# QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN
## FOR
## LAWNHURST FARMS, LLC ANAEROBIC DIGESTER GAS (ADG) SYSTEM
Agreement NEIS # 21426

*Final*
December, 2014

*Submitted to:*

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

*And*

Lawnhurst Farms
4124 County Route 5
Stanley, NY 14561

*Submitted by:*

**CDH Energy Corp.**
P.O. Box 641
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# PROJECT PARTICIPANTS

| | |
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## Introduction

This plan describes the approach that will be used to monitor the performance of the anaerobic digester gas (ADG) system that is currently being installed at Lawnhurst Farms, LLC, ("The Farm") in Stanley, NY, to produce biogas and electricity. Biogas will be used to fuel one engine-generator to produce power that will be consumed on site and/or exported back to the local utility. A monitoring system will be installed to measure and collect the data necessary to quantify the electric power produced and amount of biogas used by the engine-generator. The data will serve as the basis for payment of three (3) years of performance incentive payments, which The Farm has applied for under a Standard Performance Contract with NYSERDA based on a Total Contracted Capacity of 541 kW.

## ADG System Description

The digester system at the farm was designed by EnviTech Biogas AG. The power plant equipment will be provided by GE Jenbacher. Gas metering is provided by a Roots rotary meter while power metering is provided by a Shark 200 power meter. The site will operate one 541 kW synchronous engine-generator. Piping and controls are installed in the dedicated utility building in front of the digester. All the electrical loads at the farm are fed from a single 3-phase, 277/480 volt electrical service. The farm currently does not have the capability to isolate itself from the grid, black start, and run in island mode, in the event of a power outage. The farm does expect to export a portion of the generated electricity, and has been approved for net metering.


Installed, covered and filled digester, safety vent (left) and mixer location (1 of 4).

Digester flare (back) and dewatering well (front).

Bedding recovery unit.

Manure and food or milk waste mix tank – before entering digester.


Permanent gas analyzer ($O_2$ ,$CH_4$, $H_2S$)

Roots biogas meter – measures total biogas (generator and flare)


Shark 200 revenue grade power meter, installed in switchgear to right of DIA.NE XT3 engine controller.

Propane storage tank – only used for boiler at startup.

**Figure 1 - Photos of System Components**

**Table 1 - Biogas Systems at Lawnhurst Farms**

| | |
|---|---|
| Digester | EnviTech Anaerobic Digester, fully mixed, soft cover, heated, 194,231 cf capacity, 45 to 50 day retention time |
| Feedstock | Dairy Manure (approx. 1,400 cows), corn silage, dairy waste |
| Engine | 12 cylinder, GE Jenbacher J312 GS C81, Reciprocating Engine, 541 kW on biogas |
| Generator | Stamford CG 634 J2 – 480 VAC, 3 Phase, 541 kW |
| Biogas Conditioning | Sulfur abatement system installed in digester. |
| Engine Backup/startup Fuel | *Propane Boiler* – Used to heat digester until sufficient biogas is produced to run engine / generator. Generator cannot run on propane. |
| Heat Recovery Use | Digester heating |
| Additional Heat Recovery | Milking parlor water heating & engine building heating |

Figure 2 below shows the basic process flow of the anaerobic digester system installed at the farm. Manure is collected in one of three lagoons, one main and two secondary. Manure is then pumped from the primary lagoon to either the mixing tank or the digester. The mixing tank is used when corn silage or dairy waste is being added to the digester in addition to the manure. Flowmeters are installed on both the food waste and manure feed so that specific ratios of each feedstock can be mixed together to uniform consistency.

The digester has a $H_2S$ abatement system installed. This works by injecting air into the biogas. The $O_2$ reacts with the $H_2S$ to form $H_2O$ and elemental sulfur, which precipitates out of the biogas in solid form. When biogas leaves the digester it passes thru underground condensate lines and a condensate pit. The cooler temperature under the ground dehumidifies the biogas and is used in place of a chiller and liquid to gas heat exchanger for dehumidification. Biogas then passes thru a blower, to increase pressure, before either being combusted in the engine or flared. A pressure and temperature compensated Roots rotary gas meter measures the total biogas that flows to both the engine and flare. According to the digester design when the engine is running, the flare should never be on because the engine at full load can consume all of the biogas the digester is projected to produce.

The engine generator includes both an exhaust gas and engine jacket heat recovery system. Heat is recovered in the form of hot water which is pumped thru piping lining the perimeter of the digester to help maintain a temperature of around 100 °F. The facility also plans on using some of the recovered heat for preheating water used for cleaning in the dairy parlor.

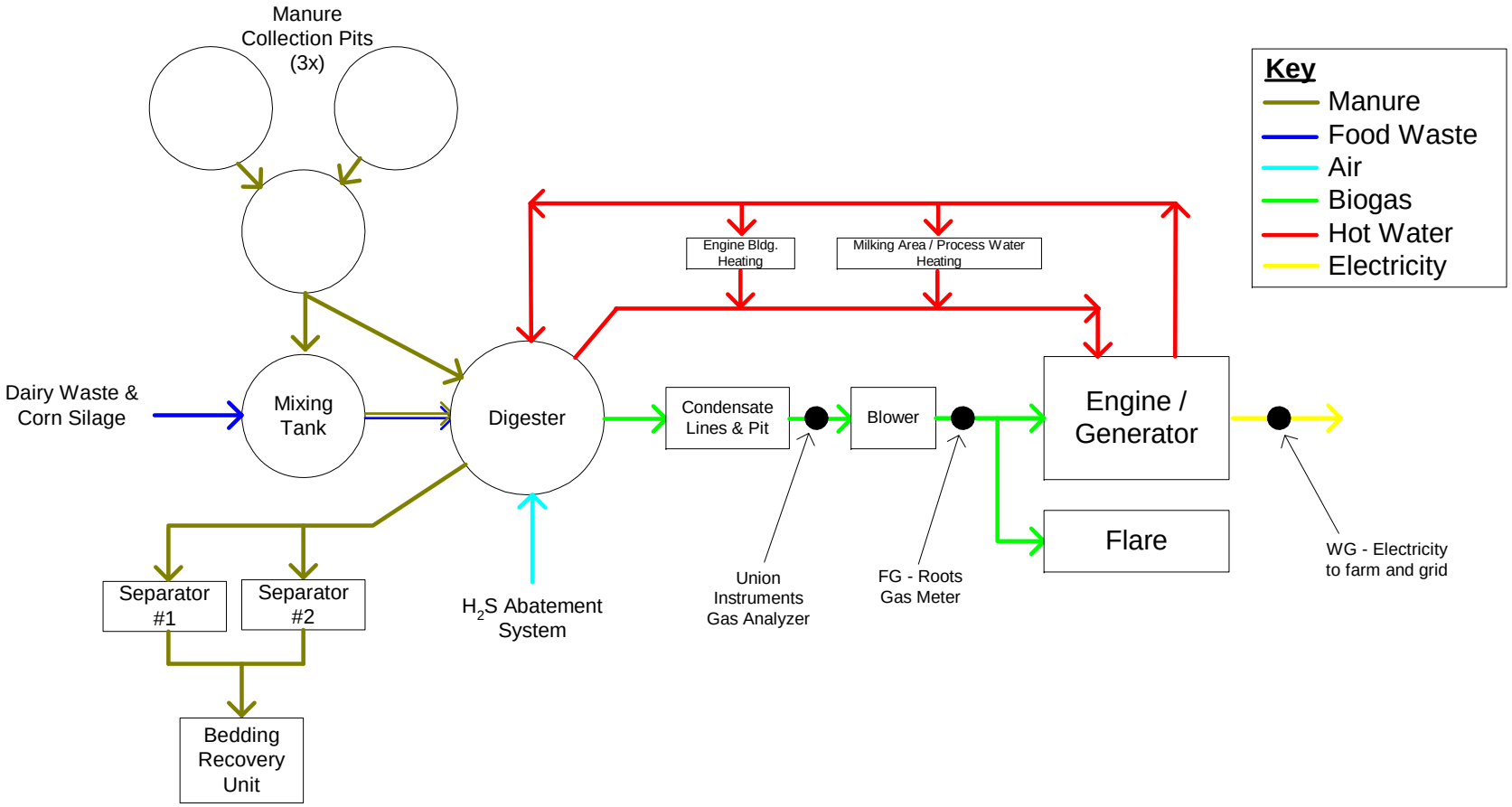


**Figure 2. Digester Schematic - Lawnhurst Farms**

# ADG System Capacity Payment Descriptions

This section describes the Capacity Incentive Payments included in the Agreement, the payment milestones to be achieved in order to receive payment, and the deliverables to be provided in achieving these milestones.

**Capacity Payment #1:** Up to 50% of Total Capacity Incentive or 50% of the total initial payments (whichever is less).

Payment Milestones: Initial payments made for major equipment and other work, acquisition of necessary permits, interconnection approval, and QA/QC plan approval.

Deliverables:

1. Documentation of payments for equipment and work.
2. Provide copies of necessary permits.
3. Provide copy of interconnection approval.
4. Work with TC to develop and get NYSERDA approval of QA / QC plan.

**Capacity Payment #2:** The remainder of the Total Capacity Incentive.

Payment Milestones: NYSERDA approval of the Project Installation Report.

# Monitoring System Equipment, Installation, Operation, and Maintenance

Table 2 shows the general location of the meters used to measure biogas flow (**FG**) and the generator electrical output (**WG**). Information on these data points is shown in Table 2.

**Table 2 - Monitored Points for ADG System**

| Point Type | Point Name | Description | Instrument | Engineering Units | Expected Range |
|---|---|---|---|---|---|
| Modbus | WG | Engine-Generator Power | Shark 200 power meter | kW | 0 – 575 kW |
| Pulse | FG | Total Gas Flow | Roots Rotary Gas Meter Series B4 G250 | SCFH | 0 – 15,000 SCFH |

The electrical output of the engine-generator (**WG**) will be measured with the Shark 200 revenue grade power meter. The power meter is installed in the switchgear directly to the right of the engine controller. The power meter will be installed according to the requirements in the appropriate operator guide.

The biogas input to the engine will be measured by a Roots Rotary flow meter (**FG**). The meter is capable of providing a pressure and temperature compensated pulse output and can measure flows up to 15,891 cfh. The meter will be installed and maintained according to the "Roots Installation and Maintenance Guidelines" by the facility. A log of maintenance activities for the meters will be maintained at the site.

The lower heating value for the biogas is estimated to be 524 Btu/$ft^{3,}$ based on past the ADG application. This value will be verified based on the logged measurements of the biogas taken by the INCA 4001 gas analyzer installed at the farm. The measurements taken by the gas analyzer include $O_2$ ,$CH_4$, $H_2S$. These values will be included in the daily transmitted file containing generator power and gas. The gas analyzer provides data at 10 minute intervals. These values will be in the local CDH database, however they will not be uploaded to the NYSERDA website. The gas analyzer location is marked in Figure 3.

The boiler backup /startup fuel flow (propane) is not metered or logged at this site. The propane will only be used to run the boiler during the startup process for the digester. Once the digester heats up and is producing sufficient amounts of biogas the facility will switch over from the propane boiler to the engine / generator. The engine / generator is tuned to run on biogas only.

The facilities control system creates and sends one data file per day. The file is row oriented and includes generator power, total gas production, flare valve position, digester pressure, digester temperature, ppm of $H_2S$, and percent of $O_2$ and $CH_4$. The data points from the gas analyzer are provided at coarse and varying intervals, while the rest of the data points are consistent 5-minute intervals.

The Farm has created a FTP site that they will upload the data files to daily. CDH has confirmed that the FTP site can be accessed and the daily log files can be downloaded, processed, and upload the data to the NYSERDA CHP Website. If the daily FTP files are interrupted, CDH will alert Envitech and request them to fix the daily file transfers and send any missing files. Once the previous days data is successfully downloaded and stored locally it is removed in order to not take up unnecessary space on the FTP server. The server has the capability to store at least forty (40) days of data.

**Management of Monitoring System Data**

The Farm will perform the following quality assurance and quality control measures to ensure the data produced from our system accurately describes system performance.

On a daily basis, The Farm equipment manager will perform inspections of the digester and engine-generator equipment and record findings into the project log.

On a weekly basis, The Farm equipment manager will perform inspections of the QA/QC meter installations and complete the routine maintenance on the meters, noting any abnormalities or unexpected readings. The Farm will also maintain a weekly log of the cumulative power generation (kWh) from the Shark 200 (**WG**) and gas flow (cf or $ft^3$) recorded by the Roots meter (**FG**) in the event that data transfer to the NYSERDA CHP Website fails or other anomalies occur.

On a weekly basis, The Farm staff will review the data stored in the NYSERDA CHP Website (chp.nyserda.org) to ensure it is consistent with our observed performance of the ADG system and logged readings. The Farm will review the data using the reporting features at the website, including:

- Monitored Data – Plots and Graphs, and
- RPS: Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program NYSERDA Incentive Program Reports.

In addition, The Farm staff will also setup and use the email reports that are available at the CHP Website to help track the system performance, including:

- a periodic email report summarizing system performance and the estimated incentive,
- an email report sent out if data is not received at the web site or does not pass the quality checks.

The website will automatically take the data collected from the data-logger and evaluate the quality of the data for each 5-minute interval using range and relational checks. Details on the range and relational checks can be found in the Database Notes.PDF document, located on the NYSERDA CHP Website.

Only data that passes the range and relational quality checks will be used in the incentive reports listed above. However, all hourly data is available from the NYSERDA CHP Website if the data quality flag of "Data Exists" is selected. In the event of a communications or meter failure, the farm will work with CDH Energy to resolve the issue in a few days.

If unanticipated loss of data occurs when the engine-generator continues to produce electricity, The Farm intends to follow the procedures outlined in Exhibit C, of their contract, i.e. taking the average output measured from similar length periods just prior and just after the outage (or other method acceptable to NYSERDA). The Farm understands that they can use this approach for up to two outages for up to 36 hours each per12-month performance period. If more than two such data outages occur per 12-month period, then the Farm will provide independent cumulative meter readings or other documentation to demonstrate any system power output during outages. Otherwise, the generator output will be assumed to equal zero for the outage period.

**Annual Performance Reports**

Lawnhurst Farms will prepare Annual Performance Reports summarizing the monthly data over the 12-month performance period. The reports will include a table (example provided below) showing the monthly kWh production, biogas use by the engine, and other data listed in Table 3, and if used, any heating oil or other fuel used for the engine/boiler. The methods for calculating these values are provided below.

Table 3 - Summary of Monthly Data for Annual Performance Reports

| Start Date of Reporting Period | Number of Days in Each Period | Electricity Production, $kWh_{generator}$ | Biogas Used by Engine, (cubic feet) | $LHV_{biogas}$ (Btu/cf) | Biogas Energy Content, $Q_{biogas}$ (BTU) | Electrical Efficiency (percent) |
|---|---|---|---|---|---|---|
| | | | | | | |
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| | | | | | | |
| TOTALS | | | | | | |

The Farm will calculate monthly values for lower heating value of the biogas ($LHV_{biogas}$) and total energy content of the biogas ($Q_{biogas}$) as follows.

## Monthly Biogas Lower Heating Value

The logged $CH_4$ data will be used to calculate an average monthly Biogas Lower Heating Value using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot CH_4$$

where:

$LHV_{methane}$ - lower heating value of methane (911 Btu/ft$^3$ at standard conditions, 60 °F and 1 atm)

$CH_4$ - measured percent methane in biogas

Since $CH_4$ data is sporadic, it will be used to calculate monthly averages. These monthly averages will then be used to calculate a monthly biogas LHV.

## Monthly Biogas Energy Content

Calculate the average monthly Biogas Energy Content using the following equation:

$$Q_{biogas} = CF \cdot LHV_{biogas}$$

where:

CF - volume (cubic feet or ft$^3$) of biogas in month

Reasonable Electrical Efficiency

The Annual Performance Report will also provide a monthly comparison of power output and fuel input for the engine to confirm their reasonableness. For instance, the electrical efficiency – measured as power output ($kWh_{generator}$) divided by the energy content of the fuel input ($Q_{biogas}$) in similar units and based on lower heating value – should be in the 25% to 35% range over any interval for the engine-generator at Lawnhurst Farms.

## Appendices

**Cut sheets and Manuals for:**

- **GE Janbacher J312 GS C81**
- **Stamford, CG 634 J2 Generator**
- **Roots Rotary Gas Meter**
- **Shark 200 Power Meter**
- **Union Instruments INCA 4001 Gas Analyzer**

GE Energy
Gas Engines

# Jenbacher type 3


## efficient, durable, reliable

Long service intervals, maintenance-friendly engine design and low fuel consumption ensure maximum efficiency in our type 3 engines. Optimized components prolong service life even when using non-pipeline gases such as landfill gas. The type 3 stands out in its 500 to 1,100 kW power range due to its technical maturity and high degree of reliability.

