QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN
FOR
WOODCREST LLC ANAEROBIC DIGESTER GAS (ADG) SYSTEM
Agreement # 43225

August 26, 2015

Submitted to:

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

and

Woodcrest Dairy LLC
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Submitted by:

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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 Woodcrest Dairy Farm (the farm) in Lisbon, 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 ten (10) 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 450 kW.

ADG System Description

The digester system at the farm was designed by RCM International, LLC. The engine-generator equipment will be provided by Martin Machinery while the gas conditioning equipment will be supplied by RCM International, LLC. Gas and power metering are provided by Sage Metering Inc. and Electro Industries GaugeTech Inc. The site will operate one 450 kW synchronous engine-generator. Biogas will be channeled from the digester to a two-stage biochemical scrubber located near the digester. Gas conditioning equipment, piping and controls will be located next to the engine skid in the utility building. All the electrical loads at the farm are 3-phase, 277/480 volt electrical service which accommodates the interconnection of the generator system. The electrical system includes controls to synchronize the generator to the grid as well as a protective relay and controls to automatically isolate the units from the utility grid in the event of a utility power outage. The farm does expect to export a portion of the generated electricity, and has been approved for net metering.

Existing Heifer Facility.

East Lagoon.

Existing Manure Scrape System.

Proposed Anaerobic Digester Site.

Figure 1 - Photos of Site and System Components

Table 1 - Biogas Systems at Woodcrest Farm

Digester	RCM Anaerobic Digester, completely mixed, Insulated floating cover, heated, 1.5 million gallon capacity, 28 day retention time
Feedstock	Dairy Manure, approximately 1,500 animals (cows and heifers)
Engine	Dresser Rand SFGLD 360, 1,200 RPM, 450 kW on biogas
Generator	Marathon Electric MagnaMax$^{DVR®}$ Model MGG-712 – 480 VAC, 3 Phase.
Biogas Conditioning	RCM/MV two-stage biochemical H_2S scrubber, de-watering system, and blower, rated for 130 scfm at 3,000 ppm.
Engine Backup/startup Fuel	Biogas Only for Engine Start-up
Heat Recovery Use	Digester and food waste tank heating

Figures 2 and 3 show the farm layout and general site plan. Cows are currently bedded with sawdust; however, the farm plans to change this practice in the future to use digested solids. Manure is currently collected with a manure scraping system from two dairy barns and the heifer barn three times per day. Raw manure and process water, including milking parlor waste, rainfall, and sprinkler water flow by gravity directly from the free-stall barns to an existing pump pit on the south side of the barn. The manure slurry is then pumped 600 feet to an existing manure lagoon.

Figure 2 – Site Plan 1 of 2

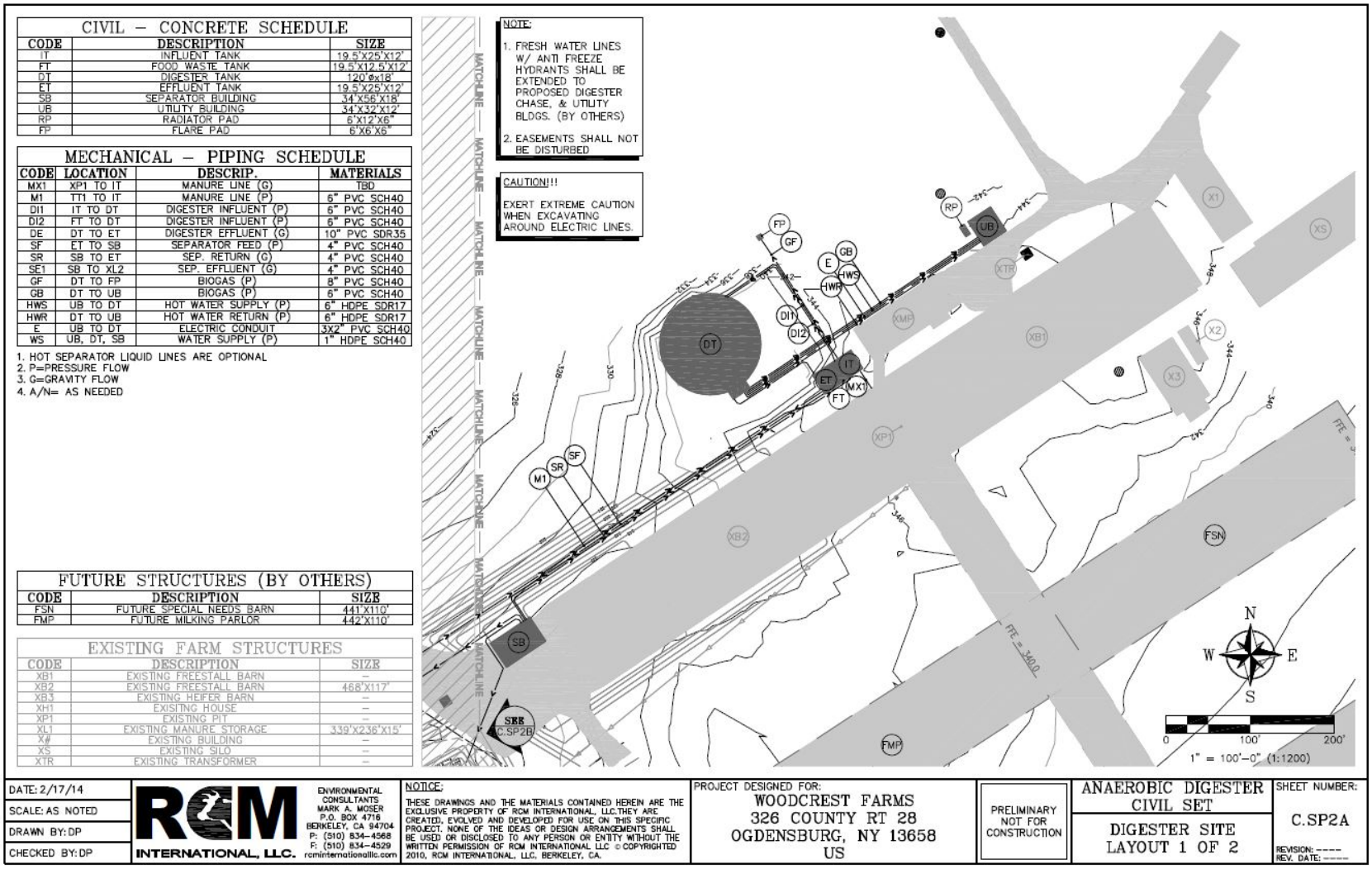


Figure 3 – Site Plan 2 of 2

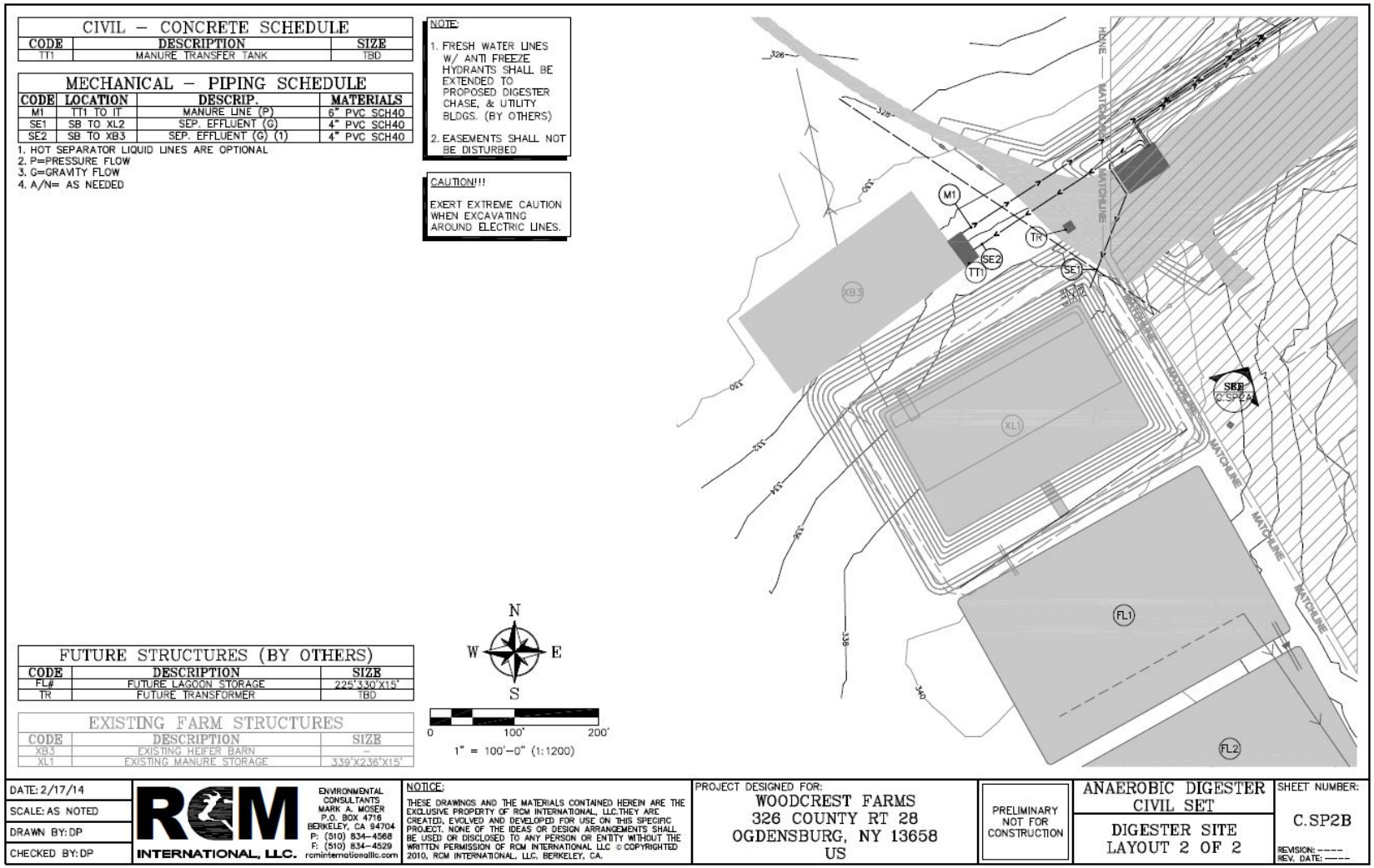


Figure 4 shows the process flow diagram for the food waste tank. Manure in the lagoon is pumped to the influent tank where it is mixed with food waste. Food waste pretreatment includes a food waste tank, heat exchanger, chopper pump, and internal mixer. The food waste tank is sized for 18,000 gallons to hold 2 days of food waste. The digester is sized to receive one truck load of approximately 7,500 gallons of liquid food waste per day. The food waste can be whey, milk products, DAF sludge, or any pumpable waste. The digester design assumes all food waste will have a total solids content average of 10%. The feedstock is pumped from the influent tank to the digester.

Figure 5 shows the process diagram for the digester and engine system. The digester tank will be equipped with an insulated floating cover, submersed mechanical mixers and an internal heat exchanger. A series of six mechanical mixers with propellers will recirculate digester contents to keep the digester contents fully mixed. The internal heat exchanger will be supplied with hot water from the utility building.

Digester effluent will flow by gravity to an external effluent sump tank where a manure pump will pump effluent to a solid-liquid separator. Separated solids will be stored in the separator building and could be used as bedding and as soil amendment. A fraction of separated liquid will be recycled to the front of the dairy barns, separator overflow will be sent back to the effluent tank and the remaining portion will be conveyed to the effluent storage tank.

Gas generated will be collected in a floating cover. The floating cover will be allowed to float as biogas is produced to provide biogas storage. Gas generated will be passed through a two-stage RCM / MV biochemical scrubber system to remove excess hydrogen sulfide. The gas leaving the gas treatment system will have reduced hydrogen sulfide content and will be used as fuel in the cogen system. Biogas from the digester is either used in the engine-generator or flared. Excess gas will be released from the digester through a buried 8-inch PVC pipe that runs to the enclosed safety flare. The biogas flare will be actuated by the digester system PLC supplied by RCM if internal gas pressure reaches the upper threshold limit as indicated by the gas pressure meter. An additional mechanical emergency relief valve will vent biogas to maintain the digester static pressure requirements.

Figure 4 - Food Waste Process Diagram

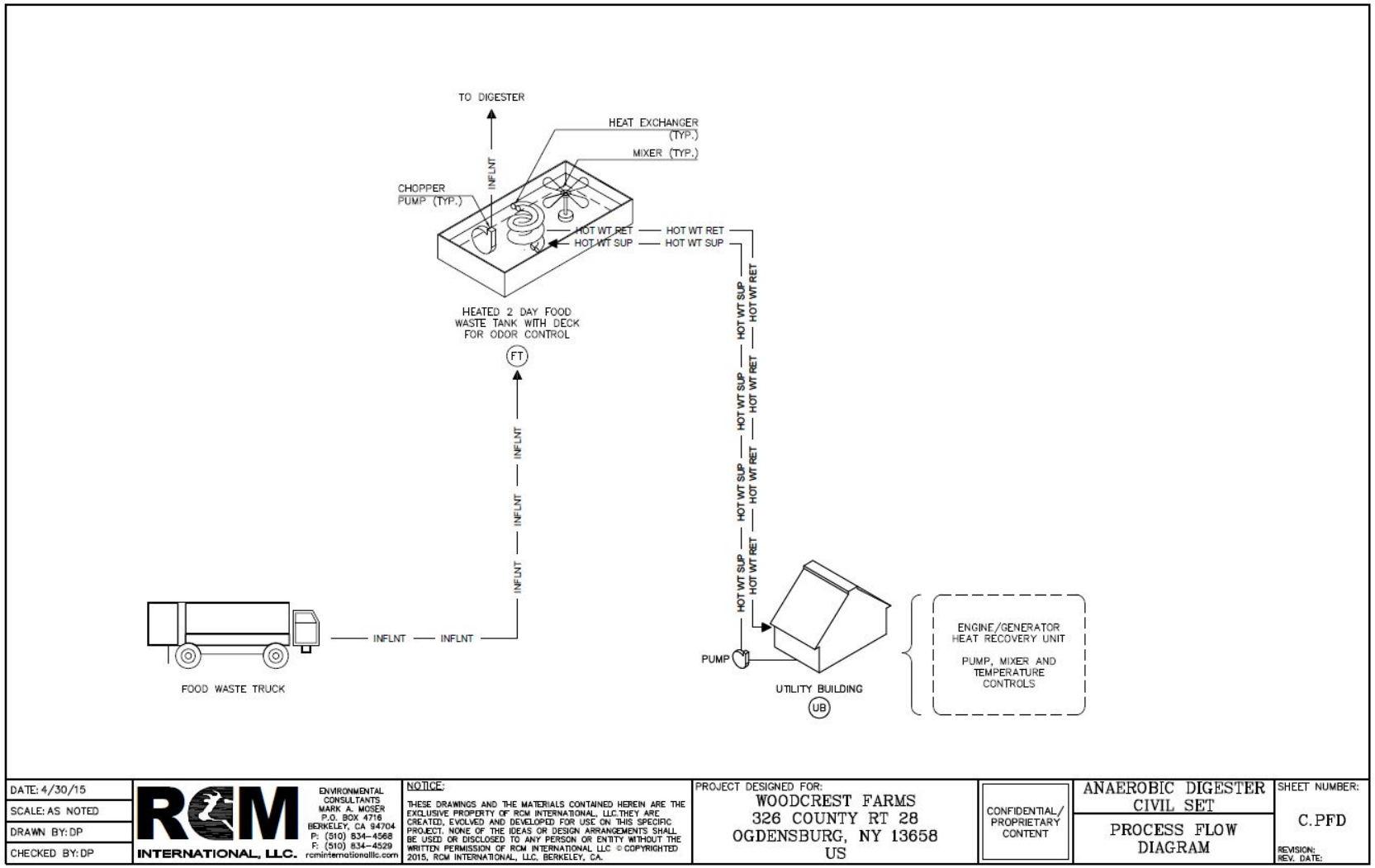
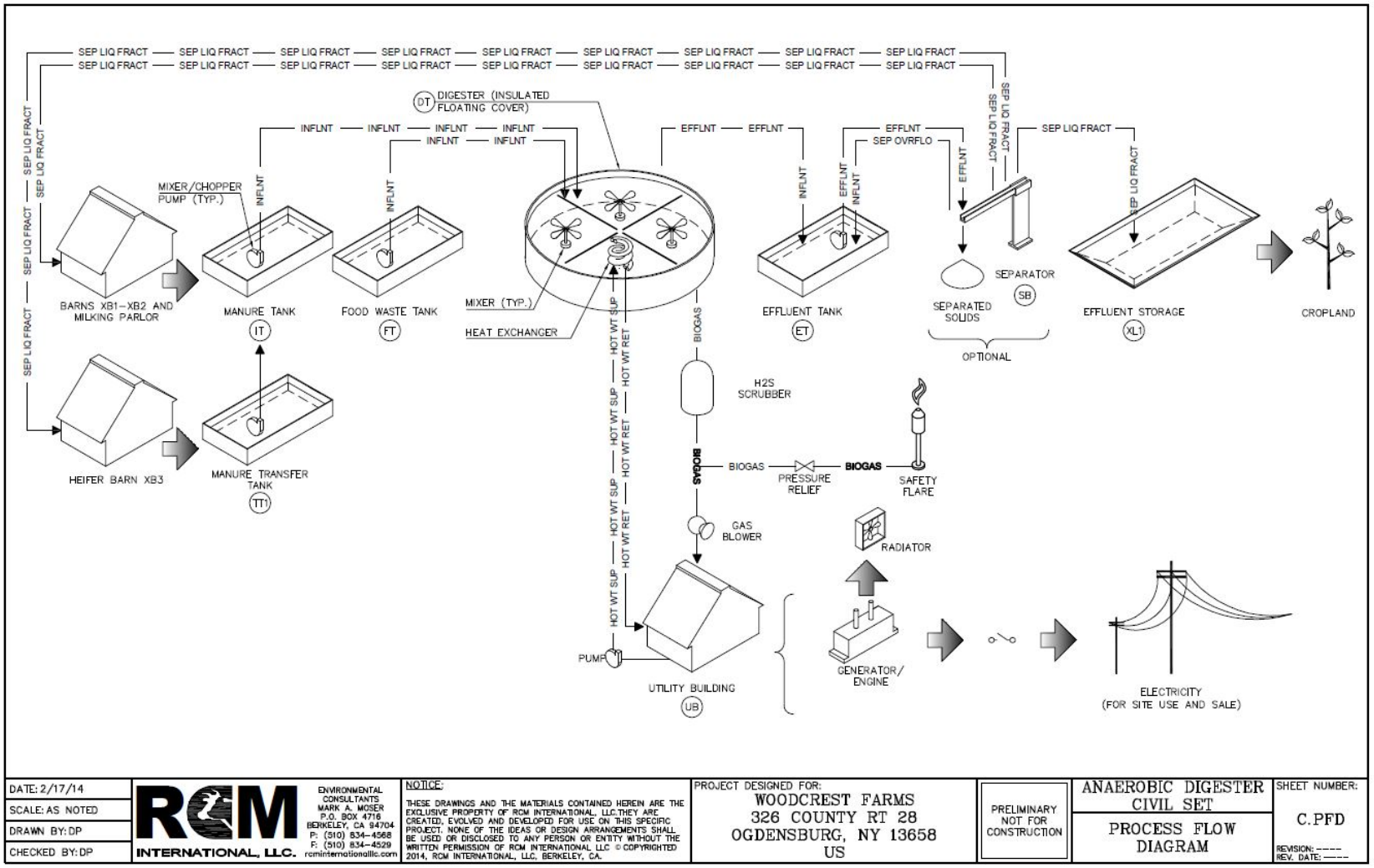


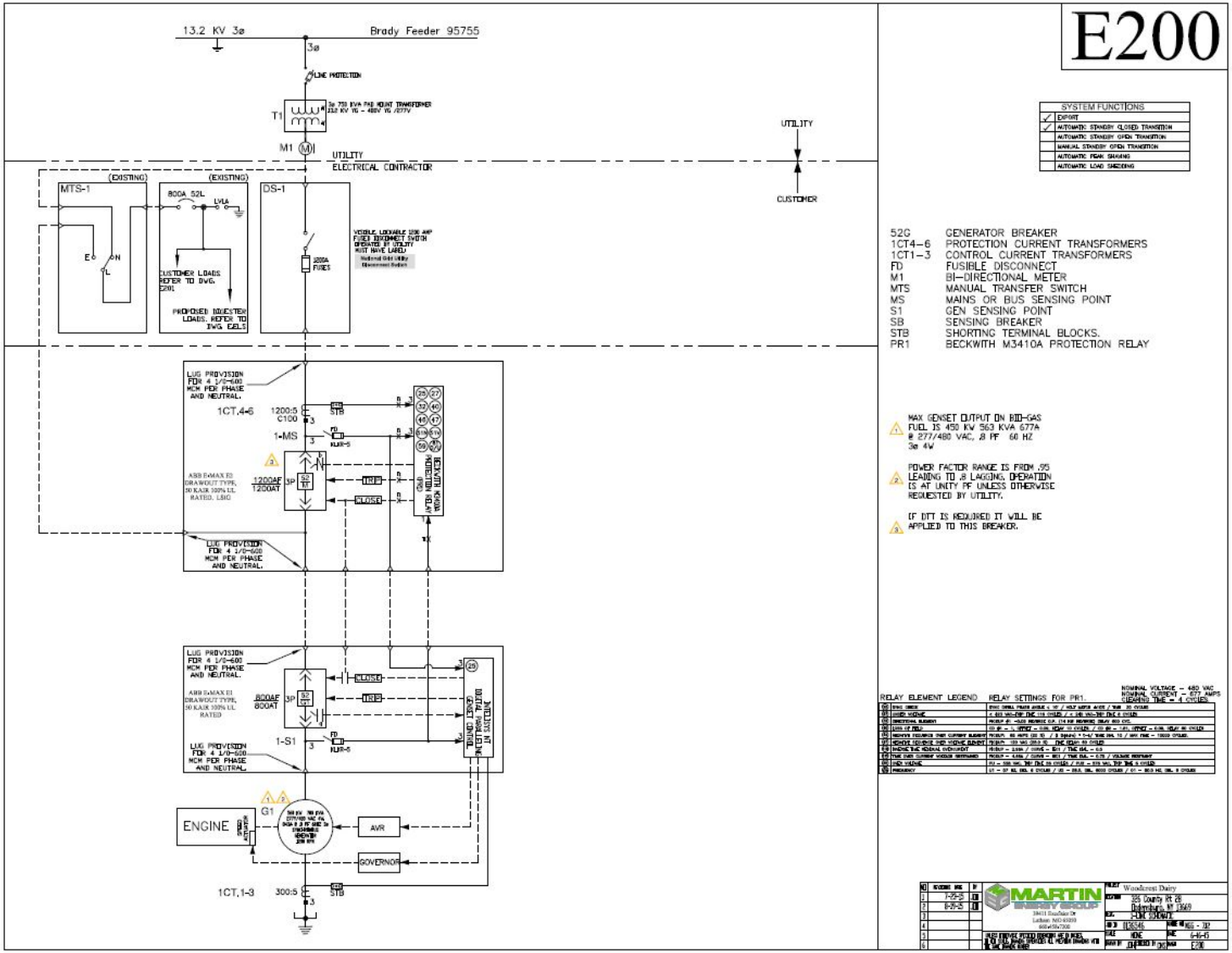
Figure 5 - Digester Process Diagram



Sage metering devices will measure gas flow to the flare (FGF) and to the engine-generator (FG). A small amount of air will be injected directly into the digester head space to help reduce H_2S in the biogas prior to the scrubber system. To further reduce the biogas H_2S levels, biogas will pass through the scrubber system. This system is the combination of two biological scrubbers and a dry chemical scrubber with a bypass loop to achieve a blended output concentration of 400 ppm or less. The biological scrubber uses circulating liquid spray to absorb H_2S gas, and bacteria utilize the sulfur byproducts. Iron sponge media used inside the chemical scrubber reacts with H_2S and traps sulfur byproducts in the media. Once the gas is scrubbed it continues into the utility building where it is then de-watered and pressurized, via the gas conditioning equipment provided by RCM, before being combusted in the engine. Measurement of H_2S is not included in the QA/QC plan since the gas clean up performance incentive was not requested.

Heat is recovered from the engine exhaust in the form of hot water. This hot water is circulated through the heat exchanger where it provides heat to the digester contents, pumped by the recirculation pump. A similar system is used to heat the food waste receiving tank, with an internal heat exchanger where hot water from the utility building is circulated. Should the heat exchanger loop be unavailable, a radiator will be used to dissipate heat from the engine.

Figure 6 – One Line Electrical Diagram



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 15% of the Total Capacity Incentive.

Payment Milestones: Initial payments made for major equipment and other work, such as the engine generator system, the anaerobic digester system, the gas scrubbing equipment, and other major components and fees for system design, engineering, CESIR study and other "soft costs".

Deliverables: Documentation that initial payments have been made to suppliers or service providers for major project components.

Capacity Payment #2: Up to 45% of the Anaerobic Digester component of Total Capacity Incentive.

Payment Milestones: NYSERDA's designated technical consultant has verified that construction/installation/upgrade of the anaerobic digestion system has been completed.

Deliverables: (a) A QA/QC Plan approved by NYSERDA and (b) Site inspection and verification by the NYSERDA technical consultant that the installation is complete and operational in accordance with the approved QA/QC Plan. The digester can be considered complete and operational if the digester structures, piping, controls and equipment are all installed for the feeding mixing, heating and unloading of digester feedstocks and for gas treatment and flaring. The completed installation may be documented with (1) a listing of the digester structures, piping, controls and equipment for feeding, mixing, heating and unloading and gas treatment and flaring and other major equipment to be installed in the design and (2) provision of as-built drawings, photos, verification by on-site inspection by the NYSERDA technical consultant, and/or other means satisfactory to NYSERDA documenting that these have been installed and are ready to operate to produce and manage the design biogas power generation rate of approximately 10,968 scf/hr identified in the project Application Package to PON 2828 Appendix B Section B as a total of 96,076,259 scf/yr. *(If the installed equipment deviates from that listed in the Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)*

Capacity Payment #3: Up to 45% of the Power Generation component of Total Capacity Incentive.

Payment Milestones: The Contractor has provided sufficient documentation to NYSERDA verifying that the power generation system has been delivered to the site (e.g., delivery receipt).

Deliverables*:* Delivery receipts, photos or other documentation acceptable to NYSERDA of delivery of the engine and generator equipment as described in the Agreement and adequate explanation of any deviations. *(If the installed equipment deviates from that listed in the*

Application Package, an explanation of the deviation must be provided for determination by NYSERDA whether the installed equipment adequately meets the terms of the Agreement.)

Capacity Payment #4: Up to 45% of the Project Enhancement component of Total Capacity Incentive.

Payment Milestones: NYSERDA's designated technical consultant has verified that construction/installation of the Project Enhancement has been completed or the required documentation for the Project Enhancement, according to applicable sections of *Using the Incentive Calculation Tool* of Exhibit D has been submitted to NYSERDA. The Contractor may request payment at this time for any Project Enhancements that have been completed and verified. Payment for Project Enhancements completed and verified after the 4th Capacity payment request has been made may be requested with the 6th Capacity payment.

Deliverables: Documentation that the project enhancement for the system designed to accept greater than 20% food waste has been completed, including pretreatment equipment, all meeting the requirement of Enhancements Section 3 of the Using Incentive Calculation portion of Exhibit D.

Capacity Payment #5: Up to 20% of the Total Capacity Incentive.

Payment Milestones: Documentation has been provided to NYSERDA that sufficiently verifies successful operation of the newly installed system and completion of interconnection, if applicable (e.g., interconnection acceptance test documentation from the utility).

Deliverables: Documentation that (a) the interconnection acceptance test has been accepted by the utility and interconnection approval has been obtained from the utility and (b) the new power generation equipment is complete and operational in accordance with the approved QA/QC Plan. The New Power Generation Capacity can be considered complete and operational if it has produced electricity at a minimum average of 75% capacity factor or 337.5 kWh/h for at least one hour.

Capacity Payment # 6: Up to 100% of the Total Capacity Incentive.

Payment Milestones: The newly installed system is successfully commissioned. Commissioning includes operating the ADG - fueled energy generation system at a minimum of 75% average capacity factor over seven (7) consecutive days, and demonstrating the ability to upload data generated by the system to NYSERDA's CHP website, if applicable. Any Project Enhancements payments that were not made with the 4th Capacity payment may be requested with this payment.

Deliverables: A Project Commissioning Report documenting the completion of all elements of the Commissioning process required by the QA/QC Plan and successful uploading of data to the website that is adequately consistent to NYSERDA's satisfaction with the data recorded on site. The Project Commissioning Report shall consist of the compilation of information prepared in meeting the deliverables requirements for all payment milestones including:

1. Documentation that construction of the ADG-to Electricity System is complete;

2. Documentation that the System has been interconnected with the utility grid:

3. Documentation that the System's New Equipment has satisfactorily operated for at least seven consecutive days, which is defined as operation with an minimum average 75% Capacity Factor of the Total Contracted Capacity or 337.5 kWh/h;

4. Documentation that the System has demonstrated the ability to upload information to NYSERDA's CHP Data Integration Website in conformance with the following section of the QA/QC Plan: Monitoring System Equipment, Installation, Operation, and Maintenance;

5. As-Built Diagrams of the installed system, including an explanation of any deviation of the equipment from that listed in the Application Package. Diagrams may consist of electronic copies of as-built drawings.

Monitoring System Equipment, Installation, Operation, and Maintenance

Figure 7 shows the general location of the meters used to measure biogas input to the engine-generator (**FG**), biogas sent to the flare (**FGF**), and the generator electrical output (**WG**).

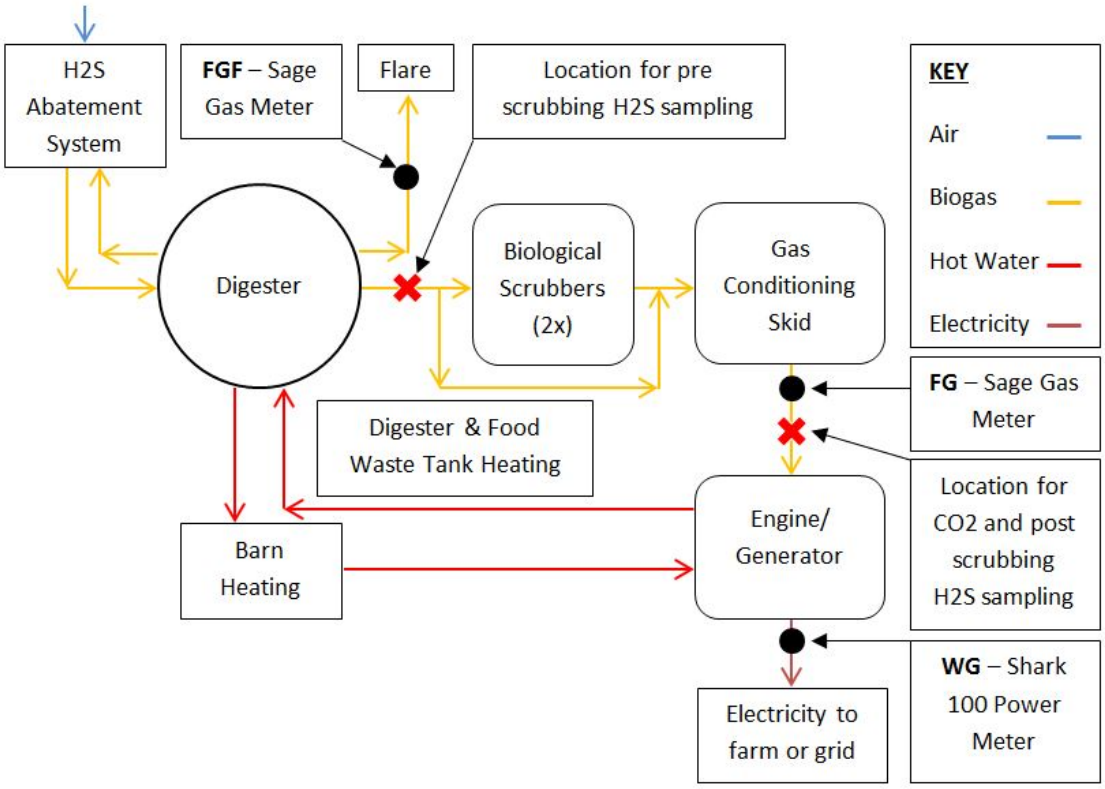


Figure 7 - Location of Meters

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	Electro Industries GaugeTech Inc. Revenue Grade Meter Model: Shark 100	kW	0-999 kW
Modbus	FG	Engine Biogas Flow	Sage Metering Inc. Model SIP-300-AC115-DIGGAS (0-135 scfm)	SCF	0 – 8,100 SCFH
Modbus	FGF	Flare Biogas Flow	Sage Metering Inc. Model SRP-050-AC115-DIGGAS (0-135 scfm)	SCF	0 – 8,100 SCFH

The electrical output of the engine-generator (**WG**) will be measured with the Electro Industries GaugeTech Inc. Shark 100 Pulse Output power meter. The power meter will be installed in a stand-alone cabinet on the side of the engine by the electrical contractor. The power meter will be installed according to the requirements in the appropriate operator guide. The CT inputs to the power meter will be fused in order to protect the power meter.

The biogas input to the engine will be measured by a Sage Prime mass flow meter (**FG**). The meter is capable of providing a temperature compensated pulse output, 4-20 mA output, or Modbus 485 output. There is a second Sage Prime mass flow meter **(FGF)** that meters the gas flow to the flare. The meters will be installed and maintained according to the "Sage Thermal Gas Mass Flow Meter Operations and Instruction Manual for Models SIP/SRP," by the facility. A log of maintenance activities for the meters will be maintained at the site.

The gas meter can measure a wide range of mass flow, however it will be calibrated to measure the expected biogas generated. Currently the system is expected to produce up to 135 scfm and the meter will be spanned to measure 0 – 135 scfm. If the actual gas flow varies significantly the meters will need to be re-spanned, this can be done on site, without removing the meters, with the purchase of a communications kit and software from Sage.

The lower heating value for the biogas is estimated to be 600 Btu/$ft^{3,}$ based on past measurements of the CO_2 content of biogas. This value will be verified weekly based on measurements of carbon dioxide using a Bacharach Fyrite CO_2 detector for a range of 0-60%. The farm staff will perform the CO_2 tests and log the results in the project log. This test is performed by taking a gas sample from the low pressure gas supply before it enters the engine generator equipment. The sampling point is marked in Figure 7 as "CO_2 Sampling".

Data logging is going to be done in one of two ways:

1) The control panels being provided may have the capabilities to perform the necessary data logging. This includes receiving signals from the power meter and two gas meters (one Modbus 485 signal, and two pulse or 4-20mA or Modbus 485) and logging time stamped data at 15 minute intervals. The data would then need to be made available to CDH Energy, the NYSERDA CHP Website Contractor, in a number of ways:
    - A nightly automated email to data_collection@cdhenergy.
    - A nightly automated upload to CDH's FTP server.
    - If a static IP address can be provided, and the data made available online, CDH could set up automated processes to pull data on a nightly basis.

2) If the control panels do not have the capabilities required, CDH will provide an Obvius AcquiSuite data logger and panel. CDH will then terminate sensor wiring to the logger, and verify that accurate measurements are being received. The facility will be responsible to provide CDH with 110 V power, and either an internet or phone connection. The data logger will be connected to an uninterruptible power supply (UPS) to ensure the data logger retains its settings and data in the event of a power outage. The

Farm will provide a static IP address that will be used by CDH Energy to communicate with the data logger.

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 power meter (**WG**) and gas flow (cf or ft^3) recorded by the Sage meters (**FG, FGF**) 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.ny.gov) to ensure it is consistent with our observed performance of the ADG system and logged readings. The farm will review the data on the website, including:

- Monitored Data – Download (CSV file)

In addition, the farm staff will also use the Monitored Data – Download (CSV file) that is available at the CHP Website to help track the system performance, including:

- 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 base time interval using range and relational checks. The range checks will be setup based on the expected ranges for the sensors (see Table 2).

The relational check will compare the kWh production data and gas production data for each base time interval to ensure that both meters are reading properly. This check is to ensure that both meters are operating properly; power cannot be produced without gas, and gas cannot be combusted by the engine without producing power.

Data that passes the range and relational quality checks will be used to compile the production amounts used for the incentive calculations. 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 D, of their contract, i.e. use data from similar periods – either just before or after the outage - to replace the lost data. The farm understands that they can use this approach for up to two 36 hour periods within each 12-month performance period. If more than two such data outages occur, the farm will provide information from other acceptable data sources (e.g., weekly recorded logs) to definitively determine the amount of power that was being produced from biogas during the period in question.

Annual Performance Reports

The farm 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 propane or other fuel used for the engine/boiler. The Farm may use the data found on the CHP Website or alternatively, they may provide their own summary of the data using on-site sources along with a narrative justifying why their data and calculations are more appropriate. 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)	Biogas Used by Flare, (cubic feet)	LHV_{biogas} (Btu/cf)	Biogas Energy Content, Q_{biogas} (BTU)
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 readings of CO_2 concentration in the biogas gathered weekly will be used to estimate the average monthly Biogas Lower Heating Value using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot (F_{CH4})$$

where:

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

F_{CH4} - fraction of biogas that is CH_4 (average of readings for each month)

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 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 31% to 38% range over any interval for the engine-generator at Woodcrest Farm.

