APPENDIX B

Department of Transportation
Interconnection Applications

-I-95 Exit 109 West
-I-95 Exit 109 East
-I-95 Exit 112
-Augusta State Airport

I-95 Exit 109 West

Interconnection Application

Forms and Agreements 4: Level 2, Level 3 and Level 4 Interconnection Application

A Customer-Generator applicant ("Applicant") hereby makes application to CMP (Utility or T & D Utility) to install and operate a generating facility interconnected with the CMP utility system. This application will be considered as an application for interconnection of generators under Expedited interconnection review provided the generator is not greater than 2 MW but shall serve as an Application for Standard interconnection review if greater than 2 MW or if Expedited review does not qualify the generator for interconnection.

Written applications should be submitted by mail, e-mail or fax to Central Maine Power Company (CMPCO), as follows:

[Utility]: Central Maine Power Company (CMPCO)
[Utility's address]: 83 Edison Drive, Augusta, ME 04336
Telephone Number: 207.621.4732
E-Mail Address: nathan.pelletier@cmpco.com.
[Utility] Contact Name: C/O Nick Pelletier
[*Utility*] Contact Title: _____

An application is a Complete Application when it provides all applicable information required below. (Additional information to evaluate a request for interconnection may be required and will be so requested from the Interconnection Applicant by Utility after the application is deemed complete).

Section 1. Applicant Information

Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)
Name: MaineDOT Environmental Office– c/o David Gardner
Mailing Address: 24 Child Street
City: Augusta State: ME Zip Code: 04333

Facility Location (if different from above): 73 Whitten Rd Augusta Me. 04330

Telephone (Daytime): 1-207-592-2471
Telephone (Evening): 1-207-592-2471
Fax Number:
E-Mail Address: david.gardner@maine.gov

Not Applicable_____
(Utility)

3001-2167-166
(Existing Account Number, if generator to be interconnected on the Customer side of a utility revenue meter)

Type of Interconnect Service Applied for _____ Network Resource, _____
(choose one)

Energy Only, X Load Response (no export) _____ Net metering

Section 2. Generator Qualifications

Data apply only to the Small Generating Facility, not the Interconnection Facilities.
Energy Source: X Solar ___ Wind ___ Hydro ___ Hydro Type (e.g. Run-of-River):_____

Diesel ___ Natural Gas ___ Fuel Oil ___ Other (state type)_____

Prime Mover: Fuel Cell ___ Recip. Engine ___ Gas Turb. ___ Steam Turb. ___
Microturbine ___ PV X Other _____

Type of Generator: Synchronous ____ Induction ____ Inverter X

Generator Nameplate Rating: 166 kW (30 Units)
Generator Nameplate kVA: 166 kVA (30 Units)

Interconnection Customer or Customer-Site Load: NONE__ kW (if none, so state)

Typical Reactive Load (if known): __N/A___
Maximum Physical Export Capability Requested 500 kW

List components of the Small Generating Facility Equipment Package that are currently certified:

	Equipment Type	Certifying Entity
1.	Solectria XGI 1500-125/125	UL 1741 SA
2.	Candian Solar Ku Max 395W	UL 1703
3.		
4.		
5.		

Is the prime mover compatible with the certified protective relay package?
Yes X No ____

Generator (or solar collector):

Manufacturer, Model Name & Number: Solectria XGI 1500-125/125

Version Number: TBD
Nameplate Output Power Rating in kW:

(Summer) 125kW (Winter) 125kW
Nameplate Output Power Rating in kVA:
(Summer) 125kVA (Winter) 125kVA

Individual Generator Power Factor:
Rated Power Factor: Leading: 0.8 PF Lagging: 0.8 PF

Total Number of Generators in wind farm to be interconnected pursuant to this Interconnection Request: _____ Elevation: _____Single-phase _____
Three- phase (4) units operating at 125 kW

Inverter Manufacturer, Model Name & Number (if used): Solectria XGI 1500-125/125

List of adjustable set points for the protective equipment or software: Per IEEE 1547

Note: *A completed Power Systems Load Flow data sheet must be supplied with the Interconnection Request*.

Small Generating Facility Characteristic Data (for inverter-based machines)

Max design fault contribution current: 27.7A@12.47kV Instantaneous or RMS? RMS
Harmonics Characteristics: <3% per IEEE519

Start-up requirements: estimated 1 kW per Solectria XGI 1500-166/166

Small Generating Facility Characteristic Data (for rotating machines) NOT APPLICABLE

RPM Frequency: _____
(*) Neutral Grounding Resistor (If Applicable): _____

Synchronous Generators: NOT APPLICABLE

Direct Axis Synchronous Reactance, Xd: _____ P.U.
Direct Axis Transient Reactance, X' d: _____ P.U.
Direct Axis Subtransient Reactance, X" d: _____ P.U.
Negative Sequence Reactance, X2 _____ P.U.
Zero Sequence Reactance, X0: _____ P.U.

KVA Base: _____

Field Volts: _____
Field Amperes: _____

Induction Generators: NOT APPLICABLE

Motoring Power (kW): _____
I^2t or K (Heating Time Constant): _____
Rotor Resistance, Rr: _____
Stator Resistance, Rs: _____
Stator Reactance, Xs: _____
Rotor Reactance, Xr: _____
Magnetizing Reactance, Xm: _____
Short Circuit Reactance, Xd": _____
Exciting Current: _____
Temperature Rise: _____
Frame Size: _____
Design Letter: _____
Reactive Power Required In Vars (No Load): _____
Reactive Power Required In Vars (Full Load): _____
Total Rotating Inertia, H: _____ Per Unit on kVA Base

Note: *Please contact the T & D Utility prior to submitting the Interconnection Request to determine if the specified information above is required.*

Excitation and Governor System Data for Synchronous Generators Only
Provide appropriate IEEE model block diagram of excitation system, governor system and power system stabilizer (PSS) in accordance with the regional reliability council criteria. A PSS may be determined to be required by applicable studies. A copy of the manufacturer's block diagram may not be substituted.

Section 3. Interconnection Facilities Information

Will a transformer be used between the generator and the Point of Common Coupling?
__X__ Yes ___No

Will the transformer be provided by the Interconnection Customer? _X_ Yes ____No

Transformer Data (If Applicable, for Interconnection Customer-Owned Transformer):

Is the transformer: Single-phase _____ Three phase X Size: 500 kVA (1 Typ.)
Transformer Impedance: 5.75% percent on 500 kVA Base

If Three Phase:
Transformer Primary: 12,470 Volts _____ Delta _____Wye ____X Wye Grounded
Transformer Secondary: 600 Volts _____ Delta ____ Wye ___X_ Wye Grounded
Transformer Tertiary: _____ Volts _____ Delta _____Wye _____ Wye Grounded

Transformer Fuse Data (If Applicable, for Interconnection Customer-Owned Fuse):
(Attach copy of fuse manufacturer's Minimum Melt and Total Clearing Time-Current Curves)

Manufacturer: TBD_ Type: _____ Size: _____
Speed: _____

Interconnecting Circuit Breaker (if applicable): NOT APPLICABLE

Manufacturer: _____ Type: _____
Load Rating (Amps): _____ Interrupting Rating (Amps): _____ Trip Speed (Cycles): _____

Interconnection Protective Relays (If Applicable):

If Microprocessor-Controlled:

List of Functions and Adjustable Setpoints for the protective equipment or software:

Setpoint Function	Minimum	Maximum
1. See ONE-LINE		
2.		
3.		
4.		
5.		
6.		

If Discrete Components:
(Enclose Copy of any Proposed Time-Overcurrent Coordination Curves)

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____

Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Current Transformer Data (If Applicable):
(Enclose Copy of Manufacturer's Excitation and Ratio Correction Curves)

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Potential Transformer Data (If Applicable):

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Section 4. General Information

Enclose copy of site electrical one-line diagram showing the configuration of all Small Generating Facility equipment, current and potential circuits, and protection and control schemes. This one-line diagram must be signed and stamped by a licensed Professional Engineer if the Small Generating Facility is larger than 50 kW.
Is One-Line Diagram enclosed? Yes _X_ No ____

Enclose copy of any site documentation that indicates the precise physical location of the proposed Small Generating Facility (e.g., USGS topographic map or other diagram or documentation).

Proposed location of protective interface equipment on property (include address if different from the Interconnection Customer's address):

_____

_____

Enclose copy of any site documentation that describes and details the operation of the protection and control schemes.

Is Available Documentation Enclosed? Yes ____ No __X__

Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).
Are Schematic Drawings Enclosed? Yes ____ No __X__

Section 5. Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by (utility) on or near my service meter location. Generating systems must be compliant with IEEE, NEC, ANSI, and UL standards, where applicable. By signing below, the Applicant also certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.

Signed: _____ Date: 03/04/2020

Section 6. Information Required Prior to Physical Interconnection
(Not required as part of the application, unless available at time of application.)

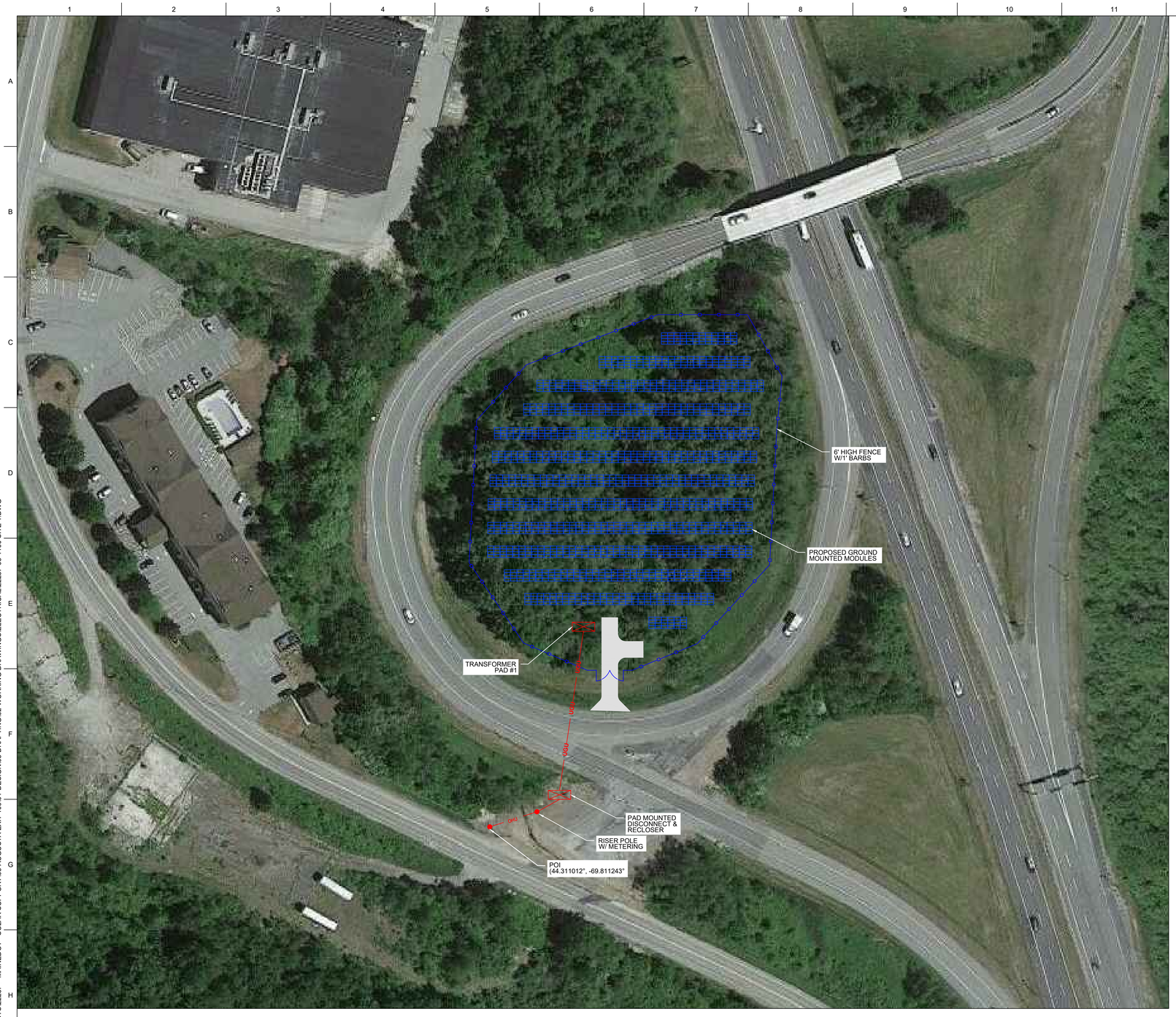
Installing Electrician: _____ Firm: _____
License No.: _____

Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Telephone: _____

Installation Date: _____ Interconnection Date: _____

Signed: _____ Date: _____
(Inspector - if required)

(In lieu of signature of Inspector, a copy of the final inspection certificate may be attached)



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GENERAL NOTES:

1. TREES MAY GROW DURING THE LIFE OF THE SYSTEM AND IMPACT THE PRODUCTION.
2. ANY AND ALL LAYOUT CHANGES, INCLUDING BUT NOT LIMITED TO SHIFTING OF THE ARRAY, ARE SUBJECT TO APROVAL BY THE DESIGN TEAM.
3. ARRAY LAYOUT DIMENSIONS SHALL BE CONSIDERED APPROXIMATE AND MAY VARY SLIGHTLY DUE TO MODULE INSTALLATION TOLERANCES AND VARYING TOPOGRAPHY.

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 395W
MODULES QUANTITY	1,728
DC RATING AT STC	711 KW
AC RATING	500 KW
INVERTER	(4) XGI125HV - 125 KW
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1450 VDC

LEGEND:

- MODULE
- ROAD (14 FT.)
- UTILITY POLE
- UGU — UNDERGROUND
- OHU — OVERHEAD
- FENCE
- TRANSFORMER PAD

PRELIMINARY
NOT FOR CONSTRUCTION

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

SEAL:

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 109 SITE 1
ME DOT
500 KW PV GENERATION FACILITY
73 WHITTEN RD., AUGUSTA, ME

SCALE: NONE **SIZE:** ARCH D

GENERAL SITE PLAN

DATE:	02/24/20
DRAWN BY:	CJB
ENGIN'D BY:	JED
PROJECT #:	22237-03
DRAWING #:	1100

PROPOSED UL1741 INVERTER INTERNAL CONTROL SETTINGS					
DEVICE	PICKUP		CLEARING TIME		
27-1	50%	(300 V)	66	CYC	(1.1 SEC)
27-2	88%	(528 V)	120	CYC	(2 SEC)
59-1	110%	(660 V)	120	CYC	(2 SEC)
59-2	120%	(720 V)	9.6	CYC	(0.16 SEC)
81U-1	58.5 HZ		18000	CYC	(300 SEC)
81U-2	56.5 HZ		9.6	CYC	(0.16 SEC)
81O-1	61.2 HZ		18000	CYC	(300 SEC)
81O-2	62 HZ		9.6	CYC	(0.16 SEC)

Base Voltage 600 V.

PF = 1.0

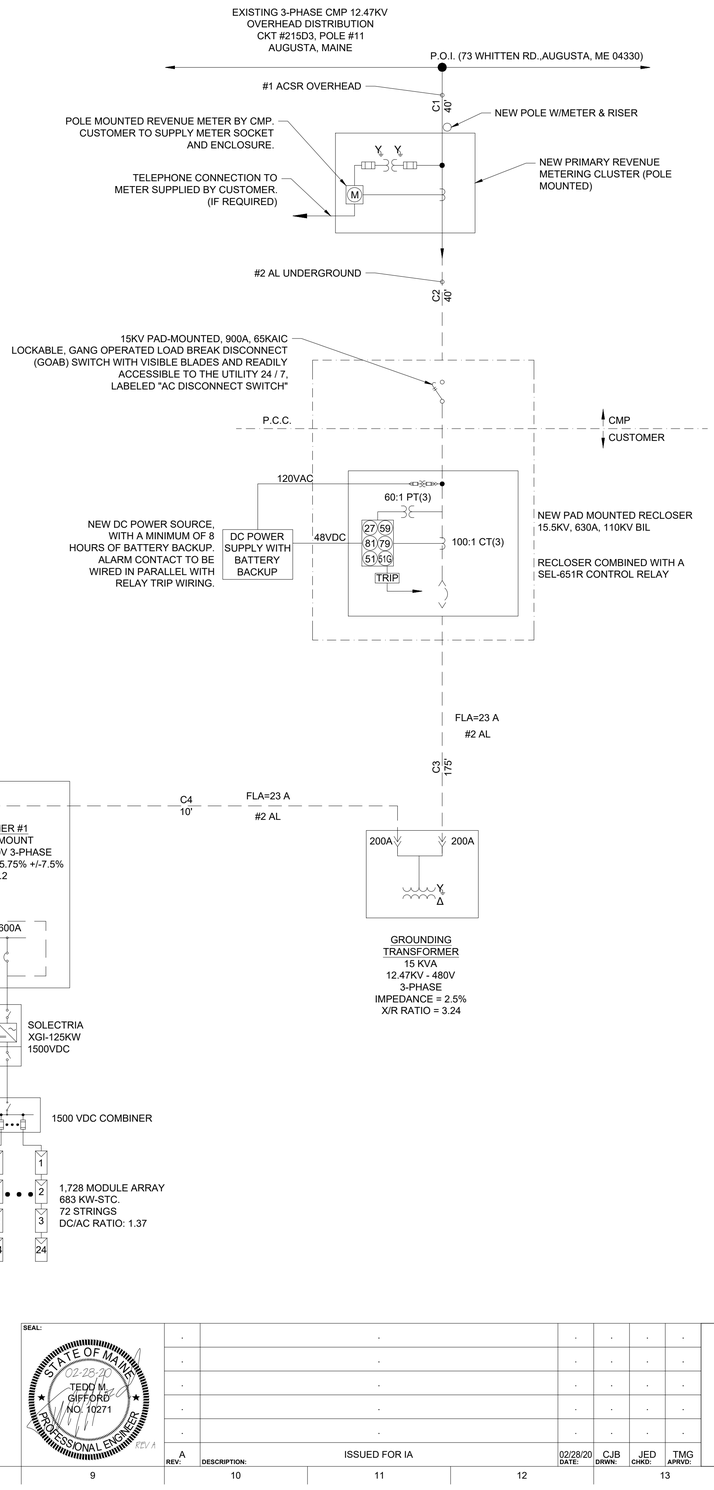
PROPOSED PROTECTION RELAY SETTINGS							
DEVICE	PICKUP			Time Delay		Total Clearing Time	
	Primary		Secondary				
27-1	50%	(3599.8 V)	(54 V)	63 CYC	1.05 SEC	66 CYC	1.1 SEC
27-2	88%	(6335.6 V)	(95.04 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-1	110%	(7919.5 V)	(118.8 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-2	120%	(8639.5 V)	(129.6 V)	6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81U-1	58.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81U-2	56.5 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81O-1	61.2 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81O-2	62 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
51		29 A	0.29 A	SET PER UTILITY STANDARDS			
51G		10 A	0.1 A	SET PER UTILITY STANDARDS			
79	0.95 PU - 1.05 PU 59 HZ - 60.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC

SETTINGS ASSUME 3 CYCLE ESTIMATED DEVICE TRIP OPENING TIME

SETTINGS ARE BASED ON IEEE 1547-2018 TABLE 1 (VOLT) AND 2 (FREQ).

SETTINGS ARE BASED ON A 108V SECONDARY PT BASE.

AC Wire and Cable Schedule													
From	To	Cable Number	Type	Material	Conductor	Voltage (kV)	Feet	Overhead - Ohms/mile Underground - Ohms/1000ft				Per Unit Value (100 MVA Base)			
								R_1	X_1	R_0	X_0	R_1	X_1	R_0	X_0
POI	Meter	C1	Overhead	ACSR	#1	12.47	40	1.4271	0.091666	1.7133	2.734672	0.006953	0.000447	0.008347	0.013323
Meter	GOAB/Recloser	C2	Underground	ACSR	#1	12.47	40	1.4271	0.091666	1.7133	2.734672	0.03671	0.002358	0.044072	0.070345
GOAB/Recloser	Grounding Xfmr	C3	Underground	AL	#2	12.47	175	0.335	0.05	0.5326	0.1272	0.037701	0.005627	0.059939	0.014315
Grounding Xfmr	Equip Pad #1	C4	Underground	AL	#2	12.47	10	0.335	0.05	0.5326	0.1272	0.002154	0.000322	0.003425	0.000818



UTILITY INTERCONNECTION NOTES:

1. INVERTERS (INV) - SOLECTRIA XGI-125KW, 1500VDC, 600VAC, NEMA 4X, MOUNTED ON UNISTRUT. INVERTERS ARE UL1741-SA-2016 LISTED AND IEEE1547-A COMPLIANT. INVERTER SHALL HAVE INTEGRATED AC & DC DISCONNECTS
2. MODULES TO BE CANADIAN SOLAR 395W KUMAX CS3U-395MS 144 CELL MONOCRYSTALLINE PANELS. MODULES ARE CERTIFIED UL 1703 COMPLIANT.
3. DAS SYSTEM TO BE DESIGNED AND ENGINEERED BY SELECTED DESIGNATED PARTY.
4. LOCATION OF THE POI: 44.31012°, -69.811243°

ONE LINE POWER DIAGRAM LEGEND:

- LOAD-BREAK SWITCH FUSE, SIZE AS INDICATED
- TRANSFORMER, SIZE AS INDICATED
- CIRCUIT BREAKER
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER / SOLID STATE TRIP UNIT
- GROUND
- L.A. LIGHTNING ARRESTOR
- CABLE TERMINATION/LOAD ELBOW
- FUSE
- GROUP AIR (GOAB) SWITCH
- (M) REVENUE METER (BY UTILITY)
- LOAD BREAK ELBOWS

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 395W
MODULES QUANTITY	1,728
DC RATING AT STC	711 KW
AC RATING	500 KW
INVERTER	(4) XGI125HV - 125 KW
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1250 VDC

DEVICE NO.	DESCRIPTION
27	UNDERVOLTAGE RELAY
50/51	INSTANTANEOUS/TIME OVERCURRENT RELAY
51G	GROUND OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59G	GROUND OVERVOLTAGE RELAY
79	AC RECLOSING RELAY
81/O	OVERFREQUENCY RELAY
81/U	UNDER FREQUENCY RELAY

LEGEND:

- OVERHEAD
- UNDERGROUND
- PRIMARY
- COMMUNICATION

PRELIMINARY
NOT FOR CONSTRUCTION

SEAL: STATE OF MAINE 02-28-20 TEDD M. GIFFORD NO. 10271 PROFESSIONAL ENGINEER REV'A

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 109 SITE 1
ME DOT
500 KW PV GENERATION FACILITY
73 WHITTEN RD., AUGUSTA, ME

SCALE: NONE **SIZE:** ARCH D

ONE LINE DIAGRAM

DATE:	02/24/20
DRAWN BY:	CJB
ENGN'D BY:	JED
PROJECT #:	22237-03
DRAWING #:	2100

NEW

CanadianSolar

KuMax

HIGH EFFICIENCY MONO PERC MODULE

CS3U-375|380|385|390|395MS

(1000 V / 1500 V)

MBB 5BB

MORE POWER

- Low power loss in cell connection
- Low NMOT: 41 ± 3 °C
  Low temperature coefficient (Pmax): -0.37 % / °C
- Better shading tolerance
- High PTC rating of up to: 93.13 %

MORE RELIABLE

- Lower hot spot temperature
- Minimizes micro-cracks
- Heavy snow load up to 5400 Pa,
  wind load up to 3600 Pa*

25 years linear power output warranty

10 years product warranty on materials and workmanship

MANAGEMENT SYSTEM CERTIFICATES

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE / MCS / CEC AU
UL 1703 / IEC 61215 performance: CEC listed (US) / FSEC (US Florida)
UL 1703: CSA / IEC61701 ED2: VDE / IEC62716: VDE / IEC60068-2-68: SGS
Take-e-way

*We can provide this product with special BOM specifically certified with salt mist, ammonia and sand blowing tests. Please talk to our local technical sales representatives to get your customized solutions.

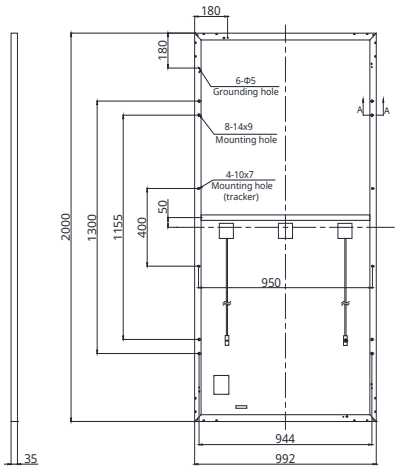
CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 30 GW deployed around the world since 2001.

* For detailed information, please refer to the Installation Manual.

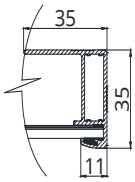
CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

ENGINEERING DRAWING (mm)

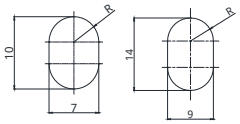
Rear View



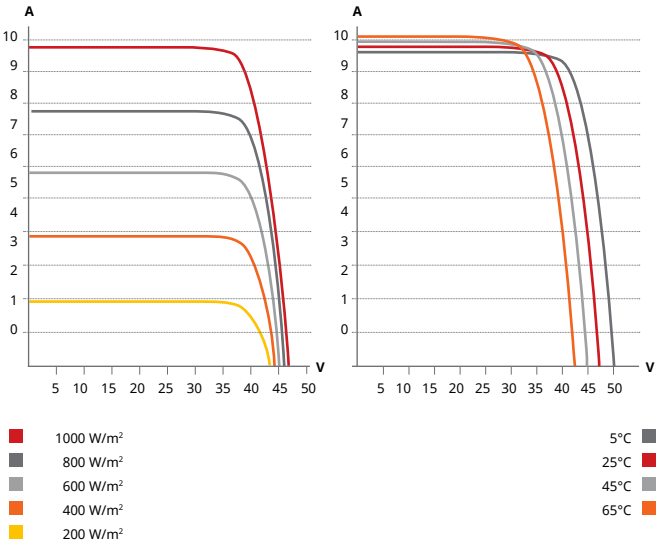
Frame Cross Section A-A



Mounting Hole



CS3U-375MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	375 W	380 W	385 W	390 W	395 W
Opt. Operating Voltage (Vmp)	39.8 V	40.0 V	40.2 V	40.4 V	40.6 V
Opt. Operating Current (Imp)	9.43 A	9.50 A	9.58 V	9.66 A	9.73 A
Open Circuit Voltage (Voc)	47.6 V	47.8 V	48.0 V	48.2 V	48.4 V
Short Circuit Current (Isc)	9.93 A	10.01 A	10.09 A	10.17 A	10.25 A
Module Efficiency	18.90%	19.15%	19.41%	19.66%	19.91%
Operating Temperature	-40°C ~ +85°C				
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)				
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)				
Max. Series Fuse Rating	30 A				
Application Classification	Class A				
Power Tolerance	0 ~ + 5 W				

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	280 W	284 W	287 W	291 W	295 W
Opt. Operating Voltage (Vmp)	36.9 V	37.1 V	37.3 V	37.5 V	37.7 V
Opt. Operating Current (Imp)	7.58 A	7.64 A	7.70 A	7.76 A	7.82 A
Open Circuit Voltage (Voc)	44.8 V	45.0 V	45.1 V	45.3 V	45.5 V
Short Circuit Current (Isc)	8.01 A	8.07 A	8.14 A	8.20 A	8.26 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2000 X 992 X 35 mm (78.7 X 39.1 X 1.38 in)
Weight	22.5 kg (49.6 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 400 mm (15.7 in) (+) / 280 mm (11.0 in) (-); landscape: 1250 mm (49.2 in);leap-frog connection: 1670 mm (65.7 in)*
Connector	T4 series
Per Pallet	30 pieces
Per Container (40' HQ)	660 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.37 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	41 ± 3°C

PARTNER SECTION

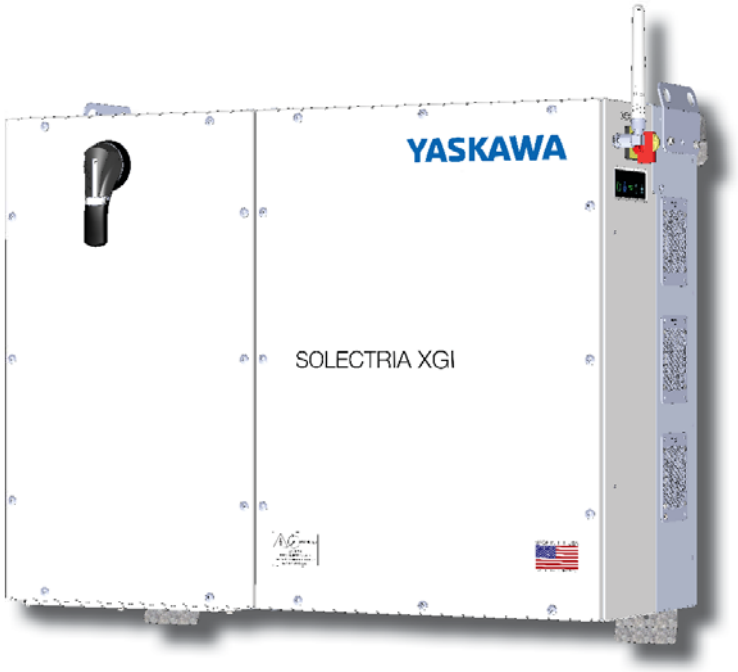
* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustments to the information described herein at any time without further notice. Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

YASKAWA

SOLECTRIA XGI™ 1500

Premium 3-Ph Transformerless Utility-Scale Inverters



Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- 99.0% peak efficiency
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades

Options

- String combiners for distributed and centralized systems
- Web-based monitoring
- Extended warranty

MADE IN THE USA

With U.S. and Global Components

Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that were selected, tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market and have been engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the new SOLECTRIA XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The XGI 1500 inverters are Made in the USA with global components and are compliant with the Buy American Act.

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	148.3 A	148.3 A	178.0 A	197.7 A
Maximum Operating PV Power	128 kW	128 kW	153 kW	170 kW
Maximum DC/AC Ratio | Max Rated PV Power	1.5 | 188 kW	1.5 | 188 kW	1.5 | 225 kW	1.5 | 250 kW
Max Rated PV Short-Circuit Current (∑Isc x 1.25)	320 A	320 A	320 A	320 A
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.9%	98.9%	99.0%	99.0%
CEC Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Option for 10 Years			
Enclosure				
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) | Width: 39.4 in. (1000 mm) | Depth: 15.1 in. (380 mm)			
Weight	245 lbs (111 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			

Specifications subject to change.

SOLECTRIA SOLAR

Yaskawa Solectria Solar
360 Merrimack Street
Lawrence, MA 01843
solectria.com

1-978-683-9700
inverters@solectria.com

DOCR-070730-O | May 2019

YASKAWA

(http://www.eaton.com/us/en-us.html)

4000358C18CM

Specifications

GENERAL SPECIFICATIONS

PRODUCT NAME
Eaton Cooper Power series RTE dual-sensing Bay-O-Net fuse link

CATALOG NUMBER
4000358C18CM

PRODUCT HEIGHT
4.72 IN

PRODUCT WEIGHT
.1 LB

COMPLIANCES
Not Applicable

CERTIFICATIONS
Not Applicable

PRODUCT SPECIFICATIONS

FUSE TYPE
Bay-O-Net

TYPE
Dual sensing

FUSE VOLTAGE RATING - MAX
23 kV

CURRENT RATING
140A

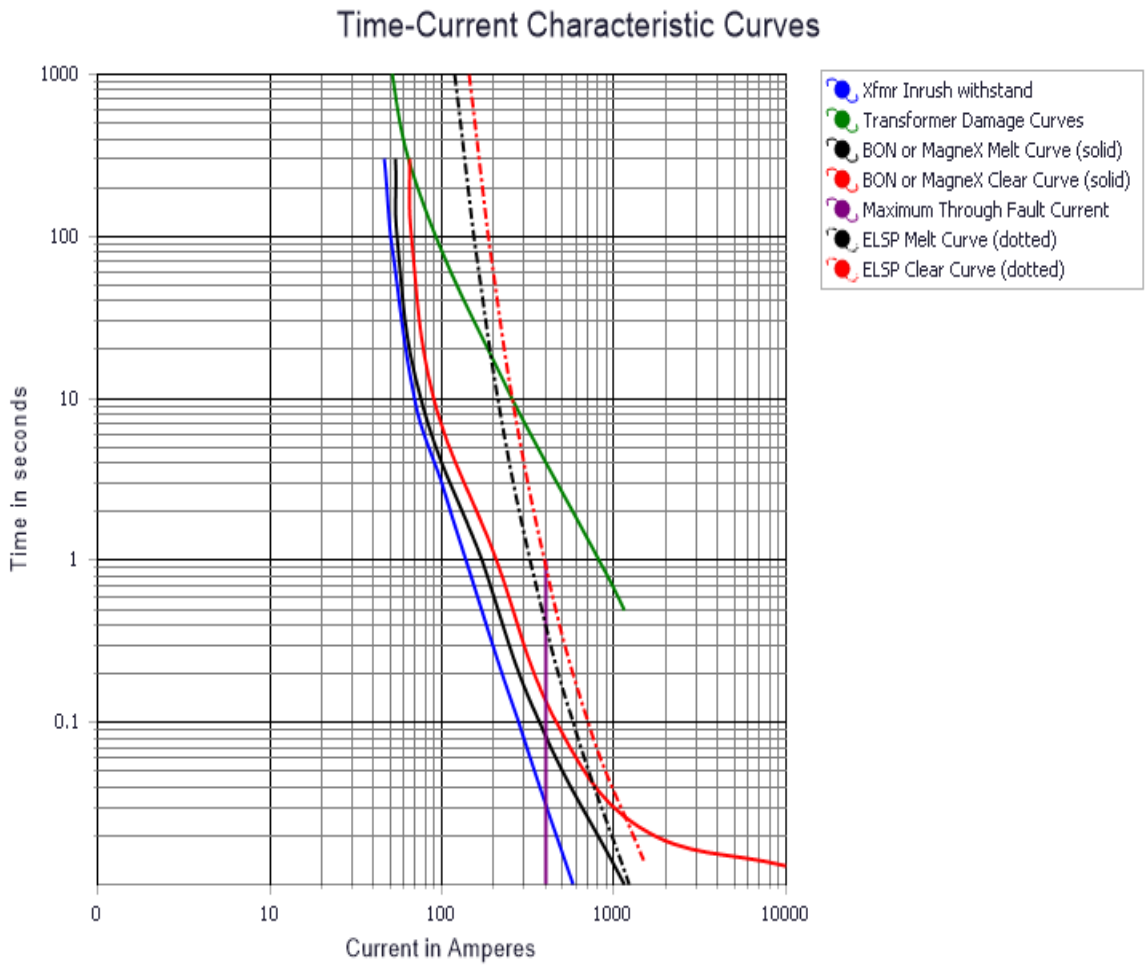
QUANTITY
50

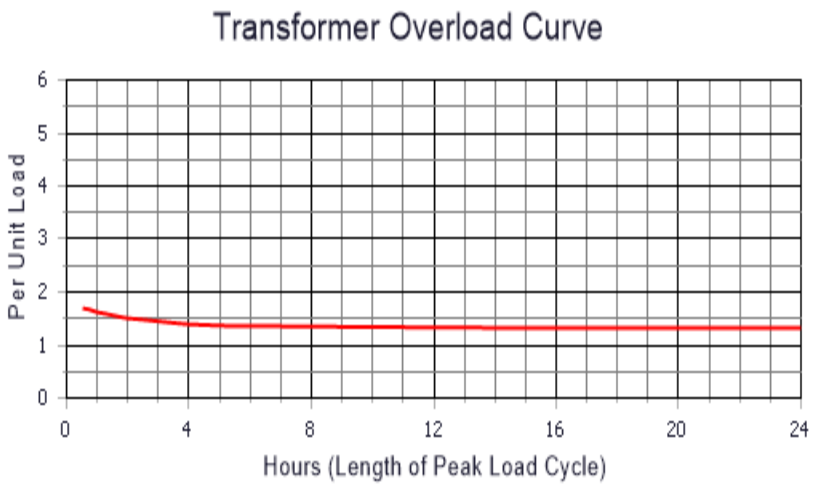
VOLTAGE RATING
23 kV

AMPERAGE RATING
140A

Download Links

TransFusion™ Coordination Program





Provided Inputs

Transformer kVA Rating: 500
Primary Voltage (kV): 12.47
Number of Phases: 3
Minimum Impedance: 5.75
Primary Connection: Wye
Secondary Connection: Wye
Protection Type: Dual Element Bay-O-Net
Desired Protection level: Least Overload
Temperature Class: 65
Ambient Temperature: 35
Transformer Preload: 75
Xfmr. Rated Current (A): 23.15
Maximum Through Fault: 403

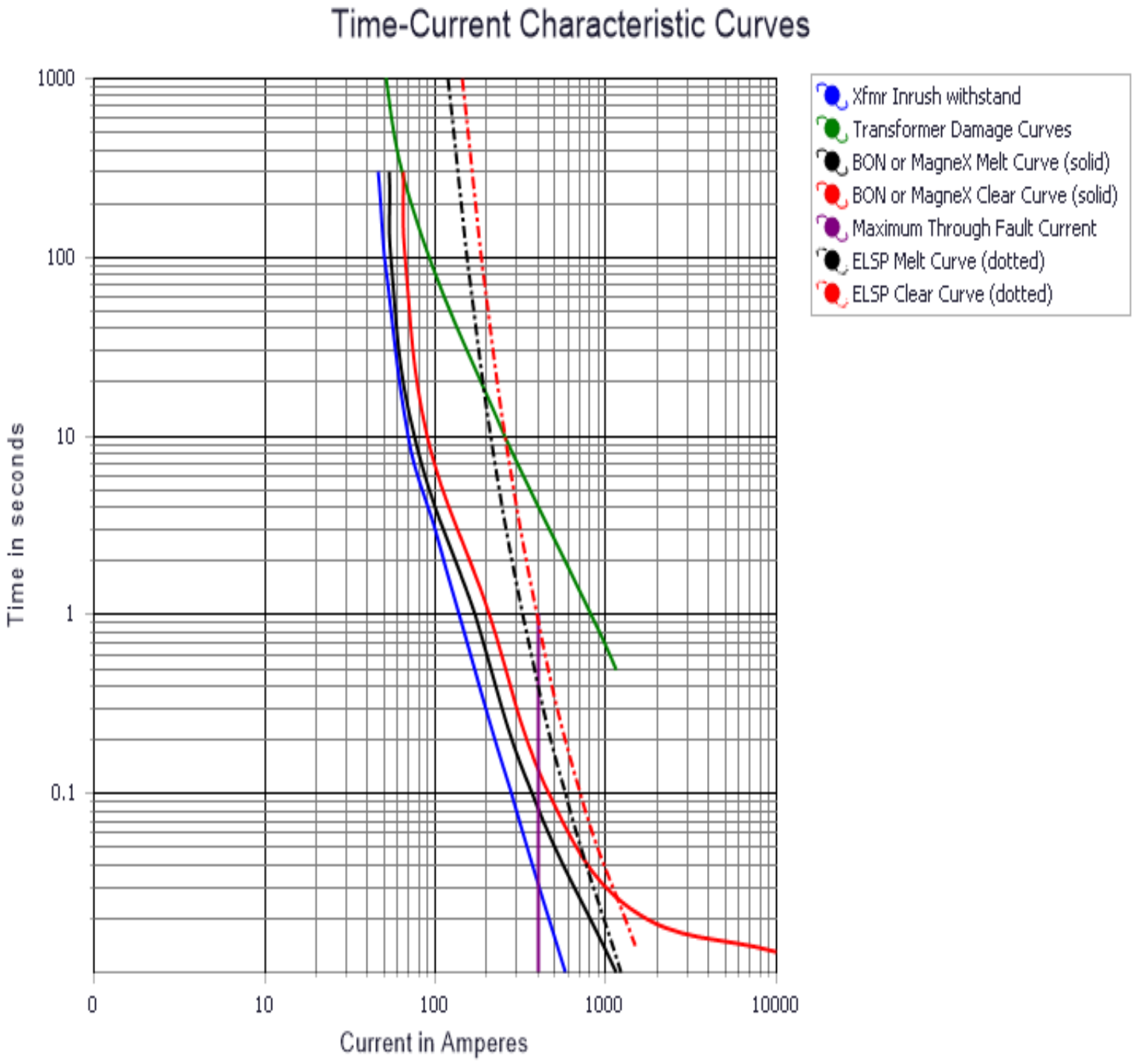
Protection Device Recommendation

Based on your criteria, we recommend the following Cooper Power Systems protection device(s) for your application:

ELSP Selection: CBUC08080C100
Bay-O-Net Selection: 4038108C09M

Powering Business Worldwide

TransFusion™ Coordination Program



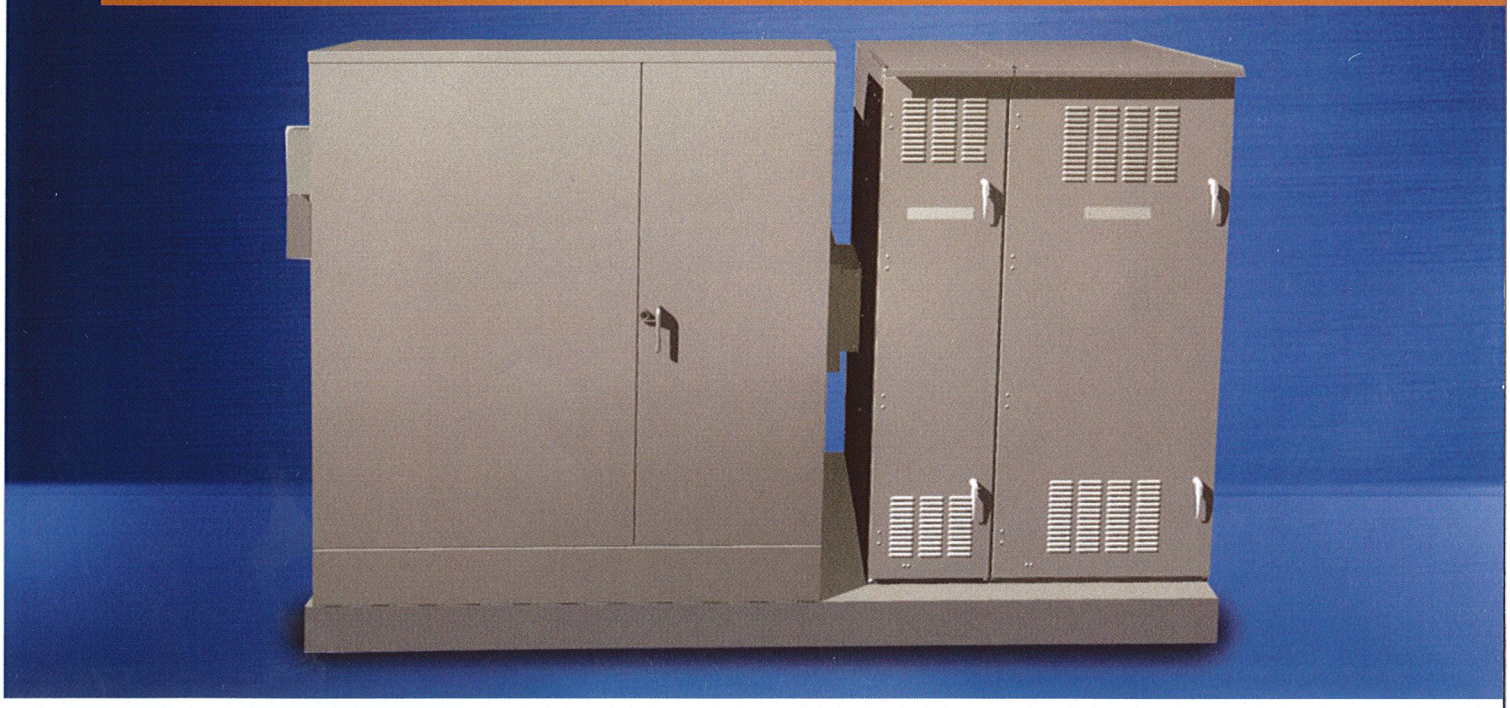
Powering Business Worldwide

Protection Device Recommendation

ELSP Selection: CBUC08080C100
Bay-O-Net Selection: 4038108C09M

1500 Vdc / 600 Vac
150 kW string inverter applications

Markets served
Renewable energy



Eaton's close-coupled solar recombiner and transformer solutions for string inverters

When it comes to commercial and utility-scale solar power, your focus is on reducing project complexity and minimizing costs. With changes in regulations and challenges with financing, you need a partner that has the expertise to reduce installation time and material, and to keep your people safe. As projects become more complex with grid connectivity and energy storage requirements, leadership, service and support become critical.

At Eaton, we know space is always at a premium, time is limited and cost matters. That's why we offer solar solutions that ease installation, save labor and lower the total cost of investment. For example, our space-saving AC solar recombiner integrates circuit breakers or fuse protection and a disconnect all within one enclosure. Integrated cable management, custom recombiner assemblies and transformers specially designed for solar PV string inverter applications are further examples of how our equipment is engineered to save our customers valuable space, time and money.

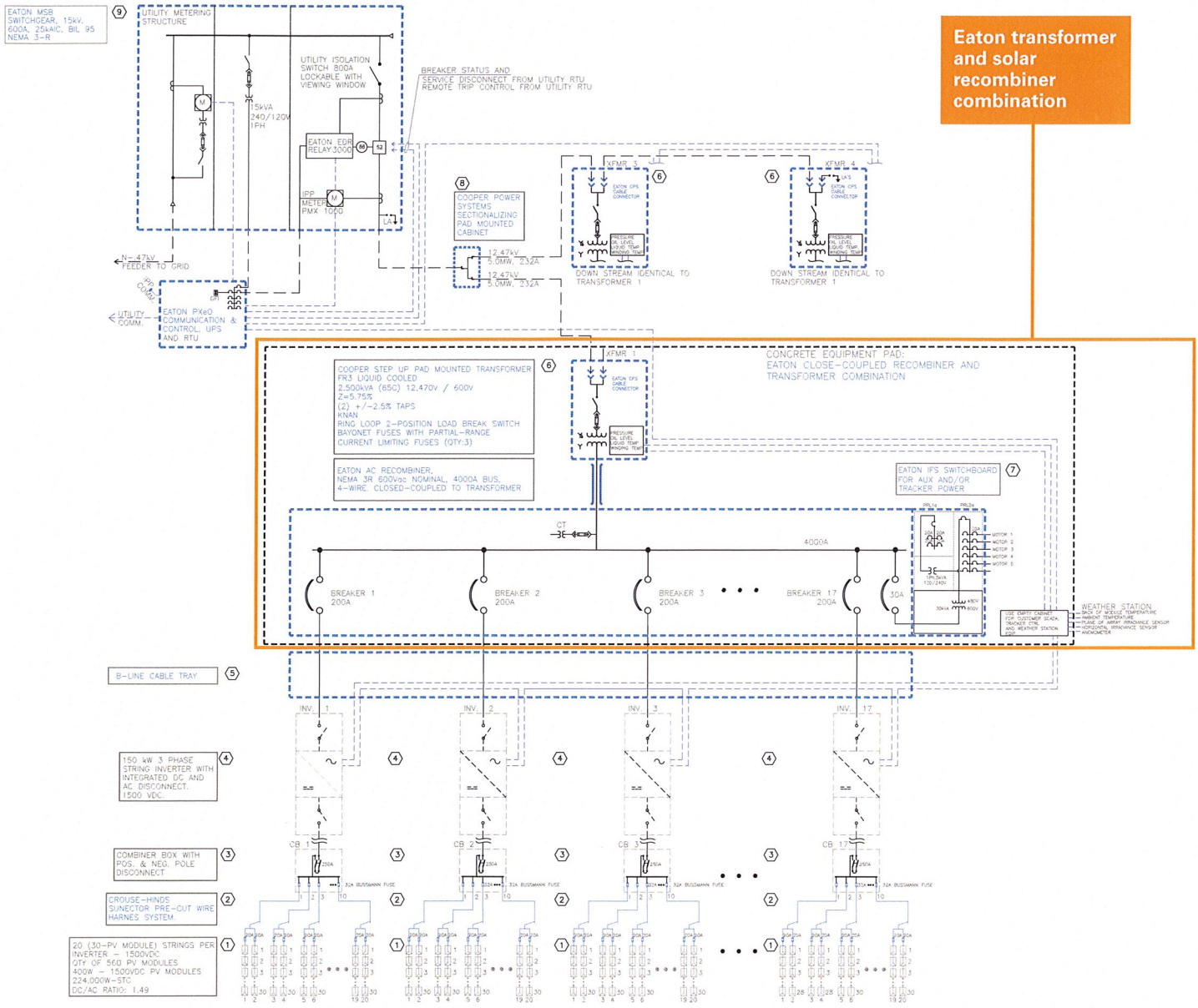
We can customize electrical system packages to specific requirements, including the physical dimensions and location of the building or installation. In addition, Eaton's regional satellite center personnel are knowledgeable in local electrical codes and utility regulations, so we design solutions that help streamline approvals by local authorities.

AC solar recombiners

- Customizable configurations for AC circuit breakers, main breakers and fusible switches
- UL® 891 listed assemblies for 480 Vac and 600 Vac applications
- Non-UL assemblies for 800 Vac applications using UL and IEC rated components
- Component integration can include metering, relays, dry-type transformers and more
- Offers close-coupling to Eaton liquid-filled transfomers
- Suitable for pour-in concrete pad installation; optional skid mounting also available

EATON
Powering Business Worldwide

One-line diagram for 1500 Vdc / 600 Vac 150 kW string inverter applications



Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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Publication No. PA083014EN / Z21370
September 2018

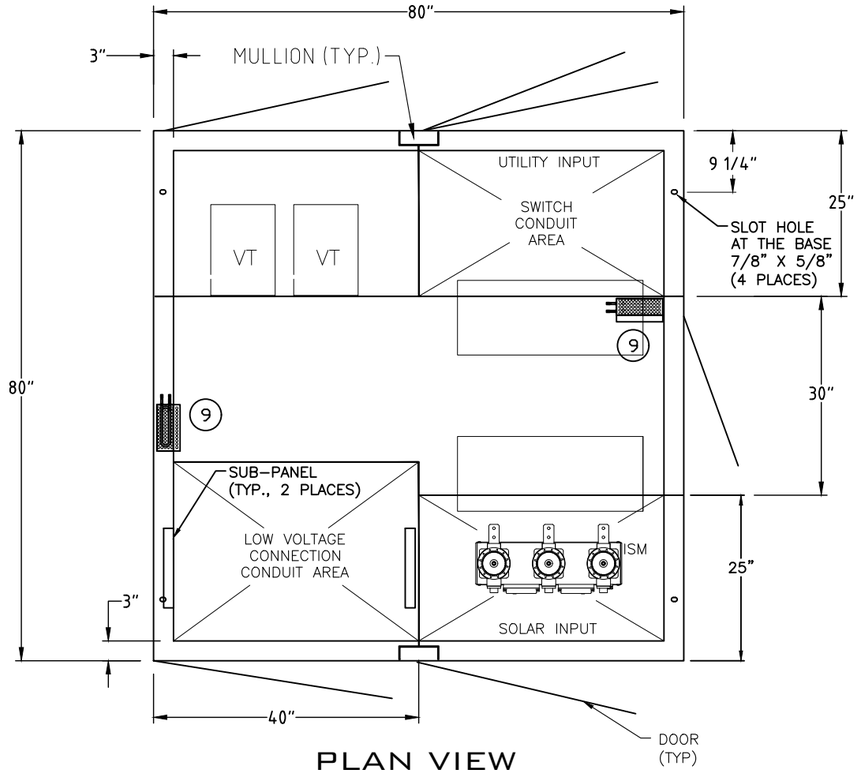
Follow us on social media to get the latest product and support information.

Powering Business Worldwide

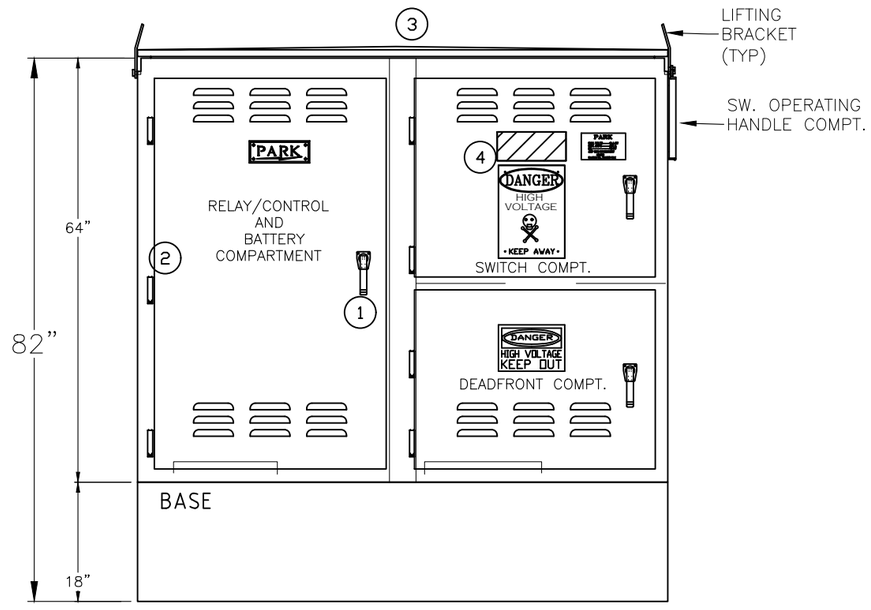
ALDON ELECTRIC
38 GREENWOOD AVENUE, WEYMOUTH, MA 02189
PHONE: 781-337-0222 FAX: 781-337-5152
WWW.ALDONELECTRIC.COM

SUBMITTAL FOR ELECTRIC:

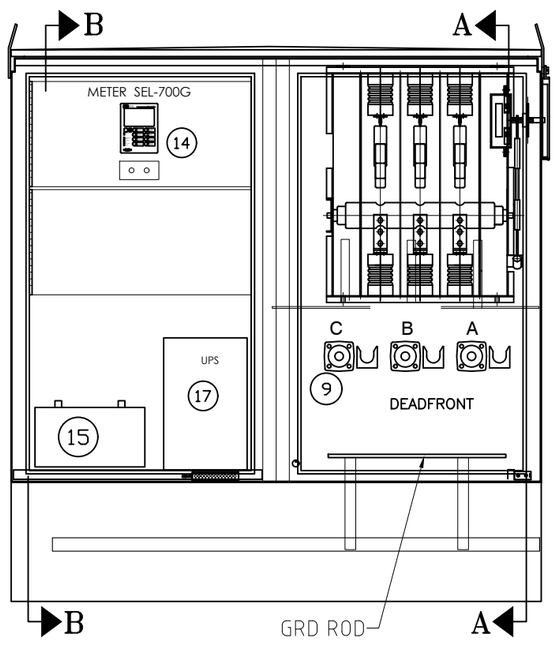
Combined Pad-mounted switchgear with recloser function and 15KV switch :



PLAN VIEW



FRONT VIEW



FRONT VIEW-INSIDE
MAIN DOOR REMOVED

LEGEND

1. PADLOCKABLE DOOR HANDLE
2. LIFT–OFF HINGE (BRASS PIN/STAINLESS STEEL TUBE)
3. SLOPED (CROWNED) WEATHERTIGHT ROOF
4. SWITCH BLADES POSITION VIEWING VINDOW
5. PADLOCKABLE COVER FOR SWITCH OPERATOR HANDLE (DETAIL–A)
6. POLYCARBONATE BARRIER
7. LOAD INTERRUPTER SWITCH
8. VACUUM FAULT INTERRUPTER
9. 200A DEAD FRONT BUSHINGS
10. INSULATOR
11. SILVER–PLATED COPPER BUS
12. COPPER GROUND BUS
13. 240V/375W HEATER
14. SEL–700G PROTECTION RELAY
15. BATTERY PACK
16. CURRENT TRANSFORMER (WINDOW TYPE)
17. 24VDC UPS
18. VOLTAGE XFMR

PARK
19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

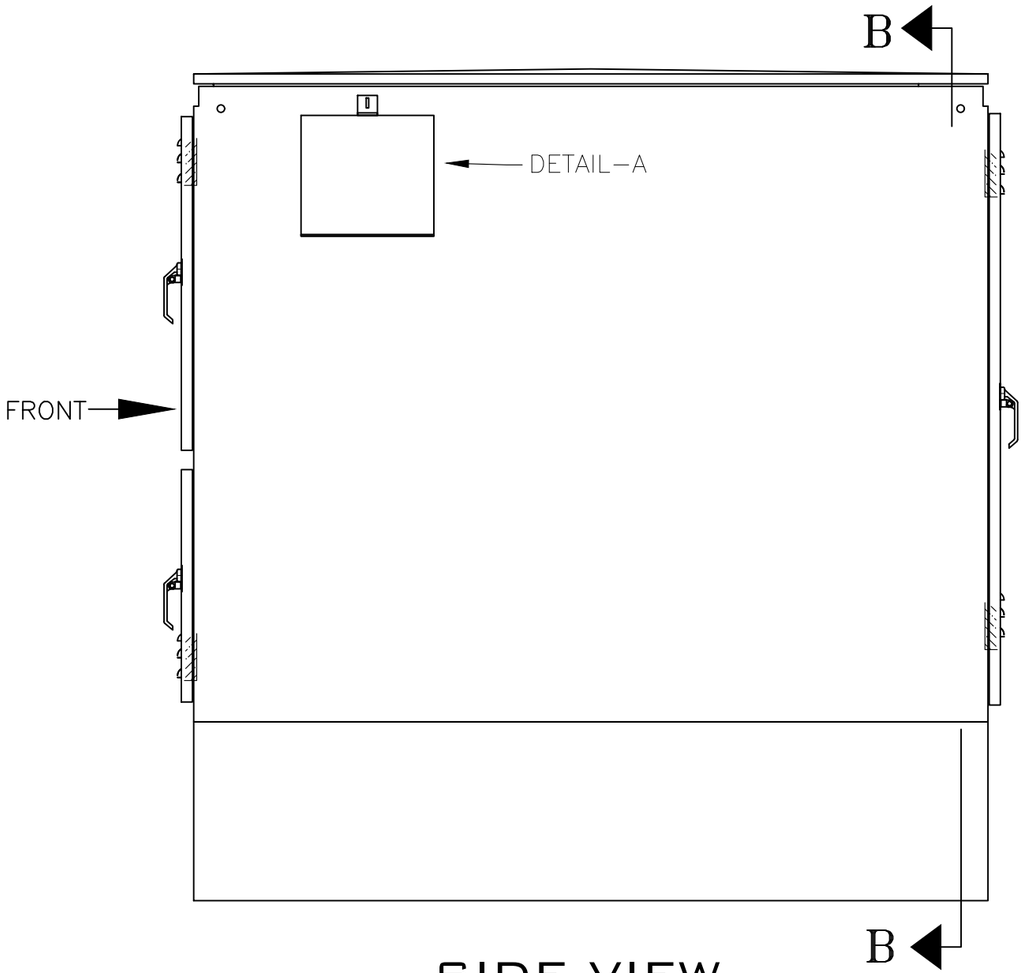
PAGE #	TYPE	DESCRIPTION
1	MECHANICAL	COVER SHEET FRONT VIEW
2	"	PLAN VIEW
3	"	SIDE VIEW
4	BOM	BILL OF MATERIAL
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

NOTES:
1. 15KV, 200A, 3PH, 3W DEAD–FRONT SWITCHGEAR–PAD MOUNTED.
2. NEMA 3R CONSTRUCTION: 11GA. WELDED STEEL, OPEN BASE–10GA. GALV. STEEL. FRONT/REAR ACCESS.
3.