## reference installations

| model, plant | key technical data | description | |
|---|---|---|---|
| **J312 GS**<br>**Containerized solution**<br>**Landfill site;**<br>**Cavenago, Italy** | Fuel ..... Landfill gas<br>Engine type ..... 2 x JMC 312 GS-L.L<br>Electrical output ..... 1,202 kW<br>Thermal output ..... 1,494 kW<br>Commissioning ..... September 1999 | Every system has its own landfill gas feeder line and exhaust gas treatment line. The generated electricity is used on-site, excess power is fed into the public grid. The employment of the CL.AIR* system ensures the purification of the exhaust gas to meet stringent Italian emission requirements. As a special feature, at this plant the thermal energy is used for landfill leachate treatment, as well as for greenhouse heating. |  |
| **J316 GS**<br>**Profusa,**<br>**producer of coke;**<br>**Bilbao, Spain** | Fuel ..... Coke gas and natural gas<br>Engine type ..... 12 x JGS 316 GS-S/N.L<br>Electrical output<br>a) with 100% coke gas ..... 5,642 kW<br>b) with 60% coke gas and 40% natural gas, or 100% natural gas ..... 6,528 kW<br>Commissioning ..... November 1995 | This installation designed by GE's Jenbacher product team enables Profusa to convert the residual coke gas with a hydrogen content of approximately 50% into valuable electrical energy. Beginning 2008, the 12 engines reached a combined total of one million operating hours. |  |
| **J320 GS**<br>**Ecoparc I;**<br>**Barcelona, Spain** | Fuel ..... Biogas and natural gas<br>Engine type ..... 5 x JMS 320 GS-B/N.L<br>Electrical output ..... 5,240 kW<br>Thermal output<br>a) with biogas ..... 2,960 kW<br>b) with natural gas ..... 3,005 kW<br>Commissioning ..... December 2001 to January 2002 | In Ecoparc I, organic waste is processed into biogas, which serves as energy source for our gas engines. The generated electricity is used on-site as well as fed into the public power grid. A portion of the thermal energy is used as process heat in the digesters, and the excess heat is bled off in the air coolers. |  |
| **J320 GS**<br>**Amtex Spinning Mills;**<br>**Faisalabad, Pakistan** | Fuel ..... Natural gas<br>Engine type ..... 12 x JGS 320 GS-N.L<br>Electrical output ..... 12,072 kW<br>Commissioning ... November 2002 (1st, 2nd engine), April 2003 (3rd engine), May 2003 (4th - 7th engine), April 2004 (8th engine), April 2005 (9th, 10th engine), March 2008 (11th, 12th engine) | The natural gas-driven units generate electricity for spinning mills in one of Pakistan's most important textile centers. Special features of this Jenbacher plant allow for high ambient temperature, dusty inlet air, and operation in island mode. |  |

GE imagination at work

# technical data

| | |
|---|---|
| Configuration | V 70° |
| Bore (mm) | 135 |
| Stroke (mm) | 170 |
| Displacement/cylinder (lit) | 2.43 |
| Speed (rpm) | 1,500 (50 Hz)<br>1,200/1,800 (60 Hz) |
| Mean piston speed (m/s) | 8.5 (1,500 rpm)<br>6.8 (1,200 rpm)<br>10.2 (1,800 rpm) |
| Scope of supply | Generator set, cogeneration system, generator set/cogeneration in container |
| Applicable gas types | Natural gas, flare gas, propane, biogas, landfill gas, sewage gas. Special gases (e.g., coal mine gas, coke gas, wood gas, pyrolysis gas) |

| Engine type | J312 GS | J316 GS | J320 GS |
|---|---|---|---|
| No. of cylinders | 12 | 16 | 20 |
| Total displacement (lit) | 29.2 | 38.9 | 48.7 |

## Dimensions l x w x h (mm)

| | | |
|---|---|---|
| Generator set | J312 GS | 4,700 x 1,800 x 2,300 |
| | J316 GS | 5,200 x 1,800 x 2,300 |
| | J320 GS | 5,700 x 1,700 x 2,300 |
| Cogeneration system | J312 GS | 4,700 x 2,300 x 2,300 |
| | J316 GS | 5,300 x 2,300 x 2,300 |
| | J320 GS | 5,700 x 1,900 x 2,300 |
| Container | J312 GS | 12,200 x 2,500 x 2,600 |
| | J316 GS | 12,200 x 2,500 x 2,600 |
| | J320 GS | 12,200 x 2,500 x 2,600 |

## Weights empty (kg)

| | J312 GS | J316 GS | J320 GS |
|---|---|---|---|
| Generator set | 8,000 | 8,800 | 10,500 |
| Cogeneration system | 9,400 | 9,900 | 11,000 |
| Container (generator set) | 19,400 | 22,100 | 26,000 |
| Container (cogeneration) | 20,800 | 23,200 | 26,500 |

# outputs and efficiencies

## Natural gas

| | | 1.500 rpm \| 50 Hz | | | | | 1.800 rpm \| 60 Hz | | | | | 1.200 rpm \| 60 Hz | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NOx <** | **Type** | **Pel (kW)[1]** | **ηel (%)** | **Pth (kW)** | **ηth (%)** | **ηtot (%)** | **Pel (kW)[1]** | **ηel (%)** | **Pth (kW)** | **ηth (%)** | **ηtot (%)** | **Pel (kW)[1]** | **ηel (%)** | **Pth (kW)** | **ηth (%)** | **ηtot (%)** |
| 500 mg/m³$_N$ | 312 | 527 | 39.9 | 626 | 47.3 | 87.2 | | | | | | | | | | |
| | 312 | 637 | 40.8 | 725 | 46.4 | 87.1 | 633 | 38.1 | 814 | 49.0 | 87.1 | 435 | 39,7 | 503 | 45,9 | 85,6 |
| | 316 | 835 | 40.0 | 968 | 47.2 | 87.2 | 848 | 38.3 | 1,089 | 49.2 | 87.4 | 583 | 40,3 | 655 | 45,2 | 85,5 |
| | 320 | 1,063 | 40.8 | 1,193 | 45.8 | 86.6 | 1,059 | 39.0 | 1,324 | 48.8 | 87.8 | 795 | 40,7 | 855 | 43,8 | 84,5 |
| 250 mg/m³$_N$ | 312 | 637 | 39.6 | 759 | 47.1 | 86.7 | 633 | 36.8 | 875 | 50.8 | 87.5 | | | | | |
| | 316 | 802 | 39.0 | 977 | 47.5 | 86.5 | 848 | 36.9 | 1,159 | 50.5 | 87.4 | | | | | |
| | 320 | 1,063 | 39.8 | 1,240 | 46.4 | 86.2 | 1,059 | 38.1 | 1,380 | 49.7 | 87.8 | | | | | |
| 350 mg/m³$_N$ | 312 | 637 | 40.1 | 741 | 46.7 | 86.9 | | | | | | 418 | 38,6 | 504 | 46,5 | 85,2 |
| | 316 | 802 | 39.2 | 984 | 48.1 | 87.3 | | | | | | 559 | 38,8 | 671 | 46,5 | 85,3 |
| | 320 | 1,063 | 40.1 | 1,226 | 46.3 | 86.4 | | | | | | 795 | 40,7 | 855 | 43,8 | 84,5 |

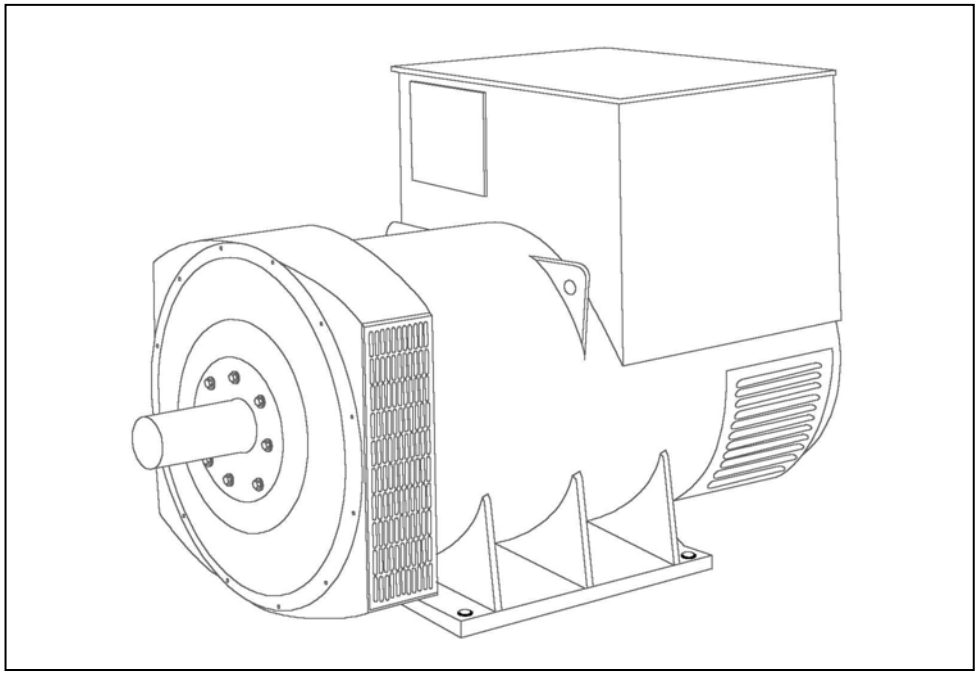
## Biogas

| | | 1,500 rpm \| 50 Hz | | | | | 1,800 rpm \| 60 Hz | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **NOx <** | **Type** | **Pel (kW)[1]** | **ηel (%)** | **Pth (kW)** | **ηth (%)** | **ηtot (%)** | **Pel (kW)[1]** | **ηel (%)** | **Pth (kW)** | **ηth (%)** | **ηtot (%)** |
| 500 mg/m³$_N$ | 312 | 526 | 41.1 | 532 | 41.5 | 82.6 | 633 | 38.1 | 787 | 47.4 | 85.5 |
| | 312 | 637 | 40.3 | 682 | 43.2 | 83.6 | | | | | |
| | 316 | 703 | 40.5 | 743 | 42.8 | 83.3 | 848 | 38.3 | 1,054 | 47.6 | 85.9 |
| | 316 | 835 | 39.9 | 920 | 44.0 | 83.9 | | | | | |
| | 320 | 1,063 | 40.8 | 1,081 | 41.5 | 82.3 | 1,059 | 39.0 | 1,269 | 46.7 | 85.7 |
| 250 mg/m³$_N$ | 312 | | | | | | 633 | 36.8 | 837 | 48.6 | 85.3 |
| | 316 | | | | | | 848 | 36.9 | 1,118 | 48.7 | 85.6 |
| | 320 | | | | | | 1,059 | 36.9 | 1,406 | 49.0 | 85.9 |
| 350 mg/m³$_N$ | 312 | | | | | | | | | | |
| | 316 | | | | | | | | | | |
| | 320 | 1,063 | 40.1 | 1,108 | 41.8 | 82.0 | | | | | |

1) Total heat output with a tolerance of +/- 8%, exhaust gas outlet temperature 120°C, for biogas exhaust gas outlet temperature 180°C
All data according to full load and subject to technical development and modification.

STAMFORD
power generation

# **HCI634H** - Technical Data Sheet



# HCI634H

## SPECIFICATIONS & OPTIONS

### STANDARDS

Newage Stamford industrial generators meet the requirements of BS EN 60034 and the relevant section of other international standards such as BS5000, VDE 0530, NEMA MG1-32, IEC34, CSA C22.2-100, AS1359.
Other standards and certifications can be considered on request.

### VOLTAGE REGULATORS

#### MX321 AVR - STANDARD

This sophisticated Automatic Voltage Regulator (AVR) is incorporated into the Stamford Permanent Magnet Generator (PMG) system and is fitted as standard to generators of this type.
The PMG provides power via the AVR to the main exciter, giving a source of constant excitation power independent of generator output. The main exciter output is then fed to the main rotor, through a full wave bridge, protected by a surge suppressor. The AVR has in-built protection against sustained over-excitation, caused by internal or external faults. This de-excites the machine after a minimum of 5 seconds.
Over voltage protection is built-in and short circuit current level adjustments is an optional facility.

### WINDINGS & ELECTRICAL PERFORMANCE

All generator stators are wound to 2/3 pitch. This eliminates triplen (3rd, 9th, 15th …) harmonics on the voltage waveform and is found to be the optimum design for trouble-free supply of non-linear loads. The 2/3 pitch design avoids excessive neutral currents sometimes seen with higher winding pitches, when in parallel with the mains. A fully connected damper winding reduces oscillations during paralleling. This winding, with the 2/3 pitch and carefully selected pole and tooth designs, ensures very low waveform distortion.

### TERMINALS & TERMINAL BOX

Standard generators feature a main stator with 6 ends brought out to the terminals, which are mounted on the frame at the non-drive end of the generator. A sheet steel terminal box contains the AVR and provides ample space for the customers' wiring and gland arrangements. It has removable panels for easy access.

### SHAFT & KEYS

All generator rotors are dynamically balanced to better than BS6861:Part 1 Grade 2.5 for minimum vibration in operation. Two bearing generators are balanced with a half key.

### INSULATION/IMPREGNATION

The insulation system is class 'H'.
All wound components are impregnated with materials and processes designed specifically to provide the high build required for static windings and the high mechanical strength required for rotating components.

### QUALITY ASSURANCE

Generators are manufactured using production procedures having a quality assurance level to BS EN ISO 9001.

The stated voltage regulation may not be maintained in the presence of certain radio transmitted signals. Any change in performance will fall within the limits of Criteria 'B' of EN 61000-6-2:2001. At no time will the steady-state voltage regulation exceed 2%.

*NB Continuous development of our products entitles us to change specification details without notice, therefore they must not be regarded as binding.*

*Front cover drawing typical of product range.*

STAMFORD
power generation

# HCI634H

## WINDING 312

| | | |
|---|---|---|
| CONTROL SYSTEM | SEPARATELY EXCITED BY P.M.G. | |
| A.V.R. | MX321 | |
| VOLTAGE REGULATION | ± 0.5 % | With 4% ENGINE GOVERNING |
| SUSTAINED SHORT CIRCUIT | REFER TO SHORT CIRCUIT DECREMENT CURVES (page 7) | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INSULATION SYSTEM | CLASS H | | | | | | | |
| PROTECTION | IP23 | | | | | | | |
| RATED POWER FACTOR | 0.8 | | | | | | | |
| STATOR WINDING | DOUBLE LAYER LAP | | | | | | | |
| WINDING PITCH | TWO THIRDS | | | | | | | |
| WINDING LEADS | 6 | | | | | | | |
| STATOR WDG. RESISTANCE | 0.003 Ohms PER PHASE AT 22°C STAR CONNECTED | | | | | | | |
| ROTOR WDG. RESISTANCE | 1.88 Ohms at 22°C | | | | | | | |
| R.F.I. SUPPRESSION | BS EN 61000-6-2 & BS EN 61000-6-4,VDE 0875G, VDE 0875N. refer to factory for others | | | | | | | |
| WAVEFORM DISTORTION | NO LOAD < 1.5% NON-DISTORTING BALANCED LINEAR LOAD < 5.0% | | | | | | | |
| MAXIMUM OVERSPEED | 2250 Rev/Min | | | | | | | |
| BEARING DRIVE END | BALL. 6224 (ISO) | | | | | | | |
| BEARING NON-DRIVE END | BALL. 6317 (ISO) | | | | | | | |
| | 1 BEARING | | | | 2 BEARING | | | |
| WEIGHT COMP. GENERATOR | 2117 kg | | | | 2145 kg | | | |
| WEIGHT WOUND STATOR | 1010 kg | | | | 1010 kg | | | |
| WEIGHT WOUND ROTOR | 866 kg | | | | 821 kg | | | |
| WR² INERTIA | 20.0438 kgm$^2$ | | | | 19.4965 kgm$^2$ | | | |
| SHIPPING WEIGHTS in a crate | 2173kg | | | | 2180kg | | | |
| PACKING CRATE SIZE | 183 x 92 x 140(cm) | | | | 183 x 92 x 140(cm) | | | |
| | 50 Hz | | | | 60 Hz | | | |
| TELEPHONE INTERFERENCE | THF<2% | | | | TIF<50 | | | |
| COOLING AIR | 1.614 m³/sec 3420 cfm | | | | 1.961 m³/sec 4156 cfm | | | |
| VOLTAGE STAR | 380/220 | 400/231 | 415/240 | 440/254 | 416/240 | 440/254 | 460/266 | 480/277 |
| VOLTAGE DELTA | 220 | 230 | 240 | 254 | 240 | 254 | 266 | 277 |
| kVA BASE RATING FOR REACTANCE VALUES | 910 | 910 | 910 | 875 | 1025 | 1063 | 1075 | 1125 |
| Xd DIR. AXIS SYNCHRONOUS | 2.99 | 2.70 | 2.51 | 2.15 | 3.37 | 3.13 | 2.89 | 2.78 |
| X'd DIR. AXIS TRANSIENT | 0.25 | 0.23 | 0.21 | 0.18 | 0.29 | 0.27 | 0.25 | 0.24 |
| X"d DIR. AXIS SUBTRANSIENT | 0.18 | 0.16 | 0.15 | 0.13 | 0.19 | 0.18 | 0.17 | 0.16 |
| Xq QUAD. AXIS REACTANCE | 1.77 | 1.60 | 1.49 | 1.27 | 2.00 | 1.86 | 1.72 | 1.65 |
| X"q QUAD. AXIS SUBTRANSIENT | 0.19 | 0.17 | 0.16 | 0.14 | 0.22 | 0.20 | 0.19 | 0.18 |
| $X_L$ LEAKAGE REACTANCE | 0.09 | 0.08 | 0.07 | 0.06 | 0.10 | 0.09 | 0.08 | 0.08 |
| $X_2$ NEGATIVE SEQUENCE | 0.20 | 0.18 | 0.17 | 0.14 | 0.23 | 0.21 | 0.20 | 0.19 |
| $X_0$ ZERO SEQUENCE | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 |
| REACTANCES ARE SATURATED | VALUES ARE PER UNIT AT RATING AND VOLTAGE INDICATED | | | | | | | |

| | |
|---|---|
| T'd TRANSIENT TIME CONST. | 0.185 |
| T"d SUB-TRANSTIME CONST. | 0.025 |
| T'do O.C. FIELD TIME CONST. | 2.44 |
| Ta ARMATURE TIME CONST. | 0.04 |
| SHORT CIRCUIT RATIO | 1/Xd |

