

Proposed Large-Scale Ground-Mounted Solar Photovoltaic Installation

0 Locust Street & 0 George D. Williams Lot
Freetown, MA

PREPARED FOR

Freetown East PV I, LLC
330 Congress Street, 6th Floor
Boston, MA 02210
617.377.4301

PREPARED BY



101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

April 8, 2022

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1

Site Plan Review Application

Completed Form SPR – Application for Site Plan Review
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**PLANNING BOARD
TOWN OF FREETOWN, MASSACHUSETTS
FORM SPR - APPLICATION FOR SITE PLAN REVIEW**

Checklist for Applicants:

The following must be included with all applications for site plan review:

- 1) Three copies of this form, a copy of the deed to the property, and if the application is submitted by anyone other than the owner, a letter signed in the presence of a notary public authorizing the applicant to act on their behalf. **See signed and notarized authorization letter provided herewith.**
- 2) 12 copies of the plan prepared in accordance with the Town of Freetown Subdivision Rules and Regulations and the Town of Freetown Site Plan Review Regulations. All plan copies must be folded.
- 3) An application fee according to the fee schedule payable to the Town of Freetown. Applicant shall also be responsible for costs associated with advertising and certified mailing of public hearing notices.
- 4) A PDF electronic file of the plan on a CD including any drainage calculations, Development Impact Statements, or Traffic Studies.
- 5) A Municipal Lien Certificate
- 6) A certified abutters list from the Town of Freetown Board of Assessors.
- 7) Engineering Review deposit
- 8) Zoning Determination from the Zoning Enforcement Officer/Building Commissioner

To the Town Clerk of the Town of Freetown Massachusetts:

The undersigned hereby submits the accompanying Special Permit Application and supporting documents for Special Permit Approval under the Rules and Regulations of the Planning Board adopted hereunder.

1. **Applicant:** Freetown East PV I, LLC Tel:(617) 377-4301
Address:330 Congress St 6th Floor, Boston, MA 02210
2. **Attorney:** Elizabeth F. Mason, Esq., Klavens Law Group, P.C. Tel:617-502-6286
Address: 20 Park Plaza, #402, Boston, MA 02116
3. **Owner:** Capital Funding Services LLC Tel: 508-245-2811

Address: 3129 County Street, Somerset, MA 02726

4. **Designer:** VHB Tel:(617) 924-1770

Address: 101 Walnut Street PO Box 9151, Watertown, MA 02471

5. **Plan Entitled:** Proposed Large-Scale Ground-Mounted Solar Photovoltaic Installation

6. **Plan Dated:** April 8, 2022

7. **Project Location:** Freetown, MA

Address: 0 Locust Street and 0 George D. Williams Lot, Freetown, MA

8. **Assessor Map/Parcel No.** Map 206, Parcels 49.01 and 43 (Parcel IDs 206-49.01-0 and 206-43-0)

Zoning District: Residential (Parcel No. 49.01), General Use (Parcel No. 43)

9. **Lot Area:** 52.6 acres (total) **Number of Lots Proposed:** 2

Lot 1A:

Total Acreage of Tract 51.0 acres **Total Percentage of Lot Coverage Proposed:** 13.7%

Lot 1B:

Total Acreage of Tract 1.6 acres **Total Percentage of Lot Coverage Proposed:** 15.0%

10. **Total Square Footage of Existing Structures:** 0

Total Square Footage of Proposed Structures: 314,846

Combined Square Footage of Existing and Proposed Structures: 314,846

11. **Total Number of Parking Spaces (Existing):** 0

Total Number of Regular Parking Spaces Proposed: 0

Total Number of Handicapped Parking Spaces Proposed: 0

Total Number of Spaces for Deliveries Proposed: 0

12. **Detailed Description of Project (use additional pages as added)**

The Applicant is proposing to construct a Large-Scale Ground-Mounted Solar Photovoltaic Installation (the Project) located at 0 Locust Street and 0 George D. Williams Lot in Freetown, Massachusetts. As proposed, the Project consists of approximately 7.2 acres of solar panels, utility infrastructure, access road, fencing, and related amenities to support this use. See attached narrative for additional information.

13. For Parcel 49.01: Deed of Property Recorded in Bristol County Fall River District Registry of Deeds in Book 10958, Page 298-300. For Parcel 43: in Book 10963, Page 76-78.

14. **Estimated Cost of Construction:** TBD **Type:** new reconstruction alteration

15. **Application Fee – based on fee schedule:** \$500

To: Board of Health, Conservation Commission, Planning/Land Use Administrator, Building Inspector, Highway Department, Fire Department, and Police Department.

According to the Special Permit Regulations in the Town of Freetown Protective By-Laws, you have the option to examine and to make recommendations on this plan and to submit your report to the Planning Board office on or before _____ (35 days from date of transmittal by the Town Clerk). Recommendations may be indicated directly on the attached plan or on separate cover.

The property owner of record should be present when submitting plans for the Planning Board's consideration. If the owner is not present, he or she shall be represented by an authorized agent with aw notarized letter of authorization. All plans must be prepared and endorsed by a Professional Land Surveyor, licensed in the Commonwealth of Massachusetts.

Owner's signature and address if not the applicant or applicant's authorization if not the owner

Owner's Signature

Owner's Address

Owner's Printed Name

Owner's Phone Number

330 Congress Street, 6th Floor, Boston, MA 02210

Applicant's Signature

Freetown East PV I, LLC

Applicant's Address

617.377.4301

Applicant's Printed Name

contracts@longroadenergy.com

Lindsey.Kester@longroadenergy.com

Applicant's Phone Number

Applicant's E-Mail Address

Owner's E-Mail Address

REPLACE WITH ORIGINAL
SIGNATURE PAGE (FROM
SARAH)

Bristol, _____, 20__

On this _____ day of _____, 200 , before me, the undersigned Notary Public, personally

appeared _____ and

proved to me through satisfactory evidence of identification, which is _____, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that they signed it voluntarily for its stated purpose.

Notary Public
My Commission Expires:

Date Received by Town Clerk:

RECEIVED BY TOWN CLERK
DATE: _____
TIME _____
SIGNATURE _____

REPLACE WITH ORIGINAL
SIGNATURE PAGE (FROM
SARAH)

April __, 2022

Freetown Planning Board
3 North Main Street
Assonet, MA 02702

Freetown Conservation Commission
3 North Main Street
Assonet, MA 02702

Freetown Zoning Board of Appeals
3 North Main Street, P.O. Box 438
Assonet, MA 02702

Re: Notarized Letter of Authorization

To Whom It May Concern:

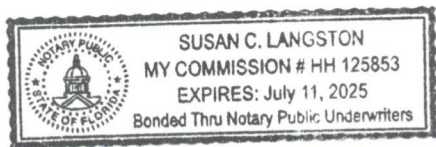
Please be advised that Capital Funding Services LLC hereby authorizes Freetown East PV I, LLC and Vanesse Hangen Brustlin, Inc. ("VHB") to act as its agents in all aspects to obtain Site Plan Approval from the Freetown Planning Board, an Order of Conditions from the Freetown Conservation Commission, and any other permits, approvals or variances needed from any other Freetown board or commission for a Large-Scale Ground-Mounted Solar Photovoltaic Installation proposed to be located on land that it owns (1) identified as Assessor's Map 206, Lot 49.01 and known as 0 Locust Street, and (2) identified as Assessor's Map 206, Lot 43-0 and known as the George D. Williams Lot.


Sincerely,

Capital Funding Services LLC,
a Massachusetts limited liability company

By: 
David J. Megna
Manager

On this 6th day of April, 2022 before me, the undersigned notary public, David J. Megna personally appeared, proved to me through satisfactory evidence of identification, which were Driver's License, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose as Manager for Capital Funding Services LLC, a Massachusetts limited liability company, as the voluntary act of the limited liability company.




Notary Public Susan C. Langston

My Commission Expires: July 11, 2025

Bk: 10958 Pg: 298

Bristol Fall River Registry of Deeds

Electronically Recorded Document

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Recording Information

Document Number	: 5484
Document Type	: DEED
Recorded Date	: March 24, 2022
Recorded Time	: 09:37:37 AM
Recorded Book and Page	: 10958 / 298
Number of Pages(including cover sheet)	: 3
Receipt Number	: 469510
Recording Fee (including excise)	: \$337.40

MASSACHUSETTS EXCISE TAX
Bristol ROD Fall River 001
Date: 03/24/2022 09:37 AM
Ctrl# 033239 12848 Doc# 00005484
Fee: \$182.40 Cons: \$40,000.00

Property Address:
0 George D Williams Lot
Assonet, MA 02702

QUITCLAIM DEED

Edward F. Lowe, Trustee of the LOWE IRREVOCABLE TRUST under a declaration of Trust dated October 30, 2014, having an address of 44 Elm Tree Drive, Assonet, MA 02702, evidenced by a trustee certificate recorded with the Bristol County Fall River District Registry of Deeds on September 15, 2016 in Book 9054 Page 77, for consideration paid, in the full consideration of **Forty Thousand AND 00/100 (\$40,000.00) DOLLARS GRANTS** to **David Megna**, with an address of 227 River Road, Westport, MA 02790, with **QUITCLAIM COVENANTS**

That certain parcel of land in Freetown in the County of Bristol and in the Commonwealth of Massachusetts, bounded and described as follows:

A certain tract of woodland situated in Freetown being #9 of the lots named in a license granted to Gilbert W. Nichols as conservator of the property of Anthony D. Hathaway of said Freetown which said license was dated May 6, 1920 and is bounded and described as follows: The "George D. Williams" woodlot of about Fourteen acres lying a little Easterly from the Taunton Road in said Freetown and bounded Northerly by land now or formerly of Caroline A. Bowers (Daniel Cudworth Land) Easterly by the "Pratt" lot now or formerly of Frances Stone; Southerly by "Ephraim Swamp" now or formerly of Anthony Charles A. Briggs and Tripp woodland now or formerly of Anthony D. Hathaway; and Westerly by land now or formerly of Anthony D. Hathaway.

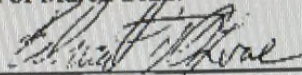
Being Parcel II conveyed to this grantor by deed dated November 13, 2014 and recorded with the Bristol County Fall River District Registry of Deeds on September 15, 2016 in Book 9054, Page 79.

Under the pains and penalty of perjury, I release any and all homestead rights that I have in the premises and hereby certify that there are no beneficiaries, spouses, former spouses, partners or former partners in a civil union who occupy or intend to occupy the premises as their principal

Bk: 10958 Pg: 300

residence or are entitled to claim the benefit of an existing estate of homestead in the property by court order or otherwise, and further state that this property is not the residence of the grantor or its families and release any interest therein but is vacant land.

WITNESS my hand and seal this 23rd of March 2022.



Edward F. Lowe, Trustee of the **LOWE IRREVOCABLE TRUST** under a declaration of Trust dated October 30, 2014

COMMONWEALTH OF MASSACHUSETTS

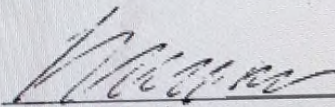
Bristol, ss:

Fall River, MA

On this 23rd day of March 2022, before me, the undersigned notary public, personally appeared **Edward F. Lowe**, who proved to me through satisfactory evidence of identification, which were Driver's Licenses; State ID; Passport; Other Government Issued ID; Other, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose and his free act and deed and who swore or affirmed to me that the contents of the documents are truthful and accurate to the best of his knowledge and belief and the free act and deed as Trustee of the **LOWE IRREVOCABLE TRUST**.



MARK L. LEVIN
Notary Public
Commonwealth of Massachusetts
My Commission Expires
April 22, 2027



Mark L. Levin
NOTARY PUBLIC
My Commission Expires: April 22, 2027

F:\WP51\DESCRIPT\0 George D Williams Lot Assonet, MA Deed from IR trust.doc

ATTEST: BR. COUNTY, F.R. DIST., Bernard J McDonald III

Bk: 10963 Pg: 76

Bristol Fall River Registry of Deeds

Electronically Recorded Document

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Recording Information

Document Number	: 5778
Document Type	: DEED
Recorded Date	: March 28, 2022
Recorded Time	: 03:08:49 PM
Recorded Book and Page	: 10963 / 76
Number of Pages(including cover sheet)	: 3
Receipt Number	: 469708
Recording Fee (including excise)	: \$155.00

 MASSACHUSETTS EXCISE TAX
 Bristol ROD Fall River 001
 Date: 03/28/2022 03:08 PM
 Ctrl# Doc# 00005778
 Fee: \$.00 Cons: \$1.00

Bk: 10963 Pg: 77

Property Address:
0 George D Williams Lot
Assonet, MA 02702

QUITCLAIM DEED

David Megna, for consideration paid, in the full consideration of **One and 00/100 (\$1.00) DOLLARS GRANTS** to **Capital Funding Services, LLC**, a duly organized **Massachusetts Limited Liability Company**, with usual mailing address of 227 River Road, Westport, MA 02790, with **QUITCLAIM COVENANTS**

That certain parcel of land in Freetown in the County of Bristol and in the Commonwealth of Massachusetts, bounded and described as follows:

A certain tract of woodland situated in Freetown being #9 of the lots named in a license granted to Gilbert W. Nichols as conservator of the property of Anthony D. Hathaway of said Freetown which said license was dated May 6, 1920 and in bounded and described as follows: The "George D. Williams" woodlot of about Fourteen acres lying a little Easterly from the Taunton Road in said Freetown and bounded Northerly by land now or formerly of Caroline A. Bowers (Daniel Cudworth Land) Easterly by the "Pratt" lot now or formerly of Frances Stone; Southerly by "Ephraim Swamp" now or formerly of Anthony Charles A. Briggs and Tripp woodland now or formerly of Anthony D. Hathaway; and Westerly by land now or formerly of Anthony D. Hathaway.

Being the same premises conveyed to this grantor by deed dated March 23, 2022 and recorded with the Bristol County Fall River District Registry of Deeds in Book 10958, Page 298.

Under the pains and penalty of perjury, I release any and all homestead rights that I have in the premises and hereby certify that there are no beneficiaries, spouses, former spouses, partners or former partners in a civil union who occupy or intend to occupy the premises as their principal residence or are entitled to claim the benefit of an existing estate of homestead in the property by court order or otherwise, and further state that this property is not the residence of the grantor or its families and release any interest therein but is vacant land.

WITNESS my hand and seal this 23rd of March 2022.

David Megna
David Megna

State of Florida

Lee, ss:
(County)

On this 23rd day of MARCH 2022, before me, the undersigned notary public, personally appeared **David Megna**, who proved to me through satisfactory evidence of identification, which were Driver's Licenses; State ID; Passport; Other Government Issued ID; Other, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose and his free act and deed and who swore or affirmed to me that the contents of the documents are truthful and accurate to the best of his knowledge and belief and the free act and deed.