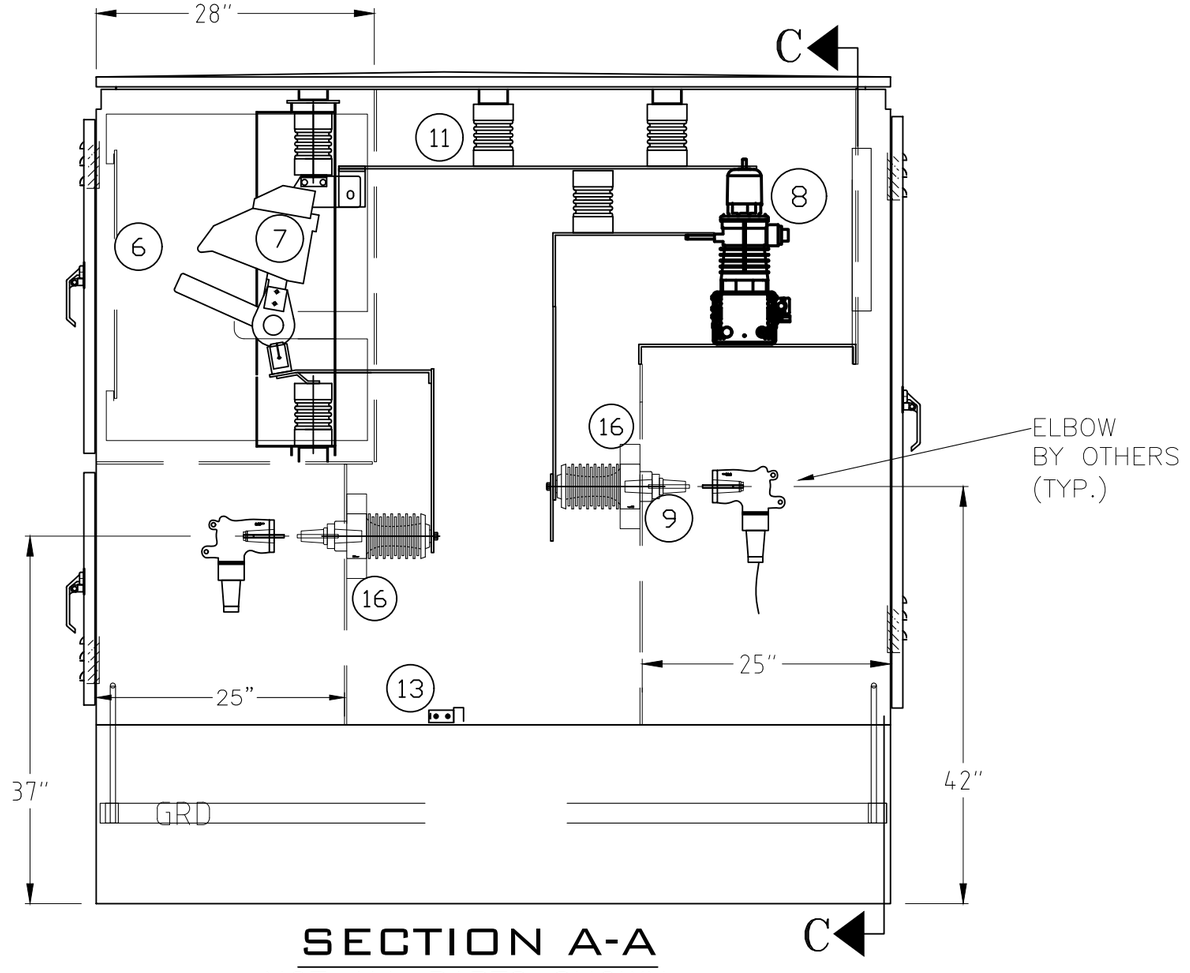
CUSTOMER APPROVAL REQUIRED
(NOT FOR PRODUCTION)
DATE : 1/13/2020

REV #	DATE	BY.	SHEET(S)	NOTES
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION: SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 1 OF 6



SIDE VIEW



SECTION A-A

NOT ALL PARTS SHOWN

PARK

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DETROIT, MICHIGAN 48234-2880

FILE LOCATION:\NUMBER2019\191544.DWG		
CUSTOMER:		
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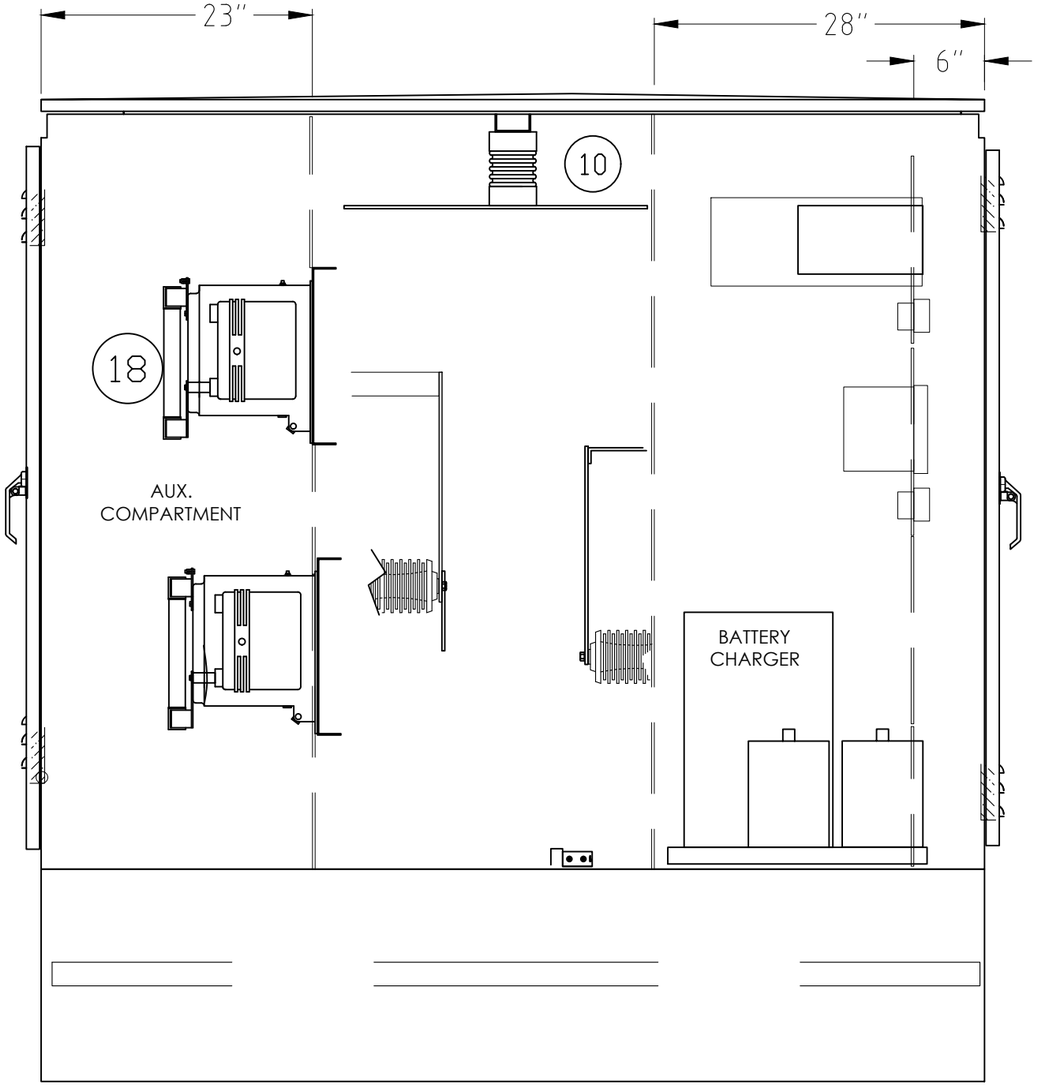
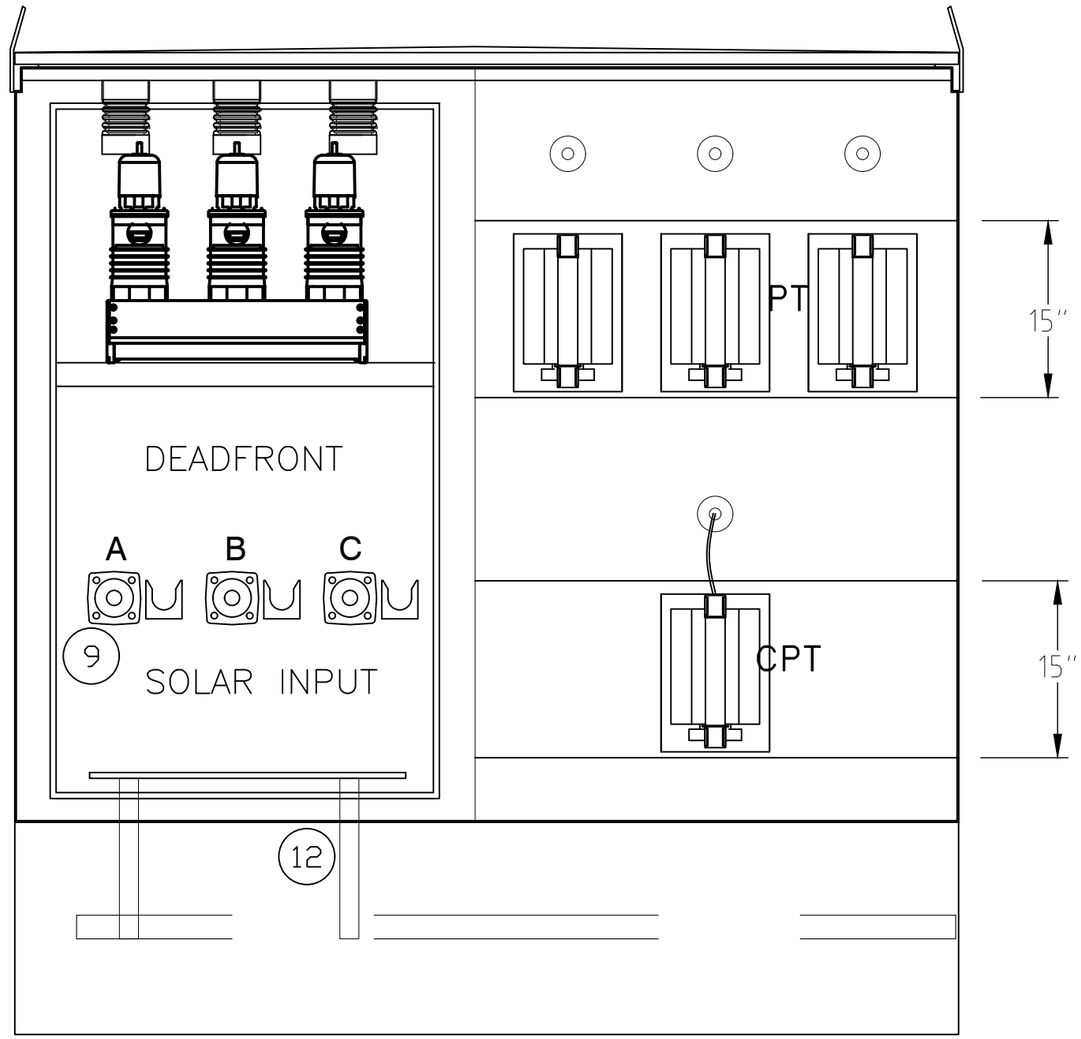
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 2 OF 6



SECTION B-B



SECTION C-C

REAR VIEW

PARK
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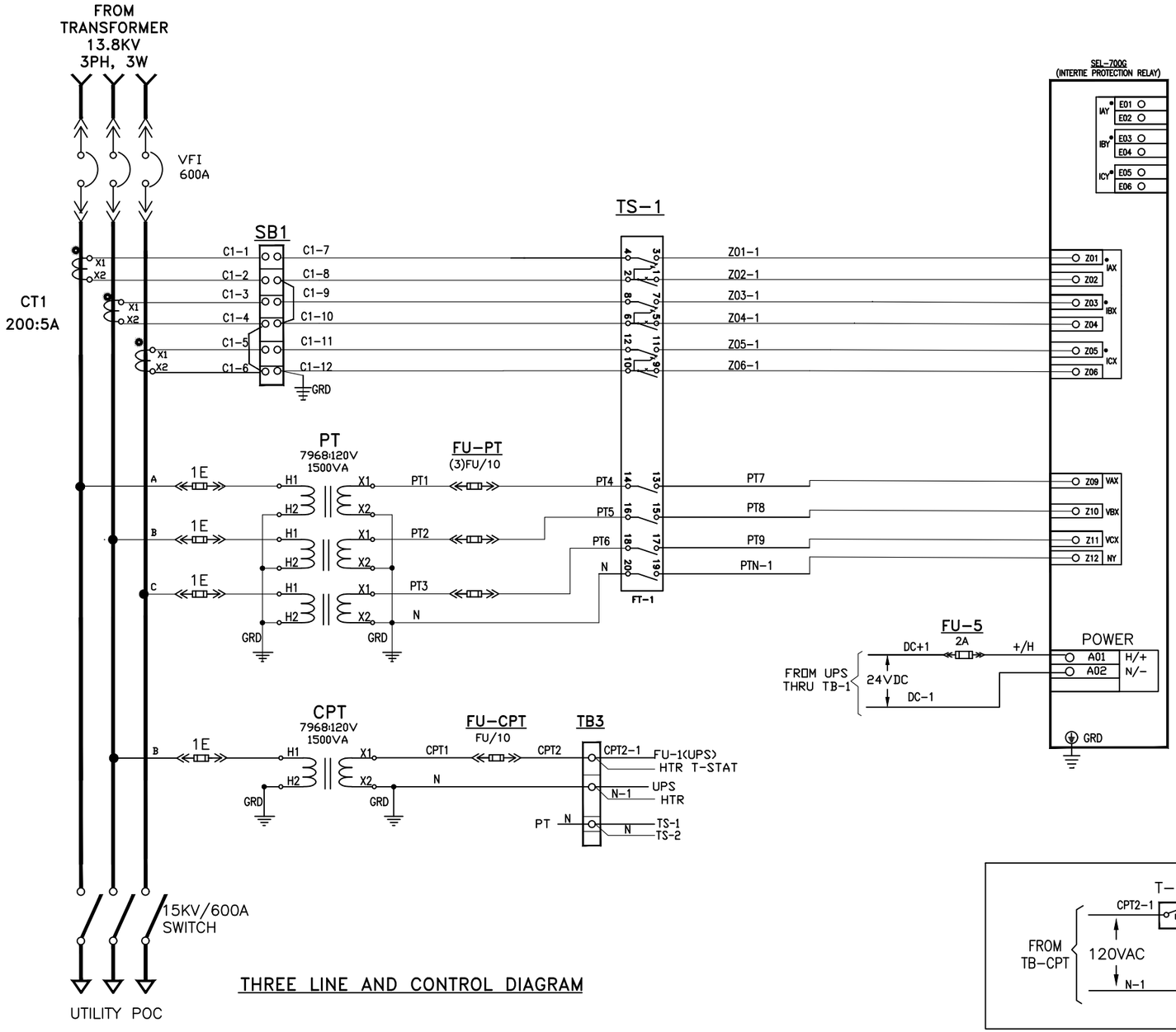
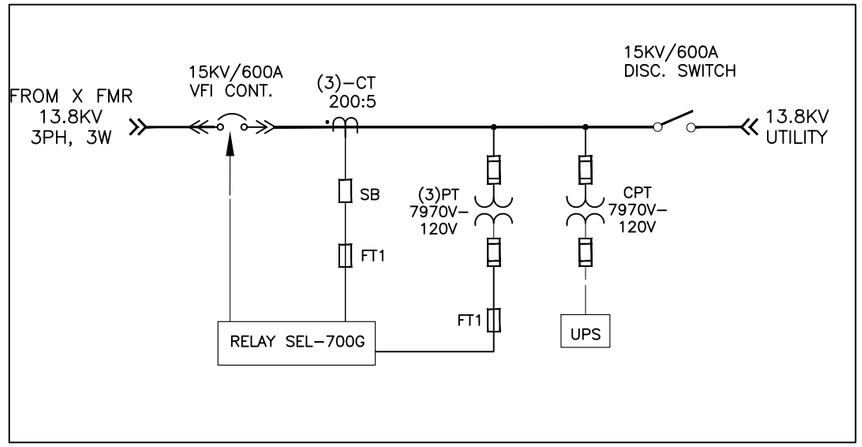
DETROIT, MICHIGAN 48234-2880

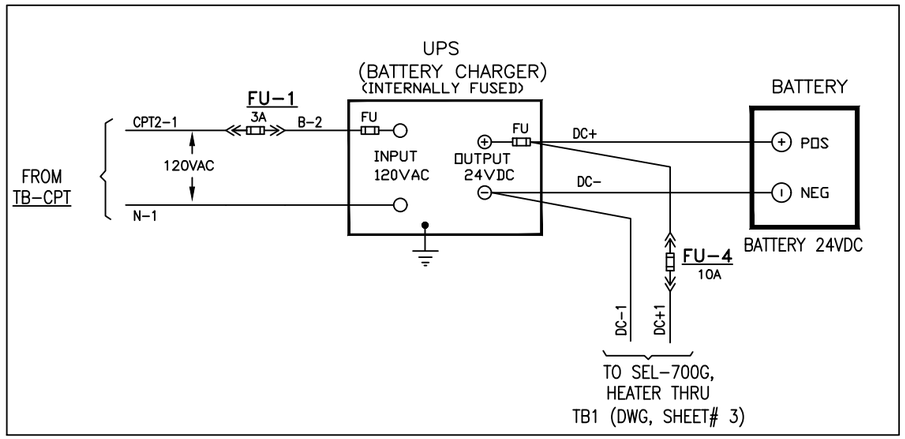
FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION: SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 3 OF 6



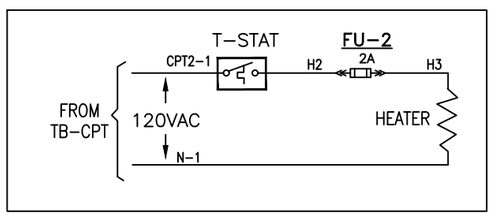
THREE LINE AND CONTROL DIAGRAM



ONE LINE DIAGRAM



BATTERY CHARGE SCHEMATIC



HEATER DIAGRAM

PARK

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DETROIT, MICHIGAN 48234-2880

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CUSTOMER:		
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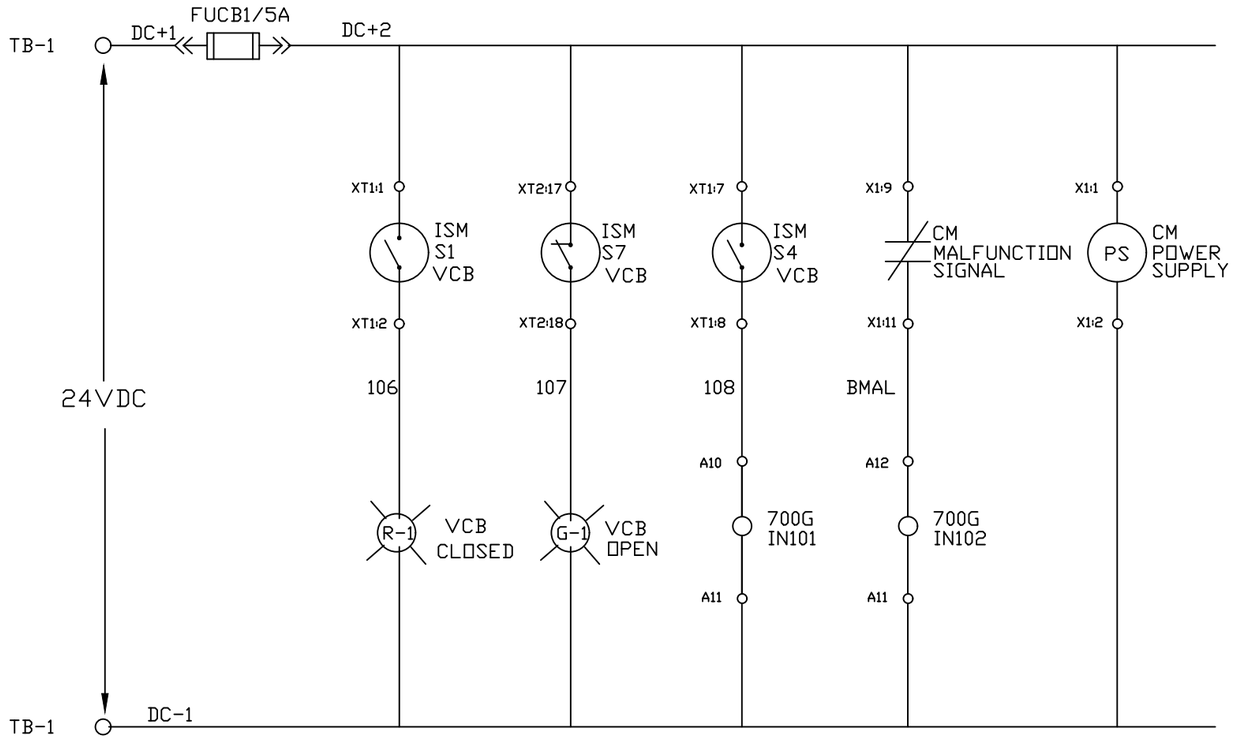
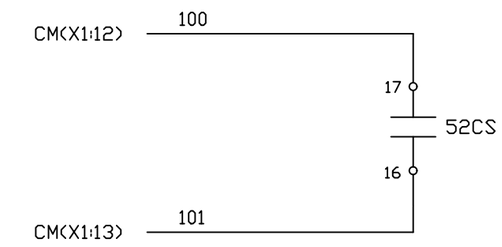
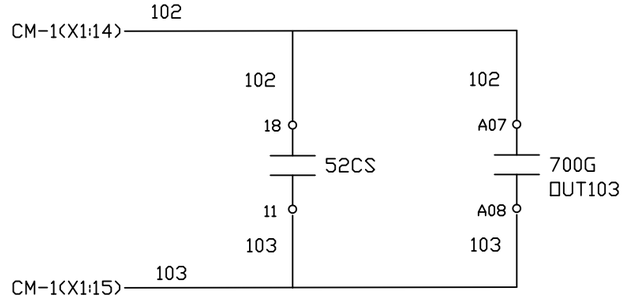
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 4 OF 6



CIRCUIT BREAKER STATUS INDICATING LIGHS, POWER SUPPLY & 700G INPUT



CIRCUIT BREAKER(CB) CLOSE COMMAND



CIRCUIT BREAKER(CB) TRIP COMMAND

PARK

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FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
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CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 5 OF 6

ITEM PM215-SC-VB-02-DF-06-NG-13.8

ITEM #	DESIGNATION	QTY	MFG. PART NUMBER	MANUFACTURER	DESCRIPTION
1	VFI	1	ISM15_LD_1(55)	TAVRIDA	ISM 3 PHASE TAVRIDA BREAKER MODULE - 15KV,800A, 20KA
2	CM	1	CM_TEL_24/60-12-01A	TAVRIDA	CONTROL MODULE FOR TAVRIDA ISM BREAKER MODULE, 24VDC
3	700G	1	0700G02B0X0X0X860200	SEL	SEL-700G GENERATOR AND INTERTIE PROTECTION RELAY, 2X16 LCD WITH8 PUSHBUTTONS, 24/48VDC, 1 - 10/100BASE-T, EIA-232, 5A CURRENT INPUT, 24VDC CONTROL.
4	PT	4	7525A65G29	ABB	VIZ-11, INDOOR application, 110kV BIL, Nominal system voltage: 15kV, Connection type: Line-Ground, Primary voltage: 7970/13800GY Volts, Secondary voltage: 120, Metering accuracy: 0.3Z, RVF: 1.1, Thermal rating: 1500, Frequency: 60Hz, Ratio: 66.4:1
5	BUSHING	6	1101-225B	ELLIOTT	200A 25KV AIR INSULATED BUSHINGS
6	CT	3	115-201	GE-ITI	CURRENT TRANSFORMER, 600V, 4.0" ID, 200:5 AMPS, C20 CLASS, RF: 2.0.
7	SB	2	EB27B06SC	GE-ITI	SHORTING BLOCK, 6 POLE, EB27B06SC
8	ENCL	1	PM215-SC-VB-02-DF-ENCL	PARK	
9	TS1 & 2	2	774B430G20	ABB	FT-1 FLEXITEST SWITCH, 10 POLE, 4 POTENTIAL, 6 CURRENT
10	SWITCH	1	255032-ED-240R6-2	S&C	SWITCH, 15KV MINI-RUPTER, MAIN CONTACT TOP, RIGHT HAND OPR, TOP MTG
11	FB1, 2 thru 7, CPT	8	30311	MERSEN	250 VOLT, 30 AMP, 1 POLE MIDGET FUSE BLOCK
12	FU3	2	ATM3	MERSEN	250 VOLT, 3 AMP MIDGET FUSE
13	FB-PT	1	30313	MERSEN	250 VOLT, 30 AMP, 3 POLE MIDGET FUSE BLOCK
14	FU-PT, CPT, FU4	5	ATM10	MERSEN	250 VOLT, 10 AMP MIDGET FUSE
15	FU5	1	ATM6	MERSEN	250 VOLT, 6 AMP MIDGET FUSE
16	FU6	1	ATM5	MERSEN	250 VOLT, 5 AMP MIDGET FUSE
17	FU2	1	ATM2	MERSEN	250 VOLT, 2 AMP MIDGET FUSE
18	UPS	1	SEI250/24-P	SEI POWER	9Amp 24 DC Output DC UPS with integrated 18 Ah battery backup (250 watts) with external battery connection
19	BATTERY	1	BP-18U	SEI POWER	External 18 Ah 24Vdc Battery Pack with Integrated Self-Test Circuitry
1					
2					
3	TB1 & TB2	2	SERIES 300	MARATHON	12 POINT TERMINAL BLOCK

PARK
19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

FILE LOCATION:\NUMBER2019\191544.DWG		
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CONSTRUCTION : OUTDOOR - NEMA 3R		
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MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 6 OF 6

I-95 Exit 109 East

Interconnection Application

Forms and Agreements 4: Level 2, Level 3 and Level 4 Interconnection Application

A Customer-Generator applicant ("Applicant") hereby makes application to CMP (Utility or T & D Utility) to install and operate a generating facility interconnected with the CMP utility system. This application will be considered as an application for interconnection of generators under Expedited interconnection review provided the generator is not greater than 2 MW but shall serve as an Application for Standard interconnection review if greater than 2 MW or if Expedited review does not qualify the generator for interconnection.

Written applications should be submitted by mail, e-mail or fax to Central Maine Power Company (CMPCO), as follows:

[Utility]: Central Maine Power Company (CMPCO)
[Utility's address]: 83 Edison Drive, Augusta, ME 04336
Telephone Number: 207.621.4732
E-Mail Address: nathan.pelletier@cmpco.com.
[Utility] Contact Name: C/O Nick Pelletier
[*Utility*] Contact Title: _____

An application is a Complete Application when it provides all applicable information required below. (Additional information to evaluate a request for interconnection may be required and will be so requested from the Interconnection Applicant by Utility after the application is deemed complete).

Section 1. Applicant Information

Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)
Name: MaineDOT Environmental Office – c/o David Gardner
Mailing Address: 24 Child Street
City: Augusta State: ME__ Zip Code: 04333

Facility Location (if different from above): 44.315064 . -69.809702 (Site)
44.314939, -69.808273 (POI)
Telephone (Daytime): 1-207-592-2471
Telephone (Evening): 1-207-592-2471
Fax Number:
E-Mail Address: david.gardner@maine.gov

Not Applicable_____
(Utility)

3001-2167-166
(Existing Account Number, if generator to be interconnected on the Customer side of a utility revenue meter)

Type of Interconnect Service Applied for _____ Network Resource, _____
(choose one)

Energy Only, X Load Response (no export) _____ Net metering

Section 2. Generator Qualifications

Data apply only to the Small Generating Facility, not the Interconnection Facilities.
Energy Source: X Solar ___ Wind ___ Hydro ___ Hydro Type (e.g. Run-of-River):_____

Diesel ___ Natural Gas ___ Fuel Oil ___ Other (state type)_____

Prime Mover: Fuel Cell ___ Recip. Engine ___ Gas Turb. ___ Steam Turb. ___
Microturbine ___ PV X Other _____

Type of Generator: Synchronous ____ Induction ____ Inverter X

Generator Nameplate Rating: 166 kW (8 Units) 125KW (3 Units)
Generator Nameplate kVA: 166 kVA (8 Units) 125KVA (3 Units)

Interconnection Customer or Customer-Site Load: NONE kW (if none, so state)

Typical Reactive Load (if known): N/A
Maximum Physical Export Capability Requested 4,980 kW

List components of the Small Generating Facility Equipment Package that are currently certified:

	Equipment Type	Certifying Entity
1.	Solectria XGI 1500-166/166	UL 1741 SA
2.	Solectria XGI 1500-125/125	UL 1741 SA
3.	Longi LR6-72BP 380M	UL 1703
4.		
5.		

Is the prime mover compatible with the certified protective relay package?
Yes X No ____

Generator (or solar collector):

Manufacturer, Model Name & Number: Solectria XGI 1500-166/166 & 125/125

Version Number: TBD
Nameplate Output Power Rating in kW:

(Summer) 166 or 125kW (Winter) 166 or 125kW
Nameplate Output Power Rating in kVA:
(Summer) 166 or 125 kVA (Winter) 166 or 125kVA

Individual Generator Power Factor:
Rated Power Factor: Leading: 0.8 PF Lagging: 0.8 PF

Total Number of Generators in wind farm to be interconnected pursuant to this Interconnection Request: _____ Elevation: _____Single-phase _____
Three- phase (8) units operating at 166 kW (3) Units at 125KW

Inverter Manufacturer, Model Name & Number (if used): Solectria XGI 1500-166/166 & 125/125

List of adjustable set points for the protective equipment or software: Per IEEE 1547

Note: *A completed Power Systems Load Flow data sheet must be supplied with the Interconnection Request*.

Small Generating Facility Characteristic Data (for inverter-based machines)

Max design fault contribution current: 94.7@12.47kV Instantaneous or RMS? RMS
Harmonics Characteristics: <3% per IEEE519

Start-up requirements: estimated 1 kW per Solectria XGI 1500-166/166

Small Generating Facility Characteristic Data (for rotating machines) NOT APPLICABLE

RPM Frequency: _____
(*) Neutral Grounding Resistor (If Applicable): _____

Synchronous Generators: NOT APPLICABLE

Direct Axis Synchronous Reactance, Xd: _____ P.U.
Direct Axis Transient Reactance, X' d: _____ P.U.
Direct Axis Subtransient Reactance, X" d: _____ P.U.
Negative Sequence Reactance, X2 _____ P.U.
Zero Sequence Reactance, X0: _____ P.U.

KVA Base: _____

Field Volts: _____
Field Amperes: _____

Induction Generators: NOT APPLICABLE

Motoring Power (kW): _____
I^2t or K (Heating Time Constant): _____
Rotor Resistance, Rr: _____
Stator Resistance, Rs: _____
Stator Reactance, Xs: _____
Rotor Reactance, Xr: _____
Magnetizing Reactance, Xm: _____
Short Circuit Reactance, Xd": _____
Exciting Current: _____
Temperature Rise: _____
Frame Size: _____
Design Letter: _____
Reactive Power Required In Vars (No Load): _____
Reactive Power Required In Vars (Full Load): _____
Total Rotating Inertia, H: _____ Per Unit on kVA Base

Note: *Please contact the T & D Utility prior to submitting the Interconnection Request to determine if the specified information above is required.*

Excitation and Governor System Data for Synchronous Generators Only
Provide appropriate IEEE model block diagram of excitation system, governor system and power system stabilizer (PSS) in accordance with the regional reliability council criteria. A PSS may be determined to be required by applicable studies. A copy of the manufacturer's block diagram may not be substituted.

Section 3. Interconnection Facilities Information

Will a transformer be used between the generator and the Point of Common Coupling?
__X__ Yes ___No

Will the transformer be provided by the Interconnection Customer? _X_ Yes ____No

Transformer Data (If Applicable, for Interconnection Customer-Owned Transformer):

Is the transformer: Single-phase _____ Three phase X Size: 1500 kVA & 300KVA
Transformer Impedance: 5.75% percent at transformer kVA Base

If Three Phase:
Transformer Primary: 12,470 Volts _____ Delta _____Wye __X__ Wye Grounded
Transformer Secondary: 600 Volts _____ Delta _____Wye __X__ Wye Grounded
Transformer Tertiary: _____ Volts _____ Delta _____Wye _____ Wye Grounded

Transformer Fuse Data (If Applicable, for Interconnection Customer-Owned Fuse):
(Attach copy of fuse manufacturer's Minimum Melt and Total Clearing Time-Current Curves)

Manufacturer: TBD_ Type: _____ Size: _____
Speed: _____

Interconnecting Circuit Breaker (if applicable): NOT APPLICABLE

Manufacturer: _____ Type: _____
Load Rating (Amps): _____ Interrupting Rating (Amps): _____ Trip Speed (Cycles): _____

Interconnection Protective Relays (If Applicable):

If Microprocessor-Controlled:

List of Functions and Adjustable Setpoints for the protective equipment or software:

Setpoint Function	Minimum	Maximum
1. See ONE-LINE		
2.		
3.		
4.		
5.		
6.		

If Discrete Components:
(Enclose Copy of any Proposed Time-Overcurrent Coordination Curves)

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____

Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Current Transformer Data (If Applicable):
(Enclose Copy of Manufacturer's Excitation and Ratio Correction Curves)

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Potential Transformer Data (If Applicable):

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Section 4. General Information

Enclose copy of site electrical one-line diagram showing the configuration of all Small Generating Facility equipment, current and potential circuits, and protection and control schemes. This one-line diagram must be signed and stamped by a licensed Professional Engineer if the Small Generating Facility is larger than 50 kW.
Is One-Line Diagram enclosed? Yes _X_ No ____

Enclose copy of any site documentation that indicates the precise physical location of the proposed Small Generating Facility (e.g., USGS topographic map or other diagram or documentation).

Proposed location of protective interface equipment on property (include address if different from the Interconnection Customer's address):

_____

_____

Enclose copy of any site documentation that describes and details the operation of the protection and control schemes.

Is Available Documentation Enclosed? Yes ____ No __X__

Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).
Are Schematic Drawings Enclosed? Yes ____ No __X__

Section 5. Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by (utility) on or near my service meter location. Generating systems must be compliant with IEEE, NEC, ANSI, and UL standards, where applicable. By signing below, the Applicant also certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.

Signed: _____ Date: 03/04/2020

Section 6. Information Required Prior to Physical Interconnection
(Not required as part of the application, unless available at time of application.)

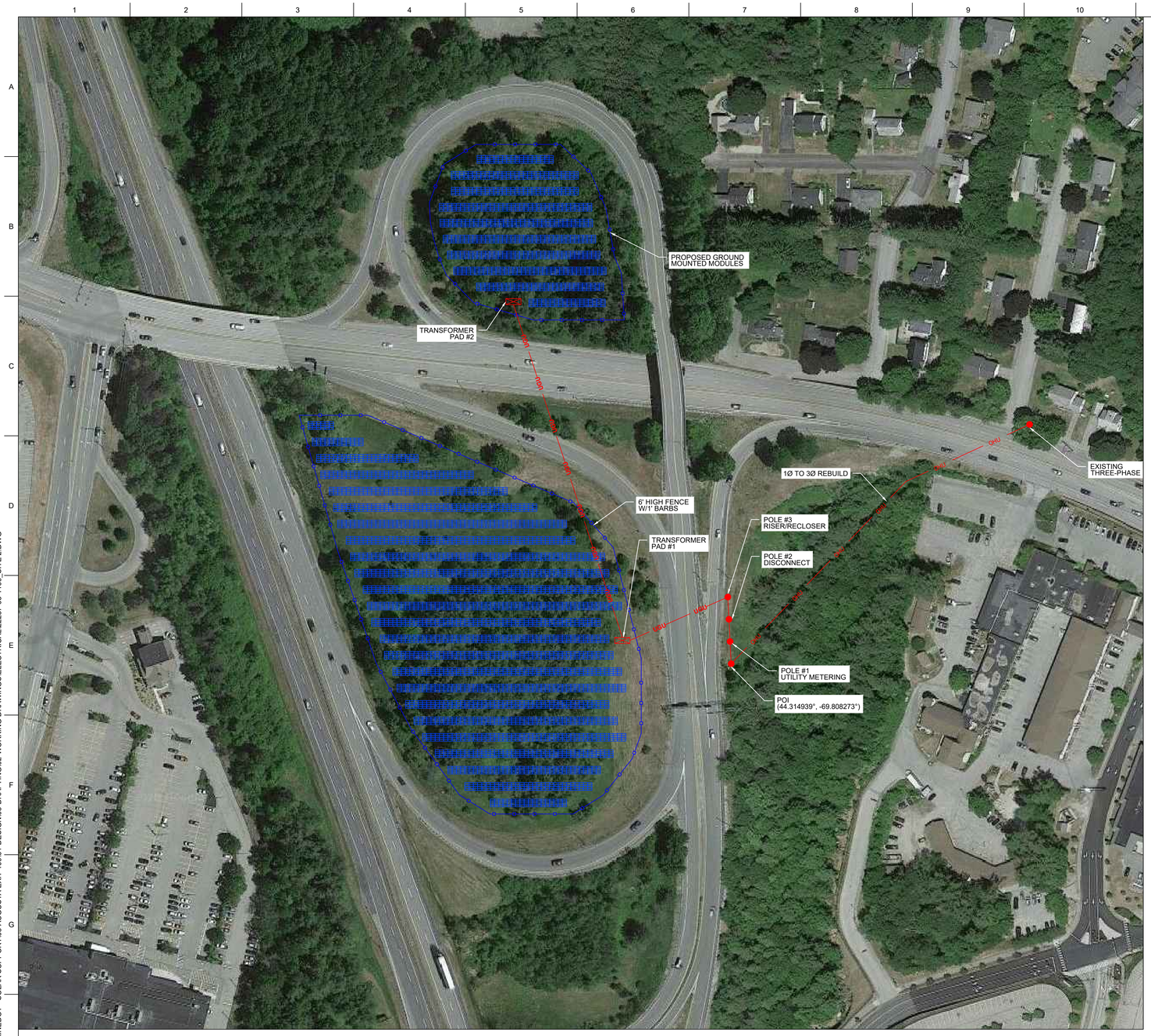
Installing Electrician: _____ Firm: _____
License No.: _____

Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Telephone: _____

Installation Date: _____ Interconnection Date: _____

Signed: _____ Date: _____
(Inspector - if required)

(In lieu of signature of Inspector, a copy of the final inspection certificate may be attached)



N

GENERAL NOTES:

1. TREES MAY GROW DURING THE LIFE OF THE SYSTEM AND IMPACT THE PRODUCTION.
2. ANY AND ALL LAYOUT CHANGES, INCLUDING BUT NOT LIMITED TO SHIFTING OF THE ARRAY, ARE SUBJECT TO APROVAL BY THE DESIGN TEAM.
3. ARRAY LAYOUT DIMENSIONS SHALL BE CONSIDERED APPROXIMATE AND MAY VARY SLIGHTLY DUE TO MODULE INSTALLATION TOLERANCES AND VARYING TOPOGRAPHY.

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 395W
MODULES QUANTITY	5,448
DC RATING AT STC	2,151 KW
AC RATING	1,703 KW
INVERTER	(8) XGI-166 (3)XGI-125
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1250 VDC

LEGEND:

- MODULE
- UTILITY POLE
- UGU — UNDERGROUND
- OHU — OVERHEAD
- FENCE
- TRANSFORMER PAD

PRELIMINARY
NOT FOR CONSTRUCTION

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

SEAL:

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 109 SITE 2
ME DOT
1.7 MWAC PV GENERATION FACILITY
AUGUSTA, ME

SCALE: NONE **SIZE:** ARCH D

GENERAL SITE PLAN

DATE:	02/24/20
DRAWN BY:	CJB
ENGIN'D BY:	JED
PROJECT #:	22237-03
DRAWING #:	1100

PROPOSED UL1741 INVERTER INTERNAL CONTROL SETTINGS					
DEVICE	PICKUP		CLEARING TIME		
27-1	50%	(300 V)	66	CYC	(1.1 SEC)
27-2	88%	(528 V)	120	CYC	(2 SEC)
59-1	110%	(660 V)	120	CYC	(2 SEC)
59-2	120%	(720 V)	9.6	CYC	(0.16 SEC)
81U-1	58.5 HZ		18000	CYC	(300 SEC)
81U-2	56.5 HZ		9.6	CYC	(0.16 SEC)
81O-1	61.2 HZ		18000	CYC	(300 SEC)
81O-2	62 HZ		9.6	CYC	(0.16 SEC)

Base Voltage 600 V.

PF = 1.0

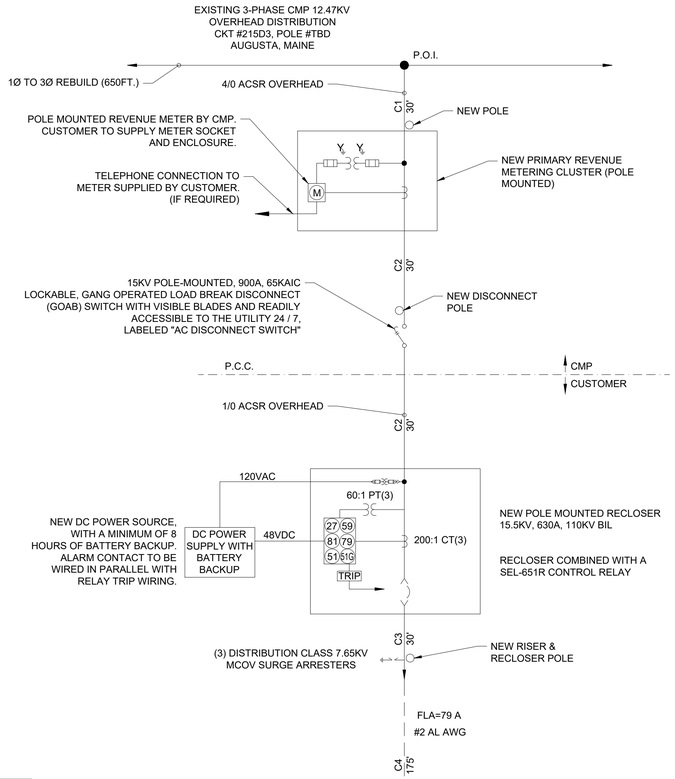
PROPOSED PROTECTION RELAY SETTINGS							
DEVICE	PICKUP			Time Delay		Total Clearing Time	
	Primary		Secondary				
27-1	50%	(3599.8 V)	(54 V)	63 CYC	1.05 SEC	66 CYC	1.1 SEC
27-2	88%	(6335.6 V)	(95.04 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-1	110%	(7919.5 V)	(118.8 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-2	120%	(8639.5 V)	(129.6 V)	6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81U-1	58.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81U-2	56.5 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81O-1	61.2 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81O-2	62 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
51		98 A	0.49 A	SET PER UTILITY STANDARDS			
51G		33 A	0.16 A	SET PER UTILITY STANDARDS			
79	0.95 PU - 1.05 PU 59 HZ - 60.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC

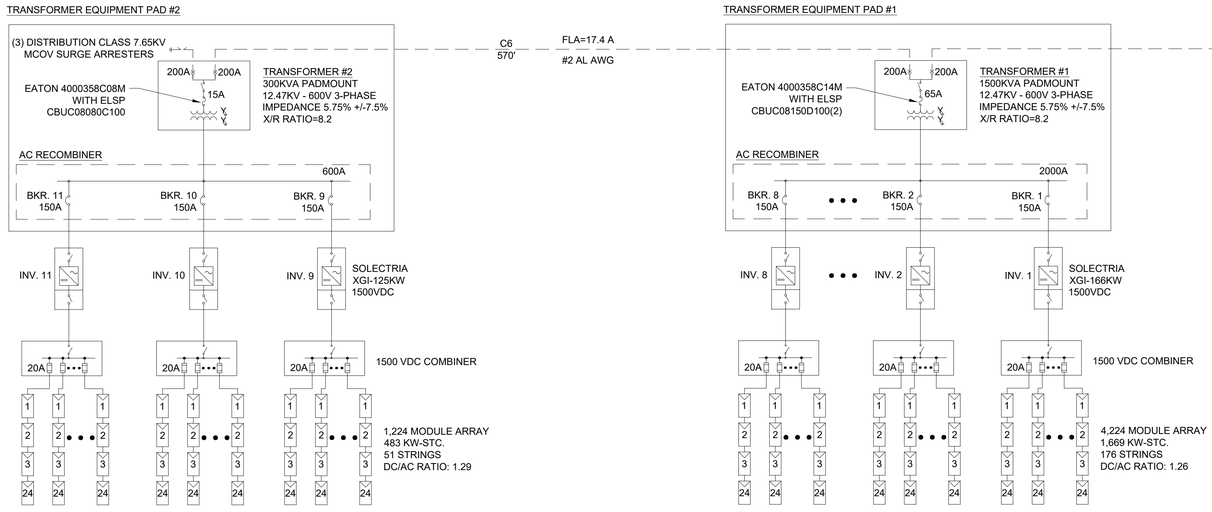
SETTINGS ASSUME 3 CYCLE ESTIMATED DEVICE TRIP OPENING TIME

SETTINGS ARE BASED ON IEEE 1547-2018 TABLE 1 (VOLT) AND 2 (FREQ).

SETTINGS ARE BASED ON A 108V SECONDARY PT BASE.

AC Wire and Cable Schedule														
From	To	Cable Number	Type	Material	Conductor	Voltage (kV)	Feet	Overhead - Ohms/mile Underground - Ohms/1000ft				Per Unit Value (100 MVA Base)			
								R_1	X_1	R_0	X_0	R_1	X_1	R_0	X_0
POI	Meter	C1	Overhead	ACSR	1/0	12.47	30	1.141	0.915438	1.427	2.733452	0.004169	0.003345	0.005214	0.009988
Meter	GOAB	C2	Overhead	ACSR	1/0	12.47	30	1.141	0.915438	1.427	2.733452	0.004169	0.003345	0.005214	0.009988
GOAB	Recloser/riser	C3	Overhead	ACSR	1/0	12.47	30	1.141	0.915438	1.427	2.733452	0.004169	0.003345	0.005214	0.009988
Recloser/riser	Grounding Xfmr	C4	Underground	AL	#2	12.47	175	0.335	0.05	0.5326	0.1272	0.037701	0.005627	0.059939	0.014315
Grounding Xfmr	Equip Pad #1	C5	Underground	AL	#2	12.47	10	0.335	0.05	0.5326	0.1272	0.002154	0.000322	0.003425	0.000818
Equip Pad #1	Equip Pad #2	C6	Underground	AL	#2	12.47	570	0.335	0.05	0.5326	0.1272	0.122797	0.018328	0.195228	0.046626





UTILITY INTERCONNECTION NOTES:

1. INVERTERS (INV) - SOLECTRIA XGI-125KW, XGI-166KW 1500VDC, 600VAC, NEMA 4X, MOUNTED ON UNISTRUT. INVERTERS ARE UL1741-SA-2016 LISTED AND IEEE1547-A COMPLIANT. INVERTER SHALL HAVE INTEGRATED AC & DC DISCONNECTS
2. MODULES TO BE CANADIAN SOLAR 395W KUMAX CS3U-395MS 144 CELL MONOCRYSTALLINE PANELS. MODULES ARE CERTIFIED UL 1703 COMPLIANT.
3. DAS SYSTEM TO BE DESIGNED AND ENGINEERED BY SELECTED DESIGNATED PARTY.
4. LOCATION OF THE POI: 44.314939°, -69.808273°

ONE LINE POWER DIAGRAM LEGEND:

- LOAD-BREAK SWITCH FUSE, SIZE AS INDICATED
- TRANSFORMER, SIZE AS INDICATED
- CIRCUIT BREAKER
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER / SOLID STATE TRIP UNIT
- GROUND
- L.A. LIGHTNING ARRESTOR
- CABLE TERMINATION/LOAD ELBOW
- FUSE
- GROUP AIR (GOAB) SWITCH
- (M) REVENUE METER (BY UTILITY)
- LOAD BREAK ELBOWS

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 390W
MODULES QUANTITY	5,448
DC RATING AT STC	2,151 KW
AC RATING	1,703 KW
INVERTER	(8) XGI-166 (3) XGI-125
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1250 VDC

DEVICE NO.	DESCRIPTION
27	UNDERVOLTAGE RELAY
50/51	INSTANTANEOUS/TIME OVERCURRENT RELAY
51G	GROUND OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59G	GROUND OVERVOLTAGE RELAY
79	AC RECLOSING RELAY
81/O	OVERFREQUENCY RELAY
81/U	UNDER FREQUENCY RELAY

LEGEND:

- OVERHEAD
- UNDERGROUND
- PRIMARY
- COMMUNICATION

PRELIMINARY
NOT FOR CONSTRUCTION

SEAL: STATE OF MAINE 02/28/20 TED M. GIFFORD NO. 10271 PROFESSIONAL ENGINEER

REV.	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 109 SITE 2
ME DOT
1.7 MWAC PV GENERATION FACILITY
AUGUSTA, ME

SCALE: NONE SIZE: ARCH D

ONE LINE DIAGRAM

DATE: 02/24/20
DRAWN BY: CJB
ENGN'D BY: JED
PROJECT #: 22237-03
DRAWING #: 2100

NEW

CanadianSolar

KuMax

HIGH EFFICIENCY MONO PERC MODULE

CS3U-375|380|385|390|395MS

(1000 V / 1500 V)

MBB 5BB

MORE POWER

- Low power loss in cell connection
- Low NMOT: 41 ± 3 °C
  Low temperature coefficient (Pmax): -0.37 % / °C
- Better shading tolerance
- High PTC rating of up to: 93.13 %

MORE RELIABLE

- Lower hot spot temperature
- Minimizes micro-cracks
- Heavy snow load up to 5400 Pa,
  wind load up to 3600 Pa*

25 years linear power output warranty

10 years product warranty on materials and workmanship

MANAGEMENT SYSTEM CERTIFICATES

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE / MCS / CEC AU
UL 1703 / IEC 61215 performance: CEC listed (US) / FSEC (US Florida)
UL 1703: CSA / IEC61701 ED2: VDE / IEC62716: VDE / IEC60068-2-68: SGS
Take-e-way

*We can provide this product with special BOM specifically certified with salt mist, ammonia and sand blowing tests. Please talk to our local technical sales representatives to get your customized solutions.

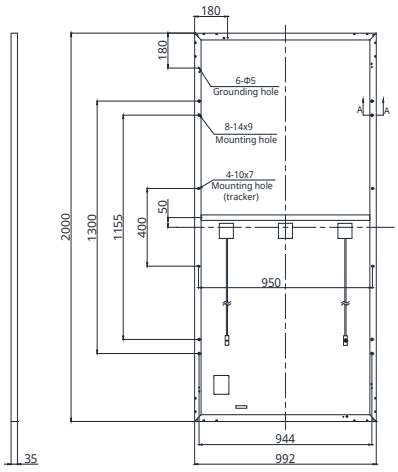
CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 30 GW deployed around the world since 2001.

* For detailed information, please refer to the Installation Manual.