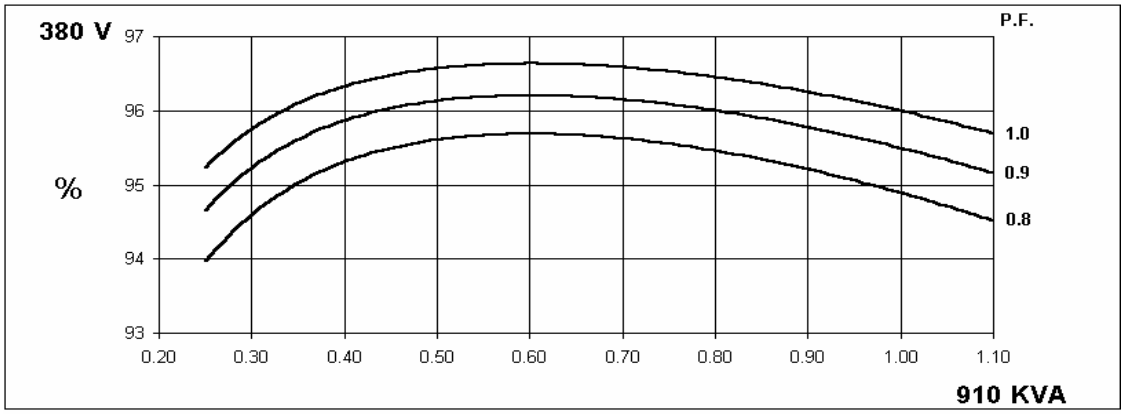
**50 Hz**

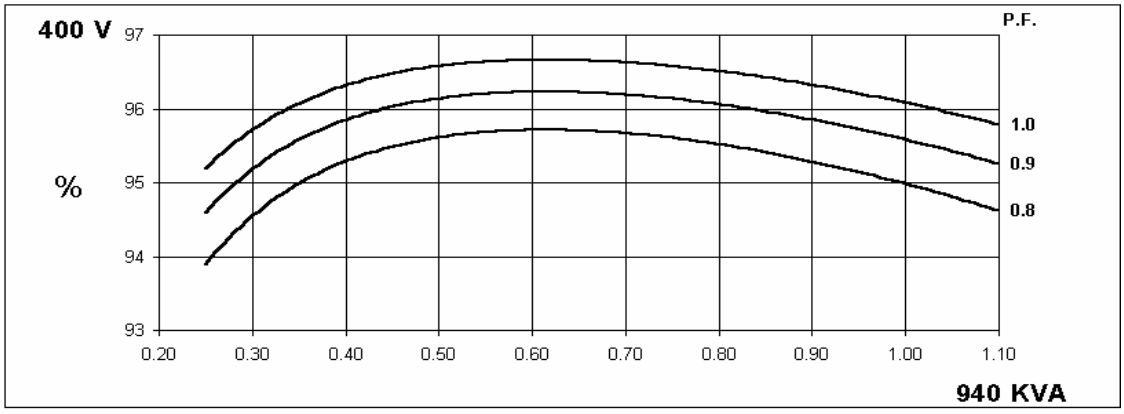
# HCI634H

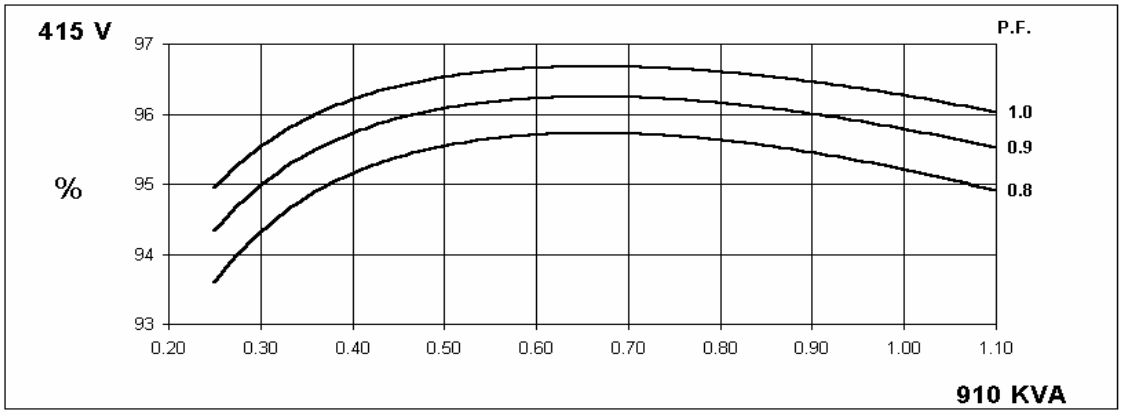
**Winding 312**

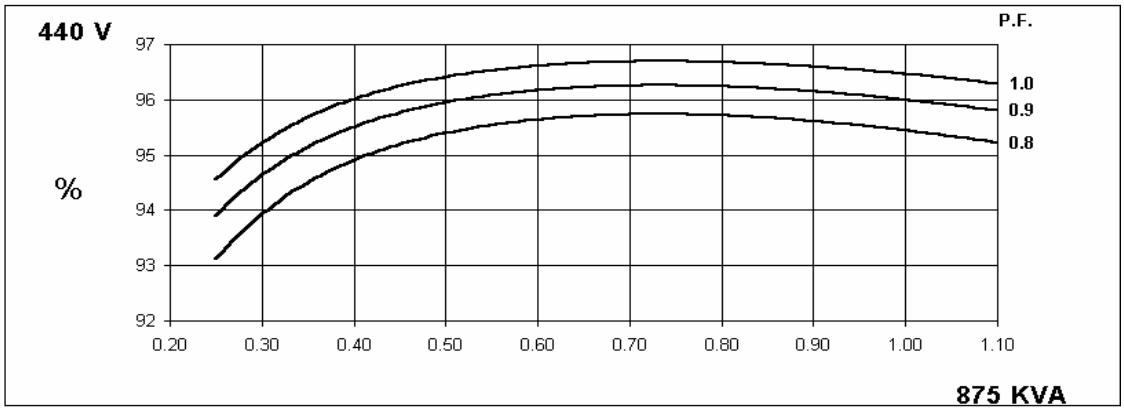
STAMFORD power generation

## THREE PHASE EFFICIENCY CURVES



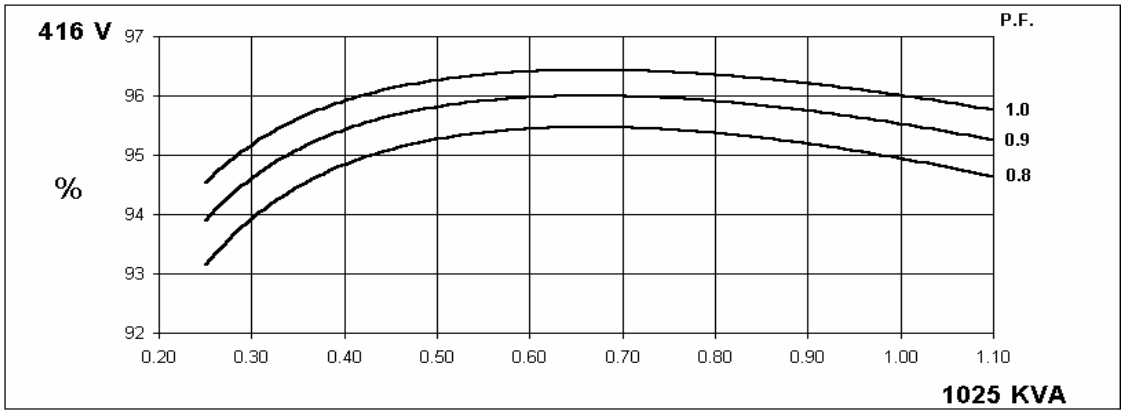
STAMFORD
power generation

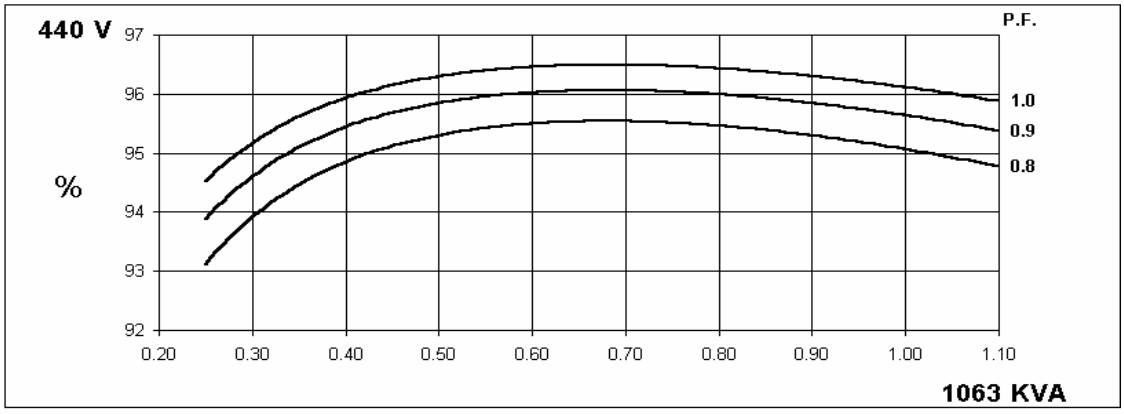
# HCI634H

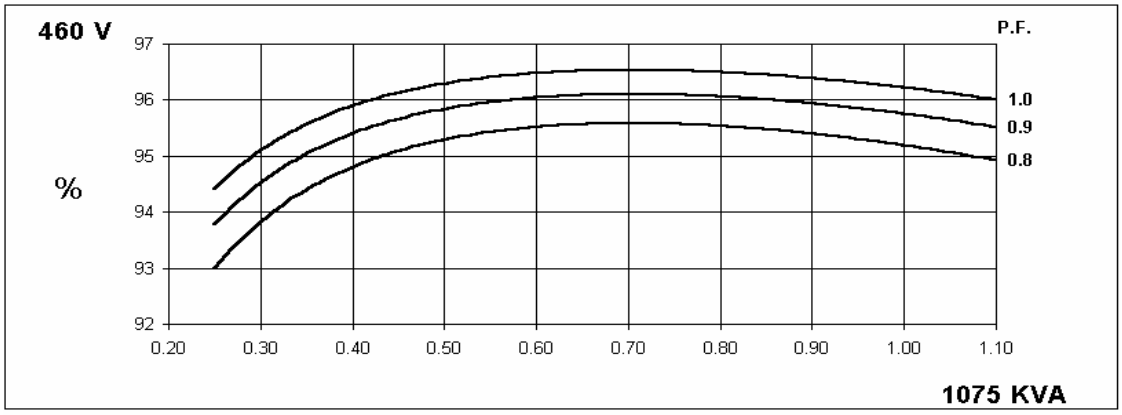
**Winding 312**

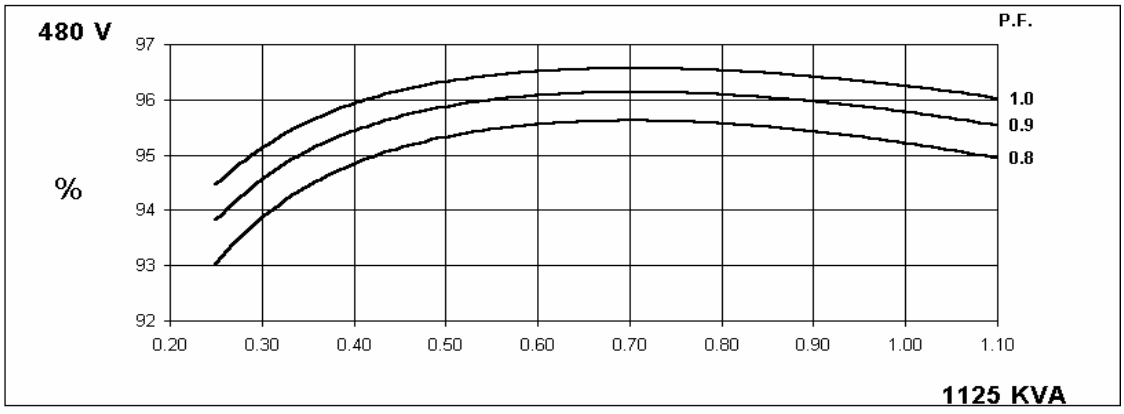
**60 Hz**

## THREE PHASE EFFICIENCY CURVES



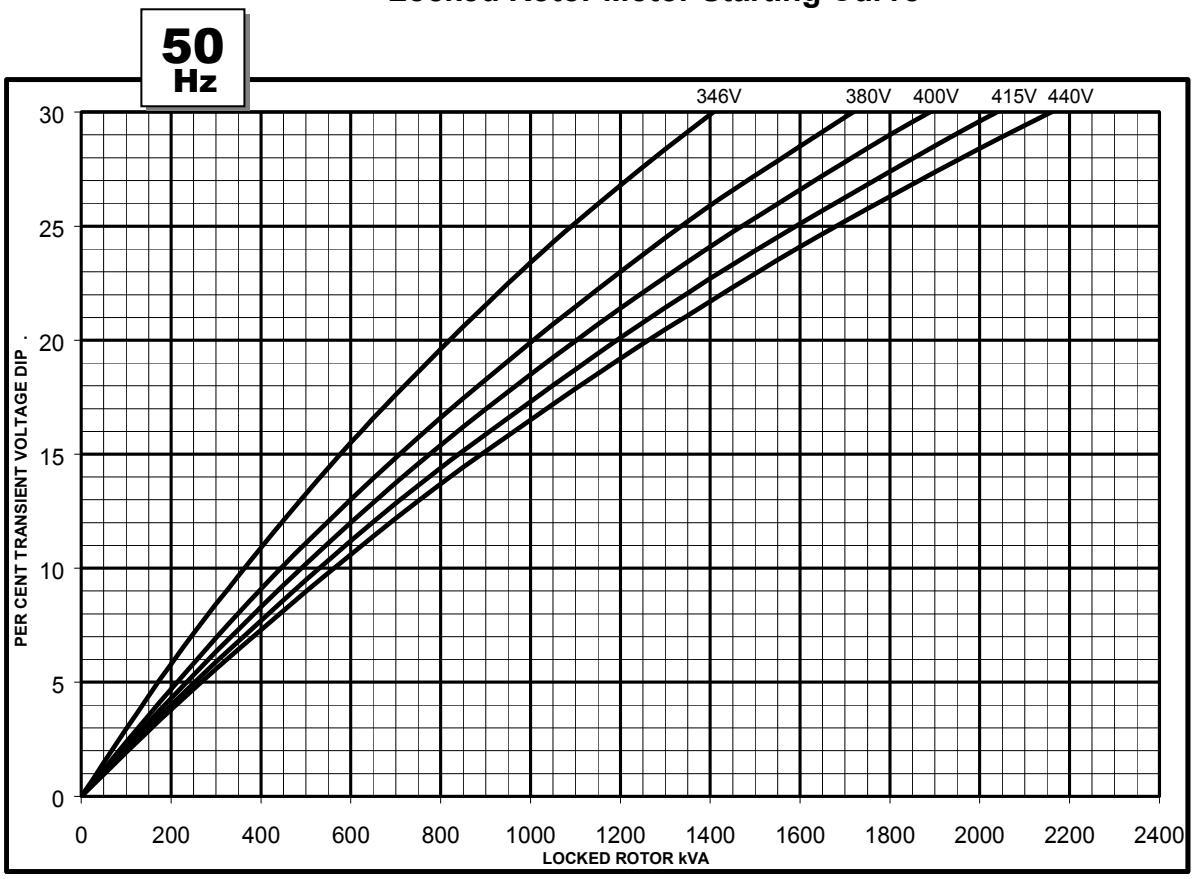



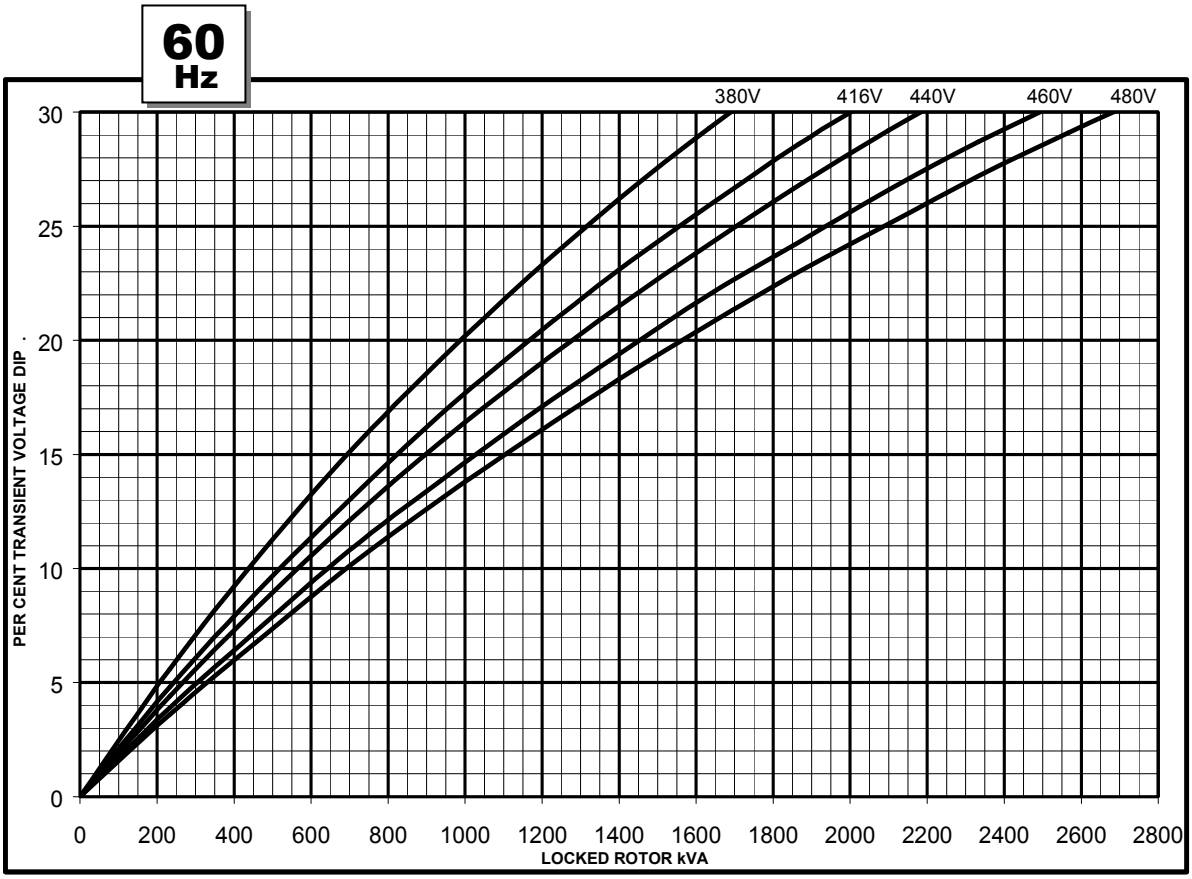



# HCI634H

**Winding 312**

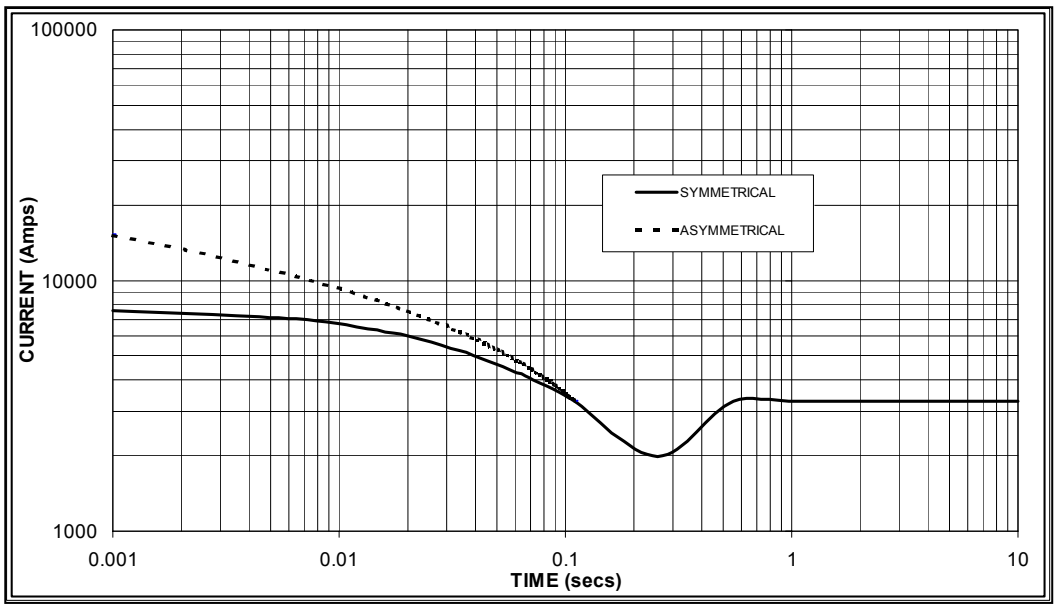
## Locked Rotor Motor Starting Curve



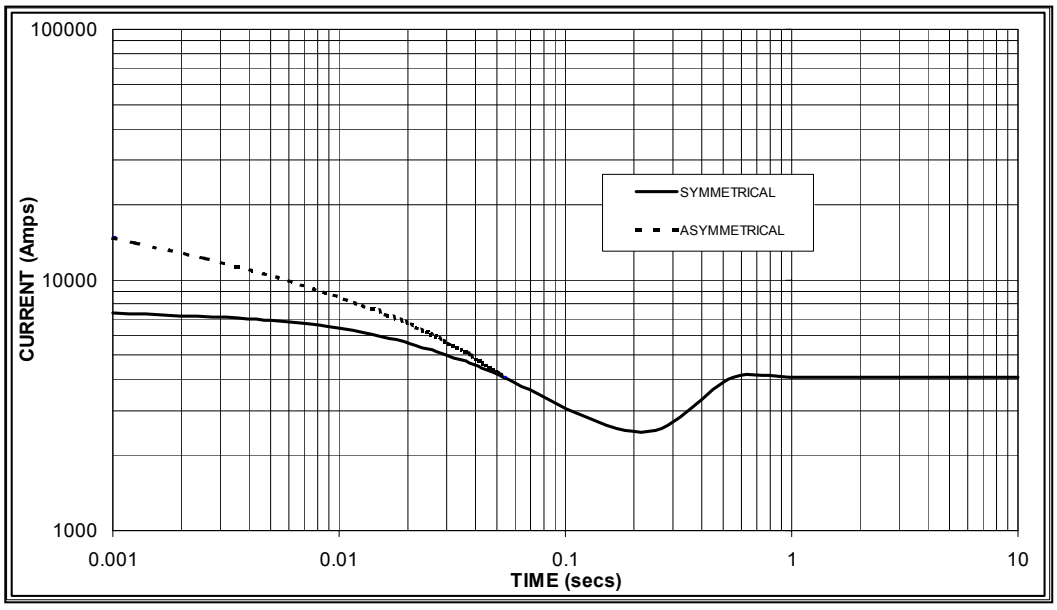
## Three-phase Short Circuit Decrement Curve. No-load Excitation at Rated Speed Based on star (wye) connection.

**50 Hz**




Sustained Short Circuit = 3,300 Amps

**60 Hz**




Sustained Short Circuit = 4,000 Amps

**Note 1**

The following multiplication factors should be used to adjust the values from curve between time 0.001 seconds and the minimum current point in respect of nominal operating voltage :

| 50Hz | | 60Hz | |
|---|---|---|---|
| Voltage | Factor | Voltage | Factor |
| 380v | X 1.00 | 416v | x 1.00 |
| 400v | X 1.07 | 440v | x 1.06 |
| 415v | X 1.12 | 460v | x 1.12 |
| 440v | X 1.18 | 480v | x 1.17 |

The sustained current value is constant irrespective of voltage level

**Note 2**

The following multiplication factor should be used to convert the values calculated in accordance with NOTE 1 to those applicable to the various types of short circuit :

| | 3-phase | 2-phase L-L | 1-phase L-N |
|---|---|---|---|
| Instantaneous | x 1.00 | x 0.87 | x 1.30 |
| Minimum | x 1.00 | x 1.80 | x 3.20 |
| Sustained | x 1.00 | x 1.50 | x 2.50 |
| Max. sustained duration | 10 sec. | 5 sec. | 2 sec. |

All other times are unchanged

**Note 3**

Curves are drawn for Star (Wye) connected machines.

# HCI634H

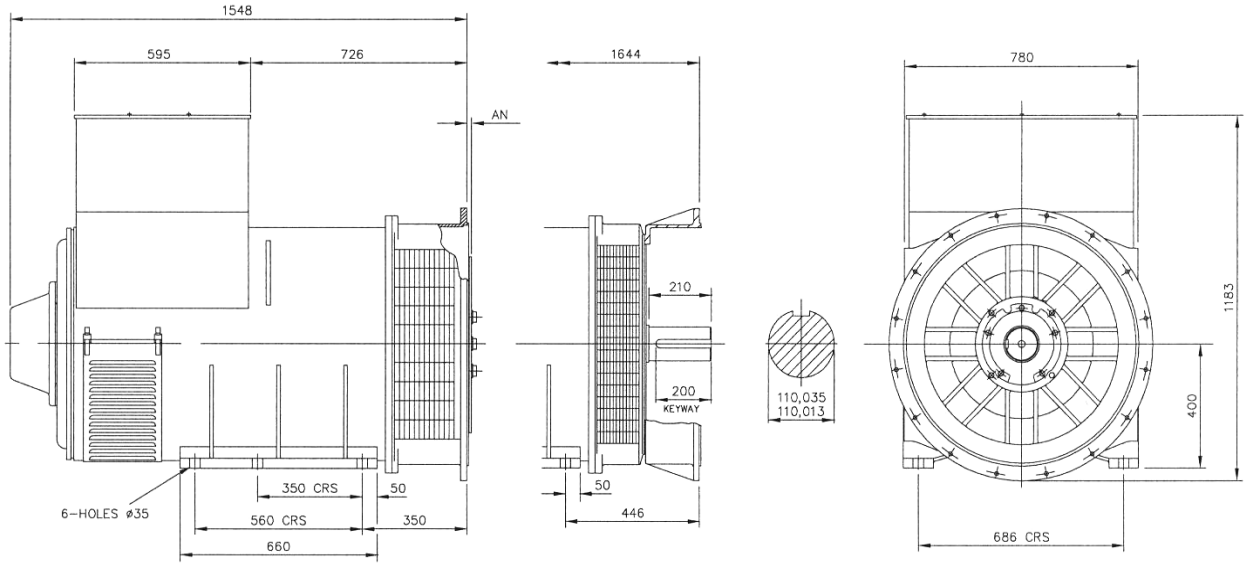
## Winding 312 0.8 Power Factor

## RATINGS

| Class - Temp Rise | | Cont. F - 105/40°C | | | | Cont. H - 125/40°C | | | | Standby - 150/40°C | | | | Standby - 163/27°C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50**Hz | Star (V) | 380 | 400 | 415 | 440 | 380 | 400 | 415 | 440 | 380 | 400 | 415 | 440 | 380 | 400 | 415 | 440 |
| | Delta (V) | 220 | 230 | 240 | 254 | 220 | 230 | 240 | 254 | 220 | 230 | 240 | 254 | 220 | 230 | 240 | 254 |
| | kVA | 830 | 860 | 830 | 800 | 910 | 940 | 910 | 875 | 960 | 980 | 960 | 920 | 1000 | 1010 | 1000 | 960 |
| | kW | 664 | 688 | 664 | 640 | 728 | 752 | 728 | 700 | 768 | 784 | 768 | 736 | 800 | 808 | 800 | 768 |
| | Efficiency (%) | 95.2 | 95.3 | 95.4 | 95.6 | 94.9 | 95.0 | 95.2 | 95.4 | 94.7 | 94.8 | 95.1 | 95.3 | 94.5 | 94.7 | 94.9 | 95.2 |