GAIL DALBY
Commission # GG 809593
Expires October 24, 2023
Board of Trial and Budget Notary Services

Gail Dalby
GAIL DALBY NOTARY PUBLIC
My Commission Expires:
OCTOBER 24, 2023

PAWP51\DESCRIPTION George D Williams Lot Assonet, MA Deed from Megna to LLC

ATTEST: BR. COUNTY, F.R. DIST., Bernard J McDonald III

The Commonwealth of Massachusetts
 Office of the Collector of Taxes
 Town of Freetown
 Municipal Lien Certificate



Number: 4692
 8/11/2021

Klavens Law Group
 20 Park Plaza 402
 Boston, MA 02116

I Certify from available information that all taxes, assessments, and charges, now payable that constitute liens as of the date of this certificate on the parcel of real estate specified in your application received on 8/11/2021 are listed below:

DESCRIPTION OF PROPERTY

Parcel Identifier	206-43	Assessed Owner	LOWE EDWARD F TR
Account	2215	Additional Owner	LOWE IRREVOCABLE TRUST
Location of Property	GEORGE D WILLIAMS LOT	Supposed Present Owner	
Acreage	8.5 Acres	Legal Reference	Book LC 45 Page 143 Deed Date 11/2/2018

VALUATION

FY	Residential	Rate1 Open Space	Rate 2 Commercial	Rate 3 Industrial	Rate 4	Exempt
2022	0	12.70	0	0.00	10,740	20.63
						0

ASSESSMENT

	2022 1st Quarter	2022 2nd Quarter	2022 3rd Quarter	2022 4th Quarter	FY 2021	FY 2020
Preliminary Tax	\$55.40	\$55.39	N/A	N/A	\$107.99	\$257.09
Actual Tax					\$113.58	-\$41.11
Interest To Date	\$0.00	\$0.00			\$0.00	\$0.00
Credits	\$55.40				\$221.57	\$215.98
Interest Credit	\$0.00				\$0.00	\$0.00
Per Diem	\$0.00	\$0.00			\$0.00	\$0.00
Balance Due	\$0.00	\$55.39			\$0.00	\$0.00

Property Tax Interest Per Diem \$0.00
 Committed Tax Balance \$55.39

PLANNING BOARD

Chapter Land

All of the amounts listed above are to be paid to the Collector. I have no knowledge of any other lien outstanding.
 INFORMATION ON THIS CERTIFICATE IS COMPLETE AS OF 8/11/2021

Jessica Thomas
 Jessica Thomas
ast collector
 Collector of Taxes

The Commonwealth of Massachusetts
 Office of the Collector of Taxes
 Town of Freetown
 Municipal Lien Certificate



Number: 4693
 8/11/2021

Klavens Law Group
 20 Park Plaza 402
 Boston, MA 02116

I Certify from available information that all taxes, assessments, and charges, now payable that constitute liens as of the date of this certificate on the parcel of real estate specified in your application received on 8/11/2021 are listed below:

		DESCRIPTION OF PROPERTY	
Parcel Identifier	206-49.01	Assessed Owner	CAPITAL FUNDING SERVICES LLC
Account	4188	Additional Owner	
Location of Property	LOCUST ST	Supposed Present Owner	
Acreage	42.704 Acres	Legal Reference	Book LC 43 Page 225 Deed Date 10/21/2016

VALUATION									
FY	Residential	Rate1	Open Space	Rate 2	Commercial	Rate 3	Industrial	Rate 4	Exempt
2022	231,900	12.70	0	0.00	0	20.63	0	20.63	0

ASSESSMENT							
	2022 1st Quarter	2022 2nd Quarter	2022 3rd Quarter	2022 4th Quarter	FY 2021	FY 2020	
Preliminary Tax	\$736.29	\$736.28	N/A	N/A	\$1,447.83	\$1,391.93	
Actual Tax					\$1,497.30	\$1,503.72	
Interest To Date	\$0.00	\$0.00			\$0.00	\$0.00	
Credits	\$736.29				\$2,945.13	\$2,895.65	
Interest Credit	\$0.00				\$0.00	\$0.00	
Per Diem	\$0.00	\$0.00			\$0.00	\$0.00	
Balance Due	\$0.00	\$736.28			\$0.00	\$0.00	

Property Tax Interest Per Diem \$0.00
 Committed Tax Balance \$736.28

PLANNING BOARD

All of the amounts listed above are to be paid to the Collector. I have no knowledge of any other lien outstanding.
 INFORMATION ON THIS CERTIFICATE IS COMPLETE AS OF 8/11/2021

Jessica Thomas

Collector of Taxes



300 foot Abutters List Report

Freetown, MA
December 20, 2021

Subject Property:

Parcel Number: 206-043
CAMA Number: 206-043
Property Address: 0 GEORGE D WILLIAMS LOT

Mailing Address: LOWE EDWARD F TR LOWE
IRREVOCABLE TRUST
44 ELM TREE DR
ASSONET, MA 02702

Abutters:

Parcel Number: 206-024
CAMA Number: 206-024
Property Address: 0 ROUTE 24

Mailing Address: MEGNA DAVID J
227 RIVER RD
WESTPORT, MA 02790

Parcel Number: 206-032
CAMA Number: 206-032
Property Address: 0 SAMMY'S LN

Mailing Address: REZENDES FMLY LTD PARTNRSHP #3
P O BOX 879
ASSONET, MA 02702

Parcel Number: 206-033
CAMA Number: 206-033
Property Address: 0 SAMMY'S LN

Mailing Address: REZENDES FMLY LTD PARTNRSHP #3
P O BOX 879
ASSONET, MA 02702

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 SOLAR LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A TOPEKA
SOLAR 1 LLC
4900 N SCOTTSDALE RD STE 5000
SCOTTSDALE, AZ 85251

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 R LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A
27R LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 SOLAR LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A TOPEKA
SOLAR 1 LLC
4900 N SCOTTSDALE RD STE 5000
SCOTTSDALE, AZ 85251

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 R LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A
27R LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-049.01
CAMA Number: 206-049.01
Property Address: 0 LOCUST ST

Mailing Address: CAPITAL FUNDING SERVICES LLC
3129 COUNTY ST
SOMERSET, MA 02726

**Freetown Board of Assessors
CERTIFIED ABUTTERS LIST**



www.cai-tech.com

12/20/2021

Data shown on this report is provided for planning and informational purposes only. The municipality and CAI Technologies are not responsible for any use for other purposes or misuse or misrepresentation of this report.

Page 1 of 1



300 foot Abutters List Report

Freetown, MA
December 20, 2021

Subject Property:

Parcel Number: 206-049.01
CAMA Number: 206-049.01
Property Address: 0 LOCUST ST

Mailing Address: CAPITAL FUNDING SERVICES LLC
3129 COUNTY ST
SOMERSET, MA 02726

Abutters:

Parcel Number: 203-022
CAMA Number: 203-022
Property Address: 3 ADUKE WAY

Mailing Address: SMALL JAMES III & KATHLEEN
3 ADUKE WAY
ASSONET, MA 02702

Parcel Number: 206-023
CAMA Number: 206-023
Property Address: 127 N MAIN ST

Mailing Address: BOY'S CLUB OF FALL RIVER
P O BOX 215
FALL RIVER, MA 02720

Parcel Number: 206-024
CAMA Number: 206-024
Property Address: 0 ROUTE 24

Mailing Address: MEGNA DAVID J
227 RIVER RD
WESTPORT, MA 02790

Parcel Number: 206-033
CAMA Number: 206-033
Property Address: 0 SAMMY'S LN

Mailing Address: REZENDES FMLY LTD PARTNRSHP #3
P O BOX 879
ASSONET, MA 02702

Parcel Number: 206-043
CAMA Number: 206-043
Property Address: 0 GEORGE D WILLIAMS LOT

Mailing Address: LOWE EDWARD F TR LOWE
IRREVOCABLE TRUST
44 ELM TREE DR
ASSONET, MA 02702

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 SOLAR LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A TOPEKA
SOLAR 1 LLC
4900 N SCOTTSDALE RD STE 5000
SCOTTSDALE, AZ 85251

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 R LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A
27R LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 SOLAR LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A TOPEKA
SOLAR 1 LLC
4900 N SCOTTSDALE RD STE 5000
SCOTTSDALE, AZ 85251

Parcel Number: 206-044
CAMA Number: 206-044
Property Address: 27 R LOCUST ST

Mailing Address: NIEMIEC FRANK & LINDA A
27R LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-047
CAMA Number: 206-047
Property Address: 35 LOCUST ST

Mailing Address: BOYNTON CHARLES M & PAULINE D
33 LOCUST STREET
ASSONET, MA 02702



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300 foot Abutters List Report

Freetown, MA
December 20, 2021

Parcel Number: 206-048
CAMA Number: 206-048
Property Address: 37 LOCUST ST

Mailing Address: CRYSTAL SPRINGS INC
P O BOX 372
ASSONET, MA 02702

Parcel Number: 206-049
CAMA Number: 206-049
Property Address: 41 LOCUST ST

Mailing Address: CROMWELL CHARLES E
41 LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-050
CAMA Number: 206-050
Property Address: 45 LOCUST ST

Mailing Address: ST JEAN BRETT TR BRETT R ST JEAN
REV TRUST
45 LOCUST ST
ASSONET, MA 02702

Parcel Number: 206-051
CAMA Number: 206-051
Property Address: 7 DANA LEE DR

Mailing Address: PORTER JAMES J & CATHERINE A
7 DANA LEE DR
ASSONET, MA 02702

Parcel Number: 206-052
CAMA Number: 206-052
Property Address: 9 DANA LEE DR

Mailing Address: WHITEHEAD JEFF & SHANNON
9 DANA LEE DR
ASSONET, MA 02702

Parcel Number: 206-053
CAMA Number: 206-053
Property Address: 11 DANA LEE DR

Mailing Address: FEIJO DAVID M & LINDA A
11 DANA LEE DR
ASSONET, MA 02702

Parcel Number: 206-054
CAMA Number: 206-054
Property Address: 0 REAR DANA LEE DR

Mailing Address: LEDGEVIEW DEVELOPMENT CO INC
117 RICHMOND RD
ASSONET, MA 02702

Parcel Number: 206-056
CAMA Number: 206-056
Property Address: 1 SIMMONS ST

Mailing Address: TAYLOR-O REILLY ANNETTE L L/E
1 SIMMONS ST
ASSONET, MA 02702

Parcel Number: 206-063
CAMA Number: 206-063
Property Address: 10 DANA LEE DR

Mailing Address: SILVA SUSAN L
10 DANA LEE DR
ASSONET, MA 02702

Parcel Number: 206-064
CAMA Number: 206-064
Property Address: 3 DEAN ST

Mailing Address: BUTLER CRAIG T
3 DEAN ST
ASSONET, MA 02702

Parcel Number: 206-083
CAMA Number: 206-083
Property Address: 82 FORGE RD

Mailing Address: SOUZA DANIEL C & DEBRA J
82 FORGE RD
ASSONET, MA 02702

Parcel Number: 206-084
CAMA Number: 206-084
Property Address: 78 FORGE RD

Mailing Address: LAVOIE NICHOLAS & KATHRYN TRS N A
& K D LAVOIE LIVING TRUSTS
78 FORGE RD
ASSONET, MA 02702



www.cai-tech.com

Data shown on this report is provided for planning and informational purposes only. The municipality and CAI Technologies are not responsible for any use for other purposes or misuse or misrepresentation of this report.

Zoning Determination from Zoning Enforcement Officer

Freetown East PV I, LLC has submitted a request for a Zoning Determination to the Zoning Enforcement Officer and will supplement this application with the determination when it is received.

VANASSE HANGEN BRUSTLIN, INC.

101 WALNUT STREET • PO BOX 9151
WATERTOWN, MASSACHUSETTS 02471

CITIZENS BANK
MASSACHUSETTS
5-7017/2110

371583

CHECK DATE

April 6, 2022

Five Hundred and 00/100

AMOUNT

Town of Freetown
3 North Main Street
Assonet, MA 02702

\$500.00

Michael G. ...
MP
AUTHORIZED SIGNATURE



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VANASSE HANGEN BRUSTLIN, INC.

101 WALNUT STREET • PO BOX 9151
WATERTOWN, MASSACHUSETTS 02471

EMILY BUSINESS FORMS 800.392.6018 VISION

371583

Check Date: 4/6/2022

Invoice Number	Date	Voucher	Amount	Discounts	Previous Pay	Net Amount
Sarah Ebaugh 4/6/22	4/6/2022	1426814	\$500.00			\$500.00
Town of Freetown		TOTAL	\$500.00			\$500.00
Citizens	6	0010095				

2

Project Narrative

Overview

The Applicant, Freetown East PV I, LLC, a subsidiary of Longroad Energy Holdings, LLC, is proposing to construct a 4.5±-megawatt (AC) large-scale ground-mounted solar photovoltaic installation (the Project) at 0 Locust Street & 0 George D. Williams in Freetown, Massachusetts (the Site) – See Figure 1, attached. The 52.6-acre site is comprised of two parcels of land: (1) 0 Locust Street, which is identified by the Town of Freetown Assessor’s Office as Map 206, Parcel 49.01, and (2) 0 George D. Williams Lot, which is identified as Map 206, Parcel 43. Both are owned by Capital Funding Services LLC .

According to the Town of Freetown Zoning Map, the Site is located within the Residential and General Use zoning districts. Large-scale ground-mounted solar photovoltaic installations are allowed as of right in these districts subject to Site Plan Review by the Planning Board.

Site Description

The Site consists entirely of undeveloped woodland and is surrounded by additional undeveloped land to the north and west. To the south and east, the Site abuts a combination of residential, undeveloped open space, and commercial/industrial lots—including a lot to the east which has an existing solar array.

Access to the Site is via an existing asphalt road with an existing curb cut off of Locust Street.

Wetland resource areas present on, or near the Site, were delineated in October 2016 by Gorodetsky Engineering and are the subject of an Order of Resource Area Delineation (ORAD) with DEP file # SE 026-0598. The resource area identified on the Site includes Bordering Vegetated Wetland (BVW). A Notice of Intent (NOI) has been prepared by VHB on behalf of the Applicant and will be submitted to the Conservation Commission for review.

According to the most recently available data provided by the Massachusetts Natural Heritage and Endangered Species Program (NHESP), no portion of the Site is located within Priority Habitat of Rare Species or Estimated Habitat of Rare Wildlife, nor are there any Certified Vernal Pools on the Site.

The Site does not lie within any Area of Critical Environmental Concern (ACEC). According to the most recent information provided by MassDEP, the Site is not located in an area designated as an Outstanding Resource Water, and no portion of the Site is located within a Zone II Interim Wellhead Protection Area.

The most recently issued Flood Insurance Rate Maps (FIRM) for the area produced by the Federal Emergency Management Agency (FEMA) indicate that no portion of the Site is within mapped floodplain for the 100-year flood zone.

The Natural Resources Conservation Service (NRCS) soil survey has mapped the majority of the Site as Woodbridge fine sandy loam.

Topography within the eastern portion of the Site generally slopes from northeast to southwest with slopes between 2 and 5%. To the west, the topography flattens out, but in general pitches towards the surrounding wetlands with a high point in the central area of upland.

Project Description

The Project will consist of the erection of racking and solar panels, a battery energy storage system, ancillary utility infrastructure (including pad mounted transformers/utility cabinets), underground electrical conduit, above ground wires and poles required for interconnection to the grid, a gravel access drive, security fencing and stormwater management systems.

Solar panels and associated infrastructure will occupy both the north and south portions of the Site, requiring tree clearing and removal. All work on the Site will remain outside of wetland resource areas, with the exception of where the access road will be widened to provide for fire department access. A new culvert will also be installed in this location, to replace the failing culvert that currently exists. As noted above, VHB has prepared and will submit an NOI to the Conservation Commission on behalf of the Applicant.