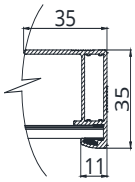
CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

ENGINEERING DRAWING (mm)

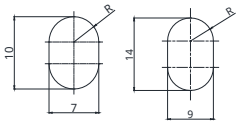
Rear View



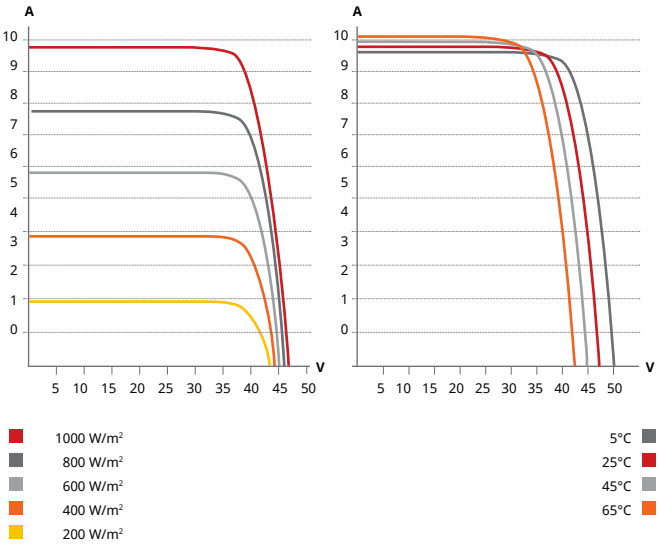
Frame Cross Section A-A



Mounting Hole



CS3U-375MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	375 W	380 W	385 W	390 W	395 W
Opt. Operating Voltage (Vmp)	39.8 V	40.0 V	40.2 V	40.4 V	40.6 V
Opt. Operating Current (Imp)	9.43 A	9.50 A	9.58 V	9.66 A	9.73 A
Open Circuit Voltage (Voc)	47.6 V	47.8 V	48.0 V	48.2 V	48.4 V
Short Circuit Current (Isc)	9.93 A	10.01 A	10.09 A	10.17 A	10.25 A
Module Efficiency	18.90%	19.15%	19.41%	19.66%	19.91%
Operating Temperature	-40°C ~ +85°C				
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)				
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)				
Max. Series Fuse Rating	30 A				
Application Classification	Class A				
Power Tolerance	0 ~ + 5 W				

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	280 W	284 W	287 W	291 W	295 W
Opt. Operating Voltage (Vmp)	36.9 V	37.1 V	37.3 V	37.5 V	37.7 V
Opt. Operating Current (Imp)	7.58 A	7.64 A	7.70 A	7.76 A	7.82 A
Open Circuit Voltage (Voc)	44.8 V	45.0 V	45.1 V	45.3 V	45.5 V
Short Circuit Current (Isc)	8.01 A	8.07 A	8.14 A	8.20 A	8.26 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2000 X 992 X 35 mm (78.7 X 39.1 X 1.38 in)
Weight	22.5 kg (49.6 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 400 mm (15.7 in) (+) / 280 mm (11.0 in) (-); landscape: 1250 mm (49.2 in);leap-frog connection: 1670 mm (65.7 in)*
Connector	T4 series
Per Pallet	30 pieces
Per Container (40' HQ)	660 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.37 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	41 ± 3°C

PARTNER SECTION

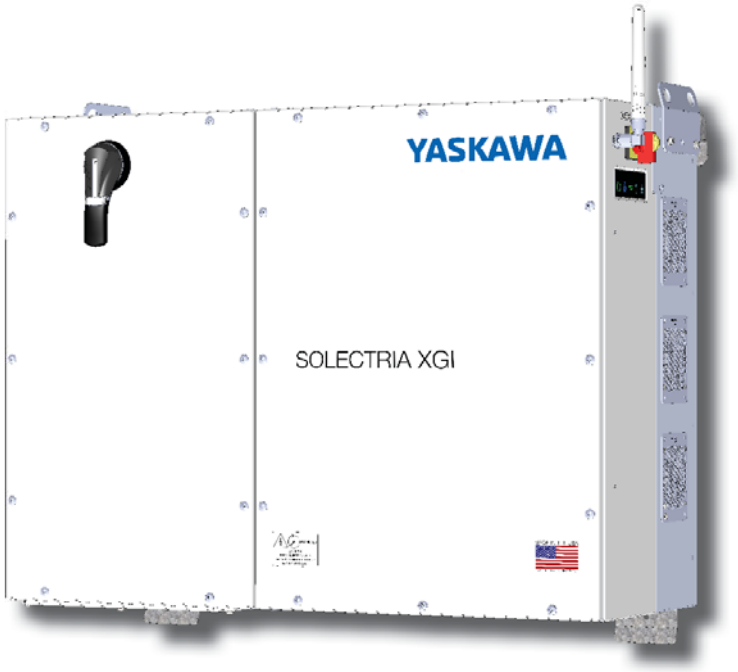
* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustments to the information described herein at any time without further notice. Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

YASKAWA

SOLECTRIA XGI™ 1500

Premium 3-Ph Transformerless Utility-Scale Inverters



Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- 99.0% peak efficiency
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades

Options

- String combiners for distributed and centralized systems
- Web-based monitoring
- Extended warranty

MADE IN THE USA

With U.S. and Global Components

Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that were selected, tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market and have been engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the new SOLECTRIA XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The XGI 1500 inverters are Made in the USA with global components and are compliant with the Buy American Act.

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	148.3 A	148.3 A	178.0 A	197.7 A
Maximum Operating PV Power	128 kW	128 kW	153 kW	170 kW
Maximum DC/AC Ratio | Max Rated PV Power	1.5 | 188 kW	1.5 | 188 kW	1.5 | 225 kW	1.5 | 250 kW
Max Rated PV Short-Circuit Current (∑Isc x 1.25)	320 A	320 A	320 A	320 A
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.9%	98.9%	99.0%	99.0%
CEC Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Option for 10 Years			
Enclosure				
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) | Width: 39.4 in. (1000 mm) | Depth: 15.1 in. (380 mm)			
Weight	245 lbs (111 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			

Specifications subject to change.

SOLECTRIA SOLAR

Yaskawa Solectria Solar
360 Merrimack Street
Lawrence, MA 01843
solectria.com

1-978-683-9700
inverters@solectria.com

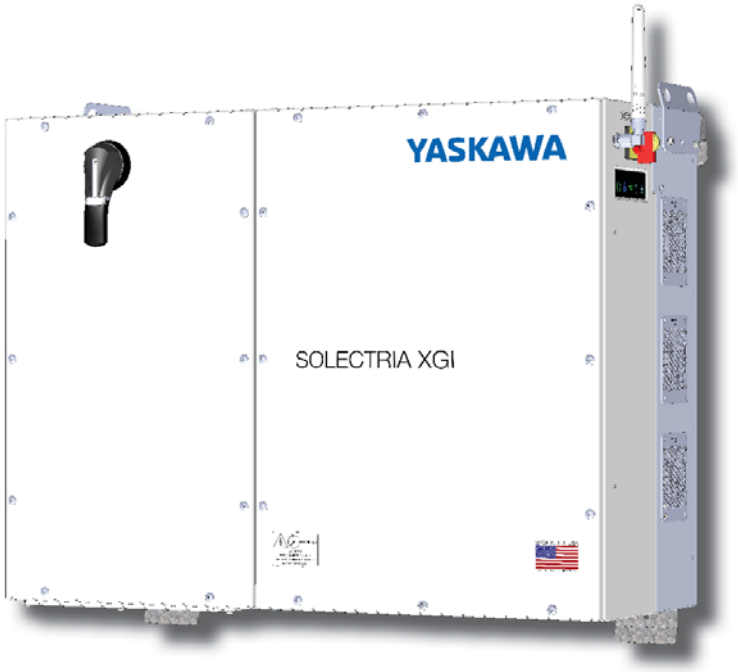
DOCR-070730-O | May 2019

YASKAWA

YASKAWA

SOLECTRIA XGI™ 1500

Premium 3-Ph Transformerless Utility-Scale Inverters



Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- 99.0% peak efficiency
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades

Options

- String combiners for distributed and centralized systems
- Web-based monitoring
- Extended warranty

MADE IN THE USA

With U.S. and Global Components

Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that were selected, tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market and have been engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the new SOLECTRIA XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The XGI 1500 inverters are Made in the USA with global components and are compliant with the Buy American Act.

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	148.3 A	148.3 A	178.0 A	197.7 A
Maximum Operating PV Power	128 kW	128 kW	153 kW	170 kW
Maximum DC/AC Ratio | Max Rated PV Power	1.5 | 188 kW	1.5 | 188 kW	1.5 | 225 kW	1.5 | 250 kW
Max Rated PV Short-Circuit Current (∑Isc x 1.25)	320 A	320 A	320 A	320 A
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.9%	98.9%	99.0%	99.0%
CEC Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Option for 10 Years			
Enclosure				
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) | Width: 39.4 in. (1000 mm) | Depth: 15.1 in. (380 mm)			
Weight	245 lbs (111 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			

Specifications subject to change.

SOLECTRIA SOLAR

Yaskawa Solectria Solar
360 Merrimack Street
Lawrence, MA 01843
solectria.com

1-978-683-9700
inverters@solectria.com

DOCR-070730-O | May 2019

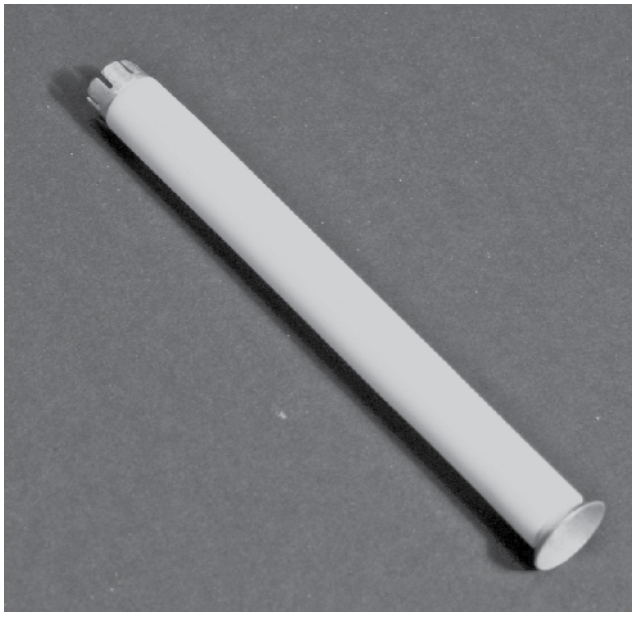
YASKAWA

Fusing Equipment
Catalog Data
CA132010EN

Effective February 2015
Supersedes 240-46 August 2012

COOPER POWER SERIES

Dual sensing Bay-O-Net fuse link



General

Eaton protects both distribution apparatus from damaging currents and to protect distribution systems from failed apparatus with its Cooper Power series dual sensing Bay-O-Net fuse link that is used in Eaton's Cooper Power series Bay-O-Net fuse assemblies (see *Catalog CA132015EN Sidewall-Mounted and Cover-Mounted Bay-O-Net Fuse Assembly*).

Dual sensing links sense not only secondary faults, excessive load currents and transformer faults, but also transformer fluid temperature. They will limit long-term transformer heating caused by overloads and high temperature environments.

Application

Bay-O-Net fuses can be used on single-phase conventional and self-protected distribution transformers and on three-phase equipment.

Its ideal use is in a two-fuse protection scheme with a current-limiting backup fuse. In this arrangement, secondary faults and overload currents are cleared by the Bay-O-Net fuse, and high level faults are cleared by the current-limiting fuse. The two fuses are connected in series, and are coordinated so that the current-limiting fuse operates only upon internal equipment failure. (See *Catalog CA132013EN ELSP Current-Limiting Backup Fuse* to order an ELSP current-limiting backup fuse.) If the bayonet fuse will not be used in series with a current-limiting fuse, an isolation link is required. (See *Catalog CA132012EN Isolation Link.)*

Bay-O-Net fuses are comparable in cost to internal cartridge fuses but have the advantages of being field-replaceable. Bay-O-Net fuses can easily be coordinated with upstream devices.

Installation

No special tools are required. A hotstick is used to remove the Bay-O-Net fuse cartridge holder from non-pressurized apparatus. The fuse cartridge is then replaced, and the holder reinserted using a hotstick. Refer to *Service information MN132002EN Bay-O-Net Fuse Re-Fusing Installation Instructions* for re-fusing instructions.

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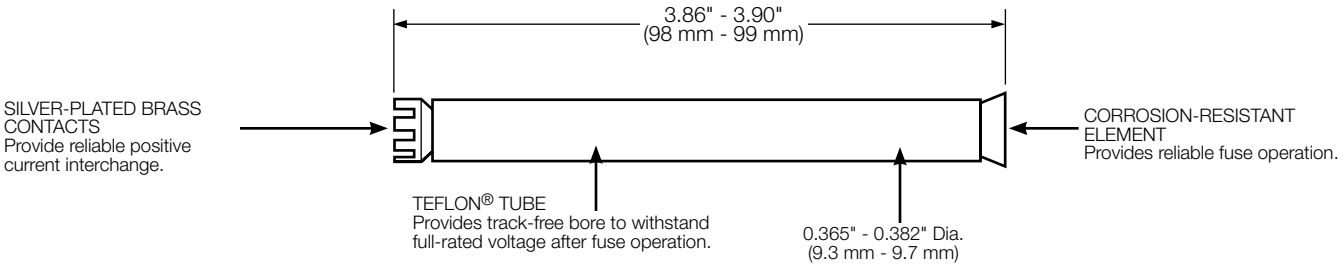

Figure 1. Dimensional and feature information.

Note: Dimensions given are for reference only.

Table 1. Electrical Ratings and Characteristics

		Maximum Single-Phase Interrupting Rating*		
Voltage (kV)	**Catalog Number**	**Cover Mount Assembly (rms asymmetrical) in Mineral Oil**	**Sidewall Mount Assembly (rms symmetrical) in Mineral Oil**	**Sidewall Mount Assembly (rms symmetrical) in Envirotemp™ FR3™ Fluid**
4.16	358C3-C14	3500 A	3500 A	3500 A
	358C16-C18	3500 A	3500 A	2000 A
8.3	358C03-C08	3500 A	3500 A	3500 A
	358C10-C12	3500 A	3500 A	2500 A
	358C14	3500 A	3500 A	1500 A
	358C16-C18	3500 A	3500 A	1200 A
15.5	358C03-C08	2500 A	2500 A	2500 A
	358C10-C12	2500 A	2500 A	1500 A
	358C14	2500 A	2500 A	1000 A
	358C16-C18	**	**	**
23.0	358C03-C08	1000 A	1000 A	1000 A
	358C10-C12	1000 A	600 A	600 A
	358C14	***	600 A	600 A
	358C16-C18	**	**	**

* In Eaton's Cooper Power series Bay-O-Net assemblies only. Where available fault current exceeds rated value, coordinated current-limiting fusing such as an ELSP (Catalog CA132013EN) or approved equivalent must be provided.

** Not rated above 8.3 kV.

*** Not rated above 15.5 kV

Table 2. Bay-O-Net Fuse Link

Continuous Current Rating (A)	Catalog Number*
3	4000358C03
8	4000358C05
15	4000358C08
25	4000358C10
50	4000358C12
65	4000358C14
100	4000358C16CB**
140	4000358C18CB**

* Add suffix "B" to order individual fuse; add "M" to order bag of 50.

** Catalog number is an integral element/cartridge/end plug design.

Ordering information

To order a dual sensing Bay-O-Net fuse link, determine the requirements of the application from Tables 3 and 4 and specify the fuse required from Table 2.

Method A

Using the correlation tables

Use the following correlation information (Tables 3 and 4) to complete Catalog Number 4000358__.

For 19.9 kV single-phase and 34.5 kV three-phase applications, an ELSP current-limiting backup fuse is recommended. (See Catalog CA132013EN for more information).

If the Bay-O-Net link is not used with a current-limiting fuse, an isolation link is required. (See Catalog CA132012EN).

Correlation is based on IEEE Std C57.92™-1981 standard, Loading Guide, IEEE Std C57.109™-1993 standard, Through-Fault Guide, and *Reference Data TD132001EN Pad-Mounted Transformer Fusing Philosophies*.

Table 3. Correlation Information
Single-Phase Transformer (Phase-to-Ground) Applications

Transformer kVA	Transformer Primary Voltage (kV)										
	2.4	4.16	4.8	7.2	7.62	8.32	12.0	12.47	13.2	13.8	14.4
5	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03
10	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03	C03
15	C08	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03
25	C10	C08	C08	C05	C05	C05	C03	C03	C03	C03	C03
37.5	C12	C10	C08	C08	C08	C08	C05	C05	C05	C05	C05
50	C12	C10	C10	C08	C08	C08	C05	C05	C05	C05	C05
75	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
100	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
167	C18	C14	C14	C12	C12	C12	C10	C10	C10	C10	C10
250	–	C16	C18	C14	C14	C14	C12	C12	C12	C12	C12
333	–	C18a	C18	C14a	C14a	C14a	C12	C12	C12	C12	C12
500	–	–	–	C18	C18	C18	C14	C14	C14	C14	C14

Table 4. Correlation Information
Three-Phase Transformer (Phase-to-Phase) Applications

Transformer kVA	Transformer Primary Voltage (kV)									
	2.4	4.16	4.8	8.32	12.0, 12.47	13.2	13.8, 14.4	20.8[b,d]	22.9[b,d]	24.9[b]
45	C10	C08	C08	C05	C03	C03	C03	C03	C03	C03
75	C12	C10	C10	C08	C05	C05	C05	C03	C03	C03
112.5	C14	C12	C10	C08	C08	C08	C08	C05	C05	C05
150	C14	C12	C12	C10	C08	C08	C08	C05	C05	C05
225	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
300	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
500	–	C18	C18	C14	C12	C12	C12	C10	C10	C10
750	–	C18[a]	C18[a]	C18	C14	C14	C14	C12[a]	C12	C12
1000	–	–	–	C18	C14[a]	C14[a]	C14[a]	C12[a]	C12	C12
1500	–	–	–	–	C18[c]	C18[c]	C18[c]	C14	C14	C14

Note: Recommendations are based on 200% transformer loading for 2 hours, 160% loading for 7 hours and thermal characteristics of typical Eaton's Cooper Power series transformers. Recommended fuses meet inrush requirement of 12 times transformer full load current for 0.1 second. Bay-O-Net fuse links alone should not be used at voltages greater than 17100 V for delta configurations or 24940 gnd Y/14400. For applications through 23 kV delta or 34500 gnd Y/19920, a 23 kV rated ELSP fuse (Catalog CA132013EN) is recommended in series with the Bay-O-Net link. Do not use fuse links 4000358C16CB or C18CB for voltages greater than 8320 V for delta configurations or 14400 gnd Y/8320.

a. Recommended fuse will result in some loss of overload capacity.

b. Recommended fuse limited to gnd Y/gnd Y transformer with less than 50% delta loading.

c. Recommended fuse limited to gnd Y primary.

d. For voltages greater than 17100 V for delta configurations or 24940 gnd Y/14400 and through 23 kV delta or 34500 gnd Y/19920, an ELSP 23 kV rated current-limiting back-up fuse (Catalog CA132013EN) in series with the Bay-O-Net fuse link is recommended.

Method B

Using time-current curves

To determine or confirm the dual sensing Bay-O-Net fuse that will coordinate with upstream and downstream system requirements, use time-current characteristic curves and specify the fuse indicated from Table 2.

Long term overload curves for selected transformer ratings are also available.

For full size TCC curves R240-91-51, long term overload curves and further information regarding either of these ordering methods, contact your Eaton representative.

Eaton
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Eaton's Cooper Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Cooperpower.com

Printed in USA
Publication No. CA132010EN

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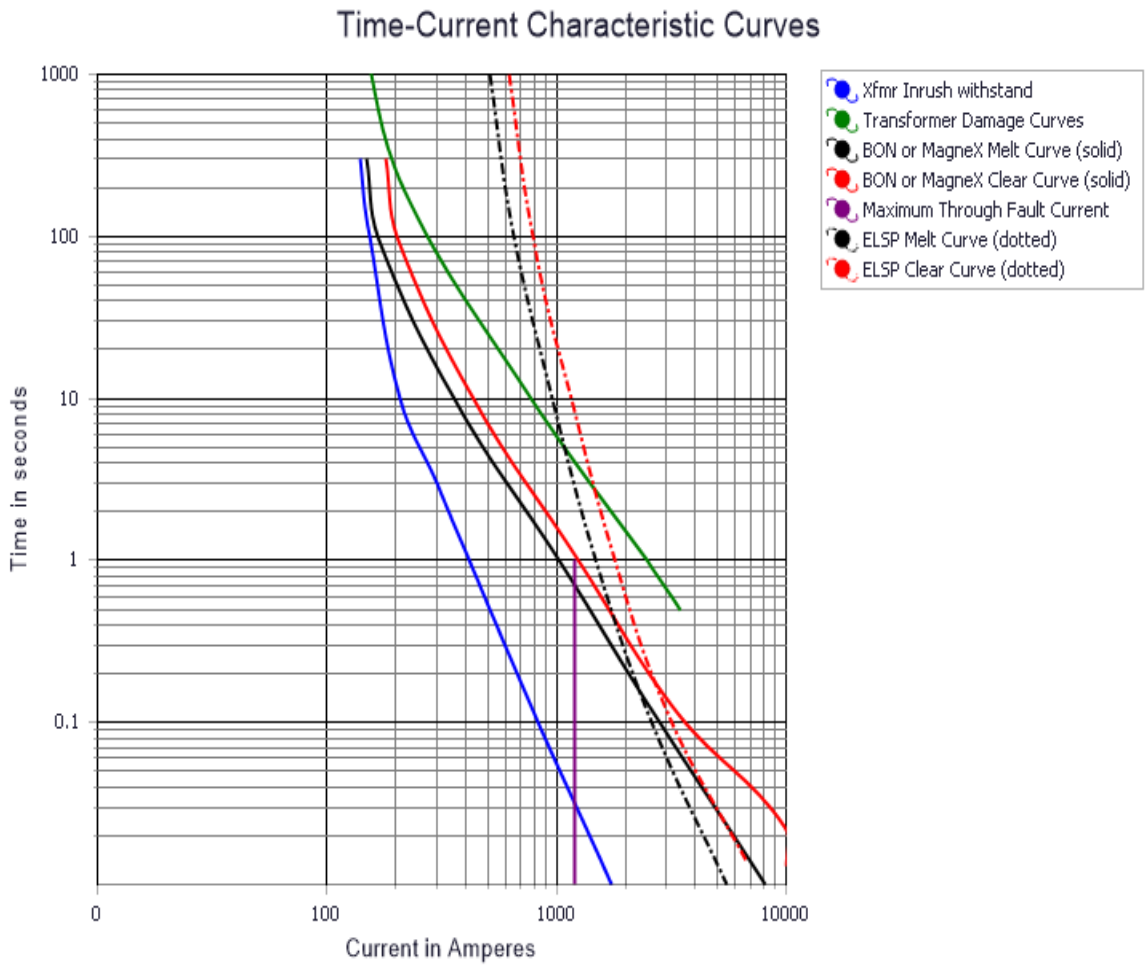
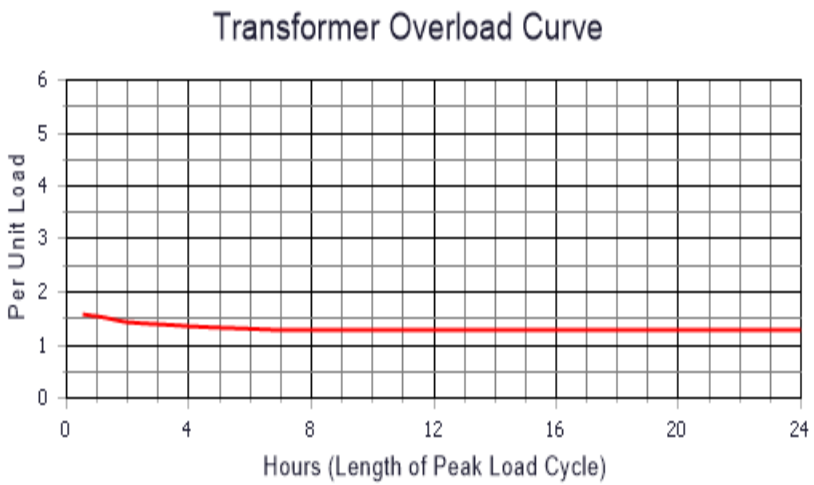
For Eaton's Cooper Power series Bay-O-Net fuse link product information call 1-877-277-4636 or visit: www.cooperpower.com.

TransFusion™ Coordination Program





Provided Inputs

Transformer kVA Rating: 1500
Primary Voltage (kV): 12.47
Number of Phases: 3
Minimum Impedance: 5.75
Primary Connection: Wye
Secondary Connection: Wye
Protection Type: Dual Sensing Bay-O-Net
Desired Protection level: Least Overload
Temperature Class: 65
Ambient Temperature: 35
Transformer Preload: 75
Xfmr. Rated Current (A): 69.45
Maximum Through Fault: 1208

Protection Device Recommendation

Based on your criteria, we recommend the following Cooper Power Systems protection device(s) for your application:

ELSP Selection: CBUC08150D100(2)
Bay-O-Net Selection: 4000358C14M

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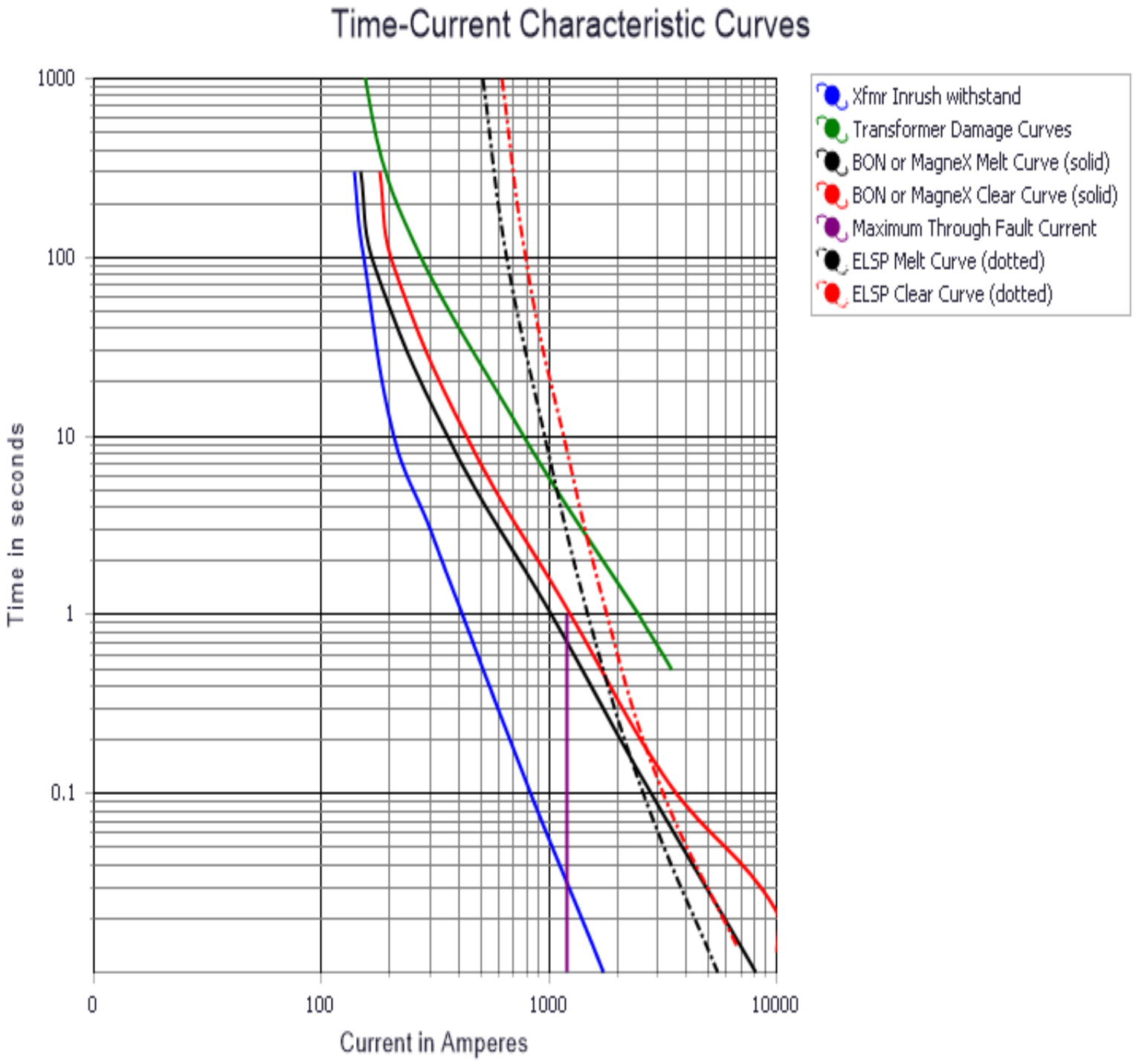
TransFusion™ Coordination Program



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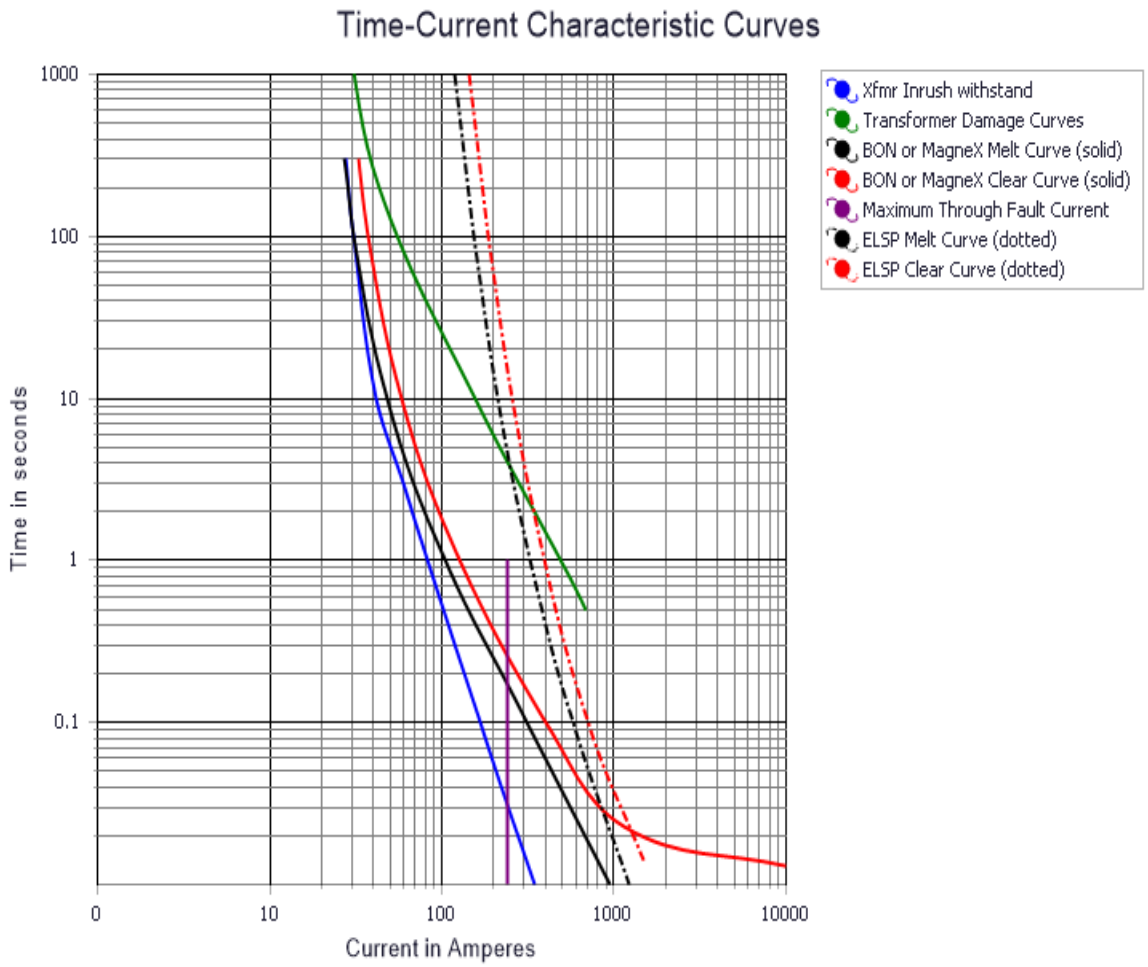
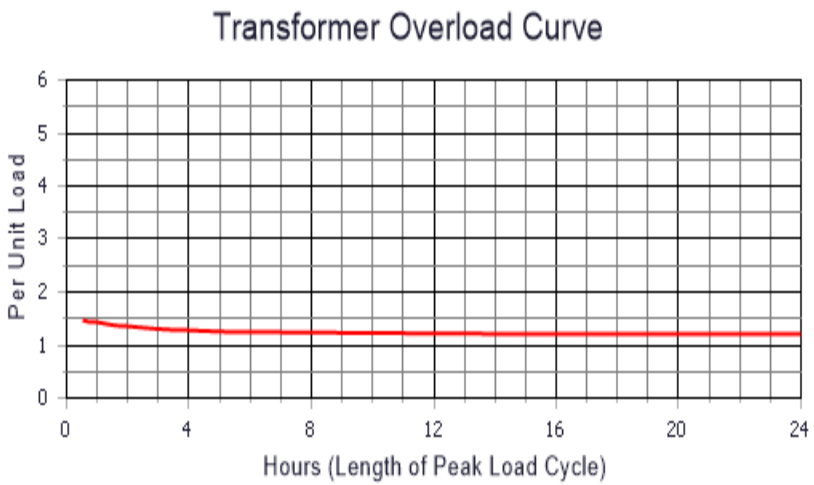
Protection Device Recommendation

ELSP Selection: CBUC08150D100(2)
Bay-O-Net Selection: 4000358C14M

TransFusion™ Coordination Program





Provided Inputs

Transformer kVA Rating: 300
Primary Voltage (kV): 12.47
Number of Phases: 3
Minimum Impedance: 5.75
Primary Connection: Wye
Secondary Connection: Wye
Protection Type: Dual Sensing Bay-O-Net
Desired Protection level: Least Overload
Temperature Class: 65
Ambient Temperature: 35
Transformer Preload: 75
Xfmr. Rated Current (A): 13.89
Maximum Through Fault: 242

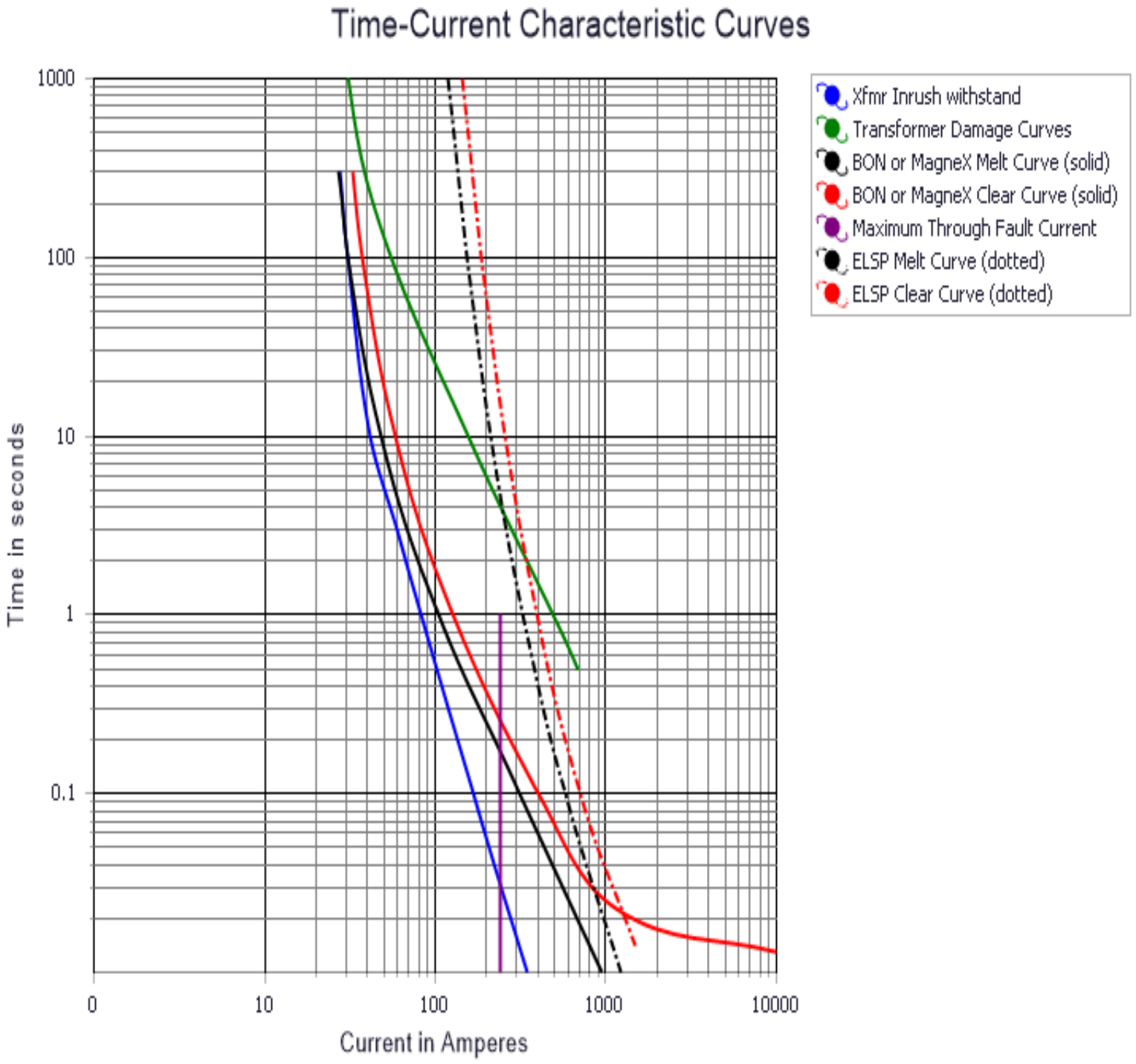
Protection Device Recommendation

Based on your criteria, we recommend the following Cooper Power Systems protection device(s) for your application:

ELSP Selection: CBUC08080C100
Bay-O-Net Selection: 4000358C08M

Powering Business Worldwide

TransFusion™ Coordination Program



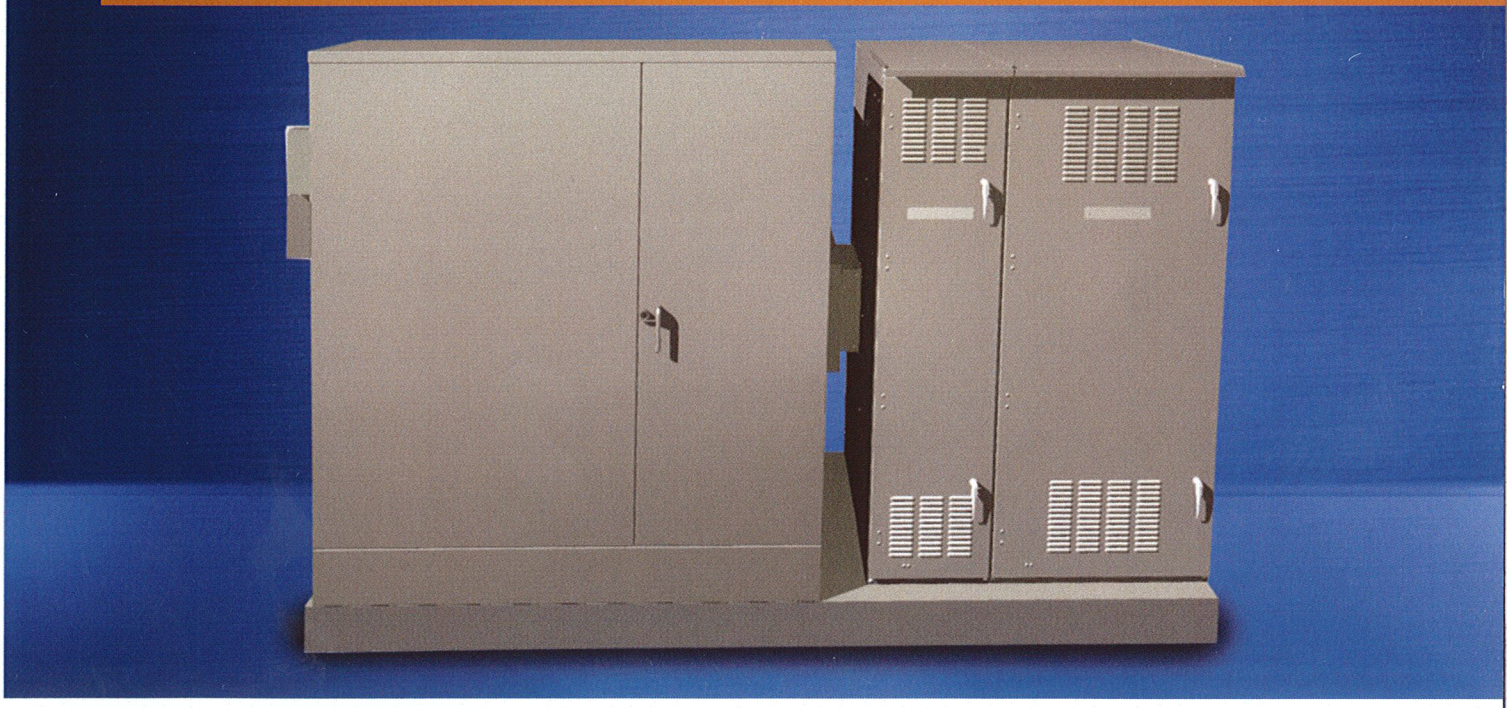
Powering Business Worldwide

Protection Device Recommendation

ELSP Selection: CBUC08080C100
Bay-O-Net Selection: 4000358C08M

1500 Vdc / 600 Vac
150 kW string inverter applications

Markets served
Renewable energy



Eaton's close-coupled solar recombiner and transformer solutions for string inverters

When it comes to commercial and utility-scale solar power, your focus is on reducing project complexity and minimizing costs. With changes in regulations and challenges with financing, you need a partner that has the expertise to reduce installation time and material, and to keep your people safe. As projects become more complex with grid connectivity and energy storage requirements, leadership, service and support become critical.

At Eaton, we know space is always at a premium, time is limited and cost matters. That's why we offer solar solutions that ease installation, save labor and lower the total cost of investment. For example, our space-saving AC solar recombiner integrates circuit breakers or fuse protection and a disconnect all within one enclosure. Integrated cable management, custom recombiner assemblies and transformers specially designed for solar PV string inverter applications are further examples of how our equipment is engineered to save our customers valuable space, time and money.

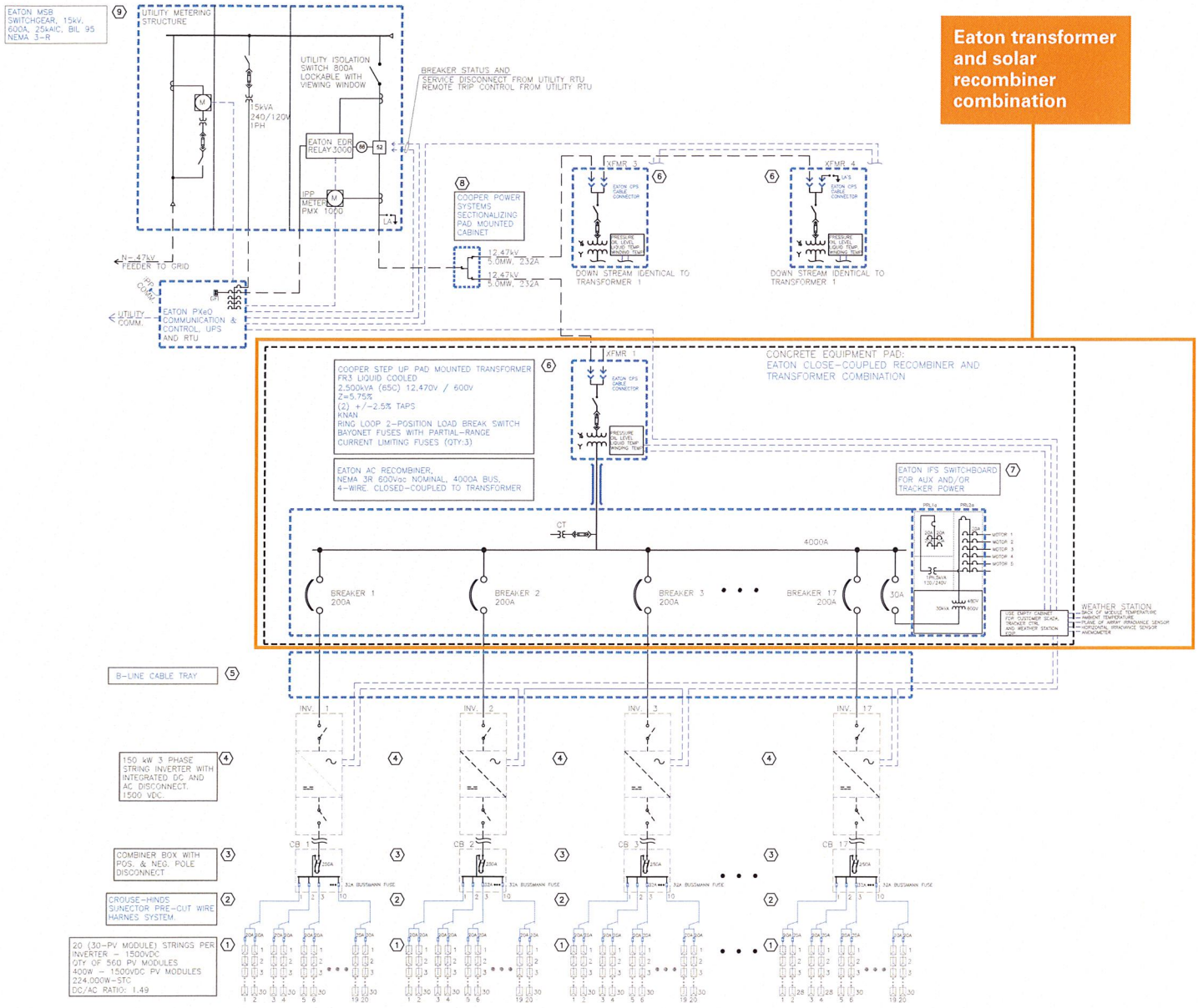
We can customize electrical system packages to specific requirements, including the physical dimensions and location of the building or installation. In addition, Eaton's regional satellite center personnel are knowledgeable in local electrical codes and utility regulations, so we design solutions that help streamline approvals by local authorities.

AC solar recombiners

- Customizable configurations for AC circuit breakers, main breakers and fusible switches
- UL® 891 listed assemblies for 480 Vac and 600 Vac applications
- Non-UL assemblies for 800 Vac applications using UL and IEC rated components
- Component integration can include metering, relays, dry-type transformers and more
- Offers close-coupling to Eaton liquid-filled transfomers
- Suitable for pour-in concrete pad installation; optional skid mounting also available

EATON
Powering Business Worldwide

One-line diagram for 1500 Vdc / 600 Vac 150 kW string inverter applications



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September 2018

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Powering Business Worldwide

I-95 Exit 112

Interconnection Application

Forms and Agreements 4: Level 2, Level 3 and Level 4 Interconnection Application

A Customer-Generator applicant ("Applicant") hereby makes application to CMP (Utility or T & D Utility) to install and operate a generating facility interconnected with the CMP utility system. This application will be considered as an application for interconnection of generators under Expedited interconnection review provided the generator is not greater than 2 MW but shall serve as an Application for Standard interconnection review if greater than 2 MW or if Expedited review does not qualify the generator for interconnection.

Written applications should be submitted by mail, e-mail or fax to Central Maine Power Company (CMPCO), as follows:

[Utility]: Central Maine Power Company (CMPCO)
[Utility's address]: 83 Edison Drive, Augusta, ME 04336
Telephone Number: 207.621.4732
E-Mail Address: nathan.pelletier@cmpco.com.
[Utility] Contact Name: C/O Nick Pelletier
[*Utility*] Contact Title: _____

An application is a Complete Application when it provides all applicable information required below. (Additional information to evaluate a request for interconnection may be required and will be so requested from the Interconnection Applicant by Utility after the application is deemed complete).

Section 1. Applicant Information

Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)
Name: MaineDOT Environmental Office – c/o David Gardner
Mailing Address: 24 Child Street
City: Augusta State: ME__ Zip Code: 04333

Facility Location (if different from above): 225 Civic Center Drive, Augusta Me. 04330
POI 44.345203, -69.794292 Pole 532
Telephone (Daytime): 1-207-592-2471
Telephone (Evening): 1-207-592-2471
Fax Number:
E-Mail Address: david.gardner@maine.gov

Not Applicable_____
(Utility)

3001-216-7174
(Existing Account Number, if generator to be interconnected on the Customer side of a utility revenue meter)

Type of Interconnect Service Applied for _____ Network Resource, _____
(choose one)

Energy Only, X Load Response (no export) _____ Net metering

Section 2. Generator Qualifications

Data apply only to the Small Generating Facility, not the Interconnection Facilities.
Energy Source: X Solar ___ Wind ___ Hydro ___ Hydro Type (e.g. Run-of-River):_____

Diesel ___ Natural Gas ___ Fuel Oil ___ Other (state type)_____

Prime Mover: Fuel Cell ___ Recip. Engine ___ Gas Turb. ___ Steam Turb. ___
Microturbine ___ PV X Other _____

Type of Generator: Synchronous ____ Induction ____ Inverter X

Generator Nameplate Rating: 125 kW (10 Units)
Generator Nameplate kVA: 125kVA (10 Units)

Interconnection Customer or Customer-Site Load: NONE__ kW (if none, so state)

Typical Reactive Load (if known): __N/A___
Maximum Physical Export Capability Requested 1.25kW

List components of the Small Generating Facility Equipment Package that are currently certified:

	Equipment Type	Certifying Entity
1.	Solectria XGI 1500-125/125	UL 1741 SA
2.	Candian Solar Ku Max 395M	UL 1703
3.		
4.		
5.		

Is the prime mover compatible with the certified protective relay package?
Yes X No ____

Generator (or solar collector):

Manufacturer, Model Name & Number: Solectria XGI 1500-125/125

Version Number: TBD
Nameplate Output Power Rating in kW:

(Summer) 125kW (Winter) 125kW
Nameplate Output Power Rating in kVA:
(Summer) 125kVA (Winter) 125kVA

Individual Generator Power Factor:
Rated Power Factor: Leading: 0.8 PF Lagging: 0.8 PF

Total Number of Generators in wind farm to be interconnected pursuant to this Interconnection Request: _____ Elevation: _____Single-phase _____
Three- phase (10) units operating at 125 kW

Inverter Manufacturer, Model Name & Number (if used): Solectria XGI 1500-125/125

List of adjustable set points for the protective equipment or software: Per IEEE 1547

Note: *A completed Power Systems Load Flow data sheet must be supplied with the Interconnection Request*.

Small Generating Facility Characteristic Data (for inverter-based machines)

Max design fault contribution current: 69.3@12.47kV Instantaneous or RMS? RMS
Harmonics Characteristics: <3% per IEEE519

Start-up requirements: estimated 1 kW per Solectria XGI 1500-125/125

Small Generating Facility Characteristic Data (for rotating machines) NOT APPLICABLE

RPM Frequency: _____
(*) Neutral Grounding Resistor (If Applicable): _____

Synchronous Generators: NOT APPLICABLE

Direct Axis Synchronous Reactance, Xd: _____ P.U.
Direct Axis Transient Reactance, X' d: _____ P.U.
Direct Axis Subtransient Reactance, X" d: _____ P.U.
Negative Sequence Reactance, X2 _____ P.U.
Zero Sequence Reactance, X0: _____ P.U.

KVA Base: _____

Field Volts: _____
Field Amperes: _____

Induction Generators: NOT APPLICABLE

Motoring Power (kW): _____
I^2t or K (Heating Time Constant):_____
Rotor Resistance, Rr: _____
Stator Resistance, Rs: _____
Stator Reactance, Xs: _____
Rotor Reactance, Xr: _____
Magnetizing Reactance, Xm: _____
Short Circuit Reactance, Xd": _____
Exciting Current: _____
Temperature Rise: _____
Frame Size: _____
Design Letter: _____
Reactive Power Required In Vars (No Load): _____
Reactive Power Required In Vars (Full Load): _____
Total Rotating Inertia, H: _____ Per Unit on kVA Base

Note: *Please contact the T & D Utility prior to submitting the Interconnection Request to determine if the specified information above is required.*

Excitation and Governor System Data for Synchronous Generators Only
Provide appropriate IEEE model block diagram of excitation system, governor system and power system stabilizer (PSS) in accordance with the regional reliability council criteria. A PSS may be determined to be required by applicable studies. A copy of the manufacturer's block diagram may not be substituted.

Section 3. Interconnection Facilities Information

Will a transformer be used between the generator and the Point of Common Coupling?
__X__ Yes ___No

Will the transformer be provided by the Interconnection Customer? _X_ Yes ____No

Transformer Data (If Applicable, for Interconnection Customer-Owned Transformer):

Is the transformer: Single-phase _____ Three phase X_ Size: 1500 kVA (1 Typ.)
Transformer Impedance: 5.75% percent on 1500 kVA Base

If Three Phase:

Transformer Primary: 12,470 Volts _____ Delta _____Wye __X__ Wye Grounded
Transformer Secondary: 600 Volts _____ Delta _____ Wye __X_ Wye Grounded
Transformer Tertiary: _____ Volts _____ Delta _____Wye _____ Wye Grounded

Transformer Fuse Data (If Applicable, for Interconnection Customer-Owned Fuse):
(Attach copy of fuse manufacturer's Minimum Melt and Total Clearing Time-Current Curves)

Manufacturer: TBD_ Type: _____ Size: _____
Speed: _____

Interconnecting Circuit Breaker (if applicable): NOT APPLICABLE

Manufacturer: _____ Type: _____
Load Rating (Amps): _____ Interrupting Rating (Amps): _____ Trip Speed (Cycles): _____

Interconnection Protective Relays (If Applicable):

If Microprocessor-Controlled:

List of Functions and Adjustable Setpoints for the protective equipment or software:

Setpoint Function	Minimum	Maximum
1. See ONE-LINE		
2.		
3.		
4.		
5.		
6.		

If Discrete Components:
(Enclose Copy of any Proposed Time-Overcurrent Coordination Curves)

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____ Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____ Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Current Transformer Data (If Applicable):
(Enclose Copy of Manufacturer's Excitation and Ratio Correction Curves)

Manufacturer: _____ Type: _____ Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____ Type: _____ Accuracy Class: _____
Proposed Ratio Connection: _____

Potential Transformer Data (If Applicable):

Manufacturer: _____ Type: _____ Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____ Type: _____ Accuracy Class: _____
Proposed Ratio Connection: _____

Section 4. General Information

Enclose copy of site electrical one-line diagram showing the configuration of all Small Generating Facility equipment, current and potential circuits, and protection and control schemes. This one-line diagram must be signed and stamped by a licensed Professional Engineer if the Small Generating Facility is larger than 50 kW.
Is One-Line Diagram enclosed? Yes _X_ No ____

Enclose copy of any site documentation that indicates the precise physical location of the proposed Small Generating Facility (e.g., USGS topographic map or other diagram or documentation).

Proposed location of protective interface equipment on property (include address if different from the Interconnection Customer's address):

_____

_____

Enclose copy of any site documentation that describes and details the operation of the protection and control schemes.

Is Available Documentation Enclosed? Yes ____ No __X__

Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).
Are Schematic Drawings Enclosed? Yes ____ No __X__

Section 5. Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by (utility) on or near my service meter location. Generating systems must be compliant with IEEE, NEC, ANSI, and UL standards, where applicable. By signing below, the Applicant also certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.

Signed: _____ Date: 03-04-2020

Section 6. Information Required Prior to Physical Interconnection
(Not required as part of the application, unless available at time of application.)