| | kW Input | 697 | 722 | 696 | 669 | 767 | 792 | 765 | 734 | 811 | 827 | 808 | 772 | 847 | 853 | 843 | 807 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50**Hz | Star (V) | 416 | 440 | 460 | 480 | 416 | 440 | 460 | 480 | 416 | 440 | 460 | 480 | 416 | 440 | 460 | 480 |
| | Delta (V) | 240 | 254 | 266 | 277 | 240 | 254 | 266 | 277 | 240 | 254 | 266 | 277 | 240 | 254 | 266 | 277 |
| | kVA | 913 | 963 | 1000 | 1025 | 1025 | 1063 | 1075 | 1125 | 1088 | 1125 | 1138 | 1188 | 1125 | 1163 | 1175 | 1219 |
| | kW | 730 | 770 | 800 | 820 | 820 | 850 | 860 | 900 | 870 | 900 | 910 | 950 | 900 | 930 | 940 | 975 |
| | Efficiency (%) | 95.2 | 95.3 | 95.3 | 95.4 | 94.9 | 95.1 | 95.2 | 95.2 | 94.8 | 94.9 | 95.0 | 95.1 | 94.6 | 94.8 | 94.9 | 95.0 |
| | kW Input | 767 | 808 | 839 | 860 | 864 | 894 | 903 | 945 | 918 | 948 | 958 | 999 | 951 | 981 | 991 | 1027 |

## DIMENSIONS




| SAE | 14 | 18 | 21 | 24 |
|---|---|---|---|---|
| AN | 25.4 | 15.87 | 0 | 0 |


**PO Box 17 • Barnack Road • Stamford • Lincolnshire • PE9 2NB**
**Tel: 00 44 (0)1780 484000 • Fax: 00 44 (0)1780 484100**
**Website: www.newage-avkseg.com**

# ROOTS® Expanded Meter Line

## B3-VRM Vapor Recovery Meter

Rated for a maximum capacity of 3000 actual cubic feet per hour, the B3-VRM meters are specifically designed and tested for vapor recovery applications and conform to the California Air Resources Board specifications TP-201.1, TP-201.1A, TP-201.2, and P-201.5, as applicable. The extremely low pressure drop associated with the ROOTS® positive displacement meter makes this meter ideal for the accurate measurement in low pressure recovery systems. Odometers on the vapor recovery meters are marked at 0.02 cubic foot increments, which allows accurately estimated readings in increments of 0.01 cubic feet. All B3-VRM meters are supplied with a 7 point certified accuracy curve for reference.

## Series Z Compact Meters

Ideal for small commercial loads at pressures up to 15 PSIG (1 Bar), the aesthetically pleasing 5C15 (500 ACFH) and 8C15 (800 ACFH) meters are easy to install and conceal. Series Z meters provide excellent measurement accuracy starting at “pilot loads” and continuing throughout the range of the meter. To match the meter configuration to the application, the user selects the following parameters when ordering:

- Dial Imperial Wheel Index
- Sealed Index Cover
- Standard (Atmospheric) or 2 PSIG Compensated Index
- Top or Bottom Inlet
- Sprague 4 (male), 45 Light (male), or 1–1/2 inch NPT (female) Connections
- Optional Inlet Strainer/Screen

## Series B4 Rotary Gas Meter

The Series B4 meters have a permanently lubricated, maintenance free uncorrected counter unit which can be rotated 355°. One low frequency (LF) and one high frequency (HF) pulse output are standard, a second low frequency (LF) pulse output is available upon request.