The Project will require the removal of approximately 24.3 acres of trees, however will be revegetated with a native meadow mix as shown on the site plans provided as an attachment to this application (the Site Plans).

Access to the Site is via an existing asphalt road with an existing curb cut off of Locust Street and a new subdivision roadway. No improvements to the access will be necessary within the Locust Street right of way. Within the Site, access will be provided via a 20' wide gravel drive with turnarounds. This access drive will be inspected during the regular maintenance visits to the facility and gravel will be replaced and re-graded as necessary to provide proper access. The Applicant anticipates coordinating with a local snow removal contractor to perform snow removal operations.

The Project will be enclosed by fencing for safety purposes and to eliminate trespassing and potential issues with vandalism. In addition, signs will be posted on the perimeter fence around the Project and at the entrance gate with emergency contact information.

The Project will be connected to the existing utility infrastructure within Locust Street. New underground conduits will be installed within the gravel drive to a point approximately 50 feet from the Locust Street right-of-way, at which point the infrastructure will transition to above ground on new utility poles.

The Project has been designed to comply with the Massachusetts Stormwater Management Standards in accordance with the WPA Regulations (310 CMR 10.00). More detailed information is provided in the Stormwater Report that is included as an attachment to this application

Compliance with the Zoning By-Laws

The Project complies with the applicable sections of the Town of Freetown Zoning By-Laws. Specially, the Project complies with the following sections as noted below:

Section 11.28 – Large-Scale Ground-Mounted Solar Photovoltaic Installations

Subsection J: Design Standards

- 1. Lighting: Lighting of solar photovoltaic installations shall be consistent with local, state and federal law. Lighting of other parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. Where feasible, lighting of solar photovoltaic installation shall be directed downward and shall incorporate full cut-off fixtures to reduce light pollution.

Currently the Applicant does not plan to include lighting on-site. If lighting is deemed required, it would be installed in compliance with these requirements.

- 2. Signage: Signs on large-scale ground-mounted solar photovoltaic installations shall comply with a municipality's sign by-law. A sign consistent with a municipality's sign by-law shall be required to identify the owner and provide a 24-hour emergency contact phone number.

Signage will be provided as required by the Town of Freetown's sign by-law. The Site Plans identify the proposed locations of signage. Exact details on signage will be included on the plans submitted to the building department prior to construction.

- 3. Utility Connections: Reasonable efforts, as determined by the Site Plan Review Authority, shall be made to place all utility connections from the solar photovoltaic installation underground, depending on appropriate soil conditions, shape and topography of the site and any requirements of the utility provider. Electrical transformers for utility interconnections may be above ground if required by the utility provider.

All utility connections are proposed underground, until the point of interconnection at Locust Street. At this point, utilities transition to a series of five (5) new utility poles in order to connect to the existing overhead wires within the Locust Street right of way. Any necessary equipment for interconnection will be mounted to these poles as required by the utility provider.

Subsection K: Safety & Environmental Standards

- 1. Emergency Services: The large-scale solar photovoltaic installation owner or operator shall provide a copy of the project summary, electrical schematic, and site plan to local Fire Chief. Upon request the owner or operator shall cooperate with local emergency services in developing an emergency response plan. All means of shutting down the solar photovoltaic installation shall be clearly marked. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation.

A copy of this application package, including the Site Plans, equipment cut sheets and the Operations & Maintenance Plan, will be provided to the Fire Department. The Owner will work with the Fire Department to develop an emergency response plan upon request.

- 2. Land Clearing, Soil Erosion and Habitat Impacts: Clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of the large-scale ground-mounted solar photovoltaic installation or otherwise prescribed by applicable laws, regulations, any by-laws.

The Project has been designed to meet this requirement. In order to prevent significant shading on the solar array, clearing will be required as shown on the Site Plans.

Subsection L: Monitoring & Maintenance

- 1. Solar Photovoltaic Installation Conditions: The large-scale ground-mounted solar photovoltaic installation owner or operator shall maintain the facility in good condition. Maintenance should include, but not be limited to, painting, structural repairs, and integrity of security measures. Site access shall be maintained to a level acceptable to the local Fire Chief and Emergency Medical Services. The owner or operator shall be responsible for the cost of maintaining the solar photovoltaic installation and any access roads, unless accepted as a public way.

The owner/ operator will maintain the facility in good condition as described above. A copy of the Operations & Maintenance Plan has been included as an attachment to this application.

- 2. Modifications: All material modifications to a solar photovoltaic installation made after the issuance of the required building permit shall require approval by the Site Plan Review Authority.

Acknowledged.

Subsection M: Abandonment or Decommissioning

- 1. Removal Requirements: Any large-scale ground-mounted solar photovoltaic installation which has reached the end of its useful life or has been abandoned consistent with Section 11.28,M,2 of this by-law shall be removed. The owner or operator shall physically remove the installation no more than 150 days after the date of discontinued operations. The owner or operator shall notify the Site Plan Review Authority by certified mail of the proposed date of discontinued operations and plans for removal. Decommissioning shall consist of:
 - a. Physical removal of all large-scale ground-mounted solar photovoltaic installation structures, equipment, security barriers and transmission lines from the site.

b. Disposal of all solid and hazardous waste in accordance with local, state and federal waste disposal regulations.

c. Stabilization or re-vegetation of the site as necessary to minimize erosion. The Site Plan Review Authority may allow the owner or operator to leave landscaping or designated below grade foundations in order to minimize erosion and disruption to vegetation.

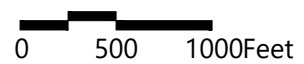
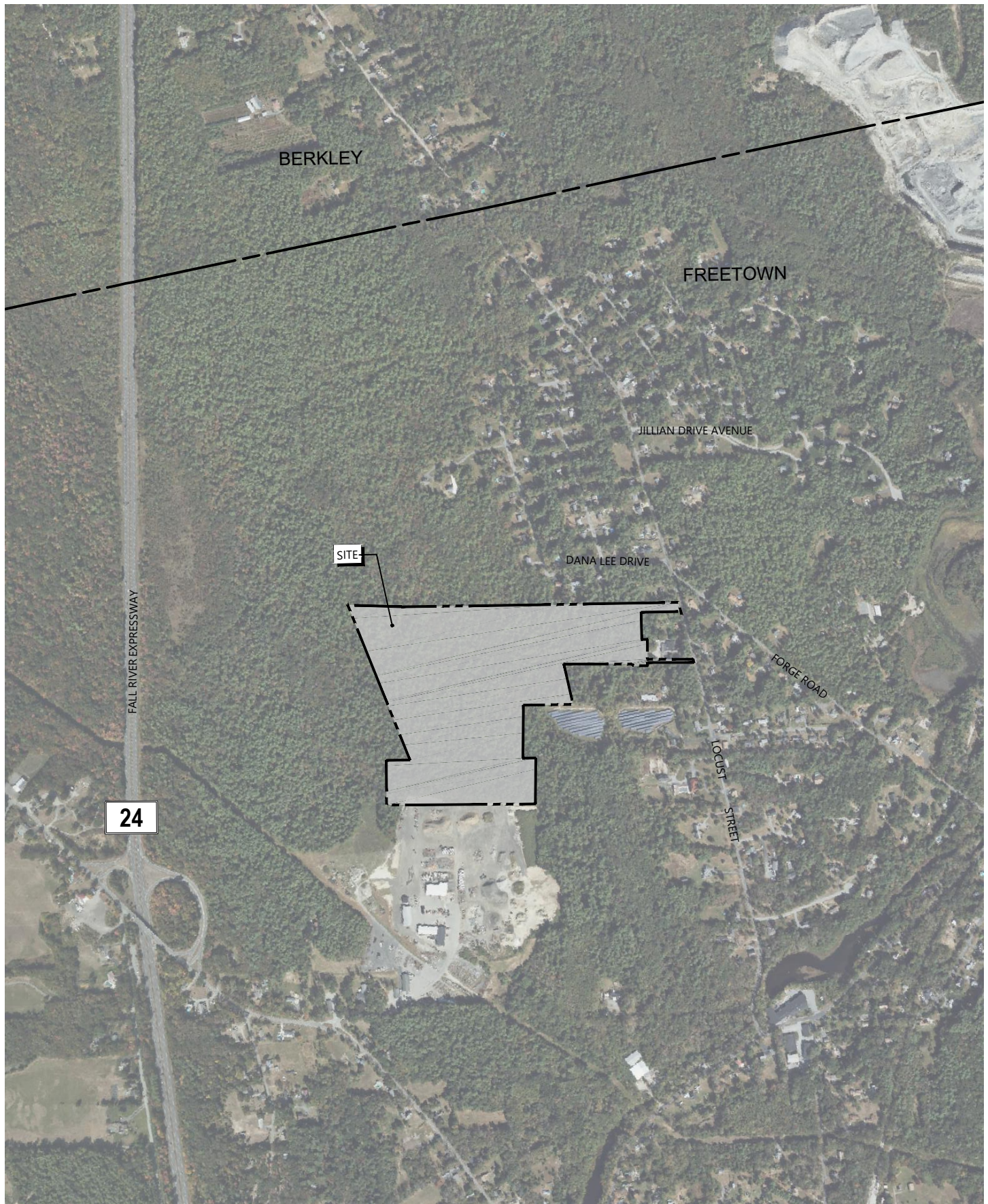
Acknowledged.

- 2. Abandonment: Absent notice of a proposed date of decommissioning or written notice of extenuating circumstances, the solar photovoltaic installation shall be considered abandoned when it fails to operate for more than one year without written consent of the Site Plan Review Authority. If the owner or operator of the large-scale ground-mounted solar photovoltaic installation fails to remove the installation in accordance with the requirements of this section within 150 days of abandonment or the proposed date of decommissioning, the town may enter the property and physically remove the installation.

Acknowledged.

3. Financial Surety: Proponents of large-scale ground-mounted solar photovoltaic projects shall provide a form of surety, either through escrow account, bond or otherwise, to cover the cost of removal in the event the town must remove the installation and remediate the landscape, in the amount and form determined to be reasonable by the Site Plan Review Authority, but in no event to exceed more than 125% of the cost of removal and compliance with the additional requirements set forth herein, as determined by the project proponent. Such surety will not be required for municipally or state-owned facilities. The project proponent shall submit a fully inclusive estimate of the costs associated with the removal, prepared by a qualified engineer. The amount shall include a mechanism for calculated increased removal costs due to inflation.

The Applicant will work with the Site Plan Review Authority to determine the appropriate amount and form of surety.



Site Locus
Locust Street
Freetown, Massachusetts

Figure 1
07/23/2021

3

Solar Documentation

Operations & Maintenance Plan

Documentation of Site Control/ Access

Acknowledgement from Utility Company Operating Grid of Project

Representative Product Cut Sheets

Decommissioning Plan/ Financial Surety

Proof of Liability Insurance

One-Line Electrical Diagram

Project Inspection and Maintenance Program

During the operational phase of the Project, the following equipment inspection and maintenance activities will be implemented as scheduled below.

The following activities will be conducted in accordance with the Original Equipment Manufacturer (OEM) but in no case less than annually:

- Complete visual inspection
- Complete mechanical inspection
- Complete electrical testing
- Complete equipment maintenance
- Inspection and maintenance of racking system

Operations and Maintenance Capability

Longroad Energy Holdings, LLC (Longroad), is an experienced operations and maintenance (O&M) manager of both large-scale solar and wind projects.

Longroad Energy Services, LLC (LES), also a subsidiary of Longroad, is currently contracted to manage 3.5 gigawatts (GW) of operating and under construction projects across the United States.

LES's O&M plan is designed to manage all operational and commercial matters related to the facility. Longroad will provide the following resources at or for the Project facility to ensure safety and complete readiness by the commercial operation date:

- Staff recruiting;
- Staff training and safety;
- Policy and procedure guidance and manuals;
- Operations and engineering readiness;
- Maintenance services readiness; and
- Install Supervisory Control and Data Acquisition (SCADA) and asset management systems.

LES employs a fully integrated, data-driven O&M strategy that maximizes project value. LES's in-house operations capabilities include real-time resource monitoring and analysis from its Portland, Maine-based Remote Operations Center (ROC), on-site and regional O&M personnel, and regional Commercial Asset Management staff.

A key to LES's success is early engagement in the development and construction process to

OPERATIONS AND MAINTENANCE PLAN – FREETOWN SOLAR, 0 LOCUST STREET

ensure seamless transition to operations. The operations team works alongside Longroad project developers and construction managers from the earliest phases of project development.

During the operations phase, LES combines advanced performance monitoring and analysis from the ROC project financial data to continually optimize site performance. LES utilizes cloud-based data management platforms to manage data and optimize project operational and financial performance. Through the use of these tools, decisions are made with a complete understanding of the short- and long-term financial implications to the projects LES manages. In addition to an experienced in-house staff, LES partners with Tier 1 suppliers of major equipment such as modules, trackers, inverters, and transformers to ensure high performance throughout each project's expected life.

Safety

Longroad's first priority is the safety of its personnel and those who work on its projects. Each operational review meeting begins with a review of safety lessons learned, and every operating decision is made within the framework of the LES Safety Program and Site Safety Plan. Longroad's safety culture begins with the hiring decisions made in staffing its teams and continues through each phase of development, construction, and operation of our projects.

All new employees must complete Longroad's onboarding safety training before reporting to their duties. Longroad continually updates its employee safety training. Annual safety refresher training of all site employees is accomplished through monthly on-as-needed safety meetings, tailgate meetings, and formal training sessions. Topics reviewed in these sessions include high voltage work, electrical safety, arc flash protection, and live work. Other areas of training include confined space entry, environmental considerations, CPR/first aid, forklift safety, crane safety, safe lifting practices, and safe driving.

Vegetation Management

Ground cover within the array areas will be monitored for growth and mowed as needed to maintain a safe work environment. Vegetation growth will be maintained under and around the solar installation at levels needed to reduce the risk of ignition from the electrical system while minimizing mowing.

The Project site will be inspected for evidence of erosion and rilling in slopes. If such conditions are observed, they will be corrected and revegetated as needed.

Growth of trees or other vegetation shading the arrays will be trimmed as needed. Excessive vegetation growth, including saplings, shrubs, large weeds, within the array areas will be removed.

Stormwater Management Features and Access Roads

OPERATIONS AND MAINTENANCE PLAN – FREETOWN SOLAR, 0 LOCUST STREET

Stormwater management features will be inspected for evidence of erosion and sediment settling. If erosion has occurred or sediment has accumulated in stormwater management features, such conditions will be corrected. Refer to the Long Term Pollution Prevention Plan provided as an attachment within the Stormwater Management Report for additional information pertaining to inspection and maintenance of stormwater management features.

The gravel access roads and roadside swales will be inspected for evidence of erosion, rilling, and clogging. If such conditions are observed, they will be corrected.

ASSIGNMENT AND ASSUMPTION OF OPTION TO LEASE

This ASSIGNMENT AND ASSUMPTION OF OPTION TO LEASE (this “Assignment”) is dated as of April 30, 2019 (the “Effective Date”), by and between Galehead DG Solutions, LLC, a wholly owned affiliate of Galehead Development, LLC (“Assignor”), and Freetown East PV I, LLC (“Assignee”).