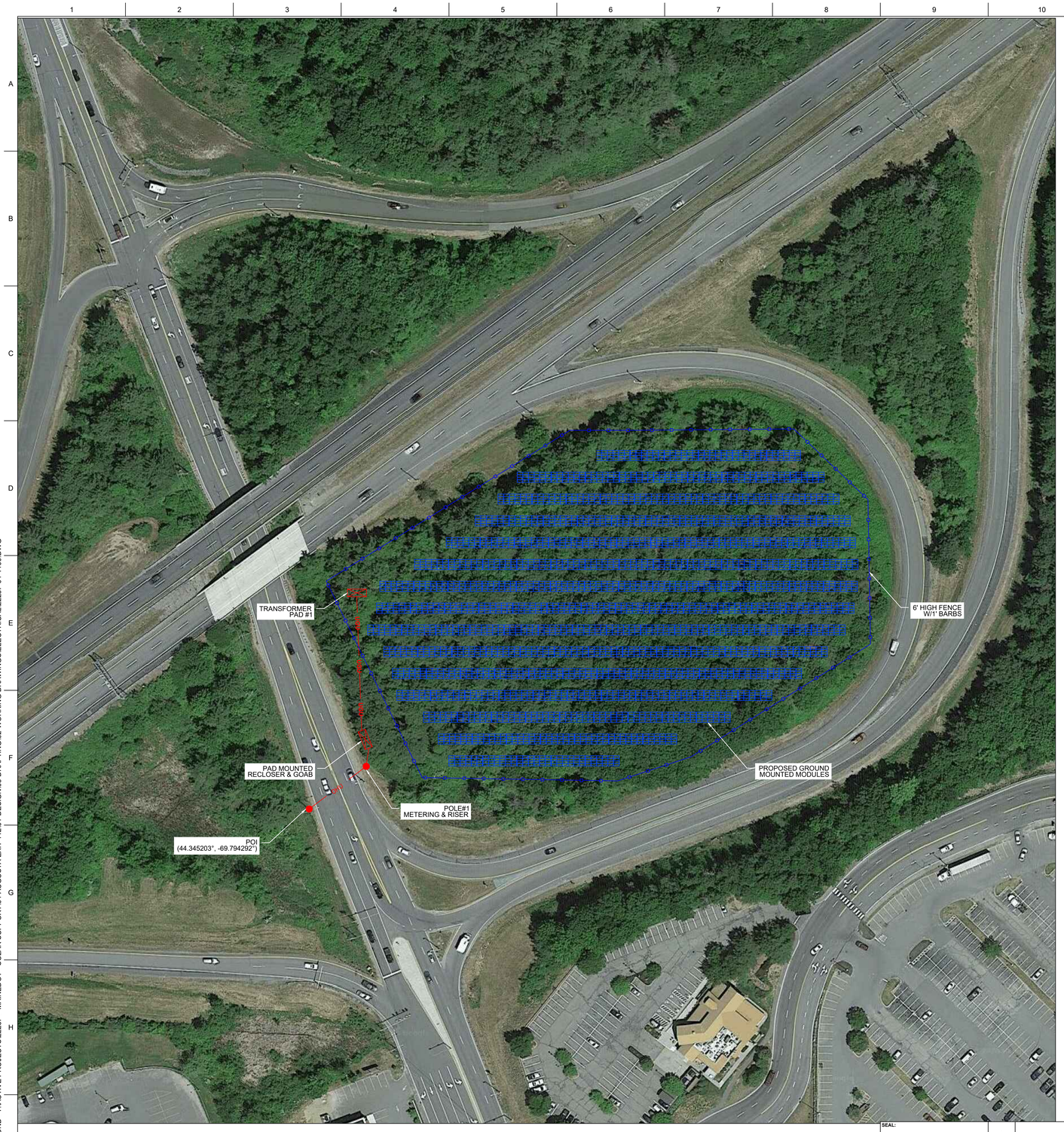
Installing Electrician: _____ Firm: _____
License No.: _____

Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Telephone: _____

Installation Date: _____ Interconnection Date: _____

Signed: _____ Date: _____
(Inspector - if required)

(In lieu of signature of Inspector, a copy of the final inspection certificate may be attached)



N

GENERAL NOTES:

1. TREES MAY GROW DURING THE LIFE OF THE SYSTEM AND IMPACT THE PRODUCTION.
2. ANY AND ALL LAYOUT CHANGES, INCLUDING BUT NOT LIMITED TO SHIFTING OF THE ARRAY, ARE SUBJECT TO APROVAL BY THE DESIGN TEAM.
3. ARRAY LAYOUT DIMENSIONS SHALL BE CONSIDERED APPROXIMATE AND MAY VARY SLIGHTLY DUE TO MODULE INSTALLATION TOLERANCES AND VARYING TOPOGRAPHY.

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 395W
MODULES QUANTITY	3,840
DC RATING AT STC	1,517 KW
AC RATING	1,250 KW
INVERTER	(10) SOLECTIA XGI-125
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1250 VDC

LEGEND:

- MODULE
- UTILITY POLE
- UGU — UNDERGROUND
- OHU — OVERHEAD
- FENCE
- TRANSFORMER PAD

PRELIMINARY
NOT FOR CONSTRUCTION

SEAL:

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 112
ME DOT
1.25 MWAC PV GENERATION FACILITY
AUGUSTA, ME

SCALE: NONE **SIZE:** ARCH D

GENERAL SITE PLAN

DATE:	02/24/20
DRAWN BY:	CJB
ENGIN'D BY:	JED
PROJECT #:	22237-04
DRAWING #:	1100

PROPOSED PROTECTION RELAY SETTINGS

DEVICE	PICKUP			Time Delay		Total Clearing Time	
	Primary		Secondary				
27-1	50%	(3599.8 V)	(54 V)	63 CYC	1.05 SEC	66 CYC	1.1 SEC
27-2	88%	(6335.6 V)	(95.04 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-1	110%	(7919.5 V)	(118.8 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-2	120%	(8639.5 V)	(129.6 V)	6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81U-1	58.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81U-2	56.5 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81O-1	61.2 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81O-2	62 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
51		72 A	0.72 A	SET PER UTILITY STANDARDS			
51G		24 A	0.24 A	SET PER UTILITY STANDARDS			
79	0.95 PU - 1.05 PU 59 HZ - 60.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC

SETTINGS ASSUME 3 CYCLE ESTIMATED DEVICE TRIP OPENING TIME
SETTINGS ARE BASED ON IEEE 1547-2018 TABLE 1 (VOLT) AND 2 (FREQ).
SETTINGS ARE BASED ON A 108V SECONDARY PT BASE.

PROPOSED UL1741 INVERTER INTERNAL CONTROL SETTINGS

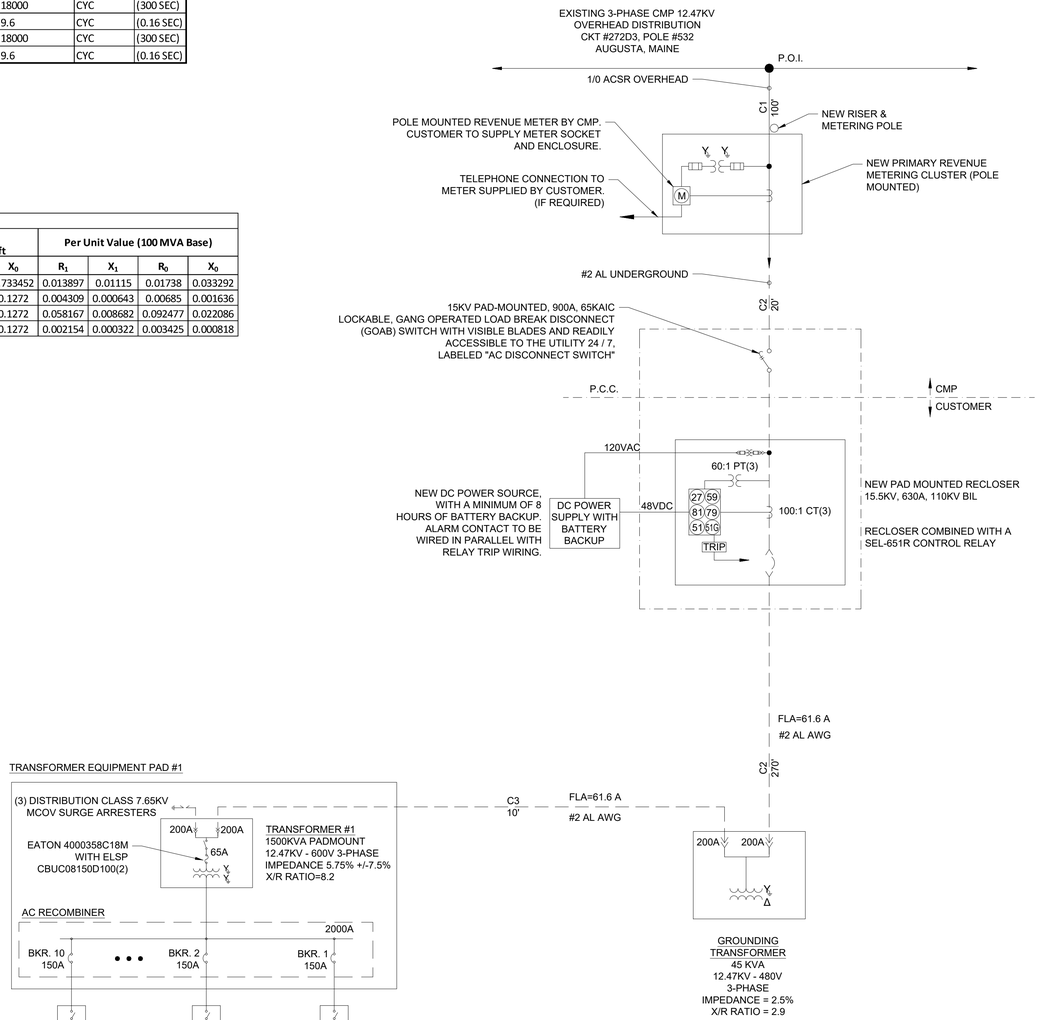
DEVICE	PICKUP		CLEARING TIME		
27-1	50%	(300 V)	66	CYC	(1.1 SEC)
27-2	88%	(528 V)	120	CYC	(2 SEC)
59-1	110%	(660 V)	120	CYC	(2 SEC)
59-2	120%	(720 V)	9.6	CYC	(0.16 SEC)
81U-1	58.5 HZ		18000	CYC	(300 SEC)
81U-2	56.5 HZ		9.6	CYC	(0.16 SEC)
81O-1	61.2 HZ		18000	CYC	(300 SEC)
81O-2	62 HZ		9.6	CYC	(0.16 SEC)

Base Voltage 600 V.

PF = 1.0

AC Wire and Cable Schedule

From	To	Cable Number	Type	Material	Conductor	Voltage (kV)	Feet	Overhead - Ohms/mile Underground - Ohms/1000ft				Per Unit Value (100 MVA Base)			
								R_1	X_1	R_0	X_0	R_1	X_1	R_0	X_0
POI	Meter/Riser	C1	Overhead	ACSR	1/0	12.47	100	1.141	0.915438	1.427	2.733452	0.013897	0.01115	0.01738	0.033292
Meter	GOAB/Recloser	C2	Underground	AL	#2	12.47	20	0.335	0.05	0.5326	0.1272	0.004309	0.000643	0.00685	0.001636
GOAB/Recloser	Grounding Xfmr	C3	Underground	AL	#2	12.47	270	0.335	0.05	0.5326	0.1272	0.058167	0.008682	0.092477	0.022086
Grounding Xfmr	Equip Pad #1	C4	Underground	AL	#2	12.47	10	0.335	0.05	0.5326	0.1272	0.002154	0.000322	0.003425	0.000818



UTILITY INTERCONNECTION NOTES:

1. INVERTERS (INV) - SOLECTRIA XGI-125KW, 1500VDC, 600VAC, NEMA 4X, MOUNTED ON UNISTRUT. INVERTERS ARE UL1741-SA-2016 LISTED AND IEEE1547-A COMPLIANT. INVERTER SHALL HAVE INTEGRATED AC & DC DISCONNECTS
2. MODULES TO BE CANADIAN SOLAR 395W KUMAX CS3U-395MS 144 CELL MONOCRYSTALLINE PANELS. MODULES ARE CERTIFIED UL 1703 COMPLIANT.
3. DAS SYSTEM TO BE DESIGNED AND ENGINEERED BY SELECTED DESIGNATED PARTY.
4. LOCATION OF THE POI: 44.345203°, -69.794292°

ONE LINE POWER DIAGRAM LEGEND:

- LOAD-BREAK SWITCH FUSE, SIZE AS INDICATED
- TRANSFORMER, SIZE AS INDICATED
- CIRCUIT BREAKER
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER / SOLID STATE TRIP UNIT
- GROUND
- L.A. LIGHTNING ARRESTOR
- CABLE TERMINATION/LOAD ELBOW
- FUSE
- GROUP AIR (GOAB) SWITCH
- (M) REVENUE METER (BY UTILITY)
- LOAD BREAK ELBOWS

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 395W
MODULES QUANTITY	3,840
DC RATING AT STC	1,517 KW
AC RATING	1,250 KW
INVERTER	(10) SOLECTIA XGI-125
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1250 VDC

DEVICE NO. DESCRIPTION

27	UNDERVOLTAGE RELAY
50/51	INSTANTANEOUS/TIME OVERCURRENT RELAY
51G	GROUND OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59G	GROUND OVERVOLTAGE RELAY
79	AC RECLOSING RELAY
81/O	OVERFREQUENCY RELAY
81/U	UNDER FREQUENCY RELAY

LEGEND:

- OVERHEAD
- UNDERGROUND
- PRIMARY
- COMMUNICATION

PRELIMINARY
NOT FOR CONSTRUCTION

SEAL: STATE OF MAINE 02-28-20 TEDD M. GIFFORD NO. 10271 PROFESSIONAL ENGINEER REV A

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/28/20	CJB	JED	TMG

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

EXIT 112 SOLAR
ME DOT
1.25 MWAC PV GENERATION FACILITY
AUGUSTA, ME

SCALE: NONE SIZE: ARCH D

ONE LINE DIAGRAM

DATE: 02/26/20
DRAWN BY: CJB
ENGN'D BY: JED
PROJECT #: 22237-04
DRAWING #: 2100

NEW

CanadianSolar

KuMax

HIGH EFFICIENCY MONO PERC MODULE

CS3U-375|380|385|390|395MS

(1000 V / 1500 V)

MBB 5BB

MORE POWER

- Low power loss in cell connection
- Low NMOT: 41 ± 3 °C
  Low temperature coefficient (Pmax): -0.37 % / °C
- Better shading tolerance
- High PTC rating of up to: 93.13 %

MORE RELIABLE

- Lower hot spot temperature
- Minimizes micro-cracks
- Heavy snow load up to 5400 Pa,
  wind load up to 3600 Pa*

25 years linear power output warranty

10 years product warranty on materials and workmanship

MANAGEMENT SYSTEM CERTIFICATES

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE / MCS / CEC AU
UL 1703 / IEC 61215 performance: CEC listed (US) / FSEC (US Florida)
UL 1703: CSA / IEC61701 ED2: VDE / IEC62716: VDE / IEC60068-2-68: SGS
Take-e-way

*We can provide this product with special BOM specifically certified with salt mist, ammonia and sand blowing tests. Please talk to our local technical sales representatives to get your customized solutions.

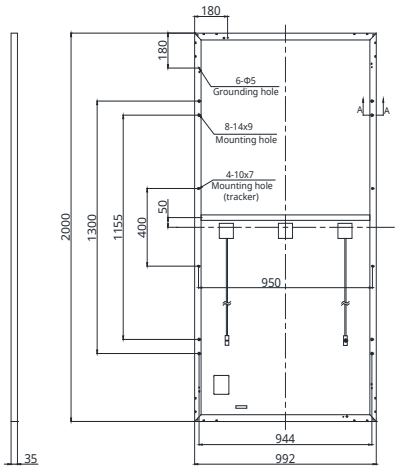
CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 30 GW deployed around the world since 2001.

* For detailed information, please refer to the Installation Manual.

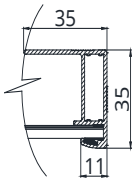
CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

ENGINEERING DRAWING (mm)

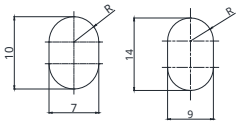
Rear View



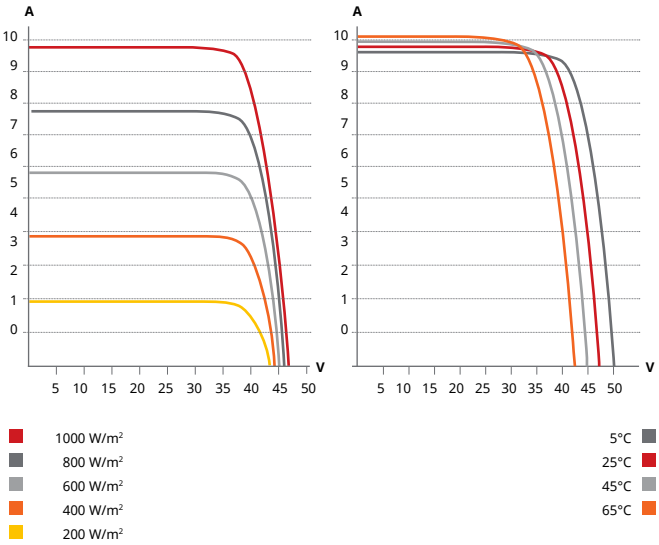
Frame Cross Section A-A



Mounting Hole



CS3U-375MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	375 W	380 W	385 W	390 W	395 W
Opt. Operating Voltage (Vmp)	39.8 V	40.0 V	40.2 V	40.4 V	40.6 V
Opt. Operating Current (Imp)	9.43 A	9.50 A	9.58 V	9.66 A	9.73 A
Open Circuit Voltage (Voc)	47.6 V	47.8 V	48.0 V	48.2 V	48.4 V
Short Circuit Current (Isc)	9.93 A	10.01 A	10.09 A	10.17 A	10.25 A
Module Efficiency	18.90%	19.15%	19.41%	19.66%	19.91%
Operating Temperature	-40°C ~ +85°C				
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)				
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)				
Max. Series Fuse Rating	30 A				
Application Classification	Class A				
Power Tolerance	0 ~ + 5 W				

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	280 W	284 W	287 W	291 W	295 W
Opt. Operating Voltage (Vmp)	36.9 V	37.1 V	37.3 V	37.5 V	37.7 V
Opt. Operating Current (Imp)	7.58 A	7.64 A	7.70 A	7.76 A	7.82 A
Open Circuit Voltage (Voc)	44.8 V	45.0 V	45.1 V	45.3 V	45.5 V
Short Circuit Current (Isc)	8.01 A	8.07 A	8.14 A	8.20 A	8.26 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2000 X 992 X 35 mm (78.7 X 39.1 X 1.38 in)
Weight	22.5 kg (49.6 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 400 mm (15.7 in) (+) / 280 mm (11.0 in) (-); landscape: 1250 mm (49.2 in);leap-frog connection: 1670 mm (65.7 in)*
Connector	T4 series
Per Pallet	30 pieces
Per Container (40' HQ)	660 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.37 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	41 ± 3°C

PARTNER SECTION

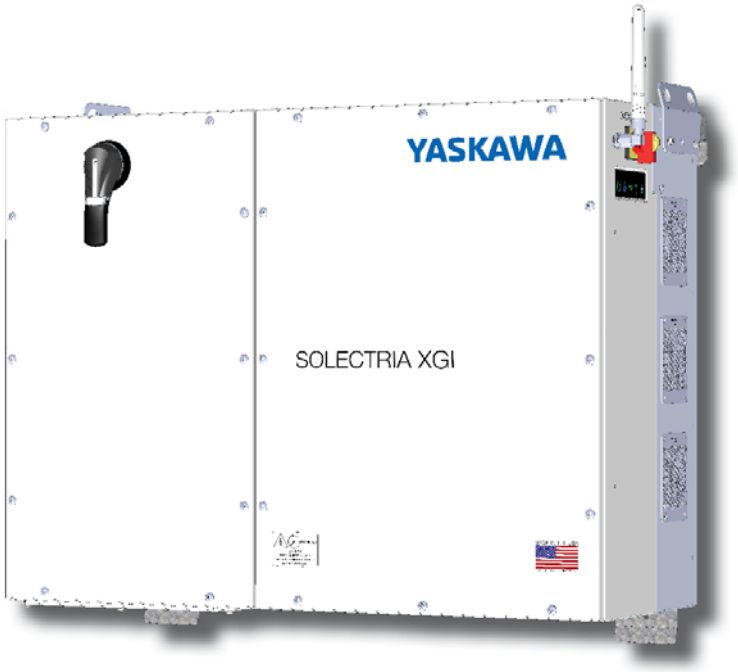
* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustments to the information described herein at any time without further notice. Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

YASKAWA

SOLECTRIA XGI™ 1500

Premium 3-Ph Transformerless Utility-Scale Inverters



Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- 99.0% peak efficiency
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades

Options

- String combiners for distributed and centralized systems
- Web-based monitoring
- Extended warranty

MADE IN THE USA

With U.S. and Global Components

Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that were selected, tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market and have been engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the new SOLECTRIA XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The XGI 1500 inverters are Made in the USA with global components and are compliant with the Buy American Act.

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	148.3 A	148.3 A	178.0 A	197.7 A
Maximum Operating PV Power	128 kW	128 kW	153 kW	170 kW
Maximum DC/AC Ratio | Max Rated PV Power	1.5 | 188 kW	1.5 | 188 kW	1.5 | 225 kW	1.5 | 250 kW
Max Rated PV Short-Circuit Current (∑Isc x 1.25)	320 A	320 A	320 A	320 A
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable	+/- 0.80 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.9%	98.9%	99.0%	99.0%
CEC Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Option for 10 Years			
Enclosure				
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) | Width: 39.4 in. (1000 mm) | Depth: 15.1 in. (380 mm)			
Weight	245 lbs (111 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			

Specifications subject to change.

SOLECTRIA SOLAR

Yaskawa Solectria Solar
360 Merrimack Street
Lawrence, MA 01843
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DOCR-070730-O | May 2019

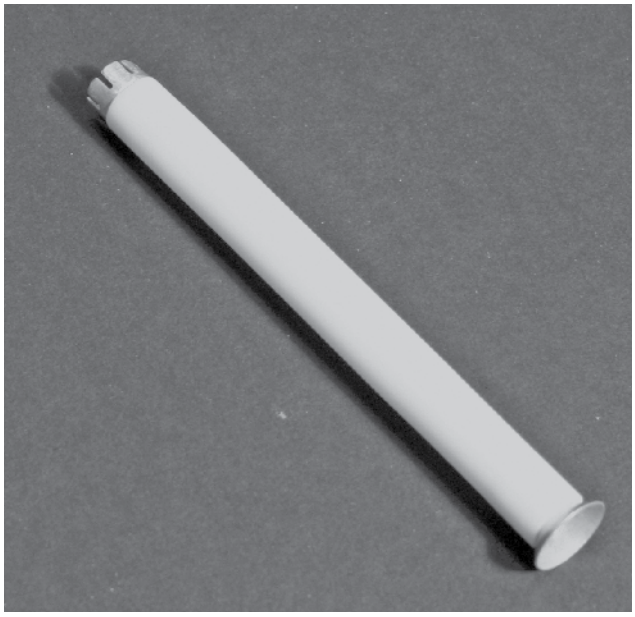
YASKAWA

Fusing Equipment
Catalog Data
CA132010EN

Effective February 2015
Supersedes 240-46 August 2012

COOPER POWER SERIES

Dual sensing Bay-O-Net fuse link



General

Eaton protects both distribution apparatus from damaging currents and to protect distribution systems from failed apparatus with its Cooper Power series dual sensing Bay-O-Net fuse link that is used in Eaton's Cooper Power series Bay-O-Net fuse assemblies (see *Catalog CA132015EN Sidewall-Mounted and Cover-Mounted Bay-O-Net Fuse Assembly*).

Dual sensing links sense not only secondary faults, excessive load currents and transformer faults, but also transformer fluid temperature. They will limit long-term transformer heating caused by overloads and high temperature environments.

Application

Bay-O-Net fuses can be used on single-phase conventional and self-protected distribution transformers and on three-phase equipment.

Its ideal use is in a two-fuse protection scheme with a current-limiting backup fuse. In this arrangement, secondary faults and overload currents are cleared by the Bay-O-Net fuse, and high level faults are cleared by the current-limiting fuse. The two fuses are connected in series, and are coordinated so that the current-limiting fuse operates only upon internal equipment failure. (See *Catalog CA132013EN ELSP Current-Limiting Backup Fuse* to order an ELSP current-limiting backup fuse.) If the bayonet fuse will not be used in series with a current-limiting fuse, an isolation link is required. (See *Catalog CA132012EN Isolation Link.)*

Bay-O-Net fuses are comparable in cost to internal cartridge fuses but have the advantages of being field-replaceable. Bay-O-Net fuses can easily be coordinated with upstream devices.

Installation

No special tools are required. A hotstick is used to remove the Bay-O-Net fuse cartridge holder from non-pressurized apparatus. The fuse cartridge is then replaced, and the holder reinserted using a hotstick. Refer to *Service information MN132002EN Bay-O-Net Fuse Re-Fusing Installation Instructions* for re-fusing instructions.

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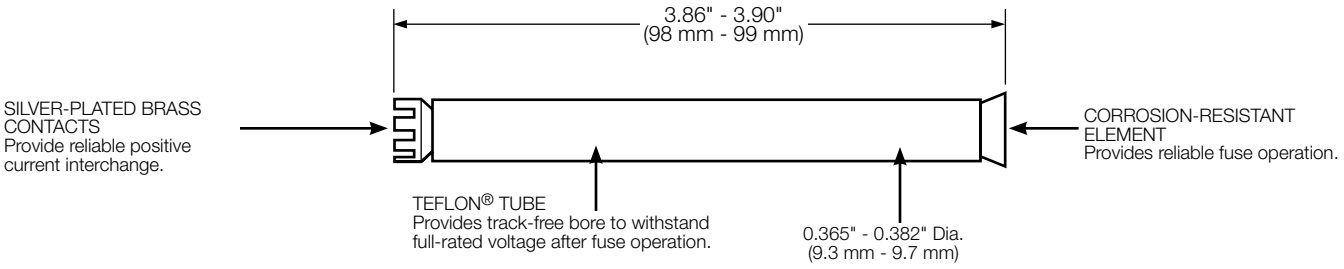

Figure 1. Dimensional and feature information.

Note: Dimensions given are for reference only.

Table 1. Electrical Ratings and Characteristics

		Maximum Single-Phase Interrupting Rating*		
Voltage (kV)	**Catalog Number**	**Cover Mount Assembly (rms asymmetrical) in Mineral Oil**	**Sidewall Mount Assembly (rms symmetrical) in Mineral Oil**	**Sidewall Mount Assembly (rms symmetrical) in Envirotemp™ FR3™ Fluid**
4.16	358C3-C14	3500 A	3500 A	3500 A
	358C16-C18	3500 A	3500 A	2000 A
8.3	358C03-C08	3500 A	3500 A	3500 A
	358C10-C12	3500 A	3500 A	2500 A
	358C14	3500 A	3500 A	1500 A
	358C16-C18	3500 A	3500 A	1200 A
15.5	358C03-C08	2500 A	2500 A	2500 A
	358C10-C12	2500 A	2500 A	1500 A
	358C14	2500 A	2500 A	1000 A
	358C16-C18	**	**	**
23.0	358C03-C08	1000 A	1000 A	1000 A
	358C10-C12	1000 A	600 A	600 A
	358C14	***	600 A	600 A
	358C16-C18	**	**	**

* In Eaton's Cooper Power series Bay-O-Net assemblies only. Where available fault current exceeds rated value, coordinated current-limiting fusing such as an ELSP (Catalog CA132013EN) or approved equivalent must be provided.

** Not rated above 8.3 kV.

*** Not rated above 15.5 kV

Table 2. Bay-O-Net Fuse Link

Continuous Current Rating (A)	Catalog Number*
3	4000358C03
8	4000358C05
15	4000358C08
25	4000358C10
50	4000358C12
65	4000358C14
100	4000358C16CB**
140	4000358C18CB**

* Add suffix "B" to order individual fuse; add "M" to order bag of 50.

** Catalog number is an integral element/cartridge/end plug design.

Ordering information

To order a dual sensing Bay-O-Net fuse link, determine the requirements of the application from Tables 3 and 4 and specify the fuse required from Table 2.

Method A

Using the correlation tables

Use the following correlation information (Tables 3 and 4) to complete Catalog Number 4000358__.

For 19.9 kV single-phase and 34.5 kV three-phase applications, an ELSP current-limiting backup fuse is recommended. (See Catalog CA132013EN for more information).

If the Bay-O-Net link is not used with a current-limiting fuse, an isolation link is required. (See Catalog CA132012EN).

Correlation is based on IEEE Std C57.92™-1981 standard, Loading Guide, IEEE Std C57.109™-1993 standard, Through-Fault Guide, and *Reference Data TD132001EN Pad-Mounted Transformer Fusing Philosophies*.

Table 3. Correlation Information
Single-Phase Transformer (Phase-to-Ground) Applications

Transformer kVA	Transformer Primary Voltage (kV)										
	2.4	4.16	4.8	7.2	7.62	8.32	12.0	12.47	13.2	13.8	14.4
5	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03
10	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03	C03
15	C08	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03
25	C10	C08	C08	C05	C05	C05	C03	C03	C03	C03	C03
37.5	C12	C10	C08	C08	C08	C08	C05	C05	C05	C05	C05
50	C12	C10	C10	C08	C08	C08	C05	C05	C05	C05	C05
75	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
100	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
167	C18	C14	C14	C12	C12	C12	C10	C10	C10	C10	C10
250	–	C16	C18	C14	C14	C14	C12	C12	C12	C12	C12
333	–	C18a	C18	C14a	C14a	C14a	C12	C12	C12	C12	C12
500	–	–	–	C18	C18	C18	C14	C14	C14	C14	C14

Table 4. Correlation Information
Three-Phase Transformer (Phase-to-Phase) Applications

Transformer kVA	Transformer Primary Voltage (kV)									
	2.4	4.16	4.8	8.32	12.0, 12.47	13.2	13.8, 14.4	20.8[b,d]	22.9[b,d]	24.9[b]
45	C10	C08	C08	C05	C03	C03	C03	C03	C03	C03
75	C12	C10	C10	C08	C05	C05	C05	C03	C03	C03
112.5	C14	C12	C10	C08	C08	C08	C08	C05	C05	C05
150	C14	C12	C12	C10	C08	C08	C08	C05	C05	C05
225	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
300	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
500	–	C18	C18	C14	C12	C12	C12	C10	C10	C10
750	–	C18[a]	C18[a]	C18	C14	C14	C14	C12[a]	C12	C12
1000	–	–	–	C18	C14[a]	C14[a]	C14[a]	C12[a]	C12	C12
1500	–	–	–	–	C18[c]	C18[c]	C18[c]	C14	C14	C14

Note: Recommendations are based on 200% transformer loading for 2 hours, 160% loading for 7 hours and thermal characteristics of typical Eaton's Cooper Power series transformers. Recommended fuses meet inrush requirement of 12 times transformer full load current for 0.1 second. Bay-O-Net fuse links alone should not be used at voltages greater than 17100 V for delta configurations or 24940 gnd Y/14400. For applications through 23 kV delta or 34500 gnd Y/19920, a 23 kV rated ELSP fuse (Catalog CA132013EN) is recommended in series with the Bay-O-Net link. Do not use fuse links 4000358C16CB or C18CB for voltages greater than 8320 V for delta configurations or 14400 gnd Y/8320.

a. Recommended fuse will result in some loss of overload capacity.

b. Recommended fuse limited to gnd Y/gnd Y transformer with less than 50% delta loading.

c. Recommended fuse limited to gnd Y primary.

d. For voltages greater than 17100 V for delta configurations or 24940 gnd Y/14400 and through 23 kV delta or 34500 gnd Y/19920, an ELSP 23 kV rated current-limiting back-up fuse (Catalog CA132013EN) in series with the Bay-O-Net fuse link is recommended.

Method B

Using time-current curves

To determine or confirm the dual sensing Bay-O-Net fuse that will coordinate with upstream and downstream system requirements, use time-current characteristic curves and specify the fuse indicated from Table 2.

Long term overload curves for selected transformer ratings are also available.

For full size TCC curves R240-91-51, long term overload curves and further information regarding either of these ordering methods, contact your Eaton representative.

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Eaton's Cooper Power Systems Division
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Waukesha, WI 53188
United States
Cooperpower.com

Printed in USA
Publication No. CA132010EN

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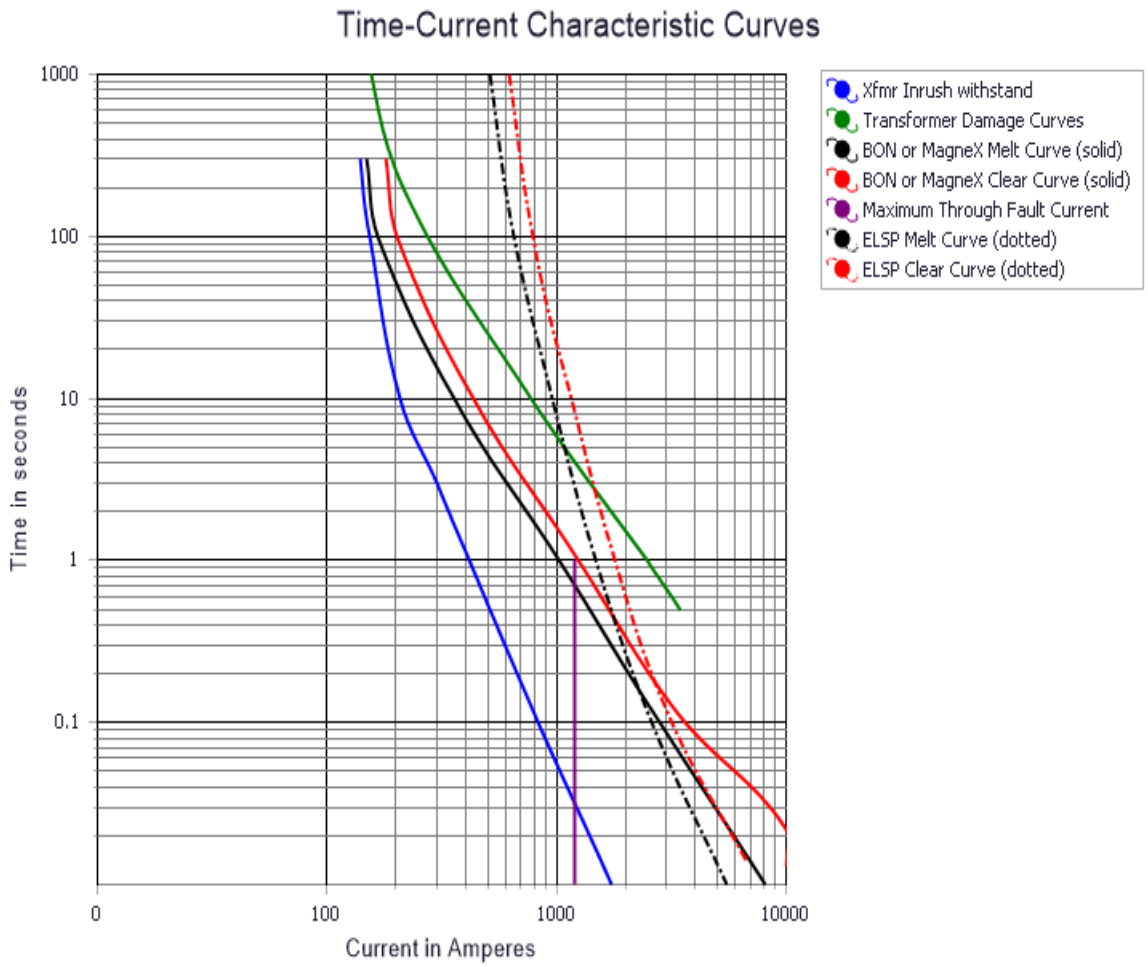
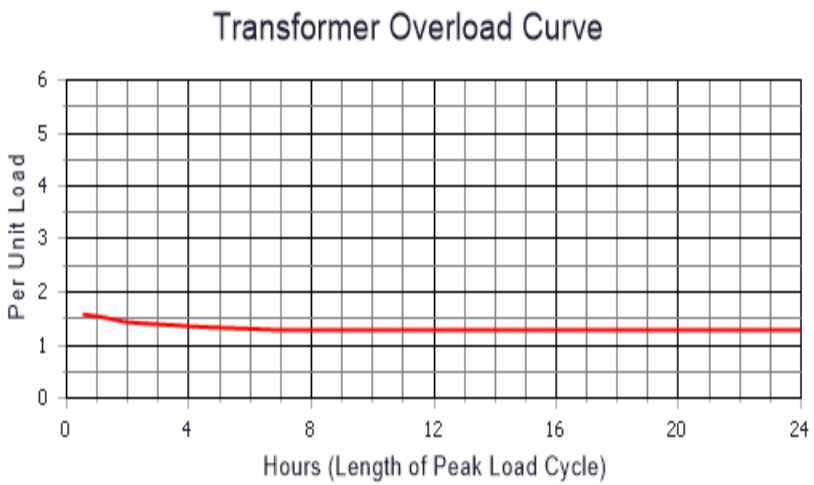
For Eaton's Cooper Power series Bay-O-Net fuse link product information call 1-877-277-4636 or visit: www.cooperpower.com.

TransFusion™ Coordination Program





Provided Inputs

Transformer kVA Rating: 1500
Primary Voltage (kV): 12.47
Number of Phases: 3
Minimum Impedance: 5.75
Primary Connection: Wye
Secondary Connection: Wye
Protection Type: Dual Sensing Bay-O-Net
Desired Protection level: Least Overload
Temperature Class: 65
Ambient Temperature: 35
Transformer Preload: 75
Xfmr. Rated Current (A): 69.45
Maximum Through Fault: 1208

Protection Device Recommendation

Based on your criteria, we recommend the following Cooper Power Systems protection device(s) for your application:

ELSP Selection: CBUC08150D100(2)
Bay-O-Net Selection: 4000358C14M

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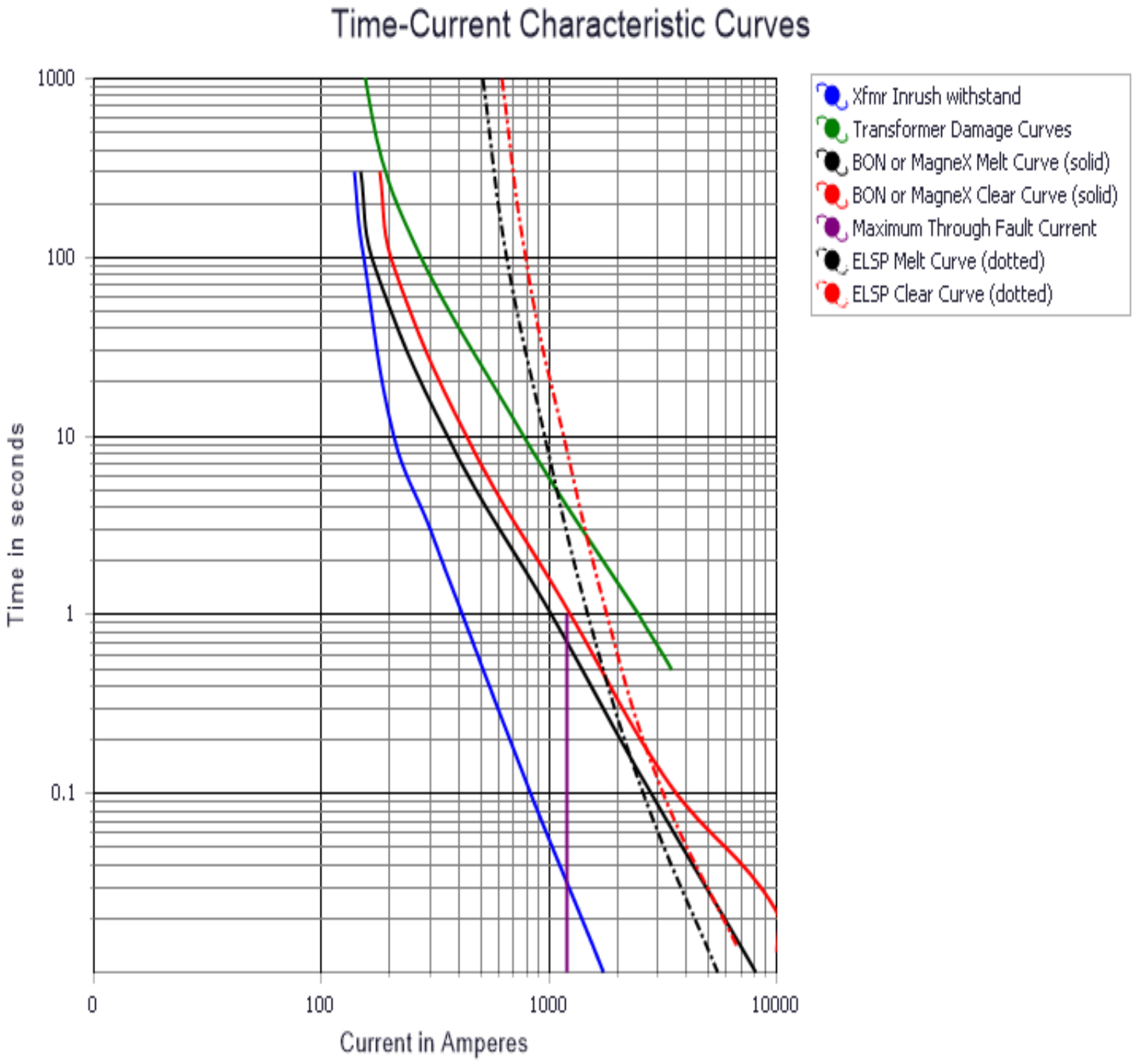
TransFusion™ Coordination Program



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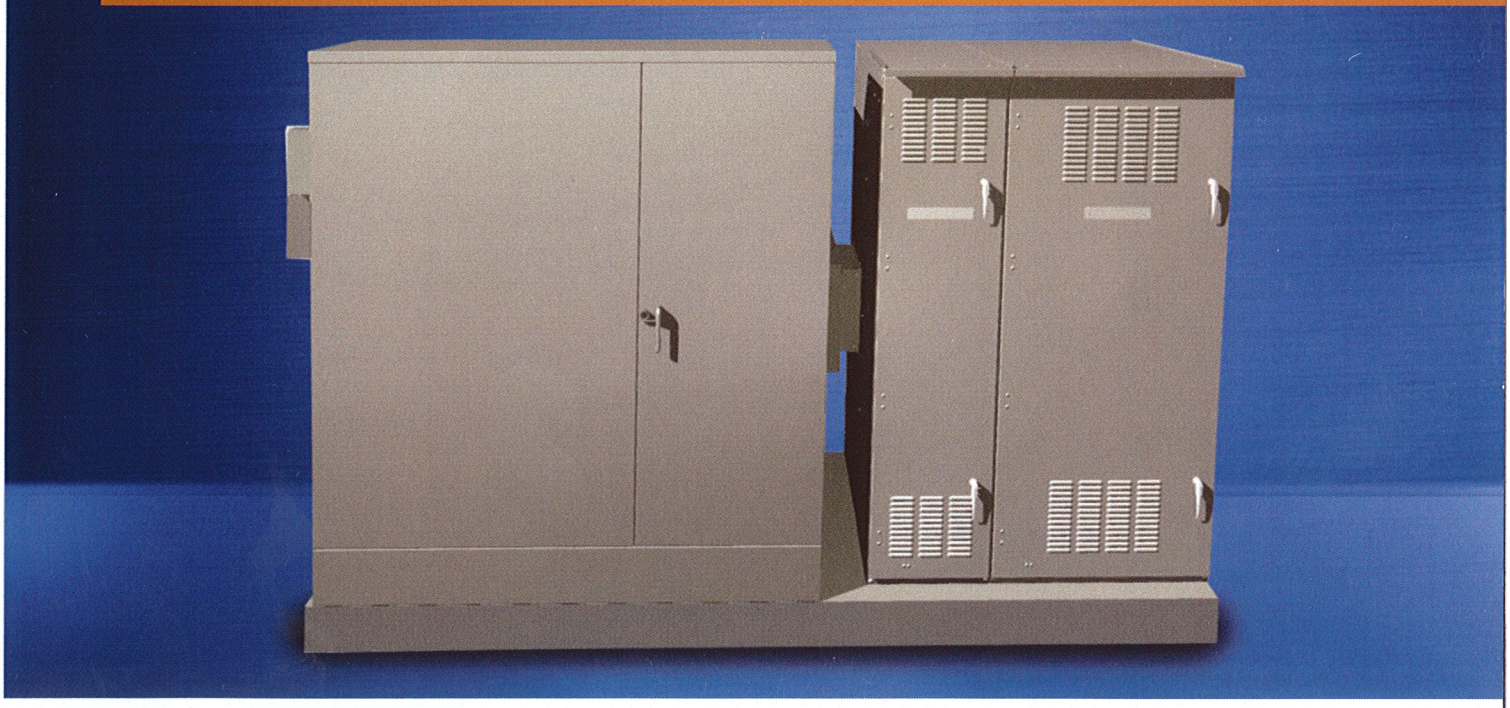
Protection Device Recommendation

ELSP Selection: CBUC08150D100(2)
Bay-O-Net Selection: 4000358C14M

1500 Vdc / 600 Vac
150 kW string inverter applications

Markets served
Renewable energy



Eaton's close-coupled solar recombiner and transformer solutions for string inverters

When it comes to commercial and utility-scale solar power, your focus is on reducing project complexity and minimizing costs. With changes in regulations and challenges with financing, you need a partner that has the expertise to reduce installation time and material, and to keep your people safe. As projects become more complex with grid connectivity and energy storage requirements, leadership, service and support become critical.

At Eaton, we know space is always at a premium, time is limited and cost matters. That's why we offer solar solutions that ease installation, save labor and lower the total cost of investment. For example, our space-saving AC solar recombiner integrates circuit breakers or fuse protection and a disconnect all within one enclosure. Integrated cable management, custom recombiner assemblies and transformers specially designed for solar PV string inverter applications are further examples of how our equipment is engineered to save our customers valuable space, time and money.

We can customize electrical system packages to specific requirements, including the physical dimensions and location of the building or installation. In addition, Eaton's regional satellite center personnel are knowledgeable in local electrical codes and utility regulations, so we design solutions that help streamline approvals by local authorities.

AC solar recombiners

- Customizable configurations for AC circuit breakers, main breakers and fusible switches
- UL® 891 listed assemblies for 480 Vac and 600 Vac applications
- Non-UL assemblies for 800 Vac applications using UL and IEC rated components
- Component integration can include metering, relays, dry-type transformers and more
- Offers close-coupling to Eaton liquid-filled transfomers
- Suitable for pour-in concrete pad installation; optional skid mounting also available

EATON
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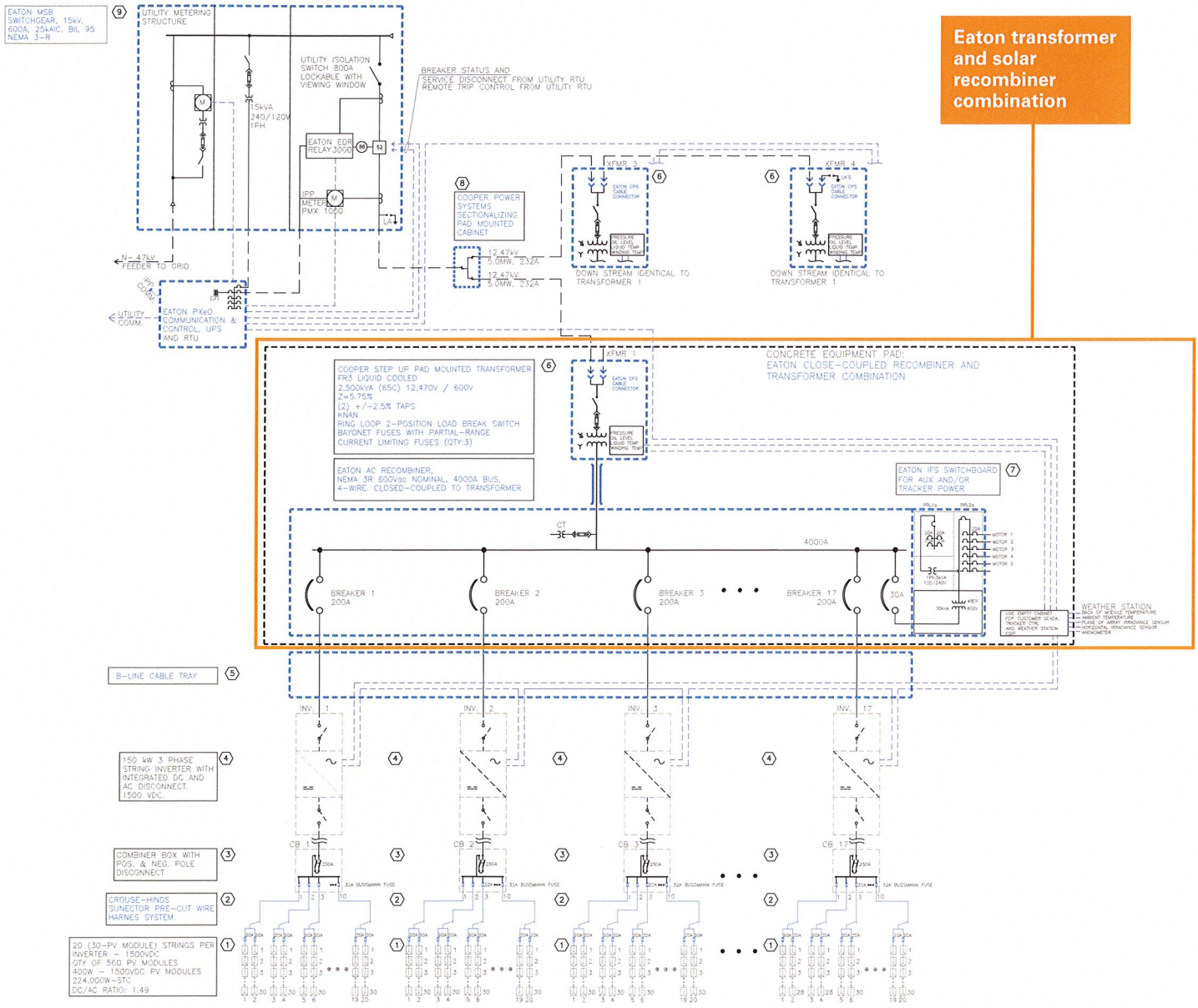
One-line diagram for 1500 Vdc / 600 Vac 150 kW string inverter applications



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United States
Eaton.com

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September 2018

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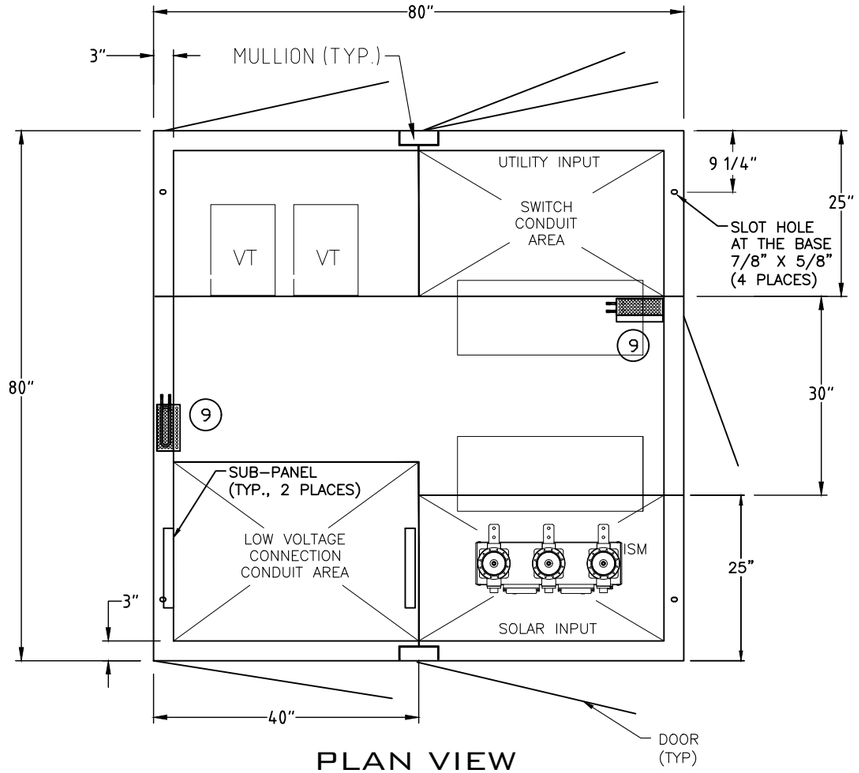
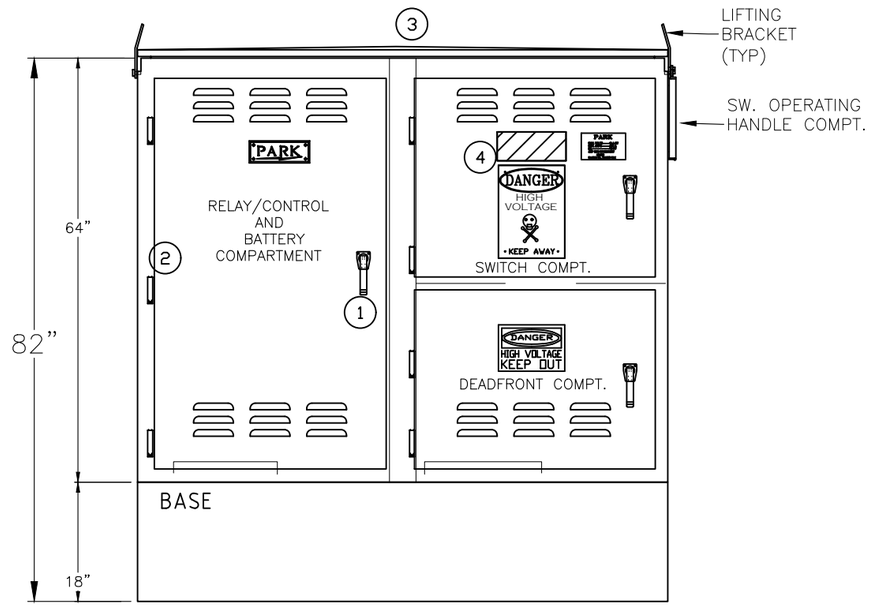
38 GREENWOOD AVENUE, WEYMOUTH, MA 02189
PHONE: 781-337-0222 FAX: 781-337-5152
WWW.ALDONELECTRIC.COM

SUBMITTAL FOR ELECTRIC:

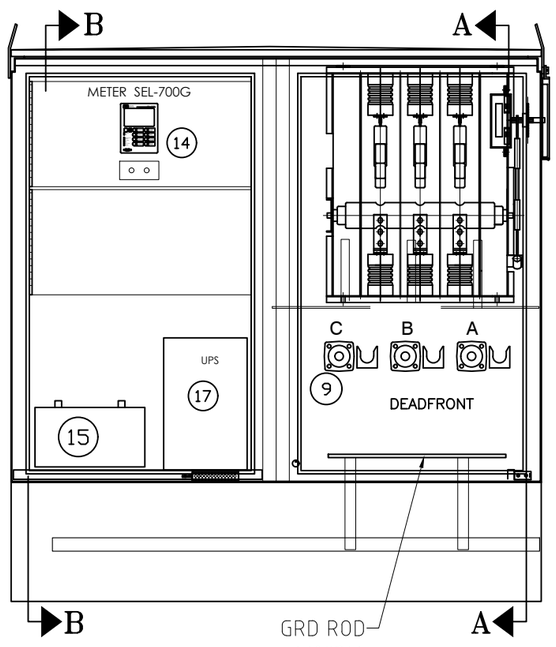
Combined Pad-mounted switchgear with recloser function and 15KV switch :



PLAN VIEW



FRONT VIEW



FRONT VIEW-INSIDE
MAIN DOOR REMOVED

LEGEND

1. PADLOCKABLE DOOR HANDLE
2. LIFT–OFF HINGE (BRASS PIN/STAINLESS STEEL TUBE)
3. SLOPED (CROWNED) WEATHERTIGHT ROOF
4. SWITCH BLADES POSITION VIEWING VINDOW
5. PADLOCKABLE COVER FOR SWITCH OPERATOR HANDLE (DETAIL–A)
6. POLYCARBONATE BARRIER
7. LOAD INTERRUPTER SWITCH
8. VACUUM FAULT INTERRUPTER
9. 200A DEAD FRONT BUSHINGS
10. INSULATOR
11. SILVER–PLATED COPPER BUS
12. COPPER GROUND BUS
13. 240V/375W HEATER
14. SEL–700G PROTECTION RELAY
15. BATTERY PACK
16. CURRENT TRANSFORMER (WINDOW TYPE)
17. 24VDC UPS
18. VOLTAGE XFMR

PARK
19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

PAGE #	TYPE	DESCRIPTION
1	MECHANICAL	COVER SHEET FRONT VIEW
2	"	PLAN VIEW
3	"	SIDE VIEW
4	BOM	BILL OF MATERIAL
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

NOTES:
1. 15KV, 200A, 3PH, 3W DEAD–FRONT SWITCHGEAR–PAD MOUNTED.
2. NEMA 3R CONSTRUCTION: 11GA. WELDED STEEL, OPEN BASE–10GA. GALV. STEEL. FRONT/REAR ACCESS.
3.