Appendices

Cut sheets and Manuals for:

Dresser-Rand Guascor, SGFLD 360, 1,200 RPM Engine

Marathon Electric MagnaMax$^{DVR®}$ Model MGG-712, 450 kW Generator

Sage Metering Inc., Model SIP-300-AC115-DIGGAS Mass Flow Meter

Sage Metering Inc., Model SRP-050-AC115-DIGGAS Mass Flow Meter

Electro Industries Gauge Tech Inc., Model Shark 100, Revenue Grade Meter

Bacharach Inc., Model 10-5032, Fyrite Gas Analyzers

DRESSER-RAND	GROUP		PRODUCT INFORMATION	INDEX
	IC	GAS	IC-G-B-36-156	A1
	POWER RATING		DATE	26/08/14
			DEP.	2

GENSET:	**SFGLD 360**	**SPEED:**	**1200**
JACKET WATER TEMPERATURE(°F):	**194**	**FUEL TYPE:**	**SEWAGE GAS**
INTERCOOLER WATER TEMP(°F):	**131**		

APPLICATION:			**CONTINUOUS**	COMPRESSION RATIO:	**11,6:1**
COOLING SYSTEM:			**TWO CIRCUITS**	REGULATION:	**Electronic**
			TWO STAGE IC	IGNITION TIMING:	**18º**
EXHAUST MANIFOLD TYPE:			**WATER COOLED**	MAX. BACK PRESSURE:	**18 ''H2O (450 mmH2O)**
EMISSIONS:					
	NOX	g/bHPh	**1**	AMBIENT CONDITIONS ISO 3046/1:	
	CO	g/bHPh	**<1,8**	Atmospheric pressure (''Hg (kPa))=	**30 (100)**
	NMHC	g/bHPh	**<0,7**	Ambient temperature (°F (°C))=	**77 (25)**
				Relative humidity (%)=	**30**

POWER RATING (4)			**NOMINAL**	**PARTIAL LOADS**		
LOAD		%	**100%**	80%	60%	40%
MECHANICAL POWER	**(3, 4, 5)**	BHP (KWb)	**675 (503)**	539 (402)	405 (302)	270 (201)
BMEP		psi (bar)	**203 (14.0)**	162 (11.2)	122 (8.4)	81 (5.6)
ELECTRICAL POWER (cosϕ 1)		kWe	**483**	386	289	190
ELECTRICAL POWER (cosϕ 0,8)		kWe	**475**	381	285	188
FUEL CONSUMPTION	**(1)**	BTU/bHP-hr (KW)	**6400 (1266)**	6559 (1036)	6909 (820)	7545 (597)
MECHANICAL EFFICIENCY		%	**39.7**	38.8	36.8	33.7
ELECTRICAL EFFICIENCY (cosϕ 1)		%	**38.2**	37.3	35.2	31.8
HEAT IN MAIN WATER CIRCUIT	**(1)**	BTU/min (KW)	**21270 (374)**	17170 (302)	13650 (240)	10690 (188)
HEAT IN SECONDARY WATER CIRCUIT	**(1)**	BTU/min (KW)	**5346 (94)**	4777 (84)	4436 (78)	3640 (64)
HEAT IN CHARGE COOLER	**(1)**	BTU/min (KW)	**1649 (29)**	1365 (24)	1194 (21)	626 (11)
HEAT IN OIL COOLER	**(1)**	BTU/min (KW)	**3696 (65)**	3412 (60)	3242 (57)	3014 (53)
HEAT IN EXHAUST GASES (25 ºC)	**(1)**	BTU/min (KW)	**15750 (277)**	13190 (232)	10580 (186)	7510 (132)
HEAT IN EXHAUST GASES (120ºC)	**(1)**	BTU/min (KW)	**11110 (195)**	9470 (166)	7620 (134)	5460 (96)
EXHAUST GAS TEMPERATURE	**(1)**	°F (°C)	**658 (348)**	680 (360)	693 (367)	702 (372)
HEAT TO RADIATION	**(1)**	BTU/min (KW)	**1024 (18)**	910 (16)	796 (14)	682 (12)
CARBURETION SETTINGS (2)						
O2 TO EXHAUST(DRY)(ONLY A REFERENCE)		%	**8.3**	8.1	7.9	7.5
MASS FLOWS						
INTAKE AIR FLOW	**(1)**	lb/h (Kg/h)	**5400 (2450)**	4360 (1980)	3410 (1540)	2380 (1080)
EXHAUST GAS FLOW (WET)	**(1)**	lb/h (Kg/h)	**5910 (2680)**	4780 (2170)	3740 (1700)	2630 (1190)

NOTES:

1. 100% LOAD TOLERANCES:
   FUEL CONSUMPTION +5%,
   COOLING CIRCUIT AND EXHAUST GASES ± 8%, RADIATION ±25%
   EXHAUST TEMPERATURE ±36°F (20°C), MASS FLOWS ± 10%.
2. THE ENGINE PERFORMANCE DATA, TIMING ADVANCE AND CARBURETION SETTINGS ARE VALID FOR A GAS
   THAT FULFILS THE REQUIREMENTS DEFINED IN IC-G-D-30-001 AND IC-G-D-30-003e. HEAT BALANCE FOR A REFERENCE GAS: CH4 62.5%, CO2 36%, N2 1,5%
3. NET POWER, MECHANICAL PUMPS NOT INCLUDED.
4. POWERS ARE VALID FOR AMBIENT TEMP.=77 ºF (25 ºC) AND AN ALTITUDE OF =1640 ft (500 m). SEE OTHER CONDITIONS IN PI IC-G-B-00-001
5. OVERLOAD NOT ALLOWED
6. THE SPECIFICATIONS AND MATERIALS ARE SUBJECT TO CHANGE WITHOUT NOTIFICATION
7. A ENGINE WITH INLET OR OUTPUT RESTRICTION OVER PUBLISHED LIMITS, OR WITH INADEQUATE MAINTENANCE OR INSTALLATION
   CAN MODIFY POWER RATING DATA.
8. EMISSIONS
9. ALTERNATOR VOLTAGE 440 V

MARTIN ENERGY GROUP
39411 Excelsior Dr
Latham MO 65050 USA

ELECTRICAL EQUIPMENT SUBMITTAL

May 29, 2015

WE ARE PLEASED TO SUBMIT THE FOLLOWING
FOR YOUR HONORED APPROVAL

Qty. 1 560 Kw* Generator System

For interconnection to utility
with a Beckwith M3410A protective relay

To be installed for:

Woodcrest Farm
Ogdensburg, NY

*Max total output limit is 450 kW. See Generator rating

39411 Excelsior Dr
Latham MO 65050 USA

Project Contact Information:

Client:
Woodcrest Farm
Attn: ----------
326 County Rt 28
Ogdensburg, NY 13669
Tel: (---)
Cell: (---)
E-Mail:

Client's Engineering Rep:
TBD

Utility Company:
National Grid
Attn: Timothy S. Dzimian
144 Kensington Ave.
Buffalo, NY 14214-2726
Tel: (716) 831-7747
Cel: (716) 445-8621
E-Mail:
Timothy.Dzimian@nationalgrid.co

Manufacturer, Generator:
Martin Energy Group
Attn: Marcus Martin
39411 Excelsior Dr.
Latham, MO 65050 USA
Tel: (660) 458-7000
Fax: (660) 458-7100
E-Mail:
mmartin@martinenergygroup.com

Manufacturer, Interconnection Paralleling Switchgear:
Martin Energy Group
Attn: Jason Hoover
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Latham, MO 65050 USA
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Fax: (660) 458-7100
E-Mail: jhoover@gen-tec.com

Digester Contractor
RCM International LLC
Attn: Mark Moser
PO Box 4716
Berkeley, CA 94704
Tel: (510) 834-4568
Fax: (510) 834-4529
E-Mail:
mmoser@RCMDigesters.com

Electrician:
TBD

Thank-you for reviewing the information submitted. Please send acceptance or comments to:
jhoover@martinenergygroup.com, or mail to: Martin Energy Group, 39411 Excelsior Dr. Latham MO 65050

Sections Index

Section I

Generator

INDEX

MAGNAMAX DVR®

Innovation Performance Reliability

Unirotor Construction

- **Single Piece Rotor Laminations**
- **Aluminum Die Cast Rotor Core**

DVR2000E

- **Patented PMG Powered**
- **Digital Voltage Regulator**

Since its market introduction, Marathon Electric's **MAGNAMAX**[DVR®] has been a technology leader and proven performer. The **MAGNAMAX**[DVR®] generator line offers as standard a permanent magnet generator excitation system, exceptional transient performance and strong motor starting capability, and utilizes the industry's first digital voltage regulator.

Each **MAGNAMAX**[DVR®] features the exclusive DVR2000E digital voltage regulator providing .25% regulation and three phase RMS sensing.

These outstanding features make **MAGNAMAX** [DVR®] the ideal generator for voltage critical applications such as:

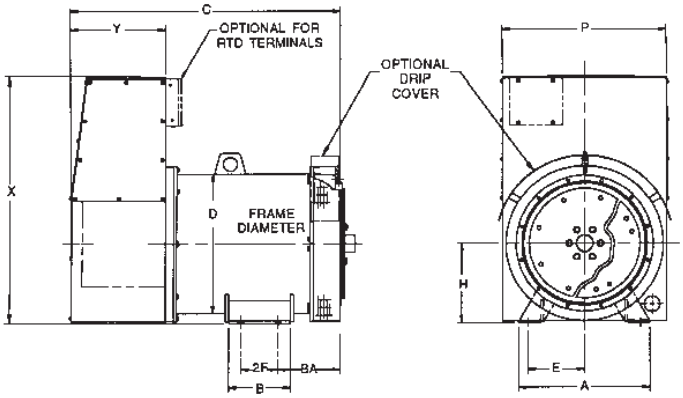
- **Telecomm Networks**
- **Hospitals**
- **Airports**
- **Commercial Buildings**
- **Computer Centers**
- **Distributed Power**

MAGNAMAX[DVR®] meets the demands of today's changing market:

- **Supporting non-linear loads (UPS systems and variable frequency drives)**
- **Providing unprecedented voltage regulation in the presence of harmonic distortion caused by non-linear loads**
- **Easy access and serviceability**
- **Providing low reactance design which minimizes the harmonic voltage distortion caused by non-linear loads**
- **Constructed for extended life**
- **Reliable performance**

MARATHON ELECTRIC
GENERATORS

MAGNAMAX DVR®



430 – 570 – 740 Frame

Dimensions in inches and (millimeters)

MAGNAMAX DVR®

ALL DIMENSIONS ARE APPROXIMATE: Contact factory for full dimensional data

Frame Size	A	B	BA	C	D	E	2F	H	P	X	Y	MAX Net Wgt. lbs. (kg)
431	21.00 (533)	10.00 (254)	10.00 (254)	38.40 (975)	22.64 (575)	9.00 (229)	6.00 (152)	13.00 (330)	26.51 (673)	39.77 (1010)	15.21 (386)	1370 (623)
432	21.00 (533)	10.00 (254)	10.00 (254)	43.40 (1102)	22.64 (575)	9.00 (229)	6.00 (152)	13.00 (330)	26.51 (673)	39.77 (1010)	15.21 (386)	1830 (832)
433	21.00 (533)	10.00 (254)	10.00 (254)	49.40 (1255)	22.64 (575)	9.00 (229)	11.00 (279)	13.00 (330)	26.51 (673)	39.77 (1010)	15.21 (386)	2365 (1075)
572	22.50 (572)	15.00 (381)	11.50 (292)	51.52 (1308)	27.64 (702)	10.00 (254)	11.00 (279)	15.50 (394)	30.77 (782)	42.64 (1083)	17.21 (437)	3110 (1411)
573	22.50 (572)	24.00 (610)	11.50 (292)	58.02 (1474)	27.64 (702)	10.00 (254)	20.00 (508)	15.50 (394)	30.77 (782)	42.64 (1083)	17.21 (437)	3620 (1642)
574	22.50 (533)	24.00 (610)	11.50 (292)	65.02 (1651)	27.64 (702)	10.00 (254)	20.00 (508)	15.50 (394)	30.77 (782)	42.64 (1083)	17.21 (437)	4240 (1923)
575	22.50 (533)	24.00 (610)	11.50 (292)	69.27 (1759)	27.64 (702)	10.00 (254)	20.00 (508)	15.50 (394)	30.77 (782)	42.64 (1083)	19.21 (488)	5000 (2268)
740	33.00 (838)	27.00 (686)	12.00 (305)	71.37 (1813)	27.64 (702)	15.00 (381)	23.00 (584)	19.00 (483)	30.77 (782)	51.45 (1307)	19.21 (488)	5200 (2359)
741	33.00 (838)	27.00 (686)	12.00 (305)	65.81 (1672)	34.24 (870)	15.00 (381)	23.00 (584)	19.00 (483)	38.02 (966)	51.45 (1307)	21.24 (539)	5490 (2490)
742	33.00 (838)	27.00 (686)	12.00 (305)	72.81 (1849)	34.24 (870)	15.00 (381)	23.00 (584)	19.00 (483)	38.02 (966)	51.45 (1307)	21.24 (539)	6300 (2858)
743	33.00 (838)	41.00 (1041)	12.00 (305)	79.31 (2014)	34.24 (870)	15.00 (381)	37.00 (940)	19.00 (483)	38.02 (966)	51.45 (1307)	21.24 (539)	7800 (3538)
744	33.00 (838)	41.00 (1041)	12.00 (305)	85.81 (2180)	34.24 (870)	15.00 (381)	37.00 (940)	19.00 (483)	38.02 (966)	51.45 (1307)	21.24 (539)	9740 (4418)

Note: Connection boxes shown are furnished as standard product. Consult factory for optional connection boxes.

MARATHON ELECTRIC GENERATORS

Your Independent Power Source for the 21st Century!

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Phone: 715-675-3359
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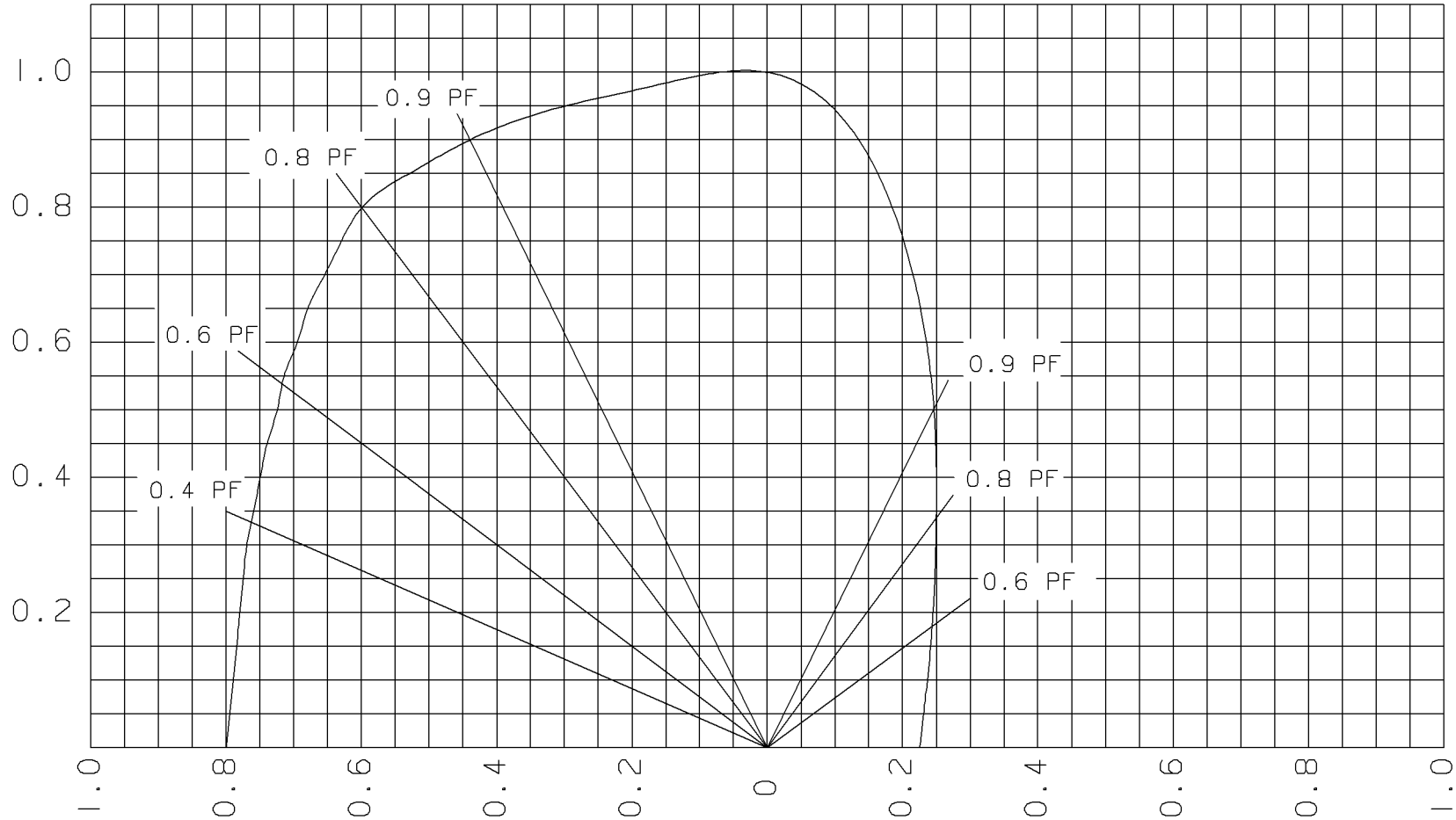
SB370 6029J/2k/11-07/SK/TP

REGAL BELOIT

MAGNAMAX GENERATOR
TYPICAL REACTIVE CAPABILITY CURVE



MARATHON ELECTRIC
WAUSAU, WISCONSIN 54401

CADD FILE NO. 526622

(TM) 12-1-92

Document Name:

Martin Energy Group
Generator Rating Guide

April 30, 2013

Revised January 8, 2015 (Martin Energy Group)

Explanation of Manufacturer and OEM performance ratings on Martin Energy Group Generator Sets.*

*The Woodcrest Farm Generator Set is rated at 450 kW by Martin Energy Group.

Explanation of applicable ratings:

Martin Electric Power Generators, designed and assembled at Latham Mo. or at Ephrata PA. are conservatively rated which is a key to the reliable operation and longevity of these machines.

As an OEM (Original Equipment Manufacturer) Martin Energy Group purchases Engines (Prime Movers) and Generator Ends (Electrical Windings) from a variety of manufacturers to design complete units (Generator Sets) that best meet the needs of a customer's application. Because the Prime Movers are manufactured, tested, and rated by one entity and the Electrical Windings by another unrelated entity, it is rare that the HP rating of the Prime Mover and the kW (or kVA) rating of the Electrical Winding will be perfectly matched. This necessitates that the manufacturer's rating of the Prime Mover, and the manufacturers rating of the Electrical Winding must both be considered when Martin Energy Group assigns an OEM output rating to the completed Generator Set.

Another factor that must be considered for an effective solution is the efficiency curves of both the Prime Mover and the Electrical Winding. Because peak efficiency is usually not at the maximum rating, equipment will be chosen, and the Generator Set rated, so that in normal operation the Generator Set will be operating as near the peak efficiency point as is possible.

Because Martin Energy Group Generator Sets are also often used for heat recovery purposes, the heat rejection curves of the Prime Mover must also be considered in the optimum rating of the Generator Set.

Many of the Generator Sets assembled by Martin Energy Group are interconnected to the electric grid. This is an additional engineering consideration because in most cases there will be some load imbalance on a typical 3ø utility distribution circuit. This imbalance causes negative sequence current in the generator windings and the result is additional heat generated in the windings of an interconnected generator at lower output than if all loads would be perfectly balanced, and is significant potential for catastrophic component failure. Because of this, all interconnected Generator Sets are rated lower by Martin Energy Group, than would be the typical continuous output rating for the Electrical Windings from the Manufacturer.

Finally, Martin Energy Group assigns a maximum kW and kVA rating to the Generator Set, based on consideration of all of the points above. This rating is a key point of the contractual sales agreement between Martin Energy Group and the Customer. The Customer is purchasing this level of output, at the stated level of efficiency for the investment agreed upon between Martin Energy Group and the Customer.

Martin Energy Group warranty support is contingent upon not exceeding the Martin Energy Group assigned rating. Exceeding this rating will immediately void all warranty.

The Martin Energy Group assigned rating is programmed into the Generator Set controls, (Intelisys NT Digital Paralleling Genset Controller) under factory level password. The Intelisys NT controller is the machine level controller which determines the operating parameters of the Generator Set based on its programmed parameters, so that the machine cannot be driven to higher levels of output. The intelisys NT has up to 7 user levels which allows Martin Energy Group to classify and restrict the access levels accordingly.The setting environment is illustrated below.

Excerpt from the Intelisys NT manual:

Setpoints

Password protection

Any setpoint can be password protected - 7 levels of protection are available. There can be up to 8 users defined, each one with different access rights (levels of protection). Every user has it's own password. The password is a four-digit number. Only setpoints protected by the protection level that is covered by currently logged-in user's access rights can be modified.

Because the controller determines the output ramp +/- of the Generator Set the Nominal kW parameter is the top limit of the output ramp. This parameter is set at the factory to the output rating that was sold to the customer and is protected by the factory level password. Only trained factory personnel have access to the factory level parameters.

Excerpt from the Intelisys NT manual: (Highlight is added)

Basic settings

Nomin power [kW – MW*] (FV)

Nominal power of the generator.
Step: 0,1 kW / 1 kW / 0,01 MW*
Range: 0,1 kW – 320,00 MW*

**Note:*
The actual setpoint units and range depend on setting of the Power format (see GenConfig manual). Nominal power of the gen-set is also its maximum operation power.

Summary for application of the ratings of Martin Generator Sets:

For accurate system performance data:

- Use Prime Mover manufacturer's bHP rating, efficiency data, and heat rejection data, in combination with the Martin Generator Set rating for fuel consumption and heat generation studies.

- Use the Generator Winding manufacturers' reactance data sheets for instantaneous and short duration fault studies where momentum of rotating mass (WR^2 Inertia) can, in most cases, produce the absolute maximum capability of the Generator Winding for a short duration.

- Use the Martin Generator Set rating to model the actual, steady state affect of the Generator Set, operating in normal conditions, interconnected to an electrical distribution circuit.

Section II

Paralleling Breaker

INDEX

Emax

Power breakers

Emax power breakers

ABB's Emax series of low voltage power circuit breakers embodies over half a century's experience and technological development in power circuit breakers. The Emax offers a series of breakers that is totally innovative in its technological design, ease of installation and use, making it the ideal solution for the growing requirements of designers, switchboard and switchgear manufacturers, installers, OEMs and users.

The Emax power circuit breakers are UL Listed and meet the ANSI and IEC Standards for low voltage power circuit breakers.

ABB Emax power circuit breakers are available in five different models with rated continuous current from 800A to 6300A and rated short-circuit current range from 42kA to 200kA (480V).

Technical catalog 1SDC200005D0201 is available upon request.

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General information
General ratings and specifications

E1

E2

E3

UL 1066		E1		E2				E3				
Levels of performance		B-A	N-A	B-A	N-A	S-A	H-A	N-A	S-A	H-A	V-A	
Frame Size	[A]	800	800	1600	800	800	800	2000	800	800	800	
	[A]	1200	1200	—	1200	1200	1200	2500	1200	1200	1200	
	[A]	—	—	—	1600	1600	1600	—	1600	1600	1600	
	[A]	—	—	—	—	—	—	—	2000	2000	2000	
	[A]	—	—	—	—	—	—	—	2500	2500	2500	
	[A]	—	—	—	—	—	—	—	3200	3200	3200	
Capacity of neutral pole for four-pole circuit breakers	[%Iu]	100	100	100	100	100	100	100	100	100	100	
Rated short circuit current												
240V	[kA]	42	50	42	65	65	85	65	85	85	125	
480V	[kA]	42	50	42	50	65	85	50	65	85	125	
600V	[kA]	42	50	42	50	65	65	50	65	85	100	
Rated short time current	[kA]	42	50	42	50	65	65	50	65	65	85	
IEC 60947-2												
Levels of performance		B	N	B	N	S	L	N	S	H	V	L
Currents: rated uninterrupted current (at 40°C) Iu	[A]	800	800	1600	1000	800	1250	2500	1000	800	800	2000
	[A]	1000	1000	2000	1250	1000	1600	3200	1250	1000	1250	2500
	[A]	1250	1250	—	1600	1250	—	—	1600	1250	1600	—
	[A]	1600	1600	—	2000	1600	—	—	2000	1600	2000	—
	[A]	—	—	—	—	2000	—	—	2500	2000	2500	—
	[A]	—	—	—	—	—	—	—	3200	2500	3200	—
	[A]	—	—	—	—	—	—	—	—	3200	—	—
Capacity of neutral pole for four-pole circuit breakers	[%Iu]	100	100	100	100	100	100	100	100	100	100	100
Rated ultimate breaking capacity under short circuit Icu												
220/230/380/400/415V	[kA]	42	50	42	65	85	130	65	75	100	130	130
440V	[kA]	42	50	42	65	85	110	65	75	100	130	110
500/525V	[kA]	42	50	42	55	65	85	65	75	100	100	85
660/690V	[kA]	42	50	42	55	65	85	65	75	85	100	85
Rated service breaking capacity under short circuit Ics												
220/230/380/400/415V	[kA]	42	50	42	65	85	130	65	75	85	100	130
440V	[kA]	42	50	42	65	85	110	65	75	85	100	110
500/525V	[kA]	42	50	42	55	65	65	65	75	85	85	65
660/690V	[kA]	42	50	42	55	65	65	65	75	85	85	65
Rated short time withstand current Icw (1s)	[kA]	42	50	42	55	65	10	65	75	75	85	15

UL 1066 and IEC 60947-2				
Overall dimensions				
Fixed: H = 418mm/16.46 in; D = 302 mm/11.89 in				
W (3 poles/4 poles)	[mm]	296/386	296/386	404/530
W (3 poles/4 poles)	[in]	11.65/15.2	11.65/15.2	15.91/20.82
Draw out: H = 461mm/18.15 in; D = 396.5 mm/15.61 in				
W (3 poles/4 poles)	[mm]	324/414	324/414	432/558
W (3 poles/4 poles)	[in]	12.76/16.3	12.76/16.3	17.01/21.97
Weights (circuit breaker complete with trip unit, RH terminals, CS, excluding accessories)				
Fixed				
3 poles/4 poles	[Kg]	45/54	50/61	66/80
3 poles/4 poles	[lbs]	99/119	110/134	145/176
Draw out				
3 poles/4 poles	[Kg]	70/82	78/93	104/125
3 poles/4 poles	[lbs]	154/181	172/205	229/275

① four poles only ② 100% neutral protection

Circuit breakers in accordance with IEC 6097-2

			E1		E2				E3				
Automatic circuit-breakers			E1B	E1N	E2B	E2N	E2S	E2L	E3N	E3S	E3H	E3V	E3L
Poles		[No.]	3 - 4			3 - 4					3 - 4		
4p c.-b neutral current-carring capacity		[%Iu]	100			100					100		
Iu	(40 °C)	[A]	800	800	1600	1000	800	1250	2500	1000	800	800	2000
			1000	1001	2000	1250	1000	1600	3200	1250	1000	1250	2500
			1250	2500		1600	1250			1600	1250	1600	
			1600	1600		2000	1600			2000	1600	2000	
										2500	2000	2500	
										3200	2500	3200	
											3200		
Ue		[V~]	690	690	690	690	690	690	690	690	690	690	690
Icu	(220...415V)	[kA]	42	50	42	65	85	130	65	75	100	130	130
Ics	(220...415V)	[kA]	42	50	42	65	85	130	65	75	85	100	130
Icw	(1s)	[kA]	42	50	42	55	65	10	65	75	75	85	15
	(3s)	[kA]	36	36	42	42	42	—	65	75	65	65	—
Automatic circuit-breakers with full-size neutral conductor													
Poles		[No.]	Standard version		Standard version				Standard version				
4p c.-b neutral current-carring capacity		[%Iu]											
Iu	(40 °C)	[A]											
Ue		[V~]											
Icu	(220...415V)	[kA]											
Ics	(220...415V)	[kA]											
Icw	(1s)	[kA]											
	(3s)	[kA]											
Switch-disconnectors			**E1B/MS**	**E1N/MS**	**E2B/MS**	**E2N/MS**	**E2S/MS**		**E3N/MS**	**E3S/MS**		**E3V/MS**	
Poles		[No.]	3 - 4	3 - 4	3 - 4	3 - 4	3 - 4		3 - 4	3 - 4		3 - 4	
Iu	(40 °C)	[A]	800	800	1600	1000	1000		2500	1000		800	
			1000	1000	2000	1250	1250		3200	1250		1250	
			1250	2500		1600	1600			1600		1600	
			1600	1600		2000	2000			2000		2000	
										2500		2500	
										3200		3200	
Ue		[V~]	690	690	690	690	690		690	690		690	
Icw	(1s)	[kA]	42	50	42	42	65		65	75		85	
	(3s)	[kA]	36	36	42	42	42		65	65		65	
Icm	(220...440V)	[kA]	88.2	105	88.2	88.2	143		143	165		286	
Automatic circuit-breakers for applications up to 1150VAC					**E2B/E**	**E2N/E**					**E3H/E**		
Poles		[No.]			3 - 4	3 - 4					3 - 4		
Iu	(40 °C)	[A]			1600	1250					1250		
					2000	1600					1600		
						2000					2000		
											2500		
											3200		
Ue		[V~]			1150	1150					1150		
Icu	(1150V)	[kA]			20	30					30 ①		
Ics	(1150V)	[kA]			20	30					30 ①		
Icw	(1s)	[kA]			20	30					30 ①		
Switch-disconnectors for applications up to 1150VAC					**E2B/E MS**	**E2N/E MS**					**E3H/E MS**		
Poles		[No.]			3 - 4	3 - 4					3 - 4		
Iu	(40 °C)	[A]			1600	1250					1250		
					2000	1600					1600		
						2000					2000		
											2500		
											3200		
Ue		[V~]			1150	1150					1150		
Icu	(1s)	[kA]			20	30					50		
Ics	(1000V)	[kA]			40	63					105		
Switch-disconnectors for applications up to 1000VDC			**E1B/E MS**		**E2N/E MS**						**E3H/E MS**		
Poles		[No.]	3 - 4		3 - 4						3 - 4		
Iu	(40 °C)	[A]	800-1250		1250						1250		
					1600						1600		
					2000						2000		
											2500		
											3200		
UE		[V~]	750 (3p)-		750 (3p)-						750 (3p)-		
			1000(4p)		1000(4p)						1000(4p)		
Icw	(1s)	[kA]	20		25						40		
Icm	(750V)	[kA]	42		52.5						105		
	(1000V)	[kA]	42		52.5						105		
Sectionalizing truck				**E1 CS**		**E2 CS**					**E3 CS**		
Iu	(40 °C)	[A]		1250		2000					3200		
Earthing switch with makeing capacity				**E1 MTP**		**E2 MTP**					**E3 MTP**		
Iu	(40 °C)	[A]		1250		2000					3200		
Earthing truck				**E1 MT**		**E2 MT**					**E3 MT**		
Iu	(40 °C)	[A]		1250		2000					3200		

① The performance at 1000V is 50kA.

16

Protection trip units and trip curves

PR121/P

4

Characteristics

PR121/P is the new basic and complete trip unit for the Emax series. The complete range of protection functions together with the wide combination of thresholds and trip times offered make it suitable for protecting a wide range of alternating current installation. In addition to protection functions the unit is provided with multifunction LED indicators. Furthermore, PR121/P allows connection to external devices enhancing its advanced characteristics like remote signalling and monitoring, or remote supervision display.

Caption

1 LED signalling Alarm for protection function L
2 LED signalling Alarm for protection function S
3 LED signalling Alarm for protection function I
4 LED signalling Alarm for protection function G
5 DIP switches for fine setting current threshold I1
6 DIP switches for main setting current threshold I1
7 DIP switches for setting current threshold I2
8 DIP switches for setting current threshold I3
9 DIP switches for setting current threshold I4
10 DIP switches for setting trip time t1 (type of curve)
11 DIP switches for setting trip time t2 (type of curve)
12 DIP switches for setting trip time t4 (type of curve)
13 Indication of the DIP switch position for network frequency
14 Indication of the DIP switch position for Neutral protection setting
15 Rating plug
16 Indication of the DIP switch positions for the various current thresholds values I1
17 Indication of the DIP switch positions for the various current threshold values I2
18 Indication of the DIP switch positions for the various current threshold values I3
19 Indication of the DIP switch positions for the various current threshold values I4
20 Indication of DIP switch positions for the various time settings t1
21 Indication of DIP switch positions for the various time settings t2
22 Indication of DIP switch positions for the various time settings t4
23 DIP switch for setting network frequency and neutral protection setting
24 Trip cause indication and trip test pushbutton
25 Test connector for connecting or testing the trip unit through an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit)
26 Serial number of protection trip unit

Operation and protection functions

Protection functions

The PR121 trip unit offers the following protection functions:

- overload (L)
- selective short-circuit (S)
- instantaneous short-circuit (I)
- earth fault (G).

Overload (L)

The inverse long time-delay trip overload protection L is type $I^2t = k$; 25 current thresholds and 8 curves are available. Each curve is identified by the trip time in relation to the current I = 3 x I1 (I1 = set threshold).

Selective short-circuit (S)

The selective short-circuit protection S can be set with two different types of curves with a trip time independent of the current (t = k) or with a constant specific let-through energy ($t = k/I^2$).

15 current thresholds and 8 curves are available, allowing a fine setting. Each curve is identified as follows:

– for curves t = k by the trip time for I > I2
– for curves $t = k/I^2$ by the trip time for I = 10xIn (In = rated current of the circuit-breaker).

The function can be excluded by setting the DIP switches to the combination labelled "OFF".

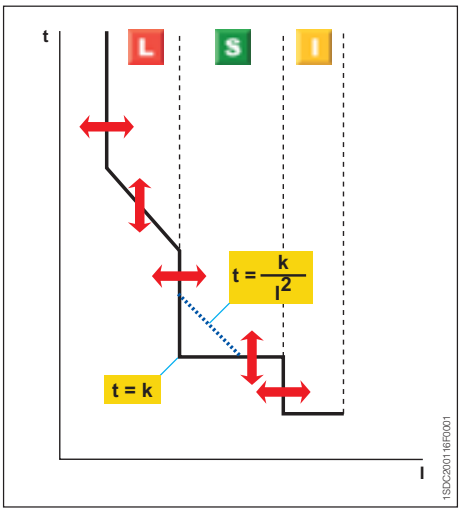
Adjustable instantaneous short-circuit (I)

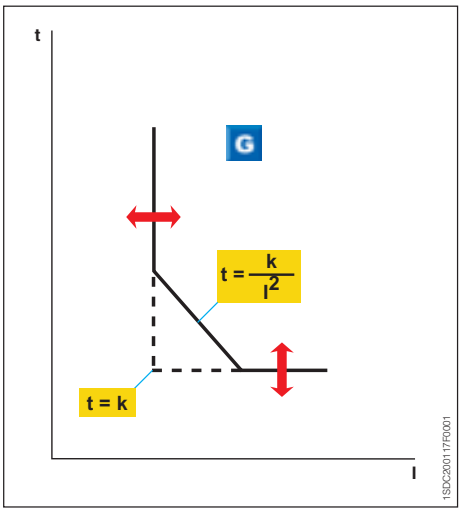
The protection I offers 15 trip thresholds and can be excluded (dip switches in "OFF" position).

Earth fault (G)

The earth fault protection G (which can be excluded) offers 7 current thresholds and 4 curves. Each curve is identified by the time t4 in relation to current I4. As per S protection the trip time can be chosen independent of the current (t = k) or with a constant specific let-through energy ($t = k/I^2$).

Note: the current values above which G is disabled are indicated in the installation manual.





Protection trip units and trip curves

PR121/P

User interface

The user communicates directly with the trip unit in the trip parameter preparation stage by means of the dip switches.
Up to four LEDs (according to the version) are also available for signalling.
These LEDs (one for each protection) are active when:

- a protection is timing. For protection L the prealarm status is also shown;
- a protection has tripped (the corresponding LED is activated by pressing the “Info/Test” pushbutton);
- a failure in connection of a current sensor or in the opening solenoid is detected. The indication is active when the unit is powered (through current sensors or an auxiliary power supply)
- wrong rating plug for the circuit-breaker.

The protection tripped indication works even with the circuit-breaker open, without the need for any internal or external auxiliary power supply. This information is available for 48 hours of inactivity after the trip and is still available after reclosing. If the query is made more than 48 hours later it is sufficient to connect a PR030/B battery unit, PR010/T, or a BT030 wireless communication unit.

Communication

By means of the BT030 wireless communication unit, PR121/P can be connected to a pocket PC (PDA) or to a personal computer, extending the range of information available for the user. In fact, by means of ABB SACE’s SD-Pocket communication software, It is possible to read the values of the currents flowing through the circuit-breaker, the value of the last 20 interrupted currents, and the protection settings.
PR121 can also be connected to the optional external PR021/K signalling unit, for the remote signalling of protections alarms and trips, and to HMI030, for the remote user interfacing.

Setting the neutral

Protection of the neutral can be set at 50%, 100% or 200% of the phase currents. Settings above 50% can be selected for E1-E2-E3-E4/f and E6/f. In particular, setting the neutral at 200% of phase current requires protection L to be set at 0.5In in order to respect the current-carrying capacity of the circuit-breaker. The user can also switch the neutral protection OFF. When three-poles circuit-breakers with external neutral current sensor are used, a setting above 100% for the neutral does not require any reduction in the L setting.

Test Function

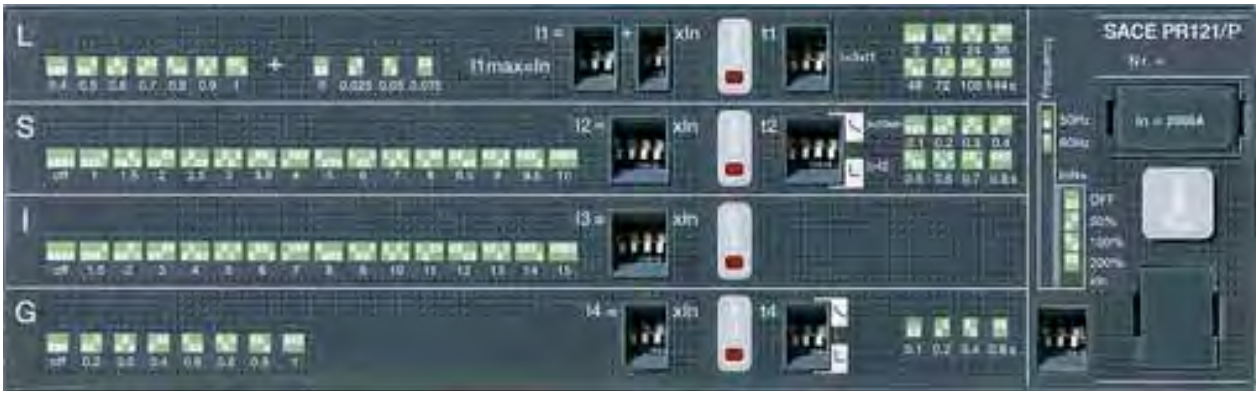
The Test function is carried out by means of the info/Test pushbutton and the PR030/B battery unit (or BT030) fitted with a polarized connector housed on the bottom of the box, which allows the device to be connected to the test connector on the front of PR121/P trip units.
The PR121/P electronic trip unit can be tested by using the SACE PR010/T test and configuration unit by connecting it to the TEST connector.