WHEREAS, Assignor is the grantee under that certain Option to Lease dated as of March 12, 2019, by and between Capital Funding Services LLC as Optionor, and Galehead DG Solutions, LLC, a wholly owned affiliate of Galehead Development, LLC, as Optionee (the “Option Agreement”);

WHEREAS, the Option Agreement provides for Assignor’s use of certain real estate described therein;

WHEREAS, Assignor is an affiliate of Assignee;

WHEREAS, as of the Effective Date, Assignor desires to assign and transfer to Assignee the Option Agreement and all of Assignor’s rights, title, and interests thereunder (the “Assigned Option Agreement”); and

WHEREAS, Assignee desires, effective as of the Effective Date, to accept and assume from Assignor the Assigned Option Agreement on the terms and conditions set forth in this Assignment.

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor and Assignee hereby agree as follows:

1. Recitals; Capitalized Terms. The above recitals are incorporated by reference in this Assignment. Capitalized terms used and not otherwise defined in this Assignment shall have the meanings given to such terms in the Option Agreement.

2. Assignment. Effective as of the Effective Date, Assignor does hereby TRANSFER, ASSIGN, CONVEY, GRANT, and DELIVER to the Assignee the Assigned Option Agreement, TO HAVE AND TO HOLD the Assigned Option Agreement, and all and singular the rights and appurtenances thereto in anywise belonging, unto Assignee, and the successors and assigns of the Assignee forever (the “Assignment”).

3. Assumption and Agreement to be Bound. Effective as of the Effective Date, Assignee accepts the assignment of the Assigned Option Agreement, assumes all of Assignor’s duties and obligations under or related to the Assigned Option Agreement, whether arising before, on or after the date hereof, and agrees to be bound in the place of Assignor with respect thereto.

4. Indemnity. Beginning on and after the Effective Date, Assignee hereby agrees to indemnify, defend and hold harmless Assignor from and against any and all claims, liabilities, actions, damages, losses, costs and expenses (including, without limitation, reasonable attorneys’ fees and court costs) in connection with any act, omission or default under or with respect to the Assigned Option Agreement and/or this Assignment.

5. Successors and Assigns. This Assignment shall inure to the benefit of and be binding upon the parties to this Assignment their respective successors and assigns. The parties shall execute and deliver such additional instruments, agreements and other documents as may be necessary to evidence or carry out the provisions of this Assignment.

6. Governing Law. This Assignment shall be governed by and construed in accordance with the laws of the State of New Mexico, without regard to its conflicts of laws principles.

7. Severability; Entire Agreement. If any part of this Assignment is determined to be unenforceable, such unenforceability shall not affect the balance of this Assignment. This Assignment is the entire agreement among the parties hereto with respect to the subject matter hereof and supersedes all prior agreements or discussions among them with respect thereto.

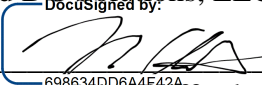
8. Execution. This Assignment may be signed in counterparts, each of which shall be deemed an original, but all of which shall be deemed but one and the same instrument.

[REMAINDER OF PAGE INTENTIONALLY BLANK]

IN WITNESS WHEREOF, the parties hereto have executed this Assignment as of the date set forth above.

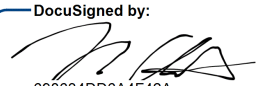
ASSIGNOR:

Galehead DG Solutions, LLC

By: 
Name: John Clifford
Title: Authorized Signatory

ASSIGNEE:

Freetown East PV I, LLC

By: 
Name: John Clifford
Title: Authorized Signatory

COMMONWEALTH OF MASSACHUSETTS

County of Bristol

OPTION TO LEASE

THIS OPTION TO LEASE (this “Agreement”) made as of the 12th day of March, 2019 (the “Effective Date”) by and between Capital Funding Services LLC (“Optionor”) and **Galehead DG Solutions, LLC** (“**Galehead**”), a wholly owned affiliate of **Galehead Development, LLC**, a Massachusetts limited liability company (“Optionee”):

WITNESSETH

WHEREAS, Optionor owns approximately 42 acres of real property located in Bristol County, MA as more particularly described on Exhibit A attached hereto and incorporated herein by reference, together with any improvements located thereon and all rights, privileges, and easements appurtenant thereto (the “Property”); and

WHEREAS, Optionee desires to acquire an option to lease 26 acres of the Property for the purpose of constructing and operating certain improvements thereon consisting of solar photovoltaic electricity generating facilities and related facilities (collectively, the “Development”).

NOW, THEREFORE, in consideration of the premises, the mutual covenants contained herein, and other good and valuable consideration, the receipt and legal sufficiency of which are hereby acknowledged, the parties hereto do hereby agree as follows:

1. **Option.**

(a) Optionor, for and in consideration of the sum of [REDACTED] (the aforesaid sum, together with all interest earned thereon and any extension payments made in accordance with the provisions of Paragraph 2 below, is hereinafter referred to as the “Option Fee”) to be paid by Optionee within ten (10) business days after the full execution of this Agreement to Optionor, does hereby give and grant unto Optionee, its successors or assigns, the exclusive right, option and privilege to lease the Property (the “Option”) in accordance with the terms and conditions set forth in this Agreement. The Option Fee shall be nonrefundable and shall be retained by Optionor regardless of whether Optionee exercises the Option. As used herein, the term “Optionee” shall also include any applicable assignee of Optionee’s interest in this Option.

(b) Optionee contemplates developing solar photovoltaic electricity generating facilities and related facilities on the Property. Prior to exercising the Option (as defined below), Optionee shall cause the Property, and to the extent then identified, the “Easement Areas”, as such term is defined in the form of Ground Lease and Easement Agreement (collectively, as it may be amended or replaced pursuant to Section 4 below, the “Lease”) attached as Exhibit B to this Agreement, to be surveyed. The term “Property,” as used herein, shall mean both the land described for the Development on Exhibit A (herein sometimes referred to as the “Site”) and also such property(ies) of Optionor, if any, as Optionee shall identify as the “Easement Areas” (as such term is defined in the Lease) for the Development. Per Optionee’s Due Diligence (as defined below), the legal description of the Site and the Easement Areas shall be amended and replaced as necessary during the Option Period and attached to the Lease as Exhibit A and the aggregate number of gross acres required for the Development on the Site shall be used to calculate the Base Rent payable thereunder.

2. **Option Term.** This Option shall begin on March 12, 2019 and, unless terminated as hereinafter provided, shall expire on the third (3rd) anniversary of the date hereof, (the aforesaid period is hereinafter referred to as the “Option Period”). The fee payable by Optionee to Optionor for the second (2nd) year of the Option Period, which commences on the first (1st) anniversary of the Effective Date and continues through the second (2nd) anniversary of the Effective Date, shall be [REDACTED] paid within ten (10) business days of the first (1st) anniversary of the Effective Date, provided that Optionee shall have the right to terminate this Agreement by written notice to Optionor delivered on or before first (1st) anniversary of the Effective Date and, in such event, no such fee shall be due and payable to Optionor. The fee payable by Optionee to Optionor for the third (3rd) year of the Option Period, which commences on the second (2nd) anniversary of the Effective Date

and continues through the third (3rd) anniversary of the Effective Date, shall be [REDACTED], paid within ten (10) business days of the second (2nd) anniversary of the Effective Date, provided that Optionee shall have the right to terminate this Agreement by written notice to Optionor delivered on or before the second (2nd) anniversary of the Effective Date and, in such event, no such fee shall be due and payable to Optionor. The fees for the second and third years of the Option Period payable above shall be referred to herein as the "Additional Option Fees". During the Option Period, Optionor shall have full use and enjoyment of the Property, including but not limited to agricultural use similar in nature to activities conducted on the Property before the effective date of this Agreement and the right to lease portions of the Property or improvements thereon to third parties, provided any such lease shall be subordinate to this Option and any such use shall not unreasonably interfere with Optionee's ability to perform its Due Diligence in accordance with this.

3. **Option Exercise.** At any time during the Option Period, Optionee may exercise this Option with respect to the Site by delivering to Optionor written notice of its election. In the event Optionee does not exercise the Option in accordance with this Paragraph 3, all rights of Optionee and obligations of Optionor under this Agreement shall terminate, except as otherwise specifically provided below.

4. **The Lease.** The Lease shall be substantially in the form attached hereto as Exhibit B, with such changes thereto as Optionee shall reasonably request and Optionor shall reasonably agree, or in such other form as Optionee shall reasonably request and Optionor shall reasonably agree (provided that such other form shall provide for the same term and base rent). Promptly following its exercise of its Option, Optionee will deliver to Optionor four (4) originals of the Lease identifying the Site (together with each Easement Agreement. Upon said delivery of the Lease by Optionee, Optionor shall execute the Lease (together with each Easement Agreement, the form of which is included therewith) and thereby lease to Optionee, and Optionee shall lease from Optionor, the Site.

Commercial Terms

Base Rent	[REDACTED] per MWdc of the solar photovoltaic installation in first year (subject to escalation thereafter as described below), payable in advance for each lease year
Escalation of Minimum Base Rent	[REDACTED] % compounded annual increase per year
Lease Term	[REDACTED] year initial term, plus [REDACTED]-year extension options
Taxes	In addition to the Base Rent, Optionee shall be liable for and shall pay as and when due any tax assessed exclusively against the Development and its resulting facilities and personal property located on the Property during the Term. Optionor shall be liable for and shall pay as and when due all real property taxes assessed against the Property and all improvements thereon, other than the Development and associated facilities, throughout the Term, as well as their personal property located on the Property.

5. **Title and Survey Matters.** It is understood and agreed that should the Option be exercised, the Property will be leased to Optionee under the Lease free and clear of all liens and encumbrances except (i) the lien of real and personal property ad valorem taxes for the year in which the Lease shall commence, (ii) such easements, covenants and restrictions as are of record as of the Effective Date and disclosed on Optionee's title commitment respecting the Property, and (iii) such matters as would be revealed by a current, accurate survey of the Property, as of the date that is the earlier of the date Optionee exercises its Option hereunder or the date of the survey, if any, obtained by Optionee regarding the Property (collectively the "Permitted Exceptions").

6. **Optionee Due Diligence.** During the Option Period, Optionee and its agents may enter the Property with reasonable notice provided to Optionor in order to conduct certain tests and inspections (including, without limitation surveys, engineering and environmental studies, soil tests, groundwater measurements, test borings and such other tests or studies which Optionee may deem advisable) and conduct other evaluations of, and inquiries into the suitability of the Property for suitability of the Development thereon (collectively, the "Due

Diligence”). Optionor agrees to cooperate with Optionee in conjunction with reasonable requests for the Due Diligence and will promptly upon the execution hereof furnish Optionee with copies of (or otherwise make available to Optionee for its inspection) any known and available information in its possession specifically requested by Optionee that would be relevant to Optionee’s Due Diligence. In the event that Optionee or its representatives destroy any crops performing necessary Due Diligence during the Option Period, Optionee shall indemnify the Optionor for damages.

7. **Optionor’s Representations.** Excepting for and subject to the application and impact of the above Permitted Exceptions thereon, Optionor hereby represents and warrants to Optionee as follows, which representations and warranties shall be deemed made by Optionor to Optionee also as of the date of Optionee’s exercise of the Option.

(a) Optionor has full power and authority to execute, deliver and carry out the terms and provisions of this Agreement. This Agreement has been duly executed and delivered by Optionor and constitutes the legal, valid and binding obligation of Optionor, enforceable against it in accordance with the terms hereof, subject as to enforceability of remedies to limitations imposed by bankruptcy, insolvency, reorganization, moratorium or other similar laws relating to or affecting the enforcement of creditors rights generally and general principles of equity.

(b) There are no material claims, actions, suits, or proceedings pending, or to the best of Optionor’s knowledge, threatened against or affecting the Property.

(c) No person, firm or other legal entity has any right or option to acquire the Property or any portion or portions thereof or any interest or interests therein.

(d) Optionor has not entered into any agreement with reference to the Property, and neither Optionor nor the Property is subject to any claim, demand, suit, unfiled lien, proceeding or litigation of any kind, pending or outstanding, or to the best of Optionor’s knowledge, threatened or likely to be made or instituted which would (i) be binding upon Optionee; or (ii) limit Optionee’s full use and enjoyment of the Property; or (iii) limit Optionor’s ability to enter into this Agreement and consummate the transaction contemplated hereby.

(e) There is no pending or, to Optionor’s best knowledge, threatened, condemnation or similar proceeding or special assessment, affecting the Property, nor to Optionor’s best knowledge is any such proceeding or assessment contemplated by any governmental authority.

(f) Optionor holds valid fee simple and marketable title to the Property (subject to the Permitted Exceptions), has done nothing to impair such title to the entire interest in the Property as Optionor received, and will warrant and defend the title against the lawful claims of all persons claiming by, under, or through Optionor.

(g) In the event this Option is exercised, occupancy and possession of the Property shall be delivered to the Optionee at the commencement of the Term of the Lease free and clear of (i) adverse parties in possession, (ii) leases in effect covering the Property and (iii) deed or other restrictions on the Property which would prohibit or restrict Optionee's intended use of the Property.

(h) To the best of Optionor's knowledge, Optionor has complied with all federal, state and local laws, rules and regulations relating to the Property and the Property is suitable for Optionee's intended use.

(i) The Property has direct and unencumbered access to public streets, and to the best knowledge and belief of Optionor, there is no pending or threatened governmental proceeding which would impair or result in the limitation or termination of such access;

(j) Optionor has not stored any hazardous substance or toxic waste on, in or under the Property or permitted the Property to be used for the storage, release or discharge of any of the same. To the best of Optionor’s knowledge, there has been no storage, release or discharge of any hazardous substance or toxic material on, in or under the Property or the location of any underground storage tank, landfill or dumping ground on, in or under or related to the Property. Optionor has no knowledge of the assertion of any environmental problem or

proceeding with respect to the Property by any governmental agency, authority or instrumentality. To the best of Optionor's knowledge, there has been no assertion of any environmental problem or proceeding with respect to any adjoining property by any governmental agency, authority or instrumentality. Optionor shall indemnify and hold Optionee harmless from any cost, loss or liability incurred with respect to any hazardous substance, toxic material, underground storage tank, landfill or dumping ground being found on, in or under the Property which results from any occurrence prior to the commencement of or during the term of the Lease not caused by Optionee or by Optionee's agents, employees or contractors.

(k) Except as specifically provided for herein, Optionor is not aware of any consent or approval of any outside person or entity (including, but not limited to, governmental agencies or authorities) that is required with respect to the execution and delivery of this Agreement or the Lease by Optionor or the consummation by Optionor of the transaction contemplated hereby or the performance by Optionor of its obligations hereunder.

8. **Representations and Warranties of Optionee.** Optionee represents and warrants unto Optionor as follows:

(a) Optionee has full power and authority to execute, deliver and carry out the terms and provisions of this Agreement. This Agreement has been duly executed and delivered by Optionee and (upon execution and delivery by Optionor) constitutes the legal, valid and binding obligation of Optionee, enforceable against it in accordance with the terms hereof, subject as to enforceability of remedies to limitations imposed by bankruptcy, insolvency, reorganization, moratorium or other similar laws relating to or affecting the enforcement of creditors rights generally and general principles of equity.