CUSTOMER APPROVAL REQUIRED
(NOT FOR PRODUCTION)
DATE : 1/13/2020

REV #	DATE	BY.	SHEET(S)	NOTES
1				
2				
3				
4				
5				
6				
7				
8				
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14				
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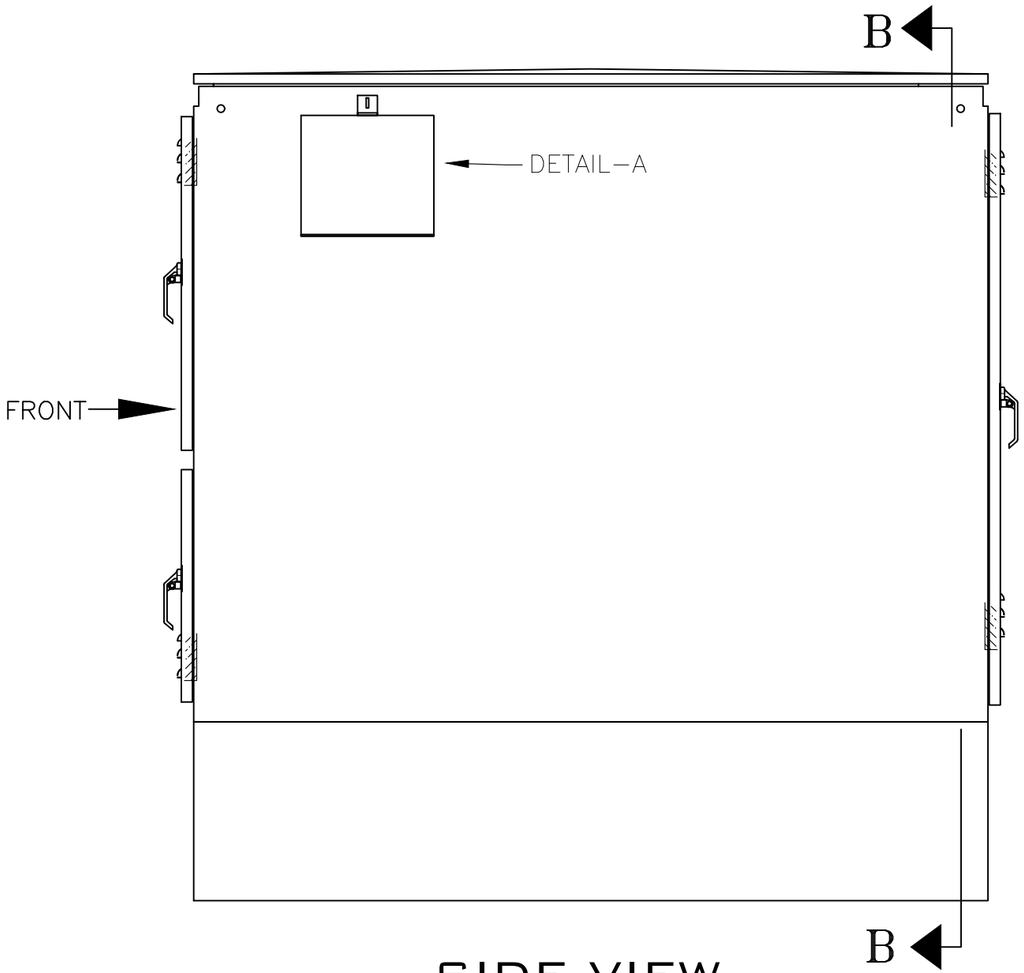
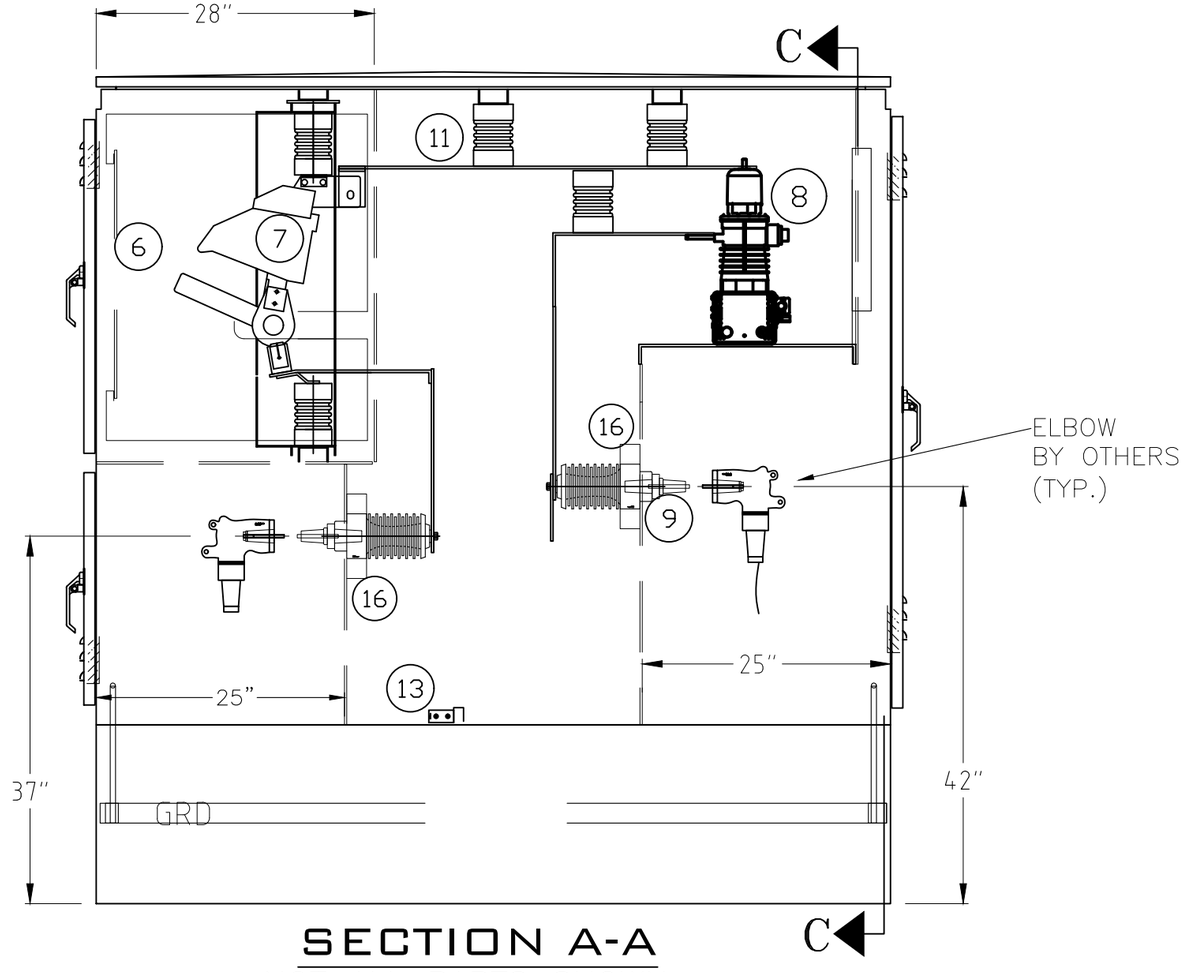
16				

FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION: SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 1 OF 6



SIDE VIEW



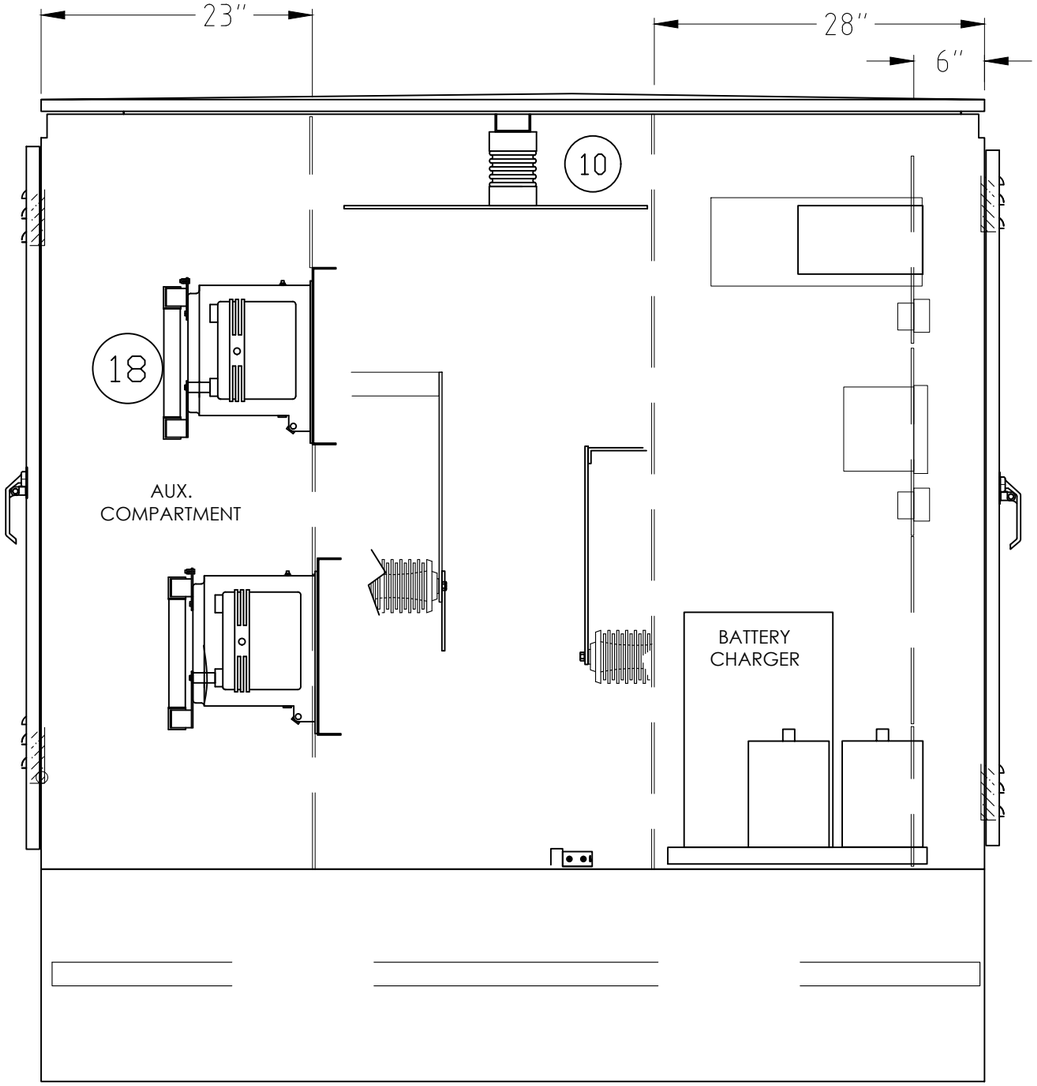
SECTION A-A

NOT ALL PARTS SHOWN

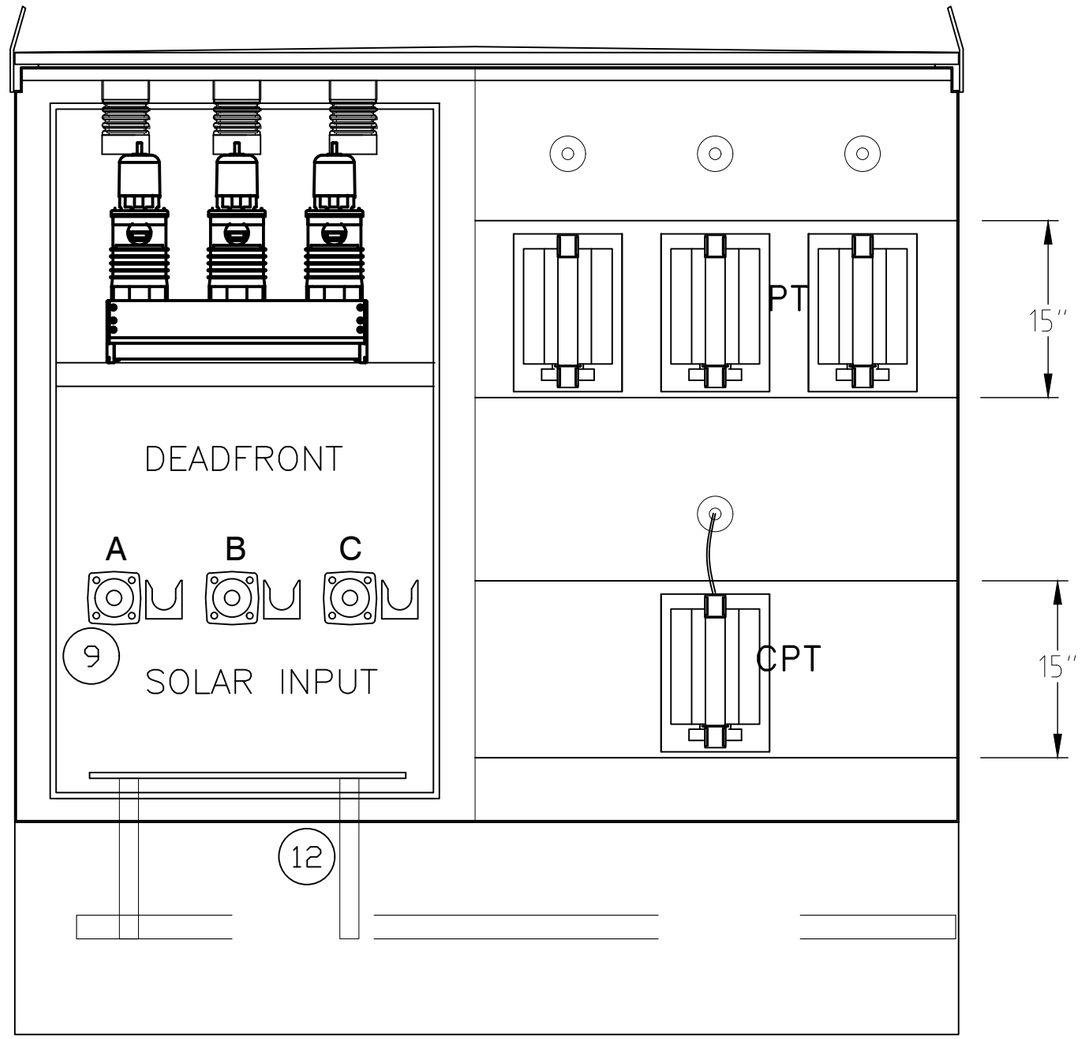
PARK

19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

FILE LOCATION:\NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION:SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED :15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 2 OF 6



SECTION B-B

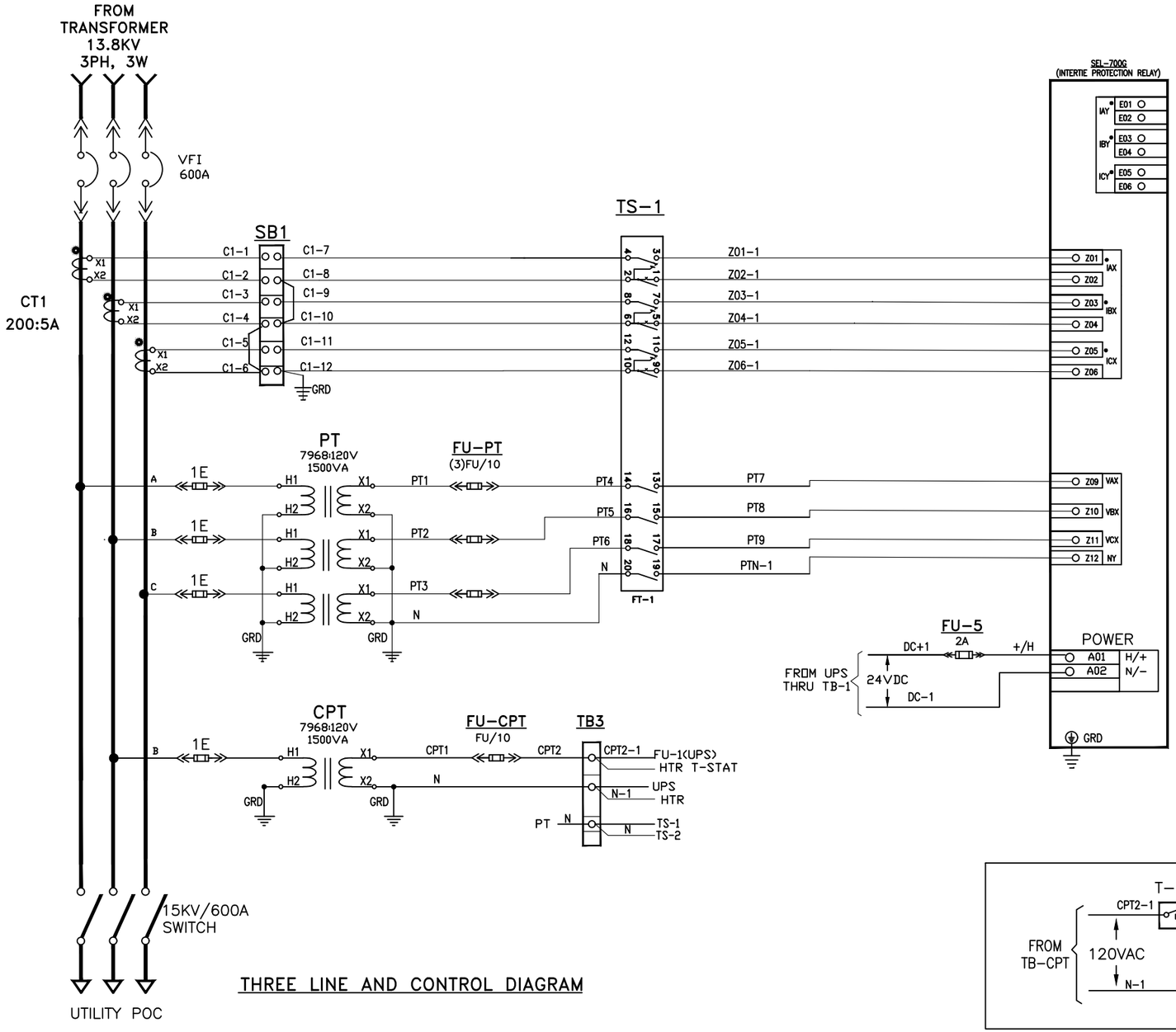


SECTION C-C

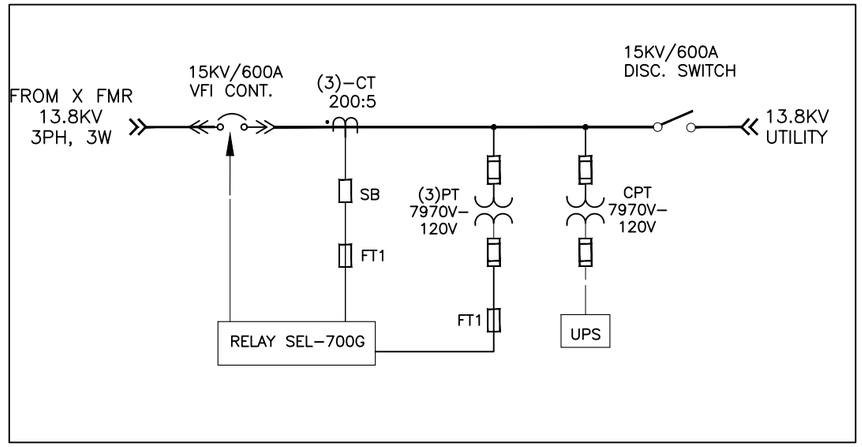
REAR VIEW

PARK
19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

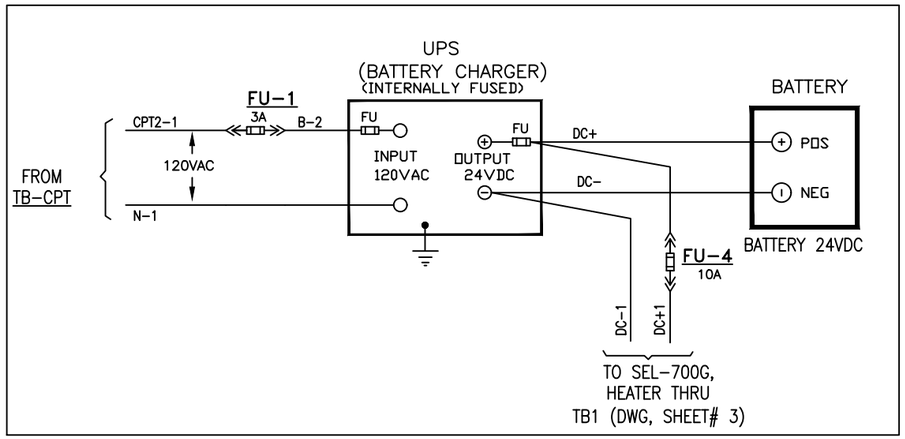
FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION: SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 3 OF 6



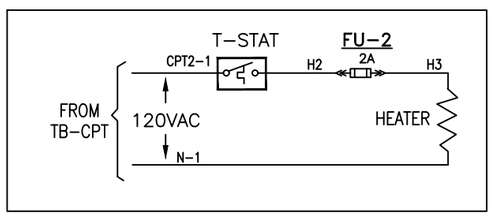
THREE LINE AND CONTROL DIAGRAM



ONE LINE DIAGRAM



BATTERY CHARGE SCHEMATIC

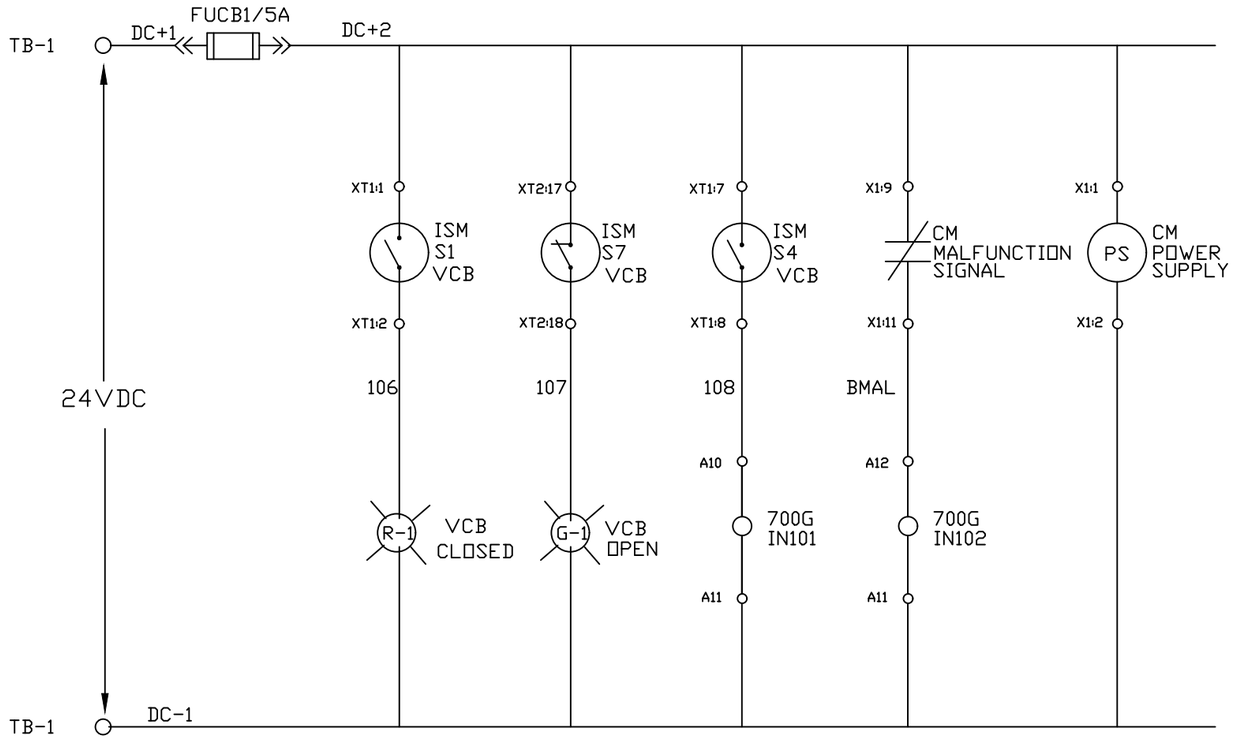


HEATER DIAGRAM

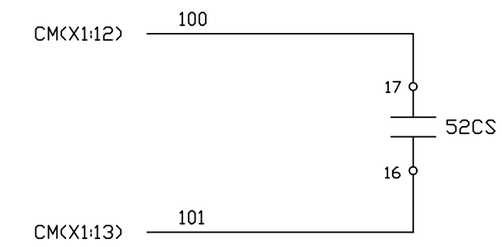
PARK

19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

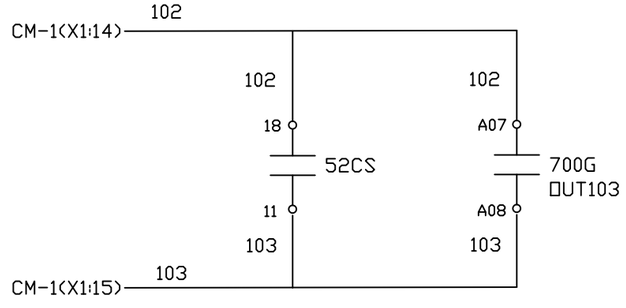
FILE LOCATION:\NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION:SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED :15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 4 OF 6



CIRCUIT BREAKER STATUS INDICATING LIGHS, POWER SUPPLY & 700G INPUT



CIRCUIT BREAKER(CB) CLOSE COMMAND



CIRCUIT BREAKER(CB) TRIP COMMAND

PARK

19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

FILE LOCATION: \NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION: SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
SYSTEM RATED : 15KV, 3-PHASE, 3-WIRE		
MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MO	P.O. #	
SALESPERSON: RO	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 5 OF 6

ITEM PM215-SC-VB-02-DF-06-NG-13.8

ITEM #	DESIGNATION	QTY	MFG. PART NUMBER	MANUFACTURER	DESCRIPTION
1	VFI	1	ISM15_LD_1(55)	TAVRIDA	ISM 3 PHASE TAVRIDA BREAKER MODULE - 15KV,800A, 20KA
2	CM	1	CM_TEL_24/60-12-01A	TAVRIDA	CONTROL MODULE FOR TAVRIDA ISM BREAKER MODULE, 24VDC
3	700G	1	0700G02B0X0X0X860200	SEL	SEL-700G GENERATOR AND INTERTIE PROTECTION RELAY, 2X16 LCD WITH8 PUSHBUTTONS, 24/48VDC, 1 - 10/100BASE-T, EIA-232, 5A CURRENT INPUT, 24VDC CONTROL.
4	PT	4	7525A65G29	ABB	VIZ-11, INDOOR application, 110kV BIL, Nominal system voltage: 15kV, Connection type: Line-Ground, Primary voltage: 7970/13800GY Volts, Secondary voltage: 120, Metering accuracy: 0.3Z, RVF: 1.1, Thermal rating: 1500, Frequency: 60Hz, Ratio: 66.4:1
5	BUSHING	6	1101-225B	ELLIOTT	200A 25KV AIR INSULATED BUSHINGS
6	CT	3	115-201	GE-ITI	CURRENT TRANSFORMER, 600V, 4.0" ID, 200:5 AMPS, C20 CLASS, RF: 2.0.
7	SB	2	EB27B06SC	GE-ITI	SHORTING BLOCK, 6 POLE, EB27B06SC
8	ENCL	1	PM215-SC-VB-02-DF-ENCL	PARK	
9	TS1 & 2	2	774B430G20	ABB	FT-1 FLEXITEST SWITCH, 10 POLE, 4 POTENTIAL, 6 CURRENT
10	SWITCH	1	255032-ED-240R6-2	S&C	SWITCH, 15KV MINI-RUPTER, MAIN CONTACT TOP, RIGHT HAND OPR, TOP MTG
11	FB1, 2 thru 7, CPT	8	30311	MERSEN	250 VOLT, 30 AMP, 1 POLE MIDGET FUSE BLOCK
12	FU3	2	ATM3	MERSEN	250 VOLT, 3 AMP MIDGET FUSE
13	FB-PT	1	30313	MERSEN	250 VOLT, 30 AMP, 3 POLE MIDGET FUSE BLOCK
14	FU-PT, CPT, FU4	5	ATM10	MERSEN	250 VOLT, 10 AMP MIDGET FUSE
15	FU5	1	ATM6	MERSEN	250 VOLT, 6 AMP MIDGET FUSE
16	FU6	1	ATM5	MERSEN	250 VOLT, 5 AMP MIDGET FUSE
17	FU2	1	ATM2	MERSEN	250 VOLT, 2 AMP MIDGET FUSE
18	UPS	1	SEI250/24-P	SEI POWER	9Amp 24 DC Output DC UPS with integrated 18 Ah battery backup (250 watts) with external battery connection
19	BATTERY	1	BP-18U	SEI POWER	External 18 Ah 24Vdc Battery Pack with Integrated Self-Test Circuitry
1					
2					
3	TB1 & TB2	2	SERIES 300	MARATHON	12 POINT TERMINAL BLOCK

PARK
19197 SHERWOOD AVE.
DETROIT, MICHIGAN 48234-2880

FILE LOCATION:\NUMBER2019\191544.DWG		
CUSTOMER:		
PROJECT: STOUGHTON RECYCLE TECHNOLOGIES		
DESCRIPTION:SWITCHGEAR LAYOUT		
CONSTRUCTION : OUTDOOR - NEMA 3R		
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MAIN BUS : 600A	NEUTRAL BUS: NA	GRD BUS: Y
ENGINEER : MD	P.O. #	
SALESPERSON: RD	S.O. # 191544	
APPROVALS:	DATE 1/13/2020	SHT# 6 OF 6

Augusta State Airport

Interconnection Application

Forms and Agreements 4: Level 2, Level 3 and Level 4 Interconnection Application

A Customer-Generator applicant ("Applicant") hereby makes application to CMP (Utility or T & D Utility) to install and operate a generating facility interconnected with the CMP utility system. This application will be considered as an application for interconnection of generators under Expedited interconnection review provided the generator is not greater than 2 MW but shall serve as an Application for Standard interconnection review if greater than 2 MW or if Expedited review does not qualify the generator for interconnection.

Written applications should be submitted by mail, e-mail or fax to Central Maine Power Company (CMPCO), as follows:

[Utility]: Central Maine Power Company (CMPCO)
[Utility's address]: 83 Edison Drive, Augusta, ME 04336
Telephone Number: 207.621.4732
E-Mail Address: nathan.pelletier@cmpco.com
[Utility] Contact Name: C/O Nick Pelletier
[*Utility*] Contact Title: _____

An application is a Complete Application when it provides all applicable information required below. (Additional information to evaluate a request for interconnection may be required and will be so requested from the Interconnection Applicant by Utility after the application is deemed complete).

Section 1. Applicant Information

Legal Name of Interconnecting Applicant (or, if an Individual, Individual's Name)
Name: MaineDOT Environmental Office-c/o David Gardner
Mailing Address: 24 Child Street
City: Augusta State: ME Zip Code: 04333

Facility Location (if different from above): 25 Bond Brook Rd, Augusta, ME 04330
44.330738°, -69.793557° "Augusta Airport 1"
Telephone (Daytime): 207-592-2471
Telephone (Evening): 207-592-2471
Fax Number: _____
E-Mail Address: david.gardner@maine.gov

CMP (Utility)	3001-216-7190 (Existing Account Number, if generator to be interconnected on the Customer side of a utility revenue meter)

Type of Interconnect Service Applied for ___ Network Resource,
X____ Energy Only, _____ Load Response (no export) _____ Net metering

Section 2. Generator Qualifications

Data apply only to the Small Generating Facility, not the Interconnection Facilities.
Energy Source: X__Solar ___ Wind ___ Hydro ___ Hydro Type (e.g. Run-of-River):____

Diesel _____Natural Gas _____Fuel Oil ____Other (state type)_____

Prime Mover: Fuel Cell ___Recip. Engine _____Gas Turb. __Steam Turb. _____
Microturbine _____ PV X Other _____

Type of Generator: Synchronous _____Induction _____Inverter X___

Generator Nameplate Rating: 125 kW (39 Units)
Generator Nameplate kVA: 125 kVA (39 Units)

Interconnection Customer or Customer-Site Load: NONE kW (if none, so state)

Typical Reactive Load (if known): NONE
Maximum Physical Export Capability Requested: 4,875 kW

List components of the Small Generating Facility Equipment Package that are currently certified:

	Equipment Type	Certifying Entity
1.	Sungrow SG125HV-20	UL 1741 SA
2.	Canadian Solar KuMax CS3U-390MS	UL 1703
3.		
4.		
5.		

Is the prime mover compatible with the certified protective relay package?
Yes X No __

Generator (or solar collector):

Manufacturer, Model Name & Number: Sungrow SG125HV-20
Version Number: TBD
Nameplate Output Power Rating in kW: (Summer) 125 kW (Winter) 125 kW
Nameplate Output Power Rating in kVA: (Summer) 125 kVA (Winter) 125 kVA

Individual Generator Power Factor:
Rated Power Factor: Leading: 0.8 PF Lagging: 0.8 PF

Total Number of Generators in PV farm to be interconnected pursuant to this Interconnection Request: _____ Elevation: _____ Single-phase _____
Three-phase 39 Units operating at 125 kW

Inverter Manufacturer, Model Name & Number (if used): Thirty nine (39) Sungrow SG125HV-20.

List of adjustable set points for the protective equipment or software: Per IEEE 1547

Note: *A completed Power Systems Load Flow data sheet must be supplied with the Interconnection Request*.

Small Generating Facility Characteristic Data (for inverter-based machines)

Max design fault contribution current: 4680A@600V Instantaneous or RMS? RMS

Harmonics Characteristics: <3% per IEEE519

Start-up requirements: 4 W per SunGrow SG125HV Unit

Small Generating Facility Characteristic Data (for rotating machines)

RPM Frequency: _____
(*) Neutral Grounding Resistor (If Applicable): _____

Synchronous Generators:

Direct Axis Synchronous Reactance, Xd: _____ P.U.
Direct Axis Transient Reactance, X' d: _____ P.U.
Direct Axis Subtransient Reactance, X" d: _____ P.U.
Negative Sequence Reactance, X2 _____ P.U.
Zero Sequence Reactance, X0: _____ P.U.

KVA Base: _____

Field Volts: _____
Field Amperes: _____

Induction Generators:

Motoring Power (kW): _____
I ^{2}t or K (Heating Time Constant):_____
Rotor Resistance, Rr: _____
Stator Resistance, Rs: _____
Stator Reactance, Xs: _____
Rotor Reactance, Xr: _____
Magnetizing Reactance, Xm: _____
Short Circuit Reactance, Xd": _____
Exciting Current: _____
Temperature Rise: _____
Frame Size: _____
Design Letter: _____
Reactive Power Required In Vars (No Load): _____
Reactive Power Required In Vars (Full Load): _____
Total Rotating Inertia, H: _____ Per Unit on kVA Base

Note: *Please contact the T & D Utility prior to submitting the Interconnection Request to determine if the specified information above is required.*

Excitation and Governor System Data for Synchronous Generators Only
Provide appropriate IEEE model block diagram of excitation system, governor system and power system stabilizer (PSS) in accordance with the regional reliability council criteria. A PSS may be determined to be required by applicable studies. A copy of the manufacturer's block diagram may not be substituted.

Section 3. Interconnection Facilities Information

Will a transformer be used between the generator and the Point of Common Coupling?
X____ Yes _____ No

Will the transformer be provided by the Interconnection Customer? X____ Yes _ No

Transformer Data (If Applicable, for Interconnection Customer-Owned Transformer):

Is the transformer: Single-phase _____ Three phase X
Size: (2) 2500 kVA
Transformer Impedance: 5.75%__ percent on own kVA Base

If Three Phase:
Transformer Primary: 12,470 Volts ____ Delta _____ Wye ____X Wye-Grounded
Transformer Secondary: 600 Volts ____ Delta X____ Wye _____ Wye-Grounded
Transformer Tertiary: ____ Volts _____ Delta _____ Wye _____ Wye Grounded

Transformer Fuse Data (If Applicable, for Interconnection Customer-Owned Fuse):
(Attach copy of fuse manufacturer's Minimum Melt and Total Clearing Time-Current Curves)

Manufacturer: TBD_____ Type: _____ Size: _____
Speed: _____

Interconnecting Circuit Breaker (if applicable):

Manufacturer: _____ Type: _____
Load Rating (Amps): _____ Interrupting Rating (Amps): _____ Trip Speed (Cycles): _____

Interconnection Protective Relays (If Applicable):

If Microprocessor-Controlled:

List of Functions and Adjustable Setpoints for the protective equipment or software:

Setpoint Function	Minimum	Maximum
1. SEE ONE LINE		
2.		
3.		
4.		
5.		
6.		

If Discrete Components:
(Enclose Copy of any Proposed Time-Overcurrent Coordination Curves)

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____
Proposed Setting: _____

Manufacturer: _____Type: _____ Style/Catalog No.: _____

Proposed Setting: _____

Current Transformer Data (If Applicable):
(Enclose Copy of Manufacturer's Excitation and Ratio Correction Curves)

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Potential Transformer Data (If Applicable):

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Manufacturer: _____Type: _____Accuracy Class: _____
Proposed Ratio Connection: _____

Section 4. General Information

Enclose copy of site electrical one-line diagram showing the configuration of all Small Generating Facility equipment, current and potential circuits, and protection and control schemes. This one-line diagram must be signed and stamped by a licensed Professional Engineer if the Small Generating Facility is larger than 50 kW.
Is One-Line Diagram enclosed? Yes X No _____

Enclose copy of any site documentation that indicates the precise physical location of the proposed Small Generating Facility (e.g., USGS topographic map or other diagram or documentation).

Proposed location of protective interface equipment on property (include address if different from the

Interconnection Customer's address):

_____

_____

Enclose copy of any site documentation that describes and details the operation of the protection and control schemes.
Is Available Documentation Enclosed? Yes ____ No _____
Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits (if applicable).
Are Schematic Drawings Enclosed? Yes _____ No _____

Section 5. Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by (utility) on or near my service meter location. Generating systems must be compliant with IEEE, NEC, ANSI, and UL standards, where applicable. By signing below, the Applicant also certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.

Signed: _____ Date: 03-04-2020

Section 6. Information Required Prior to Physical Interconnection
(Not required as part of the application, unless available at time of application.)

Installing Electrician: _____ Firm: _____
License No.: _____

Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Telephone: _____

Installation Date: _____ Interconnection Date: _____

Signed: _____ Date: _____
(Inspector - if required)

(In lieu of signature of Inspector, a copy of the final inspection certificate may be attached)

N

GENERAL NOTES:

1. TREES MAY GROW DURING THE LIFE OF THE SYSTEM AND IMPACT THE PRODUCTION.
2. ANY AND ALL LAYOUT CHANGES, INCLUDING BUT NOT LIMITED TO SHIFTING OF THE ARRAY, ARE SUBJECT TO APROVAL BY THE DESIGN TEAM.
3. ARRAY LAYOUT DIMENSIONS SHALL BE CONSIDERED APPROXIMATE AND MAY VARY SLIGHTLY DUE TO MODULE INSTALLATION TOLERANCES AND VARYING TOPOGRAPHY.

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 390W
MODULES QUANTITY	16,484
DC RATING AT STC	6,430 KW
AC RATING	4,875 KW
INVERTER	(39) SG125HV - 125 KW
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1450 VDC

LEGEND:

- MODULE
- ROAD (14 FT.)
- UTILITY POLE
- UGU — UNDERGROUND
- OHU — OVERHEAD
- FENCE
- TRANSFORMER PAD

PRELIMINARY
NOT FOR CONSTRUCTION

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/13/20	CJB	ZNT	JJS

SEAL:

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

AIRPORT SITE 1
ME DOT
4.875 MW PV GENERATION FACILITY
SCALE: NONE 25 BOND BROOK RD, AUGUSTA, ME SIZE: ARCH D

GENERAL ARRANGEMENT
SITE PV LAYOUT

DATE:	02/11/20
DRAWN BY:	CJB
ENGIN'D BY:	ZNT
PROJECT #:	22237-05
DRAWING #:	1100

2/13/2020 8:11 AM - CAMERONB - T:\ACTIVE PROJECTS\22237 - MAINEDOT - SOLAR SUPPORT\05-AUGUSTA AIRPORT 1\01-DESIGN\03-DRAFTING\02-WORKING DRAWINGS\ELECTRICAL\22237-05-1100.DWG

PROPOSED UL1741 INVERTER INTERNAL CONTROL SETTINGS					
DEVICE	PICKUP		CLEARING TIME		
27-1	50%	(300 V)	66	CYC	(1.1 SEC)
27-2	88%	(528 V)	120	CYC	(2 SEC)
59-1	110%	(660 V)	120	CYC	(2 SEC)
59-2	120%	(720 V)	9.6	CYC	(0.16 SEC)
81U-1	58.5 HZ		18000	CYC	(300 SEC)
81U-2	56.5 HZ		9.6	CYC	(0.16 SEC)
81O-1	61.2 HZ		18000	CYC	(300 SEC)
81O-2	62 HZ		9.6	CYC	(0.16 SEC)

Base Voltage 600 V.

PF = 1.0

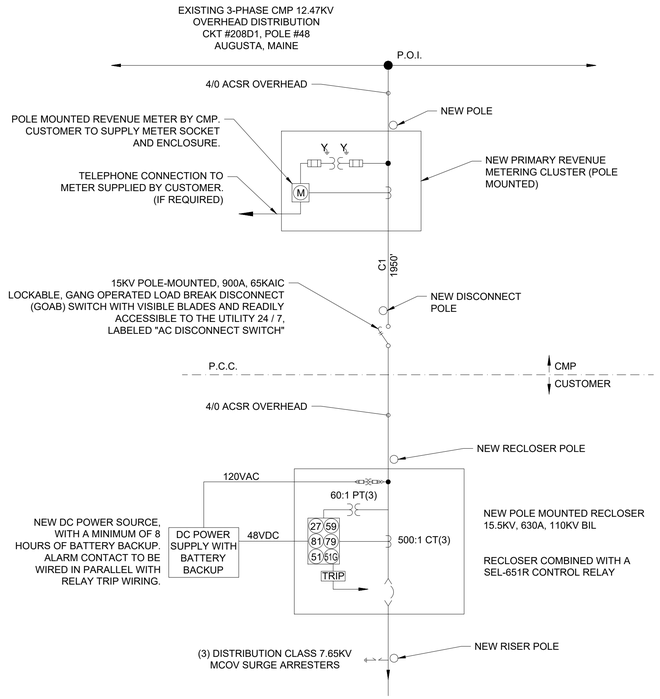
PROPOSED PROTECTION RELAY SETTINGS							
DEVICE	PICKUP			Time Delay		Total Clearing Time	
	Primary		Secondary				
27-1	50%	(3599.8 V)	(60 V)	63 CYC	1.05 SEC	66 CYC	1.1 SEC
27-2	88%	(6335.6 V)	(105.6 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-1	110%	(7919.5 V)	(132 V)	117 CYC	1.95 SEC	120 CYC	2 SEC
59-2	120%	(8639.5 V)	(144 V)	6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81U-1	58.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81U-2	56.5 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
81O-1	61.2 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC
81O-2	62 HZ			6.6 CYC	0.11 SEC	9.6 CYC	0.16 SEC
51		282 A	0.56 A	SET PER UTILITY STANDARDS			
51G		94 A	0.19 A	SET PER UTILITY STANDARDS			
79	0.95 PU - 1.05 PU 59 HZ - 60.5 HZ			17997 CYC	299.95 SEC	18000 CYC	300 SEC

SETTINGS ASSUME 3 CYCLE ESTIMATED DEVICE TRIP OPENING TIME

SETTINGS ARE BASED ON IEEE 1547-2018 TABLE 1 (VOLT) AND 2 (FREQ).

SETTINGS ARE BASED ON A 120V SECONDARY PT BASE.

AC Wire and Cable Schedule													
From	To	Cable Number	Type	Material	Conductor	Voltage (kV)	Feet	Overhead - Ohms/mile Underground - Ohms/1000ft				Per Unit Value (100 MVA Base)			
								R_1	X_1	R_0	X_0	R_1	X_1	R_0	X_0
POI	Riser	C1	Overhead	ACSR	4/0	12.47	1950	0.610896	0.866238	0.897096	2.684252	0.145089	0.205733	0.213062	0.637516
Riser	Grounding Xfmr	C2	Underground	AL	350	12.47	100	0.0638	0.0374	0.1014	0.0951	0.004103	0.002405	0.006521	0.006116
Grounding Xfmr	Equip Pad #1	C3	Underground	AL	350	12.47	50	0.0638	0.0374	0.1014	0.0951	0.002051	0.001203	0.00326	0.003058
Equip Pad #1	Equip Pad #2	C4	Underground	AL	1/0	12.47	400	0.21	0.045	0.339	0.1145	0.054019	0.011575	0.087202	0.029453



UTILITY INTERCONNECTION NOTES:

1. INVERTERS (INV) - SUNGROW SG125HV, 1500VDC, 600VAC, NEMA 4X, MOUNTED ON UNISTRUT. INVERTERS ARE UL1741-SA-2016 LISTED AND IEEE1547-A COMPLIANT. INVERTER SHALL HAVE INTEGRATED AC & DC DISCONNECTS
2. MODULES TO BE CANADIAN SOLAR 390W KUMAX CS3U-390MS 144 CELL MONOCRYSTALLINE PANELS. MODULES ARE CERTIFIED UL 1703 COMPLIANT.
3. DAS SYSTEM TO BE DESIGNED AND ENGINEERED BY SELECTED DESIGNATED PARTY.
4. LOCATION OF THE POI: 44.330738°, -69.793557°

ONE LINE POWER DIAGRAM LEGEND:

- LOAD-BREAK SWITCH FUSE, SIZE AS INDICATED
- TRANSFORMER, SIZE AS INDICATED
- CIRCUIT BREAKER
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER / SOLID STATE TRIP UNIT
- GROUND
- L.A. LIGHTNING ARRESTOR
- CABLE TERMINATION/LOAD ELBOW
- FUSE
- GROUP AIR (GOAB) SWITCH
- (M) REVENUE METER (BY UTILITY)
- LOAD BREAK ELBOWS

PV SYSTEM SUMMARY	
PV MODULES	144 CELL 390W
MODULES QUANTITY	16,484
DC RATING AT STC	6,430 KW
AC RATING	4,875 KW
INVERTER	(39) SG125HV - 125 KW
INVERTER MAX VDC INPUT	1500 VDC
INVERTER MPPT WINDOW	860-1450 VDC

DEVICE NO.	DESCRIPTION
27	UNDERVOLTAGE RELAY
50/51	INSTANTANEOUS/TIME OVERCURRENT RELAY
51G	GROUND OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59G	GROUND OVERVOLTAGE RELAY
79	AC RECLOSING RELAY
81/O	OVERFREQUENCY RELAY
81/U	UNDER FREQUENCY RELAY

LEGEND:

- OVERHEAD
- UNDERGROUND
- PRIMARY
- COMMUNICATION

PRELIMINARY
NOT FOR CONSTRUCTION

SEAL: STATE OF MAINE — 02/13/2020 — JEFFERY J. STELLY — 13899 — LICENSED PROFESSIONAL ENGINEER

REV:	DESCRIPTION:	DATE:	DRWN:	CHKD:	APRVD:
A	ISSUED FOR IA	02/13/20	CJB	ZNT	JJS

RLC ENGINEERING
267 Whitten Road
Hallowell, ME 04347
Phone 207-621-1077
Fax 207-621-1177
www.rlc-eng.com

AIRPORT SITE 1
ME DOT
4.875 MW PV GENERATION FACILITY

SCALE: NONE — 25 BOND BROOK RD, AUGUSTA, ME — SIZE: ARCH D

ONE LINE DIAGRAM

DATE: 02/11/20
DRAWN BY: CJB
ENGN'D BY: ZNT
PROJECT #: 22237-05
DRAWING #: 2100

NEW

CanadianSolar

KuMax

HIGH EFFICIENCY MONO PERC MODULE

CS3U-375|380|385|390|395MS

(1000 V / 1500 V)

MBB 5BB

MORE POWER

- Low power loss in cell connection
- Low NMOT: 41 ± 3 °C
  Low temperature coefficient (Pmax): -0.37 % / °C
- Better shading tolerance
- High PTC rating of up to: 93.13 %

MORE RELIABLE

- Lower hot spot temperature
- Minimizes micro-cracks
- Heavy snow load up to 5400 Pa,
  wind load up to 3600 Pa*

25 years linear power output warranty

10 years product warranty on materials and workmanship

MANAGEMENT SYSTEM CERTIFICATES

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE / MCS / CEC AU
UL 1703 / IEC 61215 performance: CEC listed (US) / FSEC (US Florida)
UL 1703: CSA / IEC61701 ED2: VDE / IEC62716: VDE / IEC60068-2-68: SGS
Take-e-way

*We can provide this product with special BOM specifically certified with salt mist, ammonia and sand blowing tests. Please talk to our local technical sales representatives to get your customized solutions.

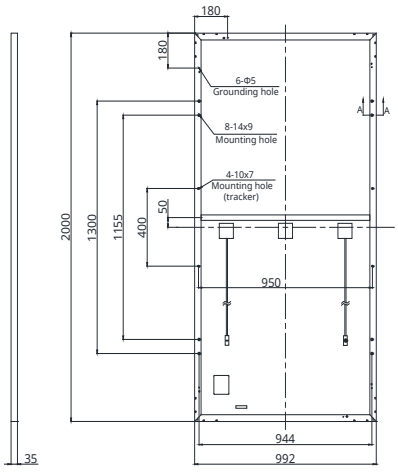
CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 30 GW deployed around the world since 2001.

* For detailed information, please refer to the Installation Manual.