Versions available

The following versions are available:

PR121/P LI

PR121/P LSI



PR121/P LSIG

Protection trip units and trip curves

PR121/P

Protection functions and setting values - PR121

Function		Trip threshold	Trip time*	Poss. excl.	Relation t=f(I)
L	Overload protection	**I1=** 0,4 - 0.425 - 0.45 - 0.475 - 0.5 - 0.525 - 0.55 - 0.575 - 0.6 - 0.625 - 0.65 - 0.675 - 0.7 - 0.725 - 0.75 - 0.775 - 0.8 - 0.825 - 0.85 - 0.875 0.9 - 0.925 - 0.95 - 0.975 - 1 x In	With current If = 3 x I1 t1 = 3 - 12 - 24 - 36 - 48 - 72 - 108 - 144 s (1)	–	$t=k/I^2$
	Tolerance (2)	Release between 1.05 and 1.2 x I1	± 10% If ≤ 6 x In ± 20% If > 6 x In		
S	Selective short-circuit protection	**I2=** 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	With current If > I2 t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s	■	t=k
	Tolerance (2)	± 7% **If** ≤ 6 x In ± 10% **If** > 6 x In	The better of the two figures: ± 10% or ± 40 ms		
		I2= 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	With current If = 10 x In t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s	■	$t=k/I^2$
	Tolerance (2)	± 7% **If** ≤ 6 x In ± 10% **If** > 6 x In	± 15% If ≤ 6 x In ± 20% If > 6 x In		
I	Instantaneous short-circuit protection	**I3=** 1.5 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 x In	Instantaneous	■	t=k
	Tolerance (2)	± 10%	≤ 30 ms		
G	Earth fault protection	**I4=** 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In	With current If > I4 t4 = 0.1 - 0.2 - 0.4 - 0.8 s	■	t=k
	Tolerance (2)	± 7%	The better of the two figures: ± 10% or ± 40 ms		
		I4= 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In	t4 = 0.1 @ 4.47 I4, t4 = 0.2 @ 3.16 I4, t4 = 0.4 @ 2.24 I4, t4 = 0.8 @ 1.58 I4	■	$t=k/I^2$
	Tolerance (2)	± 7%	± 15%		

If = fault current

* Referring to the electronics

(1) The minimum trip time is 1 s, regardless of the type of curve set (self-protection)

(2) These tolerances are valid in the following conditions:
- self-supplied trip unit at full power (without start-up)
- two- or three-phase power supply
- trip time set ≥ 100 ms

The following tolerance values apply in all cases not covered by the above:

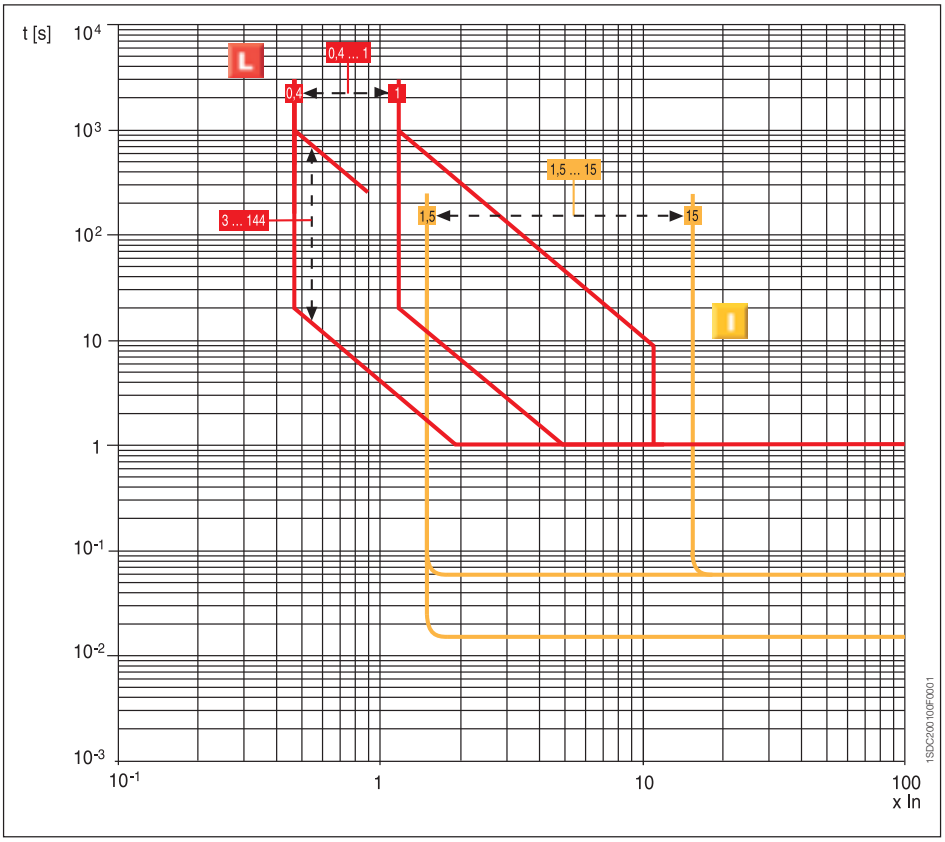
	Trip threshold	Trip time
L	Release between 1.05 and 1.2 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 15%	± 20%

Power supply

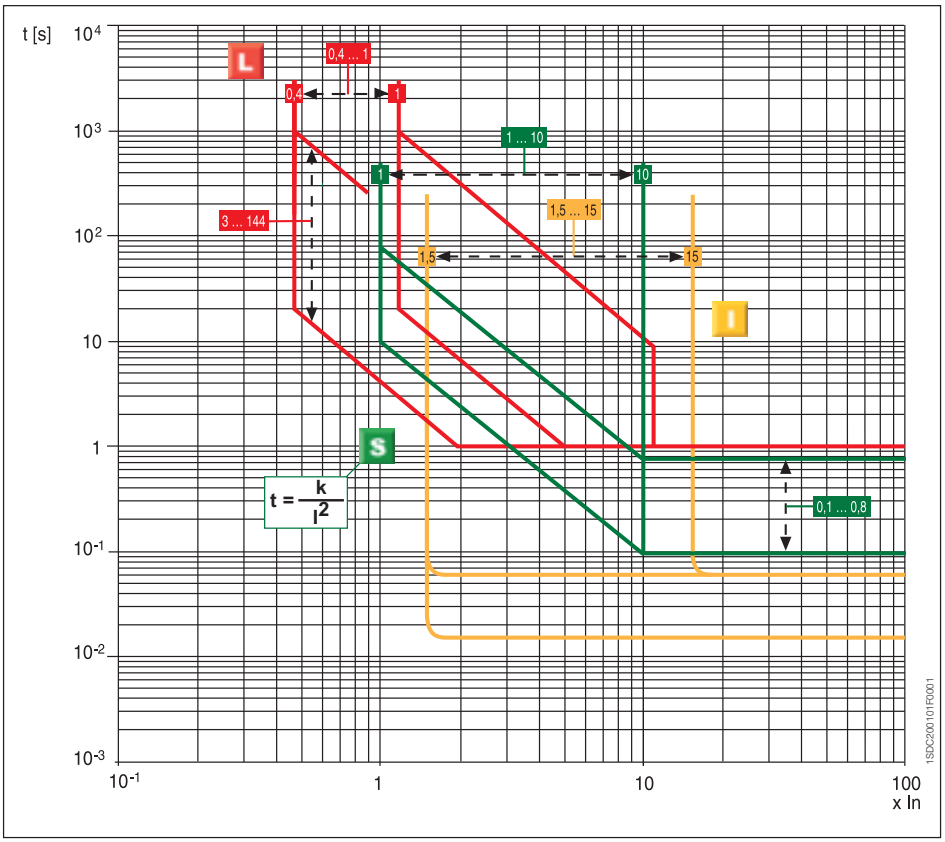
The unit does not require an external power supply either for protection functions or for alarm signalling functions. It is self-supplied by means of the current sensors installed on the circuit-breaker. For it to operate, the three phases must be loaded at 70A for E1, E2 and E3 and at 140A for E4 and E6. An external power supply can be connected in order to activate additional features, and in particular for connection to external devices: HMI030, and PR021/K.

	PR121/P
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	5%
Inrush current @ 24V	~10 A for 5 ms
Rated power @ 24V	~2 W

Functions L-I



Functions L-S-I



Threshold and trip times tolerances ..... page 4/6

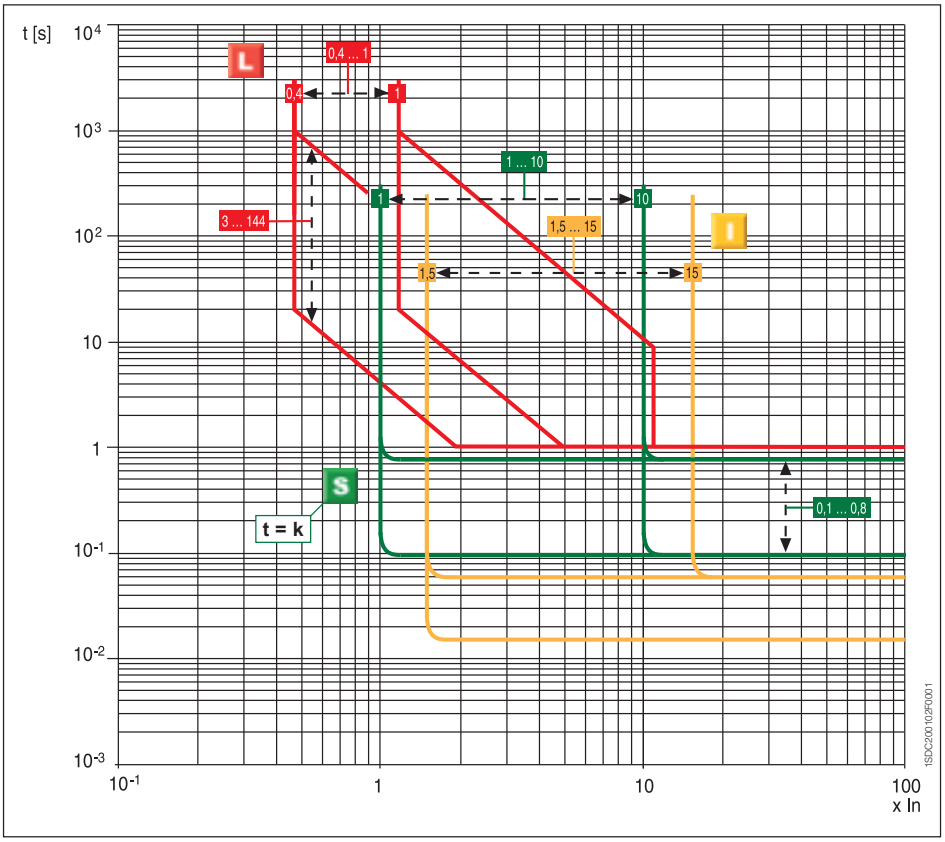
4

Protection trip units and trip curves

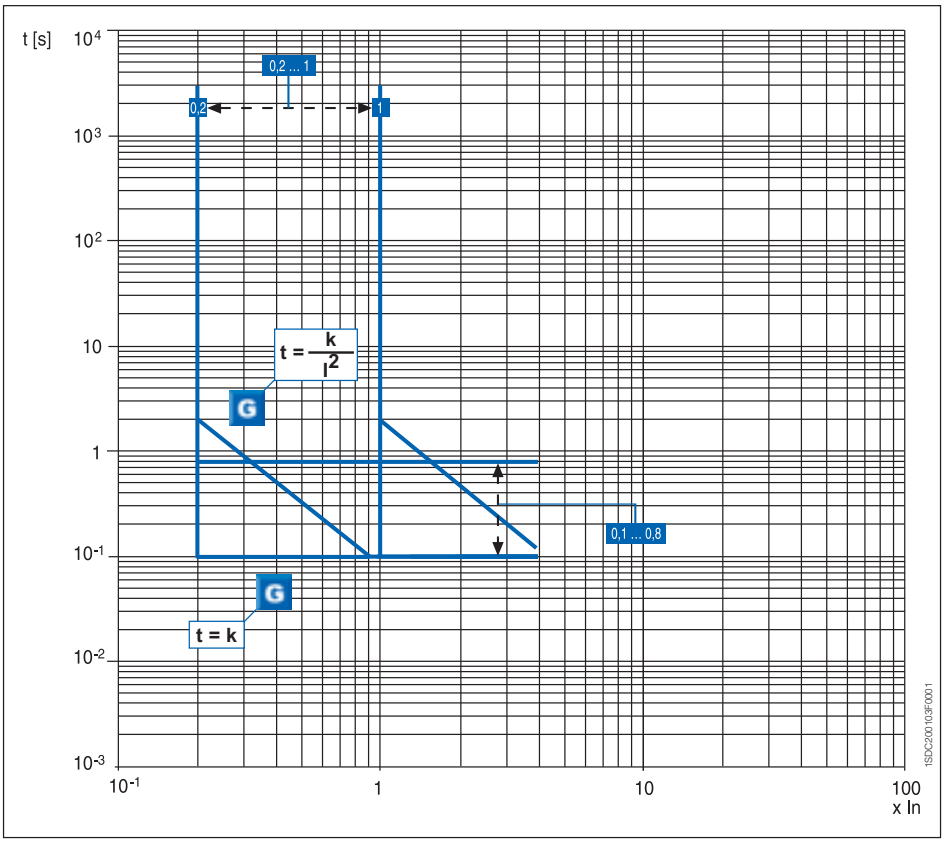
PR121/P

4

Functions L-S-I



Function G



Threshold and trip times tolerances ..... page 4/6

Section III

Intertie Protection Relay

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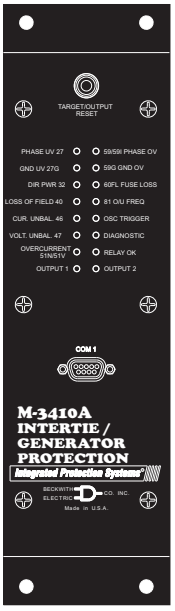
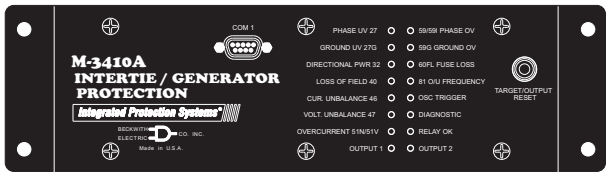
Intertie/Generator Protection Relay M-3410A

Integrated Protection System®

M-3410A Standard Panel



M-3410A Vertical Panel (Optional)



M-3410A Horizontal Panel (Optional)

- **Facilitates standardization for small/medium intertie and generator protection applications**
- **Microprocessor-based relay provides 15 protective relay functions, including Sync-Check, 2 programmable outputs and 2 programmable inputs**
- **Relay voltage inputs can be directly connected (no VT required) for voltages 480 V or less**
- **Local and remote serial communications (MODBUS protocol) capability for monitoring and control functions**

Protective Functions

- Sync-check with Phase Angle, ΔV and ΔF with dead line/dead bus options (25)
- Phase undervoltage (27) protection
- Ground undervoltage (27G) protection
- Dual-setpoint, single or three phase, directional power detection that can be selected as over/under power protection (32)
- Dual-zone, offset-mho loss-of-field for generator protection (40)
- Sensitive negative sequence overcurrent protection and alarm (46)
- Negative sequence overvoltage (47)
- Inverse time neutral overcurrent (51N)
- Phase overcurrent with voltage restraint/control (51V) protection
- Phase overvoltage (59) protection
- Ground overvoltage (59G) protection
- Peak overvoltage (59I) protection
- VT fuse-loss detection and blocking (60FL)
- Reconnect enable for intertie protection (79)
- Four-step over/under frequency (81) protection

Standard Features

- 2 programmable outputs, 2 programmable inputs, and 1 self-test output
- Oscillographic recording (COMTRADE file format)
- Time-stamped sequence of events recording for 32 events
- Metering of Voltage, Current, real and reactive Power, Power Factor, Frequency, and Positive Sequence Impedance
- One RS-232 port (COM1) on front and one RS-232 or 485 port (COM2) on rear
- M-3810A IPScom® For Windows™ Communications Software
- M-3811A IPScom For Palm OS® Communications Software
- MODBUS protocol
- Supports both 50 and 60 Hz applications
- Accepts 1A or 5 A rated CT inputs
- Relay voltage inputs can be directly connected (no VT required) for voltages ≤ 480 V ac
- Continuous Self-Diagnostics

Optional Features

- M-3801C IPSplot® Oscillograph Analysis Software
- Horizontal and Vertical panel mount versions available (see Figures 2 and 4)

PROTECTIVE FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy
	Sync Check			
25	Phase Angle Window	0° to 90°	1°	±1°
	Upper Voltage Limit	100.0 to 120.0%*	0.1%	±0.5 V or ±0.5%
	Lower Voltage Limit	70.0 to 100.0%*	0.1%	±0.5 V or ±0.5%
	Delta Voltage Limit	1.0 to 50.0%*	0.1%	±0.5 V
	Delta Frequency Limit	0.001 to 0.500 Hz	0.001 Hz	±0.001 Hz or 5%
	Sync Check Time Delay	1 to 8160 Cycles	1 Cycle	
	Dead Voltage Limit	0.0 to 50.0%*	0.1%	±0.5 V or ±0.5%
	Dead Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles

** Of nominal voltage.*

Sync Check may be operated as a stand-alone function or supervised by 79 (reconnect). Various combinations of input supervised hot/dead closing schemes may be selected. This function can only be enabled in line-to-line VT configuration and when functions 27G and 59G are not enabled.

	Phase Undervoltage			
27	Pickup #1, #2	4 to 100%*	0.1%	±0.5 V or ±0.5%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles**

** Of nominal voltage.*

*** When DFT is selected, the time delay accuracy is ±2 cycles. When RMS magnitude is selected, an additional time delay from 0 to +20 cycles may occur.*

	Ground Undervoltage			
27G	Pickup	4 to 100%*	1 %	±0.5 V or ±0.5%
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles

** Of nominal voltage, maximum of 600 V.*

This function can only be enabled when the relay is configured in line-to-line VT and the 25 function is not enabled.

	Directional Power			
32	Pickup #1, #2	–3.00 to +3.00 PU	0.01 PU	±0.02 PU or ±2%*
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles

The per-unit pickup is based on nominal VT secondary voltage and nominal CT secondary current settings for currents less than 14 A (2.8 A). This function can be selected as overpower or underpower in the forward direction (positive setting) or reverse direction (negative setting). This function can also be selected for single phase detection for line-to-ground VT.

Minimum sensitivity of 100 mA for 5 A CT (real component of current).

** Accuracy applies for a nominal current range of 2.5 A to 6 A (5 A CT) or 0.5 A to 1.5 A (1 A CT).*

Values in parentheses apply to 1 A CT secondary rating.

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy
	Loss-of-Field (dual-zone offset-mho characteristic)			
40	Circle Diameter #1, #2	0.01 to 3.00	0.01 PU	±0.01 PU or ±5%**
	Offset #1, #2	–2.0 to 2.0	0.01 PU	±0.01 PU or ±5%**
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles
27	Voltage Control (positive sequence)	4 to 100%*	0.1%	±0.5 V or ±0.5%
	Directional Element	Fixed at –13°	—	—
	Negative Sequence Overcurrent			
	Definite Time			
	Pickup	3% to 300%*	1%	±0.1 A or ±0.5%** (±0.02 A or ±0.5%)
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles
46	**Inverse Time**			
	Pickup	3% to 100%*	0.1%	±0.1 A or ±3%** (±0.02 A or ±3%)
	Characteristic Curves	Definite Time/Inverse Time/Very Inverse/Extremely Inverse/IEC/I_2^2t=K		
	Time Dial Setting	0.5 to 11.0 0.05 to 1.1 (IEC) 1 to 95 (I_2^2t=K)	0.1 0.01 1	±3 Cycles or ±10%**
	For I_2^2t=K Curve Only			
	Definite Maximum Time to Trip	600 to 65,500 Cycles	1 Cycle	±3 Cycles or ±10%**
	Reset Time (Linear)	4 minutes (from threshold of trip)		
	Negative Sequence Overvoltage			
47	Pickup #1, #2	4 to 100%*	0.1%	±0.5 V or ±0.5%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles
	Inverse Time Residual Overcurrent			
51N	Pickup	0.50 to 6.00 A (0.10 to 1.20 A)	0.1 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curves	Definite Time/Inverse Time/Very Inverse/Extremely Inverse/IEC		
	Time Dial Standard Curves #1–#4 IEC Curves #1–#4	 0.5 to 11.0 0.05 to 1.10	 0.1 0.01	 ±3 Cycles or ±10%

** Of nominal voltage.*

*** Accuracy applies for a nominal current range of 2.5 A to 6 A (5 A CT) or 0.5 A to 1.5 A (1 A CT), and for a pickup of >5%.*

** Of nominal current for currents less than 14 A (2.8 A).*

*** Accuracy applies for a nominal current range of 2.5 A to 6 A (5 A CT) or 0.5 A to 1.5 A (1 A CT), and for a pickup of >5%.*

** Of nominal voltage.*

Values in parentheses apply to 1 A CT secondary rating.

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy
Inverse Time Overcurrent, with Voltage Control or Voltage Restraint				
51V	Pickup	0.50 to 12.00 A (0.10 to 2.40 A)	0.01 A	±0.1 A or ±3% (±0.02 A or ±3%)
	Characteristic Curve	Definite Time/Inverse/Very Inverse/Extremely Inverse/IEC Curves		
	Time Dial	0.5 to 11.0 0.05 to 1.10 (IEC curves)	0.1 0.01	±3 Cycles or ±10%
	Voltage Control (VC)	4.0 to 150.0%*	0.1%	±0.5 V or ±0.5%
	or Voltage Restraint (VR)	Linear Restraint	—	—
Phase Overvoltage				
59	Pickup #1, #2	100 to 150%*	0.1%	±0.5 V or ±0.5%
	Time Delay #1, #2	1 to 8160 Cycles	1 Cycle	±2 Cycles**
Ground Overvoltage				
59G	Pickup	4 to 150%*	1%	±0.5 V or ±0.5%
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles
Peak Overvoltage				
59I	Pickup	100 to 150%*	1%	±3%**
	Time Delay	1 to 8160 Cycles	1 Cycle	±3 Cycles
VT Fuse-Loss Detection				
60 FL	A VT fuse-loss condition is detected by using the positive and negative sequence components of the voltages and currents. VT fuse-loss output can be initiated from internally generated logic or from input contacts.			
	Time Delay	1 to 8160 Cycles	1 Cycle	±2 Cycles
Reconnect Enable Time Delay				
79	Time Delay	2 to 65,500 Cycles	1 Cycle	±2 Cycles

** Of nominal voltage.*

*** When DFT is selected, the time delay accuracy is ±2 cycles. When RMS magnitude is selected, an additional time delay from 0 to +20 cycles may occur.*

** Of nominal voltage.*

This function can only be enabled when the relay is configured in line-to-line VT and the 25 function is not enabled.

**Instantaneous voltage magnitude response; intended for ferroresonance protection.*

***For fundamental (60 Hz/50 Hz) signal only. For distorted input signals, the accuracy degrades as the order of the harmonic signal increases.*

Reconnect timer starts when all outputs designated as trip outputs reset.

PROTECTIVE FUNCTIONS (*cont.*)

Device Number	Function	Setpoint Ranges	Increment	Accuracy
	Over/UnderFrequency			
81	Pickup #1, #2, #3, #4	50.00 to 67.00 Hz (40.00 to 57.00 Hz*)	0.01 Hz	±0.03 Hz
	Time Delay #1,#2, #3, #4	2 to 65,500 Cycles	1 Cycle	±2 Cycles or ±0.01%
	Nominal Settings			
	Nominal Voltage	50 to 500 V*	1 V	—
	Nominal Current	0.50 to 6.00 A	0.01 A	—
	VT Configuration	Line-Line/Line-Ground/Line-Ground-to-Line-Line**		
	Seal-in Delay	2 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

**This range applies to 50 Hz nominal frequency models.*

The pickup accuracy applies to 60 Hz models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. The accuracy is ±0.15 Hz for a range of 52 to 57 Hz, and 63 to 67 Hz (for 60 Hz nominal) and 42 to 47 Hz and 53 to 57 Hz (for 50 Hz nominal).

** Maximum measured range for (25), (59), (59G) and (59I) function settings is ≤ 600 V.*

*** When line-ground-to-line-line is selected, the relay internally calculates the line-line voltage from the line-ground voltages for all voltage-sensitive functions. When line-ground-to-line-line selection is applied, the nominal voltage selection should be the line-line nominal voltage (not line-ground nominal voltage).*

Tests and Standards

The M-3410A Generator/Intertie Protection Relay complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

All terminals except power supply and status input contacts, 2500 V ac/3500 V dc
Power Supply and Status Input Contacts:
IEC 60255-5 1,500 V dc for power supply voltages (12, 24, 48 V inputs)
2500 V ac/3500 V dc for power supply voltages (120 V ac/125 V dc input)

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Impulse Voltage

Power Supply Input Voltages, 120 V ac/125 V dc:
IEC 60255-5 5,000 V pk, +/- polarity applied to each independent circuit to earth
5,000 V pk, +/- polarity applied between independent circuits
1.2 μs by 50 μs, 500 ohms impedance, three surges at every 5 second interval

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Power Supply Input Voltages, 12, 24, 48 V dc:
IEC 60255-5 3,000 V pk, +/- polarity applied to each independent circuit to earth
3,000 V pk, +/- polarity applied between independent circuits
1.2 μs by 50 μs, 500 ohms impedance, three surges at every 5 second interval

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Insulation Resistance

IEC 60255-5 > 40 Megaohms

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Electrical Environment

Electrostatic Discharge Test

IEC 61000-4-2 Class 4 (±8 kV) - point contact discharge and air discharge

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Fast Transient Disturbance Test

IEC 61000-4-4 (±2 kV, 5 kHz) AC Power Supply Input
(±1 kV, 5 kHz) RS-232, RS-485 and ground

Surge

IEC 61000-4-5 (±2 kV, 1.2 μs by 50 μs line to ground) AC Power Supply Input
(±1 kV, 1.2 μs by 50 μs line to line) AC Power Supply Input
(±1 kV, 1.2 μs by 50 μs line to ground) RS-485 Port

Surge Withstand Capability

ANSI/IEEE C37.90.1 1989
2,500 V pk-pk Oscillatory each independent circuit to earth
2,500 V pk-pk Oscillatory between each independent circuit
5,000 V pk Fast Transient each independent circuit to earth
5,000 V pk Fast Transient between each independent circuit

■ **NOTE**: Digital data circuits (RS-232/485 communication ports) are excluded.

Radiated Susceptibility

ANSI/IEEE C37.90.2 1987	25-1000 Mhz @ 35V/m

Output Contacts

ANSI/IEEE C37.90.0 1989	Make 30 A for 0.2 seconds, off for 15 seconds for 2,000 operations Section 6.7.1, Tripping Output Performance Requirements

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, –20° C for 96 hours
IEC 60068-2-2	Dry Heat, +70° C for 96 hours
IEC 60068-2-3	Damp Heat, +40° C @ 93% RH, for 96 hours

Mechanical Environment

Vibration

IEC 60255-21-1	Vibration response Class 1, 0.5 g Vibration endurance Class 1, 1.0 g

Shock

MIL-STD-810C Method 516.2, Procedure 1, 11 ms, 15 g, 1/2 sine pulse, 3 pulses per axis

Compliance

UL-Listed per 508 – Industrial Control Equipment
CSA-Certified per C22.2 No. 14-95 – Industrial Control Equipment
CE Safety Directive – EN61010-1-1993, CAT II, Pollution Degree 2

Physical

Panel Mount

Size: 12.20" high x 12.00" wide x 2.56" deep (30.99 cm x 30.48 cm x 7.27 cm)
Approximate Weight: 5 lbs, 11 oz (2.11 kg)
Approximate Shipping Weight: 9 lbs, 13 oz (4.48 kg)

Horizontal/Vertical Panel Mount

Size: 3.46" high x 10.50" wide x 11.63" deep (8.8 cm x 26.7 cm x 29.54 cm)
Approximate Weight: 6 lbs, 4 oz (2.84 kg)
Approximate Shipping Weight: 10 lbs, 4 oz (10.7 kg)

Unit Information

Device Type(ID): SerialM-3410A

Time: 05/29/2015 13:05:19

Number: Software 3515

Version: Setpoint V01.03.02

Checksum: Calibration AF98

Checksum: FFFF

User Logo: Woodcrest Farm PR1

Communication Information

Communication Address: 1

Baud Rate (COM1/COM2): 9600 / 9600

Parity (COM1/COM2): None / None

Stop Bit (COM1/COM2): 1 / 1

FILE/SETPOINT INFORMATION

Profile Information

Name: Jason Hoover

Filename: Relay

Department: Interconnections

Company: Martin Energy Group

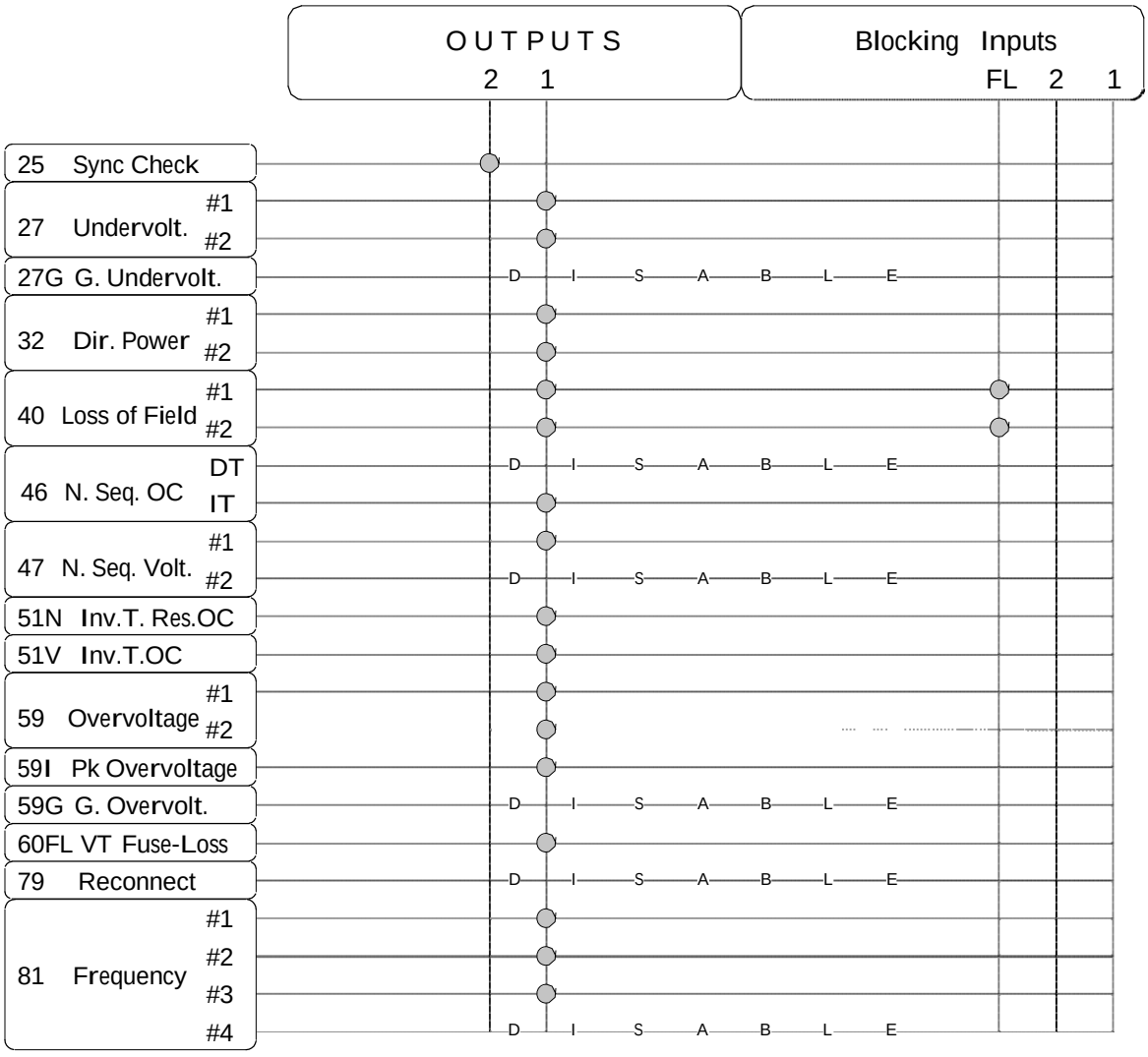
Comment: Proposed settings for PR1. Woodcrest Farm Interconnection Project

Setup Relay

Nominal Frequency:	60 Hz	C.T.Secondary Rating:	5 A
Phase Rotation:	ABC	59/27 Mag. Select:	DFT
Nominal Voltage:	480	Nominal Current:	4.23
Input Active State		Output Contact Mode	
open:		Normal:	1 , 2
close:	1 , 2	Latching:	
V.T.Configuration:	Line - Line		
Relay Seal-In Time(cycles):	Out1 30 Out2 30	Delta-Y Transform:	Disable
V.T.Phase Ratio:	1.0 : 1	V.T.(Sync./Ground) Ratio:	1.0 : 1
C.T.Phase Ratio:	160 : 1		

Output Relay Actuate
Deenergize to Trip(Failsafe): 1
Energize to Trip: 2

Configuration I/O Matrix



[25] SYNC CHECK

Phase Angle Window:	10 °	Upper Volt. Limit:	110.0 %
Lower Volt. Limit:	90.0 %	Sync Check Delay:	30 Cycles
Dead Volt. Limit:	10.0 %	Dead Time Delay:	30 Cycles
Delta Frequency:	0.200 Hz	Delta Voltage:	10.0 %
Dead V1 Hot V2:	Disable	Hot V1 Dead V2:	Disable
Dead V1 Dead V2:	Disable	Supervised by F79:	Disable
Dead Input Initiate:		Phase Selection:	AB
OUTPUTS:	2.	BLOCKING INPUTS:	

[27] UNDERVOLTAGE

PICKUP:	88.0 %	TIME DELAY:	116 Cycles	#1
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:	50.0 %	TIME DELAY:	6 Cycles	#2
OUTPUTS:	1.	BLOCKING INPUTS:		

[27G] GROUND UNDERVOLTAGE

PICKUP:		TIME DELAY:	
OUTPUTS:		BLOCKING INPUTS:	

--- D -- I -- S -- A -- B -- L -- E---

[32] DIRECTIONAL POWER

PICKUP:	-0.08 PU	TIME DELAY:	600 Cycles	#1
OVERPOWER:	Enable	Three Phase Detection:	Enable	
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:	-0.08 PU	TIME DELAY:	600 Cycles	#2
OVERPOWER:	Enable	Three Phase Detection:	Enable	
OUTPUTS:	1.	BLOCKING INPUTS:		

[40] LOSS OF FIELD

Circle Diameter:	1.00 PU	OFFSET:	0.09 PU	#1
VOLTAGE CONTROL:	Disable	TIME DELAY:	10 Cycles	
OUTPUTS:	1.	BLOCKING INPUTS:	FL.	
Circle Diameter:	1.81 PU	OFFSET:	0.09 PU	#2
VOLTAGE CONTROL:	Disable	TIME DELAY:	30 Cycles	
OUTPUTS:	1.	BLOCKING INPUTS:	FL.	
VOLTAGE:				

[46] NEGATIVE SEQUENCE OVERCURRENT

PICKUP:		TIME DELAY:		DT
OUTPUTS:	--- D -- I -- S -- A -- B -- L -- E---	BLOCKING INPUTS:		
PICKUP:	30.0 %	TIME DIAL:	10	IT
Max.Time:	10000 Cycles	CURVE TYPE:	I*I*t=K	
OUTPUTS:	1.	BLOCKING INPUTS:		

[47] NEGATIVE SEQUENCE OVERVOLTAGE

PICKUP:	25.0 %	TIME DELAY:	60 Cycles	#1
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:		TIME DELAY:		#2
OUTPUTS:	--- D -- I -- S -- A -- B -- L -- E---	BLOCKING INPUTS:		

[51N] INVERSE TIME RESIDUAL OVERCURRENT

PICKUP:	2.96 A	TIME DIAL:	0.50
CURVE TYPE:	IECI		
OUTPUTS:	1.	BLOCKING INPUTS:	

[51V] INVERSE TIME OVERCURRENT WITH VOLTAGE CONTROL OR RESTRAINT

PICKUP:	4.66 A	TIME DIAL:	0.75
CURVE TYPE:	IECI	VOLTAGE CONTROL:	Restrain
OUTPUTS:	1.	BLOCKING INPUTS:	

[59] OVERVOLTAGE

PICKUP:	110.0 %	TIME DELAY:	56 Cycles	#1
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:	120.0 %	TIME DELAY:	6 Cycles	#2
OUTPUTS:	1.	BLOCKING INPUTS:		

[59G] GROUND OVERVOLTAGE

PICKUP:		TIME DELAY:	
OUTPUTS:		BLOCKING INPUTS:	

--- D -- I -- S -- A -- B -- L -- E---

[59I] PEAK OVERVOLTAGE

PICKUP:	120 %	TIME DELAY:	6 Cycles
OUTPUTS:	1.	BLOCKING INPUTS:	

[60FL] VT FUSE-LOSS DETECTION

TIME DELAY:	10 Cycles	Input Initiate:	FL.
OUTPUTS:	1.	BLOCKING INPUTS:	

[79] RECONNECT ENABLE TIME DELAY

TIME DELAY:		Reconnect Initiate:	
OUTPUTS:		BLOCKING INPUTS:	

--- D -- I -- S -- A -- B -- L -- E---

[81] OVER/UNDER FREQUENCY

PICKUP:	57.00 Hz	TIME DELAY:	6 Cycles	#1
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:	58.50 Hz	TIME DELAY:	6000 Cycles	#2
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:	60.50 Hz	TIME DELAY:	6 Cycles	#3
OUTPUTS:	1.	BLOCKING INPUTS:		
PICKUP:		TIME DELAY:		#4
OUTPUTS:		BLOCKING INPUTS:		

--- D -- I -- S -- A -- B -- L -- E---

D Appendix D – Inverse Time Curves

This Appendix contains Inverse Time Curve families for the M-3410A functions which utilize the Inverse Time Overcurrent curves. Table D-1A and D-1B on pages D–2 and D–3 contains a list of the data that characterizes Definite Time, Inverse Time, Very Inverse Time, and Extremely Inverse Time Overcurrent Curves.

■ **NOTE**: The specified timing accuracy is applicable for currents above three times the pickup value.