(b) Except as specifically provided for herein, no consent or approval of any outside person or entity (including, but not limited to governmental agencies or authorities) is required with respect to the execution and delivery of this Agreement or the Lease by Optionee or the consummation by Optionee of the transaction contemplated hereby or the performance by Optionor of its obligations hereunder.

9. **Memorandum of Option.** If requested by Optionee, the parties hereto agree to enter into a short form Memorandum of Option for the purpose of recording the same in the applicable recording office of the county or counties in which the Property is located. Optionee shall bear the cost of preparing and recording any such Memorandum of Option.

10. **No Waste.** During the Option Period, Optionor shall commit no waste upon the Property.

11. **Default/Remedies.** In the event of a breach of this Agreement by Optionor, Optionee shall have the option, as its sole remedy hereunder, either (a) to terminate this Agreement and receive a return of its Option Fee, in which event neither party shall have any further obligation to the other hereunder except for the indemnification obligations of Paragraph 6 and Paragraph 14; or (b) to demand and sue for specific performance by Optionor of its obligations hereunder. In the event of a breach of this Agreement by Optionee that continues for sixty (60) days following written notice from Optionor, Optionor shall have the option, as its sole remedy hereunder, either (a) to terminate this Agreement in which event neither party shall have any further obligation to the other hereunder except for the indemnification obligations of Paragraph 6 and Paragraph 14; or (b) to seek an action in money damages.

12. **Survey, Engineering Data, Development Plans, Building Plans, Etc.** As soon as possible after the date hereof, Optionor shall deliver to Optionee (or otherwise make available to Optionee for copying) copies of all known and available surveys, engineering studies, site plans, development plans, building plans, special use permits, zoning information, water and sewer permits and tap-ons, and related data, licenses, permits and information with respect to the Property, if any, which may be owned by and readily available to Optionor at no cost or expense other than reasonable reproduction charges. To the extent that Optionee desires improvements to the Property in advance of exercising the Option, the parties will work cooperatively to develop a scope of work and Optionor, in its discretion, will perform such work subject to reasonable assurances of payment by Optionee for those costs.

13. **Notice.** Any notice required to be given hereunder shall be in writing and shall be deemed to have been duly delivered as of the date and time the same is either (i) when delivered personally or by email, unless such delivery is made (a) on a day that is not a business day in the place of receipt or (b) after 5:00 p.m. local time on a business day in the place of receipt, in either of which cases such delivery will be deemed to be made on the next succeeding business day, (ii) on the next business day after timely delivery to a reputable overnight courier, or (iii) deposited, postage prepaid, in the United States mail, to be mailed by registered or certified mail, return receipt requested, addressed to the party to whom the same is directed at the following addresses:

If to Optionee: John Clifford
Galehead Development LLC
200 Portland Street 5th Floor
Boston, MA 02114
Email: John.Clifford@GaleheadDev.com

If to Optionor: Capital Funding Services LLC
David J. Megna, Esq.
3129 County St.
Somerset, MA 02726
Email: attorneydavidmegna@gmail.com

14. **Brokerage.** Optionee and Optionor warrant and represent to each other that no real estate agents' commissions, binders, fees or other like charges are due and owing or, to the best of the knowledge and belief of either of them, are claimed or asserted by any person, firm or corporation in connection with this Option and any subsequent leasing of the Property. Each party agrees to hold the other harmless from and against any expense (including court costs and attorney's fees) resulting from any such claim which is based upon any dealings by any third party with the indemnifying party.

15. **Survival.** The provisions of this Agreement shall survive the expiration or any other termination of this Agreement for a period of twelve (12) months. In the event the Option is exercised and the Lease is executed, the provisions of this Agreement shall not survive and the provisions of the Lease shall control.

16. **Assignment.** This Agreement may be assigned by Optionee without the consent of Optionor; provided, however, Optionee shall notify Optionor of any such Assignment.

17. **General Provisions.** No failure of either party to exercise any power given hereunder or to insist upon strict compliance with any obligation specified herein, and no custom or practice at variance with the terms hereof, shall constitute a waiver of either party's right to demand exact compliance with the terms hereof. This Agreement contains the entire agreement of the parties hereto, and no representations, inducements, promises or agreements, oral or otherwise, between the parties not embodied herein shall be of any force or effect. No amendment to this Agreement shall be binding upon any of the parties hereto unless such amendment is in writing and executed by all parties hereto. The provisions of this Agreement shall inure to the benefit of and be binding upon the parties hereto and their respective administrators, executors, personal representatives, successors and assigns. This Agreement may be executed in multiple counterparts, each of which shall constitute an original, but all of which taken together shall constitute one and the same agreement. The headings inserted at the beginning of each paragraph are for convenience only, and do not add to or subtract from the meaning of the contents of each paragraph.

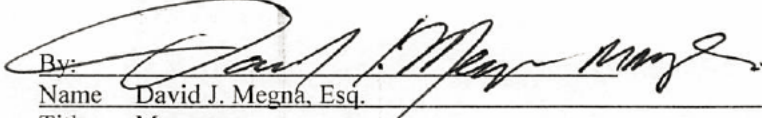
18. **Confidentiality.** Optionor agrees to keep confidential, and not publicly disclose, the terms of this Option or of the Lease and any information provided by Optionee to Optionor in relation to the transaction contemplated hereby.

Remainder of page intentionally blank

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed under seal as of the date first above written.

OPTIONOR

Capital Funding Services, LLC

By: 
Name: David J. Megna, Esq.
Title: Manager

OPTIONEE

**GaleheadDG Solutions, LLC
Galehead Development, LLC**

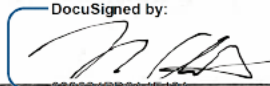
DocuSigned by:

By: _____
Name: John Clifford
Title: Authorized Signatory

EXHIBIT A

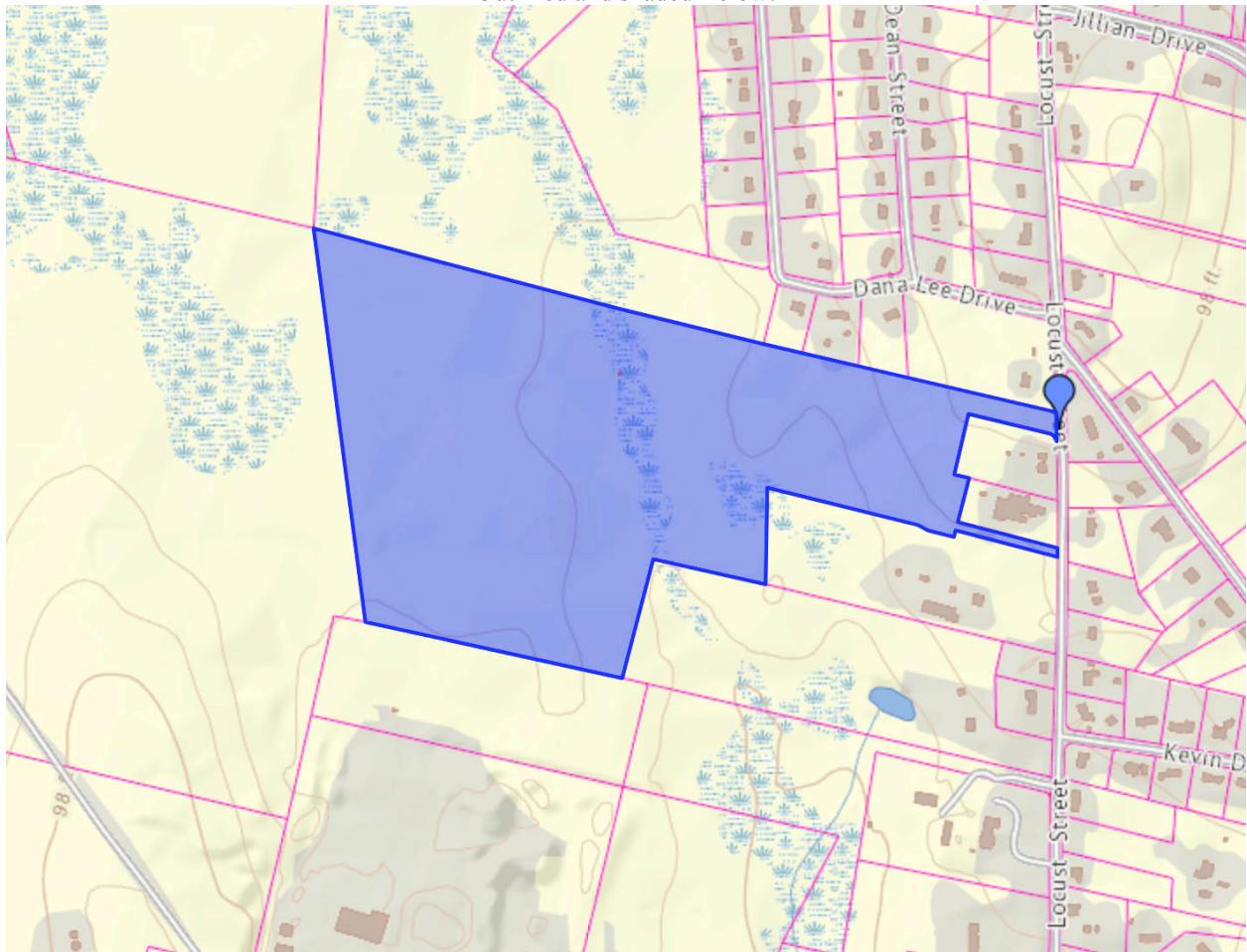
Legal Description of the Property and the Anticipated Site and Easements for the Development

Legal Description of the Property:

Located in Bristol County, Massachusetts and more particularly described as follows:

Parcels	Parcel ID	Address	Parcel Acres
1	206_49.01_0	0 Locust St. Freetown, MA 02702	26

Outlined and shaded Below:



Anticipated Site and Easements for the Development:



EXHIBIT B

Form of Ground Lease and Easement Agreement

[See attached]

GROUND LEASE AND EASEMENT AGREEMENT

This GROUND LEASE AND EASEMENT AGREEMENT (this “Ground Lease”), is dated as of _____ 201_ (“Effective Date”) between _____ (“Landlord”) and Galehead DG Solutions, LLC, a wholly owned subsidiary of Galehead Development, LLC a Massachusetts limited liability company (“Tenant”).

In consideration of the mutual agreements herein contained and other good and valuable consideration, the receipt and legal sufficiency of which are hereby acknowledged, the Parties hereto, intending to be legally bound hereby, hereby agree as follows:

1. Definitions. For all purposes of this Ground Lease the following terms shall have the meanings assigned to them in this Article 1, and include the plural as well as the singular.

- 1.1 “Affiliate” means, when used with reference to a specified Person, any other Person that directly, or indirectly through one or more intermediaries, controls, is controlled by or is under common control with the Person specified. For purposes of the foregoing, “control”, “controlled by” and “under common control with” with respect to any Person means the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such Person, whether through the ownership of voting securities, partnership interests or by contract or otherwise.
- 1.2 “Business Day” means any day other than Saturday or Sunday or a legal holiday observed by the State of _____.
- 1.3 “Casualty” means any loss or destruction of or damages to the Facility or the Site resulting from any act of God, fire, explosion, earthquake, accident or the elements, whether or not covered by insurance and whether or not caused by the fault or negligence of either Party, or such Party’s employees, agents, contractors, or visitors.
- 1.4 “Closing” has the meaning set forth in Section 23.2.
- 1.5 “Commercial Operation Date” means the date upon which Tenant notifies Landlord that the Facility is commercially operational.
- 1.6 “Easement Area” has the meaning set forth in Section 5.
- 1.7 “Environmental Laws” means any federal, state or local law, code, statute, ordinance, rule, regulation, rule of common law, guideline or informal policy position, relating to or imposing liability or standards of conduct concerning any hazardous, toxic or dangerous waste, substance or material; or any substances or mixture of any Hazardous Materials regulated thereunder, now or hereafter enacted or promulgated (collectively, and including, without limitation, any such laws which require notice of the use, presence, storage, generation, disposal or release of any Hazardous Materials to be provided to any party), including, but not limited to, the following: the Comprehensive Environmental Response, Compensation and Liability Act, as now or hereafter amended (42 U.S.C. Section 9601, et seq.); the Hazardous Materials Transportation Act, as now or hereafter

amended (49 U.S.C. Section 1801, et seq.); the Resource Conservation and Recovery Act, as now or hereafter amended (42 U.S.C. Section 6901, et seq.); and any so-called “Superfund” or “Superlien” law, or any other federal, state or local statute, law, ordinance, code, rule, regulation, order or decree regulating, relating to or imposing liability or standards of conduct concerning any hazardous, toxic or dangerous waste, substance or material; or any substances or mixture regulated under the Toxic Substance Control Act of 1976, as now or hereafter amended (15 U.S.C. Section 2601 et seq.); and any “toxic pollutant” under the Clean Water Act, as now or hereafter amended (33 U.S.C. Section 1251 et seq.); and any hazardous air pollutant under the Clean Air Act, as now or hereafter amended (42 U.S.C. Section 7901 et seq.).

- 1.8 “Environmental Liability” means any action, lawsuit, claim or proceeding (including claims or proceedings at common law or under the Occupational Safety and Health Act or similar laws relating to safety of employees) arising under or related in any way to the Environmental Laws or which seeks to impose liability for (a) noise; (b) pollution or contamination of the air, surface water, ground water or land or the clean-up of such pollution or contamination; (c) solid, gaseous or liquid waste generation, handling, treatment, storage, disposal or transportation; (d) exposure to or contamination by Hazardous Materials; (e) the safety or health of employees or (f) the manufacture, processing, distribution in commerce or use of Hazardous Materials. An “Environmental Liability” includes a common law action, whether direct or indirect, as well as a proceeding to issue, modify or terminate an Environmental Permit, or to adopt or amend a regulation to the extent that such a proceeding attempts to redress violations of an applicable permit, license, or regulation as alleged by any governmental authority.
- 1.9 “Environmental Permit” means any permit, license, approval or other authorization under any applicable Environmental Laws.
- 1.10 “Facility” means a solar photovoltaic electric generating facility or facilities and related Utilities, improvements, equipment, facilities, appurtenances and other improvements existing on the Effective Date and/or to be developed, constructed, owned, operated and maintained on the Site and the Easement Areas, including but not limited to all structures, machinery, equipment, meters, fixtures, interconnections, ancillary equipment and materials, and all additions, expansions and modifications thereto as may be located on the Site and the Easement Areas.
- 1.11 “Financing Parties” has the meaning set forth in Section 18.
- 1.12 “Financing Documents” has the meaning set forth in Section 18.
- 1.13 “Force Majeure” means all events beyond the control of the Party affected, including without limitation flood, earthquake, storm, lightning, fire, explosion, war, riot, civil disturbances, strikes, and sabotage.
- 1.14 “Hazardous Materials” means any flammable, reactive, explosive, corrosive or radioactive materials or hazardous, toxic or dangerous wastes, substances or related materials or any other chemicals, materials, wastes or substances, exposure to which is

prohibited, limited or regulated by a federal, state, county, regional or local authority, or any Environmental Laws including, but not limited to, asbestos, PCBs, petroleum products and by-products, hazardous air pollutants, or any substance identified, defined or listed as a “toxic pollutant,” “hazardous wastes,” “hazardous materials,” “hazardous substances,” “toxic substances,” “pollutant or contaminant,” “hazardous chemical,” or any hazardous air pollutant, or similarly identified in, pursuant to, or for purposes of, any Environmental Laws.