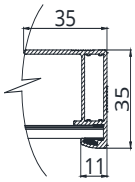
CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

ENGINEERING DRAWING (mm)

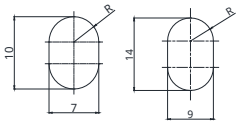
Rear View



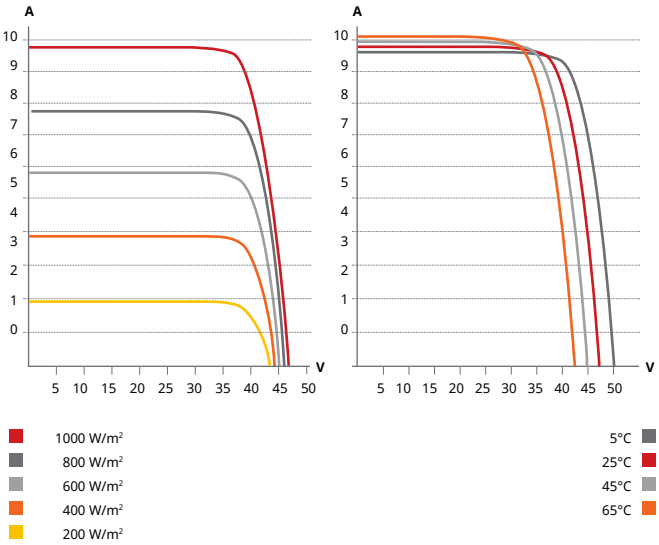
Frame Cross Section A-A



Mounting Hole



CS3U-375MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	375 W	380 W	385 W	390 W	395 W
Opt. Operating Voltage (Vmp)	39.8 V	40.0 V	40.2 V	40.4 V	40.6 V
Opt. Operating Current (Imp)	9.43 A	9.50 A	9.58 V	9.66 A	9.73 A
Open Circuit Voltage (Voc)	47.6 V	47.8 V	48.0 V	48.2 V	48.4 V
Short Circuit Current (Isc)	9.93 A	10.01 A	10.09 A	10.17 A	10.25 A
Module Efficiency	18.90%	19.15%	19.41%	19.66%	19.91%
Operating Temperature	-40°C ~ +85°C				
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)				
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)				
Max. Series Fuse Rating	30 A				
Application Classification	Class A				
Power Tolerance	0 ~ + 5 W				

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3U	375MS	380MS	385MS	390MS	395MS
Nominal Max. Power (Pmax)	280 W	284 W	287 W	291 W	295 W
Opt. Operating Voltage (Vmp)	36.9 V	37.1 V	37.3 V	37.5 V	37.7 V
Opt. Operating Current (Imp)	7.58 A	7.64 A	7.70 A	7.76 A	7.82 A
Open Circuit Voltage (Voc)	44.8 V	45.0 V	45.1 V	45.3 V	45.5 V
Short Circuit Current (Isc)	8.01 A	8.07 A	8.14 A	8.20 A	8.26 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2000 X 992 X 35 mm (78.7 X 39.1 X 1.38 in)
Weight	22.5 kg (49.6 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 400 mm (15.7 in) (+) / 280 mm (11.0 in) (-); landscape: 1250 mm (49.2 in);leap-frog connection: 1670 mm (65.7 in)*
Connector	T4 series
Per Pallet	30 pieces
Per Container (40' HQ)	660 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.37 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	41 ± 3°C

PARTNER SECTION

* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustments to the information described herein at any time without further notice. Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

SG125HV

String Inverter for 1500 Vdc System

SUNGROW
Clean power for all

HIGH YIELD

- Patented five-level topology, max. efficiency 98.9 %, European efficiency 98.7 %, CEC efficiency 98.5 %
- Full power operation without derating at 50 ℃
- Patented anti-PID function

EASY O&M

- Virtual central solution, easy for O&M
- Compact design and light weight for easy installation

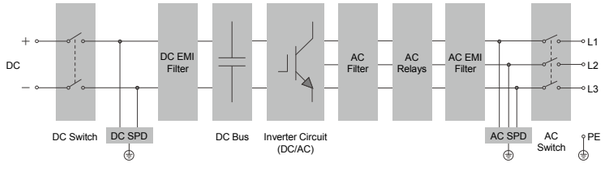
SAVED INVESTMENT

- DC 1500V,AC 600V, low system initial investment
- 1 to 5MW power block design for lower AC transformer and labor cost
- Max.DC/AC ratio up to 1.5

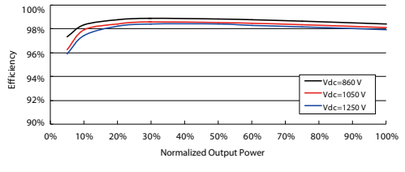
GRID SUPPORT

- Compliance with both IEC and UL safety,EMC and grid support regulations
- Low/High voltage ride through(L/HVRT)
- Active & reactive power control and power ramp rate control

CIRCUIT DIAGRAM



EFFICIENCY CURVE



Type designation	SG125HV
Input (DC)	
Max. PV input voltage	1500 V
Min. PV input voltage / Start-up input voltage	860 V / 920 V
Nominal PV input voltage	1050 V
MPP voltage range	860 – 1450 V
MPP voltage range for nominal power	860 – 1250 V
No. of independent MPP inputs	1
No. of DC inputs	1
Max. PV input current	148 A
Max. DC short-circuit current	240 A
Output (AC)	
AC output power	125 kVA @ 50 ℃
Max. AC output current	120 A
Nominal AC voltage	3 / PE, 600 V
AC voltage range	480 – 690 V
Nominal grid frequency / Grid frequency range	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz
THD	< 3 % (at nominal power)
DC current injection	< 0.5 % In
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading - 0.8 lagging
Feed-in phases / connection phases	3 / 3
Efficiency	
Max. efficiency / European efficiency	98.9% / 98.7%
CEC efficiency	98.5%
Protection	
DC reverse connection protection	Yes
AC short-circuit protection	Yes
Leakage current protection	Yes
Grid monitoring	Yes
DC switch	Yes
AC switch	Yes
Q at night function	optional
Anti-PID function	Yes
Overvoltage protection	DC Type II / AC Type II
General Data	
Dimensions (W*H*D)	670*902*296 mm 26.4''*35.5''*11.7''
Weight	76 kg 167.5 lb
Isolation method	Transformerless
Degree of protection	IP 65 NEMA 4X
Night power consumption	< 4 W
Operating ambient temperature range	-25 to 60 ℃ (> 50 ℃ derating) -13 to 140 ℉ (> 122 ℉ derating)
Allowable relative humidity range (non-condensing)	0 – 100 %
Cooling method	Smart forced air cooling
Max. operating altitude	4000 m (> 3000 m derating) 13123 ft (> 9843 ft derating)
Display / Communication	LED, Bluetooth+APP / RS485
DC connection type	OT or DT terminal (Max. 185 mm² 350 Kcmil)
AC connection type	OT or DT terminal (Max. 185 mm² 350 Kcmil)
Compliance	UL1741, UL1741SA, IEEE1547, IEEE1547.1, CSA C22.2 107.1-01-2001, FCC Part15 Sub-part B Class A Limits, California Rule 21, IEC 62109-1/-2, IEC 61000-6-2/-4, IEC 61727, IEC62116, BDEW, UNE 206007-1:2013, P.O.12.3, UTE C15-712-1:2013, CEI 0-16:2017, IEC 61683, PEA, NTCO
Grid Support	Q at night function (optional), LVRT, HVRT, ZVRT, active & reactive power regulation, PF control, soft start/stop
Type designation	SG125HV-20

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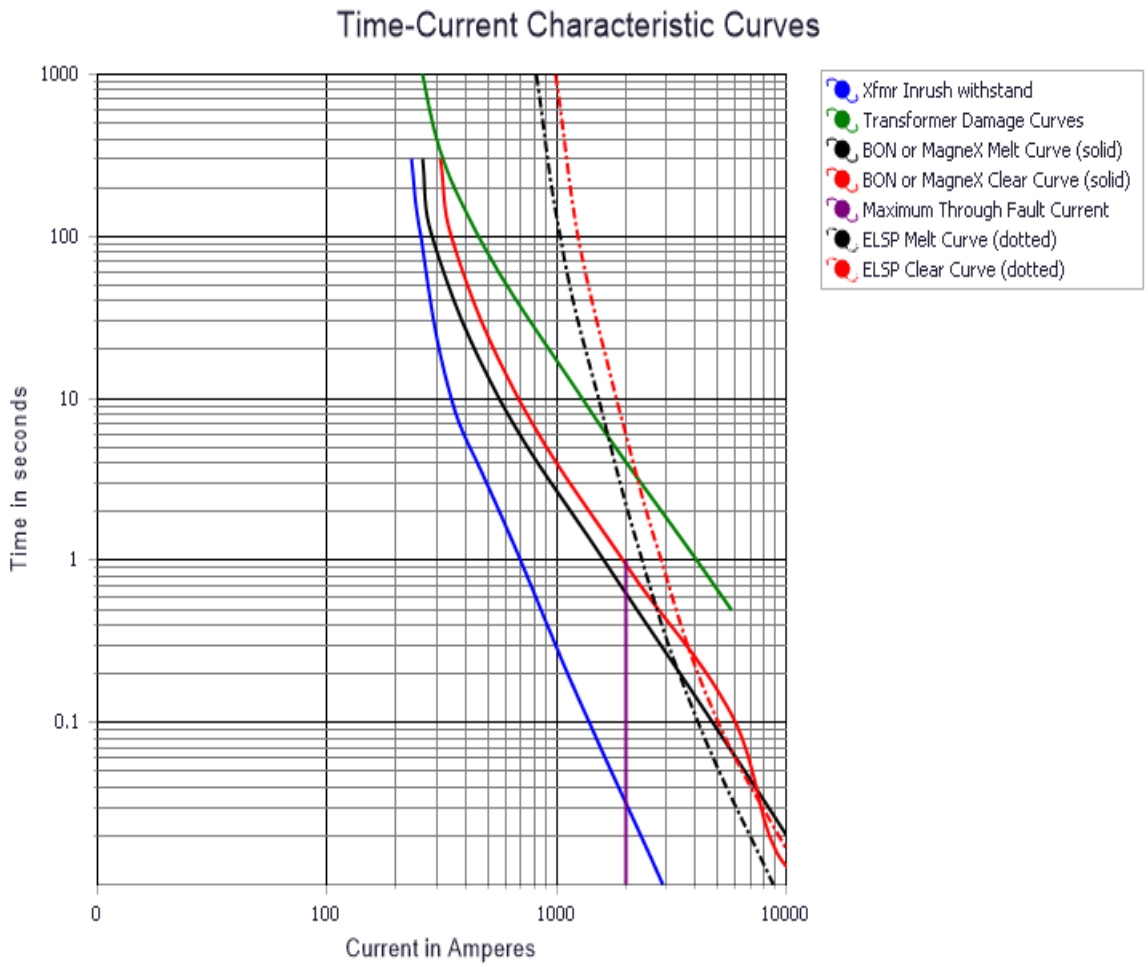
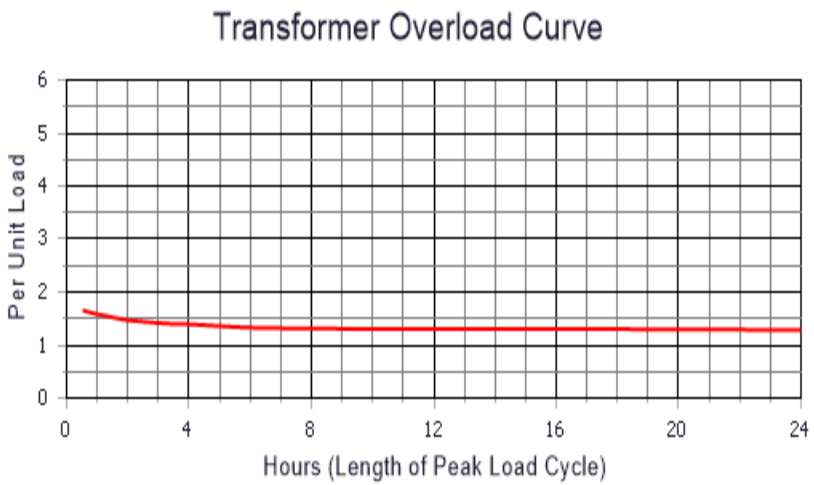
TransFusion™ Coordination Program





Provided Inputs

Transformer kVA Rating: 2500
Primary Voltage (kV): 12.47
Number of Phases: 3
Minimum Impedance: 5.75
Primary Connection: Wye
Secondary Connection: Wye
Protection Type: Dual Sensing Bay-O-Net
Desired Protection level: Least Overload
Temperature Class: 65
Ambient Temperature: 35
Transformer Preload: 75
Xfmr. Rated Current (A): 115.75
Maximum Through Fault: 2013

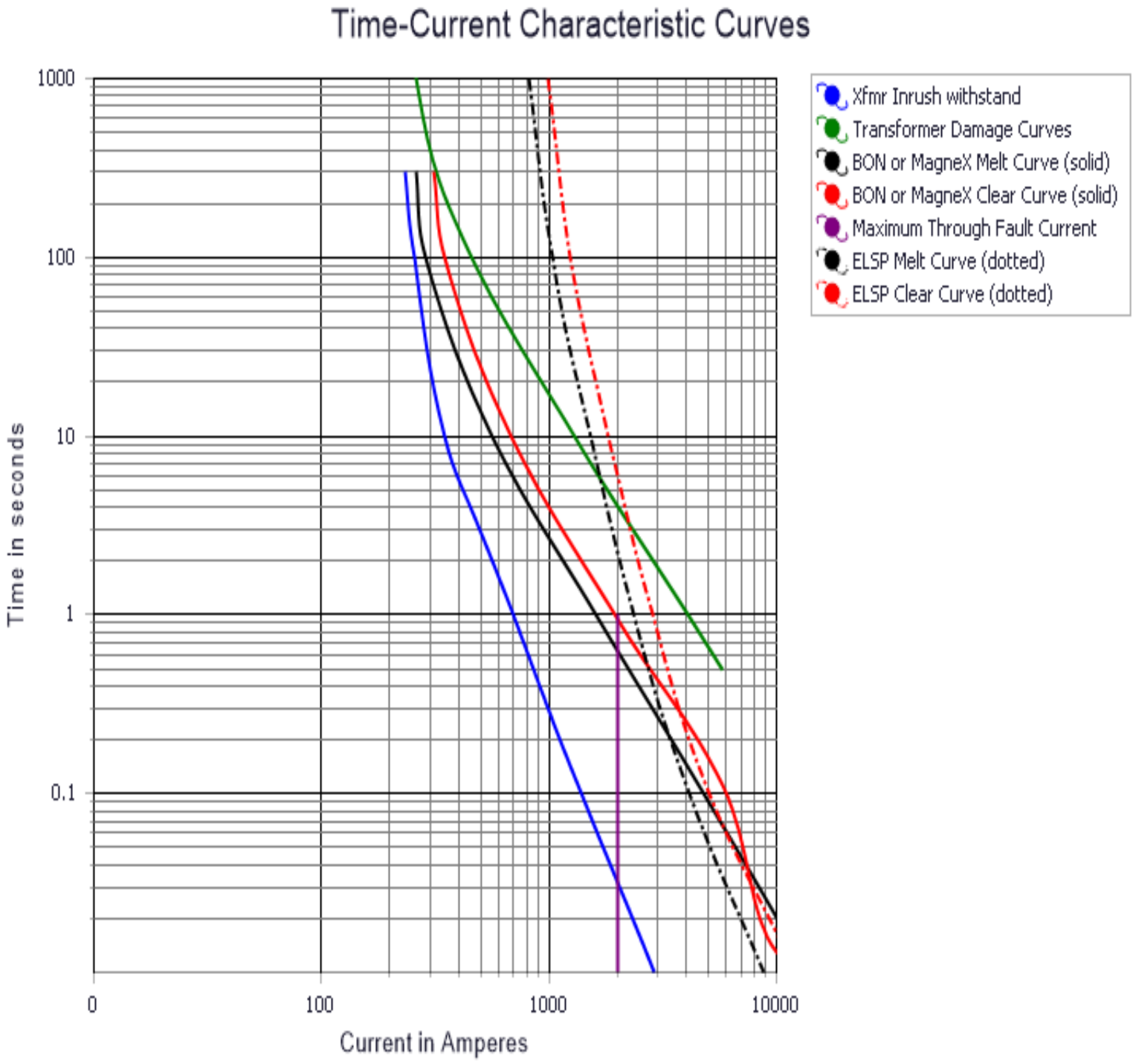
Protection Device Recommendation

Based on your criteria, we recommend the following Cooper Power Systems protection device(s) for your application:

ELSP Selection: CBUC08250D100(2)
Bay-O-Net Selection: 4000358C18M

Powering Business Worldwide

TransFusion™ Coordination Program



Powering Business Worldwide

Protection Device Recommendation

ELSP Selection: CBUC08250D100(2)
Bay-O-Net Selection: 4000358C18M

SEL-651R-2 Recloser Control

Advanced Recloser Control

New Features

The following features were added for intertie protection and control, compliant with IEEE Standard 1547-2018 "IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces."

- **Fast Rate-of-Change-of-Frequency and Vector Shift Elements.** Swiftly detect islanding conditions and disconnect distributed energy resources (DER) before any possible autoreclosing of the electric power system (EPS).
- **Longer Seconds-Based Time Delays for Frequency Elements.** Frequency elements have adequate time-delay setting range for qualifying tripping for abnormal EPS frequency. Similarly, return of normal EPS frequency is qualified before the intertie (recloser) is closed. Seconds-based timing is immune to frequency changes and allows tripping time to be absolute.
- **Additional Voltage Elements.** Adequate number of voltage elements allows for qualifying tripping for abnormal EPS voltage. Similarly, return of normal EPS voltage is qualified before the intertie (recloser) is closed.
- **Autosynchronism Element Works in Tandem With Synchronism-Check Element.** Autosynchronism element frequency and voltage control outputs automatically bring DER (versus EPS) slip frequency, phase angle, and voltage magnitude differences within allowable limits for synchronism-check closing of the intertie (recloser).

Key Features and Benefits

- **Single-Phase Tripping/Reclosing.** Interrupt, then restore service on the faulted phase, rather than affecting all three phases. When load levels vary from phase to phase, set trip levels independently for each phase.
- **Multi-Recloser Interface.** Support a number of reclosers from different manufacturers with one common control cable interface.
- **Wide-Range Recloser Compatibility.** Use the SEL-651R-2 Advanced Recloser Control with control cable interfaces for many different reclosers. Learning the settings and operation of just the SEL-651R-2 enables you to operate a wide range of reclosers.
- **ACSELERATOR QuickSet® SEL-5030 Software.** Use the eight settings groups to easily configure multiple group settings to fit operational situations. Apply custom application designs and create design templates that can be stored on the recloser control for your specific applications.
- **Low-Energy Analog (LEA) Inputs.** Reduce costs and save space with as many as six low-energy analog (LEA) voltage inputs.
- **Enclosure Options.** Choose the extra space and easy access of the dual-door enclosure or the more compact size of the single-door option. For the dual- or single-door options, select the painted cold-rolled steel enclosure (NEMA 3R rated) for normal applications or the painted type 304 stainless steel enclosure (NEMA 3RX rated) to reduce corrosion in harsh environments. Both enclosure styles also achieve an IP45 rating for solids and water ingress resistance.
- **Ethernet Communications.** Provide DNP, Modbus®, IEC 61850, File Transfer Protocol (FTP), and Simple Network Time Protocol (SNTP) capabilities through use of single fiber, dual copper, or fiber-optic Ethernet ports. A built-in web server makes firmware upgrades over Ethernet quick and secure.
- **Communications Flexibility.** Order the SEL-651R-2 with one USB port, four serial ports (three EIA-232 and one EIA-485), one Ethernet port (fiber-optic), or two Ethernet ports (copper or fiber-optic). The front-panel USB port retrieves events, settings, and templates faster than traditional EIA-232 ports.
- **Automatic Network Reconfiguration (ANR).** Improve reliability with ANR by isolating faulted line sections and restoring service to unaffected areas of the system.
- **Configurable Power Elements.** Determine power flow or VAR flow direction and magnitude with configurable power elements. Apply at system intertie points or at capacitor bank installations.
- **Total Harmonic Distortion (THD).** Monitor the system power quality based on THD with harmonic metering as high as the 16th harmonic, following IEEE 519-2014.
- **Built-In Power Supply.** Power demanding 12 Vdc accessories easily with a built-in 40 W continuous (60 W surge) auxiliary power supply.
- **Digitally Signed Firmware Upgrade.** Upload digitally signed firmware over Ethernet or serial connection. Secure algorithms guarantee the validity of the firmware file.
- **Second-Harmonic Blocking.** Secure the recloser control during transformer energization.
- **Rate-of-Change-of-Frequency Elements.** Detect rapid frequency changes to initiate load shedding or network decoupling.
- **Event Data and Fast Sampling Rate.** See more pre-fault and post-fault data with 60-cycle-length event reports. Gain better resolution with 128-samples/cycle analog data.
- **COMTRADE Event Reports.** Capture standard and high-impedance event reports in COMTRADE standard file format.
- **Synchrophasors.** Gather power system information and monitor wide-area performance with IEEE C37.118 synchrophasors.
- **High-Impedance Fault Detection.** Apply SEL Arc Sense™ technology in detecting more high-impedance faults than conventional protection for more reliable operation of distribution systems.

Compatibility Overview

Multi-Recloser Interface

An SEL-651R-2 Recloser Control ordered with the Multi-Recloser Interface is compatible with the following reclosers on one common interface:

- G&W Viper-ST
- G&W Viper-LT
- ABB Elastimold MVR
- Tavrida OSM Al_4
- ABB OVR/Gridshield (32-pin and 42-pin versions)
- Eaton NOVA NX-T

Three-Phase Reclosers With Single-Phase Tripping Capability

An SEL-651R-2 Recloser Control connects to the following three-phase reclosers with single-phase tripping capability:

- G&W Viper-ST
- G&W Viper-LT
- ABB Elastimold MVR
- ABB OVR-3/VR-3S (24-pin, 15 and 27 kV models)
- ABB Joslyn TriMod 600R
- ABB OVR/Gridshield (32-pin and 42-pin versions)
- Eaton NOVA-TS or NOVA-STS Triple-Single
- Eaton NOVA NX-T
- Tavrida OSM Al_4
- Siemens SDR Triple-Single

Three-Phase Reclosers

The SEL-651R-2 Recloser Control connects to the following three-phase reclosers:

- G&W Viper-S
- G&W Control Power Viper-S
- Eaton
  - CXE
  - Auxiliary-Powered Eaton NOVA
  - RE
  - RVE
  - RXE
  - VSA
  - VSO
  - VWE
  - VWVE 27
  - VWVE 38X
  - WE
  - WVE 27
  - WVE 38X
  - Control-Powered Eaton NOVA
- Whipp & Bourne GVR (when equipped with interface module)
- Tavrida OSM Al_2
- Siemens SDR Three-Phase

Certification

The current IEEE C37.60 test certificates are available at selinc.com.

Product Overview or Functional Overview

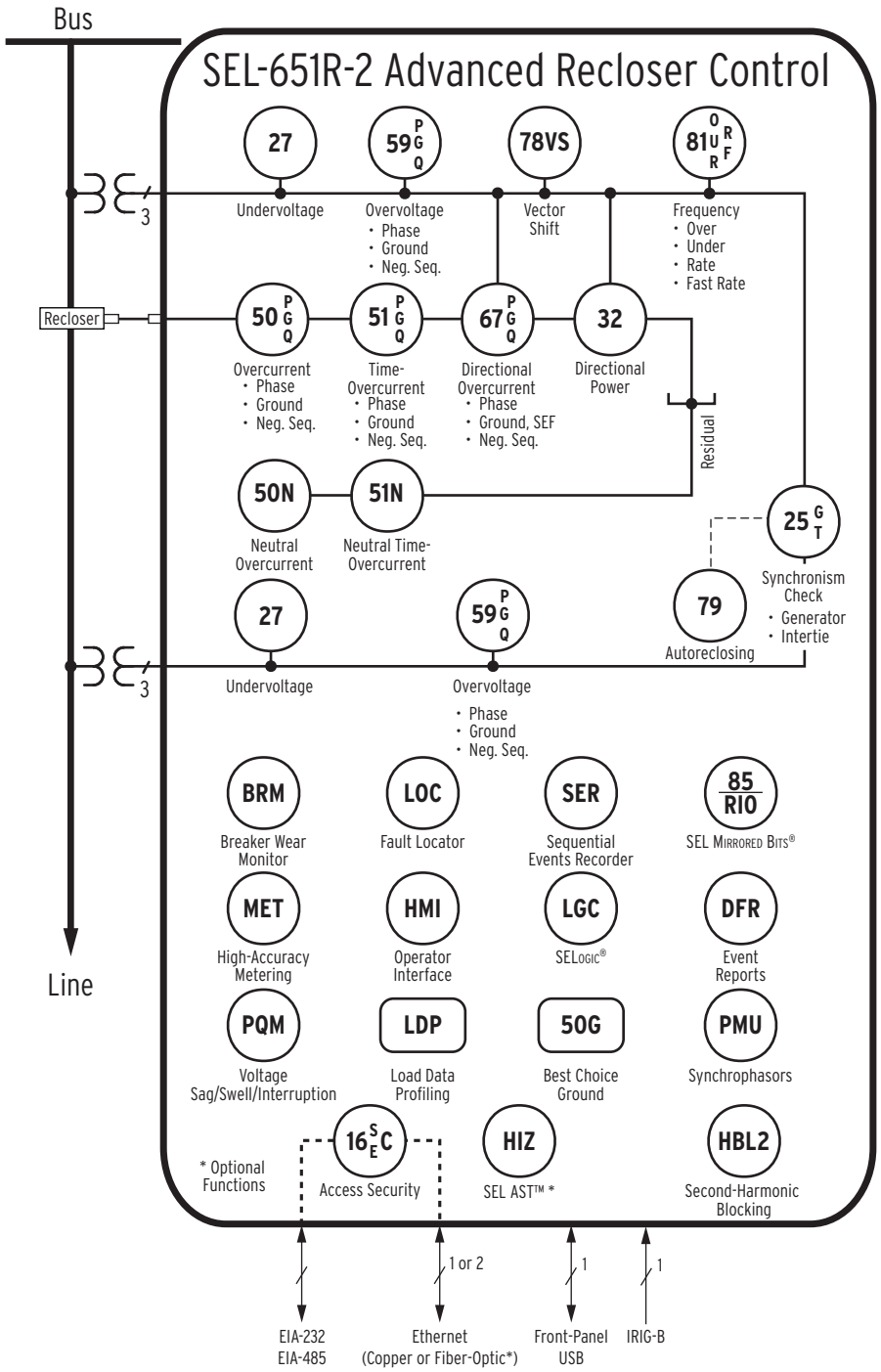


Figure 1 Functional Diagram

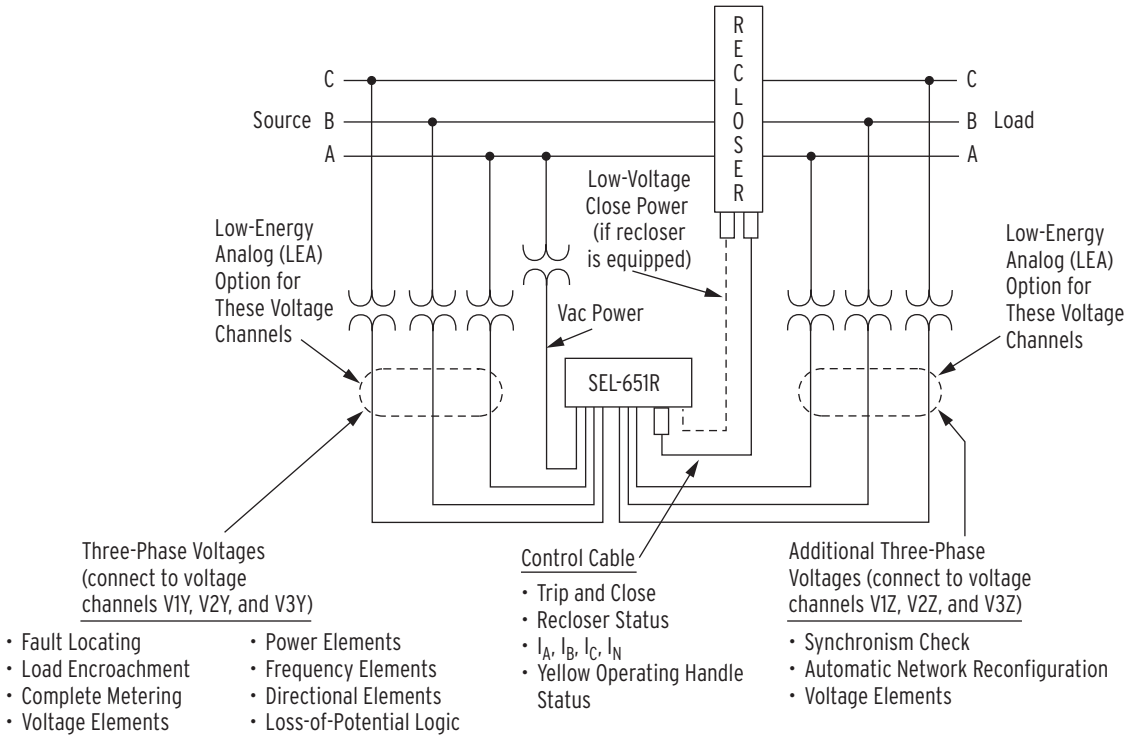


Figure 2 Connect Three-Phase Load and Source Voltages to SEL-651R-2

Control Cable

The control cable brings secondary current, recloser status, yellow operating handle status, and, in some cases, LEA voltages to the SEL-651R-2 and takes trip/close signals out to the recloser (see *Figure 3*). The control cable connects to the SEL-651R-2 via a control cable receptacle/interface at the bottom of the enclosure.

Note: Select the appropriate control cable interface when ordering.

Voltage Inputs

Connect voltages on both sides of the recloser, as shown in *Figure 2*, for such schemes as Automatic Network Reconfiguration (*Figure 12*) and synchronism check. Select the three-phase voltage channel (VY or VZ) to operate features such as the following (*Figure 2*):

- ➤ Fault locating
- ➤ Load encroachment
- ➤ Power elements
- ➤ Voltage sag/swell/interrupt recording

Order the VY and VZ voltage channels as optional LEA voltage inputs. This option allows you to connect the low-level voltage outputs from less-costly power system voltage transducers, including those built into many of the popular reclosers, to LEA voltage inputs on the SEL-651R-2.

Control Power Input

Order the control power input (shown as the Vac Power connection in *Figure 2*) as either 120 Vac, 230 Vac, 125 Vdc, or 48 Vdc.

The 120 Vac option includes a ground-fault circuit interrupter (GFCI) convenience outlet.

Use ac transfer switches (see *Figure 3*) to change to the alternate control power source when the primary control power source is unavailable. This ability is especially valuable in Automatic Network Reconfigurations such as those in *Figure 11* and *Figure 12*.

The incoming control power is converted to the following:

- ➤ 12 Vdc to run the control electronics
- ➤ Stored energy in capacitors in the power module to provide energy for the trip/close outputs of the relay module

If the incoming control power is unavailable, the 12 V battery provides energy to charge the capacitors and to run the control electronics.

The 125 Vdc and 48 Vdc power input options include a reduced level 12 V auxiliary supply for use in wetting contact inputs, but not for powering communications devices. These options do not include the battery charger, batteries, or GFCI convenience outlet.

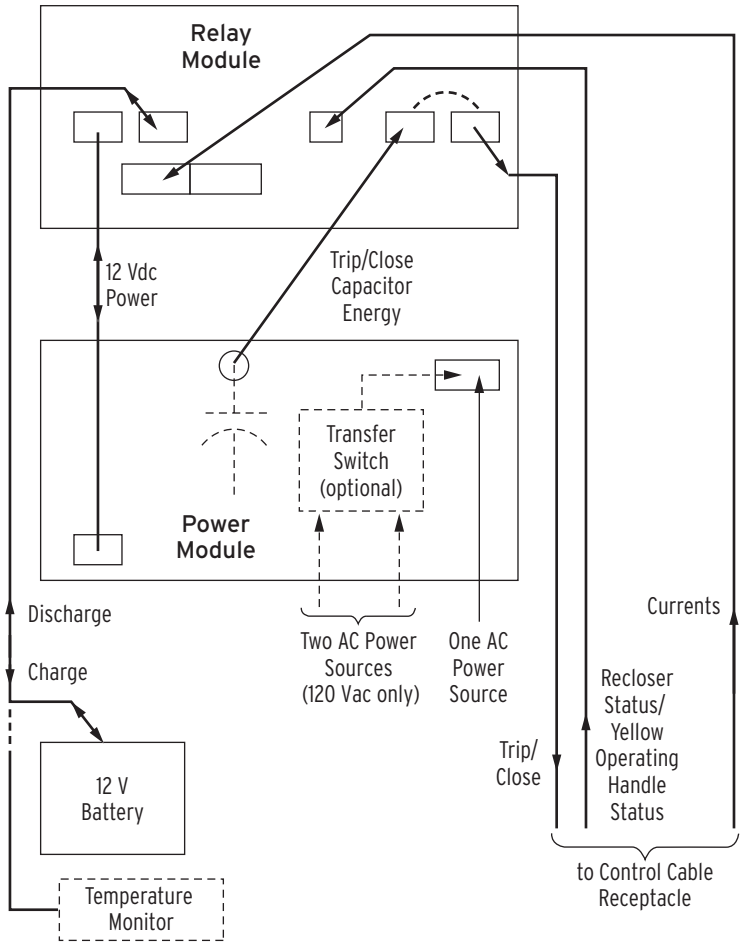


Figure 3 Major Interconnections Between SEL-651R-2 Components

Automation and Communication

Communications Connection Options

The base model SEL-651R-2 is equipped with one USB port, three independently operated EIA-232 serial ports, and one isolated EIA-485 port. Ethernet port ordering options include the following:

- Single 100BASE-FX optical Ethernet port
- Dual redundant 10/100BASE-T metallic Ethernet ports
- Dual redundant 100BASE-FX optical Ethernet ports

Note: The SEL-651R-2 Product Literature CD includes a special driver required for USB communication.

Establish communication by connecting computers, modems, protocol converters, data concentrators, port switchers, and communications processors. Connect multiple SEL-651R-2 controls to an SEL communications processor, an SEL real-time automation controller (RTAC), an SEL computing platform, or to an SEL synchrophasor vector processor for advanced data collection, protection, and control schemes (see *Figure 4*).

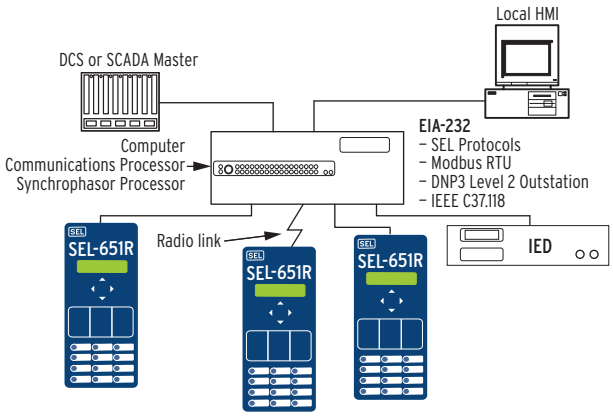


Figure 4 Typical Serial Communications Architecture

SEL manufactures a variety of standard cables for connecting SEL-651R-2 to many external devices. Consult your SEL representative for more information on cable availability. The SEL-651R-2 can communicate directly with SCADA systems, computers, and RTUs via serial or Ethernet port for local or remote communications (see *Figure 5*).

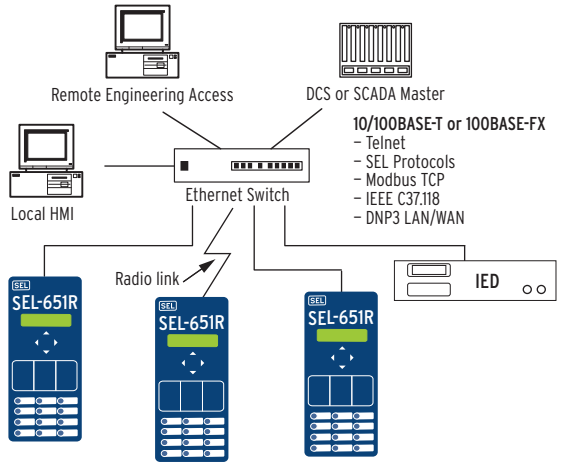


Figure 5 Typical Ethernet Communications Architecture

High-speed Ethernet ports are valuable for engineering access and control setup. Download a 60-cycle, 128 sample-per-cycle event report in as little as 40 seconds. Upgrade firmware in a scant 55 seconds from initiation to Relay Enabled.

Go beyond local engineering access and connect optional dual Ethernet ports to increase network reliability and availability (*Figure 6* and *Figure 7*). The configuration shown in *Figure 6* uses an Ethernet switch inside the control to bridge network connections and form a self-healing ring as part of a managed network. *Figure 7* shows how to connect the control for fully redundant fast-failover configuration. In either configuration, no single point of failure can prevent communication with the control. *Table 1* lists available protocols.

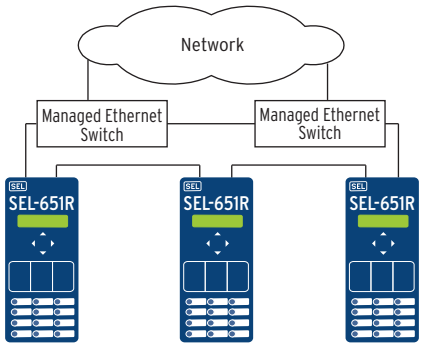


Figure 6 Self-Healing Ring Using Internal Ethernet Switch

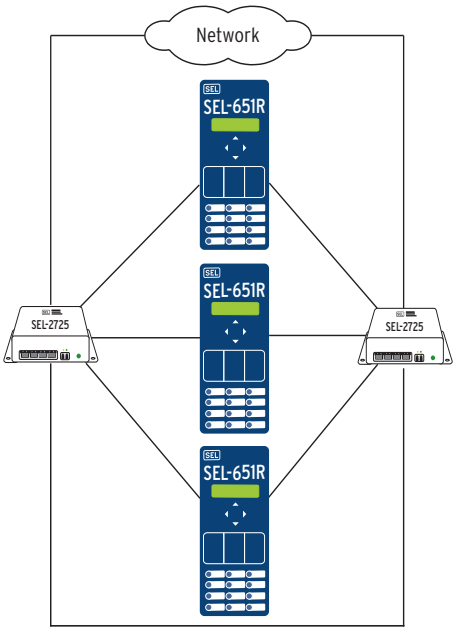


Figure 7 Failover Network Topology

Serial Communication

The SEL-651R-2 retains all the serial communications capability of previous SEL-651R models and adds an EIA-485 and Type B USB port for fast and convenient local access. Use any communications processor software that emulates a standard terminal system.

FTP

Provides the ability to read and write available settings files and read COMTRADE file format event reports from the recloser control over Ethernet.

Table 1 Open Communications Protocol

Type	Description
IEC 61850	Ethernet-based international standard for interoperability between intelligent devices in a substation. Operates remote bits, breaker controls, and input/output (I/O). Monitors Relay Word bits and analog quantities. Use MMS file transfer to retrieve COMTRADE file format event reports.
Simple ASCII	Plain language commands for human and simple machine communications. Use for metering, setting, self-test status, event reporting, and other functions.
Compressed ASCII	Comma-delimited ASCII data reports. Allows external devices to obtain relay data in an appropriate format for direct import into spreadsheets and database programs. Data are checksum protected.
Fast SER Protocol	Provides serial or Ethernet SER data transfers with original time stamp to an automated data collection system.
Modbus RTU or TCP	Serial or Ethernet-based Modbus with point remapping. Includes access to metering data, protection elements, contact I/O, targets, relay summary events, and settings groups.
Extended Fast Meter and Fast Operate	Serial or Telnet binary protocol for machine-to-machine communications. Quickly updates SEL communications processors, RTUs, and other substation devices with metering information, relay element and I/O status, time-tags, open and close commands, and summary event reports. Data are checksum protected. Binary and ASCII protocols operate simultaneously over the same communications lines so binary SCADA metering information is not lost while an engineer or technician is transferring an event report or communicating with the relay using ASCII communications through the same relay communications port.
DNP3 Serial or LAN/WAN	Serial or Ethernet-based Distributed Network Protocol with point remapping. Includes access to metering data, protection elements, contact I/O, targets, SER, relay summary event reports, and settings groups.
IEEE C37.118	Serial or Ethernet Phasor Measurement Protocol. Streams synchrophasor data to archiving historian for post disturbance analysis, to visualization software for real-time monitoring, or to synchrophasor data processor for real-time control.

Flexible Control Logic and Integration Features

Use the SEL-651R-2 control logic to provide the following improvements:

- Replace traditional panel control switches
- Eliminate RTU-to-relay wiring
- Replace traditional latching relays
- Replace traditional indicating panel lights
- Replace external timers

Eliminate traditional panel control switches:

- 12 programmable operator-control pushbuttons
  - Use to implement your control scheme via SELOGIC control equations.
  - Change operator-control pushbutton labeling to suit your control scheme (*Figure 23*).
- 16 local control points
  - Set, clear, or pulse local control points via the front-panel human-machine interface and display (*Figure 23*).
  - Program the local control points to implement your control scheme via SELOGIC control equations.
  - Use the local control points for extra functions such as trip testing or scheme enabling/disabling.
- Define custom messages (e.g., SINGLE PHASE TRIP\ ENABLED) to report power system or relay conditions on the LCD.
- Control which messages are displayed via SELOGIC control equations by driving the LCD display via any logic point in the relay. Set as many as 32 programmable display messages.

Replace RTU-to-Relay Wiring Using 32 Remote Control Points

- Set, clear, or pulse remote control points via serial port commands.
- Incorporate these points into your control scheme via SELOGIC control equations
- Use them for SCADA-type control operations such as trip, close, and settings group selection.

Replace Traditional Latching Relays Using 32 Latching Control Points

- Use these points for functions such as remote control enable.
- Program latch set and latch reset conditions with SELOGIC control equations. The latching control points retain states when the relay loses power.
- Set or reset the latching control points via operator-control pushbuttons, control inputs, remote control points, local control points, or any programmable logic condition.

- In the factory settings, these latching control points give many of the operator-control pushbuttons their ENABLE/DISABLE or ON/OFF mode of operation, where each press of the pushbutton toggles the latch to the opposite state.

Replace Traditional Indicating Panel Lights With 24 Status and Target LEDs

Change LED labeling to suit your control scheme (*Figure 23*). Note that the aforementioned 12 programmable operator-control pushbuttons also have programmable LEDs associated with them.

Replace External Timers With 64 General Purpose Timers and 16 General Purpose Up/Down Counters

- Eliminate external timers for custom protection or control schemes with 64 general purpose SELOGIC control equation timers.
- Each timer has independent time-delay pickup and dropout settings.
- Program each timer input with any element (e.g., time-qualify a voltage element).
- Assign the timer output to trip logic or other control scheme logic.
- Use the 16 general purpose up/down counters to emulate the features of motor-driven timers, which can stall in place indefinitely and then continue timing when appropriate user-set conditions exist.

SELOGIC Control Equations With Expanded Capabilities

The SEL-651R-2 is factory set for use without additional logic in many situations. For complex or unique applications, expanded SELOGIC functions allow superior flexibility and put relay logic into the hands of the protection engineer.

With expanded SELOGIC control equations you can do the following:

- Assign the relay inputs to suit your application
- Logically combine selected relay elements for various control functions
- Assign outputs to your logic functions.

To program SELOGIC control equations, combine relay elements, inputs, and outputs with SELOGIC control equation operators (see *Table 2*). You can use any element in the Relay Word in these equations. Add programmable control functions to your protection and automation systems. New functions and abilities enable you to use analog values in conditional logic statements.

Table 2 SELOGIC Control Equation Operators

Operator Type	Operators	Comments
Boolean	AND, OR, NOT	Allows combination of measuring units
Edge Detection	F_TRIG, R_TRIG	Operates at the change of state of an internal function
Comparison	>, >=, =, <=, <, < >	
Precedence Control	( )	Allows multiple and nested sets of parentheses
Comment	#	Provides for easy documentation of control and protection logic

ACSELERATOR QuickSet SEL-5030 With Design Features

Use the ACSELERATOR QuickSet SEL-5030 Software to develop settings offline. The system automatically checks interrelated settings and highlights out-of-range settings. You can transfer settings created offline by using a PC communications link with the SEL-651R-2. The software also converts event reports to oscillograms with time-coordinated element assertion and phasor/sequence element diagrams. View real-time phasors via QuickSet.

With the licensed version of QuickSet, you can commission recloser controls using only the settings you need. This version allows users to create custom Application Designs. Use these designs to quickly implement advanced schemes, such as Automatic Network Reconfiguration and single-phase tripping/reclosing. Application Designs hide settings you do not want changed (such as SELOGIC control equations), while making visible just the minimum necessary settings (such as timer and pickup settings) to implement the scheme.

All settings can be aliased and manipulated mathematically for simple end-user interfacing. You can also define custom notes and settings ranges. The Application Designs enhance security by allowing access to only a specified group of settings. Create Application Designs that include the most commonly used relay features and settings (*Figure 8*) and watch commissioning times drop drastically. Design custom templates using QuickSet for your specific applications and then store the templates on the recloser control for easy access when making settings changes.

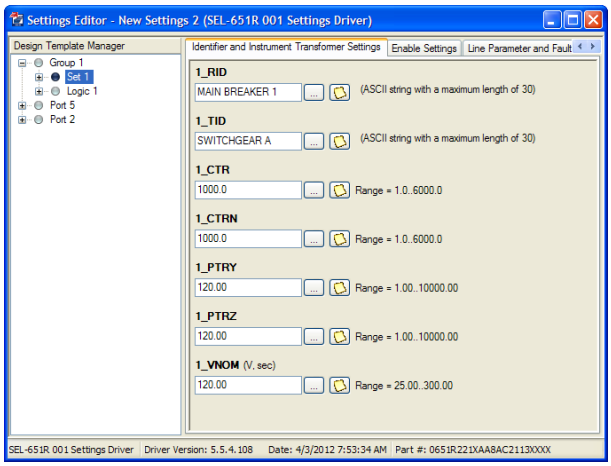


Figure 8 Example Application Designs

MIRRORED BITS Communications

The SEL-patented MIRRORED BITS® communications technology provides bidirectional recloser control-to-recloser control digital communications. MIRRORED BITS can operate independently on one or two EIA-232 serial ports on a single SEL-651R-2. With MIRRORED BITS operating on two serial ports, there is communication upstream and downstream from the SEL-651R-2 site.

This bidirectional digital communication creates eight additional virtual outputs (transmitted MIRRORED BITS) and eight additional virtual inputs (received MIRRORED BITS) for each serial port operating in the MIRRORED BITS mode (see *Figure 9*). Use these MIRRORED BITS to transmit/receive information between upstream relays and a downstream recloser control to enhance coordination and achieve faster tripping for downstream faults. MIRRORED BITS technology also helps reduce total scheme operating time by eliminating the need to assert output contacts to transmit information.

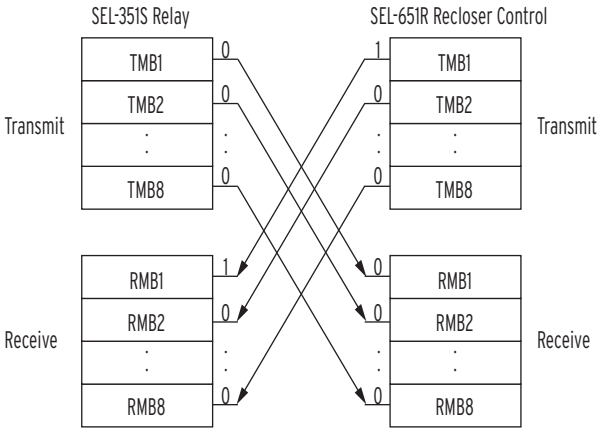


Figure 9 MIRRORED BITS Transmit and Receive Bits

Integrated Web Server

An embedded web server is included in every SEL-651R-2 recloser control. Browse to the recloser control with any standard web browser to safely read settings, verify recloser control self-test status, inspect meter reports, and read recloser control configuration and event history. The web server allows no control or modification actions at Access Level 1 or lower, so users can be confident that an inadvertent button press will have no adverse effects. *Figure 10* shows the settings display webpage.

The web server allows users with the appropriate engineering access level (2AC) to upgrade the firmware over an Ethernet connection. An Ethernet port setting enables or disables this feature, with the option of requiring front-panel confirmation when the file is completely uploaded.

The SEL-651R-2 firmware files contain cryptographic signatures that enable the SEL-651R-2 to recognize official SEL firmware. A digital signature, computed using the SHA-256 Secure Hash Algorithm, is appended to the compressed firmware file. Once the firmware is fully uploaded to the relay, the relay verifies the signature by using a Digital Signature Algorithm security key that SEL stored on the device. If the signature is valid, the firmware is upgraded in the relay. If the relay cannot verify the signature, it reverts to the previously installed firmware.

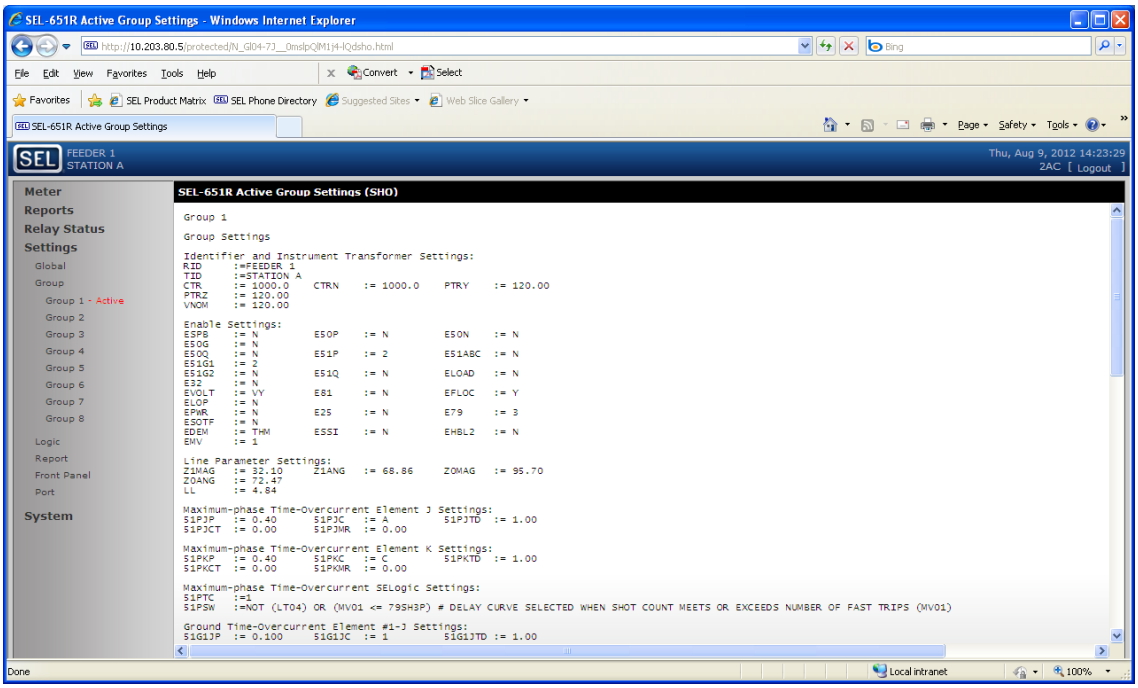


Figure 10 Settings Display Webpage

Applications

Automatic Network Reconfiguration

Automatic Network Reconfiguration augments system reliability by automatically isolating faulted line sections and restoring service to the unaffected areas of the system. In the simple Automatic Network Reconfiguration implementation in *Figure 11*, there is no direct communication between the recloser control sites and there is minimal voltage sensing. For the sample fault in *Figure 11*, system isolation and restoration is methodically accomplished with the following:

- Sectionalizing recloser tripping on sensed dead feeder (for line section isolation).
- Midpoint recloser control changing settings (for better backfeed coordination).
- Tie recloser closing into dead line sections (for restoration of unfaulted line sections from adjacent feeder).

The advanced Automatic Network Reconfiguration shown in *Figure 12* includes both source-side and load-side voltages into the SEL-651R-2 Recloser Controls and Mirrored Bits communications (via fiber optics or radio) between the recloser sites. These enhancements greatly speed up Automatic Network Reconfiguration. Automatic Network Reconfiguration is especially valuable in urban areas and for critical loads where there are tie points available to other feeders for system restoration.

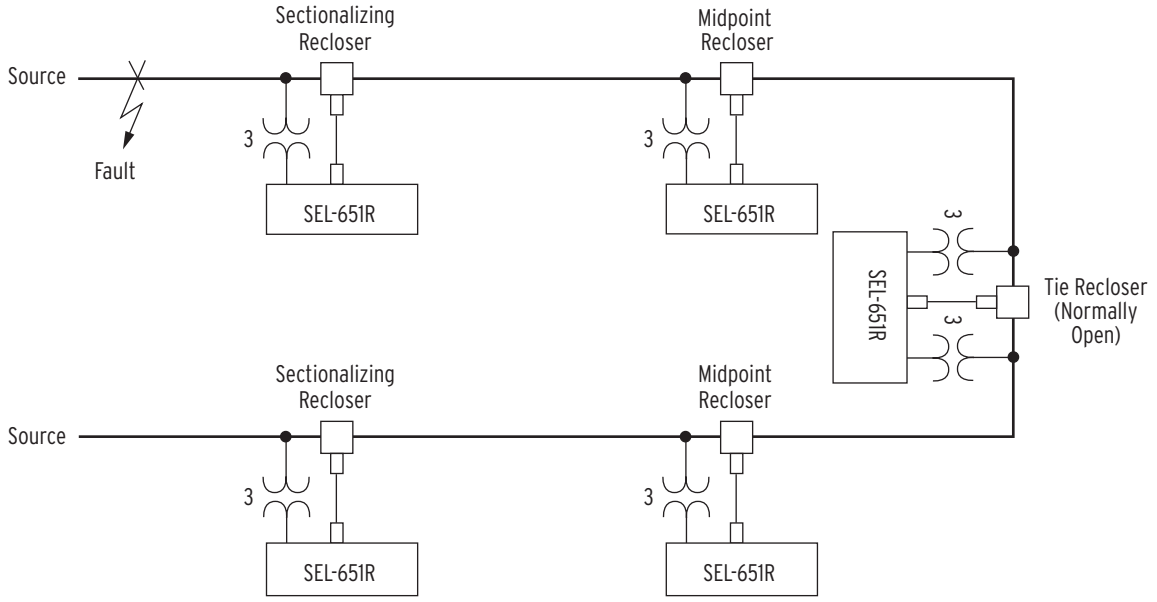


Figure 11 Simple Automatic Network Reconfiguration

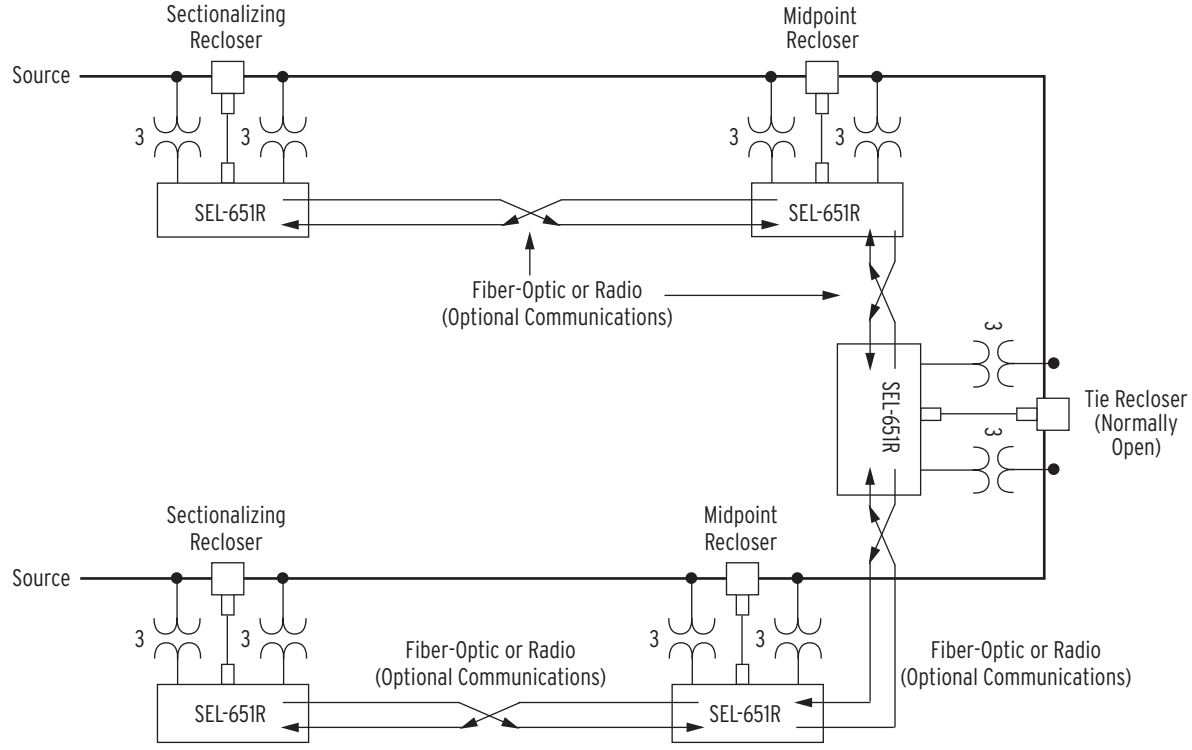


Figure 12 Advanced Automatic Network Reconfiguration

Distributed Energy Resource Interconnection

Reclosers are ideal for interconnecting microgrids and DER to area electric power systems (Area EPS). In these applications, they are commonly specified with six LEA voltage sensors built into the recloser. Utilities, consultants, microgrid owners, and DER owners use these turnkey recloser solutions at the Point of Common Coupling (PCC) as defined in IEEE 1547. *Figure 13* demonstrates autosynchronism control of the DER, resulting in eventual synchronism-check closing of the recloser when slip frequency, phase angle, and voltage magnitude differences are all within allowable limits.

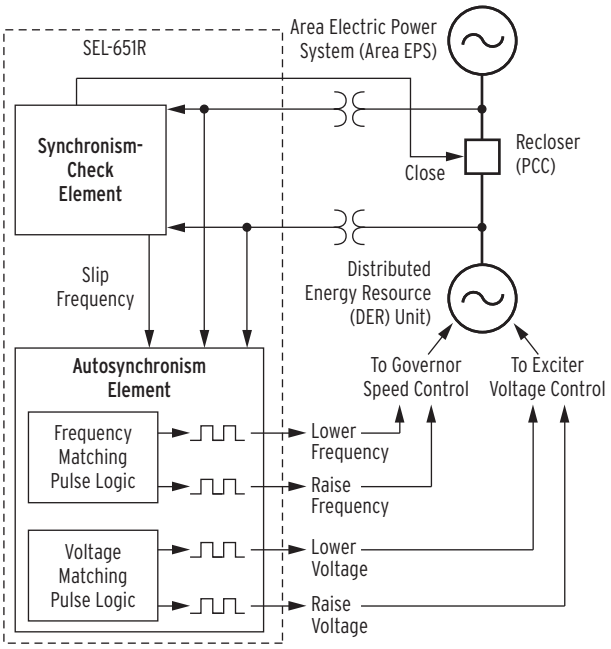


Figure 13 Distributed Energy Resource Intertie

Single-Phase Tripping/Reclosing

Single-phase tripping/reclosing also improves system reliability by keeping customers in service who are not on the faulted phase of a feeder. In *Figure 14*, a permanent fault occurs on the middle phase. Because single-phase tripping/reclosing is enabled, only the middle pole of the recloser opens for the fault. In this case, reclosing does not restore service because the fault is permanent, but only the customers on the middle phase are left without power, rather than customers on all three phases.

Available trip-reclose-lockout operation modes for the single-phase reclosers are as follows:

- Three-phase trip/reclose, three-phase lockout
- Single-phase trip/reclose, three-phase lockout
- Single-phase trip/reclose, single-phase lockout
- Single-phase trip/reclose, single-phase lockout (three-phase lockout if two or more phases involved)

Three-phase tripping is still available for all single-phase trip modes. Apply single-phase operation to rural areas where many loads are single-phase and restoration can take longer because of travel distance. Switch between single-phase and three-phase operation depending upon seasonal needs. When the load levels differ from phase to phase, set the trip levels for each phase independently.

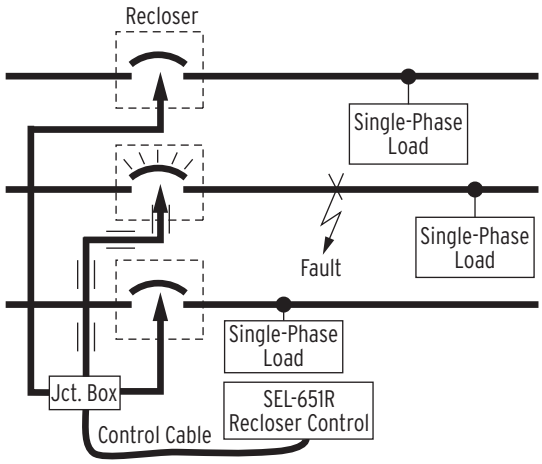


Figure 14 Single-Phase Tripping Isolates Only the Faulted Phase

Protection Features

Overcurrent Protection

Use any combination of fast and delay curves (see *Figure 15*) for phase, ground, and negative-sequence overcurrent protection. For a nominal recloser CT ratio of 1000:1, these curves can be set to levels as sensitive as 100 A primary for phase-to-ground overcurrent protection and 5 A primary for ground overcurrent protection.

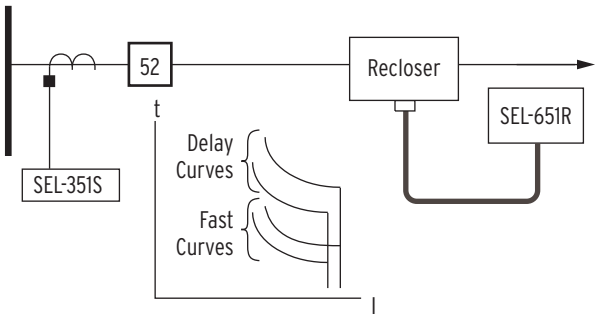


Figure 15 Coordinate the SEL-651R-2 With Other Devices

Any fast or delay curve can be set with any of the curves in *Table 3*. The U.S. and IEC curves conform to IEEE C37.112-1996, IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays. The traditional recloser curve choices in *Table 3* are listed using the older electronic control designations.