Multiple of Tap Setting	Definite Time	Inverse Time	Very Inverse Time	Extremely Inverse Time
1.50	0.69899	4.53954	3.46578	4.83520
1.55	0.64862	4.15533	3.11203	4.28747
1.60	0.60539	3.81903	2.81228	3.83562
1.65	0.56803	3.52265	2.55654	3.45706
1.70	0.53558	3.25987	2.33607	3.13573
1.75	0.50725	3.02558	2.14431	2.85994
1.80	0.48245	2.81566	1.97620	2.62094
1.85	0.46068	2.62673	1.82779	2.41208
1.90	0.44156	2.45599	1.69597	2.22822
1.95	0.42477	2.30111	1.57823	2.06529
2.00	0.41006	2.16013	1.47254	1.92006
2.05	0.39721	2.03139	1.37723	1.78994
2.10	0.38606	1.91348	1.29093	1.67278
2.15	0.37648	1.80519	1.21249	1.56686
2.20	0.36554	1.72257	1.12812	1.47820
2.30	0.35293	1.54094	1.01626	1.32268
2.40	0.34115	1.39104	0.92207	1.19250
2.50	0.33018	1.26561	0.84190	1.08221
2.60	0.31999	1.15945	0.77301	0.98780
2.70	0.31057	1.06871	0.71334	0.90626
2.80	0.30189	0.99049	0.66127	0.83527
2.90	0.29392	0.92258	0.61554	0.77303
3.00	0.28666	0.86325	0.57515	0.71811
3.10	0.28007	0.81113	0.53930	0.66939
3.20	0.27415	0.76514	0.50733	0.62593
3.30	0.26889	0.72439	0.47870	0.58700
3.40	0.26427	0.68818	0.45297	0.55196
3.50	0.26030	0.65591	0.42977	0.52032
3.60	0.25697	0.62710	0.40879	0.49163
3.70	0.25429	0.60135	0.38977	0.46554
3.80	0.25229	0.57832	0.37248	0.44175
4.00	0.24975	0.53904	0.34102	0.40129
4.20	0.24572	0.50641	0.31528	0.36564
4.40	0.24197	0.47746	0.29332	0.33460
4.60	0.23852	0.45176	0.27453	0.30741
4.80	0.23541	0.42894	0.25841	0.28346

■ **NOTE**: The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the values in the table by the time dial value.

Table D-1A M-3410A Inverse Time Overcurrent Relay Characteristic Curves (1 of 2)

Multiple of Tap Setting	Definite Time	Inverse Time	Very Inverse Time	Extremely Inverse Time
5.00	0.23266	0.40871	0.24456	0.26227
5.20	0.23029	0.39078	0.23269	0.24343
5.40	0.22834	0.37495	0.22254	0.22660
5.60	0.22684	0.36102	0.21394	0.21151
5.80	0.22583	0.34884	0.20673	0.19793
6.00	0.22534	0.33828	0.20081	0.18567
6.20	0.22526	0.32771	0.19511	0.17531
6.40	0.22492	0.31939	0.19044	0.16586
6.60	0.22360	0.31150	0.18602	0.15731
6.80	0.22230	0.30402	0.18187	0.14957
7.00	0.22102	0.29695	0.17797	0.14253
7.20	0.21977	0.29027	0.17431	0.13611
7.40	0.21855	0.28398	0.17090	0.13027
7.60	0.21736	0.27807	0.16773	0.12492
7.80	0.21621	0.27253	0.16479	0.12003
8.00	0.21510	0.26734	0.16209	0.11555
8.20	0.21403	0.26251	0.15961	0.11144
8.40	0.21300	0.25803	0.15736	0.10768
8.60	0.21203	0.25388	0.15534	0.10422
8.80	0.21111	0.25007	0.15354	0.10105
9.00	0.21025	0.24660	0.15197	0.09814
9.50	0.20813	0.23935	0.14770	0.09070
10.00	0.20740	0.23422	0.14473	0.08474
10.50	0.20667	0.22923	0.14180	0.07943
11.00	0.20594	0.22442	0.13894	0.07469
11.50	0.20521	0.21979	0.13615	0.07046
12.00	0.20449	0.21536	0.13345	0.06667
12.50	0.20378	0.21115	0.13084	0.06329
13.00	0.20310	0.20716	0.12833	0.06026
13.50	0.20243	0.20341	0.12593	0.05755
14.00	0.20179	0.19991	0.12364	0.05513
14.50	0.20119	0.19666	0.12146	0.05297
15.00	0.20062	0.19367	0.11941	0.05104
15.50	0.20009	0.19095	0.11747	0.04934
16.00	0.19961	0.18851	0.11566	0.04784
16.50	0.19918	0.18635	0.11398	0.04652
17.00	0.19881	0.18449	0.11243	0.04539
17.50	0.19851	0.18294	0.11102	0.04442
18.00	0.19827	0.18171	0.10974	0.04362
18.50	0.19811	0.18082	0.10861	0.04298
19.00	0.19803	0.18029	0.10762	0.04250
19.50	0.19803	0.18014	0.10679	0.04219
20.00	0.19803	0.18014	0.10611	0.04205

■ **NOTE**: The above times are in seconds and are given for a time dial of 1.0. For other time dial values, multiply the values in the table by the time dial value.

Table D-1B M-3410A Inverse Time Overcurrent Relay Characteristic Curves (2 of 2)

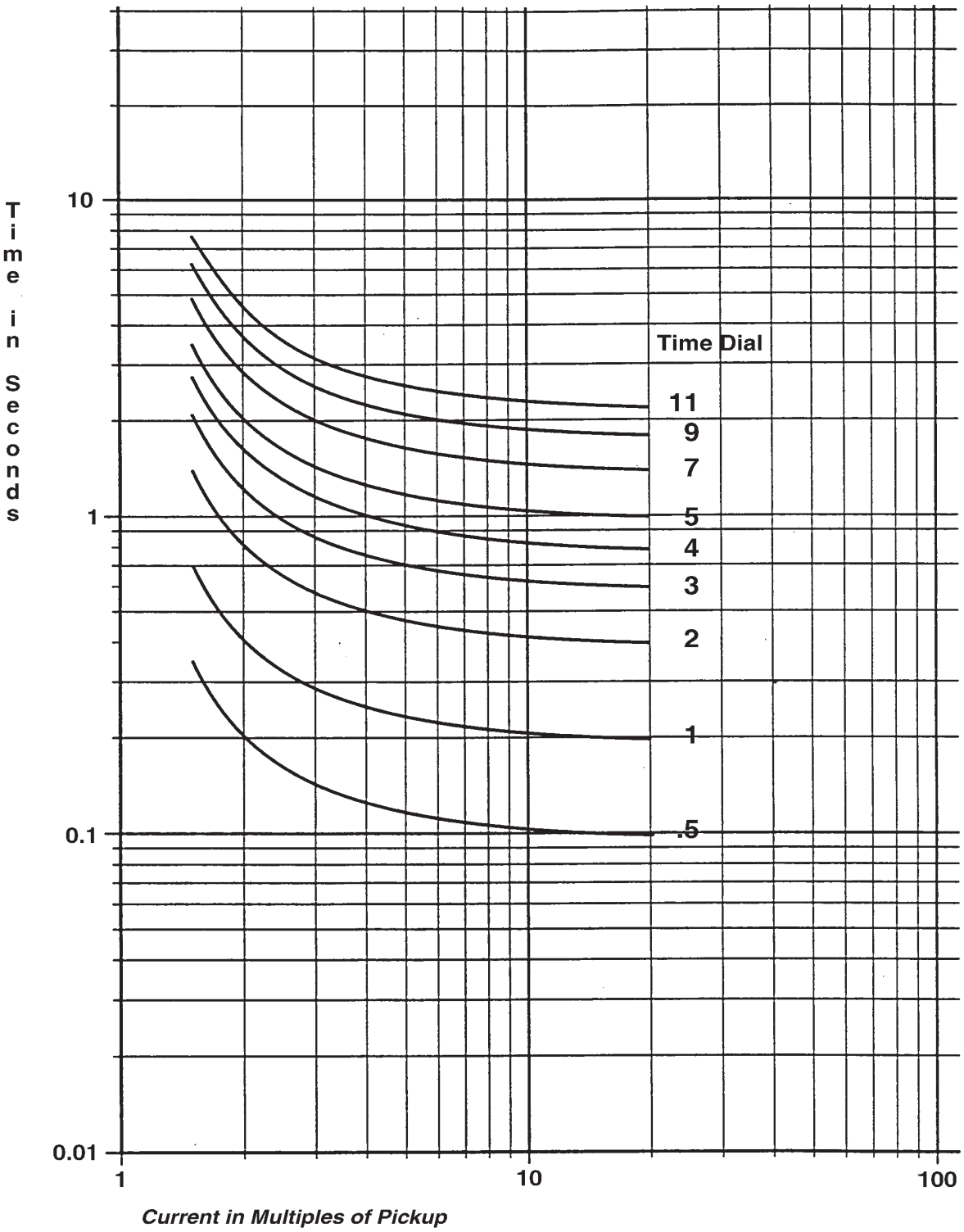


Figure D-1 Definite Time Overcurrent Curve

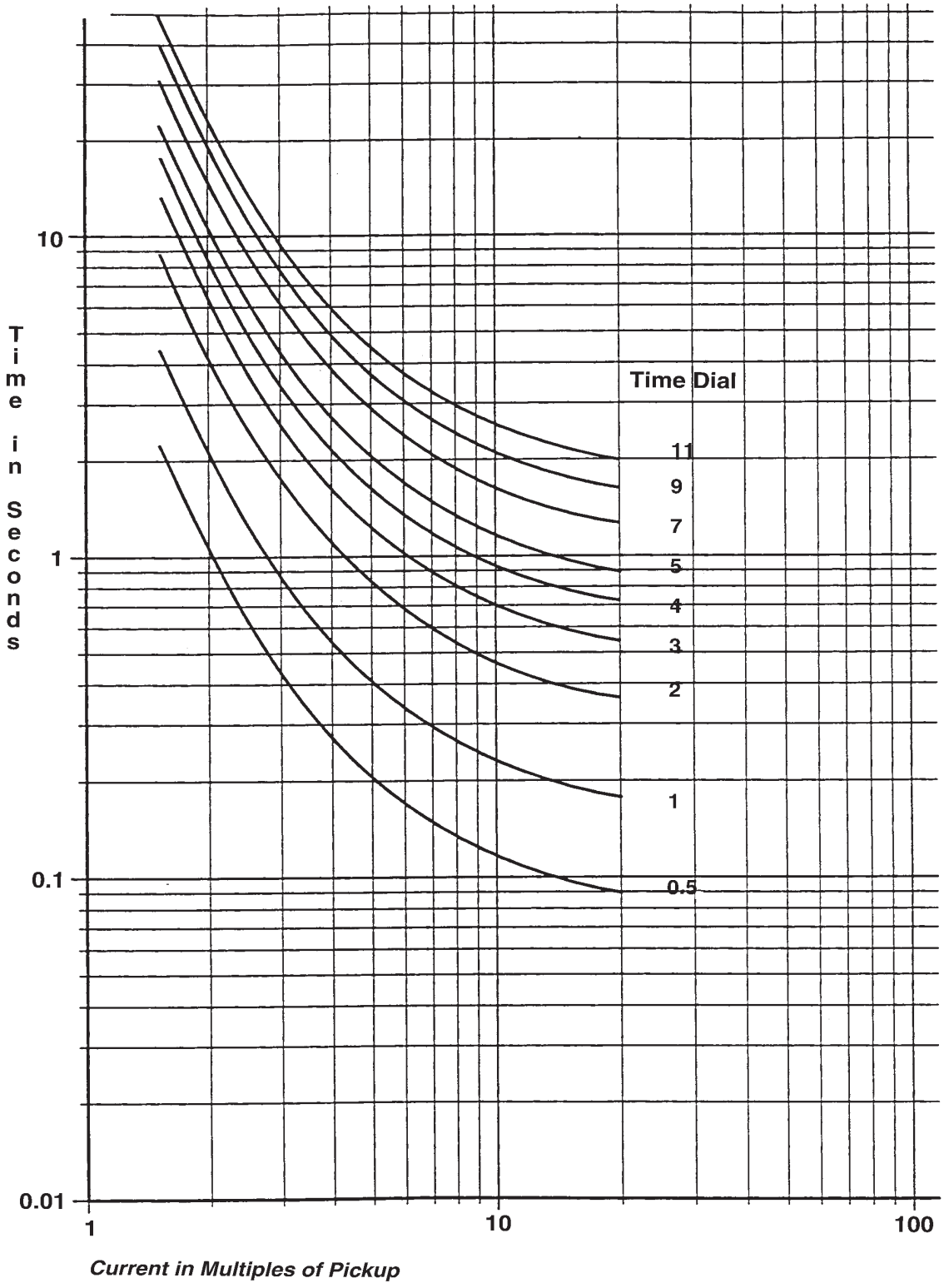


Figure D-2 Inverse Time Overcurrent Curve

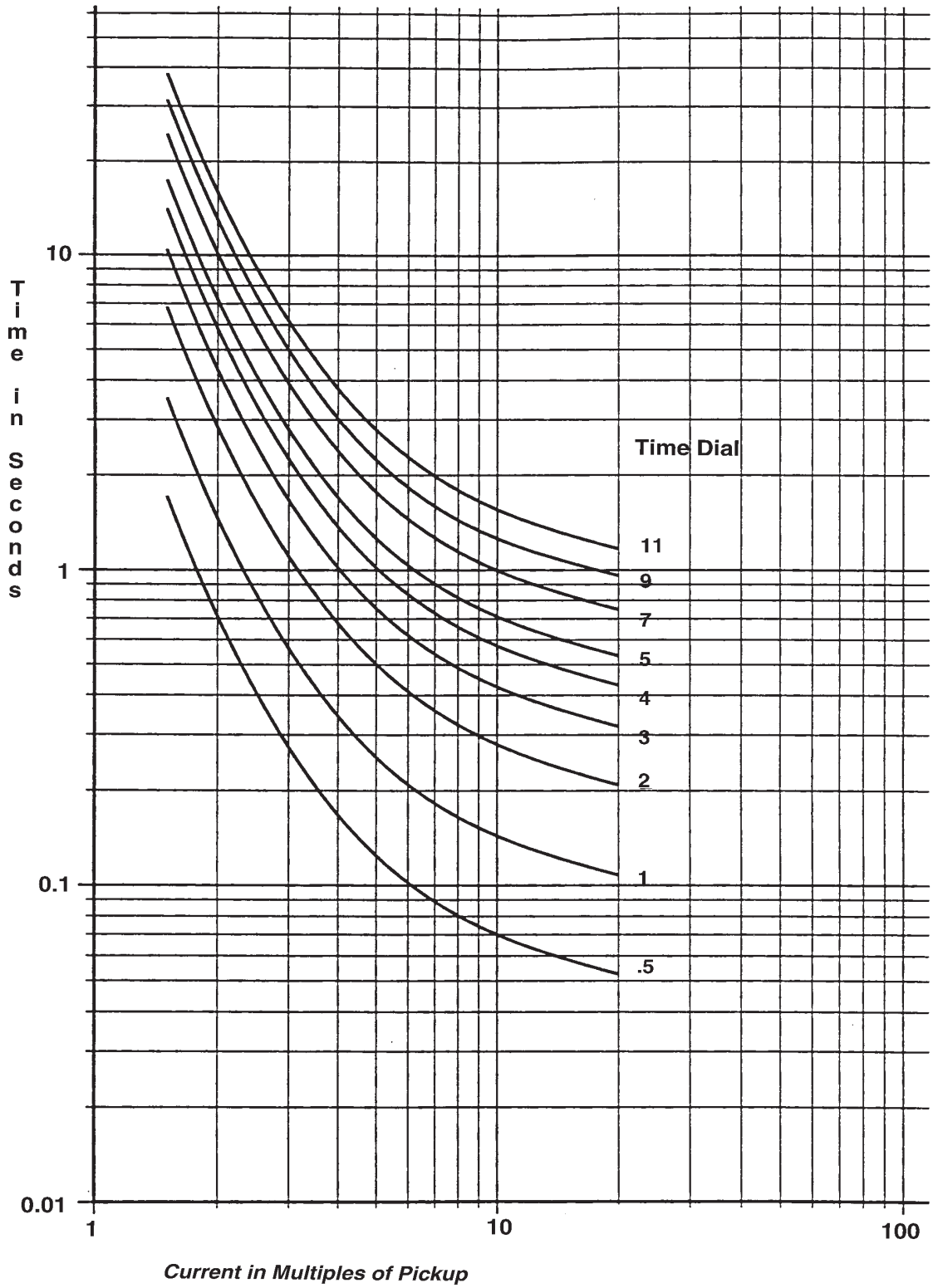


Figure D-3 Very Inverse Time Overcurrent Curve

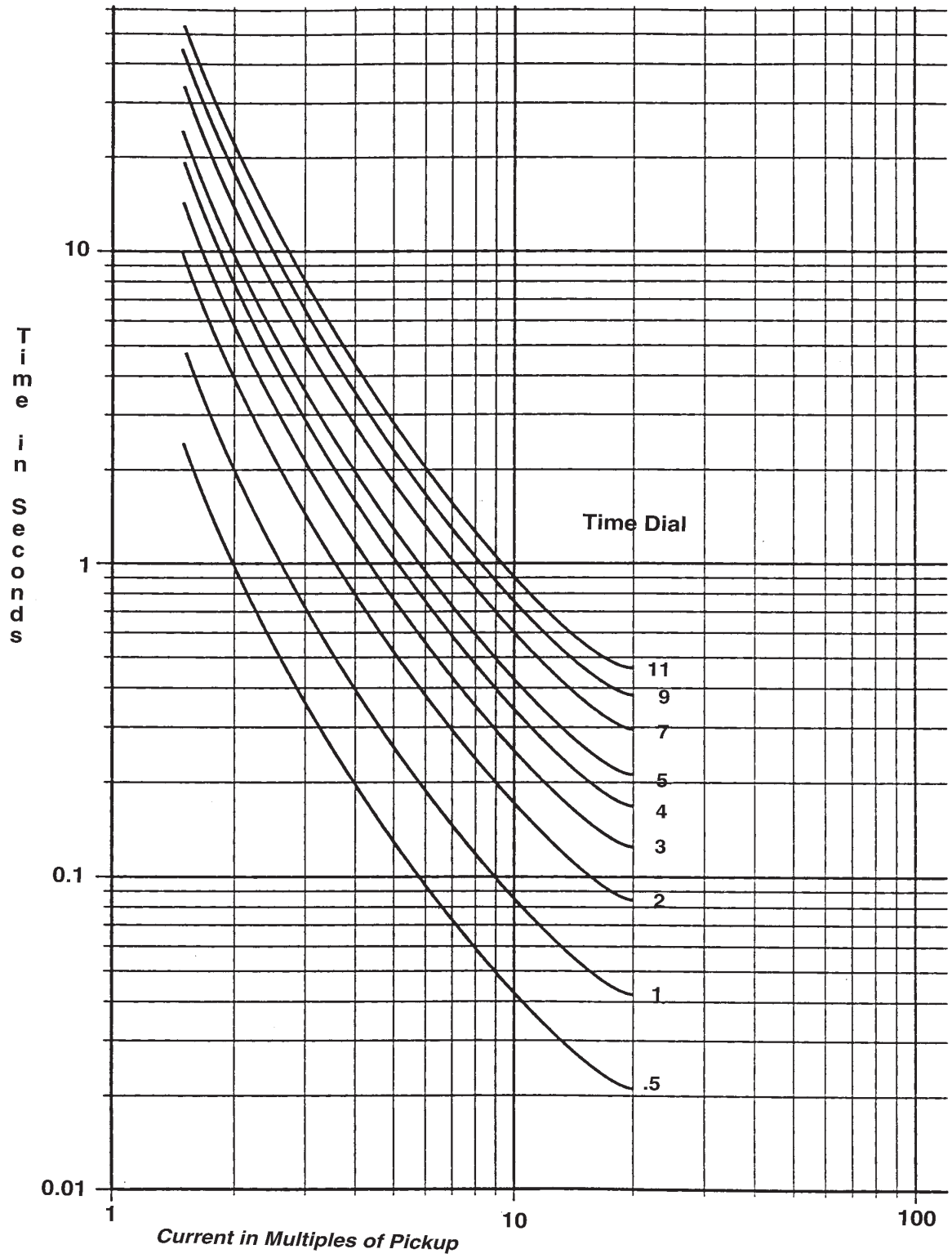
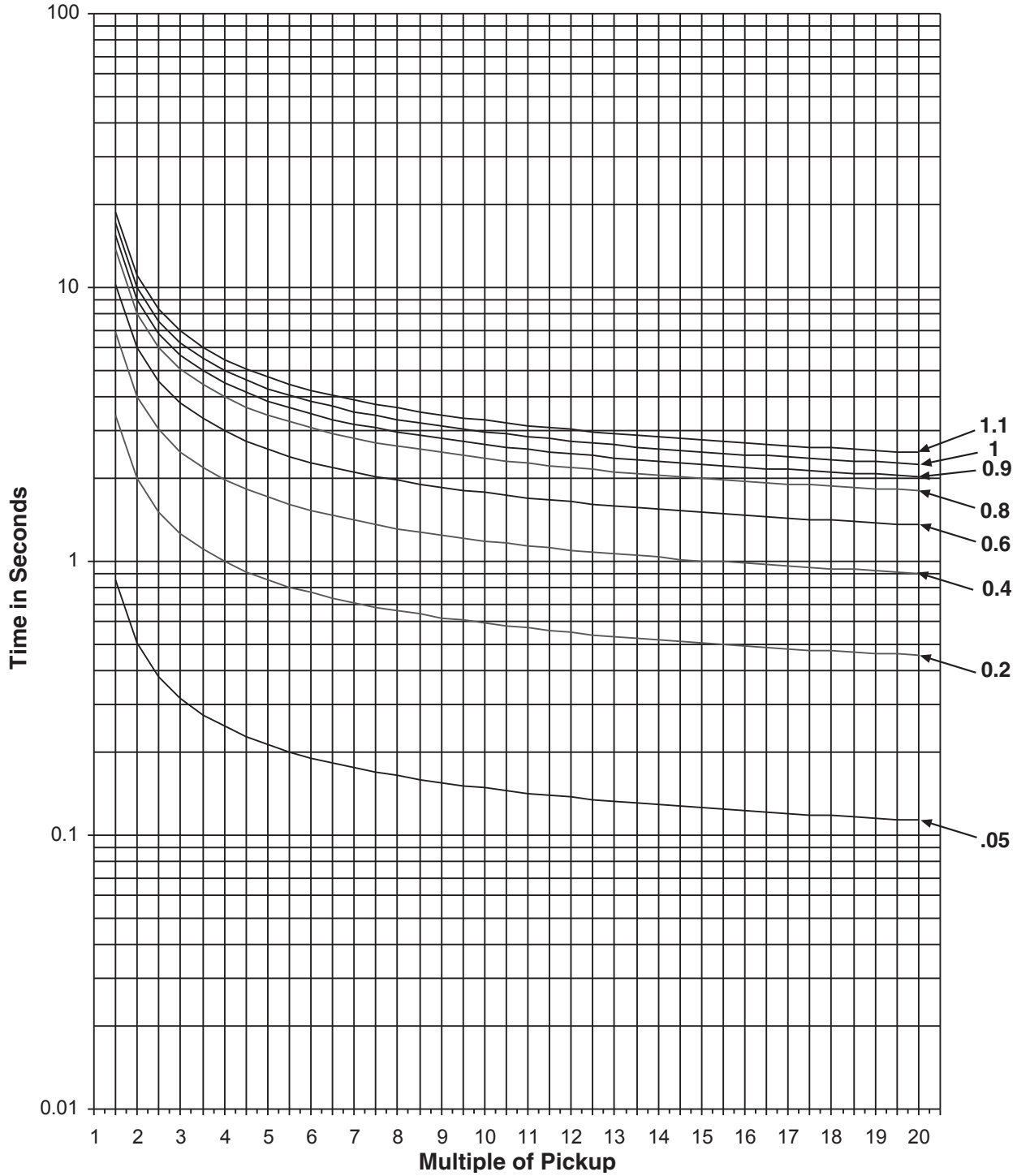
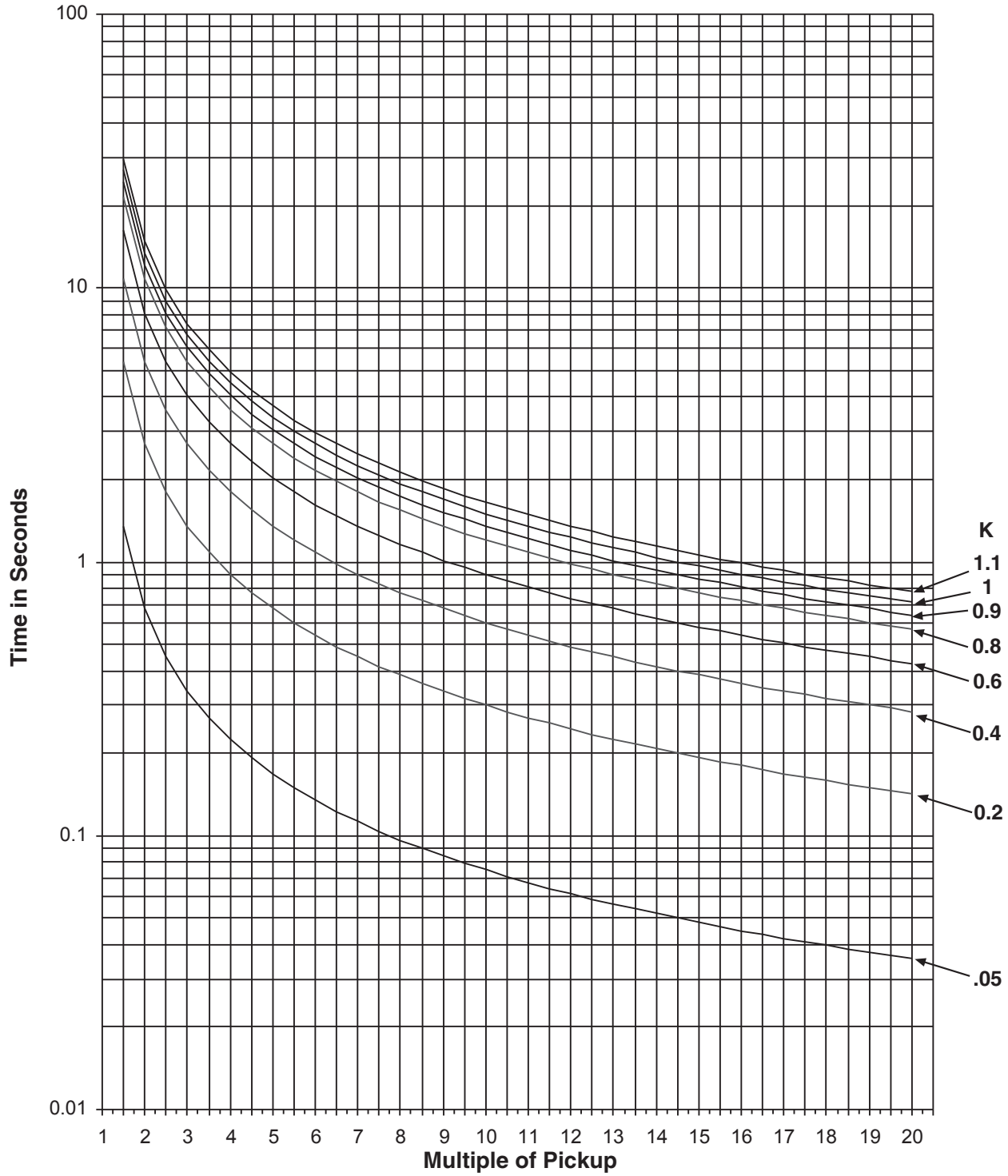


Figure D-4 Extremely Inverse Time Overcurrent Curve



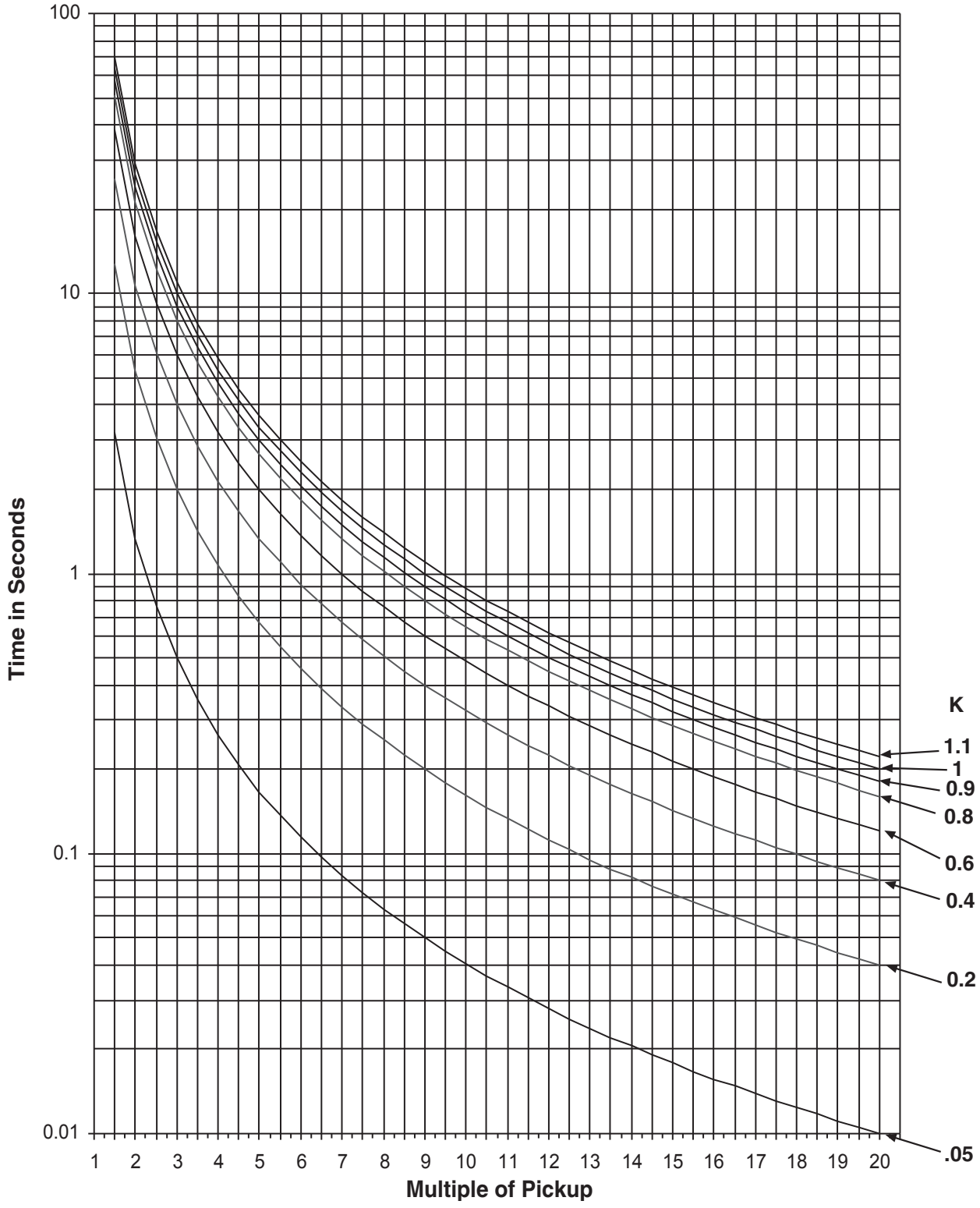
$$t = TD \times \left[\frac{0.14}{M^{0.02} - 1} \right]$$

Figure D-5 IEC Curve #1 Inverse



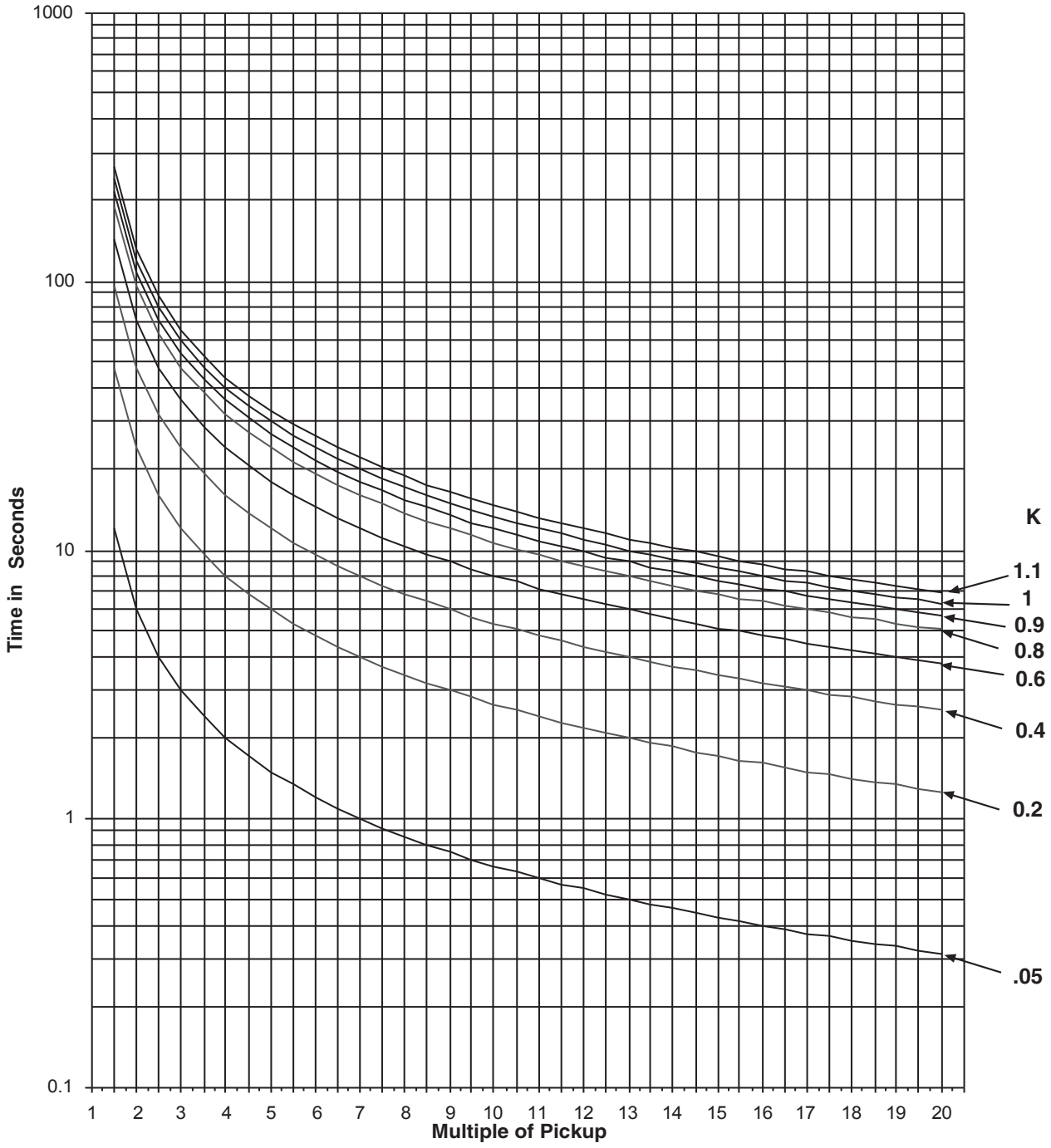
$$t = TD \times \left[\frac{13.5}{M - 1} \right]$$

Figure D-6 IEC Curve #2 Very Inverse



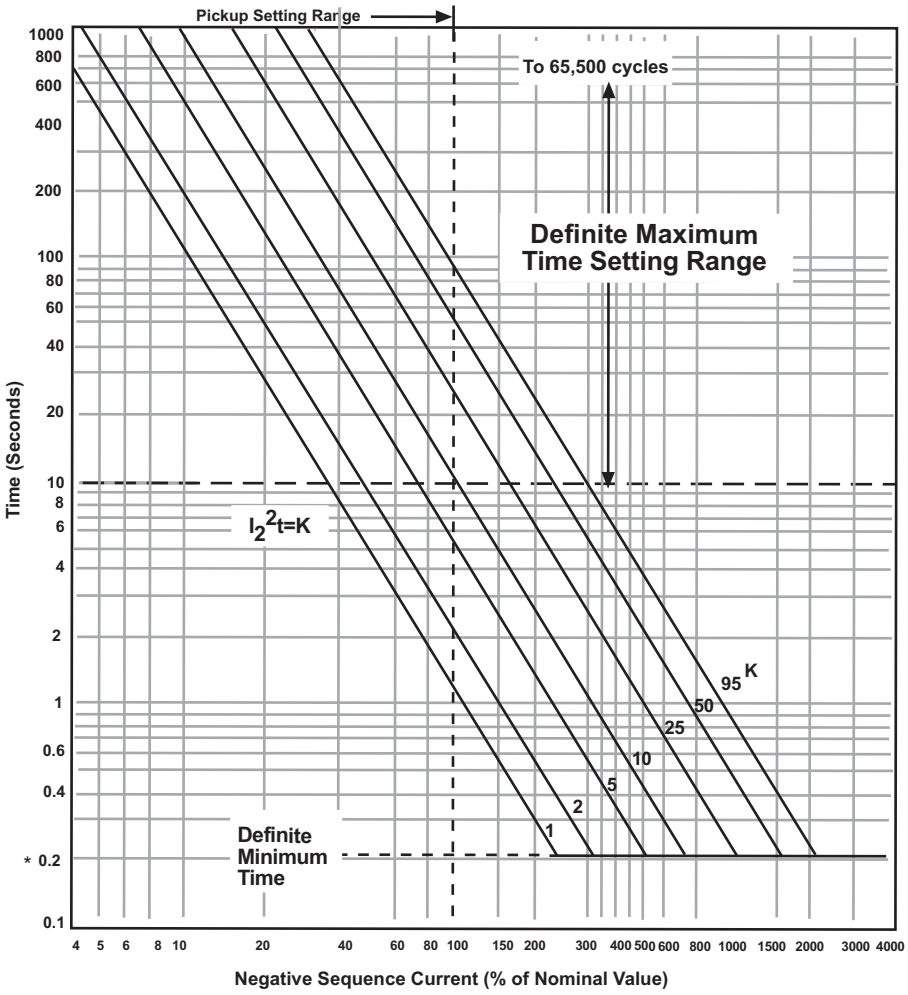
$$t = TD \times \left[\frac{80}{M^2 - 1} \right]$$

Figure D-7 IEC Curve #3 Extremely Inverse



$$t = TD \times \left[\frac{120}{M - 1} \right]$$

Figure D-8 IEC Curve #4 Long-Time Inverse



■ **NOTE**: When the phase current exceeds 3X I nominal, the operating times will be greater than those shown.

* 0.24 seconds for 50 Hz units.