- 1.15 “Landlord’s Parties” means Landlord, its officers, directors, partners, members, affiliates, lenders, employees, shareholders, attorneys, lessees (other than Tenant), sublessees, licensees, invitees, contractors, subcontractors, consultants, agents and any of their respective successors and assigns.
- 1.16 “Lease Year” means each consecutive twelve (12) month period during the Term commencing with the first day of the first full calendar month following the Rent Commencement Date (or if the Rent Commencement Date shall occur on the first day of a calendar month, commencing on the Rent Commencement Date) and ending on the last day of the calendar month completing such twelve (12) month period.
- 1.17 “MWdc” means the design or rated nameplate capacity of the solar photovoltaic electric generating facility (as determined by the manufacturer).
- 1.18 “Official Records” means the Official Records of _____ County, _____.
- 1.19 “Party” or “Parties” means Landlord and/or Tenant, as applicable.
- 1.20 “Person” means any individual, corporation, partnership, limited liability company, joint venture, association, joint stock company, trust, estate, unincorporated organization or other business entity, or any governmental authority.
- 1.21 “Release” means any release, pumping, pouring, emptying, injecting, escaping, leaching, dumping, seepage, spill, leak, flow, discharge, disposal or emission of a Hazardous Material whether on, under or migrating to or from the property of any Party.
- 1.22 “Rent Commencement Date” the date that Tenant issues its Notice to Proceed (“NTP”) to its Engineering, Procurement and Construction (“EPC”) contractor.
- 1.23 “Rent Payment Term” means the period of time commencing with the Rent Commencement Date and expiring at the end of the Term.
- 1.24 “Site” means the property described on Exhibit A attached hereto together with all improvements located thereon as of the Effective Date, together with all rights, privileges and easements appurtenant thereto.
- 1.25 “Tenant’s Parties” means Tenant, its officers, directors, partners, members, affiliates, lenders, employees, shareholders, attorneys, lessees, sublessees, licensees, invitees, contractors, subcontractors, consultants, agents and any of their respective successors and assigns.

- 1.26 “Transfer” means a transfer or conveyance of Landlord’s interest in (i) the Site, (ii) the Easements and/or (iii) this Ground Lease.
- 1.27 “Utilities” means the services and related improvements, equipment and facilities necessary for the operation of the Facility, including, but not limited to, natural gas, electrical power, water, storm water, sanitary sewer, roads, telephone and telecommunication services, improvements, equipment and facilities.

2. Lease; Term.

2.1 Lease of Site; Term. Landlord hereby leases the Site to Tenant, and Tenant hereby leases the Site from Landlord, upon the terms and conditions hereof, for a term which shall commence on the Effective Date, and expire _____ (___) years after the Commercial Operation Date (the “Initial Term”); provided, that upon not less than 180 days’ written notice (a “Renewal Notice”) to Landlord prior to the expiration of the then expiring term, Tenant may elect to extend the term of this Lease for a period of five (5) years (the “First Renewal Term”), followed by up to one additional period of five (5) years, which may also be exercised by Tenant providing a Renewal Notice to Landlord not less than 180 days prior to the expiration of the then existing term (the “Second Renewal Term”, together with the First Renewal Term and the Initial Term, collectively, the “Term”), with each such renewal term commencing on the expiration of the then expiring term and continuing for the period specified in such Renewal Notice delivered by Tenant.

2.2 Termination Right. Tenant shall have the right to terminate this Ground Lease as follows:

2.2.1 In the event of a condition outside of Tenant’s reasonable control that prevents or materially adversely affects Tenant’s ability to use or operate any Facility located on the Site for the purposes of generating or selling electricity (a “Force Majeure Condition”), Tenant shall notify Landlord of same (“Tenant’s Force Majeure Notice”) and the parties shall meet and discuss whether there is any commercially feasible alternative for Tenant to maintain its operations on the Site. If the parties, each negotiating in good faith, cannot come to a mutually satisfactory agreement within 60 days following the date of Tenant’s Force Majeure Notice, then Tenant may, at any time following such date, elect to terminate this Ground Lease without payment of any premium, fee or other amount (other than accrued and unpaid rent, if any, through the effective date of such termination) by giving Landlord not less than 120 days notice of such termination (“Tenant’s Force Majeure Termination Notice”). In the event Tenant elects to terminate this Ground Lease with respect to less than all of the Site due to a Force Majeure Condition, Tenant’s election shall contain a description of the portion of the Site for which Tenant intends to continue this Ground Lease and the Parties shall enter and execute with due diligence an Amendment to this Ground Lease in order to (i) effectuate any revision to this Ground Lease that is required as a result of Tenant’s election and (ii) proportionately reduce the rental due hereunder.

Upon the effective date of any such termination with respect to all of the Site, as set forth in Tenant’s Force Majeure Termination Notice, this Ground Lease shall terminate

automatically and without further notice, and neither party shall have any further obligations under this Ground Lease, except as specifically set forth herein, and Tenant shall surrender the Site and Easement Areas pursuant to Article 6 hereof.

2.2.2 If for any reason other than as set forth in Section 2.2.1 above Tenant elects to terminate this Ground Lease (other than any termination based on Landlord's default, if applicable), Tenant shall notify Landlord of same ("Tenant's Elective Termination Notice") and this Ground Lease shall terminate effective as of the date which is the later of (i) the date Landlord receives Tenant's Elective Termination Notice, or (ii) the date set forth in said Tenant's Elective Termination Notice. In the event Tenant elects to terminate this Ground Lease pursuant to the provisions of this Section 2.2.2, Tenant shall pay to Landlord a termination fee (the "Termination Fee") in an amount equal to three (3) months' rent (calculated based on the annual rental rate then in effect). Upon the effective date of any such termination and the payment of the Termination Fee, this Ground Lease shall terminate and neither party shall have any further obligations under this Ground Lease, except as specifically set forth herein, and Tenant shall surrender the Site and Easement Areas pursuant to Article 6 hereof.

2.3 Holdover. If Tenant shall remain in possession of the Site after the expiration or termination of the Term, such possession shall be on a month-to-month tenancy, and the provisions of the Ground Lease shall remain applicable, except that the Base Rent shall be increased by 10%, and shall be prorated and paid in monthly installments.

3. Severance. The Parties agree that all improvements at any time constructed by or for Tenant on the Site or within any Easement Area, whether prior to the Effective Date or after the same, and all equipment at any time acquired by or for Tenant and located on the Site or within any Easement Area, including (without limitation) all improvements and equipment comprising the Facility, are hereby severed by agreement and intention of the Parties and shall remain severed from the Site and any Easement Area, shall be considered with respect to the interests of the Parties hereto as the sole and exclusive property of Tenant or a Financing Party designated by Tenant, and, even though attached to or affixed to or installed upon the Site or within an Easement Area, shall not be considered to be fixtures or a part of the Site or such Easement Area and shall not be or become subject to the lien of any mortgage or deed of trust heretofore or hereafter placed on the Site or any Easement Area by Landlord. Landlord irrevocably waives any rights it may have under the laws of the State of _____ arising under this Ground Lease or otherwise to any lien upon, or any right to distress or attachment upon, or any other interest in, any item constituting part of the Facility or any other equipment or improvements constructed or acquired by or for Tenant and located on the Site or within any Easement Area. Upon the termination of this Lease, and subject to any amendment or extension to this Lease, Tenant shall remove any and all of the aforesaid improvements and equipment and restore the Property to substantially its original condition as of the time of the execution of this Lease.

4. Rent.

- 4.1 Rent. During the Rent Payment Term, Tenant shall pay annual rent (“Base Rent”), in advance, to Landlord commencing on the Rent Commencement Date and on each anniversary of the Rent Commencement Date thereafter (each such payment date, a “Rent Payment Date”). During the Initial Term and commencing on the Rent Commencement Date, Base Rent shall be in the amount of \$_____ per MWdc of the Site per year, payable annually in advance. During the First Renewal Term, Base Rent shall be in the amount of \$_____ per MWdc of the Site per year, payable annually in advance. During the Second Renewal Term, Base Rent shall be in the amount of \$_____ per MWdc of the Site per year, payable annually in advance. The MWdc of the Site shall be as determined by Tenant’s s Interconnection Agreement (the “Interconnection Agreement”) of the Site.
- 4.2 Interest. Any overdue monetary payment due Landlord, other than late charges, not received by Landlord within ten (10) Business Days after Tenant receives notice from Landlord that such payment shall be due shall bear interest from the eleventh (11th) Business Day following the due date until the date paid. The interest charged shall be equal to the lesser of 10% per annum or the maximum rate allowed by law.
- 4.3 Late Charge. Tenant agrees to pay, upon demand by Landlord, for each payment past due for ten (10) or more Business Days after receipt of written notice of nonpayment, a late charge in an amount equal to 5% of the amount past due.

5. Further Assurances. Landlord and Tenant each agree to execute and deliver all further instruments and documents, including, without limitation, a shared facilities agreement, if necessary, and take any further action that may be reasonably necessary to effectuate the purposes and intent of this Ground Lease. To such end, Landlord shall grant to Tenant and Tenant’s Parties, or to such entity as Tenant may reasonably request, at no additional consideration, nonexclusive easements and rights-of-way in, to, over, under and across the Site and/or adjacent lands owned or controlled by Landlord, and any improvements thereon, as Tenant deems reasonably necessary or desirable in connection with the development, construction, ownership, operation, maintenance and expansion of the Facility (the “Operational Easements”) as well as a solar skyway easement (the “Solar Skyway Easement”) (the Operational Easements and the Solar Skyway Easement herein collectively referred to as the “Easements”, each also herein sometimes referred to as an “Easement”), which Easements shall burden real property owned or controlled by the Landlord (each an “Easement Area”, more than one, the “Easement Areas”). All Easements shall (a) be non-exclusive, (b) be co-terminous with the Term hereof (as the same may be extended), and (c) be appurtenant to the Site, benefit and run with the Site and burden and run with the applicable Easement Area. Without limiting the generality of the foregoing, Landlord acknowledges and agrees that Tenant may require Easements for solar skyway protection, construction laydown areas, pedestrian and vehicular ingress, egress and access, parking and circulation, electrical transmission lines, water lines, fire lines, gas lines, storm drainage, sewer lines, telephone lines, fiber optic lines, and other or associated Utilities, facilities and/or equipment serving the Facility and/or the Site. Upon any such request by Tenant, Landlord shall execute one or more easement agreements reflecting certain of the Operational Easements in substantially the form of attached Exhibit B, and a Solar Skyway Easement in substantially the form of attached Exhibit C, which easement agreements shall be recorded in the Official Records at Tenant’s expense. Landlord shall not grant or convey

any easement or other interest that, if used or enjoyed in accordance with its terms, would interfere with Tenant's operation, use and enjoyment of the Facility, the Site, and/or the Easements. If there are any mortgages, deeds of trust or other security interests with respect to the Site and/or any Easement Area(s), within thirty (30) days after Tenant's written request, Landlord shall obtain a commercially reasonable subordination, non-disturbance and attornment agreement, in a form provided by and satisfactory to Tenant from any lender or beneficiary which provides, among other things, that Tenant's occupancy or use of the Easements in accordance with the terms of the applicable easement agreement will not be disturbed.

6. Surrender of Site. Upon expiration of the Term, any termination of this Ground Lease, and any termination of this Ground Lease with respect to any portion of the Site and/or Easement Areas, Tenant shall surrender to Landlord the Site and the Easements as provided in this Article 6. In accordance with and subject to the terms of Section 3 above, within ninety (90) days after the termination or expiration of the Term, Tenant shall commence to decommission, dismantle and remove the Facility and all other property of Tenant located on the Site and the Easement Areas, returning the Site and the Easement Areas to their condition as of the Effective Date to the extent reasonably practical, and shall complete such decommissioning, dismantling and removal within one hundred eighty (180) days of commencement of the work, or such other period of time as may be agreed to by Landlord in its reasonable discretion. Landlord hereby grants to Tenant and Tenant's Parties a license to enter upon the Site and the Easement Areas to perform the activities required to be performed by Tenant pursuant to this Article 6, which license shall be effective commencing upon the date of termination or expiration of the Term and shall terminate upon the date on which such decommissioning, dismantling and removal activities are complete.

7. Nontermination. Except as specifically provided to the contrary in this Ground Lease, this Ground Lease shall not terminate, nor shall Tenant's interest in the Site, the Easements, or the Facility be extinguished, lost, conveyed or otherwise impaired, or be merged into or with any other interest or estate in the Site, the Easement Areas or any other property interest, in whole or in part, by any cause or for any reason whatsoever, including, without limitation, the following: (a) destruction of all or any part of the Facility, the Site or the taking of the Facility, or the Site or any portion thereof by condemnation, requisition, eminent domain or otherwise, (b) any prohibition, limitation or restriction of Tenant's Parties' or any Financing Party's use of all or any part of the Site or the Easements or of Tenant's Parties' or any Financing Party's use of the Facility, or the interference of such use by any Person, or any eviction by paramount title or otherwise, (c) any inadequacy, incorrectness or failure of the description of the Site, the Easements or any other property or rights intended to be granted or conveyed by this Ground Lease, or (d) insolvency, bankruptcy, reorganization or similar proceedings by or against either Party.

8. Possession and Quiet Enjoyment. As long as no Tenant Event of Default under this Ground Lease has occurred and is continuing beyond any applicable cure period, Landlord covenants and agrees that Tenant shall enjoy quiet possession of the Site and the Easements without any disturbance from Landlord or any person claiming by or through Landlord.