Table 3 Curve Choices Resident in the SEL-651R-2

Curve Type	Curve Choices
All Traditional Recloser Curves	A, B, C, D, E, F, G, H, J, KP, L, M, N, P, R, T, V, W, Y, Z, 1, 2, 3, 4, 5, 6, 7, 8, 8PLUS, 9, KG, 11, 13, 14, 15, 16, 17, 18
U.S. Curves	Moderately inverse, inverse, very inverse, extremely inverse, short-time inverse
IEC Curves	Class A (standard inverse), class B (very inverse), class C (extremely inverse), long-time inverse, short-time inverse

You can also specify traditional recloser curves in a curve setting by using the newer microprocessor-based control designations (the SEL-651R-2 works with either designation). For example, a given traditional recloser curve has these two designations:

- Older electronic control designation: A
- Newer microprocessor-based control designation: 101

Traditional Recloser Curve A and 101 are the same curve.

Fast and delay curves (including U.S. or IEC curve choices) can be modified with these traditional recloser control curve modifiers:

- Constant time adder—adds time to curve
- Vertical multiplier (time dial)—shifts whole curve up or down in time
- Minimum response time—holds off curve tripping for minimum time

Instantaneous overcurrent trip, definite-time overcurrent trip, and high-current lockout variations are also available.

The SEL-651R-2 has two reset characteristic choices for each time-overcurrent element. One choice resets the elements if current drops below pickup for at least one cycle. The other choice emulates electromechanical induction disk elements, where the reset time depends on the time dial setting, the percentage of disk travel, and the amount of post-fault load current.

Load Encroachment

Load-encroachment logic (*Figure 16*) prevents operation of phase overcurrent elements under high load conditions. This unique SEL feature permits load to enter a predefined area (shown in the impedance plane in *Figure 16*) without causing a trip, even though load current is above phase minimum trip.

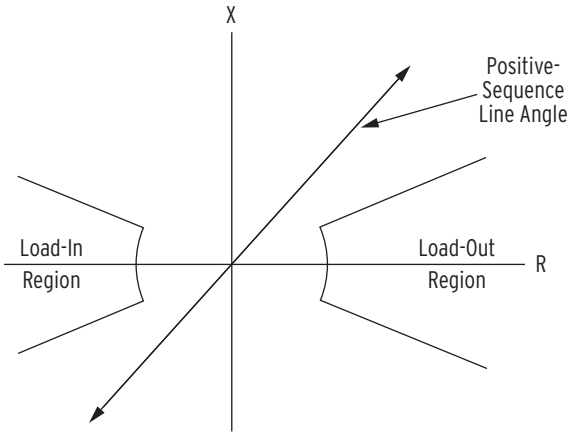


Figure 16 Load-Encroachment Logic Defines Load Zones (No Trip Zones)

Directional Elements Increase Sensitivity and Security

Phase and ground directional elements are standard. An automatic setting mode sets all directional thresholds based on replica line impedance settings. Phase directional elements provide directional control to the phase-overcurrent and negative-sequence overcurrent elements. Positive-sequence and negative-sequence directional elements work together. The positive-sequence directional element memory provides a reliable output for close-in, and forward- or reverse-bolted three-phase faults where each phase voltage is zero. The negative-sequence directional element uses the same patented principle proven in the SEL-351 Relay. Apply this directional element in virtually any application regardless of the amount of negative-sequence voltage available at the recloser control location.

Ground directional elements provide directional control to the ground overcurrent elements. The following directional elements work together to provide ground directionality:

- Negative-sequence voltage-polarized element
- Zero-sequence voltage-polarized element

Our patented Best Choice Ground Directional Element® logic selects the best ground directional element for the system conditions. This scheme eliminates directional element settings. You can also override this automatic setting feature for special applications.

Loss-of-Potential Logic Supervises Directional Elements

Voltage-polarized directional elements rely on valid input voltages to make correct decisions. The SEL-651R-2 includes loss-of-potential logic that detects one, two, or three blown potential fuses and disables the

directional elements. For example, in a loss-of-potential condition, you can enable forward-set overcurrent elements to operate nondirectionally. This patented loss-of-potential logic is unique, because it only requires a nominal setting and is universally applicable.

Reclosing

The SEL-651R-2 can reclose as many as four (4) times. This allows for as many as five operations of any combination of fast and delay curve overcurrent elements. The SEL-651R-2 verifies that adequate close power is available before issuing an autoreclose. Reset timings for an autoreclose and for a manual/remote close from lockout are set separately. Traditionally, the reset time for a manual/remote close from lockout is set less than the reset time for an autoreclose. Front-panel LEDs track the control state for autoreclosing: 79 RESET, 79 CYCLE, or 79 LOCKOUT (see *Figure 23* and *Table 5*). Sequence coordination logic is enabled to prevent the SEL-651R-2 from tripping on its fast curves for faults beyond a downstream recloser. Customize reclosing logic by using SELOGIC control equations. Use programmable timers, counters, latches, logic functions, and analog compare functions to optimize control actions.

Power Elements

Four independent directional three-phase power elements are available in the SEL-651R-2. Each enabled power element can be set to detect real power or reactive power. With SELOGIC control equations, the power elements provide a wide variety of protection and control applications. Typical applications include the following:

- Overpower and/or underpower protection and control
- Reverse power protection and control
- VAR control for capacitor banks

Harmonic Blocking Elements Secure Protection During Transformer Energization

Transformer inrush can cause sensitive protection to operate. Use the second-harmonic blocking feature to detect an inrush condition and block selected tripping elements until the inrush subsides. Select the blocking threshold as a percentage of fundamental current, and optimize security and dependability with settable pickup and dropout times. Use the programmable torque control equation to only enable the blocking element immediately after closing the breaker.

Fast Rate-of-Change-of-Frequency Protection for Fast Islanding Protection

The fast rate-of-change-of-frequency protection, 81RF, provides a faster response compared to frequency (81) and rate-of-change-of-frequency (81R) elements. Fast operating speed makes the 81RF element suitable for detecting islanding conditions. The element uses a characteristic (see *Figure 18*) based on the frequency deviation from nominal frequency (DF = FREQ – NFREQ) and the rate-of-change of frequency (DFDT) to detect islanding conditions.

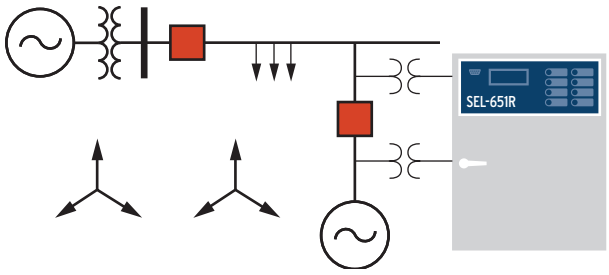


Figure 17 Fast Islanding Detection

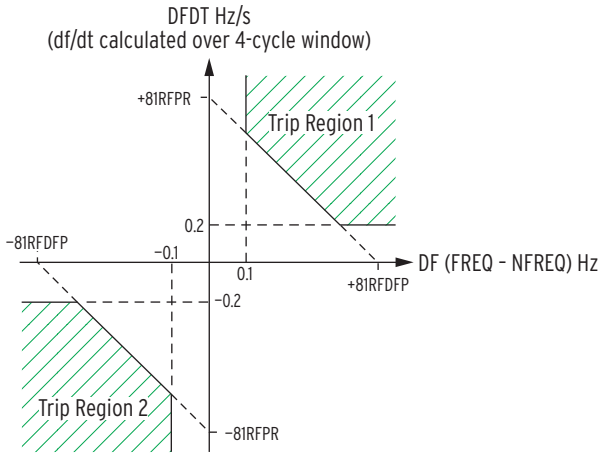


Figure 18 81RF Characteristics

Under steady-state conditions, the operating point is close to the origin. During islanding conditions, depending on the islanded system acceleration, the operating point enters Trip Region 1 or Trip Region 2 of the characteristic. 81RFDFP (in Hz) and 81RFRP (in Hz/sec) are the settings used to configure the characteristic.

Vector Shift (78VS) Protection

When distributed generators (DG) are connected in the utility network, the vector shift (78VS) element is used to detect islanding conditions and trip the DG. Failure to trip islanded generators can lead to problems such as personnel safety, out-of-synchronization reclosing, and deg-

radation of power quality. Based on the change in the angle of the voltage waveform, the islanding condition can be detected by the vector shift function.

Use the vector shift element with the 81RF element as a backup for fast and secure islanding detection. The vector shift element operates within three cycles, which is fast enough to prevent reclosing out-of-synchronism with the network feeders to avoid generator damage.

Fault Locating

The SEL-651R-2 provides an accurate estimate of fault location even during periods of substantial load flow. The fault locator uses fault type, replica line impedance settings, and fault conditions to develop an estimate of fault location without communications channels, special instrument transformers, or prefault information. This feature contributes to efficient line crew dispatch and fast service restoration. The fault locator requires three-phase voltage inputs.

High-Impedance Fault Detection

High-impedance faults are short-circuit faults with fault currents smaller than what a traditional overcurrent element can detect.

The SEL-651R-2 with Arc Sense technology includes logic that can detect HIF signatures without being affected by loads or other system operation conditions. High-impedance fault event reports are stored in both Compressed ASCII and COMTRADE file format.

The SEL-651R-2 offers another method of detecting high-impedance faults. A ground overcurrent element is used to count the number of times the ground current exceeds a threshold in a given amount of time. If the count exceeds a set threshold, the relay asserts an alarm indicating a potential high-impedance fault.

Monitoring and Metering

Event Reporting and Sequential Events Recorder (SER)

Event Reports and Sequential Events Recorder features simplify post-fault analysis and help improve your understanding of both simple and complex protective scheme operations. These features also aid in testing and troubleshooting relay settings and protection schemes. Increase the availability of information by accessing settings, events, and other data over a single communications link.

Event Reporting and Oscillography

In response to a user-selected internal or external trigger, the voltage, current, and element status information contained in each event report confirms relay, scheme, and system performance for every fault. Decide how much detail is necessary when an event report is triggered: 4, 16, 32, or 128 samples/cycle resolution analog data. The relay stores the following:

- 40 event reports (when event report length is 15 cycles)
- 25 event reports (when event report length is 30 cycles)
- 15 event reports (when event report length is 60 cycles)

Reports are stored in nonvolatile memory and are available in Standard ASCII, Compressed ASCII, and COMTRADE file format. Relay settings operational in the relay at the time of the event are appended to each event report.

High-impedance fault event reports are also available in Compressed ASCII and COMTRADE file formats. The information used to determine if a high-impedance fault is present on the system is included in the report. The relay stores the following:

- 28 event reports (when event report length is 2 minutes)
- 14 event reports (when event report length is 5 minutes)
- 7 event reports (when event report length is 10 minutes)
- 3 event reports (when event report length is 20 minutes)

Demodulated IRIG-B time code can be input into either the IRIG-B BNC connector or Serial Port 2. Connect a high-quality time source such as the SEL-2401 Satellite-Synchronized Clock to the BNC IRIG-B connector to enable microsecond accurate time synchronization. Connect an SEL communications processor (combining data and IRIG signals) to Serial Port 2 on the SEL-651R-2 for millisecond accurate time synchronization.

The recloser control also synchronizes the internal clock to an NTP server via SNTP with 5 ms accuracy. Connect all possible time sources (IRIG, SNTP, DNP) and the recloser control automatically selects the most accurate.

The ACSELERATOR Analytic Assistant® SEL-5601 Software and QuickSet can read a Compressed ASCII or COMTRADE file format version of the event report, which contains even more information than the standard ASCII event report. Using Analytic Assistant and QuickSet, you can produce oscillographic traces and digital element traces on the PC display. A phasor analysis screen allows users to analyze the prefault, fault, and post-fault intervals, observing the directly measured inputs, as well as the calculated sequence component signals.

Event Summary

Each time the relay generates a standard event report, it also generates a corresponding Event Summary, a concise description of an event that includes the following information:

- Relay/terminal identification
- Event date and time
- Event type
- Fault location
- Recloser shot count at time of trigger
- System frequency at the start of the event report
- Front-panel fault targets at the time of trip
- Phase (IA, IB, IC), ground (IG = 3I0), and negative-sequence (3I2) current magnitudes in amperes primary measured at the largest phase current magnitude in the triggered event report

Set the relay to automatically send an Event Summary in ASCII text to one or more serial ports each time an event report is triggered.

Sequential Events Recorder (SER)

Use this feature to gain a broad perspective on relay element operation. Select items that trigger an SER entry including I/O change of state, element pickup/dropout, recloser state changes, etc. The relay SER stores the latest 1,024 entries.

Synchrophasor Measurements

Use the IEEE C37.118-2005 protocol to send synchrophasor data to SEL synchrophasor applications. These include the SEL-3373 Station Phasor Data Concentrator (PDC), SEL-3378 Synchrophasor Vector Processor (SVP), SEL-3530 Real-Time Automation Controller (RTAC), and SEL SYNCHROWAVE® software suite. The SEL-3373 Station PDC time correlates data from multiple SEL-651R-2 recloser controls and concentrates the result into a single-output data stream. The SEL-3378 SVP enables control applications based on synchrophasors, which allows users to do the following:

- Directly measure the oscillation modes
- Act on the results
- Properly control islanding of distributed generation using wide-area phase-angle slip and acceleration measurements
- Customize synchrophasor control applications based on unique power system requirements

You can then use SYNCHROWAVE software to archive and display wide-area system measurements, which are precisely time-aligned using synchrophasor technology.

The data rate of SEL-651R-2 synchrophasors is selectable, with a range of 1–60 messages per second. This flexibility is important for efficient use of communications capacity. The SEL-651R-2 phasor measurement accuracy meets the highest IEEE C37.118-2005 Level 1 requirement of 1 percent total vector error (TVE). Use the low-cost SEL-651R-2 in any application that otherwise would have required purchasing a separate dedicated phasor measurement unit (PMU).

Use the SEL-651R-2 with the SEL communications processors, or the SEL-3530 RTAC, to change nonlinear state estimation into linear state estimation. If all necessary lines include synchrophasor measurements, state estimation is no longer necessary because the system state is directly measured.

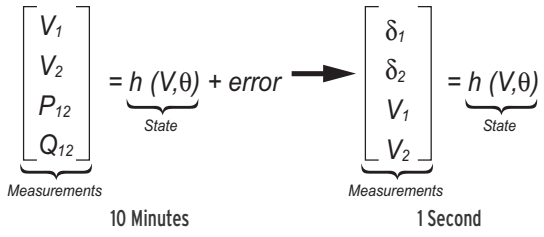


Figure 19 Synchrophasor Measurements Turn State Estimation Into State Measurement

Improve Situational Awareness

Improve information for system operators by using advanced synchrophasor-based tools to provide a real-time view of system conditions. Use system trends, alarm points, and preprogrammed responses to help operators prevent a cascading system collapse and maximize system stability. Awareness of system trends helps operators more accurately set system protection levels based on measured data.

Figure 20 Visualization of Phase Angle Measurements Across a Power System

Better information helps users do the following:

- Increase system loading while maintaining adequate stability margins
- Improve operator response to system contingencies such as overload conditions, transmission outages, or generator shutdown
- Increase system knowledge with correlated event reporting and real-time system visualization.
- Validate planning studies to improve system load balance and station optimization

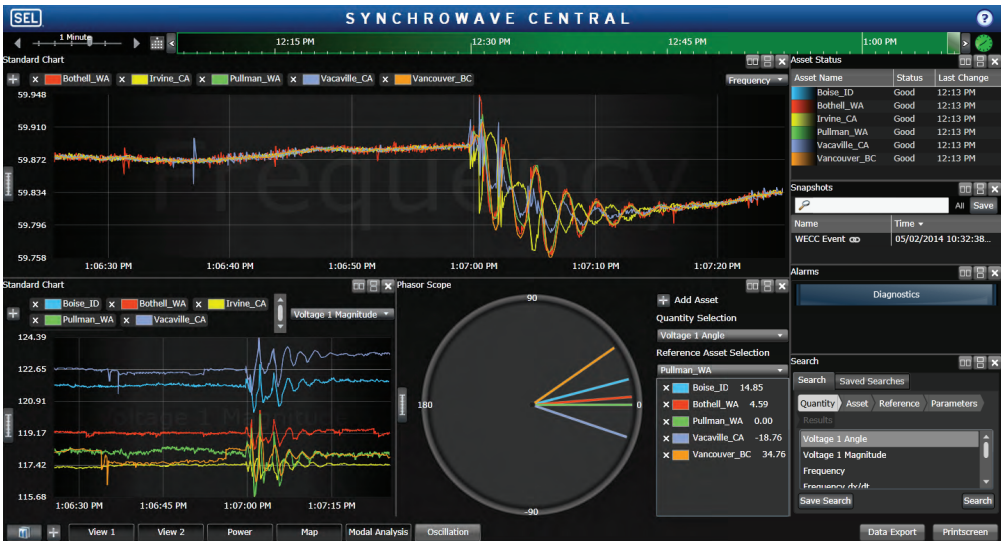


Figure 21 SEL-5078-2 SYNCHROWAVE Central Real-Time, Wide-Area Visualization Tool

Voltage Sag/Swell/Interrupt (VSSI) Report

The VSSI report captures power quality data related to voltage disturbances over a long period. Captured data include the magnitude of currents, one set of three-phase voltages, a reference voltage, and the status of the VSSI elements (Relay Word bits).

Use VSSI report information to analyze power quality disturbances or protective device actions that last longer than the time window of a conventional event report. The VSSI recording rate varies from fast to slow, depending on changes in the triggering elements. VSSI data (a minimum of 3855 entries) are stored to nonvolatile memory just after they are generated.

Recloser Wear Monitor

Reclosers experience mechanical and electrical wear every time they operate. The recloser wear monitor measures unfiltered ac current at the time of trip and the number of close-to-open operations as a means of monitoring this wear. Every time the recloser trips, the recloser control records the magnitude of the raw current in each phase. This current information is integrated on a per-phase basis.

When the integration exceeds the threshold set by the recloser wear curve (see *Figure 22*), the SEL-651R-2 asserts a logic point for the affected phase. Use the logic point for alarming or to modify reclosing. This method of monitoring recloser wear is based on breaker rating methods from switchgear manufacturers.

Figure 22 shows three set points needed to emulate a breaker wear curve. The set points in *Figure 22* can be programmed to customize the recloser wear curve. Predetermined set points are available for traditional reclosers, following recommendations for reclosers in ANSI C37.61-1973.

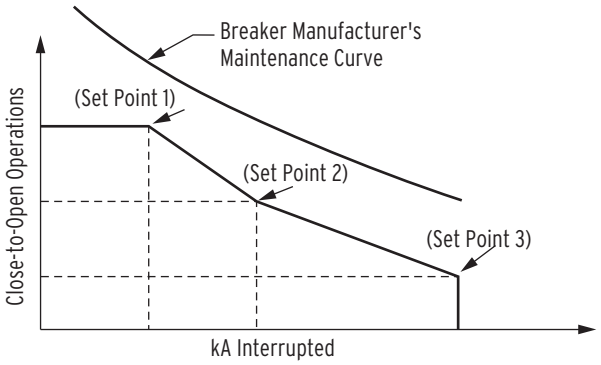


Figure 22 Recloser Contact Wear Curve and Settings

Load Profile

The load profile recorder in the SEL-651R-2 is capable of recording as many as 15 selectable analog quantities at a periodic rate (5, 10, 15, 30, or 60 minutes) and storing the data in a report in nonvolatile memory. Choose any of the analog quantities listed in *Table 4* (except peak demands). At a five-minute periodic recording rate and with 15 selected analog quantities, the SEL-651R-2 stores as many as 26 days of load profile data. More days of storage are available if you choose longer periodic recording rates or select fewer analog quantities.

Metering

The SEL-651R-2 provides extensive and accurate metering capabilities, as shown in *Table 4*. See *Specifications* for metering accuracies. The SEL-651R-2 reports all metered quantities in primary quantities (current in A primary and voltage in kV primary). Use the THD elements for the current and voltage channels for harmonics-based decisions or operations.

The phantom voltage feature creates balanced three-phase voltage values for metering from a single-phase voltage connection. These derived three-phase voltage values are also used in three-phase power and energy metering.

Table 4 Available Metering Quantities (Sheet 1 of 2)

Instantaneous Quantities	**Fundamental Values**
Currents	
$I_{A, B, C, N}$	Phase and neutral current channels
I_G	Ground (residual current)
I_1, $3I_2$, $3I_0$	Positive-, negative-, and zero-sequence
Voltages	Values for both VY and VZ three-phase voltage channels
$V_{A, B, C, AB, BC, CA}$	Line-to-neutral and line-to-line
V_1, V_2, $3V_0$	Positive-, negative-, and zero-sequence

Table 4 Available Metering Quantities (Sheet 2 of 2)

Power	
$MW_{A, B, C, 3P}$	Megawatts, single- and three-phase
$MVAR_{A, B, C, 3P}$	Megavars, single- and three-phase
$MVA_{A, B, C, 3P}$	Megavolt-amperes, single- and three-phase
$PF_{A, B, C, 3P}$	Power factor, single- and three-phase (with leading or lagging indication)
Demand Quantities	**Present and Peak (Fundamental Values)**
Currents	
$I_{A, B, C, N}$	Phase and neutral current channels
I_G	Ground (residual current)
$3I_2$	Negative-sequence
Power	
$MW_{A, B, C, 3P}$	Megawatts, single- and three-phase (in and out)
$MVAR_{A, B, C, 3P}$	Megavars, single- and three-phase (in and out)
$MVA_{A, B, C, 3P}$	Megavolt-amperes, single- and three-phase
Energy Quantities	**In and Out (Fundamental Values)**
$MWh_{A, B, C, 3P}$	Megawatt hours, single- and three-phase
$MVARh_{A, B, C, 3P}$	Megavar hours, single- and three-phase
Maximum/Minimum Quantities	**Fundamental Values**
Currents	
$I_{A, B, C, N}$	Phase and neutral current channels
I_G	Ground (residual current)
Voltages	Values for both VY and VZ three-phase voltage channels
$V_{A, B, C}$	Line-to-neutral
Power	
MW_{3P}	Megawatts, three-phase
$MVAR_{3P}$	Megavars, three-phase
MVA_{3P}	Megavolt-amperes, three-phase
RMS Quantities	
Currents	
$I_{A, B, C, N}$	Phase and neutral current channels
Voltages	Values for both VY and VZ three-phase voltage channels
$V_{A, B, C}$	Line-to-neutral
Power (average)	
$MW_{A, B, C, 3P}$	Megawatts, single- and three-phase
Harmonic Quantities and Total Harmonic Distortion (THD)	**Through the 16th Harmonic**
Currents	
$I_{A, B, C, N}$	Phase and neutral current channels
Voltages	Values for both VY and VZ three-phase voltage channels
$V_{A, B, C}$	Line-to-neutral

Additional Features

Status and Trip Target LEDs/ Operator Controls

The SEL-651R-2 includes 24 programmable status and trip target LEDs, as well as 12 programmable direct-action operator-control pushbuttons on the front panel. These targets are shown in *Figure 23* and explained in *Table 5*. Customize the versatile SEL-651R-2 front panel to fit your needs. Optional tricolor LEDs even allow you to customize color. Use SELOGIC control equations and slide-in configurable front-panel labels to change the function and identification of target LEDs and operator-control pushbuttons and LEDs. Functions are simple to configure using QuickSet. Print label sets using templates or write labels by hand.

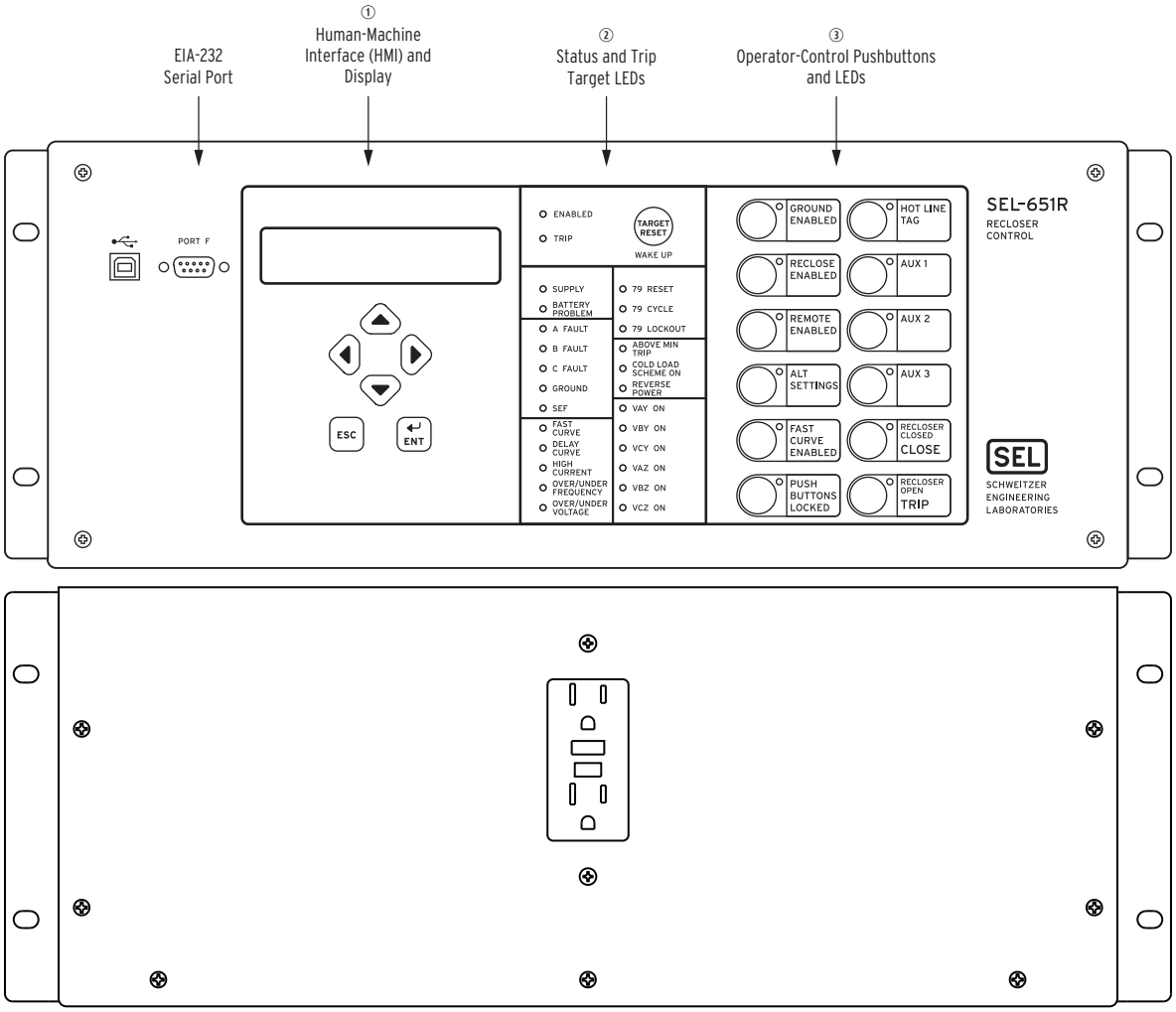


Figure 23 Front View of SEL-651R-2 Relay and Power Modules (Dual-Door Enclosure)

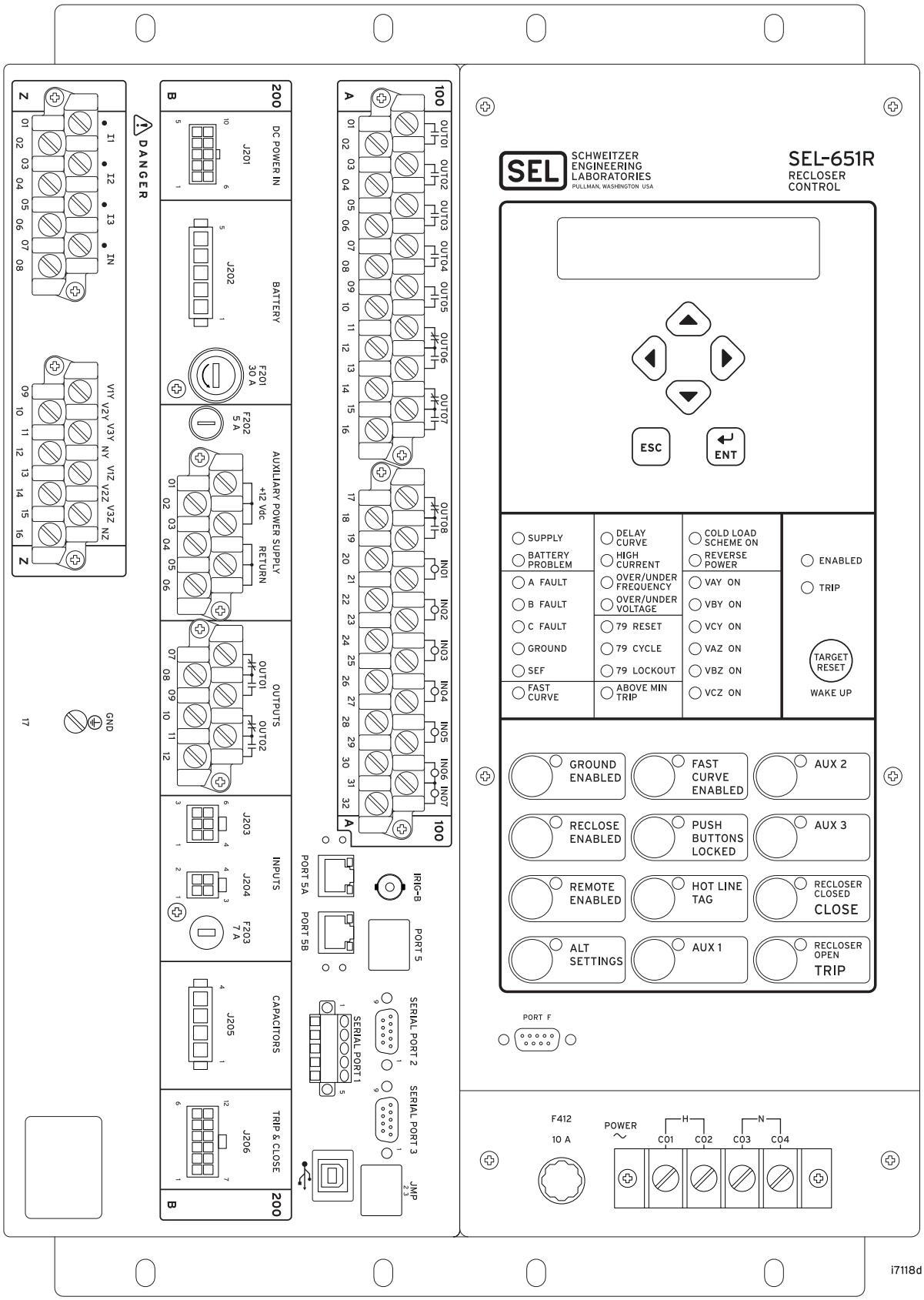


Figure 24 Front View of SEL-651R-2 Relay and Power Modules (Single-Door Enclosure)

Table 5 Factory-Default Front-Panel Interface Definitions (see *Figure 22*)

	Function	Definition
1	HMI Pushbuttons and Display	Navigate through the menu and various available functions (e.g., Metering, Event Summaries, Settings) by using the HMI pushbuttons and 2 x 16 LCD.
2	ENABLED[a]	SEL-651R-2 is powered correctly, functional, and has no self-test failures.
	TRIP[a]	Trip occurred.
	TARGET REST/WAKE UP Pushbutton[a]	Reset latched-in target LEDs; wake up the control after it has been put to sleep.
	SUPPLY	Supply power is present and OK.
	BATTERY PROBLEM	Indicates battery problems.
	A FAULT, B FAULT, C FAULT	Phases A, B, or C involved in fault.
	GROUND	Ground involved in fault.
	SEF	Sensitive earth fault overcurrent element trip (not set from factory).
	FAST CURVE	Fast curve overcurrent element trip.
	DELAY CURVE	Delay curve overcurrent element trip.
	HIGH CURRENT	High-set overcurrent element trip (not set from factory).
	OVER/UNDER FREQUENCY	Over- and underfrequency element trip (not set from factory).
	OVER/UNDER VOLTAGE	Over- and undervoltage element trip (not set from factory).
	79 RESET	The control is in the reset state, ready for a reclose cycle.
	79 CYCLE	The control is actively in the trip/reclose cycle mode.
	79 LOCKOUT	All reclose attempts were unsuccessful.
	ABOVE MIN TRIP	Current levels above minimum set overcurrent element pickup (not set from factory).
	COLD LOAD SCHEME ON	Cold Load Scheme active (not set from factory).
	REVERSE POWER	Reverse power flow exceeds power element set point (not set from factory).
	VAY, VBY, VCY ON	VY voltage channels energized.
	VAZ, VBZ, VCZ ON	VZ voltage channels energized (not set from factory).
3	GROUND ENABLED	Enable/disable ground overcurrent elements.
	RECLOSE ENABLED	Enable/disable autoreclosing.
	REMOTE ENABLED	Enable/disable remote control.
	ALTERNATE SETTINGS	Switch active setting group between main and alternate setting groups.
	FAST CURVE ENABLED	Enable/disable fast curve overcurrent element.
	PUSH BUTTONS LOCKED	Block the function of other operator controls (except WAKE UP and TRIP). Three-second delay to engage/disengage.
	HOT LINE TAG	No closing or autoreclosing can take place via the control.
	AUX 1	User programmable; e.g., program to Trip Test—test autoreclose logic without applying current.
	AUX 2	User programmable; e.g., program to enable/disable delay curve tripping.
	AUX 3	User programmable.
	RECLOSER CLOSED/CLOSE	Recloser status/close recloser.
	RECLOSER OPEN/TRIP	Recloser status/trip recloser (go to lockout).

[a] These indicated LEDs and the operator control have fixed functions. All other LEDs and operator controls (with corresponding status LEDs) can change function by programming at a higher logic level.

Control Inputs and Outputs

The basic SEL-651R-2 includes the following control inputs and outputs:

- Dedicated trip/close outputs that exit the SEL-651R-2 on a control cable receptacle/interface at the bottom of the enclosure (see *Figure 3*).
- Two Form C (normally closed/normally open) standard interrupting output contacts: OUT201 and OUT202 (row 200; *Figure 25*). OUT201 is factory-programmed as an alarm output.

Order the following additional I/O (row 100; *Figure 25*):

- Optoisolated inputs IN101–IN107 (12 Vdc rating; IN106 and IN107 share a common terminal)
- Form A (normally open) standard interrupting output contacts OUT101–OUT105
- Form C (normally closed/normally open) standard interrupting output contacts OUT106–OUT108

Assign the optoisolated inputs for control functions, monitoring logic, and general indication. Set input debounce time independently for each input. Each output contact is programmable using SELOGIC control equations.

Rear-Panel Diagrams

See *Figure 23* and *Figure 24* for the front views of the SEL-651R-2 Relay module.

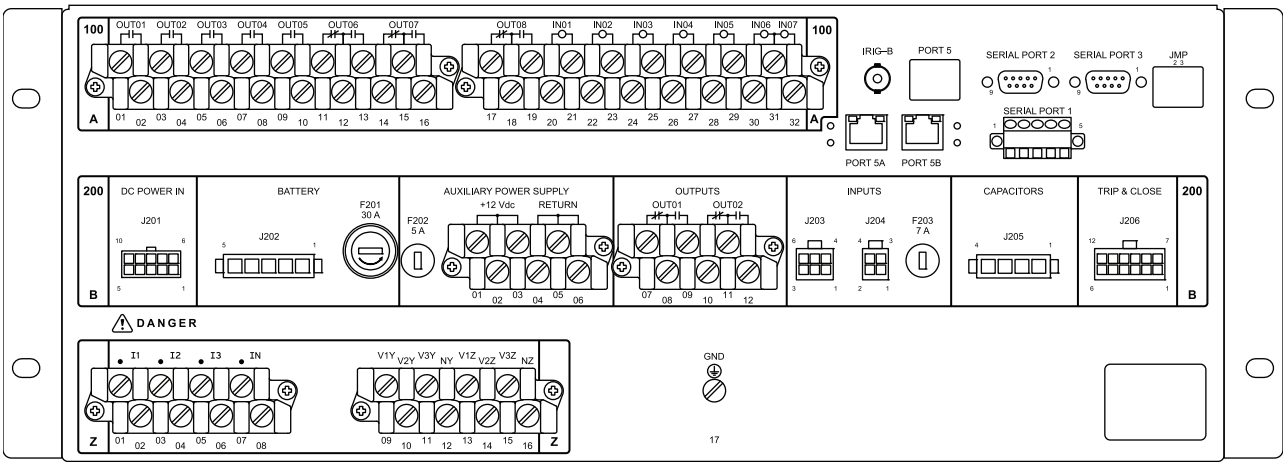


Figure 25 Rear View of the SEL-651R-2 Relay Module

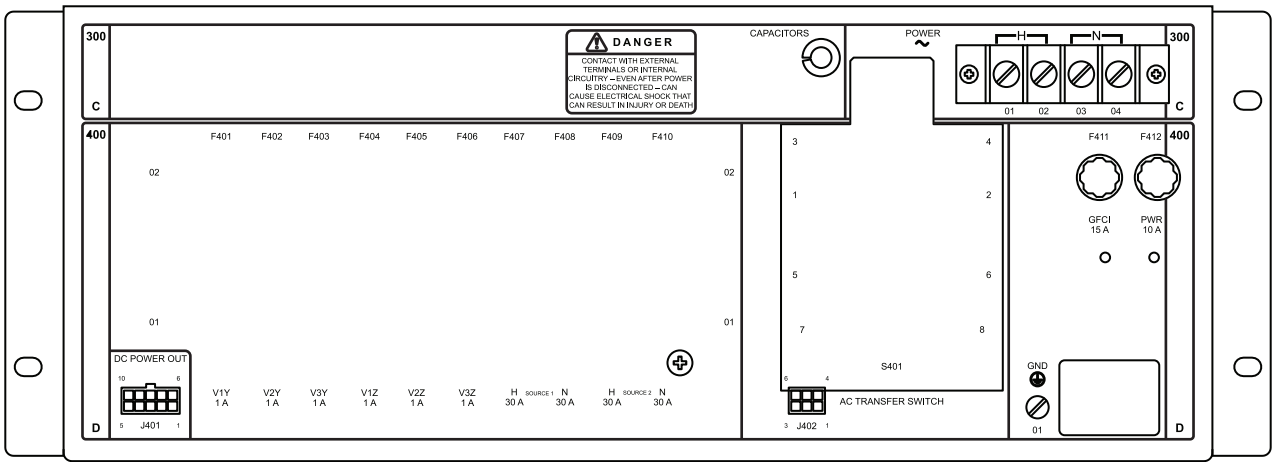
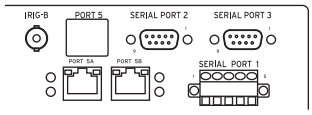
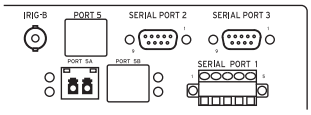


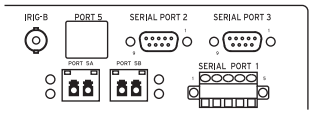
Figure 26 Rear View of the SEL-651R-2 Power Module (Dual-Door Enclosure)



Optional dual redundant 10/100BASE-T metallic Ethernet ports (5A and 5B) with EIA-485 serial Port 1



Optional single 100BASE-FX fiber Ethernet port (5A) with EIA-485 serial Port 1



Optional dual redundant 100BASE-FX Ethernet ports (5A and 5B) with EIA-485 serial Port 1

Figure 27 SEL-651R-2 Rear-Panel Communications Port Configurations

Enclosure Dimensions

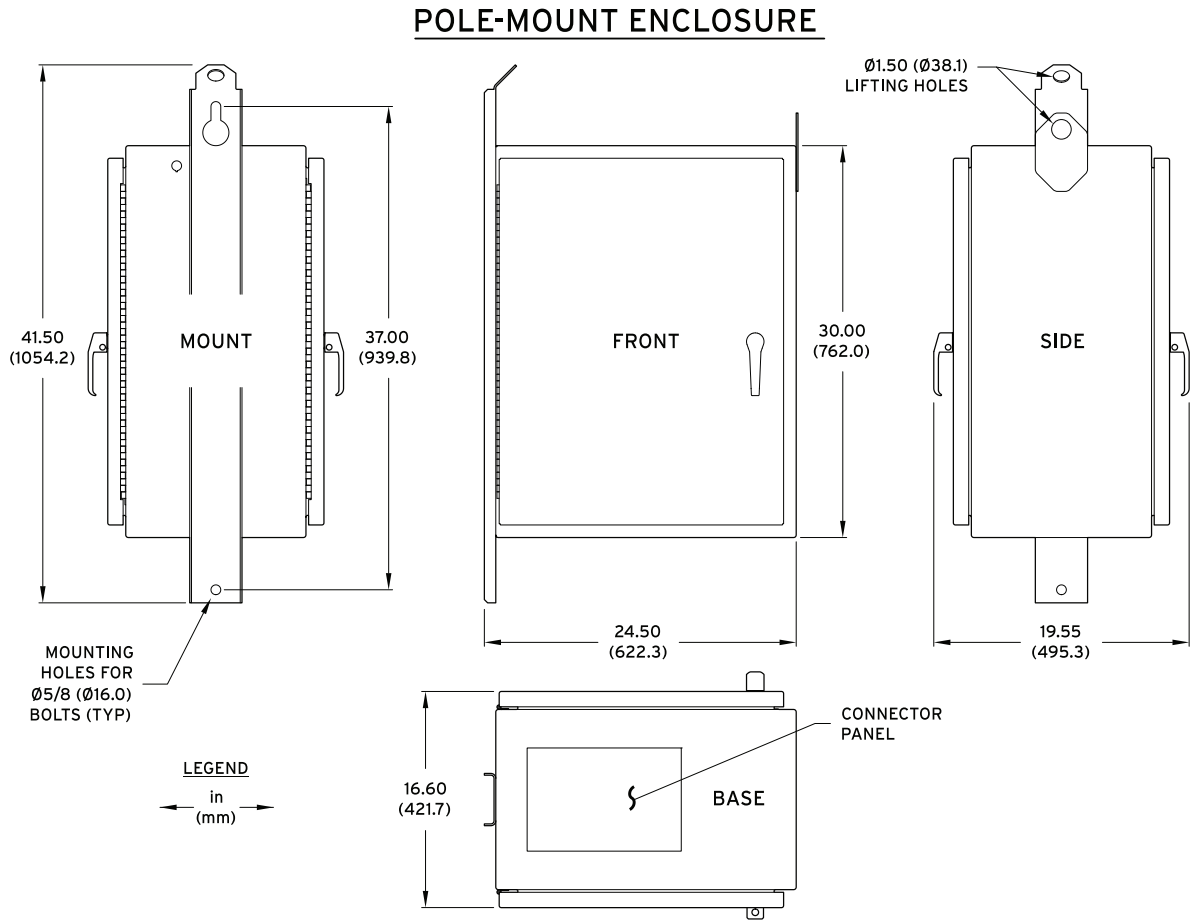


Figure 28 SEL-651R-2 Dimensions and Mounting Drill Plan (Dual-Door Enclosure)

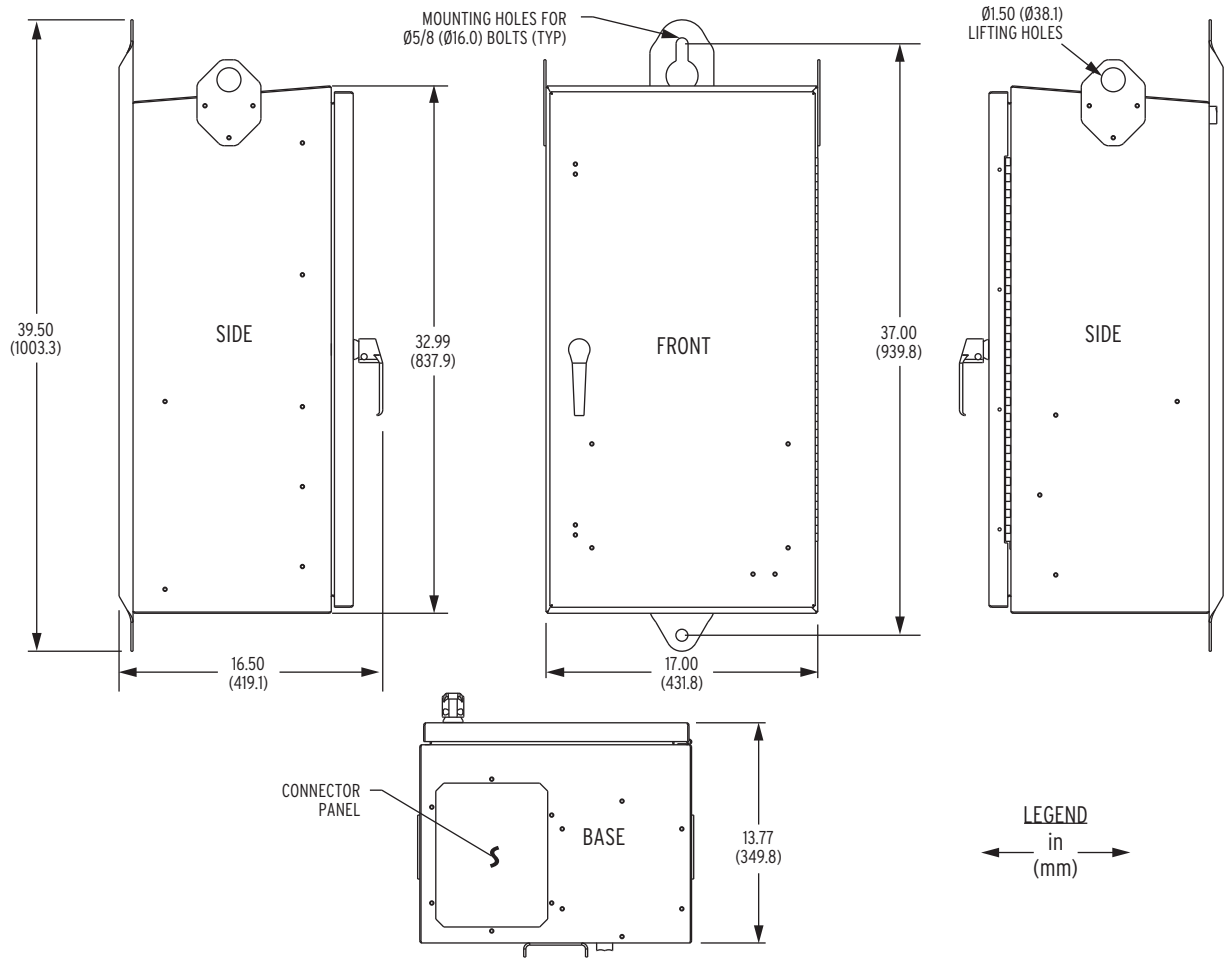


Figure 29 SEL-651R-2 Dimensions and Mounting Drill Plan (Single-Door Enclosure)

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

General

AC Current Inputs

Channels IA, IB, IC

1 A Nominal:	3 A continuous (4 A continuous at 55°C), linear to 20 A symmetrical; 100 A for 1 s; 250 A for 1 cycle
Burden:	0.13 VA @ 1 A, 1.31 VA @ 3 A

Channel IN

0.2 A Nominal:	15 A continuous, linear to 5.5 A symmetrical; 100 A for 1 s; 250 A for 1 cycle
Burden:	<0.5 VA @ 0.2 A

AC Voltage Inputs

300 V Maximum (PT):	300 V_{L-N} continuous (connect any voltage as high as 240 Vac, with allowance for surge): 600 Vac for 10 s
Burden:	<0.03 VA @ 67 V <0.06 VA @ 120 V <0.80 VA @ 300 V
8 V LEA Maximum:	8 V_{L-N} continuous (connect any voltage as high as 6.5 Vac, with allowance for surge): 300 Vac for 10 s
Burden:	Relay Input Z = 1 MΩ
Common Mode Voltage	
Operation:	3 Vac
Without Damage:	50 Vac
Eaton NOVA LEA:	37 V_{L-N} continuous (connect any voltage as high as 29.6 Vac with allowance for surge): 250 Vac for 10 s
Burden:	Relay Input Z = 165 kΩ
Common Mode Voltage	
Operation:	3 Vac
Without Damage:	53 Vac

Lindsey SVMI LEA:	200 V_{L-N} continuous (connect any voltage as high as 160 Vac with allowance for surge): 250 Vac for 10 s
Burden:	Relay Input Z = 1 MΩ
Common Mode Voltage	
Operation:	3 Vac
Without Damage:	25 Vac
Siemens LEA:	8.49 V_{L-N} continuous (connect any voltage as high as 6.79 Vac with allowance for surge): 155 Vac for 10 s
Burden:	Relay Input Z = 24.22 kΩ
Common Mode Voltage	
Operation:	3 Vac
Without Damage:	50 Vac

Frequency and Rotation

Note: 60/50 Hz system frequency and ABC/ACB phase rotation are user-settable.

Frequency Tracking Range:	40–66 Hz
Maximum Rate of Change:	~20 Hz/s (The relay will not measure faster-changing frequencies and will revert to nominal frequency if the condition is maintained for longer than 0.25 s)

Note: Voltage V*n*Y or V*n*Z (where *n* = 1, 2, or 3) required for frequency tracking, depending upon Global setting FSELECT.

Power Supply

120 Vac Nominal

Rated Range:	85–132 Vac
Frequency Range:	40–65 Hz
Maximum Burden:	250 VA average, 500 VA peak
Inrush:	<100 A (I^2t < 24 A^2 – s)

230 Vac Nominal

Rated Range:	170–265 Vac
Frequency Range:	40–65 Hz
Maximum Burden:	250 VA average, 500 VA peak
Inrush:	<50 A (I^2t < 6 A^2 – s)

125 Vdc Nominal

Rated Range:	110.0–137.5 Vdc
Maximum Burden:	25 W continuous, 300 W for 1.5 s

48 Vdc Nominal

Rated Range:	43–60 Vdc
Maximum Burden:	25 W continuous, 300 W for 1.5 s

12 V Accessory Power Supply

For Models With AC Power Supply

12 Vdc ±10%, 40 W continuous, 60 W for 6 s every 60 s

For Models With DC Power Supply

12 Vdc ±10%, 3 W (0.25 A) continuous

Note: Some models momentarily dip to 9 Vdc during trip/close operations.

Output Contacts (Except Trip and Close)

Make:	30 A per IEEE C37.90-2005, Section 5.8
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C
1 s Rating:	50 A
MOV Protection:	270 Vac, 360 Vdc, 40 J
Pickup Time:	<5 ms
Update Rate:	1/8 cycle

Breaking Capacity (10,000 Operations):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Cyclic Capacity (1 Cycle/Second):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Note: Per IEC 60255-0-20:1974, using the simplified assessment method.

AC Output Ratings

Maximum Operational Voltage (U_E) Rating:	240 Vac
Insulation Voltage (U_I) Rating (Excluding EN 61010-1):	300 Vac
Utilization Category:	AC-15 (control of electromagnetic loads >72 VA)
Contact Rating Designation:	B300 (B = 5 A, 300 = rated insulation voltage)
Voltage Protection Across Open Contacts:	270 Vac, 40 J
Rated Operational Current (I_E):	3 A @ 120 Vac 1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (I_{THE}) Rating:	5 A
Rated Frequency:	50/60 ± 5 Hz
Electrical Durability Make VA Rating:	3600 VA, cos φ = 0.3
Electrical Durability Break VA Rating:	360 VA, cos φ = 0.3

Trip and Close Outputs

Traditional Interface Rating

Coil Voltage:	24 ± 2.4 Vdc
Coil Current:	15.5 A (Close), 12.2 A (Trip)

G&W Viper-ST/-LT, ABB Elastimold MVR, and ABB OVR/Gridshield (32-Pin and 42-Pin Versions) Rating

Coil Voltage:	155 + 5, –3 Vdc
Coil Current:	12–17 A (Close), 4 A (Trip) (per phase)
Pulse Duration:	52–55 ms (Close), 27–30 ms (Trip)

ABB OVR-3/VR-3S (24-Pin, 15 and 27 kV Models) Rating

Coil Voltage:	48 + 5, –3 Vdc
Pulse Duration:	85 ms (Close), 45 ms (Trip)

Control-Powered Eaton NOVA Rating

Coil Voltage:	48 + 5, –3 Vdc

ABB Joslyn TriMod 600R Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	35 ms (Close), 14 ms (Trip)

Eaton NOVA-TS or NOVA-ST Triple-Single Rating

Coil Voltage:	48 + 5, –3 Vdc

Tavrida OSM AI_2 Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	60 ms (Close), 15 ms (Trip)

Tavrida OSM AI_4 Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	60 ms (Close), 15 ms (Trip)

Siemens SDR Triple-Single Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	65 ms (Close), 40 ms (Trip)

Siemens SDR Three-Phase Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	65 ms (Close), 40 ms (Trip)

Eaton NOVA NX-T Rating

Coil Voltage:	155 + 5, –3 Vdc
Pulse Duration:	45 ms (Close), 10 ms (Trip)

Note: Supports an entire trip-close-trip-close-trip-close-trip-close-trip-lockout sequence every minute.

Optoisolated Inputs (Optional)

When Used With DC Control Signals

125 Vdc:	On for 105–150 Vdc; off below 75 Vdc
12 Vdc:	On for 9.6–27 Vdc

When Used With AC Control Signals

125 Vdc:	On for 89.6–150.0 Vac; off below 53.0 Vac

Note: AC mode is selectable for Inputs IN101 and IN102 when ordered with 125 Vdc options via Global settings IN101D and IN102D. AC input recognition delay from time of switching: 0.75 cycles maximum pickup, 1.25 cycles maximum dropout.

Note: All optoisolated inputs draw less than 10 mA of current at nominal voltage or AC rms equivalent.

Status Inputs

DC Dropout Range:	0–4 Vdc
DC Pickup Range:	8–28 Vdc
Current Draw:	1–10 mA

Communications Ports

EIA-232:	One front, two rear
EIA-485:	One rear with 2100 Vdc of isolation
Per Port Data Rate Selections:	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600
USB:	One front port (Type B connector, CDC class device)
Ethernet:	One 10/100BASE-T rear port (RJ45 connector) (discontinued option) Two 10/100BASE-T rear ports optional (RJ45 connector) One or two 100BASE-FX rear ports optional (LC connectors multimode) Internal Ethernet switch included with second Ethernet port

Time-Code Inputs

Recloser Control accepts demodulated IRIG-B time-code input at Port 2 or the BNC input.

Port 2, Pin 4 Input Current:	1.8 mA typical at 4.5 V (2.5 kΩ resistive)
BNC Input Current:	4 mA typical at 4.5 V (750 Ω resistive when input voltage is greater than 2 V)

Synchronization Accuracy

Internal Clock:	±1 µs
Synchrophasor Reports (e.g., **MET PM**, **EVE P**, **CEV P**):	±10 µs
All Other Reports:	±5 ms

Simple Network Time Protocol (SNTP) Accuracy

Internal Clock:	±5 ms

Unsynchronized Clock Drift

Relay Powered:	2 minutes per year typical

Operating Temperature

Relay Module:	–40° to +85°C (–40° to +185°F)
Batteries:	–40° to +80°C (–40° to +176°F)
Entire SEL-651R-2 unit:	–40° to +55°C (–40° to +131°F)

Note: LCD contrast impaired for temperatures below –20°C (–4°F). The entire SEL-651R-2 unit is operationally tested to +70°C (+158°F). The 15°C (27°F) difference between the +55°C rating and +70°C is for direct sunlight temperature rise.

Weight

<114 kg (<250 lb)

Battery Specifications

Base Version Requirements

Normal Capacity:	16 ampere-hours @ 25°C
Run Time (Relay Electronics Operate Plus One Trip/Close Cycle):	≥9.6 hours @ 25°C ≥3.2 hours @ –40°C
Recharge Time (Deep Discharge to Fully Charged):	≤9.6 hours @ 25°C
Estimated Life:	≥4 years @ 25°C ≥1 year @ +80°C

Extended Capacity Option Requirements

Normal Capacity:	40 ampere-hours @ 25°C
Run Time (Relay Electronics Operate Plus One Trip/Close Cycle):	≥24 hours @ 25°C ≥8 hours @ –40°C
Recharge Time (Deep Discharge to Fully Charged):	≤24 hours @ 25°C
Estimated Life:	≥4 years @ 25°C ≥1 year @ +80°C

Processing Specifications and Oscillography

AC Voltage and Current Inputs

128 samples per power system cycle, 3 dB low-pass filter cut-off frequency of 3 kHz.