Figure D-9 (46) Negative Sequence Overcurrent Inverse Time Curves for Generator Protection

Section IV

Potential and Current Transformers

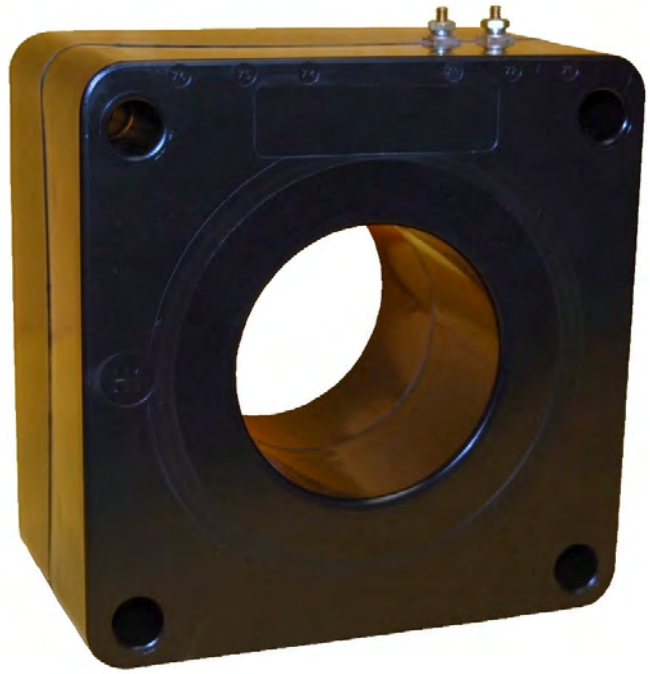
INDEX

Current Transformer
Models 112, 113, 114, 115, 117
Window Diameter 2.25", 2.75", 3.25", 4.00", 4.62"

REGULATORY AGENCY APPROVALS

E93779 LR89403

Manufactured to meet the requirements of ANSI/IEEE C57.13.
Classified by U.L. in accordance with IEC 44-1



APPLICATION:
Relaying and metering.

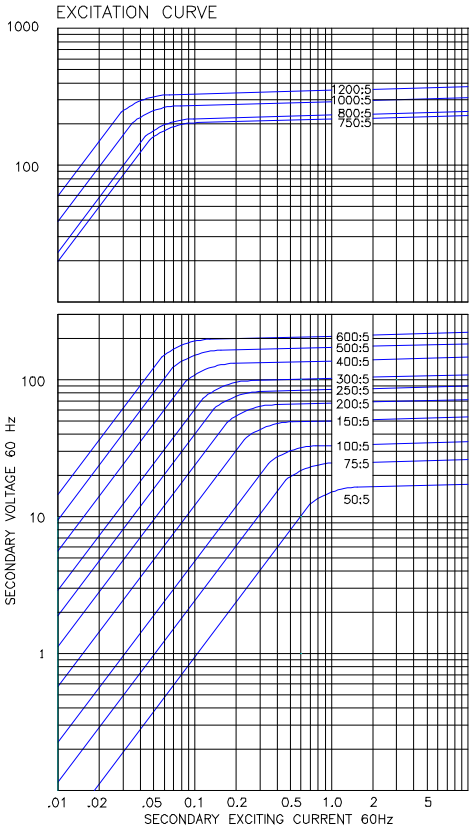
FREQUENCY:
50-400 Hz.

INSULATION LEVEL:
600 Volts, 10 kV BIL full wave.

Terminals are brass studs No. 8-32 with one flatwasher, lockwasher and regular nut.

Order mounting bracket kit 0221B01525 separately.

Multi-ratios available upon request.

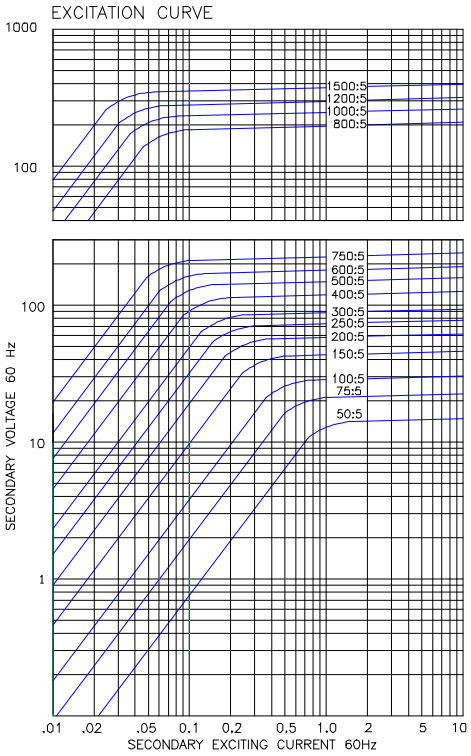


Model 112 *Window Diameter 2.25"*

Approximate weight 25 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8	(OHMS @75°C)	@ 30°C	@ 55°C
112—500	50:5	C10	1.2	2.4	—	—	—	0.029	2.0	2.0
112—750	75:5	C20	0.6	1.2	2.4	4.8	—	0.046	2.0	2.0
112—101	100:5 *	C20	0.6	0.6	2.4	2.4	4.8	0.062	2.0	2.0
112—151	150:5 *	C50	0.3	0.6	1.2	1.2	2.4	0.093	2.0	2.0
112—201	200:5 *	C50	0.3	0.3	0.6	0.6	1.2	0.124	2.0	2.0
112—251	250:5 *	C50	0.3	0.3	0.3	0.3	0.6	0.155	2.0	2.0
112—301	300:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.186	2.0	2.0
112—401	400:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.248	2.0	1.5
112—501	500:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.341	2.0	1.5
112—601	600:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.409	1.5	1.33
112—751	750:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.495	1.5	1.0
112—801	800:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.529	1.5	1.0
112—102	1000:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.661	1.33	1.0
112—122	1200:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.793	1.33	1.0

* Industry Canada approval No. AE-10837

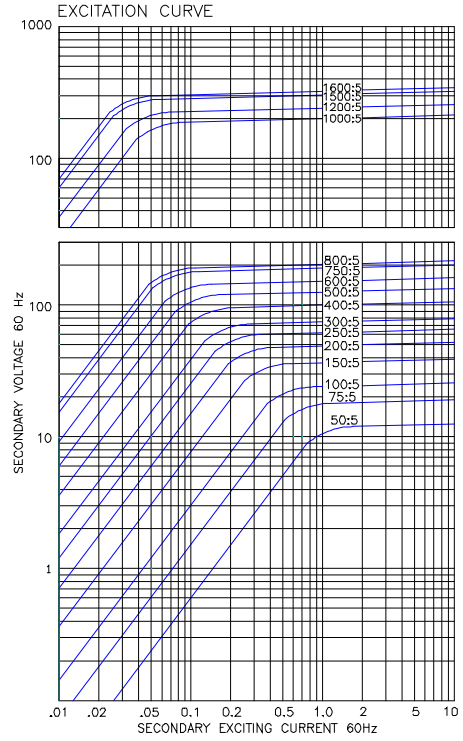


Model 113 *Window Diameter 2.75"*

Approximate weight 13 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
113—500	50:5	C10	2.4	4.8	—	—	—	0.033	2.0	2.0
113—750	75:5	C10	0.6	1.2	4.8	4.8	—	0.043	2.0	2.0
113—101	100:5	C20	0.6	0.6	2.4	2.4	4.8	0.059	2.0	2.0
113—151	150:5	C20	0.3	0.3	0.6	1.2	2.4	0.089	2.0	2.0
113—201	200:5 *	C20	0.3	0.3	0.6	0.6	1.2	0.118	2.0	2.0
113—251	250:5 *	C50	0.3	0.3	0.6	0.6	1.2	0.163	2.0	2.0
113—301	300:5 *	C50	0.3	0.3	0.3	0.6	1.2	0.195	2.0	2.0
113—401	400:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.260	2.0	1.5
113—501	500:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.325	2.0	1.5
113—601	600:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.390	1.5	1.33
113—751	750:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.488	1.5	1.0
113—801	800:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.503	1.5	1.0
113—102	1000:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.629	1.33	1.0
113—122	1200:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.755	1.33	1.0
113—152	1500:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.943	1.0	0.8

* Industry Canada Approval No. T-190



Model 114 *Window Diameter 3.25"*

Approximate weight 22 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
114—500	50:5	C10	2.4	4.8	—	—	—	0.024	2.0	2.0
114—750	75:5	C10	1.2	2.4	4.8	—	—	0.040	2.0	2.0
114—101	100:5	C10	1.2	1.2	2.4	4.8	—	0.055	2.0	2.0
114—151	150:5 *	C20	0.6	0.6	1.2	2.4	4.8	0.082	2.0	2.0
114—201	200:5 *	C20	0.3	0.3	0.6	1.2	2.4	0.112	2.0	2.0
114—251	250:5 *	C50	0.3	0.3	0.6	1.2	1.2	0.141	2.0	2.0
114—301	300:5 *	C50	0.3	0.3	0.6	0.6	1.2	0.165	2.0	2.0
114—401	400:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.220	2.0	1.5
114—501	500:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.267	2.0	1.5
114—601	600:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.371	1.5	1.33
114—751	750:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.464	1.5	1.0
114—801	800:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.495	1.5	1.0
114—102	1000:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.597	1.5	1.0
114—122	1200:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.716	1.33	1.0
114—152	1500:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.896	1.0	0.8
114—162	1600:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.955	1.0	0.8

* Industry Canada Approval No. T-191

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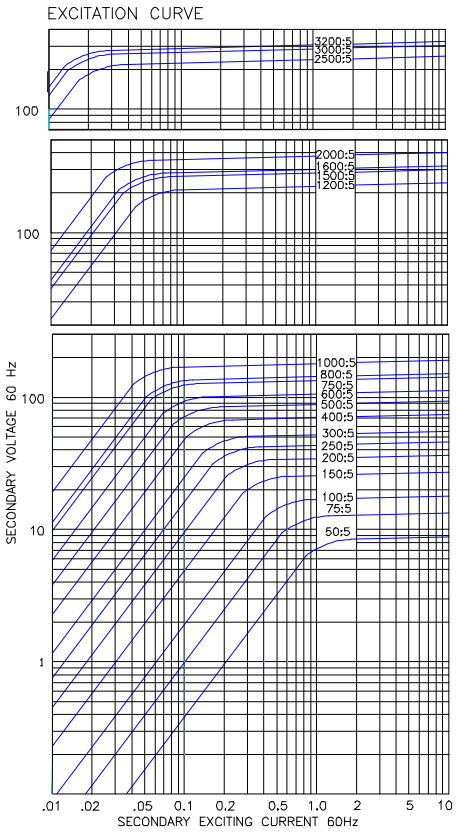
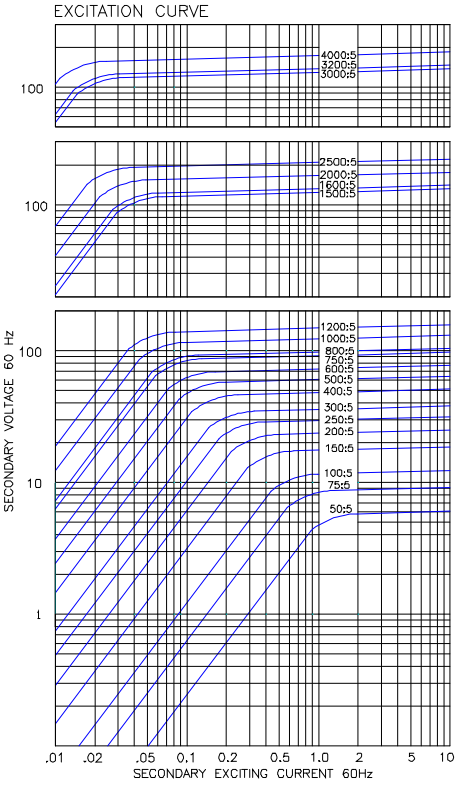


Model 115 *Window Diameter 4.00”*

Approximate weight 19 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
115—500	50:5	—	2.4	4.8	—	—	—	0.025	2.0	2.0
115—750	75:5	—	1.2	2.4	4.8	—	—	0.037	2.0	2.0
115—101	100:5	C10	1.2	1.2	2.4	4.8	—	0.046	2.0	2.0
115—151	150:5 *	C10	0.6	0.6	1.2	2.4	4.8	0.074	2.0	2.0
115—201	200:5 *	C20	0.3	0.6	0.6	1.2	2.4	0.099	2.0	2.0
115—251	250:5 *	C20	0.3	0.3	0.6	1.2	2.4	0.127	2.0	2.0
115—301	300:5 *	C20	0.3	0.3	0.3	0.6	1.2	0.148	2.0	2.0
115—401	400:5 *	C50	0.3	0.3	0.3	0.3	0.6	0.208	2.0	2.0
115—501	500:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.247	2.0	1.5
115—601	600:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.305	2.0	1.5
115—751	750:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.428	1.5	1.33
115—801	800:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.457	1.5	1.0
115—102	1000:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.571	1.5	1.0
115—122	1200:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.660	1.33	1.0
115—152	1500:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.825	1.0	0.8
115—162	1600:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.880	1.0	0.8
115—202	2000:5 *	C200	0.3	0.3	0.3	0.3	0.3	1.100	1.0	0.8
115—252	2500:5 *	C100	0.3	0.3	0.3	0.3	0.3	1.292	1.0	0.8
115—302	3000:5 *	C200	0.3	0.3	0.3	0.3	0.3	1.550	0.8	0.6
115—322	3200:5 *	C200	0.3	0.3	0.3	0.3	0.3	1.653	0.8	0.6

* Industry Canada Approval No. T-192

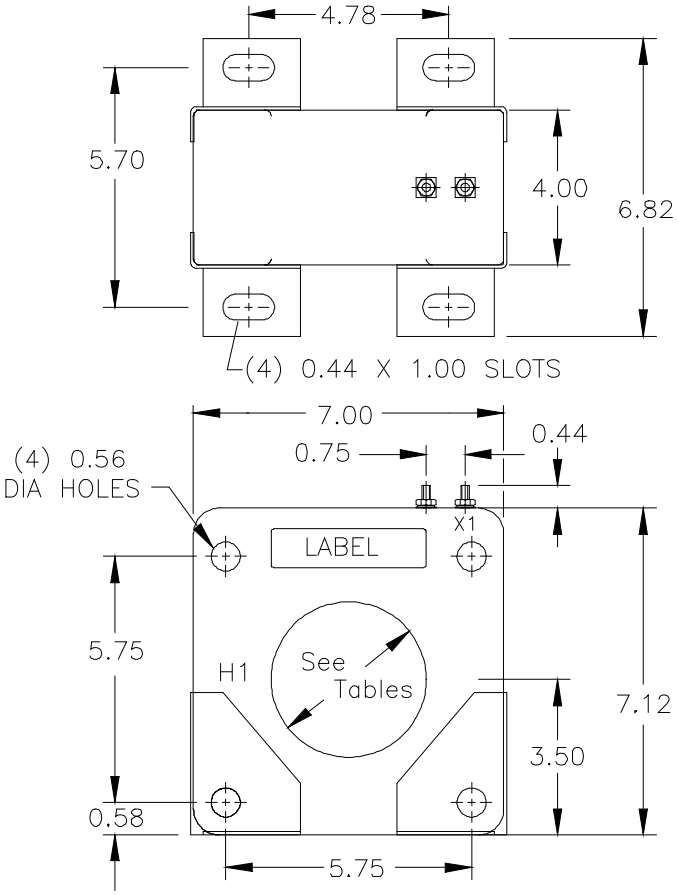


Model 117 *Window Diameter 4.62”*

Approximate weight 13 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8	(OHMS @ 75°C)	@ 30°C	@ 55°C
117—500	50:5	—	2.4	4.8	—	—	—	0.015	2.0	2.0
117—750	75:5	—	0.6	1.2	4.8	4.8	—	0.024	2.0	2.0
117—101	100:5	—	0.6	0.6	2.4	2.4	—	0.043	2.0	2.0
117—151	150:5	C10	0.3	0.3	0.6	1.2	4.8	0.069	2.0	2.0
117—201	200:5	C10	0.3	0.3	0.6	0.6	4.8	0.085	2.0	2.0
117—251	250:5 *	C20	0.3	0.3	0.6	0.6	2.4	0.106	2.0	2.0
117—301	300:5 *	C20	0.3	0.3	0.3	0.3	2.4	0.145	2.0	2.0
117—401	400:5 *	C20	0.3	0.3	0.3	0.3	1.2	0.184	2.0	2.0
117—501	500:5 *	C20	0.3	0.3	0.3	0.3	0.6	0.236	2.0	1.5
117—601	600:5 *	C20	0.3	0.3	0.3	0.3	0.6	0.283	2.0	1.5
117—751	750:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.354	1.5	1.33
117—801	800:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.425	1.5	1.33
117—102	1000:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.531	1.5	1.0
117—122	1200:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.637	1.33	1.0
117—152	1500:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.768	1.33	1.0
117—162	1600:5 *	C50	0.3	0.3	0.3	0.3	0.3	0.819	1.0	0.8
117—202	2000:5 *	C100	0.3	0.3	0.3	0.3	0.3	1.024	1.0	0.6
117—252	2500:5 *	C100	0.3	0.3	0.3	0.3	0.3	1.279	1.0	0.6
117—302	3000:5 *	—	0.3	0.3	0.3	0.3	0.3	1.428	1.0	0.6
117—322	3200:5 *	—	0.3	0.3	0.3	0.3	0.3	1.523	1.0	0.6
117—402	4000:5 *	—	0.3	0.3	0.3	0.3	0.3	2.385	0.8	0.6

* Industry Canada Approval No. T-193



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Section V

Digital Genset Controller

INDEX

InteliSys^{NT}

PREMIUM AND COGENERATION GEN–SET CONTROLLER

ComAp

Description

InteliSys^{NT} is an expandable controller for both single and multiple gen-sets operating in standby or parallel modes, especially in cogeneration (CHP) and other complex applications.

Detachable construction (consisting of IS-NT-BB and IS-Display or InteliVision 8) allows easy installation with the potential for many different extension modules designed to suit individual customer requirements.

A built-in synchronizer and digital isochronous load sharer allow a total integrated solution for gen-sets in standby, island parallel or mains parallel. Native co-operation of up to 32 gen-sets is a standard feature.

InteliSys^{NT} supports many standard ECU types and is specially designed to easily integrate new ones.

A powerful graphic display with user-friendly controls allows any user whatever their ability to find the information they need. The display on the basic version is capable of displaying graphical languages (e.g. Chinese).

ComAp is able to offer customized firmware solutions.

Benefits

- Support of engines with ECU (Electronic Control Unit)
- Excellent configurability to match customers' needs exactly
- Complete integrated gen-set solution incorporating built-in PLC and signal sharing via CAN bus – minimum external components needed
- Many communication options – easy remote supervising and servicing
- Perfect price/performance ratio
- Gen-set performance log for easy problem tracing

AMPS

ComAp is a member of AMPS (The Association of Manufacturers of Power generating Systems).

ISO 9001 CERTIFIED

ComAp products meet the highest standards, with every stage of production undertaken in accordance with the ISO certification obtained in 1998.

c UL us

Selected ComAp products have the UL Certification.

Features

- CHP support (programmable PID loops and other built-in PLC functions)
- Support of engines with ECU (J1939, Modbus and other proprietary interfaces); alarm codes displayed in text form
- Automatic synchronizing and power control (via speed governor or ECU)
- Baseload, Import/Export, TempByPower
- Peak shaving
- Voltage and PF control (AVR)
- Generator measurement: U, I, Hz, kW, kVAr, kVA, PF, kWh, kVAhr
- Mains measurement: U, I, Hz, kW, kVAr, PF
- Selectable measurement ranges for AC voltages and currents – 120/277 V, 0–1/0–5 A
- Inputs and outputs configurable for various customer needs
- Controller redundancy
- 2× RS232/RS485 interface with Modbus protocol support; Analog/GSM/ISDN/CDMA modem communication support; SMS messages; ECU Modbus interface; secondary RS485 converter is isolated
- Event-based history (up to 1000 records) with customer-selectable list of stored values; RTC; statistic values
- Integrated PLC programmable functions
- Interface to remote display units (IS-Display or/and InteliVision 8)
- USB 2.0 slave interface
- Dimensions 284×180 mm (front panel)
- Sealed to IP65

Integrated fixed and configurable protections

- 3 phase integrated generator protections (U + f)
- IDMT overcurrent + Shortcurrent protection
- Overload protection
- Reverse power protection
- Earth fault protection
- 3 phase integrated mains protections (U + f)
- Vector shift protection
- All binary/analog inputs free configurable for various protection types: HistRecOnly / Alarm Only / Alarm + History indication / Warning / Off load / Slow stop / BreakerOpen&Cooldown / Shutdown / Shutdown override / Mains protect / Sensor fail
- Phase rotation and phase sequence protection
- Additional 160 programmable protections configurable for any measured value to create customer-specific protections
- Application security

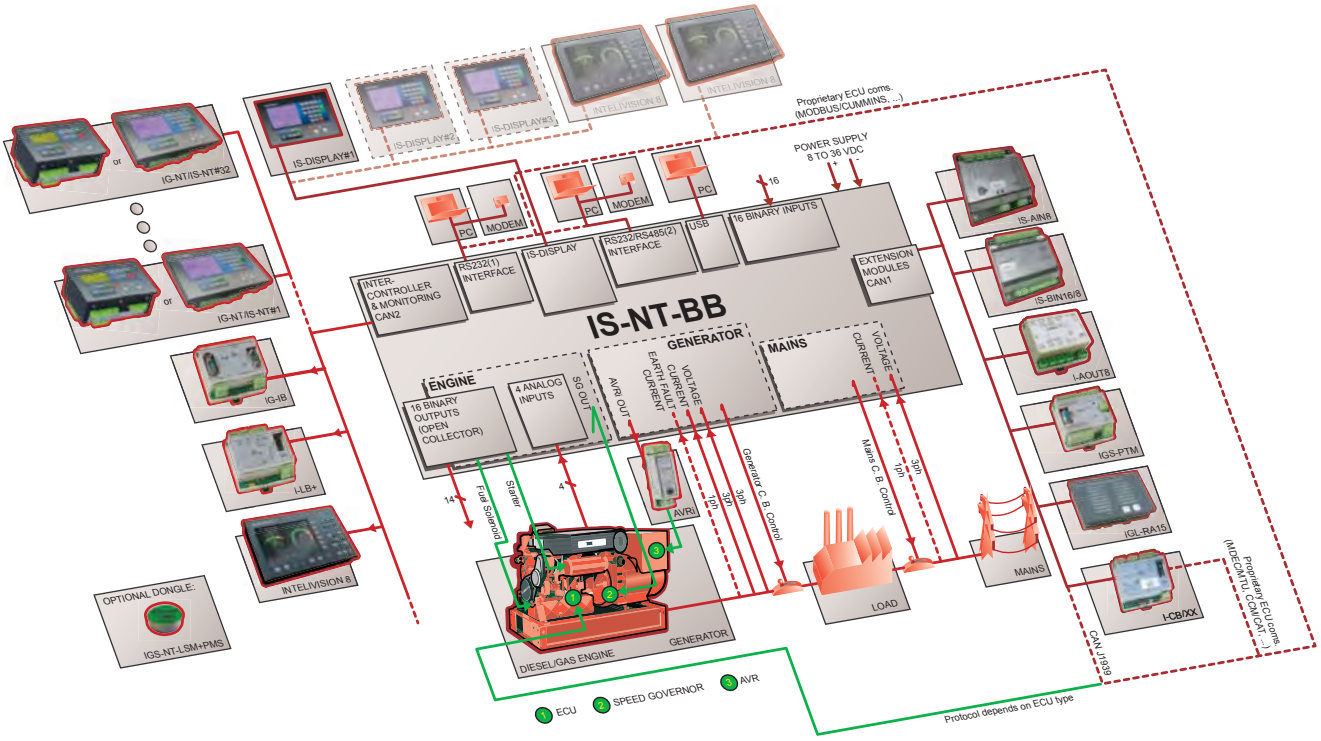
ANSI CODES

ANSI code	Protection
59	Overvoltage
27	Undervoltage
47	Voltage asymmetry
81H	Overfrequency
81L	Underfrequency
50+51	Overcurrent
46	Current unbalance
32	Overload

ANSI code	Protection
50N+64	Earth fault
32R	Reverse power
25	Synchronism check
47	Phase rotation
37	Undercurrent*
55	Power factor*
71	Gas (fuel) level

* can be created using universal protections

Schematic diagram



ComAp

Technical Data

Power supply

	Controller	IS-Display	IG-Display
Voltage supply	8-36V DC	8-36V DC	8-36V DC
Consumption depends on supply voltage	0,4A at 8VDC	0,3A at 8VDC	0,4A at 8VDC
	0,15 A at 24VDC	0,1 A at 24VDC	0,14 A at 24VDC
	0,1A at 36VDC	0,09A at 30VDC	0,12A at 30VDC
Battery voltage measurement tolerance	2 % at 24V		
RTC battery life-cycle	10 year		

Hint:

When internal RTC battery becomes flat, controller function (e.g. Ready for stand by) does not change until controller power supply is switched off. Some time before the battery is completely exhausted, a warning message appears in Alarmlist: "RTCbatteryFlat".

After the next power switch on (with flat battery already) controller:

- Stays in the INIT state (not possible to run genset)
- All History records disappear except of “System log: SetpointCS err” record
- Time and Date values are set to zero
- Statistics values are random

Operating conditions

Operating temperature	-20..+70°C *
Operating temperature IS-NT-BB	-40..+70°C *
Operating temperature (LT version)	-40..+70°C *
Storage temperature	-30..+80°C
Storage temperature IS-NT-BB	-40..+80°C
Flash memory data retention time	10 years
Protection front panel	IP65
Humidity	95% without condensation IEC/EN 60068-2-30
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)
Vibration	5 - 25 Hz, ±1,6mm 25 - 100 Hz, a = 4 g
Shocks	a = 200 m/s^2

Hint:

* USB port should be used only above 0°C.

Dimensions and weight

Dimensions	180x120x80mm
Weight	950g

Mains and generator

Nominal frequency	50-60Hz
Frequency measurement tolerance	0,1Hz

Current inputs

	IG-xx	IG-xxC / IS-NT-BB / IM-NT
Nominal input current (from CT)	5 A	1 A / 5 A
Load (CT output impedance)	< 0,1 Ω	< 0,1 Ω
CT input burden	< 0,2 VA per phase (Inom=5A)	< 0,1 VA per phase (Inom=1A) < 0,2 VA per phase (Inom=5A)
Max. measured current from CT	10 A	2 A / 10 A
Current measurement tolerance	2% from the Nominal current	2% from the Nominal current
Max. peak current from CT	150 A / 1s	150 A / 1s
Max. continuous current	12 A	2,4 A / 12 A

Voltage inputs – IG/IS-NT and modifications

	IG-xx	IG-xxC / IS-NT-BB / IM-NT
Nominal voltage (ph-N / ph-ph)	277/480 VAC	120/207 or 277/480 VAC
Maximal measured/allowed voltage	346/600 VAC	150/260 or 346/600 VAC
Input resistance	0,6 MΩ phase to phase	0,6 MΩ phase to phase
	0,3 MΩ phase to neutral	0,3 MΩ phase to neutral
Voltage measurement tolerance	1 % from the Nominal voltage	1 % from the Nominal voltage
Over voltage class	III / 2 (EN61010)	III / 2 (EN61010)

Hint:
kW, kWh, Load sharing, VAr sharing measurement tolerance is 3%.

Binary inputs and outputs

Binary inputs

	IG-NT / IG-NTC	IG-EE / IG-EEC / IM-NT	IS-NT-BB
Number of inputs	12	6	16
Input resistance	4,7 kΩ	4,7 kΩ	4,7 kΩ
Input range	0-36 VDC	0-36 VDC	0-36 VDC
Switching voltage level for close contact indication	0-2 V	0-2 V	0-2 V
Max voltage level for open contact indication	8-36 V	8-36 V	8-36 V

Binary open collector outputs

	IG-NT / IG-NTC	IG-EE / IG-EEC / IM-NT	IS-NT-BB
Number of outputs	12	6	16
Maximum current	0,5 A	0,5 A	0,5 A
Maximum switching voltage	36 VDC	36 VDC	36 VDC

Analog inputs

Not electrically separated	
Number of inputs	3 / 0 / 4 unipolar (IG-NT(x) / IG-EE(x), IM-NT / IS-NT-BB)
Resolution	10 bits
Jumper selectable range	V, ohm, mA
Maximal resistance range	2500 Ω
Maximal voltage range	5 V
Maximal current range	0 – 20 mA
Input impedance	180 Ω for mA measuring
Input impedance	> 100 kΩ for V measuring
Resistance measurement tolerance	± 2 % ± 2 Ω out of measured value
Voltage measurement tolerance	± 1 % ± 1mV out of measured value
Current measurement tolerance	± 1 % ± 0,5mA out of measured value

D+ function

Max. D+ output current	300 mA
Guaranteed level for signal Charging OK	80% of supply voltage

Speed pick-up input

Type of sensor	magnetic pick-up
Minimum input voltage	2 Vpk-pk (from 4 Hz to 4 kHz)
Maximum input voltage	50 Veff
Minimum measured frequency	4 Hz
Maximum measured frequency	10 kHz (min. input voltage 6Vpk-pk)
Frequency measurement tolerance	0,2 %

Communication interface

RS232 interface

Maximal distance	10m
Speed	up to 57.6kBd

RS485 interface

Maximal distance	1000m
Speed	up to 57.6kBd

CAN bus interface

Galvanically separated	
Maximal CAN bus length	200m
Speed	250kBd
Nominal impedance	120Ω
Cable type	twisted pair (shielded)

Following dynamic cable parameters are important especially for maximal 200 meters CAN bus length and 32 iS-COM units connected:

Nominal Velocity of Propagation	min. 75% (max. 4,4 ns/m)
Wire crosscut	min.0,25 mm^2
Maximal attenuation (at 1 MHz)	2 dB / 100m

Recommended Industrial Automation & Process Control Cables:
BELDEN (see http://www.belden.com):
3082A DeviceBus for Allen-Bradley DeviceNet
3083A DeviceBus for Allen-Bradley DeviceNet
3086A DeviceBus for Honeywell SDS

3087A DeviceBus for Honeywell SDS
3084A DeviceBus for Allen-Bradley DeviceNet
3085A DeviceBus for Allen-Bradley DeviceNet
3105A Paired EIA Industrial RS485 cable

LAPP CABLE (see http://www.lappcable.com)
Unitronic BUS DeviceNet Trunk Cable
Unitronic BUS DeviceNet Drop Cable
Unitronic BUS CAN
Unitronic-FD BUS P CAN UL/CSA

Analog outputs

Speed governor output	± 10 V DC / 5 V PWM (500 – 3000Hz), max. 15 mA
AVRi outputs	PWM to IG-AVRi
Current output	0 – 20 mA ± 0,3mA
Voltage output	0 – 10 V DC, max. 15 mA
Max load resistance	470R at 9,4V

IG-AVRi

Power supply:	18V AC from IG-AVRi Trans/LV or IG-AVRi Trans/100
Absolutely maximum power supply range:	15 - 25 VAC or 20 - 35VDC
Inputs:	+AVR, -AVR (two wires, PWM from IG-CU)
Outputs:	OUT1, OUT2 floating (potential free) voltage source.
AVRi output voltage range:	potentiometer adjustable from +- 1V to +-10V DC.
AVRi output current:	max 15 mA.
Mechanical dimensions:	96 x 27 x 43 mm , DIN rail (35 mm) mounted

IG-AVRi Trans/LV

Primary voltage 1:	230-277 VAC
Absolute low limit:	230 VAC – 20%
Absolute high limit:	277 VAC + 20%
Primary voltage 2:	400-480 VAC
Absolute low limit:	400 VAC – 20%
Absolute high limit:	480 VAC + 20%
Frequency:	50 - 60 Hz
Secondary voltage:	18 V AC, 5 VA
Operating temperature	-30..+70°C

IG-AVRi Trans/100

Primary voltage:	100 – 120 VAC
Absolute low limit:	100 VAC – 20%
Absolute high limit:	120 VAC + 20%
Frequency:	50 - 60 Hz
Secondary voltage:	18 V AC
Operating temperature	-30..+70°C

IGS-PTM

Voltage supply	8-36V DC
Consumption	0,1A depend on supply voltage
Mechanical dimensions:	40 x 95 x 45 mm , DIN rail (35 mm) mounted
Interface to controller	CAN
Operating temperature	-30..+70°C

Binary inputs

Number of inputs	8
Input resistance	4,7 kΩ
Input range	0 - 36 VDC
Switching voltage level for close contact indication	0 - 2 V
Max voltage level for open contact indication	8-36 V

Binary open collector outputs

Number of outputs	8
Maximum current	0,5 A
Maximum switching voltage	36 VDC

Analog inputs

Not electrically separated	
Number of inputs	4
Resolution	10 bits
Maximal resistance range	0 – 250 Ω
Maximal voltage range	0 – 100 mV
Maximal current range	0 – 20 mA
Resistance measurement tolerance	1 % ± 2 Ω out of measured value
Voltage measurement tolerance	1,5 % ± 1mV out of measured value
Current measurement tolerance	2,5 % ±0,5mA out of measured value

Analog output

Not electrically separated	
Number of inputs	1
Resolution	10 bits
Output range	0 to 20 mA ± 0,33 mA

IS-AIN8

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Max. consumption	250 mA
Mechanical dimensions:	150 x 160 x 50 mm , DIN rail (35 mm) mounted
Connection to controller (galvanically separated)	CAN1
Operating temperature	-40..+70°C
Storage temperature	-40..+80°C
Protection front panel	IP 20
Humidity	95% without condensation
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)

Analog inputs

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Number of inputs	8
Not galvanic separated	
Resolution	16 bits

Each analog input can be software configured to:

		Measuring range From	to	Accuracy
Resistance		0 Ω	2400 Ω	± 0,5 %
		0 Ω	250 Ω	± 1,0 %
Current	Passive	0 / 4 mA	20 mA	± 0,5 %
	Active	4 mA	20 mA	± 0,5 %
	Active	0 mA	± 20 mA	± 0,5 %
Voltage	Thermocouples J, K, L type			± 0,2 %
		0 mV	100 mV	± 0,2 %
		- 1000 mV	+ 1000 mV	± 0,5 %
		0 mV	2500 mV	± 0,5 %

Hint:

Sensors must be isolated from the engine body (except for thermocouples (since HW version 5.0)). Follow rear sticker description and remove the appropriate jumpers in case of thermocouples not isolated from the engine body.
It's possible to connect voltage up to 10V to an analog input if an external volt box which is described on p.53 is used.

I-AOUT8

Voltage supply	8-36V DC
Consumption	0,1A depend on supply voltage
Mechanical dimensions:	40 x 95 x 45 mm , 35 mm DIN rail mounted
Interface to controller	CAN
Operating temperature	-30..+70°C
Number of analog outputs	8 (not electrically separated)
Output range	0 to 10 VDC 0 to 20 mA PWM (1200 Hz)

IS-BIN16/8

Nominal power supply	24 VDC
Power supply range	8 – 36 VDC
Max. consumption	250 mA
Mechanical dimensions:	150 x 160 x 50 mm , DIN rail (35 mm) mounted
Connection to controller (galvanically separated)	CAN1
Operating temperature	-30..+70°C
Storage temperature	-40..+80°C
Protection front panel	IP 20
Humidity	95% without condensation
Standard conformity	
Low Voltage Directive	EN 61010-1:95 +A1:97
Electromagnetic Compatibility	EN 50081-1:94 (EN 61000-6-3) EN 50081-2:96 (EN 61000-6-4) EN 50082-1:99 (EN 61000-6-1) EN 50082-2:97 (EN 61000-6-2)

Binary inputs

Galvanically separated two groups	
Number of inputs	8 + 8
Input resistance	3 kΩ
Input voltage range	0-36 VDC
Input voltage level for open contact	8 to Power supply VDC

Input voltage level for close contact	0 to 2 VDC

Voltage level is defined between Binary input and Binary input COM terminal.

Open collector outputs

Number of outputs (galvanically separated)	8
Maximum current	0,5 A
Maximum switching voltage	36 VDC

Frequency inputs

Number of inputs	2 (RPM1, RPM2)

RPM1

Type of sensor	magnetic pick-up
Minimum input voltage	2 Vpk-pk (from 4 Hz to 4 kHz)
Maximum input voltage	50 Veff
Maximum measured frequency	8 kHz (min. input voltage 6Vpk-pk), frequency mode

RPM2

Type of sensor	Contact or Active sensor
Minimal pulse width	10 ms, integration mode
Maximum measured frequency	60 Hz, integration mode

Note: RPM1, RPM2 are available from IS SW version 2.6

IGL-RA15

Power supply

Voltage supply	8-36V DC
Consumption	0,35-0,1A (+1A max horn output) Depend on supply voltage

Operating conditions

Operating temperature	-20..+70°C
Storage temperature	-30..+80°C
Protection front panel	IP65

Dimensions and weight

Dimensions	180x120x55mm
Weight	950g

Horn output

Maximum current	1 A
Maximum switching voltage	36 VDC

I-CB, I-CR

Power supply

Voltage input	8-36V DC
Consumption	0.1A depend on power supply

Operating conditions

Operating temperature	-20 ÷ +70 °C
Storage temperature	-30 ÷ +80 °C

Humidity	85% without condensation
Protection	IP20

Dimensions and weight

Dimensions	95x96x43 mm, DIN rail (35 mm) mounted
Weight	300g

CAN bus interface

Galvanic separated	
Maximal CAN bus length	200m
Speed	up to 250kBd (depends on ECU type connected)
Nominal impedance	0Ω
Cable type for iS connection	sted pair (shielded)

RS232 interface

Maximal distance	0m
Speed	p to 19.2kbps (depends on ECU type connected)

I-LB

Voltage supply	-36V DC
Consumption	,1A depend on supply voltage
Operating temperature	30..+70°C
Mechanical dimensions:	5 x 96 x 43 mm , DIN rail (35 mm) mounted
Interface to modem or PC	S232, RS422, RS485, (USB – I-LB+ version)
Interface to controller	AN

IG-IB

Voltage supply	-36V DC
Consumption	,1A depend on supply voltage
Mechanical dimensions:	5 x 96 x 43 mm , DIN rail (35 mm) mounted
Interface to controller	S232 or CAN
Interface to modem	S232
Interface to Ethernet	J45 (10baseT)
Operating temperature	30..+70°C
Storage temperature	30..+70°C

I-RBxx

Number of relays:	6 or 8 in sockets
Nominal voltage:	4 VDC
Voltage range:	6,8 – 36 VDC
Relay opens at:	0% of nominal voltage
Electric / mechanic cycles:	00 000 / 10 000 000
Operating temperature range:	40°C to 70°C
Maximal load:	6 A resistive load at 24VDC
	4 A inductive load at 24 VDC
(I-RBxx-231)	2 A at 231VAC
Contacts protection:	aristor 14DK390

IG-MTU

Primary voltage Ph-Ph	x400 VAC / 50Hz (3x480 VAC / 60 Hz)
Secondary voltage Ph-N	x 230 V AC (3x277 VAC / 60 Hz) , 5 VA
Mechanical dimensions:	5 x 95 x 60 mm , DIN rail (35 mm) mounted
Primary/secondary Phase shift	1°
Operating temperature	30..+70°C

Settings for INTELISYS NT Digital Paralleling Genset Controller.