9. Use of Site; Development of Facility.

- 9.1 Use. During the Term, Tenant shall have exclusive use of the Site. Tenant may use the Site and the Easement Areas for purposes related to due diligence investigations and studies, and the construction, use, operation, repair, ownership, replacement, expansion, modification, upgrade or maintenance of the Facility and for any other lawful use. Moreover, Tenant shall have a right to use the Site and Easement Areas to undertake any other activities, whether accomplished by Tenant or a third person or entity authorized by Tenant, that Tenant determines are necessary, appropriate, desirable or convenient in connection with, incidental to or to accomplish any of the foregoing purposes for the Facility.
- 9.2 Construction of the Facility. Tenant shall determine whether and when to construct (or cause the construction of) the Facility on the Site and within the Easement Areas in its sole discretion and nothing herein shall obligate Tenant to construct the Facility on the Site or within the Easement Areas. Should Tenant seek to obtain any permits, licenses, exemptions or certifications in connection with the Facility, Landlord agrees to cooperate fully and promptly with Tenant in such efforts. To the extent permitted by law, all permits, licenses, exemptions and certifications for the construction of the Facility shall be in the name of and for the benefit of Tenant or a party designated by Tenant. Landlord has no obligation to upgrade, update, expand, replace, make additions to, or otherwise modify the Site or the Facility.
- 9.3 Maintenance. During the Term, Tenant shall be responsible for the general maintenance of the Site, and so much of the Easement Areas as may be agreed upon, in accordance with prudent industry standards given the permitted use hereunder.
- 9.4 Liens. Tenant shall keep the Site and Easement Areas free and clear of any mechanics' or materialmen's lien arising out of work performed, materials furnished or obligations incurred in connection with Tenant's obligations for construction, utilities and services, repairs or alterations under this Ground Lease. In the event any lien is placed upon the Site or Easement Areas as a result of any act or omission of Tenant, Tenant shall pay such lien or may provide a bond or otherwise insure Landlord against such lien within sixty (60) calendar days after notice to Tenant of such lien being perfected, and may thereafter contest such lien or payment at Tenant's sole cost and expense. Tenant shall indemnify Landlord against any loss, damage, cost or expenses in connection with any such lien or encumbrance that may be claimed or asserted against the Site or Easement Areas.
- 9.5 Subsurface Rights. To the extent Landlord possesses sub-surface rights with respect to the Site, all prospecting for or development of geothermal substances, minerals, oils, gas, petroleum, or other substances located on, within, underneath, adjacent to, or within the vicinity of the Site shall be performed a minimum of five hundred (500) feet from the Site and in such manner and by methods that will neither penetrate within five hundred (500) feet directly beneath the surface of the ground within the Site nor interfere with the exercise of the rights granted herein. Any damages or loss to either the Facility or the Site that are directly related to prospecting for or development of geothermal substances, minerals, oils, gas, petroleum, or other substances located on, within, underneath, adjacent to, or within the vicinity of the Site shall be borne solely by

the Landlord. Landlord shall fully cooperate with any request by Tenant to obtain a surface use, accommodation or like agreement from the holder of any mineral, oil, gas, petroleum or other subsurface right.

10. Insurance.

10.1 Coverage. As to all activities hereunder, the following insurance shall be obtained and maintained in force during the Term by Tenant so long as such insurance is available at commercially reasonable rates.

(a) Commercial General Liability. Commercial General Liability insurance including, but not limited to, coverage for premises/operations, explosion, collapse and underground hazards, products/completed operations, property damage and bodily injury providing for minimum limits of \$1,000,000.00 for bodily injury, including death, and property damage, arising from any one occurrence, and a \$2,000,000.00 aggregate limit.

(b) Workers' Compensation Insurance. Workers' Compensation insurance or qualified self-insurance in accordance with State and Federal laws.

(c) Policy Terms. The liability policy described above in clause (a) shall be primary, without right of contribution from any other insurance which may be carried by Landlord, and (b) shall include Landlord, as an additional insured to the extent of the indemnity obligations assumed hereunder by Tenant with respect to liability coverage.

10.2 Certificates. Prior to commencement of construction of the Facility and thereafter upon Landlord's written request (but no more than one (1) time in any calendar year), Tenant shall provide Landlord hereto with written evidence of the insurance required in Section 10.1(a) – (b) above in the form of appropriate insurance certificates specifying amounts of coverage and expiration dates of all policies in effect.

10.3 Waiver of Subrogation. Notwithstanding any provision in this Ground Lease to the contrary, each party waives and releases, to the extent of the proceeds that are payable to it in respect of any policy or policies of property insurance that it maintains in force or that is required to be maintained by this Ground Lease, any and all rights of recovery, claim, action or cause of action that it may now or later have against the other or the other's agents, officers, managers and employees, by virtue of any loss or damage that may occur to the Facility or related improvements or to personal property located at the Facility, regardless of cause or origin, including, without limitation, the negligence of Landlord or Tenant or any of their respective agents, representatives, employees, contractors or invitees. All policies obtained hereunder shall have a provision waiving rights of subrogation by the insurer against the Parties hereto.

10.4 Waiver of Insurance; Right to Self-Insure. In the event any insurance (including the limits of deductibles thereof) hereby required to be maintained, other than insurance required by law to be maintained, shall not be commercially available and commercially feasible in

the commercial insurance market, in Tenant's reasonable determination, Tenant shall advise Landlord of same explaining in detail the basis for such conclusions. In such event, the applicable requirement shall be deemed waived, and Tenant shall be deemed to self-insure for such coverage(s). Any such waiver shall be effective only so long as such insurance shall not be available and commercially reasonable, in Tenant's reasonable discretion. Notwithstanding anything herein to the contrary, Tenant shall have the right to self-insure.

11. Damage or Destruction of Facility. If the Facility or any part thereof is damaged or destroyed by any Casualty, all insurance proceeds related thereto shall be the property of Tenant, and Tenant shall have the right, but not the obligation, to repair and restore the Facility or to construct and operate such new facility as it deems appropriate. If the Facility is damaged or destroyed and Tenant elects not to repair or restore the Facility or to construct a new facility, Tenant shall have the right to terminate this Ground Lease, without penalty, effective as of the date of Casualty by giving written notice of termination to Landlord within ninety (90) days after the date of Casualty. If Tenant exercises its termination right as provided in the preceding sentence, Tenant shall surrender the Site and the Easement Areas as provided in Article 6 above but shall not be required to make any payment under Section 2.2 above.

12. Liabilities.

12.1 General.

(a) Tenant. Tenant shall indemnify, defend and hold Landlord and Landlord's Parties harmless from any and all claims, losses, expenses, liabilities, actions, suits, or judgments for personal injury or property damage, including those of third parties (collectively, "Losses") by reason of, resulting from, whether directly or indirectly, or arising out of or related to (i) the negligence or willful misconduct of Tenant or any Tenant Party in connection with the transactions contemplated by this Ground Lease; (ii) any release of Hazardous Materials on the Site caused or permitted by Tenant or any Tenant Party; or (iii) any environmental claim from a third party with regard to a violation or alleged violation of any Environmental Laws by Tenant or any Tenant Party.

(b) Landlord. Landlord shall indemnify, defend and hold Tenant and Tenant's Parties harmless from any and all Losses to the extent arising prior to or after the Effective Date by reason of, resulting from, whether directly or indirectly, or arising out of or related to (i) the negligence or willful misconduct of Landlord or any Landlord Party in connection with the transactions contemplated by this Ground Lease; (ii) the inaccuracy of any representation or warranty of Landlord contained in this Ground Lease; (iii) any release of Hazardous Materials on the Site or any of the Easement Areas caused or permitted by Landlord or any Landlord Party; or (iv) any environmental claim from a third party with regard to a violation or alleged violation of any Environmental Laws by Landlord or any party other than Tenant.

(c) The provisions of this Section 12.1 shall survive the expiration or termination of the Term, and, as to Landlord's obligation to indemnify, defend, and hold Tenant and Tenant's Parties harmless, shall survive Landlord's Transfer with respect to any occurrence prior to such Transfer.

12.2 Consequential Damages. Notwithstanding anything to the contrary in this Ground Lease, neither Party hereto shall be liable to the other for consequential or punitive damages, including but not limited to loss of use or loss of profit or revenue.

13. Default.

13.1 Events of Default. The following events shall be deemed to be events of default by Tenant ("Tenant Events of Default") under this Ground Lease:

(a) Failure to make any payment required to be made hereunder, including taxes or any other sum to be paid hereunder, within twenty (20) Business Days after the date the same is due which shall have remained unpaid for ten (10) Business Days after written notice of such failure has been given to Tenant by Landlord.

(b) Failure to comply in any material respect with any material term, provision or covenant of this Ground Lease, other than the payment of sums to be paid hereunder, without curing such failure within sixty (60) days after written notice thereof from Landlord; or if such failure cannot reasonably be cured within the said sixty (60) days and Tenant shall not have commenced to cure such failure within said period and shall not thereafter with reasonable diligence proceed to cure such failure.

13.2 Landlord's Remedies. Upon the occurrence of any Tenant Event of Default, but subject to the terms and conditions of Article 18 hereof, Landlord may, at its option, and in addition to and cumulatively of any other rights Landlord may have at law or in equity or under this Ground Lease, (a) cure the Tenant Event of Default on Tenant's behalf, in which event Tenant shall reimburse Landlord on demand for all actual sums so expended by Landlord, (b) terminate this Ground Lease by notice to Tenant and in conformity with procedures required hereby and by applicable law, or (c) enforce, by all proper and legal suits and other means, its rights hereunder, including the collection of sums due hereunder, in which event Landlord shall have all remedies available at law or in equity, and should it be necessary for Landlord to take any legal action in connection with such enforcement, Tenant shall pay Landlord all reasonable attorneys' fees and expenses so incurred, all without prejudice to any remedies that might otherwise be used by Landlord for recovery or arrearages of sums due hereunder, damages as herein provided, or breach of covenant.

13.3 Landlord Events of Default. The following events shall be deemed to be events of default by Landlord ("Landlord Events of Default") under this Ground Lease regardless of the pendency of any bankruptcy, reorganization, receivership, insolvency or other proceeding

which have or might have the effect of preventing Landlord from complying with the terms of this Ground Lease.

(a) Failure to pay any payment required to be made hereunder within twenty (20) Business Days after the date the same is due which shall have remained unpaid for ten (10) Business Days after written notice of such failure has been given to Landlord by Tenant.

(b) Failure to comply in any material respect with any material term, provision or covenant of this Ground Lease, other than the payment of sums to be paid hereunder, without curing such failure within sixty (60) days after due written notice thereof from Tenant; or if such failure cannot reasonably be cured within the said sixty (60) days and Landlord shall not have commenced to cure such failure within said period and shall not thereafter with reasonable diligence and good faith proceed to cure such failure.

(c) Any act(s) or omission(s) of Landlord that, in the aggregate, in any way, directly or indirectly, adversely, materially, and substantially impacts, affects or impairs Tenant's ability to operate and/or the operation of the Facility.

13.4 Tenant's Remedies. Upon the occurrence of any Landlord Event of Default, Tenant may, at its option, and in addition to and cumulatively of any other rights Tenant may have at law or in equity or under this Ground Lease, (a) cure the Landlord Event of Default on Landlord's behalf, in which event Landlord shall reimburse Tenant on demand for all sums so expended by Tenant or Tenant may elect to offset any such amounts against subsequent installments of Base Rent or any other sums due from Tenant to Landlord hereunder, (b) terminate this Ground Lease by notice to Landlord and in conformity with procedures required hereby and by applicable law, or (c) enforce, by all proper and legal suits and other means, its rights hereunder, including the collection of sums due hereunder, in which event Tenant shall have all remedies available at law or in equity, and should it be necessary for Tenant to take any legal action in connection with such enforcement, the Landlord shall pay Tenant all reasonable attorneys' fees and expenses so incurred, all without prejudice to any remedies that might otherwise be used by Tenant for recovery or arrearages of sums due hereunder, damages as herein provided, or breach of covenant.

14. Governing Law. This Ground Lease and all provisions hereof, shall be governed by and interpreted in accordance with the laws of the State of _____.

15. Force Majeure.

15.1 Force Majeure. The performance of each Party's respective obligations under this Ground Lease, other than failure or delay in payment of obligations, shall be excused during such times and to the extent such performance is prevented by reason of Force Majeure.

15.2 Resumption of Performance. The Party whose performance is suspended, prevented or delayed by Force Majeure shall promptly notify

the other Party of such occurrence and its estimated duration. Subject to any rights of termination under this Ground Lease, such Force Majeure shall be promptly remedied, if and to the extent reasonably possible.

16. Condemnation. If at any time the Site, the Easements, or any portion thereof is condemned or transferred in lieu of condemnation, the net proceeds of such condemnation or transfer shall be divided between Landlord and Tenant (or Tenant's designee) in the proportions specified in the condemnation award or agreement of transfer or, if not so specified, in proportion to the fair value of Landlord's and Tenant's respective interests in the Site and the Easements, provided that to the extent that the net proceeds of any condemnation or transfer in lieu of condemnation are attributable to the Facility or improvements constructed by or on behalf of Tenant on the Site and/or the Easements, such proceeds shall be paid solely to Tenant or Tenant's designee, with Landlord receiving any proceeds attributable solely to the residual value of the fee estate of the Site. For the purpose of this Article 16, the net proceeds of a condemnation or transfer in lieu of condemnation shall mean the total proceeds of such condemnation or transfer less the costs and expenses incurred in connection therewith (including legal fees).

16.1 If the entire Site is condemned or transferred in lieu of condemnation, the Term shall terminate at the time title vests in the condemning authority. If a portion of the Site is condemned or transferred in lieu of condemnation, the Ground Lease shall continue in full force and effect with respect to that portion of the Site which has not been so condemned or transferred, and Base Rent shall abate with respect to that portion of the Site which has been so condemned or transferred. Notwithstanding the foregoing, Tenant may terminate this Ground Lease without penalty by giving written notice of termination to Landlord if, in Tenant's discretion, the Site or the Easements are not suitable for Tenant's intended use following such condemnation or transfer in lieu thereof.

17. Maintenance Responsibilities of Parties. No Party shall have any duty or responsibility to the other Party in respect of the Site or the Easement Areas or the use, maintenance or condition thereof except such obligations of such Party as are specifically set forth in this Ground Lease.

18. Mortgage of Tenant's Interest.

18.1 Tenant may at any time elect to finance all or any portion of the Facility with one or more financial institutions, leasing companies, institutions or affiliates or subsidiaries thereof (each a "Financing Party," collectively, the "Financing Parties") and in connection therewith Tenant may enter into various agreements and execute various documents relating to such financing, which documents may, among other things, assign this Ground Lease and the Easements to a Financing Party, grant a sublease in the Site and a lease of the Facility from such Financing Party to Tenant, grant the Financing Parties a sublease or other real property interest in Tenant's interests in and to the Site, grant a mortgage and/or security interest in Tenant's interest in the Facility and/or this Ground Lease and Tenant's other interests in and to the Site, including, but not limited to, any easements, rights of way or similar interests (such documents, "Financing Documents"). Landlord acknowledges notice of the foregoing and consents to the foregoing actions and

Financing Documents described above, and Landlord agrees to execute, and agrees to cause any and all of Landlord's lenders to execute, such subordination agreements, consents, estoppels and other acknowledgements of the foregoing as Tenant or the Financing Parties may reasonably request. Landlord agrees that if requested by Tenant, Landlord will furnish the Financing Parties with a counterpart of each notice or other document delivered by Landlord to Tenant in connection with this Ground Lease.