## Series A (LM-MA) Meters

The 8C175 compact meter, like the Series Z, is also ideal for small commercial applications, but with a higher pressure rating. This meter is rated for a 175 PSIG (12 Bar) working pressure. Also available as a Vapor Recovery Meter that is C.A.R.B. approved and available with a High Frequency transmitter (PX).

## Series A1 Foot Mount Meter

The 102M125 Foot Mount meter is used for the measurement of high volume industrial gas loads for capacities up to 965.3 MSCFH at 125 PSIG (27,334 $Nm^3/h$ at 8,6 Bar).

# SHARK®200

## UPGRADABLE FULLY FEATURED POWER & ENERGY METER

Revenue Grade with Advanced I/O and Power Quality


Shark® 200
Meter/Transducer

Shark® 200T
Transducer Only

c UL us LISTED
ELECTRICAL & ELECTRONIC MEASURING & TEST EQUIP. 22CZ

ISO 9001:2000

www.electroind.com

### From Simple to Sophisticated

- Simple Multifunction Meter: V-Switch™ Key 1
- Historical Data-logging: V-Switch™ Key 2
- Advanced Power Quality Waveform Recorder: V-Switch™ Keys 5 or 6

### Industry Leading Performance

- Highly Accurate Metering Technology
- Expandable I/O with 100BaseT Ethernet
- V-Switch™ Technology Upgrade
- Extensive Data Logging
- Power Quality Recording
- Up to 512 Samples/Cycle
- Embedded Web Server

**Electro Industries/GaugeTech**
*The Leader in Power Monitoring and Smart Grid Solutions*

## HIGH PERFORMANCE WAVEFORM RECORDING


### Basic Features Summary

- 0.2% Class Revenue Certifiable Energy and Demand Metering
- Meets ANSI C12.20 and IEC 687 (0.2% Class)
- Multifunction Measurement
- 3 Line .56" LED display
- % of Load Bar for Analog Perception
- Standard RS485 (Modbus and DNP 3.0)
- IrDA Port Enables Laptop PC Reading and Programming
- Ultra-Compact
- Fits both ANSI and DIN Cutouts

### Advanced Features Summary

- High Performance Waveform Recorder
- Up to 4 Megabytes Flash for Historical Data Logging & PQ Recording
- Extremely Configurable Field Upgradable I/O
- 100BaseT Ethernet – Rapid Response™ Technology
- V-Switch™ Technology

## APPLICATIONS

- Utility Metering
- Substations
- Power Generation
- Submetering
- Power Quality Studies
- Load Studies
- Commercial Metering
- Industrial Metering
- Campus Metering
- Analog Meter Replacement
- Disturbance Recording
- Voltage Recording

## ACCURACY AND UPGRADE SWITCHES

Electro Industries introduces a new standard in panel mounted power metering. The Shark® 200 metering system is an ultra-compact power metering device providing industry leading revenue metering functionality combined with advanced data-logging, power quality, communication and I/O traditionally found only in high performance and high cost systems. This product is designed to incorporate advanced features in a cost effective, small package for large scale, low cost deployment within an electrical distribution system.

## V-Switch™ TECHNOLOGY

The Shark® 200 meter is equipped with EIG's exclusive V-Switch™ technology. This technology allows users to upgrade and add features by using communication commands as needed, even after the meter is installed.

V-Switches Include the Following Features:

| Feature | V1 | V2 | V3 | V4 | V5 | V6 |
|---|---|---|---|---|---|---|
| Multifunction Measurement with I/O Expansion | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 Megabytes Data-Logging | | ✓ | ✓ | ✓ | | |
| 3 Megabytes Data-Logging | | | | | ✓ | |
| 4 Megabytes Data-Logging | | | | | | ✓ |
| Harmonic Analysis | | | ✓ | ✓ | ✓ | ✓ |
| TLC and CT/PT Compensation | | | ✓ | | | |
| Limit and Control Functions | | | | ✓ | ✓ | ✓ |
| 64 Samples per Cycle Waveform Recorder | | | | | ✓ | |
| 512 Samples per Cycle Waveform Recorder | | | | | | ✓ |

## ACCURACY

| Measured Parameters | Accuracy % | Display Range |
|---|---|---|
| Voltage L-N | 0.1% | 0-9999 Scalable V or kV |
| Voltage L-L | 0.2% | 0-9999 V or kV Scalable |
| Current | 0.1% | 0-9999 Amps or kAmps |
| +/- Watts | 0.2% | 0-9999 Watts, kWatts, MWatts |
| +/-Wh | 0.2% | 5 to 8 Digits Programmable |
| +/-VARs | 0.2% | 0-9999 VARs, kVARs, MVARs |
| +/-VARh | 0.2% | 5 to 8 Digits Programmable |
| VA | 0.2% | 0-9999 VA, kVA, MVA |
| VAh | 0.2% | 5 to 8 Digits Programmable |
| PF | 0.2% | +/- 0.5 to 1.0 |
| Frequency | +/- 0.03 Hz | 45 to 65 Hz |
| %THD | +/- 2.0% | 1 to 99.99% |
| % Load Bar | +/- 1 Segment | (0.005 to 6) A |

**Note:** Applies to 3 element WYE and 2 element Delta connections. See full accuracy specifications in Shark® 200 Meter User Manual. Neutral current 2% accuracy.

### Traceable Watt-Hour Test Pulse for Accuracy Verification

The Shark® 200 device is a traceable revenue meter. It contains a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy. This is an essential feature required of all billing grade meters.

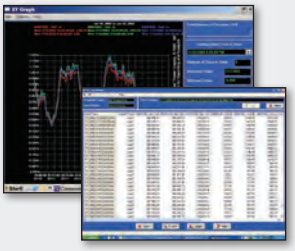
- Utility Block and Rolling Average Demand
- Historical Load Profiling
- Transformer Log Compensation
- CT/PT Compensation

## EXTENSIVE DATA-LOGGING CAPABILITY (V2 and Higher)

The Shark®200 meter offers the capability of having 2 Megabytes of data-logging to be used for historical trends, limit alarms, I/O changes and sequence of events. The unit has a real-time clock that allows for time stamping of all the data in the instrument when log events are created.

### Historical Logs

- 3 Assignable Historical Logs
- Independently Program Trending Profiles
- Up to 64 Parameters per Log



Historical Trending

### System Events Log

To protect critical billing information, the meter records and logs the following with a time stamp:

- Demand Resets
- System Startup
- Log Resets
- Programmable Settings Changes
- Password Requests
- Energy Resets
- Log Reads

### I/O Change Log

- Provides a Time Stamped Log of any Relay Output
- Provides a Time Stamped Log of Input Status Changes
- 2048 Events Available

### Limit/Alarm Log

- Provides Magnitude and Duration of an Event
- Includes Time Stamps and Alarm Value
- 2048 Events Available

Alarm Log

### Limits Alarms and Control Capability (V4 Option)

Limit Events

- Any measured parameter
- Up to 16 Limits
- Voltage Imbalance
- Current Imbalance
- Based on % of full scale settings

Limit Set Up

## HIGH PERFORMANCE POWER QUALITY ANALYSIS (V5 AND V6)

### Simultaneous Voltage and Current Waveform Recorder

The unit records up to 512 samples per cycle for a voltage sag or swell or a current fault event. The unit provides the pre- and post-event recording capability shown in the table below. Waveform records are programmable to the desired sampling rate. V5 provides up to 3 Megabytes storage and V6 provides a total of 4 Megabytes.

The meter's advanced DSP design allows Power Quality triggers to be based on a 1 cycle updated RMS. Up to 170 events can be stored until the memory fills. The meter stores waveform data in a first-in/first-out circular buffer to insure data is always recording.

**Optional Waveform Recorder**

| | Samples per Cycle | Pre Event Cycles | Post Event Cycles | Max Waveform per Event | Number of Stored Events |
|---|---|---|---|---|---|
| V5 | 16 | 32 | 96 | 256 | 85 |
| | 32 | 16 | 48 | 128 | 85 |
| | 64 | 8 | 24 | 64 | 85 |
| V6 | 128 | 4 | 12 | 32 | 170 |
| | 256 | 2 | 6 | 16 | 170 |
| | 512 | 1 | 3 | 8 | 170 |

Note: Sampling rate based on 60Hz systems. For 50Hz systems, multiply by 1.2.

### Waveform Scope

The unit uniquely offers a waveform scope to view the real time waveform for voltage and current. Waveform scope allows the meter to be used as a basic oscilloscope throughout a power system.

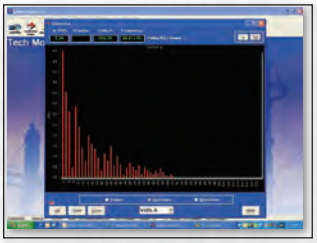

Waveform Scope Display

### Independent CBEMA Log Plotting

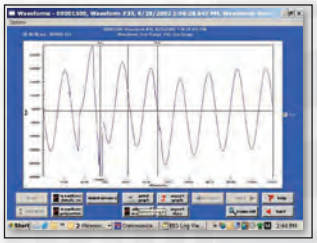
The meter stores an independent CBEMA log for magnitude and duration of voltage events. This allows a user to quickly view total surges, total sags and duration without retrieving waveform data.

### Harmonic Recording to the 40th Order

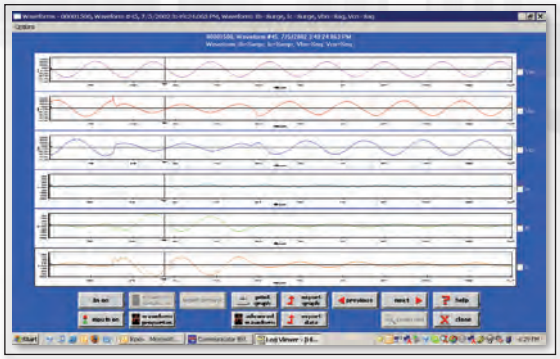
The Shark® 200 meter provides advanced harmonic analysis to the 40th order for each voltage and current channel in real time. Using the stored waveforms, harmonic analysis is available to the 255th order.



Harmonic Spectrum (40th Order)



Waveform Zoomed



6 Channels of Waveforms

## STANDARD COMMUNICATION CAPABILITY

The Shark® 200 meter provides two independent communication ports with advanced features.

**Rear Mounted Serial Port with KYZ Pulse**

- **RS485** - This port allows RS485 communication using Modbus or DNP 3.0 Protocols. Baud rates are from 9600 to 57.6k.
- **KYZ Pulse** - In addition to the RS485, the meter also includes Pulse Outputs mapped to absolute energy.

**Front Mounted IrDA Communication**

Uniquely, the Shark® 200 meter also has an optical IrDA port, allowing you to program it with an IrDA-enabled laptop PC.

## FIELD EXPANDABLE I/O AND COMMUNICATION CAPABILITIES

**The Shark® 200 meter offers unequaled I/O expandability.** Using the two universal option slots, the unit can easily be configured to accept new I/O cards even after installation. The unit auto-detects installed I/O option cards. Up to 2 cards of any type can be used per meter.

**1. INP100S: 100BaseT Ethernet Capability**

The meter can provide 100BaseT Ethernet functionality.

Using this card, a user can connect to 12 simultaneous Modbus TCP/IP connections.

- Embedded web server
- Network Time Protocol (NTP) Support

**2. 1mAOS: Four Channel Bi-directional 0-1mA Outputs**

- Assignable to any parameter
- 0.1% of full scale
- 0 to 10K Ohms
- Range +/- 1.20mA

**3. 20mAOS: Four Channel 4-20mA Outputs**

- Assignable to any parameter
- 0.1% of full scale
- 0 to 850 Ohms at 24VDC
- Loop Powered using up to 24 Volts DC

**4. RO1S: Two Relay Outputs / Two Status Inputs**

- 250VAC/30VDC - 5A Relays, Form C
- Trigger on user set alarms
- Set delays and reset delays
- Status Inputs – Wet / Dry Auto Detect (Up to 150 VDC)
- Must be used with V4 or higher V-Switch™ option for limit based alarms and control

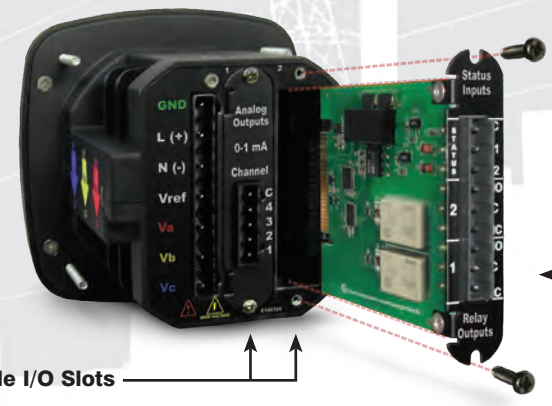
**5. PO1S: Four Pulse Outputs / Four Status Inputs**

- Programmable to any energy parameter and pulse value
- Form A: Normally open contacts
- Also used for End of Interval pulse
- Can function for manual relay control and limit based control (V4-V6 Options)
- 120mA continuous load current
- Status Inputs - Wet/Dry Auto Detect (Up to 150 VDC)

**6. FOVPS or FOSTS: Fiber Optic Card**

- EIG's exclusive Fiber Optic Daisy Chain switchable built-in logic mimics RS485 half duplex bus, allowing you to daisy chain meters for lower installation costs. Full duplex is also assignable.
- ST Terminated Option (-FOST)
- Versatile Link Terminated Option (-FOVP)
- Modbus and DNP 3.0 protocols available

Meter Auto Detects I/O Card Type

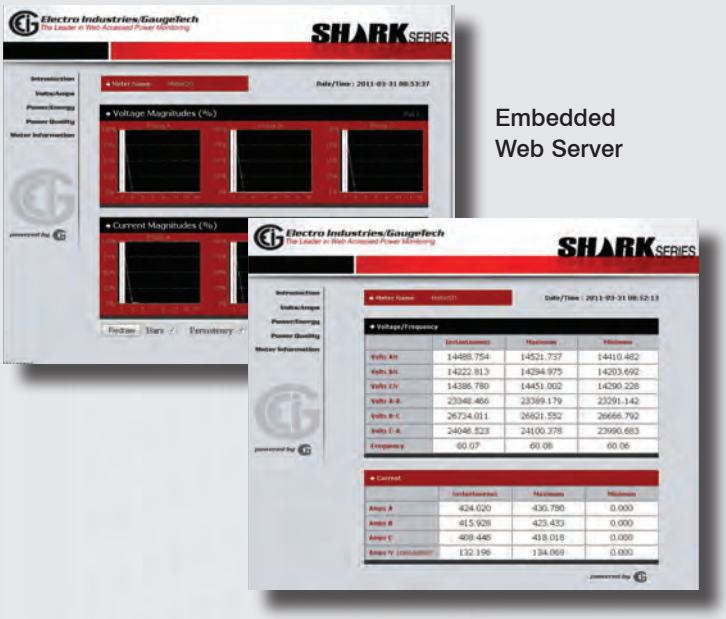



**Note:** I/O cards can be ordered separately - see last page.

## 100BASE T ETHERNET (INP100S)

### Simultaneous Data Connections


*Simultaneous Connections to Multiple Software Systems*



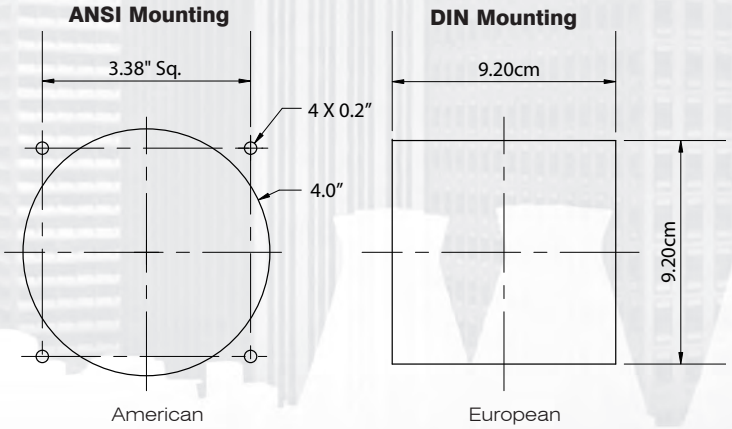

Embedded Web Server

### 100BaseT ETHERNET AND WEB SERVER

Electro Industries Rapid Response™ Ethernet card allows for high speed Ethernet communication utilizing a 100BaseT protocol communicating with up to 12 connections with Modbus TCP. The card supports a static IP address and is treated like a node on the network. The Shark® 200 meter provides fast and reliable updates to HMI packages, SCADA and COM EXT download software. The Web Server allows access by almost all browsers over the Internet.