RE: Woodcrest Interconnection Project

Name	Firmware ver.	Application	Date	App. ver.	Filename		
Woodcrest	IS-NT-AFR-2.0 R:23.05.2012	SPI	15/06/2015	2.0	Roberts SPI 06-15-2015.ANT		

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
ProcessControl	Base load	450	kW	7		0	600
ProcessControl	Base PF	1.00		7		0.60	1.20
ProcessControl	Import load	0	kW	7		-32000	32000
ProcessControl	Import PF	1.00		7		0.60	1.20
ProcessControl	Load ctrl PtM	BASELOAD		7			
ProcessControl	PF ctrl PtM	BASEPF		7			
ProcessControl	Export limit	DISABLED		7			
ProcessControl	ParallelEnable	YES		7			
ProcessControl	Synchro enable	FORWARD		7			
ProcessControl	#Neutral cont	EACH		7			

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Basic settings	Nomin power	450	kW	7		1	32000
Basic settings	Nomin current	677	A	7		1	10000
Basic settings	CT ratio prim	800	A	7		1	15000
Basic settings	CT ratio sec	/5A		7			
Basic settings	Im3/ErFlCurCTp	800	A	7		1	15000
Basic settings	Im3/ErFlCurCTs	/5A		7			
Basic settings	VT ratio	1.00	V/V	7		0.10	500.00
Basic settings	Vg InpRangeSel	277 V		7			
Basic settings	Vm VT ratio	1.00	V/V	7		0.10	500.00
Basic settings	Vm InpRangeSel	277 V		7			
Basic settings	GenNomV	277	V	7		80	34641
Basic settings	GenNomVph-ph	480	V	7		130	60000
Basic settings	MainsNomV	277	V	7		80	34641
Basic settings	MainsNomVph-ph	480	V	7		130	60000
Basic settings	Nominal freq	60	Hz	7		45	65
Basic settings	Nominal RPM	1200	RPM	7		100	4000

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Gener protect	Ishort	150	%	7	ANSI Device 50	100	500
Gener protect	Ishort del	0.00	s	7		0.00	10.00
Gener protect	2Inom del	10.0	s	7	ANSI Device 51	0.0	600.0
Gener protect	Gen >V BOC	110	%	7	ANSI Device 59	90	150
Gener protect	Gen <V BOC	90	%	7	ANSI Device 27	20	110
Gener protect	Gen >V Sd	150	%	7	ANSI Device 59	50	150
Gener protect	Gen V del	600.00	s	7		0.00	600.00
Gener protect	Gen >f	102.0	%	7	ANSI Device 81-O	98.0	150.0
Gener protect	Gen <f	98.0	%	7	ANSI Device 81-U	20.0	102.0
Gener protect	Gen f del	500.00	s	7		0.00	600.00
Gener protect	Reverse power	5	%	7	ANSI Device 32R	0	50
Gener protect	ReversePwr del	5.0	s	7		0.0	600.0
Gener protect	EarthFaultCurr	1500	A	7	ANSI Device 51N	0	10000
Gener protect	EthFltCurr del	3.0	s	7		0.0	600.0
Gener protect	Gen V unbal	10	%	7	ANSI Device 47	0	200
Gener protect	Gen V unb del	3.0	s	7		0.0	600.0
Gener protect	Gen I unbal	50	%	7	ANSI Device 46	0	200
Gener protect	Gen I unb del	3.0	s	7		0.0	600.0

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Mains protect	Mains >V MP	110	%	7	ANSI Device 59	90	150
Mains protect	Mains > V del	0.50	s	7		0.00	600.00
Mains protect	Mains <V MP	90	%	7	ANSI Device 27	50	110
Mains protect	Mains < V del	0.30	s	7		0.00	600.00
Mains protect	Mains >>V MP	120	%	7	ANSI Device 59	90	150
Mains protect	Mains >> V del	0.00	s	7		0.00	600.00
Mains protect	Mains <<V MP	80	%	7	ANSI Device 27	50	110
Mains protect	Mains << V del	0.00	s	7		0.00	600.00
Mains protect	Mains Avg>V MP	110.0	%	7	ANSI Device 59	100.0	150.0
Mains protect	Mains >f	102.0	%	7	ANSI Device 81-O	98.0	150.0
Mains protect	Mains >f Del	0.50	s	7		0.00	600.00
Mains protect	Mains <f	98.0	%	7	ANSI Device 81-U	50.0	102.0
Mains protect	Mains <f Del	0.30	s	7		0.00	600.00
Mains protect	FwRet break >U	60.0	s	7		0.0	800.0
Mains protect	FwRet break <U	60.0	s	7		0.0	800.0
Mains protect	FwRet break >f	60.0	s	7		0.0	800.0
Mains protect	FwRet break <f	60.0	s	7		0.0	800.0
Mains protect	FwRet break VS	60.0	s	7		0.0	800.0

Mains protect	AfMainsFlRun	60.0	s	7		0.0	600.0
Mains protect	VectorS prot	PARALLEL ONLY		7			
Mains protect	VectorS limit	10	°	7		1	45
Mains protect	Mains V unbal	10	%	7	ANSI Device 47	0	200
Mains protect	Mains Vunb del	1.0	s	7		0.0	600.0

Group	Name	Value	Dimension	Password	Description	Low limit	High limit
Sync/Load ctrl	Voltage window	10.0	%	7	ANSI Device 25 voltage match	0.0	100.0
Sync/Load ctrl	GtoM AngleReq	0	°	7	angle compensation for delta config.	-45	45
Sync/Load ctrl	Phase window	10	°	7	ANSI Device 25 angle match	0	90
Sync/Load ctrl	Dwell time	0.3	s	7	ANSI Device 25	0.0	25.0
Sync/Load ctrl	Load ramp	180	s	7		0	240
Sync/Load ctrl	Load gain	10.0	%	7		0.0	200.0
Sync/Load ctrl	Load int	50	%	7		0	100
Sync/Load ctrl	RampStartLevel	2	%	7		0	100
Sync/Load ctrl	GCB open level	10	%	7		0	100
Sync/Load ctrl	GCB open del	240	s	7		180	1800
Sync/Load ctrl	Sync timeout	NO TIMEOUT	s	7		1	1800; NO TIMEOUT
Sync/Load ctrl	Sync attempts	OFF		7		1	9; OFF

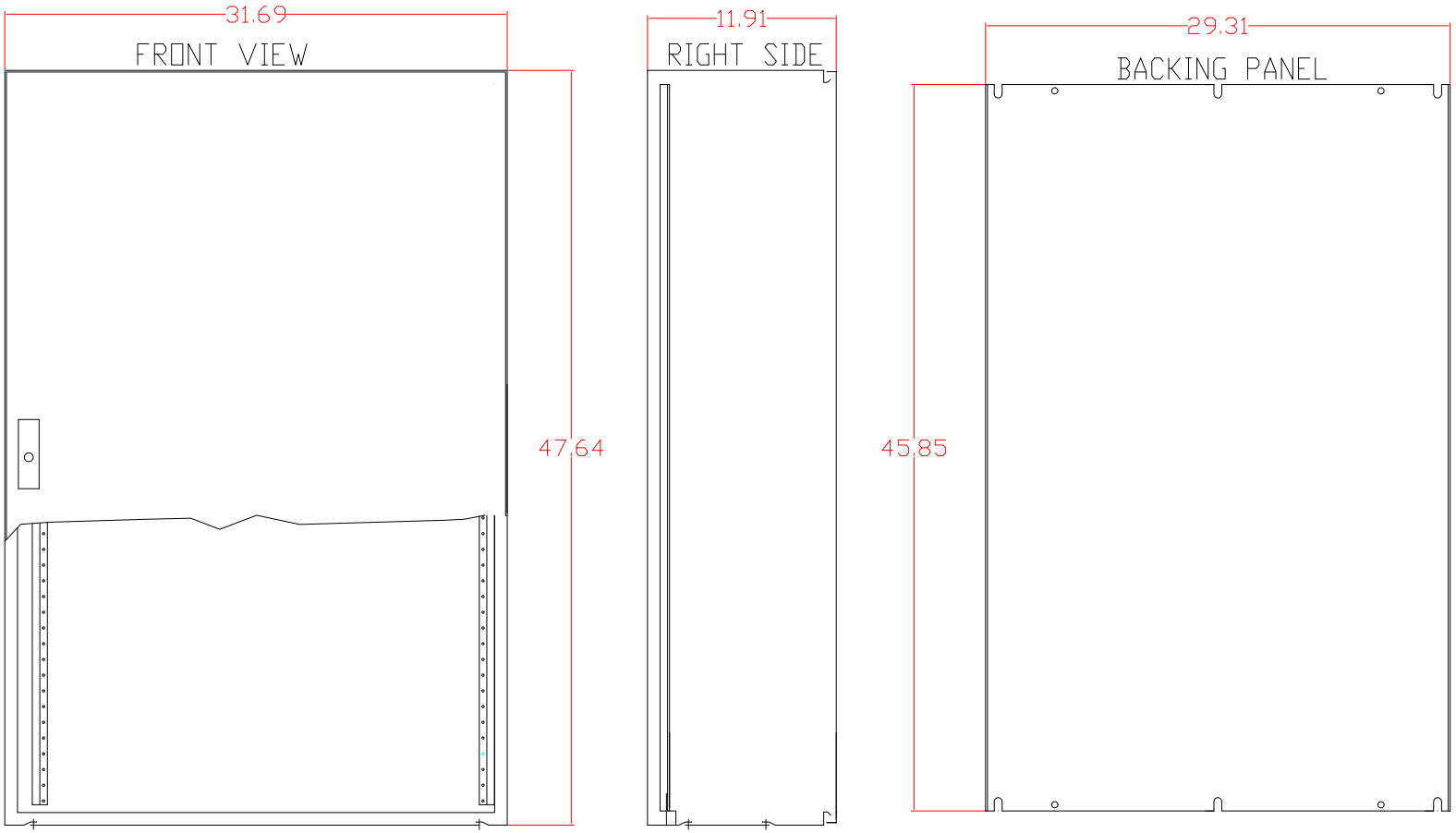
Section VI

Control Panel and Breaker Panel

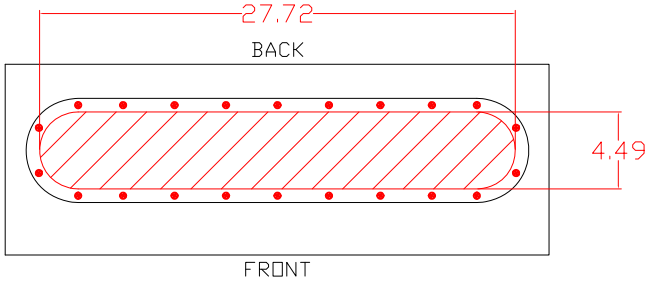
INDEX


InteliSys
STOP
THIS EQUIPMENT IS SUPPLIED BY MORE THAN ONE POWER SOURCE
WARNING
GEN-TEC LLC

Engine Control Panel



BOTTOM CONDUIT ENTRY AREA



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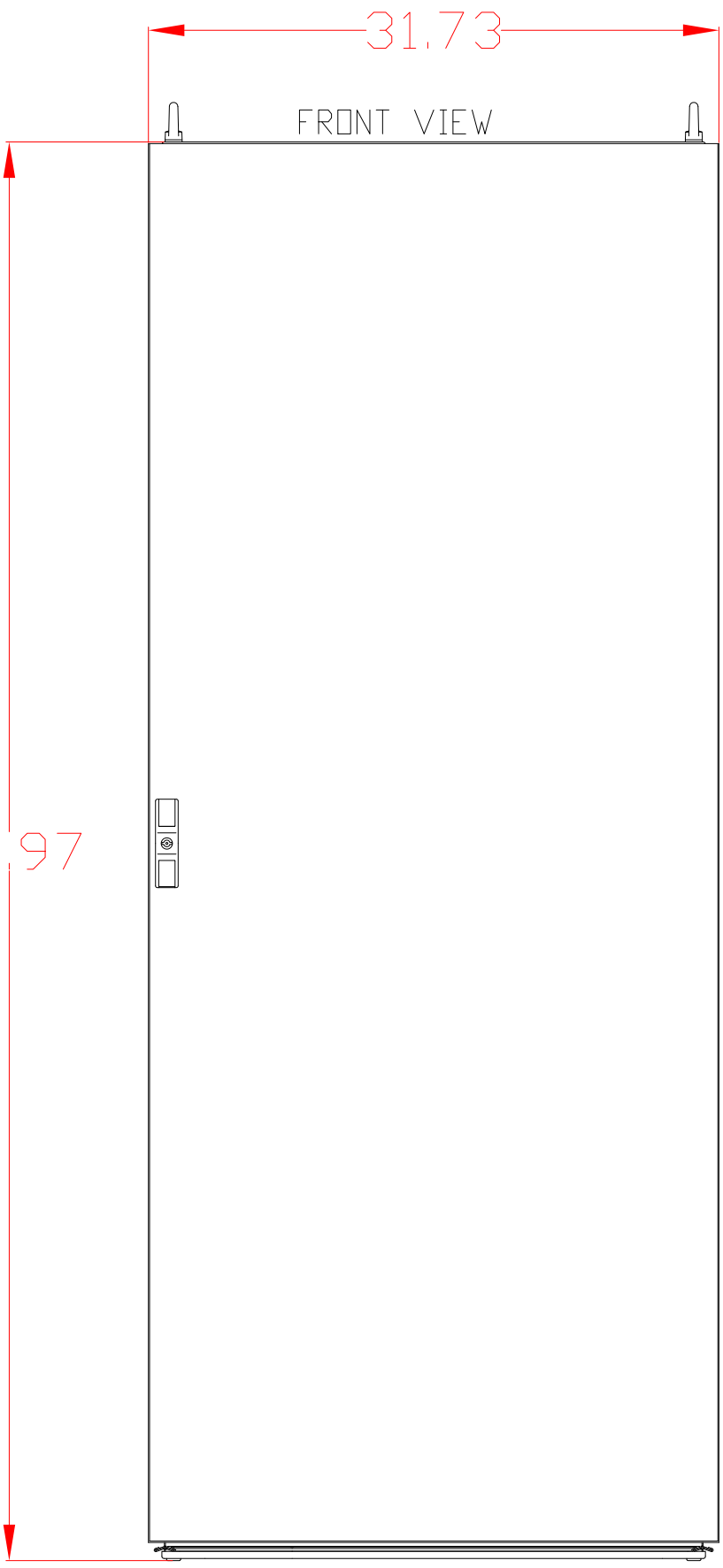
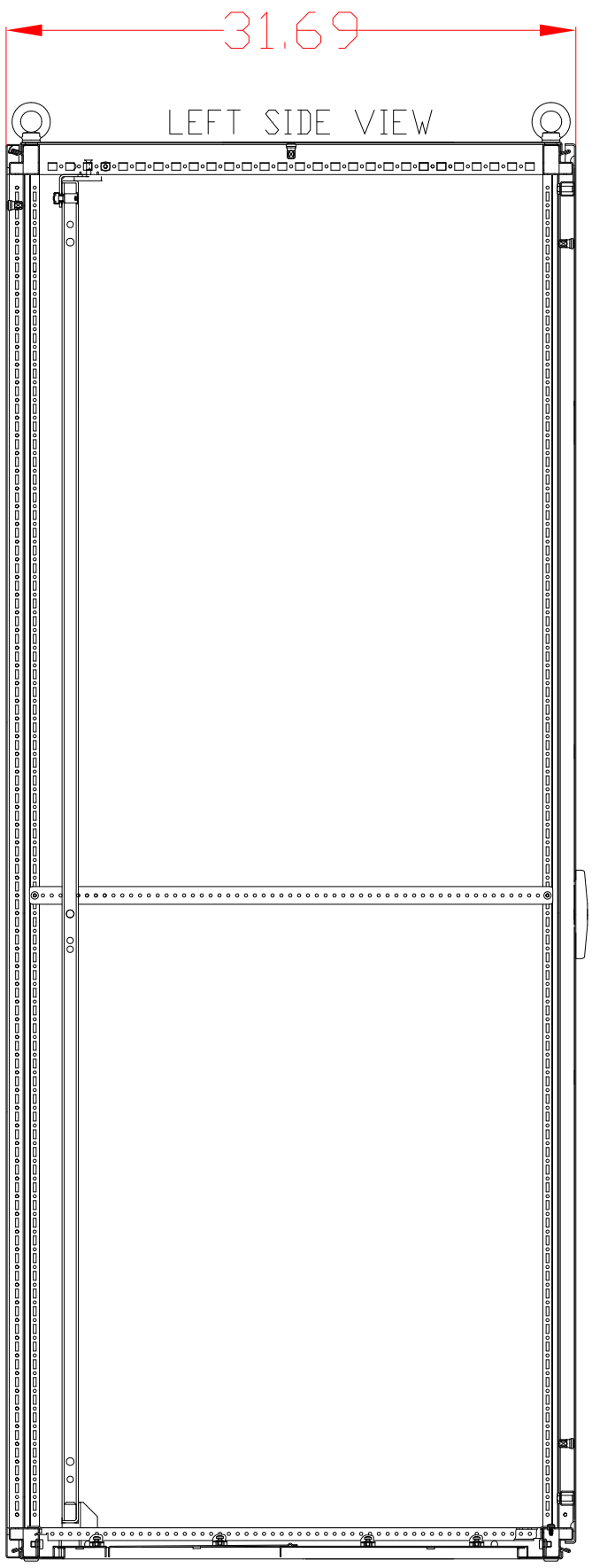
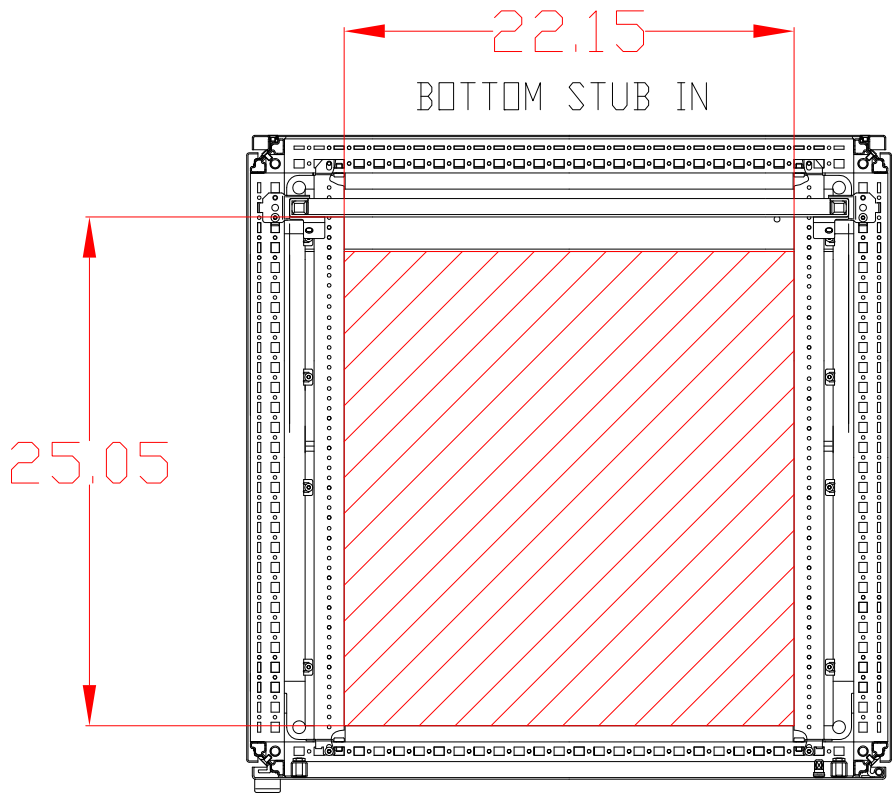
Breaker Panel
M-3410A
INTERTIE / GENERATOR
PROTECTION
STOP
THIS EQUIPMENT IS SUPPLIED BY MORE THAN ONE POWER SOURCE
WARNING
WARNING
ARC FLASH AND SHOCK HAZARD
GEN-TEC LLC
DANGER
HIGH VOLTAGE

Breaker Panel







Section VII

Description of Operation

INDEX

Project Name:

Woodcrest Farm

Ogdensburg, NY

Document type:

Description of Equipment and Operation for Proposed New Interconnected Biogas Generation System.

Job ID#: 106WCF

I. Applications.

A.	Parallel Export Operation.
B.	
C.	

II. Notes.

1. Utility Status = Available (means all breakers and switches are closed so that utility power is available at the utility side of 52G1.)

2. The Equipment may only be operated by qualified professionals who have been adequately trained and authorized.

III. System Components.

52G	Breaker to connect G1 to the Load Bus.
52G1	Electrically Operated Generator Intertie Breaker. (also GCB)
52M	Manually Operated Mains Breaker.
CP	ComAp Intelisys NT Digital Paralleling Control Panel.
DS-1	600A manually operated Disconnect Switch(s)
G1	Bio-gas Fueled Generator.
PR1	M3410A Beckwith Utility Protection Relay.

IV. Operation Scenarios.

1. **Normal Parallel Operation**: (Use drawing E200)

A. To start G1 and begin Normal Parallel Operation the System Status must be according to Table 1, (see Note 1)

Table 1.

Utility Status	PR1	52G1	G1
Available	No Active Trip	Open	Off

B. The Operator initiates G1 operation by selecting “Auto” operation either by remote dial in or via the HMI screen on the CP. (see Note 2)

C. G1 Cranks > Starts > Ramps up to Operating Speed > Stabilizes > Ready for Load. (Table 2)

Table 2.

Utility Status	PR1	52G1	G1
Available	No Active Trip	Open	On

D. When G1 = Ready for Load: CP > Starts Sync Operation > Attains Sync Parameters > Close 52G1, supervised by PR1. (Table 3)

E. When G1 is on-line the CP increases the output according to a programmable ramp until the load target setpoint is attained. The load target setpoint can be adjusted via an external analog input.

Table 3.

Utility Status	PR1	52G1	G1
Available	No Active Trip	Closed	On

F. For a normal shutdown the Operator can select “Stop” operation either by remote dial in or via the HMI screen on the CP.

G. The CP will > Ramp down G1 Output to near 0. > OPEN 52G1 > G1 cool down cycle > Shut down.

H. System status returns to Table #1.

I. G1 can be re-started by performing steps IV.1.B-D.

2. **Generator Fault Types**:

A. There are 3 different types of possible faults. When any type II or Type III fault is cleared it is followed by a 5 minute Time Delay before 52G1 can be re-closed. This is to ensure a minimum of 5 minutes between any re-closure attempts per IEEE-1547.

I. Warning Fault. Audio / Visual **W**arning Alarms. (Figure 4)

II. BOC Fault: Audio / Visual Alarms, Immediate **B**reaker **O**pen and subsequent Engine **C**ool Down. (Figure 5)

III. SD Fault: Audio / Visual Alarms, Immediate Breaker Open and immediate Engine **S**hut **D**own. (Figure 6)

Figure 4.

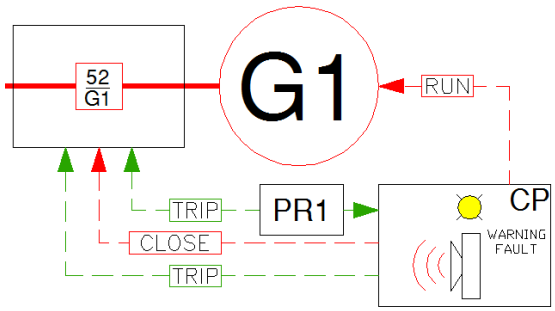


Figure 5.

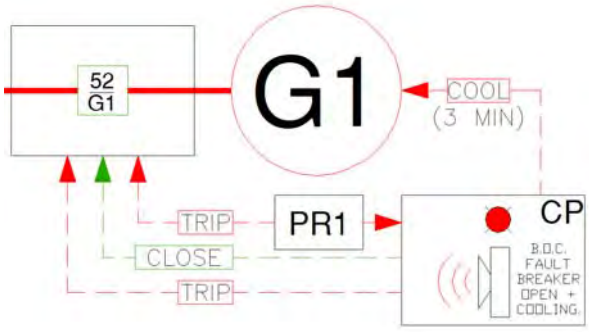
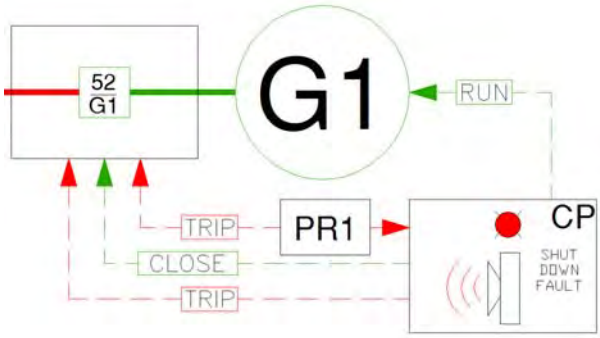


Figure 6.



3. **Utility System Fault or Disturbance During Parallel Operation**:

A. If the voltage, frequency, or current deviate from the parameters programmed in PR1 a trip signal will be issued by PR1. To trip, PR1 activates output O01 which OPENS contacts 1&2. (DWG# E400.1)

B. The result of a trip signal by PR1 is a break in the supply voltage of the Undervoltage Trip Coil, (TC) When TC is de-energized for any reason 52G1 will trip. This is an inherent safety feature since a sudden loss of control power will trip the breaker and therefore isolate the generation facility from the mains. (DWG# E400.1)

C. PR1 self-test contacts 6&7 are also wired in series to the trip circuit for an added measure of redundant protection. If the PR1 processor fails for any reason it will cause a trip. (DWG# E400.1)

D. Any trip signal from PR1 or from the external trip input that operates relay K7 will result in a breaker trip and G1 shut down. (DWG# E400.1) See Table 4.

E. After Utility Status returns to normal the Operator must reset the fault either by remote dial in or via the HMI screen on the CP. The CP will allow G1 to restart, after a minimum of 5 minutes of normal Utility Status, and the system will operate according to **IV. 1. Normal Start and Parallel Operation**:

Table 4.

Utility Status	PR1	52G1	G1
Available	No Active Trip	Open	Off

Section VIII

Energization Plan

INDEX

Woodcrest Farm Interconnection Project

Job ID#: 0136546 6-16-2015

I. Applicable Drawings.

NOTE: This document references the job drawings listed below and may reference components listed in the legend of a specified drawing which are not listed in the component list in Item III. It is important to use the drawings in conjunction with this document to gain a thorough understanding of the intended operation.

Drawing #	Description	Revision #	Revision Date
E100	Master Legend		6-16-15
E200	1-Line Drawing		6-16-15
E201	1-Line Drawing for Loads		6-16-15
E400.1	Breaker Control Drawing		6-16-15

II. System Components.

52G	Breaker to connect G1 to the Load Bus.
52G1	Electrically Operated Generator Intertie Breaker. (also GCB)
52M	Manually Operated Mains Breaker.
CP	ComAp Intelisys NT Digital Paralleling Control Panel.
DS-1	600A manually operated Disconnect Switch(s)
G1	Bio-gas Fueled Generator.
PR1	M3410A Beckwith Utility Protection Relay.

III. Energizing Sequence.

1. **Utility System Energization** : (Use DWG# E200 unless otherwise noted)

NOTE 1: The following steps assume that the applicable building electrical inspections have been performed by the AHJ (Authority Having Jurisdiction) , the equipment is grounded and all ungrounded conductors have been tested and confirmed to be ungrounded and have expected continuity. (No phases switched and no unexpected grounding.)

NOTE 2: The following steps assume that no part of the system has been energized. If the Main Service Panel has already been energized, begin at Item 2.F.

NOTE: 3: The following steps to be performed only by trained, qualified personnel, authorized by the entity listed at the beginning of each item. (PEC = Project Electrical Contractor. / MEG = Martin Energy Group. / UP = Utility Personnel.)

A. PEC - Confirm 52M (800 Amp) is OPEN. Confirmed_____

B. PEC - Confirm that all branch breakers in the 800 Amp Service Entrance Panel are OPEN. (E201) Confirmed_____

C. PEC - Confirm DS-1 is OPEN. Confirmed_____

D. MEG - confirm 52G1 is open and the close circuit is disabled by the jumper being removed at Engine Control Panel terminals TB1-42&43. (E400.1) Confirmed_____

E. MEG - confirm G1 is disabled (E-stop ON). Confirmed_____

F. UP - CLOSE “LINE PROTECTION” Equipment. Confirmed_____

G. UP - confirm expected voltage and frequency at the secondary taps of T1. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____ Phase Sequence: A-B-C_____ A-C-B_____

NOTES:

2. **Woodcrest Farm System**: (Use DWG# E200 unless otherwise noted)

A. PEC - Confirm expected voltage and frequency at the primary connections of the Service Entrance Panel. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____ Phase Sequence: A-B-C_____ A-C-B_____

B. PEC - Confirm Phase Sequence (Rotation) is correct for site equipment. Confirmed_____ CW_____ CCW_____

C. PEC - CLOSE 52M. Confirmed_____

D. PEC - Confirm expected voltage and frequency on the bus of the Service Entrance Panel. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____

E. PEC - CLOSE the remaining load breakers. After closing each breaker, and before closing another breaker, confirm the correct operation of all loads connected to the individual circuit. Breakers in the Service Entrance Panel are CLOSED and Loads operating correctly. Confirmed_____

List Exceptions (if any):

F. PEC - confirm expected voltage and frequency at the primary connections of DS-1. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____ Phase Sequence: A-B-C_____ A-C-B_____

G. PEC - CLOSE DS-1. Confirmed_____

NOTES:

3. Biogas Generator G1 System :

A. MEG - confirm expected voltage and frequency at the primary connections of 52G1. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____ Phase Sequence: A-B-C_____ A-C-B_____

B. MEG - Start G1in Manual Mode (52G1 is still OPEN) and confirm expected voltage and frequency at the secondary connections of 52G1. Confirmed_____

Voltage A-B_____ B-C_____ C-A_____ (Secondary Values) Frequency_____ Phase Sequence: A-B-C_____ A-C-B_____

C. MEG - monitor the sync scope on the HMI of the Intelisys NT controller and the sync scope in the software of PR1. Confirm, using a meter, that there is very low voltage potential between the primary and secondary terminals of 52G1 (all three phases) when the Intelisys NT controller and the PR1 protection relay show a synchronous condition. Confirmed_____

D. MEG - (with G1 not running) re-install the wire jumper in the 52G1 CLOSE circuit at Engine Control Panel terminals TB1-42&43. (E400. Confirmed_____

E. MEG - (with G1 not running) install a wire jumper in the 52G1 CLOSE circuit at 52G1 Panel terminals TB8-5&6. (E400. Confirmed_____

F. At this point the system is energized and ready for the **Witness Test Procedure for the Woodcrest Farm Interconnection Project**.

End of Energization Procedure.

NOTES:

Section IX

Test Procedures

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Woodcrest Farm Biogas Interconnection Project

Gen-Tec LLC Job ID#: 0136546

Test #	Description	Check box
1.	Relay Test. (by authorized testing firm) The relay testing firm will provide the relay test procedure and report form.	
2.	Current Transformer Test. (by authorized testing firm, same as relay tester) The relay testing firm will provide the CT test procedure and report form.	
3.	Potential Transformer Test. (if applicable) (by authorized testing firm, same as relay tester) The relay testing firm will provide the PT test procedure and report form.	
4.	Inspection by Authority Having Jurisdiction. (AHJ)	
5.	Energization Plan.	
6.	Commissioning Checklist.	
7.	Witness / Final Commissioning Test. The inserted document is only a MEG commissioning test sheet. The relay testing firm will provide the actual witness test procedures and report forms, which will be the same as the relay, CT, and PT tests above. PTs may not be applicable.	

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On-Site Commissioning Checklist.

PARALLELING SWITCHGEAR

SWITCHGEAR MODEL NUMBER/DESCRIPTION _____ IN SERVICE DATE_____
SERIAL NUMBER _____
CUSTOMER _____ JOB REF. No.:_____
TECHNICIAN NAME_____
TECHNICIAN SIGNATURE_____
YOUR INITIALS = OK NA = NOT APPLICABLE

PHYSICAL INSTALLATION

___ Proper clearances for service/maintenance access __Front, __Sides, __Rear
___ Switchgear equipped with correct enclosure for adequate protection from elements of weather. Enclosure is _____type. (Nema 3R for outdoor,etc.)
___ Doors and latches operated properly.
___ Client has key(s) for door latches.

ELECTRICAL POWER INSTALLATION

___ Overcurrent and short-circuit protection between mains and switchgear.
Ampere Frame: _____, Trip setting/Fuse rating (amp)_____,
Poles:____, Type: _____
___ Power cables, proper cabinet entry method, insulation protected against damage at point of entry and all areas inside switchgear.
___ Adequate clearance on terminations/bare conductors.
___ Power cables, adequate rating for generator capacity. Generator Nameplate Capacity kW_____
___ Power cables, phase sequences are same for each genset
___ Power cables, connections are tight and secure
___ Breaker covers, shields, lug shields are in place.

ELECTRICAL CONTROL WIRES INSTALLATION

___ Proper cabinet entry method, insulation protected against damage at point of entry and all areas inside switchgear.
___ Interconnection completed; (genset to controls and terminal board interconnects as shown on the drawings). Photos of these terminations are requested.

OPERATING CHECKS

___ Phase rotation, Checked genset and utility.
___ Run unit in Manual and confirm synchronizing and voltage matching using 2 analog voltmeters.
___ Parallel generator set, record operating data at intervals.
___ Test import/export control if required.
___ Simulate Utility failure to “utility monitor relay”.
___ Utility witnessed test, approved, verbal or written.

COMMENTS _____
_____

SIGNED_____/_____ SIGNED_____/_____
Gen-Tec llc *Date* *Client* *Date*

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Woodcrest Farm Interconnection Project

MEG Job ID#: 0136546

I. Application.

A. Parallel Export Operation.

II. Reference Materials.

Item	Abr. / #	Description	Version / Revision
1.	IM	Beckwith M-3410A Instruction Manual	http://www.beckwithelectric.com/products/m-3410a.html
2.	E200	1-line Drawing	
3.	E201	1-line Drawing for Loads	
4.	E310.1	3-line Drawing, Voltage Sensing	
5.	E311.1	3-line Drawing, Current Sensing	
6.	E400.1	Breaker Control Drawing	

III. System Components.

52G	Breaker to connect G1 to the Load Bus.
52G1	Electrically Operated Generator Intertie Breaker. (also GCB)
52M	Manually Operated Mains Breaker.
CP	ComAp Intelisys NT Digital Paralleling Control Panel.
DS-1	600A manually operated Disconnect Switch(s)
G1	Bio-gas Fueled Generator.
PR1	M3410A Beckwith Utility Protection Relay.

IV. Notes.

Note 1: All the non-operating checkpoints of the Commissioning Checklist must be confirmed and documented before proceeding with the commissioning test procedures.

Note 2: The Energization Plan must be confirmed and documented before proceeding with the commissioning test procedures.

Note 3: The applicable Protection Relay settings will need tested and documented by an approved 3rd party using a test set, and following the Relay Test Procedures provided by the relay manufacturer.

Note 4: The parallel tests need to be done in conjunction with Witness Testing by the hosting utility, or after permission to operate in parallel.

V. Generator Operation Tests.

Test 1:	**Test Purpose**	Comments	
	Confirm start function of G1.		
	Application		
	Initiate G1 operation by selecting “Auto” operation either by remote dial in or via the HMI screen on the CP.		
	Result	Pass	Fail
	G1 starts and operates in Auto mode.		

Test 2:	**Test Purpose**	Comments	
	Confirm CP acknowledgement of G1run status.		
	Application		
	When the generator is running the GCB Enable output (O10) is energized by the CP. This does not close the breaker but only closes a contact (K10, 11-14) in the series trip circuit that will allow 24 Vdc to energize the under voltage Trip Coil (TC, De-energize to trip) if no other device in the series circuit is declaring a fault. (DWG# E400.1)		
	Result	Pass	Fail
	CP output O10 activates, K10 relay energizes and Trip coil is energized when G1 attains “running” status		

Test 3:	**Test Purpose**	Comments	
	Confirm CP voltage and frequency control of G1.		
	Application		
	Connect a Volt Meter, preferably an analog type, across the open terminals of phase A on 52G1. After the starting functions are successfully completed the CP will initiate a sync hunt where the frequency and voltage are driven into synchronism with the mains. When the CP shows a synchronized condition, confirm that there is < 20 Vac voltage potential across the open terminals of phase A on 52G1. Repeat the process for Phase B and Phase C.		
	Result	Pass	Fail
	CP brings G1 into Synchronism with the Mains. There is < 20 Vac potential across any terminals of 52G1 when the CP declares a synchronized condition.		

Test 4:	**Test Purpose**	Comments	
	Close 52G1 in synchronism, supervised by PR1. (Also see DTT section)		
	Application		
	When Synchronism is attained the CP energizes its output #3 (O03) When O03 is ON it operates the relay K3. K3 11-14 contacts are closed resulting in a command to close 52-G1. This signal is supervised by Output #2 (sync check terminals 3-4) of PR1. (DWG# E400.1)		
	Result	Pass	Fail
	CP brings G1 into Synchronism with the Mains. There is < 20 Vac potential across any terminals of 52G1 when the CP declares a synchronized condition.		

Test 5:	**Test Purpose**				Comments	
	Confirm proper parallel operation of G1.					
	Application					
	When 52G1 is closed the CP will control the genset output to ascend a programmable load “ramp”. The upper limit of the ramp is the nominal output capacity of the genset as noted on DWG# E200. (450 kW)					
	Result				Pass	Fail
	The CP drives G1 loading according to CP load ramp parameters.					
	Load Ramp Parameters:	Max kW	_____	= 100%	Ramp Time	_____

Test 6:	**Test Purpose**	Comments	
	Confirm proper parallel operation of G1.		
	Application		
	When 52G1 is closed the CP will control the genset output to ascend a programmable load “ramp”. The upper limit of the ramp is the nominal output capacity of the genset as noted on DWG# E200. (450 kW)		
	Result	Pass	Fail
	The CP drives G1 loading according to CP load ramp parameters.		

Notes:

VI. Simulated Utility Fault Test.

Test 1:	**Test Purpose**	Comments	
	Demonstrate that a Trip signal from PR1 trips 52G1.		
	Application		
	While G1 is operating in parallel, simulate a voltage or frequency deviation by interrupting the sensing of any of the 3 phases. This can be done at the test switches. If the voltage, frequency, or current deviate from the parameters programmed in PR1 a trip signal (O01 terminals 1-2) will be issued by PR1. (DWG# E310.1 and E400.1)		
	Result	Pass	Fail
	When PR1 Trip Output was activated 52G1tripped.		
	Note: The result of any trip signal by PR1 is a break in the supply voltage of the Undervoltage Trip Coil, (TC) When TC is de-energized for any reason it will trip the breaker 52G1. (DWG# E400.1)		

Test 2:	**Test Purpose**	Comments	
	Demonstrate that PR1 self-test contacts TRIP 52G1.		
	Application		
	PR1 self-test contacts (terminals 6-7) are wired in series to the trip circuit for an added measure of redundant protection. If the PR1 processor fails for any reason it will cause a trip. (DWG# E400.1) While operating in parallel, open the circuit at Test Switch 1, blade H.		
	Result	Pass	Fail
	When Test Switch 1 blade H is opened 52G1 trips immediately and a Utility Relay fault is declared in the CP.		

