 in. (60.3 mm)*	8.0…420 gpm (30…1590 lpm)
	Copper	3.70 in. (94.0 mm)	3.38 in. (85.9 mm)*	5.50 in. (139.7 mm)	2.13 in. (54.0 mm)*	8.0…375 gpm (30…1419 lpm)
	Tubing	3.21 in. (81.5 mm)	3.85 in. (98.0 mm)	4.75 in. (120.7 mm)	2.00 in. (50.8 mm)	8.0…365 gpm (30…1381 lpm)

* Varies due to U-bolt configuration

PART NUMBER CONSTRUCTION



PART NUMBER CONSTRUCTION—REMOTE FLOW TRANSDUCERS, SMALL PIPES 1/2…2 IN. (15…50 MM)

DTT				-		-		
Piping Environment								
PVC -40…194° F (-40…90° c)	S							
CPVC 40…94° F (40…90° C)	C							
Nominal Pipe Size								
1/2 in.		D						
3/4 in.		F						
1 in.		G						
1-1/4 in.		H						
1-1/2 in.		J						
2 in.		L						
Pipe Type								
ANSI Pipe			P					
Copper Pipe			C					
Tubing			T					
Cable Length								
20 ft (6.1 m)					020			
50 ft (15 m)					050			
100 ft (30 m)					100			
Conduit Type								
None - (Bare Twinax Cable)							N	
Flexible Armored (LiquidTite)							A	
Conduit Length								
0 ft (0 m)								000
20 ft (6.1 m)								020
50 ft (15 m)								050
100 ft (30 m)								100

SCADA System by TVC systems (Data Collection)