### SHARK® 200 METER ANSI AND DIN MOUNTING

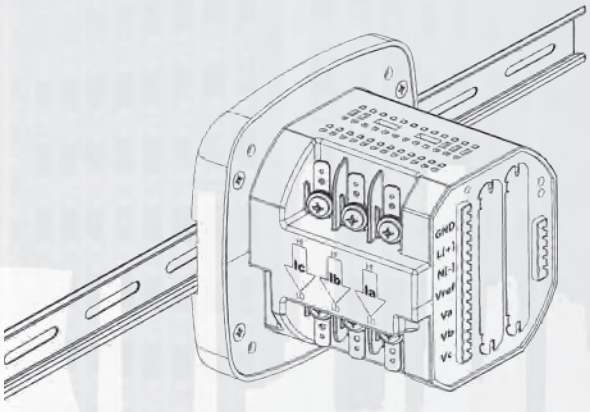
The unit mounts directly in an ANSI C39.1 (4" Round form) or an IEC 92 mm DIN square form. This is perfect for new installations and for existing panels. In new installations, simply use DIN or ANSI punches. For existing panels, pull out old analog meters and replace them with the Shark® 200 meter. The meter uses standard voltage and current inputs so that CT and PT wiring does not need to be replaced.




*(One meter fits both standards)*

### SHARK® 200T TRANSDUCER

This transducer version of the Shark® 200 meter does not include a display. The unit mounts directly to a DIN rail and provides an RS485 Modbus or DNP 3.0 output and the expandable I/O.

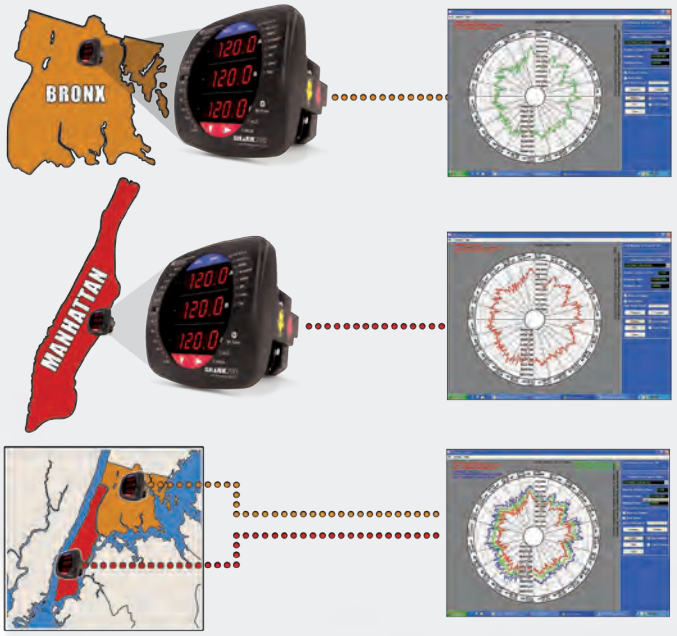



**Shark® 200T - DIN Rail Mounted Transducer**

## SUBSTATION VOLTAGE RECORDING

Traditionally, voltage recording meters were relegated to high cost metering or monitoring solutions. The Shark® 200 meter can be placed throughout an electrical distribution network. The meter provides one of the industry's lowest cost methods of collecting voltage information within a Utility power distribution grid.

- Voltage reliability analysis insuring proper voltage to customers
- Compare voltage reliability throughout transmission or distribution networks
- Monitor the output of substation transformers or line regulators
- Initiate conservation voltage reduction, reducing system demand




## LOAD PROFILING

The Shark® 200 meter allows you to log substation data over time with regard to electrical usage, demand, voltage, current, PF and many other parameters. This enables a complete analysis of the power system over time.

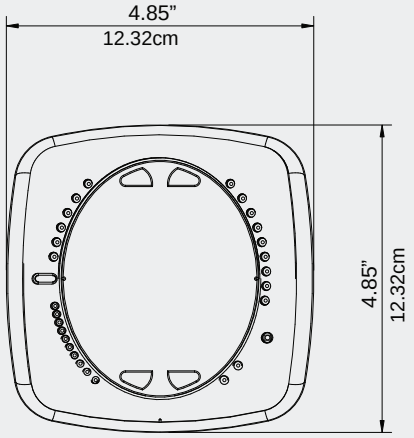
- Provide revenue accurate load profiling
- Determine substation usage
- Analyze feeder capacity and utilization
- Provide time based load profile for planning one estimation
- Data trend PF distribution and imbalances for system efficiency analysis


## LOW COST SUBSTATION TELEMETRY

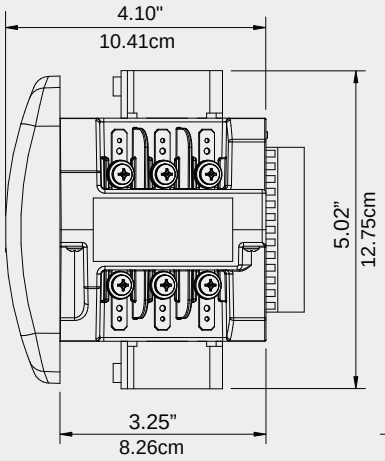
The Shark® 200 meter's advanced output capability brings back data using many different communication mediums such as RS485, Ethernet and analog outputs. This insures that one meter can be used for almost every substation application no matter what communication infrastructure is needed.

- Perfect for new or retrofit applications
- Multiple Com paths
- One meter provides outputs for every application
- Multiple systems and/or user accessing data simultaneously

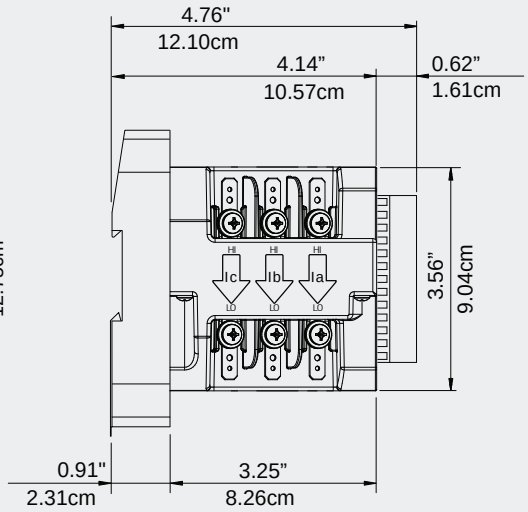
## DIMENSIONAL DRAWINGS




Shark® 200 Meter Face



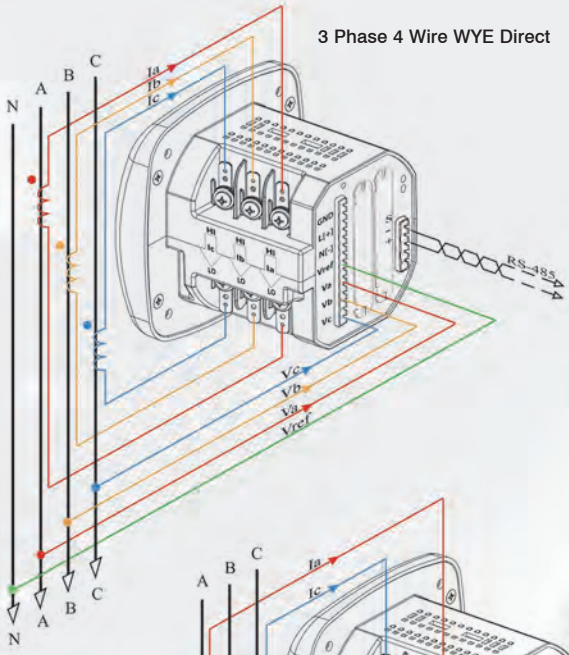

Shark® 200 Meter Side



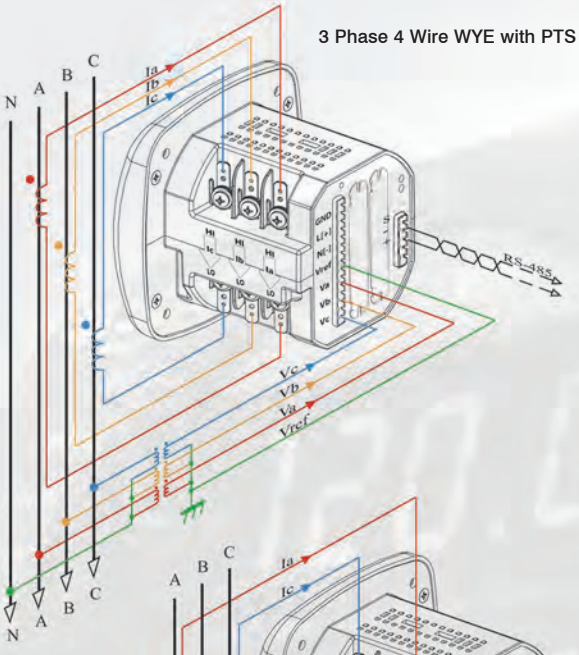

Shark® 200T Transducer Side

## WIRING DIAGRAMS

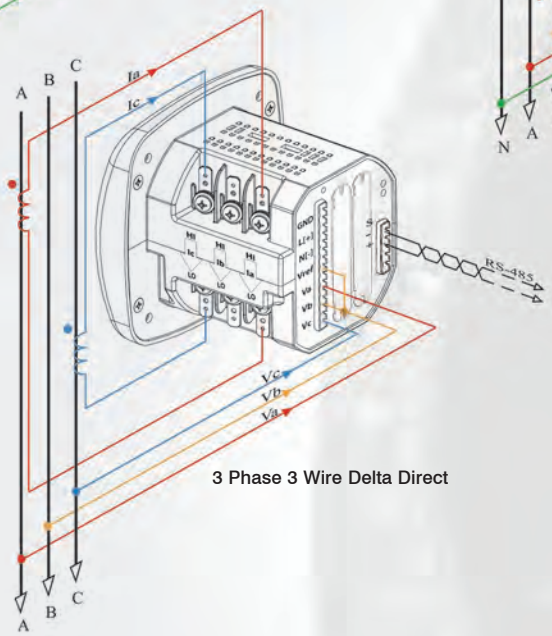
3 Phase 4 Wire WYE Direct



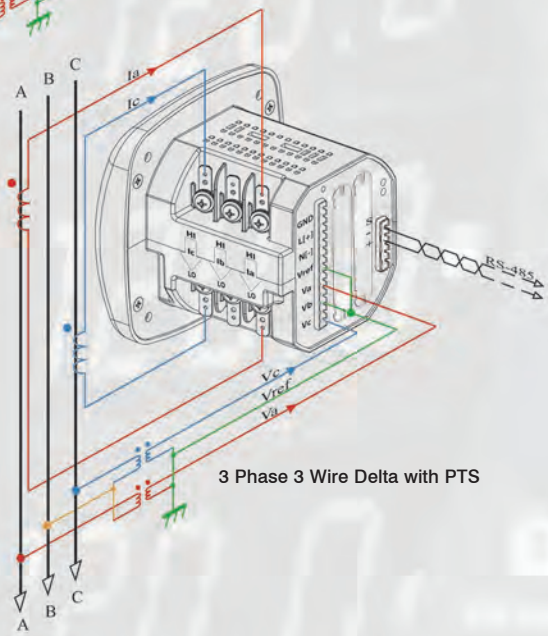

3 Phase 4 Wire WYE with PTS




3 Phase 3 Wire Delta Direct




3 Phase 3 Wire Delta with PTS



## Specifications

### Voltage Inputs
- 20-576 Volts Line To Neutral, 0-721 Volts Line to Line
- Universal Voltage Input
- Input Withstand Capability – Meets IEEE C37.90.1 (Surge Withstand Capability)
- Programmable Voltage Range to Any PT ratio
- Supports: 3 Element WYE, 2.5 Element WYE, 2 Element Delta, 4 Wire Delta Systems
- Burden: Input Impedance 1 Mega Ohms. Burden 0.014W at 120Volts
- Input wire gauge max (AWG 12 / 2.5mm$^2$ )

### Current Inputs
- Class 10: (0.005 to 11) A, 5 Amp Nominal
- Class 2: (0.001 to 2) A, 1A Nominal Secondary
- Fault Current Withstand (at 23°C): 100 Amps for 10 Seconds, 300 Amps for 3 Seconds, 500 Amps for 1 Second
- Continuous current withstand: 20 Amps for Screw Terminated or Pass Through Connections
- Programmable Current to Any CT Ratio
- Burden 0.005VA per phase Max at 11Amps
- Pickup Current: 0.1% of Nominal
  Class 10: 5mA
  Class 2: 1mA
- Pass through wire diameter: 0.177" / 4.5mm

### Isolation
All Inputs and Outputs are galvanically isolated to 2500 Volts

### Environmental Rating
*Storage:* (-20 to +70)° C
*Operating:* (-20 to +70)° C
*Humidity:* to 95% RH Non-Condensing
*Faceplate Rating:* NEMA12 (Water Resistant)
Mounting Gasket Included

### Sensing Method
- True RMS
- Sampling at over 400 samples / cycle on all channels of measured readings simultaneously
- Harmonics resolution to 40th order
- Waveform up to 512 samples/cycle

### Update Rate
- Watts, VAR and VA - every 6 cycles
- All other parameters - every 60 cycles

### Power Supply
Option D2:
- (90 to 265) Volts AC and (100 to 370) Volts DC. Universal AC/DC Supply

Option: D:
- (18-60) Volts DC (24-48 VDC Systems) Burden: 10VA Max

### Standard Communication Format
- 2 Com Ports (Back and Face Plate)
- RS485 Port (Through Back Plate)
- IrDA (Through Faceplate)
- Com Port Baud Rate: (9,600 - 57,600)
- Com Port Address: 1-247
- 8 Bit, No parity
- Modbus RTU, ASCII or DNP 3.0 Protocols

### KYZ Pulse
- Type Form C Contact
- On Resistance: 35 Ohms Max
- Peak Voltage: 350 VDC
- Continuous Load Current: 120mA
- Peak Load Current: 350mA (10ms)
- Off State Leakage Current@ 350VDC: 1uA

### Dimensions and Shipping
- Weight: 2 lbs
- Basic Unit: H4.85 x W4.85 x L4.65
- Shark® 200 meter mounts in 92mm DIN & ANSI C39.1 Round Cut-outs
- Shark® 200T Transducer DIN rail mounted
- 2-inch DIN Rail Included
- Shipping Container Dimensions: 6" cube

### Meter Accuracy
- See page 2
- *Note: For 2.5 element programmed units, degrade accuracy by an additional 0.5% of reading.*

### Compliance:
- IEC 687 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- IEC1000-4-2 – ESD
- IEC1000-4-3 – Radiated Immunity
- IEC 1000-4-4 – Fast Transient
- IEC 1000-4-5 – Surge Immunity

## Ordering Information

All fields must be filled in to create a valid part number.

| | Model | | Frequency | | Current Input | | V-Switch Pack | | Power Supply | | I/O Slot 1* | | I/O Slot 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Option Numbers: | | – | | – | | – | | – | | – | | – | |
| Example: | **Shark200** | - | 60 | - | 10 | - | V2 | - | D2 | - | INP100S | - | X |
| | Shark200 (Meter/Transducer) | | 50 50 Hz System | | 10 10 Amp Secondary | | V1 Multifunction Meter Only | | D2 90-265V AC/DC | | X None | | X None |
| | Shark200T (Transducer Only) | | 60 60 Hz System | | 2 2 Amp Secondary | | V2 Standard Data-Logging Memory | | D 18-60V DC | | RO1S 2 Relays / 2 Status | | RO1S 2 Relays / 2 Status |
| | | | | | | | V3 Power Quality Harmonics | | | | PO1S 4 Pulses / 4 Status | | PO1S 4 Pulses / 4 Status |
| | | | | | | | V4 Limits & Control | | | | 1mAOS 4 channel Analog Output 0-1 (bidirectional) | | 1mAOS 4 channel Analog Output 0-1 (bidirectional) |
| | | | | | | | V5 64 Samples/cycle Waveform Recording | | | | 20mAOS 4 Channel Analog Output 4-20mA | | 20mAOS 4 Channel Analog Output 4-20mA |
| | | | | | | | V6 512 Samples/cycle Waveform Recording | | | | FOSTS Fiber Optic Output ST Terminated | | FOSTS Fiber Optic Output ST Terminated |
| | | | | | | | | | | | FOVPS Fiber Optic Output VPIN Terminated | | FOVPS Fiber Optic Output VPIN Terminated |
| | | | | | | | | | | | INP100S 100BaseT Ethernet | | INP100S 100BaseT Ethernet |

* *I/O cards can be ordered separately using the above part numbers.*

## Additional Accessories

### Communication Converters
9PINC – RS232 Cable

CAB6490 - USB to IrDA Adapter

Unicom 2500 - RS485 to RS232 Converter

Unicom 2500-F – RS485 to RS232 to Fiber Optic Converter

Modem Manager, Model #, MM1 – RS485 to RS232 Converter for Modem Communication

IrDA232 - IrDA to RS232 Adapter for Remote Read

### Compliance Documents
Certificate of Calibration, Part #: CCal – This provides Certificate of Calibration with NIST traceable Test Data.