Test 3:	**Test Purpose**	Comments	
	Demonstrate that the external TRIP input TRIPS 52G1.		
	Application		
	Any trip signal from the external trip input that operates relay K7 (terminals 11-12) will result in a breaker trip and G1 shut down. (DWG# GTAC106119-BC) Apply a jumper at terminals TB3-11&12 during G1 parallel operation to simulate an external TRIP input.		
	Result	Pass	Fail
	Terminals TB3-10&11 were closed during G1 parallel operation and 52G1 tripped immediately and an external trip fault was declared in the CP.		

Test 4:	**Test Purpose**	Comments	
	Demonstrate that the Genset cannot be started with an active PR1 fault.		
	Application		
	Apply a START command while PR1 has an active fault.		
	Result	Pass	Fail
	A Start command was applied while a PR1 shutdown fault was active and G1 did not start.		

Test 5:	**Test Purpose**	Comments	
	Demonstrate that the genset cannot be started for a minimum of 5 minutes after utility parameters return to normal.		
	Application		
	Activate a PR1 fault. De-activate the PR1 fault and apply a START command.		
	Result	Pass	Fail
	Start command was applied during the 5 minute interim after utility parameters were returned to normal. G1 does not start until the 5 minutes have elapsed.		

Notes:

Date:___/___/_____

Commissioning Technician Signature: **X**_____

Utility Representative Signature: **X**_____

Notes:

Section X

System Electrical Schematic Diagrams

INDEX

E100

DEVICE LEGEND

16/8	DIGITAL I/O MODULE
52G1	GENERATOR PARALLELING BREAKER
86	MANUAL RESET LOCKOUT RELAY
ABC	AUTOMATIC BATTERY CHARGER
AFR	AIR FUEL RATIO CONTROLLER
AO8	8 ANALOG OUTPUTS
BH	BLOCK HEATER
BHC	BLOCK HEATER CONTACTOR
BPS	BLOCK HEATER PUMP STARTER
CC	CLOSE COIL
EK1	LP / NG FUEL SOLENOID VALVE
EK2	START SOLENOID
EK3	BIO-GAS FUEL SOLENOID VALVE
EK4	LUBE PUMP SOLENOID
ES	EMERGENCY STOP SWITCH
ES10	HIGH INTAKE VACUUM WARNING
ES11	LOW OIL PRESSURE SHUTDOWN
ES12	HIGH OIL PRESSURE SHUTDOWN
ES13	HIGH WATER TEMPERATURE SHUTDOWN
ES14	LOW WATER FLOW SHUTDOWN
ES15	LOW WATER LEVEL SHUTDOWN
ES16	HIGH AFTER COOLER TEMPERATURE SHUTDOWN
ES17	HIGH OIL TEMPERATURE SHUTDOWN
ES18	LOW GAS PRESSURE SHUTDOWN
ES19	HIGH GAS PRESSURE SHUTDOWN
ES20	LOW ENGINE WATER PRESSURE
ES21	LOW AFTER COOLER CIRCUIT WATER PRESSURE
F1-20	FUSE, BLADE TYPE IN CONTROL CABINET
GA	GOVERNOR ACTUATOR
GC	GOVERNOR CONTROLLER
GF1-6	BLADE TYPE FUSES ON GENSET
GF7	BATTRY NEG. FUSE ON GENSET
GFV	GENERATOR FIELD VOLTAGE SENSOR
GPR	GENERATOR PROTECTION RELAY
IM	IGNITION MODULE
IS BB	INTELISYS NT GENSET CONTROL
IS DS	INTELISYS NT DISPLAY SCREEN
K1	START RELAY
K2	IGNITION RELAY
K3	CLOSE GCB RELAY
K4	LP GAS RELAY
K5	BIO-GAS RELAY
K6	EXTENDED IGNITION RELAY
K7	EXTERNAL TRIP RELAY
K8	GCB CLOSED RELAY
K9	MCB OPEN (TRIP BYPASS) RELAY
K10	READY FOR LOAD RELAY
K11	LUBE PUMP RELAY
K12	CLOSE MCB RELAY
K13	OK TO CLOSE GCB RELAY
K31	ALARM HORN RELAY
K32	SPARE
K33	IDLE RELAY
K34	SPARE
K35	EGS-02 RESET RELAY
K36	UTILITY PROTECTION TRIP RELAY
K37	SYNC SIGNAL RELAY
K38	HELLENDS FAULT
K39	HELLENDS ALARM
K40	BLOCK HEATER RELAY
K44	SWITCH AUX 1 RELAY
K45	SWITCH AUX 2 RELAY
K51	WARNING STROBE LIGHT
K52	VENT LOUVER
K71-75	RAD FAN RELAY
LPM	LUBE PUMP MOTOR
LPR	LUBE PUMP RELAY
LPS	LUBE PUMP STARTER
LS1-4	INTERNAL BREAKER LIMIT SWITCHES
MAP	MANIFOLD AIR PRESSURE SENSOR
MAT	MANIFOLD AIR TEMPERATURE SENSOR
MDS	MANUAL DISCONNECT SWITCH
MMS	MANUAL MOTOR STARTER/PROTECTOR
MPR	MAINS PROTECTION RELAY
MS	MOTOR STARTER
OC	OPEN COIL
OH	OIL HEATER
OHR	OIL HEATER RELAY
P1-5	PIN & SLEEVE CONNECTORS
PR3	BASLER BE1-59N GROUND OVERVOLTAGE REL.
RES	REMOTE EMERGENCY STOP
RTB	RAD TERMINAL BLOCK
SDS	SERVICE DISCONNECT SWITCH
TB1	GENSET & BREAKER INTERFACE
TB2	DC POWER DISTRIBUTION
TB3	UTILITY RELAY INTERFACE
TB4	BREAKER PANEL TERMINAL STRIP
TC	TRIP COIL
THC	THERMAL CONTACT
TS1-2	TEST SWITCH #1 & #2
VFD	VARIABLE FREQ DRIVE
WPR	WATER PUMP STARTER
WPS	WATER PUMP STARTER

INTELISYS INPUTS / OUTPUTS

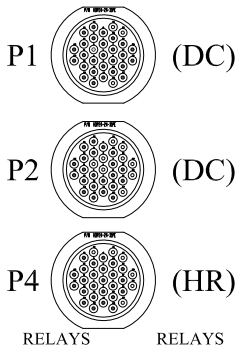
I01	GCB FEEDBACK INPUT
I02	MCB FEEDBACK INPUT
I03	GCB TRIPPED INPUT
I04	EMERGENCY STOP INPUT
I05	REMOTE START/STOP
I06	UTILITY RELAY TRIP INPUT
I07	OK TO CLOSE GCB INPUT
I08	EXTERNAL TRIP
I09	DTT TRIP
I10	HIGH INTAKE VACUUM SHUTDOWN INPUT
I11	LOW OIL PRESSURE SHUTDOWN INPUT
I12	HIGH OIL TEMP/ HI OIL PRESSURE
I13	HIGH WATER TEMP. SHUTDOWN INPUT
I14	LOW OIL LEVEL SHUTDOWN INPUT
I15	LOW COOLANT LEVEL SHUTDOWN INPUT
I16	HIGH INTAKE TEMP. SHUTDOWN INPUT
O01	START OUTPUT
O02	IGNITION OUTPUT
O03	CLOSE GCB OUTPUT
O04	LP GAS OUTPUT
O05	BIO-GAS OUTPUT
O06	ALARM HORN OUTPUT
O07	LUBE PUMP OUTPUT
O08	IDLE OUTPUT
O09	EXTENDED IGNITION OUTPUT
O10	READY FOR LOAD OUTPUT
O11	START VFD OUTPUT
O12	SPARE OUTPUT
O13	EGS-02 RESET OUTPUT
O14	TURN ON BLOCK HEATER
O15	SPARE OUTPUT (NOT USED)
O16	CLOSE MCB OUTPUT (OPTIONAL)

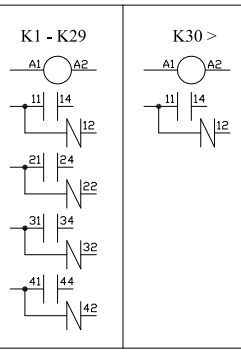
INTERFACE TERMINAL BOARD

TB1

1	BATTERY POS. OUTPUT
2	BATTERY NEG. OUTPUT
3	BATTERY NEG. TO CH4 MONITOR
4	CH4 VALUE SIGNAL
5	BATTERY POS. TO CH4 MONITOR
6	BATTERY POS. TO DIGESTER PRES. SENSOR
7	4-20 mA INPUT FROM DIGESTER PRES. SENSOR
8	CANBUS COMMON
9	CANBUS HIGH
10	CANBUS LOW
11	CANBUS SHIELD
12	ANA. OUT SIG. SPARE (4-20 mA)
13	ANA. OUT COM. SPARE
14	ANA. SHIELD
15	START (SPARE) VFD (DRY CONTACT OUTPUT)
16	
17	SPARE ANALOG INPUT
18	SPARE ANALOG INPUT COM
19	ANA. OUT SIG. TO GAS BLOWER (4-20 mA)
20	ANA. OUT COM. TO GAS BLOWER
21	ANA. IN SIG. FROM GAS BLOWER VFD (4-20 mA)
22	ANA. IN COM. FROM GAS BLOWER VFD
23	REMOTE START (DRY CONTACT INPUT)
24	
25	START GAS BLOWER VFD (DRY CONTACT OUTPUT)
26	
27	SPARE
28	CLOSE SIGNAL TO BREAKER
29	OPEN SIGNAL TO BREAKER
30	BATTERY POS. TO BREAKER
31	BATTERY NEG. TO BREAKER
32	UNDERVOLTAGE SIGNAL TO BREAKER
33	BREAKER CLOSED SIGNAL FROM BREAKER
34	BREAKER TRIPPED SIGNAL FROM BREAKER
35	MCB FEEDBACK DRY CONTACT
36	
37	CAN 2 COMMON
38	CAN 2 HIGH
39	CAN 2 LOW
40	CAN 2 SHIELD
41	SPARE
42	EXTERNAL INHIBIT CLOSE CONTACT
43	
44	REMOTE E-STOP INPUT
45	
46	SPARE DRY CONTACT (OUTPUT)
47	
48	SPARE
49	SPARE
50	SPARE
51	BATTERY POS. TO RAD CONTROL BOX
52	BATTERY NEG. TO RAD CONTROL BOX
53	CANBUS COMMON
54	CANBUS H
55	CANBUS L
56	CANBUS SHEIELD
57	SPARE ANALOG OUT SIGNAL
58	SPARE ANALOG OUT COMMON
59	SPARE ANALOG OUT SHIELD
60	SPARE ANALOG IN SIGNAL
61	SPARE ANALOG IN COMMON
62	SPARE ANALOG IN SHIELD
63	ENMET SIGNAL COMMON
64	HIGH CH4 LEVEL WARNING FROM ENMET
65	HIGH CH4 LEVEL SHUTDOWN FROM ENMET
66	24V POS. TO ROOM TEMP SENSOR
67	4-20mA SIGNAL FROM ROOM TEMP SENSOR
68	SPARE
69	SPARE
70	SPARE

CONTROL PANEL PLUGS





DRAWING LEGEND

E100	LEGEND, MASTER
E200	1-LINE DRAWINGS
E300	3-LINE INTERCONNECTION DRAWINGS
L300	3-LINE PLANT LOAD DRAWINGS
E400	DC CONTROL DRAWINGS
E420	CONTROL DRAWING, GENERATOR EXCITATION

LOCATION CODE

TB1 54 C

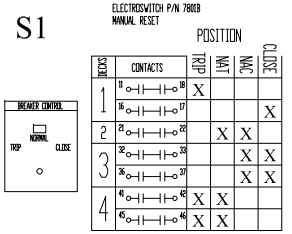
- A - AC DISTRIBUTION CUBICLE
- B - BREAKER CUBICLE
- C - CONTROL CUBICLE
- E - CONNECTIONS MADE IN ENCLOSURE IF APPLICABLE
- G - ENGINE/GENERATOR MOUNTED
- H - HEAT RECOVERY SKID
- O - OUTSIDE CONNECTIONS MADE ON SITE
- R - RADIATOR
- S - GAS / HOT WATER SKID
- --------INTERCONNECT WIRING

SYMBOLS

- PIN & SLEEVE CONNECTOR
- TB1 - MAIN TERMINAL BOARD
- TB2 - POSITIVE DC POWER DISTRIBUTION TERMINAL
- TB2 - NEGATIVE DC POWER DISTRIBUTION TERMINAL
- DEVICE TERMINAL
- PTB - TERMINAL BLOCK IN CONTROL CUBICLE

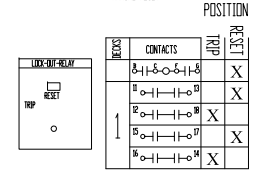
S1 BREAKER CONTROL SWITCH

ELECTROSWITCH P/N 7801B
MANUAL RESET



86 LOCKOUT RELAY

ELECTROSWITCH P/N 7801B
MANUAL RESET



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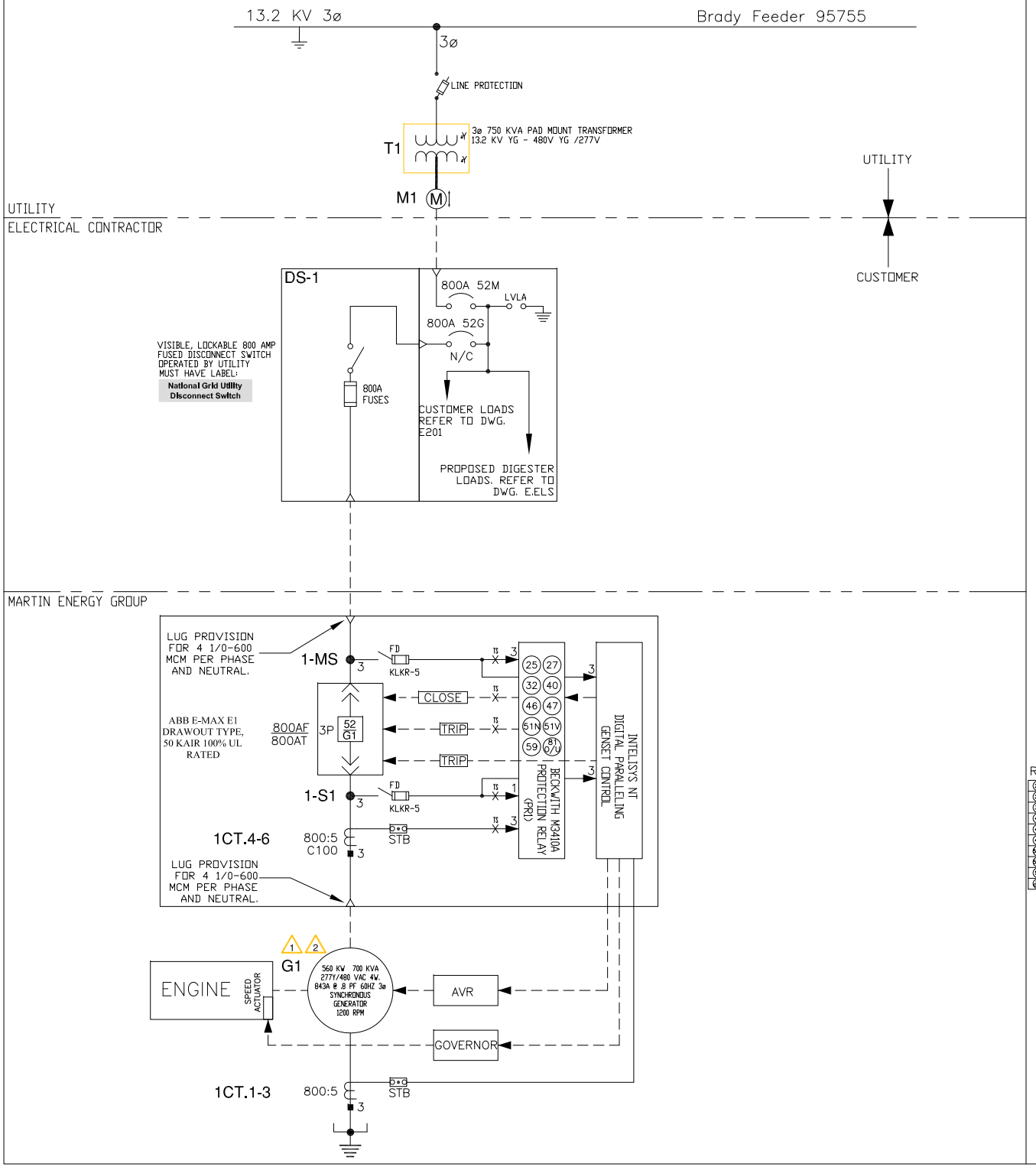
MARTIN ENERGY GROUP
39411 Excelsior Dr
Latham MO 65050
660-458-7000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	MASTER DRAWING LEGEND
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E100

E200

SYSTEM FUNCTIONS	
✓	EXPORT
	AUTOMATIC STANDBY CLOSED TRANSITION
	AUTOMATIC STANDBY OPEN TRANSITION
	MANUAL STANDBY OPEN TRANSITION
	AUTOMATIC PEAK SHAVING
	AUTOMATIC LOAD SHEDDING



52G	GENERATOR BREAKER
1CT4-6	PROTECTION CURRENT TRANSFORMERS
1CT1-3	CONTROL CURRENT TRANSFORMERS
FD	FUSIBLE DISCONNECT
M1	BI-DIRECTIONAL METER
MTS	MANUAL TRANSFER SWITCH
MS	MAINS OR BUS SENSING POINT
S1	GEN SENSING POINT
SB	SENSING BREAKER
STB	SHORTING TERMINAL BLOCKS.
PR1	BECKWITH M3410A PROTECTION RELAY

1. MAX GENSET OUTPUT ON BIO-GAS FUEL IS 450 KW 563 KVA 677A @ 277/480 VAC, .8 PF 60 HZ 3ø 4W

2. POWER FACTOR RANGE IS FROM .95 LEADING TO .8 LAGGING. OPERATION IS AT UNITY PF UNLESS OTHERWISE REQUESTED BY UTILITY.

NOMINAL VOLTAGE - 480 VAC
NOMINAL CURRENT - 677 AMPS
CLEARING TIME = 4 CYCLES.

RELAY ELEMENT LEGEND	RELAY SETTINGS FOR PR1.
25 SYNC CHECK	SYNC DWELL PHASE ANGLE < 10° / VOLT MATCH ±10% / TIME 30 CYCLES
27 UNDER VOLTAGE	< 423 VAC-TRIP TIME 116 CYCLES / < 240 VAC-TRIP TIME 6 CYCLES
32 DIRECTIONAL ELEMENT	PICKUP #1 -0.06 REVERSE O.P. (14 KW REVERSE) DELAY 600 CYC.
40 LOSS OF FIELD	CD #1 - 1, OFFSET - 0.09, DELAY 10 CYCLES. / CD #2 - 1.81, OFFSET - 0.09, DELAY 60 CYCLES
46 NEGATIVE SEQUENCE OVER CURRENT ELEMENT	PICKUP: 68 AMPS (20 %) / (I Square) * t=k/ TIME DIAL 10 / MAX TIME - 10000 CYCLES.
47 NEGATIVE SEQUENCE OVER VOLTAGE ELEMENT	PICKUP: 120 VAC (25.0 %) TIME DELAY: 60 CYCLES
51N INVERSE TIME RESIDUAL OVERCURENT	PICKUP - 2.96A / CURVE - IEC1 / TIME DIAL - 0.5
51V TIME OVER CURRENT VOLTAGE RESTRAINED	PICKUP - 4.66A / CURVE - IEC1 / TIME DIAL - 0.75 / VOLTAGE RESTRAINT
59 OVER VOLTAGE	PU - 528 VAC, TRIP TIME 56 CYCLES / PU2 - 576 VAC, TRIP TIME 6 CYCLES
81 O/U FREQUENCY	U1 - 57 HZ, DEL. 6 CYCLES / U2 - 58.5, DEL. 6000 CYCLES / O1 - 60.5 HZ, DEL. 6 CYCLES

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PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	1-LINE SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E200

E201

SECONDARY DISTRIBUTION SWITCHBOARD

277/480 4W
REFER TO DWG.
E200

225A 3P	225A 3P	225A 3P	225A 3P	225A 3P	225A 3P	300A 3P	100A 3P	100A 2P	100A 2P	100A 2P	100A 2P	60A 3P	60A 3P	SPARE	SPARE

HVP-1
277/480
ELECTRIC
ROOM

HVP-3
277/480
2007 COW
BARN

HVP-4
277/480
2008 COW
BARN

120/
208
150
KVA
3ø

LVP-1
120/208
3ø 400A M.B.
ELECTRIC
ROOM

PP-5
120/208
1ø 100A
2007 COW
BARN

PP-6
120/208
3ø 100A
2008 COW
BARN

HVP-2
277/480
3ø 300A M.B.
CALF
BARN

120/
208
75
KVA
3ø

LVP-2
120/208
3ø 225A M.B.

120/
240
50
KVA
1ø

PP-2
120/240
1ø 200A
EXISTING
MILKING
PARLOR

PP-1
120/240
1ø 200A
EXISTING
MILKING
PARLOR

120/
240
50
KVA
1ø

PP-3
120/240
1ø 200A
EXISTING
HOUSE

120/
240
50
KVA
1ø

PP-4
120/240
1ø 200A
NEW SERVICE
ROUND BARN &
HIRED HAND HOUSE

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DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

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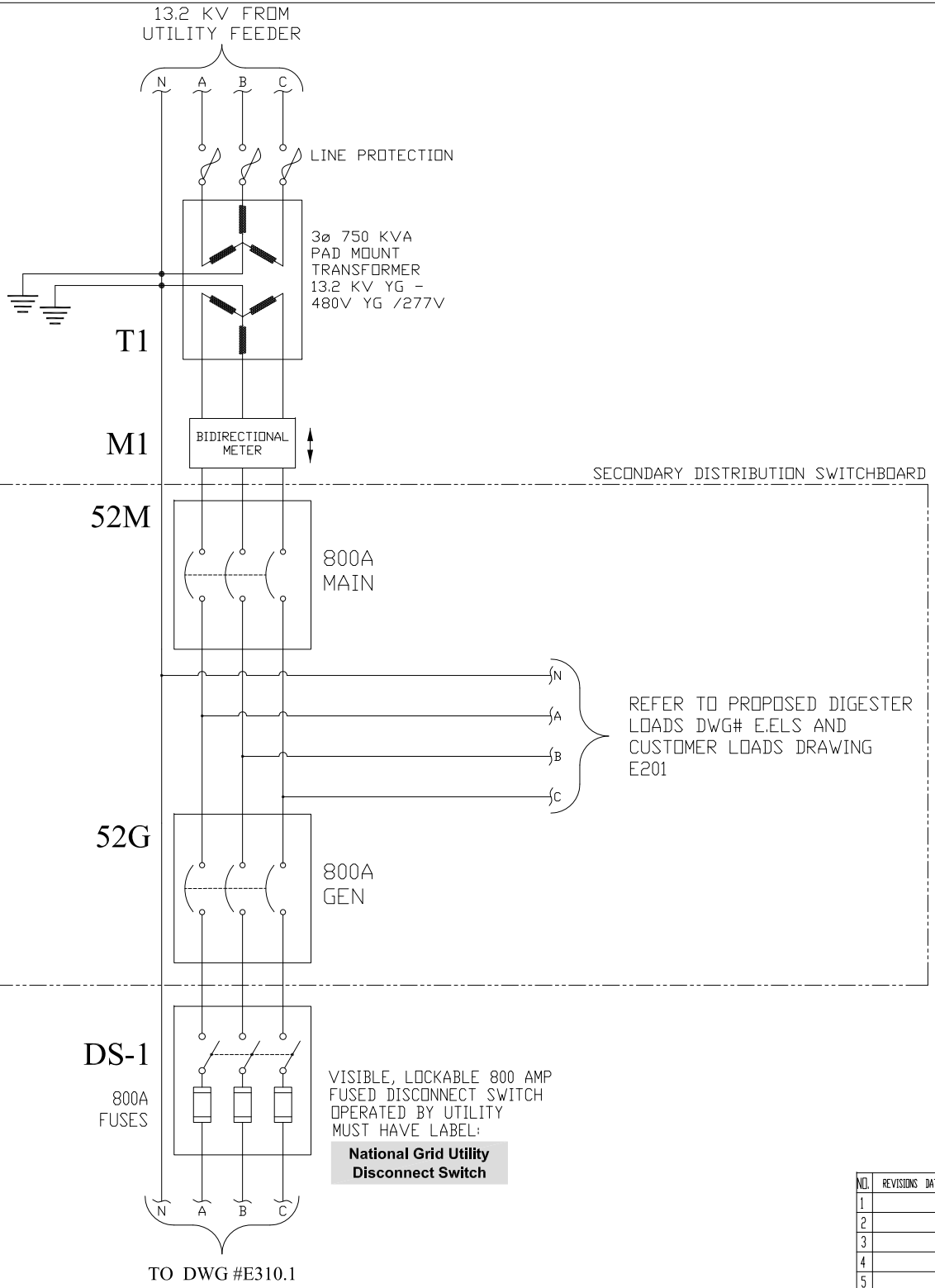
660-458-7200

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	1-LINE SCHEMATIC FOR LOADS
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E201



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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	3-LINE SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E300.1

GEN CONTROL
AREA 52G1 PANEL.

G1 CONTROL
PANEL.

SITE WIRING BY
CUSTOMER

TO DWG# E300.1

N A B C

LUG PROVISION
FOR 2 1/0-600
MCM PER PHASE
AND NEUTRAL.

1-MS

52G1

ABB E-MAX E1
DRAWOUT TYPE,
50 KAIR 100% UL
RATED

800AF
800AT

1-S1

F15 F16 F17 FD2

BRANCH RATED
IR - 200,000 A
5A CLASS CC

F12 F13 F14 FD1

BRANCH RATED
IR - 200,000 A
5A CLASS CC

PR1

TEST SWITCHES
1 A TS2
3 B TS2
5 C TS2
25M TS2
27N TS2
BECKWITH M3410A (PR1)

TB4 13 14 15 22 23 24
TB3 13 14 15 16 17 18

INTELISYS NT
MAINS
GEN
INTELISYS NT

N A B C

TO DWG #E303

BREAKER AREA
52G1 PANEL.

GEN CONTROL
AREA 52G1 PANEL.

G1 CONTROL
PANEL.

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MARTIN ENERGY GROUP
39411 Excelsior Dr
Latham MO 65050
660-458-7200

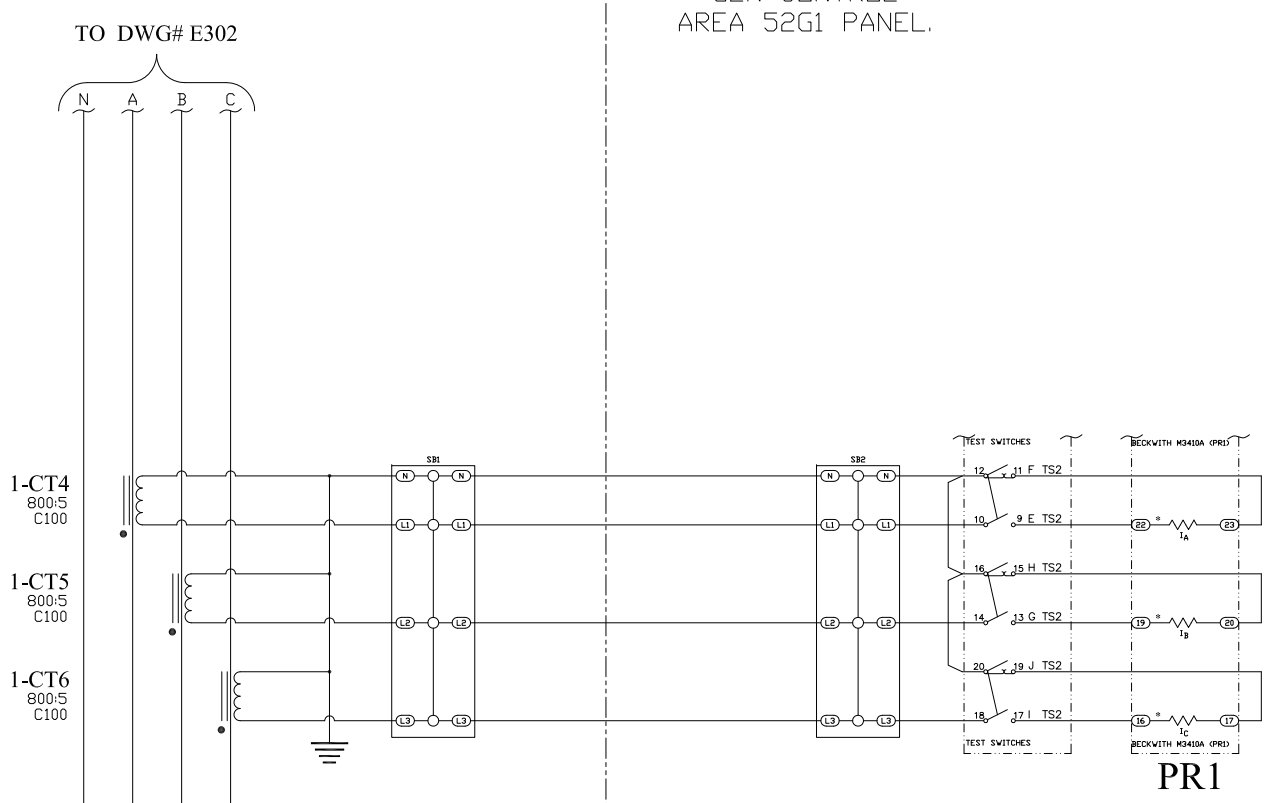
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH
THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	3-LINE SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E310.1

E311.1

BREAKER AREA
52G1 PANEL.

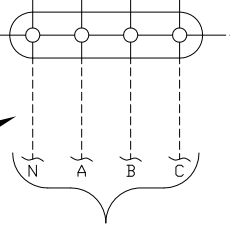
GEN CONTROL
AREA 52G1 PANEL.



BREAKER AREA
52G1 PANEL.

GEN CONTROL
AREA 52G1 PANEL.

FACTORY WIRING
IN G1 CONTAINER



NO.	REVISIONS	DATE	BY
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MARTIN ENERGY GROUP
39411 Excelsior Dr
Latham MO 65050
660-458-7200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	3-LINE SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E311.1

E312.1

FACTORY WIRING
IN G1 CONTAINER

TO DWG# E303

N A B C

G1 CONTROL
PANEL.

G1
CONNECTION
BOX.

G1

560 KW 700 KVA
277Y/480 VAC 4W.
843A @ .8 PF 60HZ 3ø SYNCHRONOUS
GENERATOR
1200 RPM

1 2

1-CT1
800:5

1-CT2
800:5

1-CT3
800:5

1-CT4
800:5

SB3 SB4 SB5 SB6

INTELISYS NT

INTELISYS NT

G1 CONTROL
PANEL.

G1
CONNECTION
BOX.

1 MAX GENSET OUTPUT ON BIO-GAS FUEL IS 450 KW 563 KVA 677A @ 277/480 VAC, .8 PF 60 HZ 3ø 4W

2 POWER FACTOR RANGE IS FROM .95 LEADING TO .8 LAGGING. OPERATION IS AT UNITY PF UNLESS OTHERWISE REQUESTED BY UTILITY.

NO.	REVISIONS DATE	BY
1		
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6		

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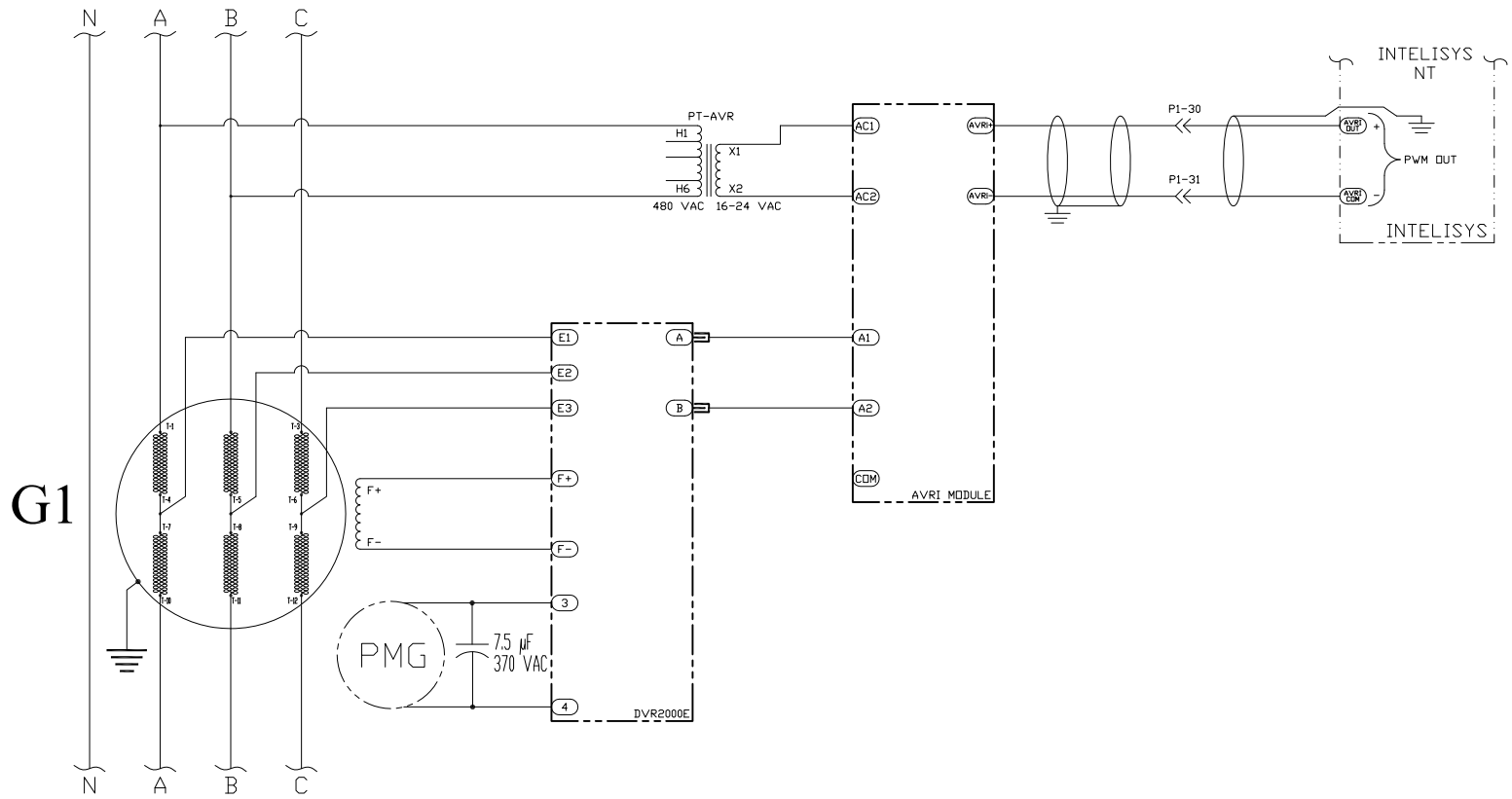
PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	3-LINE SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E312.1

E420.1



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39411 Excelsior Dr
Latham MO 65050
660-458-7200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	EXCITATION SYSTEM SCHEMATIC
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E420.1

E400

DEVICE LEGEND

CC	CLOSE COIL
F1-6,10	FUSE, BLADE TYPE AUTOMOTIVE
GCB	GENERATOR CIRCUIT BREAKER
IS BB	INTELISYS NT GENSET CONTROL
K3	CLOSE GCB RELAY
K7	EXTERNAL TRIP RELAY
K8	GCB CLOSED RELAY
K9	TRIP BYPASS RELAY
K10	READY FOR LOAD RELAY
K36	UTILITY RELAY TRIP SIGNAL RELAY
K37	SYNC SIGNAL RELAY
K41	DTT SIGNAL RELAY
LS1-6	INTERNAL BREAKER LIMIT SWITCHES
M	CIRCUIT BREAKER SPRING CHARGING MOTOR
MCB	MAINS CIRCUIT BREAKER
OC	OPEN COIL
P1-5	PIN & SLEEVE CONNECTORS
PR1	BECKWITH M3410A UTILITY RELAY
TB1	GENSET & BREAKER INTERFACE
TB2	DC POWER DISTRIBUTION
TB3	UTILITY RELAY INTERFACE
TB4	UTILITY CABINET TERMINAL BLOCK
TB4	BREAKER CABINET TERMINAL BLOCK
TB8	EXTERNAL PROTECTION RELAY INTERFACE
TS1	TEST SWITCH #1
TC	24 VDC TRIP COIL (DE-ENERGIZE TO TRIP)

INTELISYS BINARY INPUTS / OUTPUTS

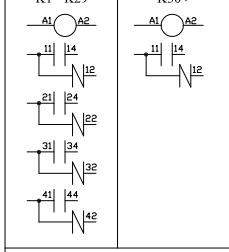
24 VDC NEGATIVE

I01	GCB FEEDBACK INPUT
I02	MCB FEEDBACK INPUT
I04	EMERGENCY STOP INPUT
I05	REMOTE START/STOP INPUT
I06	UTILITY RELAY TRIP INPUT
I07	OK TO CLOSE
I08	EXTERNAL TRIP
I09	DTT TRIP

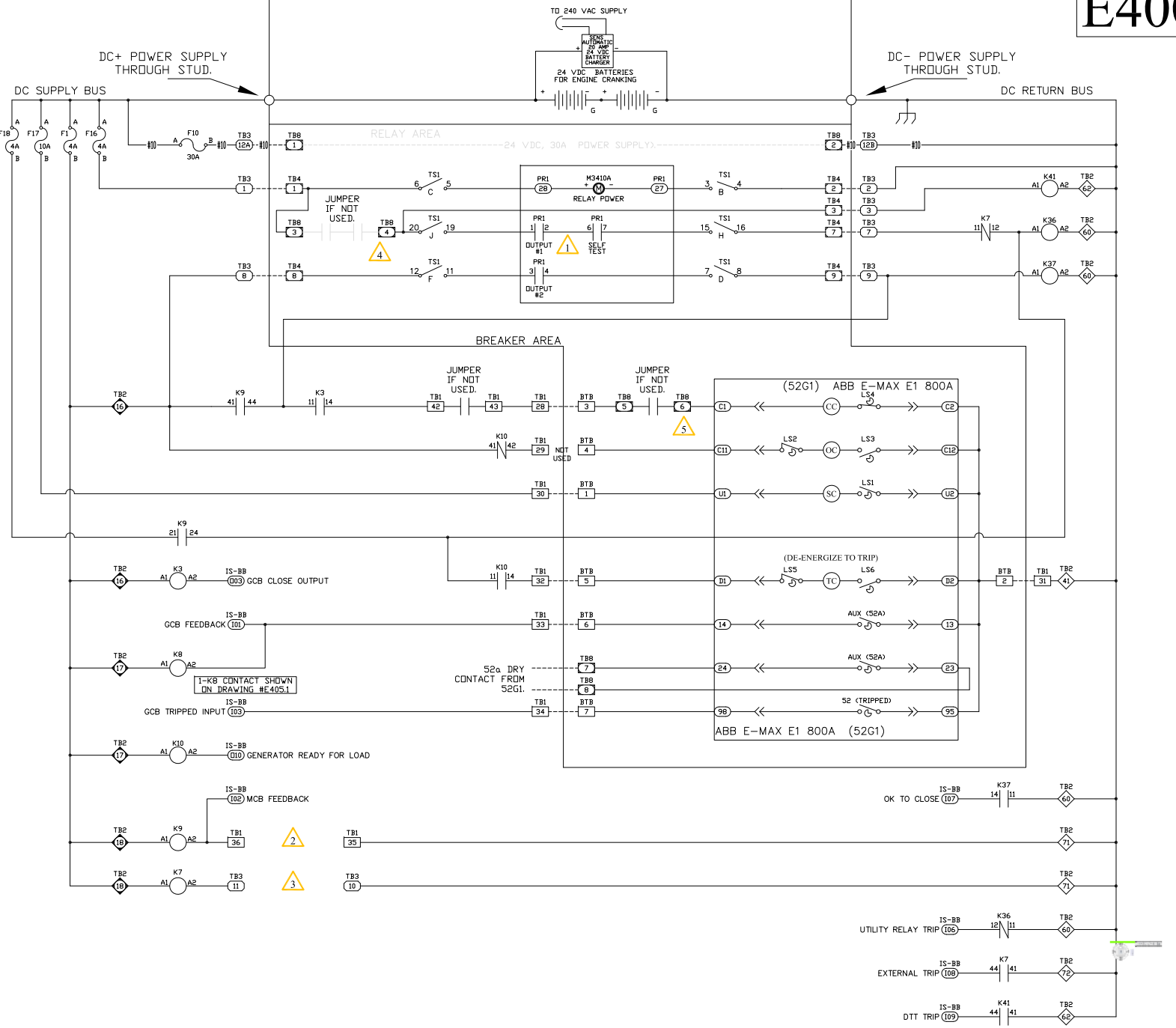
24 VDC POSITIVE

O03	GCB CLOSE OUTPUT
O10	GCB ENABLE OUTPUT

RELAYS K1 - K29 | RELAYS K30 >



1. OUTPUT #1 AND SELF TEST CONTACTS ARE CLOSED FOR NORMAL OPERATION AND OPEN FOR TRIP!
2. AN EXTERNAL CLOSED CONTACT ENSURING SEPARATION FROM THE MAINS, SUCH AS A KIRK KEY SYSTEM, CAN BE APPLIED AT TB1-35&36 TO ENSURE THE GENERATOR IS SEPARATED FROM THE GRID. ALLOWS THE GENERATOR TO BE USED AS A STANDBY UNIT. (ONLY FOR PROLONGED OUTAGES.)
3. AN EXTERNAL CLOSED CONTACT CAN BE APPLIED BETWEEN TB3-10&11 FOR AN EXTERNAL TRIP INPUT. (OPTIONAL)
4. AN EXTERNAL OPEN CONTACT (CLOSED FOR NORMAL OPERATION) CAN BE APPLIED BETWEEN TB8-3&4 FOR AN EXTERNAL TRIP INPUT. FOR DTT TRIP CONTROL.
5. AN EXTERNAL OPEN CONTACT (CLOSED TO ALLOW OPERATION) CAN BE APPLIED BETWEEN TB8-5&6 TO BLOCK BREAKER CLOSURE. FOR DTT TRIP CONTROL.