Digital Filtering

Digital low-pass filter then decimate to 32 samples per cycle followed by one-cycle cosine filter.
Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.

Protection and Control Processing

Most Elements:	Four times per power system cycle
Time-Overcurrent Elements:	Two times per power system cycle

Oscillography

Length:	15, 30, or 60 cycles
Total Storage:	11 s of analog and binary
Sampling Rate:	128 samples per cycle unfiltered 32 and 16 samples per cycle unfiltered and filtered 4 samples per cycle filtered
Trigger:	Programmable with Boolean expression
Format:	ASCII and Compressed ASCII Binary COMTRADE (128 samples per cycle unfiltered)

Time-Stamp Resolution: 1 µs when high-accuracy time source is connected (**EVE P** or **CEV P** commands)

Time-Stamp Accuracy: See *Time-Code Inputs* in these specifications.

Sequential Events Recorder

Time-Stamp Resolution: 1 ms

Time-Stamp Accuracy (With Respect to Time Source): ±5 ms

Control Element Settings Ranges and Accuracies

Instantaneous/Definite-Time Overcurrent Elements (50)

Current Pickup Range (A Secondary)

- Phase and Neg.-Seq.: 0.05–20.00 A, 0.01 A steps
- Ground: 0.005–20.000 A, 0.001 A steps
- Neutral: 0.005–2.500 A

Steady-State Pickup Accuracy

- Phase and Neg.-Seq.: ±0.01 A plus ±3% of setting
- Ground: ±0.001 A plus ±3% of setting (IN < 4.7 A)
±0.010 A plus ±3% of setting (IN ≥ 4.7 A)
- Neutral: ±0.001 A plus ±3% of setting

Transient Overreach: ±5% of pickup

Pickup/Dropout Time: 1.25 cycles

Time Delay Range: 0.00–16,000.00 cycles, 0.25–cycle steps

Time Delay Accuracy: ±0.25 cycle plus ±0.1% of setting

Time-Overcurrent Elements (51)

Current Pickup Range (A Secondary)

- Phase and Neg.-Seq.: 0.05–3.20 A, 0.01 A steps
- Ground: 0.005–3.200 A, 0.001 A steps
- Neutral: 0.005–0.640 A, 0.001 A steps

Steady-State Pickup Accuracy

- Phase and Neg.-Seq.: ±0.01 A plus ±3% of setting
- Ground: ±0.001 A plus ±3% of setting (IN < 4.7 A)
±0.010 A plus ±3% of setting (IN ≥ 4.7 A)
- Neutral: ±0.001 A plus ±3% of setting

Time Dials

- U.S.: 0.5–15.0, 0.01 steps
- IEC: 0.05–1.00, 0.01 steps

Recloser Curves: 0.10–2.00, 0.01 steps

Curve Timing Accuracy: ±1.50 cycles plus ±4% of setting, between 2 and 30 multiples of pickup

Second-Harmonic Blocking Elements

Pickup Range: 5% to 100% of fundamental, 1% steps

Steady-State Pickup Accuracy: 2.5 percentage points

Pickup/Dropout Time: <1.25 cycles

Time Delay: 0.00–16,000.00 cycles, 0.25-cycle steps

Timer Accuracy: ±0.25 cycle and ±0.1% of setting

Undervoltage (27) and Overvoltage (59)

Pickup Ranges (V Secondary)

300 V Maximum Inputs

- Phase: 1.00–300.00 V, 0.01 V steps
- Phase-to-Phase: 1.76–520.00 V, 0.02 V steps
- Sequence: 2.00–300.00 V, 0.02 V steps

8 V LEA Maximum Inputs

- Phase: 0.03–8.00 V[a]
- Phase-to-Phase: 0.05–13.87 V[a]
- Sequence: 0.05–8.00 V[a]

Eaton NOVA LEA Inputs (37 Vac Maximum)

- Phase: 0.12–37.09 V[a]
- Phase-to-Phase: 0.21–64.24 V[a]
- Sequence: 0.25–37.09 V[a]

Lindsey SVMI LEA Inputs (200 Vac Maximum)

- Phase: 1.00–200.00 V
- Phase-to-Phase: 1.76–346.00 V
- Sequence: 2.00–200.00 V

Siemens LEA Inputs (8.49 Vac Maximum)

- Phase: 0.03–8.49 V[a]
- Phase-to-Phase: 0.05–14.72 V[a]
- Sequence: 0.05–8.00 V[a]

Steady-State Pickup Accuracy

300 V Maximum

- Phase: ±0.5 V plus ±1% of setting
- Phase-to-Phase: ±1 V plus ±2% of setting
- Sequence: ±1.5 Vac plus ±3% of setting @ 12.5–300 Vac

8 V LEA Maximum[a]

- Phase: ±10 mV plus ±1% of setting
- Phase-to-Phase: ±20 mV plus ±2% of setting
- Sequence: ±30 mVac plus ±3% of setting @ 0.33–8.00 Vac

Eaton NOVA LEA[a]

- Phase: ±60 mV plus ±1% of setting
- Phase-to-Phase: ±120 mV plus ±2% of setting
- Sequence: ±180 mVac plus ±3% of setting @ 1.55–37.09 Vac

Lindsey SVMI LEA[a]

- Phase: ±0.5 V plus ±1% of setting
- Phase-to-Phase: ±1 V plus ±2% of setting
- Sequence: ±1.5 Vac plus ±3% of setting @ 12.5–200 Vac

Siemens LEA[a]

- Phase: ±10 mV plus ±1% of setting
- Phase-to-Phase: ±20 mV plus ±2% of setting
- Sequence: ±30 mVac plus ±3% of setting @ 0.33–8.49 Vac

Transient Overreach: ±5%

Pickup/Dropout Time: <1.25 cycles

Vector Shift (78VS)

Pickup Range:	2.0–30.0°
Accuracy:	±1.5°, ±10% of setting
Pickup Time:	<3 cycles

Synchronism-Check Elements (25)

Slip Frequency Pickup Range:	0.005–0.500 Hz, 0.001 Hz steps
Slip Frequency Pickup Accuracy:	±0.003 Hz
Phase Angle Range:	0–80°, 0.01° steps
Phase Angle Accuracy:	±4°

Under- and Overfrequency Elements (81)

Frequency Range:	40.00–66.00 Hz, 0.01 Hz steps
Frequency Accuracy:	±0.01 Hz

Cycle-Based Delay Timers

Time Delay Range:	2.00–16,000.00 cycles, 0.25-cycle steps
Time Delay Accuracy:	±0.25 cycle plus ±0.1%

Seconds-Based Delay Timers

Time Delay Range:	0.10–1000.00 s, 0.01s steps
Time Delay Accuracy:	±6 ms plus ±0.1% of setting

Undervoltage Frequency Element Block Range

300 V Inputs:	12.50–300.00 V[a]

Rate-of-Change-of-Frequency Element (81R)

Pickup Range:	0.10–15.00 Hz/s, 0.01 Hz/s steps
Dropout:	95% of pickup
Pickup Accuracy:	±100 mHz/s and ±3.33% of pickup
Pickup/Dropout Time:	See *Equation 4.5* in the *SEL-651R-2 Instruction Manual*
Pickup Time Delay:	0.10–60.00 s, 0.01-second steps
Dropout Time Delay:	0.00–60.00 s, 0.01-second steps
Timer Accuracy:	±6 ms and ±0.1% of setting

Autosynchronizing

Frequency Matching

Speed (Frequency) Control Outputs

Raise:	Digital output, adjustable pulse duration and interval
Lower:	Digital output, adjustable pulse duration and interval

Frequency Synchronism

Timer:	5–3600 s, 1 s increments
Frequency Adjustment Rate:	0.01–10.00 Hz/s, 0.01 Hz/s increment
Frequency Pulse Interval:	1–120 s, 1 s increment
Frequency Pulse Minimum:	0.02–60.00 s, 0.01 s increment
Frequency Pulse Maximum:	0.10–60.00 s, 0.01 s increment
Kick Pulse Interval:	1–120 s, 1 s increments
Kick Pulse Minimum:	0.02–2.00 s, 0.01 s increments
Kick Pulse Maximum:	0.02–2.00 s, 0.01 s increments

Voltage Matching

Voltage Control Outputs

Raise:	Digital output, adjustable pulse duration and interval
Lower:	Digital output, adjustable pulse duration and interval
Voltage Synchronized Timer:	5–3600 s, 1 s increments
Voltage Adjustment Rate (Control System):	0.01–30.00 V/s, 0.01 V/s increment
Voltage Pulse Interval:	1–120 s, 1 s increment
Voltage Control Pulse Minimum:	0.02–60.00 s, 0.01 s increment
Voltage Control Pulse Maximum:	0.10–60.00 s, 0.01 s increment
Timing Accuracy:	±0.5% plus ±1/4 cycle

Power Elements[b]

Minimum Current:	0.01 A
Minimum Voltage:	40 V
Steady-State Pickup Accuracy:	0.58 W plus ±5% of setting at unity power factor
Pickup/Dropout Time:	<3.75 cycles
Time Delay Accuracy:	±0.25 cycle plus ±0.1% of setting

Load Encroachment[b]

Minimum Current:	0.1 A
Minimum Voltage:	12.5 Vac
Forward Load Impedance:	0.5–640.0 Ω secondary
Forward Positive Load Angle:	–90° to +90°
Forward Negative Load Angle:	–90° to +90°
Negative Load Impedance:	0.50–640 Ω secondary
Negative Positive Load Angle:	+90° to +270°
Negative Negative Load Angle:	+90° to +270°

Pickup Accuracy

Impedance:	±3%
Angle:	±2°

SELogic Control Equation Variable Timers

Pickup Ranges

0.00–999,999.00 Cycles:	0.25-cycle steps (programmable timers)
Pickup/Dropout Accuracy:	±0.25 cycle plus ±0.1% of setting

Metering Accuracies

Accuracies specified at 20°C and at nominal system frequency unless noted otherwise.

Instantaneous and Maximum/Minimum Metering

Voltages

VAY, VBY, VCY, VAZ, VBZ, VCZ:	±0.2% (50–300 V), ±0.5° for PTs ±0.2% (0.67–8.00 V), ±0.5° for 8 V LEAs ±0.2% (3.09–37.09 V), ±0.5° for Eaton NOVA LEAs ±0.2% (25–200.00 V), ±0.5° for Lindsey SVMI LEAs ±0.2% (0.71–8.49 V), ±0.5° for Siemens SDR LEAs

VABY, VBCY, VCAY, VABZ, VBCZ, VCAZ:	±0.4% (50–300 V), ±1.0° for PTs ±0.4% (1.16–13.86 V), ±1.0° for 8 V LEAs ±0.4% (5.35–64.28 V), ±1.0° for Eaton NOVA LEAs ±0.4% (43.30–346.41 V), ±1.0° for Lindsey SVMI LEAs ±0.4% (1.22–14.70 V), ±1.0° for Siemens SDR LEAs
3V0Y, V1Y, V2Y, 3V0Z, V1Z, V2Z:	±0.6% (50–300 V), ±1.0° for PTs ±0.6% (0.67–8.00 V), ±1.0° for 8 V LEAs ±0.6% (3.09–37.09 V), ±1.0° for Eaton NOVA LEAs ±0.6% (25.00–200.00 V), ±1.0° for Lindsey SVMI LEAs ±0.6% (0.71–8.49 V), ±1.0° for Siemens SDR LEAs

Currents

IA, IB, IC[c]:	±0.5 mA plus ±0.1% of reading (0.1–2 A), ±0.5°
IN:	±0.08 mA plus ±0.1% of reading (0.005–4.5 A), ±1°
3I1, 3I0, 3I2:	±0.01 A plus ±3% of reading (0.1–2 A), ±1°

Power

Apparent (MVA)

MVAA, MVAB, MVAC, MVA3P:	±1.2% (V_{phase} > 50 Vac[d], I_{phase} > 0.1 A)

Real (MW)

MWA, MWB, MWC, MW3P:	±0.7% @ PF = 1, ±1.0% @ PF > 0.87 (V_{phase} > 50 Vac[d], I_{phase} > 0.1 A)

Reactive (MVAR)

MVARA, MVARB, MVARC, MVAR3P:	±0.7% @ PF = 0, ±1.0% @ PF < 0.50 (V_{phase} >50 Vac[d], I_{phase} > 0.1 A)

Energy

Megawatt Hours (In and Out)

MWhA, MWhB, MWhC, MWh3P:	+1.2% @ PF = 1, (V_{phase} > 50 Vac[d], I_{phase} > 0.1 A)

Megavar Hours (In and Out)

MVARhA, MVARhB, MVARhC, MVARh3P:	+1.2% @ PF = 0, (V_{phase} > 50 Vac[d], I_{phase} > 0.1 A)

Demand Metering

Currents

IA, IB, IC:	±0.25% (0.1–2 A)
IN (Measured):	±0.25% (0.005–4.5 A)
3I2, 3I0 (IG):	±3% ± 0.01 A, (0.1–20.0 A)

Synchrophasor Accuracy

Maximum Data Rate in Messages per Second

IEEE C37.118 Protocol:	60 (nominal 60 Hz system) 50 (nominal 50 Hz system)
SEL Fast Message Protocol:	1
IEEE C37.118-2005 Accuracy:	Level 1 at maximum message rate when phasor has the same frequency as A-phase voltage, frequency-based phasor compensation is enabled (PHCOMP := Y), and the narrow band filter is selected (PMAPP := N). Out-of-band interfering frequency (Fs) test, 10 Hz ≤ Fs ≤ (2 • NFREQ).
Current Range:	(0.2–2.0) • I_{nom} (I_{nom} = 1 A phase, 0.2 A neutral)
Frequency Range:	±5 Hz of nominal (50 or 60 Hz)
Voltage Range:	30–250 V for PTs 0.8–8.0 V for 8 V LEA inputs 3.71–37.09 V for Eaton NOVA LEA inputs 30–300 V for Lindsey SVMI LEA inputs 0.85–8.49 V for Siemens SDR LEA inputs
Phase Angle Range:	–179.99° to +180.00°

Harmonic Metering

Voltages

VAY, VBY, VCY, VAZ, VBZ, VCZ:	Accuracies valid for THD <100%, 30 V < fundamental < 200 V sec, 50 Hz or 60 Hz
Fundamental Magnitude:	±5%
02–16 Harmonic Percentage:	±5 percentage points[e]

Currents

IA, IB, IC:	Accuracies valid for THD < 100%, fundamental voltage < 200 V, 50 Hz or 60 Hz
1 A and 0.2 A Nominal:	0.02 A < fundamental current < 1 A sec
Fundamental Magnitude:	±5%
02–16 Harmonic Percentage:	±5 percentage points[e]

RMS Metering

Voltages

VAY, VBY, VCY, VAZ, VBZ, VCZ:	±1.2% V_{phase} > 50 Vac[d] for PTs

Currents

IA, IB, IC:	±0.5 mA plus ±0.2% (0.1–2.0 A)
IN (Measured):	±0.08 mA plus ±0.20% (0.005–4.500 A)

Average Real Power (MW)

MWA, MWB, MWC, MW3P:	±2.0% @ PF = 1 (V_{phase} > 50 Vac[c], I_{phase} > 0.1 A)

Type Tests

Recloser Type Tests

IEEE C37.60-2003, Section 6.13 Control Electronic Elements Surge Withstand Capability (SWC) Tests

6.13.1 Oscillatory and fast transient surge tests (a control-only test, performed in accordance with IEEE C37.90.1-2002)

6.13.2 Simulated surge arrester operation test (performed with the control connected to the following reclosers)

G&W Viper-ST:	27 kV, 12.5 kA interrupting, 800 A continuous 38 kV, 12.5 kA interrupting, 800 A continuous
ABB Elastimold MVR:	15/17 kV, 12.5 kA interrupting, 800 A continuous 38 kV, 12.5 kA interrupting, 800 A continuous
Eaton NOVA:	27 kV, 12.5 kA interrupting, 630 A continuous
Eaton Recloser Type “WVE-27”:	38 kV, 8 kA interrupting, 560 A continuous
ABB OVR-3:	27 kV, 12.5 kA interrupting, 630 A continuous
Eaton NOVA-TS:	15.5 kV, 8 kA interrupting, 400 A continuous
Eaton NOVA (Control Powered):	27 kV, 12.5 kA interrupting, 630 A continuous

Tavrida OSM Al_2: 27 kV, 12.5 kA interrupting, 600 A continuous

Tavrida OSM Al_4: 27 kV, 12.5 kA interrupting, 600 A continuous

IEC 62271-111:2012/IEEE C37.60-2012, Section 6.111 Control Electronic Elements Surge Withstand Capability (SWC) Tests

6.111.2 Oscillatory and fast transient surge tests

6.111.3 Simulated surge arrester operation test

Both performed with the control connected to the following reclosers:

G&W Electric Viper-ST, Solid Dielectric

Voltage Rating: 38 kV

Current Break Rating: 12.5 kA

Continuous Current Rating: 800 A

Eaton Type NOVA 15, Aux. Power

Voltage Rating: 15.5 kV

Current Break Rating: 12.5 kA

Continuous Current Rating: 630 A

Tavrida OSM25_Al_2(630_150_2)

Voltage Rating: 27 kV

Current Break Rating: 12.5 kA

Continuous Current Rating: 630 A

ABB OVR/Gridshield TS Recloser (32-Pin)

Voltage Rating: 27 kV

Current Break Rating: 12.5 kA

Continuous Current Rating: 1000 A

Electromagnetic Compatibility Emissions[f]

Radiated and Conducted Emissions:
EN/IEC 60255-26:2013, Section 7.1
CISPR 22:2008
EN 55022:2010 + AC:2011
CISPR 11:2009 + A1:2010
EN 55011:2009 + A1:2010
FCC 47 CFR:2014, Part 15.107
FCC 47 CFR:2014, Part 15.109
Severity Level: Class A

Electromagnetic Compatibility Immunity[f]

Radiated RF Immunity:
EN/IEC 60255-26:2013, Section 7.2.4
IEC 61000-4-3:2006 + A1:2007 + A2:2010
EN 61000-4-3:2006 + A1:2008 + A2:2010
Severity Level: 10 V/m
IEEE C37.90.2-2004
Severity Level:
20 V/m (average)
35 V/m (peak)

Conducted RF Immunity:
EN/IEC 60255-26:2013, Section 7.2.8
IEC 61000-4-6:2008
EN 61000-4-6:2009
Severity Level: 10 Vrms

Electrostatic Discharge Immunity:
EN/IEC 60255-26:2013, Section 7.2.3
IEC 61000-4-2:2008
Levels 2, 4, 6, and 8 kV contact;
Levels 2, 4, 8, and 15 kV air
IEEE C37.90.3-2001
Levels 2, 4, and 8 kV contact;
Levels 4, 8, and 15 kV air

Electrical Fast Transient Burst Immunity:
EN/IEC 60255-26:2013, Section 7.2.5
EN/IEC 61000-4-4:2012
4 kV, 5 kHz on power supply, I/O, and ground
2 kV, 5 kHz on communications ports

Surge Immunity[g, h]:
EN/IEC 60255-26:2013, Section 7.2.7
Severity Level: Zone A
Severity Level: Zone B on IRIG-B
IEC 61000-4-5:2005
EN 61000-4-5:2006
Severity Level 4:
2 kV line-to-line
4 kV line-to-earth
Severity Level 3 on IRIG-B:
2 kV line-to-earth

Surge Withstand Capability:
EN/IEC 60255-26:2013, Section 7.2.6
IEC 61000-4-18:2006 + A1:2010
EN 61000-4-18:2007 + A1:2010
Severity Level:
Power supply and I/O
2.5 kV common mode
1.0 kV differential mode
Communications ports
1.0 kV common mode
IEEE C37.90.1-2012
2.5 kV oscillatory
4.0 kV fast transient

Environmental

Cold[f]:
IEC 60068-2-1:2007
Test Ad: 16 hours at –40°C

Damp Heat, Cyclic[f]:
IEC 60068-2-30:2005
Test Db: 25° to 55°C, 6 cycles, Relative Humidity: 95%

Dry Heat[f]:
IEC 60068-2-2:2007
Test Bd: Dry heat, 16 hours at +85°C

Vibration[f]:
IEC 60255-21-1:1988
EN 60255-21-1:1995
Severity Level:
Endurance Class 1
Response Class 2
IEC 60255-21-2:1988
EN 60255-21-2:1995
Severity Level:
Shock Withstand, Bump Class 1
Shock Response Class 2
IEC 60255-21-3:1993
EN 60255-21-3:1995
Severity Level:
Quake Response Class 2

Enclosure Ingress Protection[i]:
IEC 60529:2001 + CRGD:2003
[BS EN 60529 Second Edition—1992 + REAF:2004]
IP45

Safety[f]

Insulation Coordination

IEC 60255-27:2013, Section 10.6.4
EN 60255-27:2014, Section 10.6.4
IEEE C37.90-2005, Section 8

Severity Level—HiPot:
2.5 kVac on optoisolated inputs, contact outputs, CTs, and PTs
0.75 kVdc on IRIG-B, EIA-485, and Ethernet ports
3.6 kVdc on power supply
Type tested for one minute

Severity Level—Impulse:
5.0 kV on optoisolated inputs, contact outputs, CTs, PTs, and power supply
0.8 kV on IRIG-B, EIA-485, and Ethernet ports

[a] See Section 9: Settings in the SEL-651R-2 Instruction Manual for details on how to set voltage elements when using LEA inputs.

[b] Voltage, Power, and Impedance values listed for 300 Vbase (PT) inputs.

[c] Accuracies specified with balanced phase voltages at 120 Vac.

[d] Voltage threshold for given accuracy is 0.67 Vac for 8 V LEA inputs, 1.70 Vac for Eaton NOVA LEA inputs, 14.00 Vac for Lindsey SVMI LEA inputs, and 0.60 Vac for Siemens SDR LEA inputs.

[e] For example, for a particular harmonic value applied at 10% of fundamental, the harmonic value meters in the range of 5% to 15%.

[f] SEL enclosure excluded from test.

[g] Serial cable (non-fiber) lengths assumed to be <3 m.

[h] The following pickup/dropout delays are used:
Under- and overvoltage elements: 0.0/0.0 cycles
(Eaton NOVA and Lindsey LEAs required 6.0/6.0 cycles)
Phase instantaneous overcurrent elements: 0.5/1.0 cycles
Neutral instantaneous overcurrent elements: 0.0/4.0 cycles
Digital inputs: 0.5/0.5 cycles

[i] SEL enclosure included in test.

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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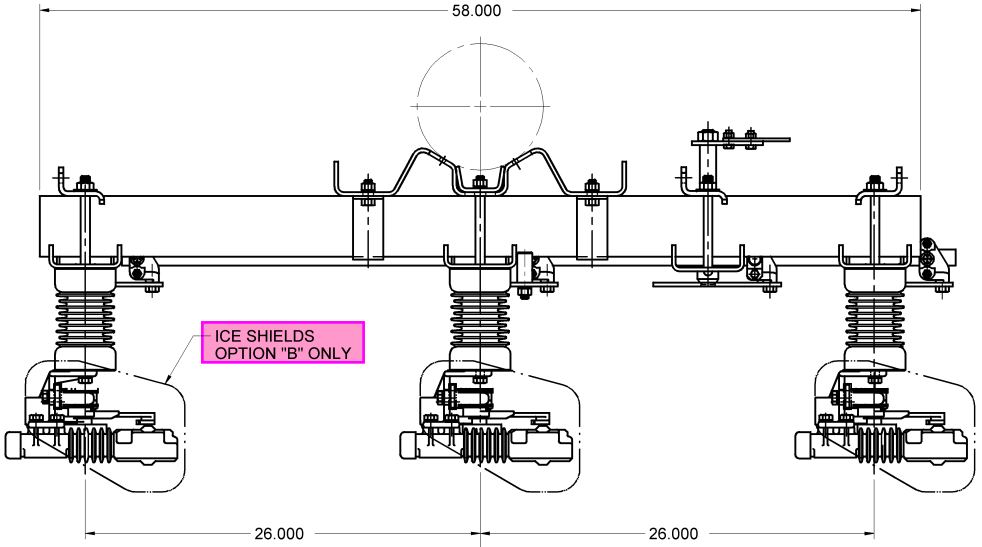
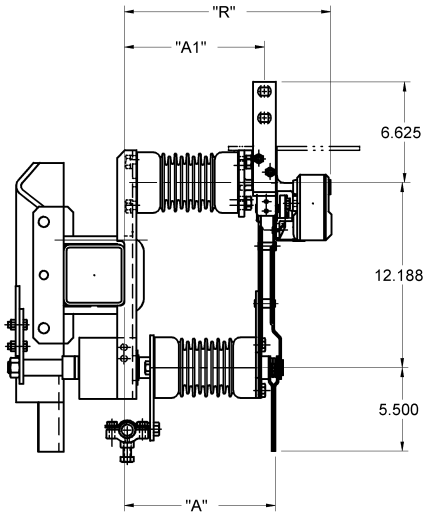
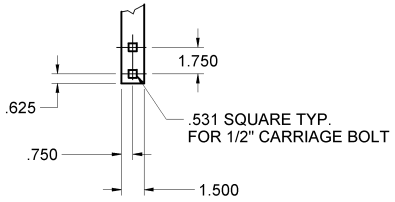
PDS651R-02

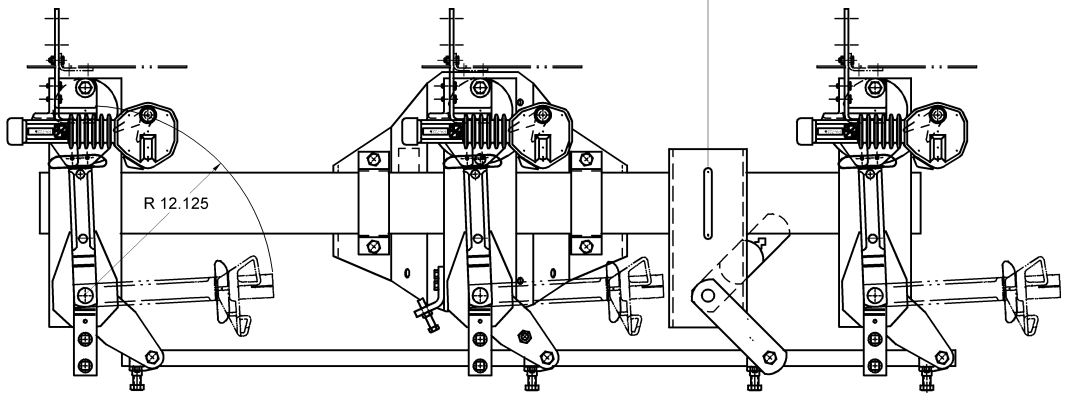
CATALOG NUMBER		INSULATOR TYPE	"A"	"A1"	"R"
STEEL BASE	INSULATED BASE				
147512	147532	CYPOXY	10.000	9.188	13.812
147512-Z3	147532-Z3	CYPOXY	13.250	12.438	17.062
147512-SP	147532-SP	PORCELAIN	13.250	12.438	17.062
147512-SP-Z2	147532-SP-Z2	PORCELAIN	10.750	9.938	14.562
147512-SP-Z3	147532-SP-Z3	PORCELAIN	17.250	16.438	21.062
147512-K	147532-K	SILICONE	13.250	12.438	17.062
147512-K-Z3	147532-K-Z3	SILICONE	17.250	16.438	21.062







TERMINAL PAD DETAIL (TYP)



NAMEPLATE DATA

CATALOG NO.	SEE TABLE
KV.-NOM.-MAX.-BIL.	14.4-17.0-110
AMP. CONT.	900
AMP. MOMENTARY	40,000
AMP. INTERR. WHEN SWITCHING	
PARALLEL CIRCUITS	900
LOAD	900
CABLE	SEE PRICE SHEET 765

* BASIC CATALOG NO'S ARE SHOWN (REVISIONS AND SUFFIX NO'S ARE OMITED)

UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMS TO BE: ±
ANGLES TO BE: ±
WHEN CHECKED, BREAK ALL CORNERS ☐
WHEN CHECKED, REMOVE ALL BURRS ☐

MATERIAL: NONE
FINISH: NONE

DRAWING NO. 1475X2-DIM SE

REVISIONS

NO.	NOTICE NO.	DATE	REV BY
000	SC523381	7/22/2008	DP

DRAWING SIZE: C
DRAWN BY: PETROVID
SCALE: NONE
ORIGINATION DATE: 7/22/2008
USED ON
NEXT ASSEMBLY: ED'S
PRODUCT DESCRIPTION: OMNI-RUPTER

S&C ELECTRIC COMPANY
Excellence Through Innovation

DESCRIPTION
S & C OMNI-RUPTER SWITCH-OUTDOOR DISTRIBUTION THRE-POLE SIDE-BREAK INTEGER STYLE-VERTICAL MOUNTING CKLOCKWISE OPENING (14.4KV)

SHEET 1 OF 1
CATALOG DIMENSIONAL
DRAWING NO. SE
1475X2-DIM

TABLE I

CATALOG NUMBER *	STANDARD MOUNTING ARRANGEMENT (ED)	SWITCH BASE TYPE	RATING NOM. (kV)	RATING MAX. (kV)	RATING CONTINUOUS & INTERRUPTING (AMPERES,RMS)	RATING PEAK- WITHSTAND (AMPERES)	DIMENSIONS IN INCHES C	DIMENSIONS IN INCHES D
147512	ED-703	STEEL	14.4	17.0	900	65000	26	58
147513			25.0	29.0			33	75
147532	ED-713	INSULATED	14.4	17.0			26	58
147533			25.0	29.0			33	75

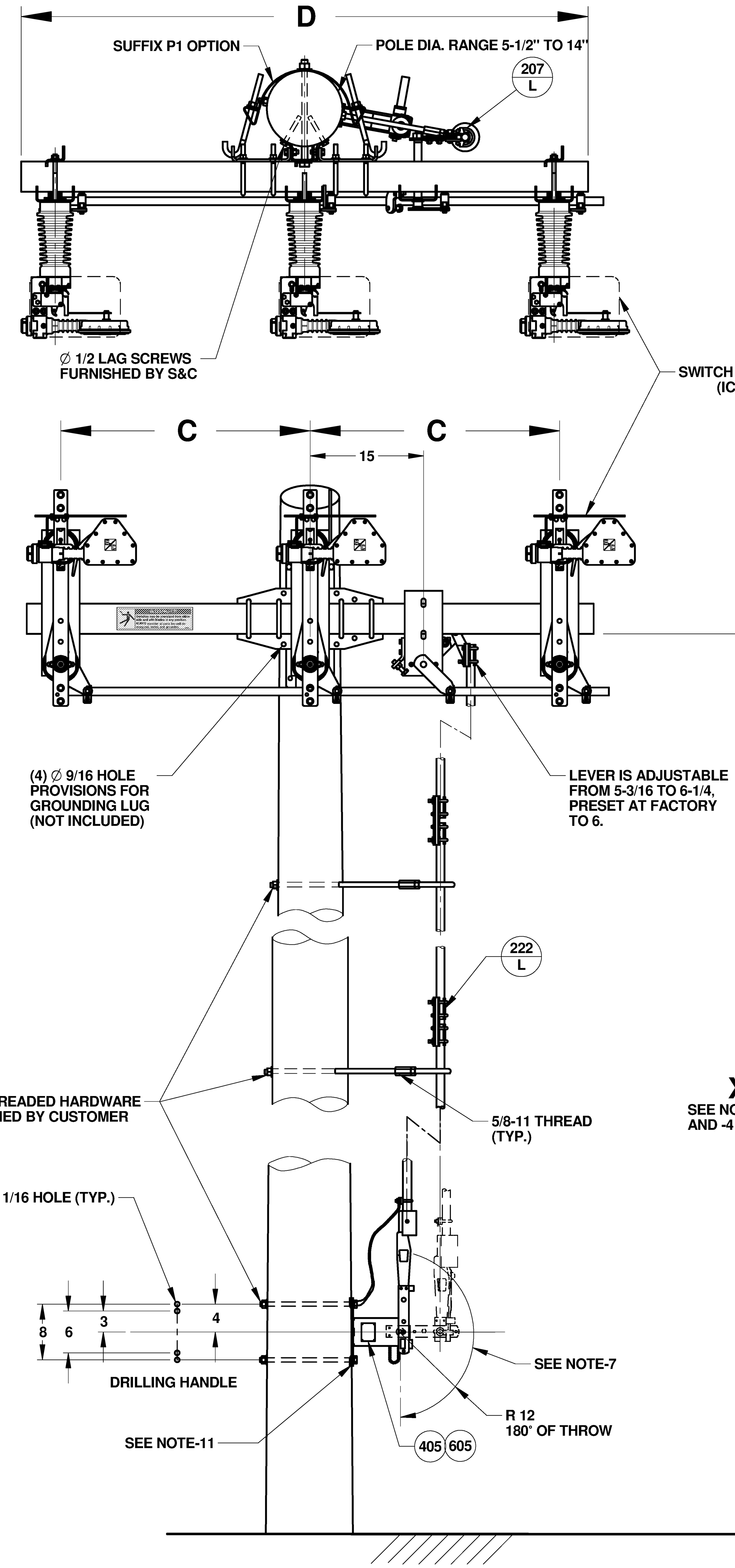
* BASE CATALOG AND STANDARD MOUNTING ARRANGEMENT (ED) NUMBERS ARE SHOWN (SUFFIXES ARE OMITTED)

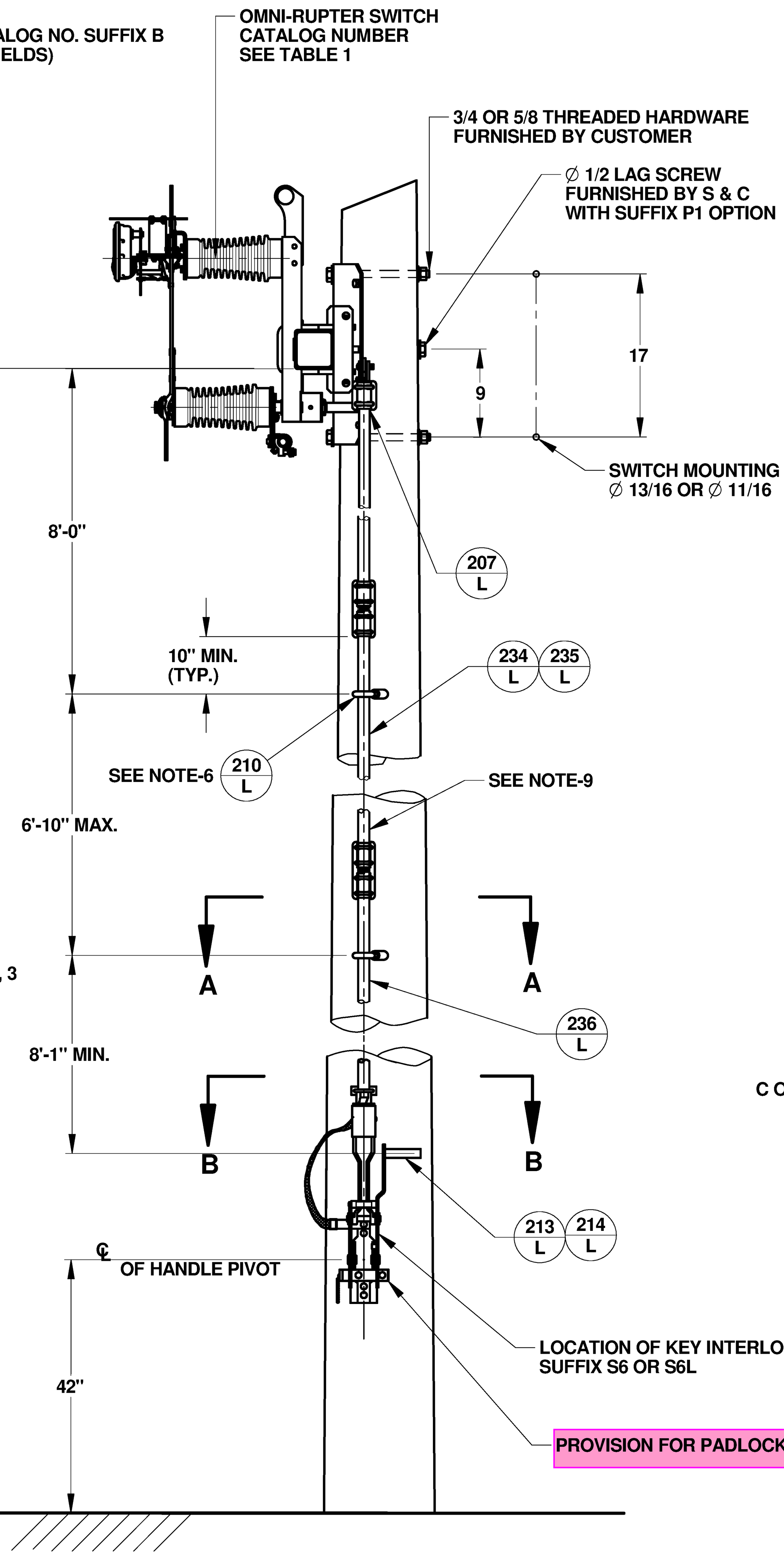
NOTES FOR NO SUFFIX S2, S6, S6L & S10. SEE SHEET-2 FOR S15.

1. WHEN THE OPERATING HANDLE IS INSTALLED AT THE RECOMMENDED HEIGHT OF 42”, THE MAXIMUM SWITCH MOUNTING HEIGHT (X) IS 52’-8” PARTS FURNISHED WITH THIS ED WILL ALLOW A HEIGHT (X) 0F 32’-1”.
2. FOUR LENGTHS OF 3/4 IPS PIPE (ITEM 235 & 236) ARE PROVIDED FOR FIELD ASSEMBLY. THE LOWER PIPE LENGTH (ITEM 236) IS THREADED ON ONE END TO ACCOMMODATE THE OPERATING HANDLE. DO NOT CUT THIS END. THE OTHER THREE LENGTHS CAN BE CUT TO SUIT.
3. WHEN THE DISTANCE “X” IS BETWEEN 25’-4” AND 32’-1”, USE ADDITIONAL STRAIGHT COUPLING, ROD GUIDES AND PIPE LENGTHS PROVIDED.
4. WHEN THE DISTANCE “X” IS BETWEEN 32’-1” AND 52’-8”, ADDITIONAL STRAIGHT COUPLINGS, ROD GUIDES AND PIPE LENGTHS ARE REQUIRED. THESE PARTS ARE NOT INCLUDED WITH THIS STANDARD ED & MUST BE ORDERED SEPARATELY.
5. WITH OMNI-RUPTER SWITCH CLOSED ASSEMBLE COMPLETE VERTICAL PIPE INCLUDIING COUPLINGS, ROD GUIDES AND OPERATING HANDLE. WITH THE VERTICAL PIPE ACTING AS A PLUMB LINE, LOCATE HANDLE RADIALLY TO THE POLE PER SECTION B-B AND DRILL THRU HOLES FOR 5/8 DIA. HARDWARE.
6. LOCATE THE UPPERMOST ROD GUIDE 8’-0” BELOW THE UNDERSIDE OF SWITCH CROSSARM. LOCATE THE LOWEST ROD GUIDE AT LEAST 8’-1” ABOVE THE OPERATING HANDLE PVOT. DISTRIBUTE ANY ADDITIONAL ROD GUIDES UNIFORMLY AT INTERVALS OF 6’-10” MAXIMUM. ALSO MAINTAIN AT LEAST 10 INCHES CLEARANCE BETWEEN THE UPPER EDGE OF EACH ROD GUIDE AND THE LOWER EDGE OF THE STRAIGHT COUPLING IMMEDIATELY ABOVE. DRILL HOLES FOR 5/8 DIA. HARDWARE FOR ROD GUDES ON A LINE PROJECTED THRU THE CENTER OF THE POLE AND VERTICAL PIPE.
7. FOR PROPER SETTING OF ROD GUIDES, MOVE RECIPROCATING HANDLE TO MID POSITION AS SHOWN DOTTED, AND TEMPORARILY SECURE WITH HARDWARE WITH HANDLE IN MID POSITION, ADJUST ROD GUIDE DISTANCE FROM FACE OF POLE, SO THE PIPE IS CENTRALLY LOCATED IN EACH LOOP. CUSTOMER MUST USE PROPER LENGTH THREADED ROD TO ACHIEVE THIS CONDITION. RECHECK HANDLE TOGGLE PER INSTRUCTION SHEET.
8. SEE RD-7397 FOR CONSTRUCTION INFORMATION OF STANDARD MINOR MODIFICATION.
9. RECOMMENDED LOCATION OF INSULATOR AND/OR FIBERGLASS SECTION WHEN SUFFIX S2 AND/OR S10 ARE SPECIFIED.
10. KEY INTERLOCK ADDED TO HANDLE WHEN SUFFIX S6 IS SPECIFIED.
11. USE SPACER PROVIDED WITH OPERATING HANDLE WHEN HANDLE IS MOUNTED ON A FLAT SURFACE.

TABLE II

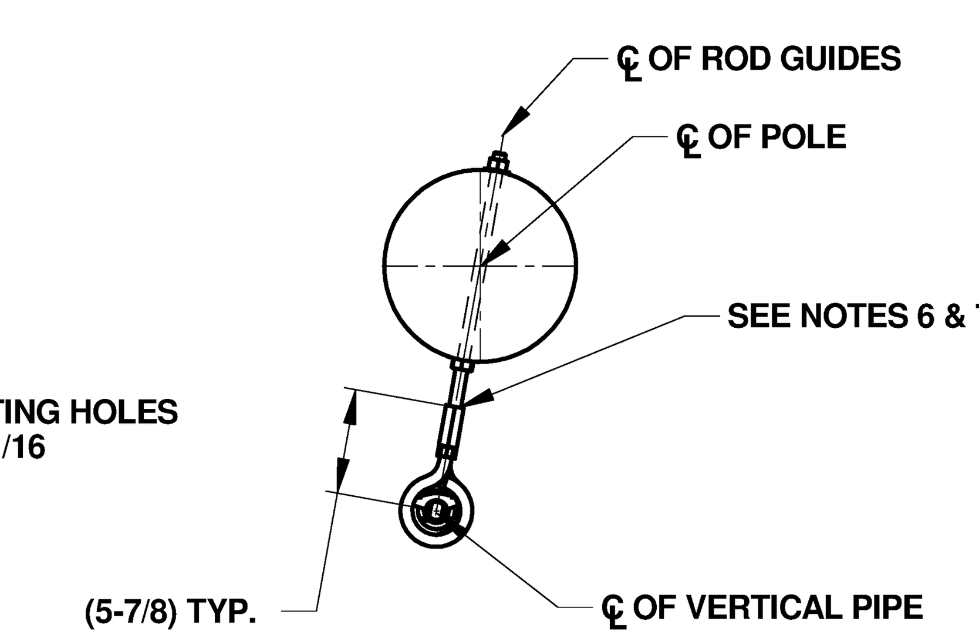
SWITCH CATALOG SUFFIX OPTIONS	
B	ICE SHIELDS
C	HARSH ENVIRONMENT CONTACTS
K	SILICONE INSULATOR AT RATED VOLTAGE CLASS
K-Z3	OVER INSULATED SILICONE INSULATOR
L71	INTERNATIONAL CRATING
L72	ENCLOSED INTERNATIONAL CRATE
P1	POLE BAND & J-BOLT
P2	PROVISIONS FOR POLE BAND & J-BOLT
SP	PORCELAIN INSULTORS
SP-Z2	UNDER INSULATED PORCELAIN INSULTORS
SP-Z3	OVER INSULATED PORCELAIN INSULTORS
Z2	UNDER INSULATED CYPOXY INSULTORS
Z3	OVER INSULATED CYPOXY INSULTORS
STANDARD MOUNTING ARRANGEMENT SUFFIX OPTIONS	
S2	CYPOXY INSULATOR UNIT
S6	KEY INTERLOCK
S6L	PROVISIONS FOR LOCK
S10	FIBERGLASS INSULATING SECTION
S15	HEAVY-DUTY VERTICAL OPERATING SHAFT
V1	1 PIPE SECTION, COUPLING & GUIDE BRACKET
V2	2 PIPE SECTIONS, COUPLINGS & GUIDE BRACKETS
V3	3 PIPE SECTIONS, COUPLINGS & GUIDE BRACKETS



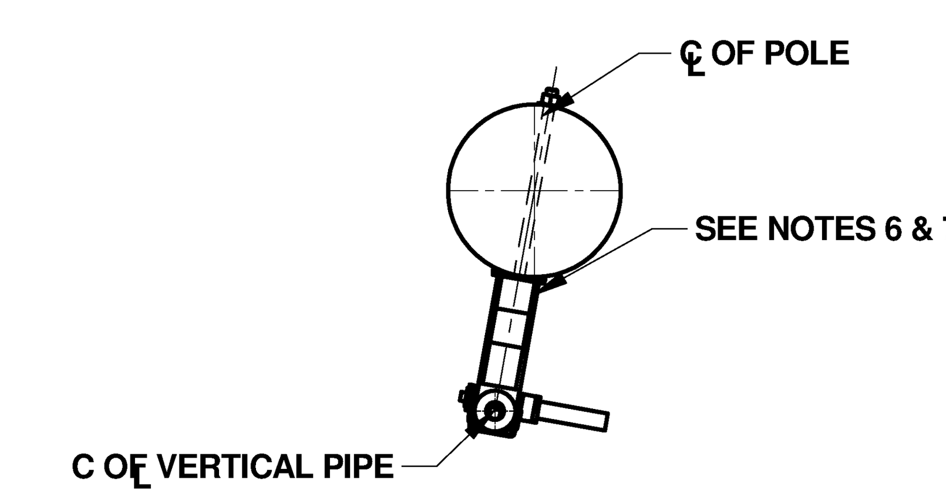


ROD GUIDE ARRANGEMENT FOR THREE SECTIONS OF VERTICAL OPERATING SHAFT

L "L" SIGNIFIES SHIPPED LOOSE ITEMS



SECTION A-A



SECTION B-B

25 kV SWITCH SHOWN

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED.

REVISIONS

NO.	NOTICE NO.	DATE	REV BY
000	SC544037	6/18/2011	SP
001	SC544503	6/23/2011	SP
002	SC555407	10/15/2012	DP
003	SC556118	11/8/2012	DP
004	SC556580	12/10/2012	RFS
005	SC561002	5/29/2013	DP
006	SC564148	10/10/2013	DP

⚠ WARNING

THE EQUIPMENT COVERED BY THIS PUBLICATION MUST BE INSTALLED, OPERATED, AND MAINTAINED BY QUALIFIED PERSONS WHO ARE KNOWLEDGEABLE IN THE INSTALLATION, OPERATION, AND MAINTENANCE OF OVERHEAD ELECTRIC POWER DISTRIBUTION EQUIPMENT ALONG WITH ASSOCIATED HAZARDS.

THESE INSTUCTIONS ARE INTENDED ONLY FOR SUCH QUALIFIED PERSONS. THEY ARE NOT INTENDED TO BE A SUBSTITUTE FOR ADEQUATE TRAINING AND EXPERIENCE IN SAFETY PROCEDURES FOR THIS TYPE OF EQUIPMENT.

⚠ CAUTION

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DRAWING NO. ED-7X3R4 SE

MATERIAL:

FINISH:

DRAWING SIZE: D | DRAWN BY: PINZARIS
SCALE: | ORIGINATION DATE: 6/7/2005
USED ON
NEXT ASSEMBLY: -------
PRODUCT DESCRIPTION: OMNI-RUPTER

S&C ELECTRIC COMPANY
Excellence Through Innovation

DESCRIPTION
STANDARD MOUNTING ARRANGEMENT OMNI-RUPTER VERTICAL SWITCH WITH RECIPROCATING TYPE OPERATING MECHANISMTHREE-POLE STYLE CLOCKWISE OPENING

SHEET 1 OF 2

ERECTION DRAWING

DRAWING NO. ED-7X3R4 SE

REVISIONS			
NO.	NOTICE NO.	DATE	REVBY
000	SC544037	6/18/2011	SP
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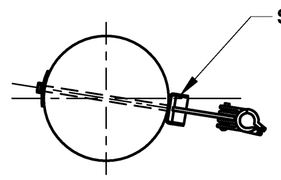
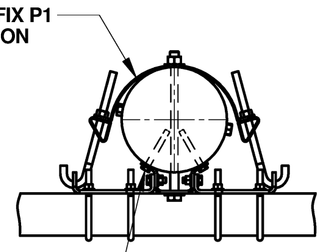
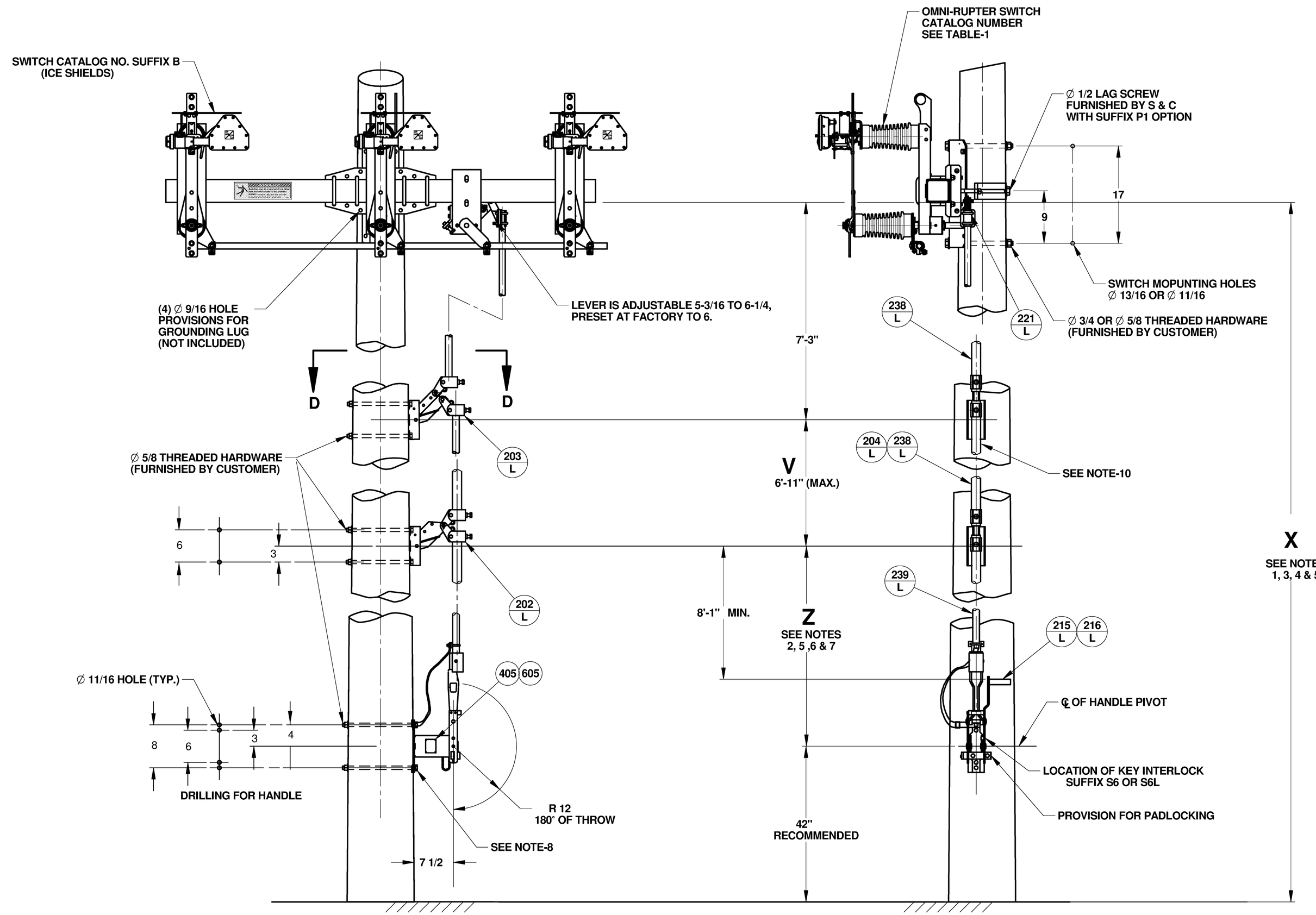


SECTION D-D



NOTES FOR SUFFIX S15

1. WHEN THE OPERATING HANDLE IS INSTALLED AT THE RECOMMENDED HEIGHT OF 42", THE MAXIMUM SWITCH MOUNTING HEIGHT (X) IS 52'-11" PARTS FURNISHED WITH THIS ED WILL ALLOW A HEIGHT (X) 0F 32'-2".
2. FOUR LENGTHS OF 1-1/4 IPS PIPE (ITEM 238 & 239) ARE PROVIDED FOR FIELD ASSEMBLY. THE LOWER PIPE LENGTH (ITEM 239) IS THREADED ON ONE END TO ACCOMMODATE THE OPERATING HANDLE. DO NOT CUT THIS END. THE OTHER THREE LENGTHS CAN BE SHORTENED TO SUIT.
   CUTTING LENGTHS ARE AS FOLLOWS:
   FOR INTERMEDIATE PIPE SECTIONS (ITEM 238), LENGTH=V MINUS 1"
   FOR LOWER PIPE SECTION (ITEM 239), LENGTH=Z MINUS 10"
3. WHEN THE DISTANCE "X" IS BETWEEN 25'-3" AND 32'-2", USE ADDITIONAL ROD GUIDE (ITEM 202) AND PIPE LENGTH PROVIDED.
4. WHEN THE DISTANCE "X" IS BETWEEN 32'-2" AND 52'-11", ADDITIONAL ROD GUIDES AND PIPE LENGTHS ARE REQUIRED. THESE PARTS ARE NOT INCLUDED WITH THIS STANDARD ED & MUST BE ORDERED SEPARATELY.
5. WHEN THE PIPE IS TO BE FACTORY CUT, THE X, V AND Z DIMENSIONS MUST BE SUPPLIED WITH ORDER.
6. WITH OMNI-RUPTER CLOSED, ASSEMBLE THE UPPERMOST PIPE SECTION TO SWITCH LEVER. WITH THE PIPE ACTING AS A PLUMB LINE, LOCATE THE UPPER ROD GUIDE RADIALLY TO THE PIPE PER SECTION D-D AND 7'-3" BELOW THE SWITCH CROSS ARM. DRILL THRU HOLES FOR 5/8 HARDWARE FOR THE ROD GUIDE ON A LINE PROJECTED THRU THE CENTER OF THE POLE AND THE VERTICAL PIPE.
7. REPEAT STEP 6 FOR INTERMEDIATE ROD GUIDES AND OPERATING HANDLE. LOCATE THE LOWEST ROD GUIDE 8'-1" ABOVE THE TOP OF THE OPERATING HANDLE IN THE HIGHEST POSITION AND DISTRIBUTE BALANCE OF ROD GUIDES UNIFORMLY AT INTERVALS OF 6'-11" MAXIMUM. DRILL THRU HOLES AS IN STEP 5.
8. USE SPACER PROVIDED WITH OPERATING HANDLE WHEN HANDLE IS MOUNTED ON A FLAT SURFACE.
9. SEE RD-7397 FOR CONSTRUCTION INFORMATION OF STANDARD MINOR MODIFICATION.
10. RECOMMENDED LOCATION OF INSULATOR WHEN SUFFIX S2 IS SPECIFIED.
11. KEY INTERLOCK ADDED TO HANDLE WHEN SUFFIX S6 IS SPECIFIED.



L — "L" SIGNIFIES SHIPPED LOOSE ITEMS

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED.

25 kV SWITCH SHOWN

SUFFIX "S15" MOUNTING ARRANGEMENT

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MATERIAL | FINISH

PROPRIETARY STATEMENT

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D	PINZARIS
SCALE	ORIGINATION DATE
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USED ON	
NEXT ASSEMBLY	

PRODUCT DESCRIPTION	
OMNI-RUPTER	

S&C ELECTRIC COMPANY
Excellence Through Innovation

DESCRIPTION
STANDARD MOUNTING ARRANGEMENT OMNI-RUPTER VERTICAL SWITCH WITH RECIPROCATING TYPE OPERATING MECHANISMTHREE-POLE STYLE CLOCKWISE OPENING

SHEET 2 OF 2
ERECTION DRAWING
DRAWING NO. ED-7X3R4 SE