### Current Transformer Kits
CT200K – 200/5 Ratio 1.00" Window 3 CTs
CT400K – 400/5 Ratio, 1.25" Window, 3 CTs
CT800K – 800/5 Ratio, 2.06" Window, 3 CTs
CT2000K – 2000/5 Ratio, 3.00" Window, 3 CTs

### CT Specifications:
**Frequency:** 50 to 400Hz; Insulation: 600 Volts, 10kV BIL
**Flexible Leads:** UL 1015 105°C, CSA Approved, 24" Long, #16AWG

### Software Option Numbers
COMEXT3 – CommunicatorEXT 3.0 for Windows®

* Consult factory application engineer for additional transformer ratios, types or window sizes.

**Electro Industries/GaugeTech**
1800 Shames Drive • Westbury, NY 11590
**1-877-EIMETER** (1-877-346-3837) • **E-Mail:** sales@electroind.com
**Tel:** 516-334-0870 • **Web Site:** www.electroind.com • **Fax:** 516-338-4741



E 149702 032311 O

# INCA30xx and INCA40xx

## Process gas analyzer for the measurement of biogas, biomethane, landfill gas and sewage gas

Version: V0.11R02
Dok-ID: WM-0007

**UNION Instruments GmbH**
Tel. +49 (0) 721 9 52 43-0
Fax +49 (0) 721 9 52 43-33
info@union-instruments.com
www.union-instruments.com

# Explanations on T-Model and Housing

The INCA process gas analyzer is composed of a housing and a base plate (T-Model).

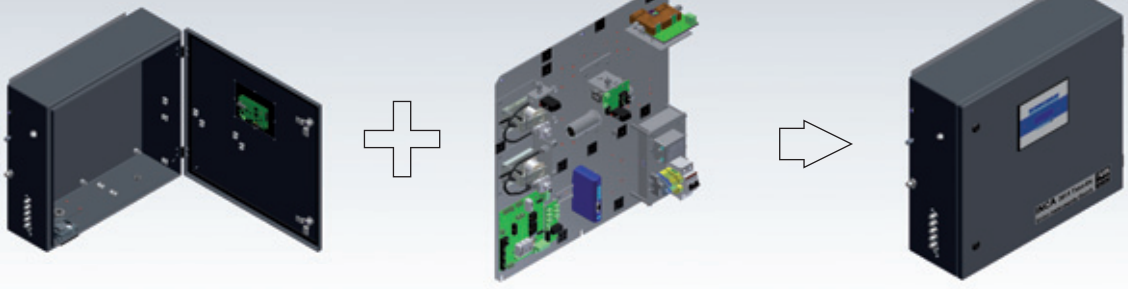
### Housing

indicates the type of gas conditioning, like e.g. gas drying and switching of measuring points.

### T-Model

indicates the sensor system and with it the gas types and concentrations which are to be measured.

### Device



INCA3011 _ _ _-04

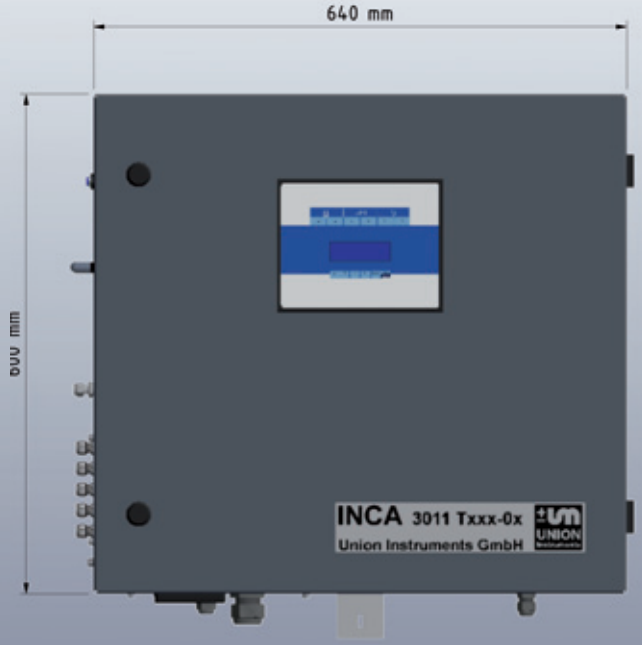
T100

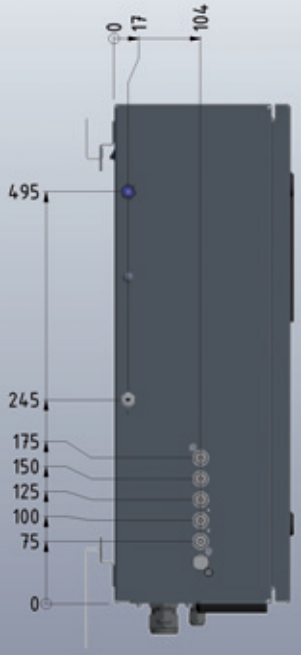
INCA3011 T100-04

# INCA3011 Txxx-0x

Multi-channel measuring device for condensate-free gases with flexible measuring ranges





## Matrix T-Models - Discontinuously measuring

| Component | $CH_4$ discontinuously | $CO_2$ discontinuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T137 | 100 | 10 | 100 | - | - | - | 25 | - | 4000 |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) continuously | $O_2$ (Paramagnetic) continuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
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| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T045 | - | - | - | - | - | - | - | 25 | - |
| T051 | - | 100 | - | - | - | - | - | - | - |
| T053 | - | 10 | - | - | - | - | - | - | - |
| T095 | 100 | 100 | - | - | - | - | 25 | - | - |
| T101 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T107 | 100 | - | - | - | - | - | - | - | - |
| T113 | - | - | - | - | - | - | 25 | - | - |
| T127 | 100 | 100 | - | 2000 | - | - | - | 5 | 4000 |
| T141 | 100 | 100 | - | 10000 | - | - | 25 | - | 4000 |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value
[3] Only for one measuring point

# Specification INCA3011 Txxx-0x

## INCA3011 Txxx-0x

for indoor installation

Consisting of:
aluminium housing, power supply, controller display,
electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 640x600x229 mm |
| Weight | 21 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets | 1–4 |
| Calibration gas inlets | 1 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. (optionally 300 mbar) |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Rel. gas humidity | < 95 % condensate-free |
| Condensate trap | Yes |

**Ambient conditions**

| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |
| Storage temperature | 0–60 °C |

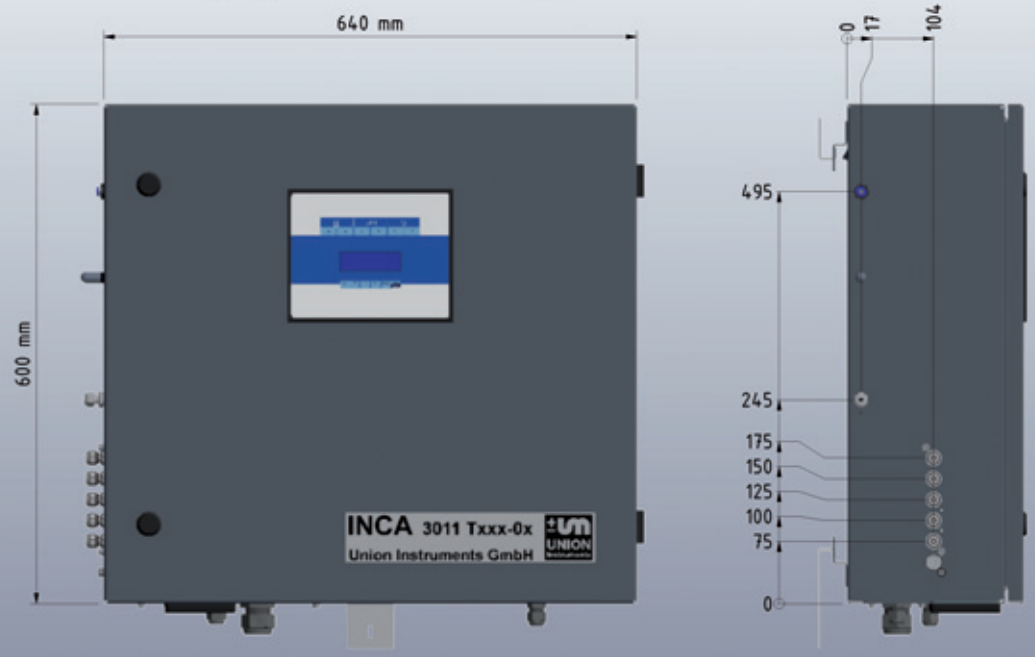
**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |

# INCA3021 Txxx-0x

Multi-channel measuring device
for condensate-free gases
with flexible measuring ranges and
two calibration gas inlets





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|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T137 | 100 | 10 | 100 | - | - | - | 25 | - | 4000 |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) continuously | $O_2$ (Paramagnetic) continuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T045 | - | - | - | - | - | - | - | 25 | - |
| T051 | - | 100 | - | - | - | - | - | - | - |
| T053 | - | 10 | - | - | - | - | - | - | - |
| T095 | 100 | 100 | - | - | - | - | 25 | - | - |
| T101 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T107 | 100 | - | - | - | - | - | - | - | - |
| T113 | - | - | - | - | - | - | 25 | - | - |
| T127 | 100 | 100 | - | 2000 | - | - | - | 5 | 4000 |
| T141 | 100 | 100 | - | 10000 | - | - | 25 | - | 4000 |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value
[3] Only for one measuring point

# Specification INCA3021 Txxx-0x

## INCA3021 Txxx-0x

for indoor installation

Consisting of:
aluminium housing, power supply, controller display,
electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 640x600x229 mm |
| Weight | 21 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets | 1–3 |
| Calibration gas inlets | 2 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. (optionally 300 mbar) |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Rel. gas humidity | < 95 % condensate-free |
| Condensate trap | Yes |

**Ambient conditions**

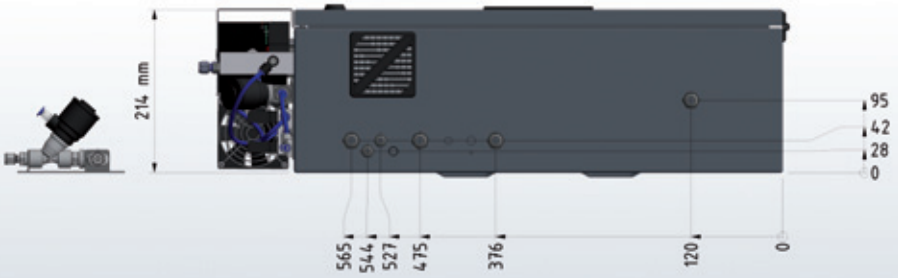
| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |
| Storage temperature | 0–60 °C |

**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |

# INCA4001 Txxx-xx

Multi-channel measuring device
for condensate-carrying gases
with sample gas cooler and flexible
measuring ranges.
Measuring point switching with
pneumatic valves


# Matrix T-Models - Discontinuously measuring

| Component | $CH_4$ discontinuously | $CO_2$ discontinuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value

# Specification INCA4001 Txxx-xx

## INCA4001 Txxx-xx

for indoor installation

Consisting of:
aluminium housing, power supply, controller display,
electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 741x600x214 mm |
| Weight | 29 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets | 1–10 |
| Calibration gas inlets | 1 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. (opitionally 300 mbar) |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Rel. gas humidity | ≤ 100% (condensate possible) |
| Condensate trap | Yes |

**Sample gas cooler**

| | |
|---|---|
| Cooling principle | thermoelectric |
| Dewpoint | 3–30 °C adjustable |
| Condensate removal | Vacuum jet pump |

**Pneumatics**

| | |
|---|---|
| Control pressure | 6–8 bar (87–116 psi) |
| Compressor | 10 l |

**Ambient conditions**

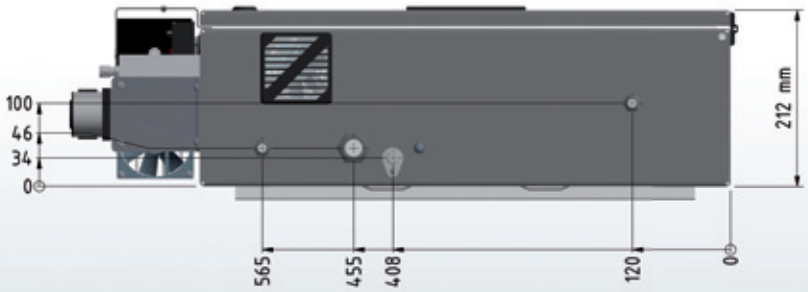
| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |
| Storage temperature | 0–60 °C |

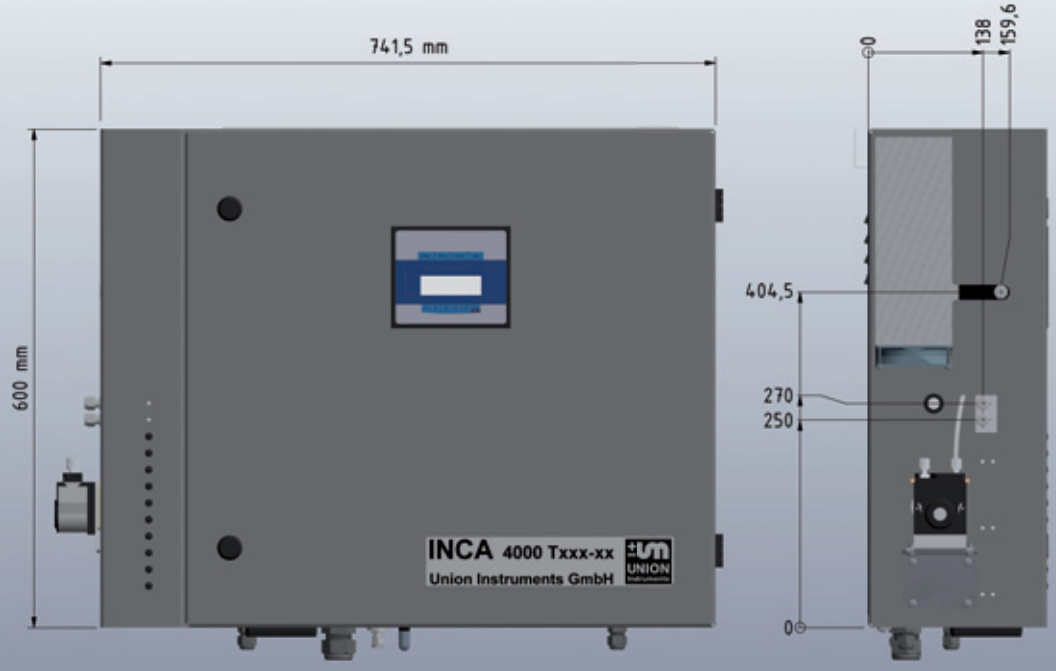
**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |

# INCA4002 Txxx-01

Single-channel measuring device for condensate-carrying gases with sample gas cooler and flexible measuring ranges

## Matrix T-Models - Discontinuously measuring

| Component | $CH_4$ discontinuously | $CO_2$ discontinuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T137 | 100 | 10 | 100 | - | - | - | 25 | - | 4000 |

## Matrix T-Models - Continuously measuring[3]

| Component | $CH_4$ continuously | $CO_2$ continuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) continuously | $O_2$ (Paramagnetic) continuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T045 | - | - | - | - | - | - | - | 25 | - |
| T051 | - | 100 | - | - | - | - | - | - | - |
| T053 | - | 10 | - | - | - | - | - | - | - |
| T095 | 100 | 100 | - | - | - | - | 25 | - | - |
| T101 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T107 | 100 | - | - | - | - | - | - | - | - |
| T113 | - | - | - | - | - | - | 25 | - | - |
| T127 | 100 | 100 | - | 2000 | - | - | - | 5 | 4000 |
| T141 | 100 | 100 | - | 10000 | - | - | 25 | - | 4000 |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value
[3] Only for one measuring point