ALL SYSTEMS SHOWN DE-ENERGIZED.

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MARTIN ENERGY GROUP
39411 Excelsior Dr
Latham MO 65050
660-458-7200

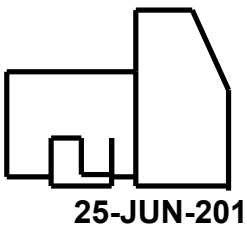
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. DO NOT SCALE. DRAWING SUPERSEDES ALL PREVIOUS DRAWINGS WITH THE SAME DRAWING NUMBER

PROJECT	Woodcrest Dairy
LOCATION	326 County Rt 28 Ogdensburg, NY 13669
DESC.	BREAKER CONTROL DRAWING
JOB ID	0136546
QUOTE NO.	MGG - 712
SCALE	NONE
DATE	6-16-15
DRAWN BY	JDH
CHECKED BY	CNS
DWG#.	E400.1

MARATHON ELECTRIC GENERATORS

TYPICAL SUBMITTAL DATA

MODEL : 574 Frame 6 Pole



Submittal Data: 480Volts*, 560kW, 700kVA, 0.8P.F., 1200RPM, 60Hz, 3Phase **25-JUN-2015**

Kilowatt ratings at	**1200RPM**	**60 Hertz**	**12 LEADS Standard 3 phase**
kW (kVA)	**3 Phase**	**0.8 Power Factor**	**Dripproof or Open Enclosure**

		Class F					Class H		
Voltage*	**80º C ① Continuous**	**90º C ① Lloyds**	**95º C ① ABS**	**105º C British Standard**	**105º C Continuous**	**130º C ① Standby**	**125º C British Standard**	**125º C Continuous**	**150º C ① Standby**
480/240					560(700)				

① *Rise by resistance method, Mil-Std-705, Method 680.1b.* *British Standard Rating per BS 5000*

Submittal Data: 480Volts*, 560kW, 700kVA, 0.8P.F., 1200RPM, 60Hz, 3Phase **STD. CONNECTION**

Mil-Std-705B Method	**Description**	**Value**
301.1b	Insulation Resistance	>1.5 Meg
302.1a	High Potential Test	
	Main Stator	2160 Volts
	Main Rotor	1500 Volts
	Exciter Stator	1500 Volts
	Exciter Rotor	1500 Volts
	PMG Stator	NS**
401.1a	Stator Resistance, Line to Line	
	High Wye Connection	0.006782 Ohms
	Rotor Resistance	2.005 Ohms
	Exciter Stator	21.2Ohms
	Exciter Rotor	0.145Ohms
	PMG Stator	NS**
410.1a	No Load Exciter Field Amps	0.73 A DC
	at 240/480 Volts Line to Line	
420.1a	Short Circuit Ratio	0.778
421.1a	Xd Synchronous Reactance	2.621 p.u.
422.1a	X2 Negative Sequence React.	0.090 p.u.
423.1a	X0 Zero Sequence Reactance	0.067 p.u.
425.1a	X'd Transient Reactance	0.119 p.u.
426.1a	X''d Subtransient Reactance	0.091 p.u.
--	Xq Quadrature Synch. React.	N/A
427.1a	T'd Transient Short Circuit Time Constant	0.237 sec.
428.1a	T''d Subtransient Short Circuit Time Constant	0.097 sec.
430.1a	T'do Transient Open Circuit Time Constant	2.698 sec.
432.1a	Ta Short Circuit Time Constant of Armature Winding	0.018 sec.

Mil-Std-705B Method	**Description**	**Value**
505.3b	Overspeed	1500 RPM
507.1c	Phase Sequence CCW-ODE	ABC
508.1c	Voltage Balance, L-L or L-N	0.20%
601.4a	L-L Harmonic Maximum - Total (Distortion Factor)	5.0%
601.4a	L-L Harmonic Maximum - Single	3.0%
601.1c	Deviation Factor	5.0%
---	TIF (1960 Weightings)	< 50
---	THF (IEC, BS & NEMA Weightings	< 2 %

Additional Prototype Mil-Std Methods are Available on Request.

--	Generator Frame	574
--	Type	MAGNAMAX
--	Insulation	Class H
--	Coupling	Double Bearing
--	Amortisseur Windings	Full
--	Excitation	Ext. Voltage Regulated, Brushless
--	Voltage Regulator	DVR2000E+
--	Voltage Regulation	0.25%
--	Cooling Air Volume	1122 CFM
--	Heat rejection rate	2166 Btu's/min
--	Full load current	947.2 amps
--	Minimum Input hp required	896.8
	Efficiency at rated load :	94.3%
--	Full load torque	3920 Lb-ft

(3) Excitation support system or PMG required to sustain short circuit currents.

** Voltages refer to wye (star) connection, unless otherwise specified.*

*** Not supplied as standard equipment.*

0 Data rev. 06/01/92

Version : 2015.06

Sage Integral Prime
Insertion Style, 115VAC Power

Specifications

Wetted Parts:	316L SS Wetted parts, C267 Hastelloy Options Available
Process Temperature:	Standard -40° to 200°F, Optional to 300° F and 450° F
Pressure Rating:	500psig, 1000psig Optional
Accuracy:	+/- ½ % of Full Scale +/- 1% of Reading
Repeatability:	0.2%
Outputs:	4-20mA (Flow), 24VDC Pulse (Total)
Digital Communication:	Modbus RS485/RTU
User Supplied Power:	115VAC (100-230V~, 50/60Hz)
Enclosure:	Nema 4, Powder Coated Aluminum
Electronics Temp Rating:	-40° to 150° F (-40° to 66° C)

Model Number

(Example: SIP-05-06-AC115-CO2)

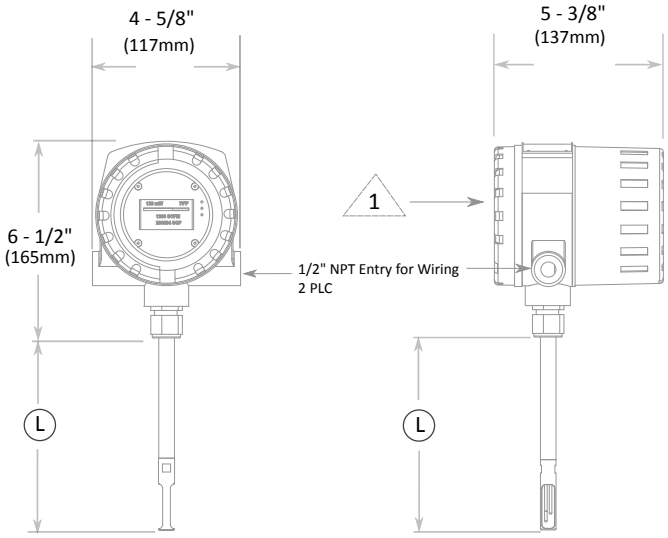
SIP-[ ]-[ ]-AC115-[ ]

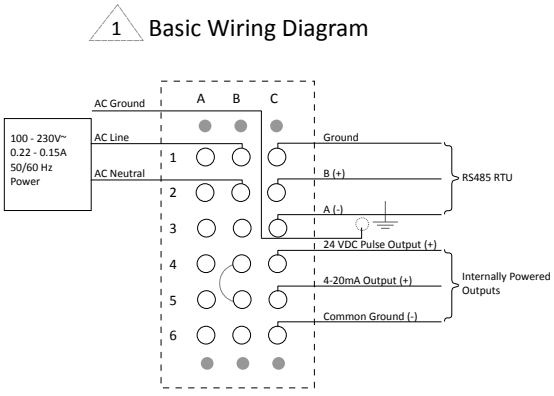
Probe Lengths

Code (L) 1/2" Diameter		Code (L) 3/4" Diameter	
05-06	6" (152 mm)	**07-06**	6" (152mm)
05-12	12" (305 mm)	**07-12**	12" (305mm)
05-15	15" (381 mm)	**07-15**	15" (381mm)
05-18	18" (457 mm)	**07-18**	18" (457mm)
05-24	24" (610 mm)	**07-24**	24" (610mm)
05-30	30" (762 mm)	**07-30**	30" (762mm)
05-36	36" (914 mm)	**07-36**	36" (914mm)
		07-48	48" (1219mm)

Gas

Code		Code	
AIR	AIR	**CL2**	CHLORINE
N2	NITROGEN	**CO**	CARBON MONOXIDE
NG	NATURAL GAS	**HE**	HELIUM
CH4	METHANE	**H2**	HYDROGEN
PROPANE	PROPANE	**DIG GAS**	DIGESTER GAS
BUTANE	BUTANE	**BIOGAS**	BIOGAS
NH3	AMMONIA	**LFG**	LANDFILL GAS
CO2	CARBON DIOXIDE	**FLARE GAS**	FLARE GAS
AR	ARGON	**FLUEGAS**	FLUEGAS
O2	OXYGEN	**MIX**	MIXTURE
O3	OZONE		





Sage Remote Prime
In-Line Style With NPT End Connections, 115VAC Power

Specifications

Wetted Parts:	316L SS Wetted parts, C267 Hastelloy Options Available
Process Temperature:	Standard -40° to 200°F, Optional to 300° F and 450° F
Pressure Rating:	500psig, 1000psig Optional
Accuracy:	+/- ½ % of Full Scale +/- 1% of Reading
Repeatability:	0.2%
Outputs:	4-20mA (Flow), 24VDC Pulse (Total)
Digital Communication:	Modbus RS485/RTU
User Supplied Power:	115VAC (100-230V~, 50/60Hz)
Enclosure:	Nema 4, Powder Coated Aluminum
Electronics Temp Rating:	-40° to 150° F (-40° to 66° C)

Model Number

(Example: SRP-050-AC115-CO2)

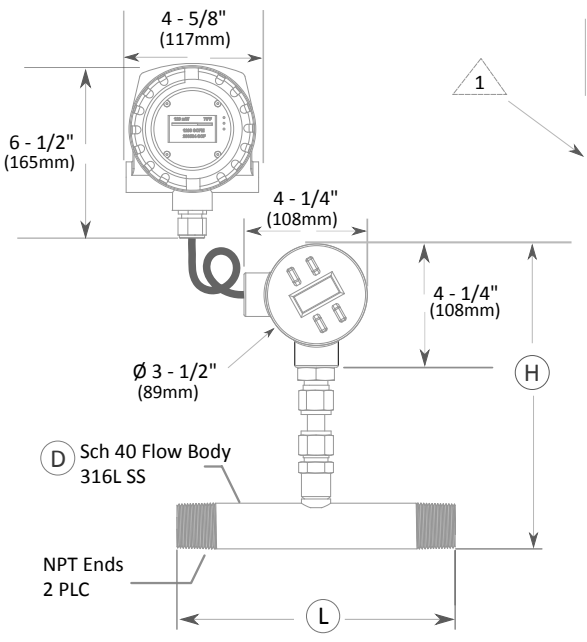
SRP-[ ]-AC115-[ ]

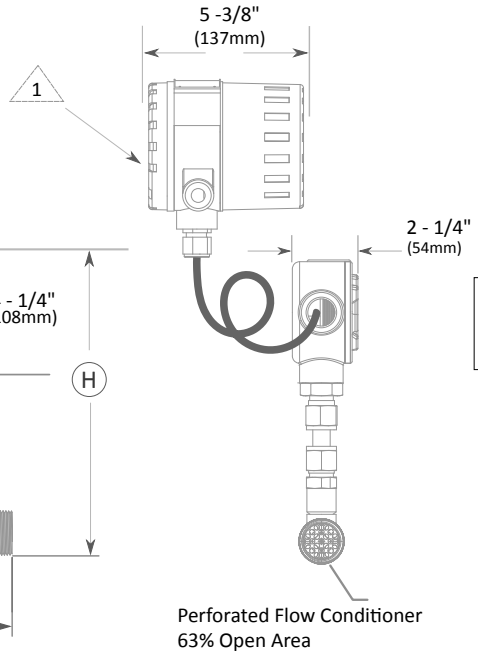
Flow Bodies

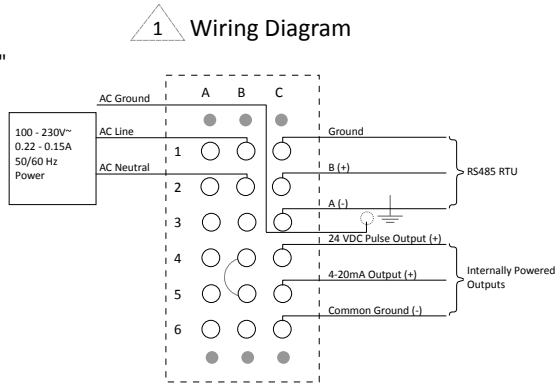
Code	D	L	H
025	1/4" (8mm)	6" (152.4mm)	10.09" (256mm)
030	3/8" (10mm)	6" (152.4mm)	10.15" (258mm)
050	1/2" (15mm)	7" (177.8mm)	10.24" (260mm)
075	3/4" (20mm)	7" (177.8mm)	10.35" (263mm)
100	1" (25mm)	8" (203.2mm)	10.47" (266mm)
125	1-1/4" (32mm)	10" (254mm)	10.65" (271mm)
150	1-1/2" (40mm)	12" (304.8mm)	10.77" (274mm)
200	2" (50mm)	12" (304.8mm)	11.00" (279mm)
250	2-1/2" (65mm)	12" (304.8mm)	11.25" (286mm)
300	3" (80mm)	12" (304.8mm)	11.57" (294mm)
400	4" (100mm)	12" (304.8mm)	12.07" (307mm)

Gas

Code		Code	
AIR	AIR	CL2	CHLORINE
N2	NITROGEN	CO	CARBON MONOXIDE
NG	NATURAL GAS	HE	HELIUM
CH4	METHANE	H2	HYDROGEN
PROPANE	PROPANE	DIG GAS	DIGESTER GAS
BUTANE	BUTANE	BIOGAS	BIOGAS
NH3	AMMONIA	LFG	LANDFILL GAS
CO2	CARBON DIOXIDE	FLARE GAS	FLARE GAS
AR	ARGON	FLUEGAS	FLUEGAS
O2	OXYGEN	MIX	MIXTURE
O3	OZONE		







SHARK® 100

MULTIFUNCTION POWER AND ENERGY METER

Revenue Grade

Features

- 0.2% Class Energy and Demand Metering
- Measurements including Voltage, Current, Power, Frequency, Energy, etc.
- Optional KYZ Pulse and Standard IrDA Port
- Power Quality Measurements (%THD and Alarm Limits)
- V-Switch™ Technology - Field Upgrade without Removing Installed Meter
- Large Bright Red LED Display
- % of Load Bar for Analog Meter Perception
- Optional RS485 Modbus and DNP 3.0 Protocols
- Optional 100BaseT Ethernet
- Fits Both ANSI and DIN Cut-Outs
- Available in a Transducer-Only Version

Applications

- Utility Metering
- Commercial Metering
- Substations
- Industrial Metering
- Power Generation
- Campus Metering
- Submetering
- Analog Meter Replacement

Introduction

Electro Industries introduces one of the industry's highest performance revenue grade panel meters. Based on an all new platform, this low cost meter significantly outperforms other devices many times its price. This unit is perfect for new metering applications and as a simple replacement of existing analog meters. The Shark® meter excels in metering energy accurately, exceeding ANSI C12.20 (0.2%) and IEC 62053-22 (0.2%) energy measurement standards. The unit utilizes high speed DSP technology with high resolution A/D conversion to provide revenue certifiable accuracy for Utility Billing, Substation Metering, Submetering and Critical Metering applications.

High Performance and Economical Pricing for High Volume Deployment

Superior Accuracy and Virtual Upgrade Switches

V-Switch™ Technology

The Shark® 100 meter is equipped with EIG's exclusive V-Switch™ technology. This technology allows users to upgrade and add features as needed by using communication commands, even after the meter is installed.

Available V-Switches:

- V-Switch 1 – Volts and Amps Meter – Default
- V-Switch 2 – Volts, Amps, kW, kVAR, PF, kVA, Freq
- V-Switch 3 – Volts, Amps, kW, kVAR, PF, kVA, Freq, kWh, kVAh, kVARh and DNP 3.0
- V-Switch 4 – Volts, Amps, kW, kVAR, PF, kVA, Freq, kWh, kVAh, kVARh, %THD Monitoring, Limit Exceeded Alarms and DNP 3.0

Measured Parameters	Accuracy % of Reading	Display Range
Voltage L-N	0.1%	0-9999 Scalable V or kV
Voltage L-L	0.1%	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	0.01 Hz	45 to 65 Hz
%THD	5.0%	0 to 100%
% Load Bar	1-120%	10 Digit Resolution Scalable

Note: Typical results are more accurate. Applies to 3 Element WYE and 2 Element Delta Connections. Add 0.1% of Full Scale plus 1 digit to Accuracy specs for 2.5 Element connections.

Traceable Watt-Hour Test Pulse for Accuracy Verification

The Shark® 100 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.

Additional Features Include:

- Utility Block and Rolling Average Demand
- Adjustable Demand Profiles
- Max and Min Available on Most Other Parameters
- Voltage Provides Instantaneous Max and Min for Surge and Sag Limits

Measured Values	Real-Time	Avg	Max	Min
Voltage L-N	•		•	•
Voltage L-L	•		•	•
Current Per Phase	•	•	•	
Watts	•	•	•	•
VAr	•	•	•	•
VA	•	•	•	•
PF	•	•	•	•
+Watt-hr	•			
-Watt-hr	•			
Watt-hr net	•			
+VAR-hr	•			
-VAR-hr	•			
VAR-hr net	•			
VA-hr	•			
Frequency	•		•	•
%THD	•		•	•
Voltage Angles	•			
Current Angles	•			
% of Load Bar	•			

Advanced Communication Capability with IrDA Interface

The Shark® 100 meter provides two independent communication ports with advanced features.

Back Mounted Communication Port with KYZ Pulse

- RS485 (Option 485P) – This port allows RS485 communication using Modbus or DNP 3.0 Protocols. Baud rates are from 9,600 to 57,600.
- KYZ Pulse – In addition to the RS485, the meter also includes a KYZ pulse mapped to positive energy. This is a fixed energy pulse. Pulse values are:

Voltage Level	Class 10 Models	Class 2 Models
Below 150V	0.2505759630	0.0501151926
Above 150V	1.0023038521	0.2004607704

Optional 10/100BaseT Ethernet

Ethernet (Option INP10) – 10/100BaseT Ethernet with Modbus TCP protocol.

Front Mounted IrDA Communication

Uniquely, the Shark® meter also has an optical IrDA port, allowing the unit to be set up and programmed using a remote laptop PC without need for a communication cable. To configure the meter, just point at it with an IrDA-equipped PC.

Rugged and Safe Voltage and Current Inputs

The Shark® 100 meter is ruggedly designed for harsh electrical applications in both high voltage and low voltage power systems. This is especially important in Power Generation, Utility Substation and Critical User applications. The structural and electrical design of this meter was developed based on the recommendations and approval of many of our utility customers.

High Isolation Universal Voltage Inputs

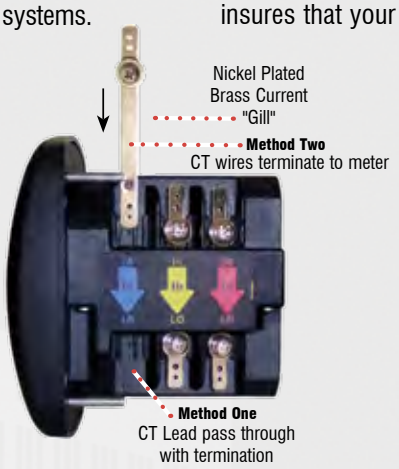
Voltage inputs allow measurement of up to 416 Volts Line to Neutral and 721 Volts Line to Line. This insures proper meter safety when wiring directly to high voltage systems. One unit will perform to specification on 69 Volt, 120 Volt, 230 Volt, 277 Volt and 347 Volt power systems.

Short Circuit Safe Current Inputs

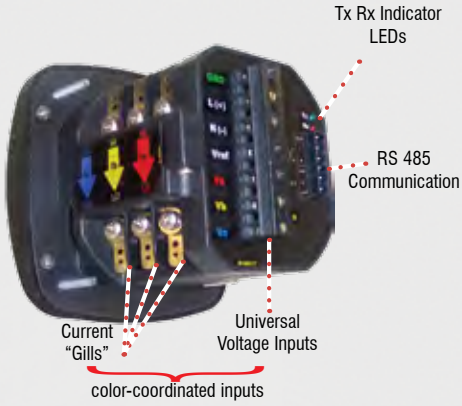
Current inputs use a unique dual input method:

- **Method One** – CT Lead Pass Through. The CT Lead passes directly through the meter without any physical termination on the meter. This insures that the meter cannot be a point of failure on the CT circuit. This is preferable to utility users when sharing relay class CTs. No Burden is added to the secondary CT circuit.
- **Method Two** – Current "Gills." This unit additionally provides ultra-rugged termination pass-through bars, allowing the CT leads to be terminated on the meter. The Shark® meter's stud-based design insures that your CTs will not open in a fault condition.

FRONT VIEW

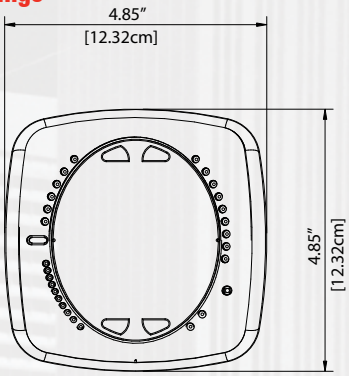


SIDE VIEW

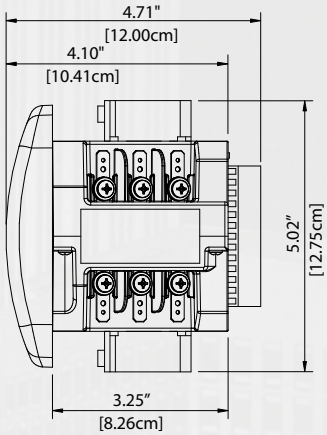


REAR VIEW

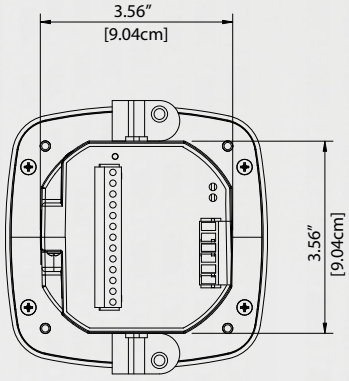
Dimensional Drawings



FRONT VIEW

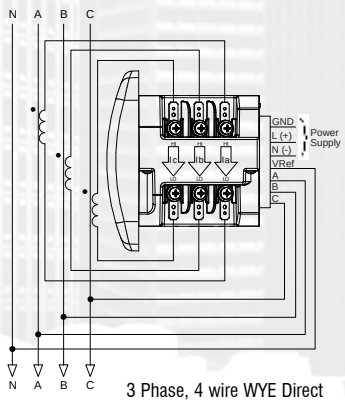


SIDE VIEW

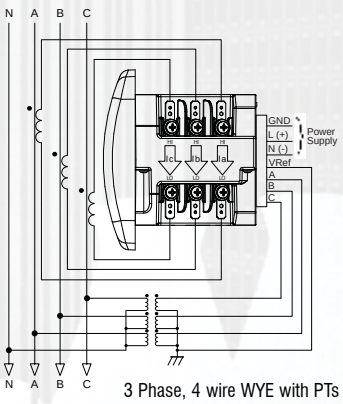


REAR VIEW

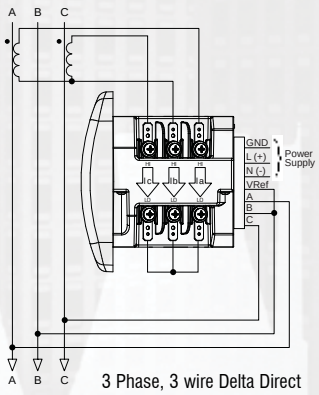
Wiring Diagrams



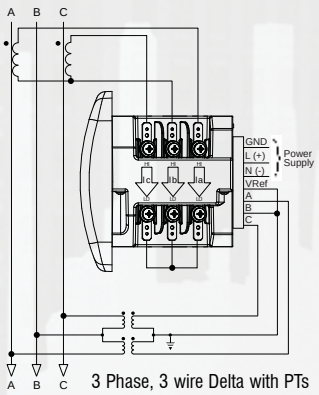
3 Phase, 4 wire WYE Direct



3 Phase, 4 wire WYE with PTs



3 Phase, 3 wire Delta Direct



3 Phase, 3 wire Delta with PTs

Easy to Use and Install

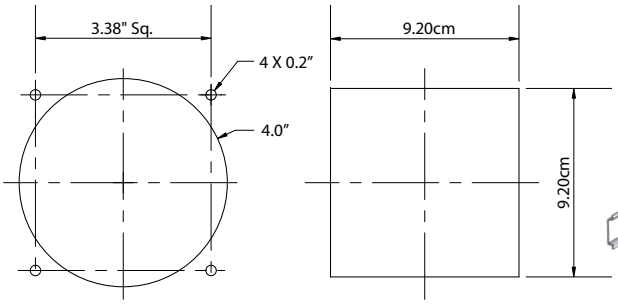
From user interface to mechanical construction, the Shark® 100 Meter was designed to be easy and intuitive, so an installer with minimal meter experience and training can easily install and use this product.

- Easy to use faceplate programming
- PC setup
- Phasor diagram showing wiring status
- Auto scroll feature
- Analog style % of Load Bar
- Shallow panel depth
- Color coordinated voltage and current inputs

Shark® 100 meter ANSI and DIN Mounting

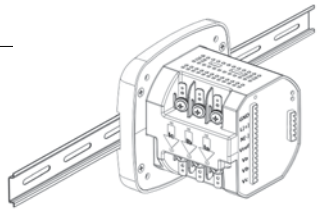
The unit mounts directly in an ANSI C39.1 (4" round form) or an IEC 92mm DIN square form. This is perfect for new installations and for existing panels. In new installations, simply use DIN or ANSI punches.

- Perfect for switchgear panel direct retrofits
- Mounts in only 4.25" panel depth
- Uses minimal panel space
- Uses standard CT or PT wiring



ANSI Mounting

DIN Mounting



Shark® 100T - DIN Rail Mounted Transducer

Specifications

Voltage Inputs
- 20-416 Volts Line To Neutral, 20-721 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: 0.36VA per phase Max at 600V, 0.014VA at 120 Volts
- Input wire gauge max (AWG 12 / 2.5mm^2)

Current Inputs
- Class 10: (0 to 10) A, 5 Amp Nominal
- Class 2: (0 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
- Programmable Current to Any CT Ratio
- Burden 0.005VA per phase Max at 11Amps
- 5mA Pickup Current
- Pass through wire gauge dimension: 0.177" / 4.5mm
- Continuous current withstand: 20 Amps for screw terminated or pass through current connections

Isolation
All Inputs and Outputs are galvanically isolated to 2500 Volts AC.

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
- RMS
- Sampling at 400+ Samples per Cycle on all channels measured readings simultaneously
- Harmonic %THD (% of Total Harmonic Distortion)

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:
- 18-60VDC

Burden: 10VA max.

Communication Format
- 2 Com Ports (Back and Faceplate)
  - RS485 Port (Through Backplate)
  - IrDA (Through Faceplate)
- 10/100BaseT Ethernet Modbus TCP (INP10)
- Com Port Baud Rate: (9,600 to 57,600)
- Com Port Address: 0-247
- 8 Bit, No parity
- Modbus RTU, ASCII or DNP 3.0 Protocols

KYZ Pulse
- Type Form A
- On Resistance: 23-35 Ohm
- Peak Voltage: 350 VDC
- Continuous Load Current: 120 mA
- Peak Load Current: 350mA (10ms)
- Off Stat Leakage Current @ 350VDC: 1 mA
- Opto-Isolation: 3750V (60Hz, 1min)

Dimensions and Shipping
- Weight: 2 lbs
- Basic Unit: H4.85 x W4.85 x L4.25
- Shark100 – mounts in 92mm DIN and ANSI C39.1 4" Round Cut-outs
- Shark100T-DIN rail mounted transducer
- Shipping Container Dimensions: 6" cube

Meter Accuracy
- See page 2

Compliance:
- IEC62053-22 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- EN61000-6-2 - Immunity for Industrial Environments: 2005
- EN61000-6-4 - Emission Standards for Industrial Environments: 2007
- EN61326-1 - EMC Requirements: 2006

Ordering Information: To order, please fill out ordering guide:

	Model		Frequency		Current Class		V-Switch Pack		Power Supply		COM		Mounting (Shark100 Only)
Option Numbers:		-		-		-		-		-		-	
Example: Shark 100		-	60	-	10	-	V2	-	D2	-	X	-	X
	Shark100 *(Meter/Transducer)*		**50** 50 Hz System		**10** 5 Amp Secondary		**V1** Default V-Switch Volts / Amps		**D2** (90-265)VAC or (100-370)VDC		**X** No Com		**X** ANSI Mounting
	Shark100T *(Transducer Only)*		**60** 60 Hz System		**2** 1 Amp Secondary		**V2** Above with Power & Freq		**D** 18-60V DC		**485P** RS485+Pulse *(Standard in Shark® 100T Transducer)*		**DIN** DIN Mounting Brackets
							V3 Above with DNP 3.0 and Energy Counters				**INP10** 10/100BaseT + Pulse		
							V4 Above with %THD & Limits						

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

Compliance Documents

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

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

Fyrite®
Gas Analyzers

Fast, accurate and easy to use instruments for measuring and analyzing carbon dioxide or oxygen. Fyrite Analyzers are available for either CO_2 or O_2 analysis, and each model is produced in three scale ranges.

All six instruments are similar in appearance and size, but differ in important construction details, as well as in the absorbing fluids.

Each model, therefore, is suitable only for the particular gas analysis or scale range for which it has been manufactured. Accuracy is within $\pm$1/2% CO_2 or O_2.

Operation

Fyrite absorbing fluid is selective in the chemical absorption of carbon dioxide or oxygen, respectively. Therefore, the Fyrite's accuracy, which is well within the range required for industrial and professional applications, does not depend upon complicated sequential test procedures. In addition, Fyrite readings are unaffected by the presence of most background gases in the sample.

The number of tests possible with one fluid charge depends on the concentration of samples being tested. At midpoint scale reading the CO_2 fluid is good for approximately 300 gas samples and the O_2 fluid for 100 tests. The need to replace fluid can be easily determined with a simple test, and replacement is an easy procedure. These test procedures, as well as other good information, are provided in the Fyrite manual 11-9026.

Features

Fyrite Indicators have a broad range; they may be exposed to ambient temperatures from -30° to 150°F, and gases up to 850°F may be tested with standard aspirator sampling equipment (special sampling equipment for higher gas temperatures or dry gases is available). Order Fyrite Instruction Manual 11-9026. For temperatures above 1400°F, a ceramic sampling tube (Bacharach Part # 11-0164) is available.

Applications

0-7.6% CO_2 –
CO_2 tests of controlled atmospheres in fruit, vegetable, meat storage rooms, and incubator monitoring.

0-7.6% O_2 –
Oxygen determination in flammable gases; oxygen tests to check inertness of atmosphere in silos, fuel tanks, etc.

0-20% CO_2 –
Flue gas combustion tests; CO_2 tests of heat treating atmospheres.

0-21% O_2 –
Flue gas combustion tests, oxygen deficiency test. Checking oxygen concentrations in hydrogen cooled generators and oil sealed inert gas transformers.

0-60% CO_2 –
Checking CO_2 in inert gas blankets in tankers and barges carrying gasoline and other combustibles; CO_2 tests on lime kilns; checking CO_2 in sewage plant digesters.

0-60% O_2 –
Oxygen test in connection with oxygen and gas anesthesiology.

Note: United States and Foreign Postal Regulations prohibit Fyrite fluid, in or out of any unit, from being shipped parcel post.

Single Kits - Single Kits contain either a Fyrite CO_2 or a Fyrite O_2 Indicator, Sampling Assembly and a carrying case.

Duplex Kits - Special Fyrite Kits containing various combinations of Oxygen and Carbon Dioxide Indicators, Sampling Assembly and a carrying case.

Repair Kits - One bottle of Fyrite fluid, valve plunger gasket, top gasket, screws, diaphragm, and envelope of filtering material.

Refill Kits - Two bottles of Fyrite fluid, top gasket, screws, and envelope of filtering material.

USA

COMPLETE KIT ITEM NO.[1]	SCALE RANGE	FYRITE	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5053	0-7.6%	11-7042	11-7039
10-5000[2]	0-20%	11-7032	11-7029
10-5032	0-60%	11-7034	11-7029
O_2 Testing			
10-5054	0-7.6%	11-7044	11-7039
10-5011	0-21%	11-7036	11-7029
10-5046	0-60%	11-7038	11-7029

EXPORT

COMPLETE KIT ITEM NO.[3]	SCALE RANGE	FYRITE (DRY)	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5083	0-7.6%	11-7041	11-7039
10-5001	0-20%	11-7031	11-7029
10-5033	0-60%	11-7033	11-7029
O_2 Testing			
10-5084	0-7.6%	11-7043	11-7039
10-5012	0-21%	11-7035	11-7029
10-5042	0-60%	11-7037	11-7029

DUPLEX KITS

COMPLETE KIT ITEM NO.[4]	CO_2 FYRITE	OXYGEN FYRITE	ASSEMBLY ITEM NO.
10-5020	0-20%	0-21%	11-7029
10-5021[4]	0-20%	0-21%	11-7029
10-5090[5,6]	0-7.6%	0-7.6%	11-7039
10-5106[5,6]	0-7.6%	0-21%	11-7039
10-5111[5,6]	0-60%	0-21%	11-7029

[1]Domestic shipments only
[2]Also includes Fire Efficiency Finder
[3]Export use only. Kits shipped without fluid.
[4]Export only
[5]Special order only: check factory for price and availability
[6]No export equivalent. Order components separately

FYRITE FLUID*

GAS TYPE	RANGE	ITEM NO. 3 BOTTLE CTN.
Carbon Dioxide		
	0-7.6%	10-5100 (11-0053)
	0-20%	10-5057 (11-0057)
	0-60%	10-5057 (11-0057)
Oxygen		
	0-7.6%	10-5103 (11-0059)
	0-21%	10-5060 (11-0169)
	0-60%	10-5060 (11-0169)

REPAIR KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	11-7053
	0-20%	11-7052
	0-60%	11-7052
Oxygen	0-7.6%	11-7055
	0-21%	11-7054
	0-60%	11-7054

REFILL KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	not available
	0-20%	11-7047
	0-60%	11-7047
Oxygen	0-7.6%	not available
	0-21%	11-7050
	0-60%	11-7050

**Note: Only genuine Bacharach Fyrite Fluid is to be used in your Fyrite Analyzer. Substitute fluids may cause the Fyrite to be inaccurate or inoperative. Numbers in parentheses are old part numbers for reference only and not to be used for ordering.*