# Specification INCA4002 Txxx-01

## INCA4002 Txxx-01

for indoor installation

Consisting of:
aluminium housing, power supply, controller display,
electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 741,5x600x212 mm |
| Weight | 29 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets | 1 |
| Calibration gas inlets | 1 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Rel. gas humidity | ≤ 100 % (condensate possible) |
| Condensate trap | Yes |

**Sample gas cooler**

| | |
|---|---|
| Cooling principle | thermoelectric |
| Dewpoint | 3–30 °C adjustable |
| Condensate removal | Hose pump |

**Ambient conditions**

| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |

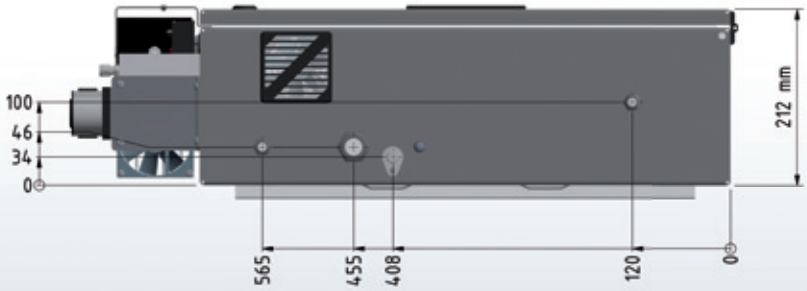
| | |
|---|---|
| Storage temperature | 0–60 °C |

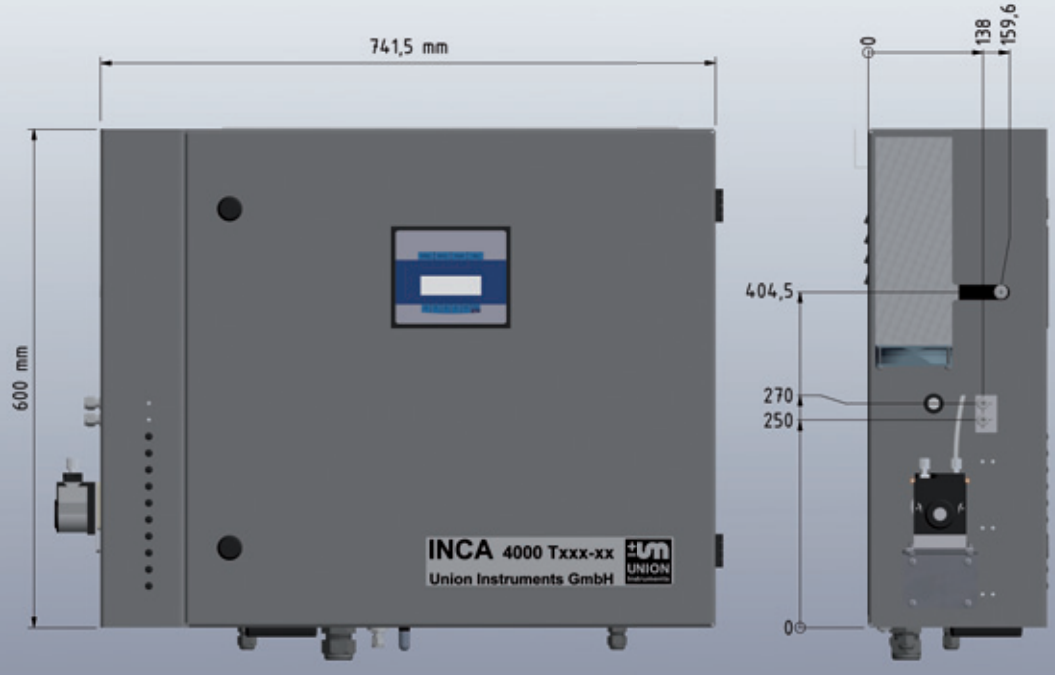
**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |

# INCA4002 Txxx-0x(0x)

Multi-channel measuring device
- 1 channel with sample gas cooler
- up to 3 channels for condensate-free gases

# Matrix T-Models - Discontinuously measuring

| Component | $CH_4$ discontinuously | $CO_2$ discontinuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] | ± 15% MV[2] | | | |
| | | | | | > 25 ppm | > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value

# Specification INCA4002 Txxx-0x(0x)

Consisting of:
aluminium housing, power supply, controller display, electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 741,5x600x212 mm |
| Weight | 29 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets I | 1 (cooled inlet, condensate possible) |
| Sample gas inlets II | 1–3 (condensate free) |
| Calibration gas inlets | 1 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Condensate trap | Yes |

**Sample gas cooler**

| | |
|---|---|
| Cooling principle | thermoelectric |
| Dewpoint | 3–30 °C adjustable |
| Condensate removal | Hose pump |

**Ambient conditions**

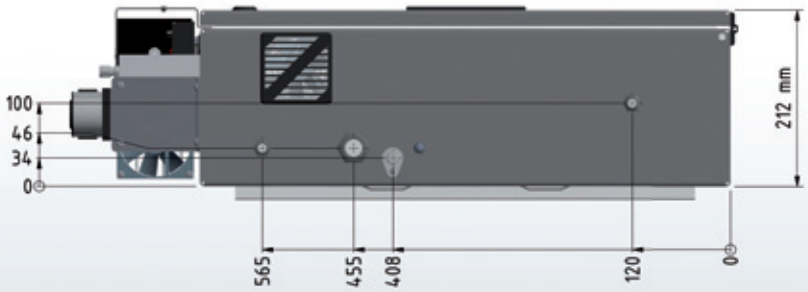
| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |
| Storage temperature | 0–60 °C |

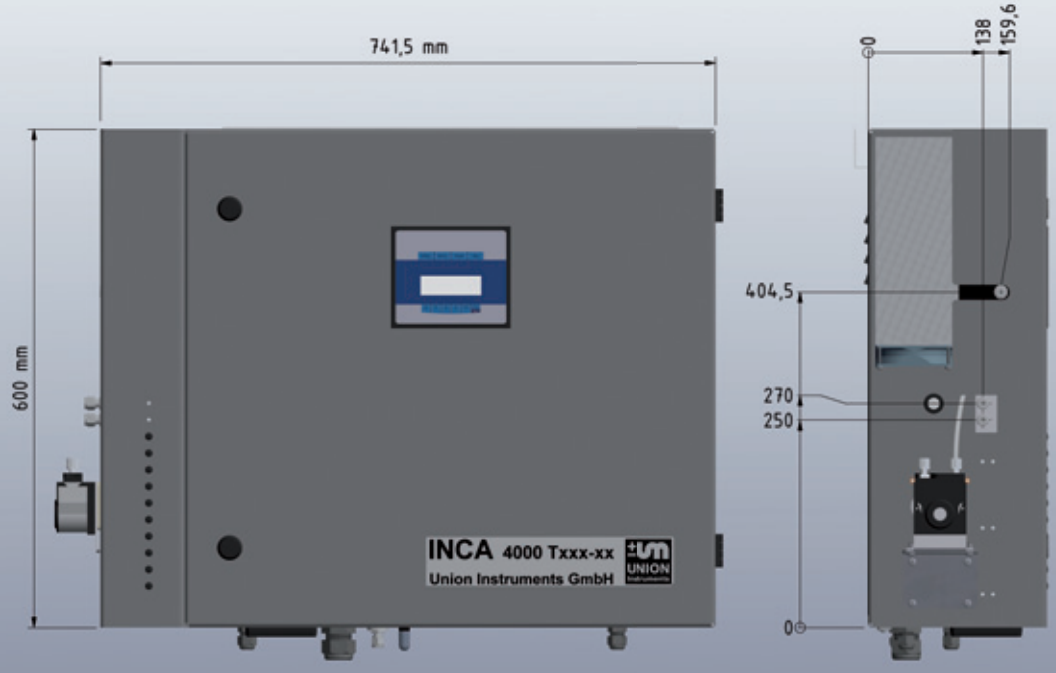
**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |

# INCA4003 Txxx-0x

Multi-channel measuring device
for condensate-carrying gases
with sample gas cooler and flexible
measuring ranges.
Measuring point switching with
electrical ball valve

# Matrix T-Models - Discontinuously measuring

| Component | $CH_4$ discontinuously | $CO_2$ discontinuously | $H_2S$ discontinuously | $H_2S$ discontinuously | $H_2S$ +µPulse discontinuously | $H_2S$ +µPulse discontinuously | $O_2$ (Chemical) discontinuously | $O_2$ (Paramagnetic) discontinuously | $H_2$ discontinuously |
|---|---|---|---|---|---|---|---|---|---|
| Measurement range | Vol% | Vol% | ppm | ppm | ppm | ppm | Vol% | Vol% | ppm |
| Measurement accuracy | ± 1% FS[1] | ± 1% FS[1] | ± 3 ppm | ± 60 ppm | ± 3 ppm (≤ 25 ppm) | ± 5 ppm (≤ 25 ppm) | ± 1% FS[1] | ± 1% FS[1] | ± 5% FS[1] |
| | | | | | ± 15% MV[2] > 25 ppm | ± 15% MV[2] > 25 ppm | | | |
| T060 | - | - | 100 | - | - | - | - | - | 4000 |
| T062 | - | - | 100 | - | - | - | - | - | - |
| T096 | - | - | - | - | 10000 | - | - | - | - |
| T098 | 100 | - | - | - | 10000 | - | 25 | - | - |
| T100 | 100 | 100 | - | - | 10000 | - | 25 | - | - |
| T140 | 100 | 100 | - | - | 10000 | - | 25 | - | 4000 |
| T160 | 100 | 100 | - | - | | 50000 | 25 | - | - |

[1] FS = Linearity error relative to full scale value
[2] MV = Linearity error relative to measured value

# Specification INCA4003 Txxx-0x

## INCA4003 Txxx-0x

for indoor installation

Consisting of:
aluminium housing, power supply, controller display,
electrical interface, pumps, control valves

| | |
|---|---|
| Dimensions (WxHxD) | 740x600x212 mm |
| Weight | 29 kg |
| Protection class | IP42 |
| Power supply | 100–240 V, 50/60 Hz |

**Gas inlets**

| | |
|---|---|
| Sample gas inlets | 1–4 |
| Calibration gas inlets | 1 |
| Purge gas inlets | 1 |
| Gas connections | Compression fitting 6 mm |
| Max. gas inlet pressure | 20 mbar rel. |
| Min. gas inlet pressure | -100 mbar rel. |
| Flame arrester | ATEX certification G IIC |
| Rel. gas humidity | ≤ 100% (condensate possible) |
| Condensate trap | Yes |

**Sample gas cooler**

| | |
|---|---|
| Cooling principle | thermoelectric |
| Dewpoint | 3–30 °C adjustable |
| Condensate removal | Hose pump |

**Ambient conditions**

| | |
|---|---|
| Operating temperature | 5–40 °C |
| Humidity | 0–95 % relative humidity |
| Atmospheric pressure | 900–1250 hPa (0,9–1,2 bar) |

| | |
|---|---|
| Storage temperature | 0–60 °C |

**Interfaces**

| | |
|---|---|
| Relays | 3 |
| Communication Interface | RS232 |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# QA/QC Plan Addendum - Lawnhurst Farms

4124 County Route 5
Stanley, NY 14561

**Site Contact**
Don Jensen III
Lawnhurst Farms, LLC
585-738-9403
lawnhurst@gmail.com

Steve McGlynn
Envitec
585-802-0174
s.mcglynn@envitec-biogas.com

- CDH was on site October 7, 2014 to verify metering and complete the sites Project Installation Report (PIR)

## Summary

Data is collected by Envitec's control system and made available to CDH to download via FTP. Multiple data files are made daily, and consist of data in varying time stamps.

| Data Point | Data File | Description | Eng Units | Instrument / Transducer |
|---|---|---|---|---|
| WG | Messwerte | Energy Generated | kW | Jenbacher DIA.NE XT3 Engine Controller |
| FG | Protokollierung | Biogas to Engine | cfh | Roots Rotary Gas Meter - B4 G250 |
| H2S | Messwerte | Hydrogen Sulfide in Biogas | ppm | INCA 4001 Gas Analyzer |
| O2 | Messwerte | Oxygen in Biogas | % | INCA 4001 Gas Analyzer |
| CH4 | Messwerte | Methane in Biogas | % | INCA 4001 Gas Analyzer |
| TD | Messwerte | Digester Temperature | F | - |
| PD | Messwerte | Digester Pressure | bar | - |
| FLARE | Protokollierung | Flare Runtime | Minutes | - |
| WG_ACC | Protokollierung | Energy generated - Accumulated | kWh | Jenbacher DIA.NE XT3 Engine Controller |
| WG_d | Protokollierung | Energy Generated - Shark 200 Meter | kWh | Shark 200 Power Meter |
| WG_KW_d | Messwerte | Power Generated - Shark 200 Meter | kW | Shark 200 Power Meter |

## Procedure

- Generator power was verified by comparing collected data from the DIA.NE XT3 engine controller to data from the Shark 200 revenue grade power meter.

- Gas data was verified by timing the face of the gas meter to determine the gas flow rate. The calculated gas flow rate and the generator power output were then used to calculate the engines electrical efficiency.

Generator Power

| | Shark 200 Daily kWh | DIA.NE XT3 Daily kWh | Diff. % |
|---|---|---|---|
| 9/1/2014 | 12,578.9 | 12,500.0 | 0.6% |
| 9/2/2014 | 12,352.1 | 12,300.0 | 0.4% |
| 9/3/2014 | 11,878.8 | 11,800.0 | 0.7% |
| 9/4/2014 | 11,782.6 | 11,700.0 | 0.7% |
| 9/5/2014 | 12,042.3 | 11,900.0 | 1.2% |
| 9/6/2014 | 12,707.2 | 12,600.0 | 0.8% |
| 9/7/2014 | 13,097.1 | 13,000.0 | 0.7% |
| 9/8/2014 | 12,855.3 | 12,700.0 | 1.2% |
| 9/9/2014 | 10,395.9 | 10,300.0 | 0.9% |
| 9/10/2014 | 13,075.4 | 13,000.0 | 0.6% |
| 9/11/2014 | 13,107.1 | 12,900.0 | 1.6% |
| 9/12/2014 | 13,107.6 | 13,000.0 | 0.8% |
| 9/13/2014 | 13,098.8 | 13,000.0 | 0.8% |
| 9/14/2014 | 12,184.2 | 12,100.0 | 0.7% |
| 9/15/2014 | 12,588.9 | 12,500.0 | 0.7% |
| 9/16/2014 | 12,473.4 | 12,400.0 | 0.6% |
| 9/17/2014 | 10,461.7 | 10,400.0 | 0.6% |
| 9/18/2014 | 12,803.0 | 12,700.0 | 0.8% |
| 9/19/2014 | 13,045.4 | 12,900.0 | 1.1% |
| 9/20/2014 | 13,006.2 | 13,000.0 | 0.0% |
| 9/21/2014 | 12,818.1 | 12,700.0 | 0.9% |
| 9/22/2014 | 11,558.0 | 11,400.0 | 1.4% |
| 9/23/2014 | 12,992.4 | 12,900.0 | 0.7% |
| 9/24/2014 | 13,027.2 | 13,000.0 | 0.2% |
| 9/25/2014 | 13,092.5 | 12,900.0 | 1.5% |
| 9/26/2014 | 13,065.0 | 13,000.0 | 0.5% |
| 9/27/2014 | 12,560.7 | 12,500.0 | 0.5% |
| 9/28/2014 | 12,021.7 | 11,900.0 | 1.0% |
| 9/29/2014 | 12,452.6 | 12,400.0 | 0.4% |
| 9/30/2014 | 12,997.1 | 12,900.0 | 0.7% |
| | | *Avg:* | *0.8%* |

## Biogas $H_2S$

| H2S Analyzer (PPM) | Draeger Tube (PPM) |
|---|---|
| 250 | 475 |
| 250 | 50 |
| 250 | 400 |

## Biogas Flow

| | Roots Reading (m^3) |
|---|---|
| 11:01 | 2893023 |
| 11:16 | 2893102 |

| | |
|---|---|
| 79 | m^3/15-min |
| 316 | m^3/hr |
| 11,159 | cfh |

| | |
|---|---|
| 540 | Generator kW |
| 578 | Btu/cf |

| | |
|---|---|
| 28.6% | Generator Eff. |