- 18.2 Landlord agrees that it shall not terminate this Ground Lease, or assert a partial or total eviction, unless it has given each Financing Party prior written notice of its intent to terminate this Ground Lease or assert a partial or total eviction, and the Financing Parties fail to cure the condition giving rise to such right of termination within, as applicable, (i) thirty (30) days following the expiration of Tenant's cure period set forth in Section 13.1(a) or (ii) ninety (90) days following the expiration of Tenant's cure period set forth in Section 13.2(b); provided, however, that and provided, further, that the Financing Parties shall have no obligation to cure any default on the part of Tenant that is not reasonably susceptible of cure.
- 18.3 If the default under this Ground Lease is of such a nature that it cannot be practicably cured without first taking possession of the Facility and the Site or if such default is of a nature that is not susceptible of being cured by the Financing Parties, then Landlord shall not be entitled to terminate this Ground Lease or assert a partial or total eviction by reason of such default if and so long as the Financing Parties proceed diligently to attempt to obtain possession of the Facility and the Site pursuant to the rights of the Financing Parties under the Financing Documents and upon obtaining such possession, the Financing Parties shall proceed diligently to cure such default if such default is reasonably susceptible of being cured by the Financing Parties. The Financing Parties shall not be required to continue to proceed to obtain possession, or to continue in possession of the Site, pursuant to Section 18.3 if and when such default is cured.
- 18.4 If the Financing Parties (or their designee) or another Person shall succeed to the rights of Tenant under this Ground Lease through possession or foreclosure action, delivery of a deed (or assignment of this Ground Lease) in lieu of foreclosure or otherwise, Landlord shall recognize the Financing Parties (or their designee) or such other Person (the Financing Parties, their designees, or such Person, a "Successor-Tenant"), as Tenant under this Ground Lease and Landlord and/or such Successor-Tenant shall promptly execute and deliver any instrument that either may reasonably request to evidence such recognition as Tenant under this Ground Lease. Furthermore, this Ground Lease shall continue in full force and effect as, a direct lease between Successor-Tenant and Landlord upon all terms, conditions and covenants as are set forth in this Ground Lease, except that (x) Successor-Tenant shall assume the obligations of Tenant to be performed hereunder first arising from and after the date such Successor-Tenant succeeds to the rights of Tenant under this Ground Lease, (y) Successor-Tenant shall promptly cure all outstanding monetary defaults of Tenant (including paying all prior unpaid Rent) and (z) Successor-Tenant shall promptly cure all other outstanding non-monetary defaults of Tenant that are continuing as of the date such Successor-Tenant succeeds to the rights of Tenant under this Ground Lease, are reasonably susceptible of cure and of which Successor-Tenant has received notice and a reasonable opportunity to cure (in accordance

with the provisions of Section 18.2 above) once it has obtained possession of the Site. If the Successor-Tenant is one or more of the Financing Parties, such party shall not be personally liable to Landlord for the performance of its obligations hereunder except to the extent of its interest in the Facility.

- 18.5 In the case of termination of this Ground Lease by reason of any default or for any other reason including rejection in bankruptcy, Landlord shall give prompt notice thereof to the Financing Parties. Landlord, on written request of the Financing Parties made any time within ninety (90) days after the giving of such notice by Landlord (and upon cure by the Financing Parties of all monetary defaults of Tenant), shall promptly execute and deliver a new lease of the Site to the Financing Parties or their nominee, for the remainder of the term of this Ground Lease upon all of the terms and conditions contained in this Ground Lease (subject to any changes as the parties may mutually agree) which new lease shall require the Financing Parties or their nominee to cure promptly all other non-monetary defaults of Tenant that are continuing as of the date of such new lease, are reasonably susceptible of cure and of which the Financing Parties or their nominee has received notice and a reasonable opportunity to cure (in accordance with the provisions of Section 18.2 above) once the Financing Parties or their nominee has obtained possession of the Site).
- 18.6 Notwithstanding anything to the contrary contained in this Ground Lease, Landlord agrees that any delivery of a deed or assignment of this Ground Lease pursuant to foreclosure proceedings, or by deed or assignment in lieu of foreclosure or otherwise to the Financing Parties or to any successors or assigns of the Financing Parties (including any purchaser of the leasehold estate) in and to the Site upon or following a foreclosure pursuant to the Financing Documents (or delivery of a deed or assignment of this Ground Lease in lieu of foreclosure) shall not be subject to the prior written consent of Landlord.
- 18.7 Landlord agrees that without the prior written consent of the Financing Parties, Landlord shall not (x) accept a surrender of this Ground Lease, (y) permit the subordination of this Ground Lease to any mortgage encumbering the fee estate of the Site, or Landlord's interest in this Ground Lease, or (z) in the event of any bankruptcy of Tenant, file any application seeking to reject this Ground Lease under the United States Bankruptcy Code. Any such purported action without the Financing Parties' consent shall be void.
- 18.8 Landlord shall consider in good faith (and, where customary, accept) any modifications or amendments to this Ground Lease reasonably requested by the Financing Parties in connection with the financing or refinancing of the Facility from time to time. In addition, Landlord shall promptly execute any additional documentation (including any non-disturbance and attornment agreement), as may be mutually agreed upon in form and substance, that is reasonably requested by the Financing Parties.
- 18.9 The provisions of this Article 18 are for the benefit of the Financing Parties as well as of Landlord and Tenant, and shall be enforceable by each. Landlord hereby agrees that none of the Financing Parties shall be obligated to perform any obligation hereunder or shall have any obligation or liability to Landlord with respect to this Ground Lease, except as provided in this Article 18 or in any other agreement or instrument entered into

(i) by a Financing Party and Landlord in connection with the mortgaging, encumbrance pledge and/or collateral assignment of this Ground Lease by Tenant or (ii) by a Financing Party or its designee in connection with the assumption of interests, rights and obligations hereunder.

19. Landlord's Representations and Covenants.

19.1 Condition of Title; Warranty of Authority; Enforceability. Landlord represents and warrants as of the Effective Date that Landlord owns fee title to the Site and the Easement Areas free and clear of any lien, interest or encumbrance, subject only to the matters and exceptions approved in writing by Tenant on or before the Effective Date and shown in that certain Title Insurance Commitment prepared by _____, Commitment No. _____ having an effective date of _____, 201__ (the "Commitment"). At any time on or after the Effective Date, Tenant may obtain for itself and/or any Financing Party, at Tenant's expense, an ALTA Extended Coverage policy of title insurance in a form and with exceptions acceptable to Tenant and/or such Financing Party in its sole discretion (the "Title Policies"). Landlord agrees to cooperate fully and promptly with Tenant in its efforts to obtain the Title Policies, and Landlord shall take such actions as Tenant or any Financing Party may reasonably request in connection therewith. Landlord represents and warrants that (a) there are no pending or threatened claims, actions or suits affecting the Site or the Easement Areas or Landlord's interest in the Site or the Easement Areas; (b) the execution and performance of this Ground Lease by Landlord does not violate any contract, agreement or instrument to which Landlord is a party and Landlord has not entered into any contract, agreement or instrument with respect to the Site or the Easement Areas with any third party other than Tenant; (c) the execution, delivery and performance by it under this Ground Lease have been duly authorized by all necessary action by Landlord and do not violate any provision of any current law applicable to Landlord, the Site or the Easement Areas or any order, judgment or decree of any court or other agency presently binding on Landlord or conflict with or result in a breach of or constitute a default under any contractual obligation of Landlord; and (d) this Ground Lease is the legally valid and binding obligation of Landlord enforceable against it in accordance with its terms except as enforcement may be limited by bankruptcy, insolvency, or reorganization, moratorium or similar laws or equitable principles relating or limiting creditors rights generally.

19.2 Environmental. Landlord represents and warrants that, to Landlord's knowledge, as of the Effective Date (a) the Site and Easement Areas are free of known or identified Hazardous Materials, no Hazardous Materials have ever been produced or disposed upon the Site or the Easement Areas, no Release has occurred on the Site or the Easement Areas and Hazardous Materials have not migrated to the Site or the Easement Areas, (b) the Site and the Easement Areas and are in compliance with all Environmental Laws, (c) neither the Site nor the Easement Areas are subject to any Environmental Liability, threatened Environmental Liability or alleged Environmental Liability, and (d) Landlord has not received notice of any violation of Environmental Laws affecting the Site or the Easement Areas.

19.3 Subordination Agreements. Landlord shall, at its expense, within sixty (60) days following the Effective Date (or such later date as Tenant may request), remove, or cause to be subordinated to the Ground Lease, all monetary obligations that are described as exceptions in the Commitment. Any such subordination agreement shall be in a form as may be reasonably acceptable to Tenant, which provides, among other things, that Tenant's occupancy or use of the Site and the Easement Area(s) in accordance with the terms of this Ground Lease will not be disturbed by anything related to said exceptions to the Title Policies.

20. Utilities. Tenant shall pay for all Utilities consumed by Tenant at the Site during the Term.

21. Taxes.

21.1 Covenant to Pay Taxes and Assessments. Commencing as of the Rent Commencement Date, Tenant shall be responsible for and promptly pay before default any and all real and personal property taxes or assessments ("Taxes and Assessments"), if any, that may be levied or assessed against the Site (but not any Easement Area(s)) or any improvements or other property owned by or under the control of Tenant situated on the Site or any Easement Area.

21.2 Separate Tax Parcel(s); No Proration at Commencement and Expiration of Term. The Parties shall use good faith and duly diligent efforts to cause the Site to be designated as a separate tax parcel, independent from the balance of Landlord's surrounding property, if any. At all times during the term hereof when the tax bills for the Site are being sent to Landlord, Landlord shall deliver copies of same to Tenant within twenty (20) days following Landlord's receipt of same. In the event the Site is so designated as a separate tax parcel, Tenant shall be responsible for paying, and shall timely pay, all Taxes and Assessments (or similar) applicable to the separate tax parcel. In the event the Site is not a separate tax parcel, Tenant shall be responsible for only paying its proportionate share thereof, based on a per acre allocation of the acreage within the Site and such Easement Area and the total acreage of the larger parcel of which the Site and/or Easement Area is a portion. Until such time, if ever, that the Site is designated as one or more separate tax parcel(s), Landlord shall be responsible for timely paying all Taxes and Assessments for all of the larger parcel(s) within which the Site and the Easement Areas are located, and following Landlord's payment of same, Landlord shall provide Tenant with a paid receipt for such Taxes and Assessments and Tenant shall reimburse Landlord for its prorata share (on a per acre basis) of such Taxes and Assessments. In the event Landlord fails to timely pay any Taxes and Assessment for which Landlord is responsible hereunder, Tenant shall have the right to make such payment and to offset the cost thereof against any future amounts owed to Landlord hereunder.

21.3 Tenant's Right to Contest Taxes. Tenant shall have the sole right to contest any Taxes or Assessments payable by Tenant by appropriate legal proceedings which shall have the effect of preventing the collection of the tax or assessment and the sale or foreclosure of any lien for such tax or assessment. Tenant shall have the right, at its sole expense, to institute and prosecute, in Landlord's name, any suit or action to contest any tax or

assessment payable by Tenant or to recover the amount of any such tax or assessment but, in such event, Tenant hereby covenants and agrees to indemnify and save Landlord harmless from any and all reasonable and documented costs and expenses, including attorneys' fees, in connection with any such suit or action. Any funds recovered by Tenant as a result of any such suit or action shall belong to Tenant.

22. Assignment.

22.1 Assignment by Landlord. Landlord may assign this Ground Lease only to an assignee acquiring fee title to the Site. In furtherance of the foregoing, the Landlord shall not, without Tenant's prior written consent, which it may withhold in its sole discretion, assign, sell, hypothecate or otherwise transfer the rights to develop, install, operate and maintain solar photovoltaic electric generating systems on, over, under and across the Site or any other rights granted under this Ground Lease, including the right to receive payments from Tenant, separate and apart from fee title to the Site, and any attempted assignment shall be void ab initio. Landlord reserves the right, during the term of this Ground Lease, to encumber the Site by mortgage or other security instrument, as long as Landlord's lender subordinates its lien(s) to this Ground Lease and to the liens of any Financing Party. If the Site is subject to a mortgage, Landlord agrees to pay all obligations secured by such mortgage. If Landlord does not pay such obligations, Tenant may pay, but is not obligated to pay, any of such obligations which Landlord does not pay, and Tenant may offset such payments against fees otherwise due Landlord under this Ground Lease.

22.2 Assignment by Tenant. Tenant may sell, assign, sublease, mortgage, pledge, or otherwise transfer its interest in this Ground Lease without the prior written consent of Landlord, provided that said transferee assumes all of the obligations of Tenant under this Ground Lease arising after such transfer.

23. Right of First Offer.

23.1 Right of First Offer. Throughout the Term of this Ground Lease, Tenant shall have a continuing right to purchase the Site as it becomes available (the "Right of First Offer"). Should Landlord (a) receive an offer to purchase the Site or any portion thereof from any third party during the Term, which offer the Landlord contemplates accepting (a "Bona Fide Offer") or (b) intend to offer all of the Site for sale (a "Landlord Offer" and, together with a Bona Fide Offer, collectively, an "Offer"), Landlord shall promptly give written notice and a copy of such Bona Fide Offer to Tenant, or the material terms of a Landlord Offer (including, without limitation, purchase price, location and size of offered acreage, due diligence contingencies and closing date), as applicable. Tenant shall have the right to purchase the Site or portions thereof as set forth in the relevant Offer by giving written notice to Landlord that Tenant is exercising its Right of First Offer upon the terms set forth in the relevant Offer, no later than thirty (30) Business Days after Tenant's receipt of the relevant Offer from Landlord. If such Offer includes acreage outside of the Site, Tenant may, at its option, purchase only the Site or portion thereof covered by the Offer or the entirety of the acreage covered by the Offer and Tenant shall pay a prorated purchase price based on acreage for the Site if Tenant

purchases only the Site. Landlord shall not be permitted to offer a portion of the Site for sale pursuant to a Landlord Offer or to seek any subdivision of the Site without the prior written consent of Tenant in its sole and absolute discretion. If Tenant does not exercise its Right of First Offer within such 30-Business Day period, then Landlord may sell the Site to the third party who made the Bona Fide Offer or any other third party with respect to an Landlord Offer on the same terms, covenants and conditions as presented to Tenant in the relevant Offer, subject to Article 22 above and the terms and conditions of this Ground Lease; provided, that if there is any material change to the terms of the Offer, Landlord shall promptly send Tenant a copy of the revised Offer and Tenant shall have a Right of First Offer to purchase the Site according to the terms of the revised Offer under the procedure set forth in this Section 23.1. Any such sale shall be made, if at all, within six (6) months of the end of the 30-Business Day period, and if the sale is not completed within such time period, Tenant's Right of First Offer shall revive and the provisions of this Section 23.1 shall again be operative.

23.2 Closing. If Tenant exercises its Right of First Offer or otherwise purchases the Site, the closing of the sale (the "Closing") shall be conducted as follows.

(a) Closing shall take place at a time and in a location mutually acceptable to the Parties hereto; provided, that Closing shall take place no later than the expiration of the then current Term hereof unless extended in writing by the Parties.

(b) Landlord shall deliver marketable title to the Site or the applicable portion thereof to Tenant by general warranty deed, free and clear of all liens and other encumbrances, other than those created, approved, or agreed to by Tenant, as evidenced by an ALTA Extended Coverage Owner's policy of title insurance in the full amount of the purchase price issued by the title company approved by Tenant and in a form approved by Tenant in its sole discretion. Further, Landlord shall grant to Tenant the Easements then in effect as permanent indefeasible easements appurtenant to the Site.

(c) Except as otherwise provided by this Ground Lease or otherwise agreed to by the Parties, Landlord and Tenant shall share all closing costs in accordance with the custom and practice in _____ County, _____.

(d) The sale of the Site or the applicable portion thereof to Tenant shall be made subject to the following representations and covenants by Landlord as "seller" effective as of the date of Closing.

(i) Landlord has marketable, fee simple title to the Site and the Easement Areas or the applicable portion(s) thereof and Landlord has full power and authority to sell the Site or the applicable portion thereof and to grant the Easements as permanent indefeasible easements appurtenant to the Site. The documents delivered by Landlord at closing will be duly authorized, executed and delivered by Landlord, and will be the legal, valid and binding obligations of Landlord.

(ii) Landlord has not sold, transferred, pledged or assigned its interests in the Site or the Easement Areas or the applicable portion(s) thereof to any person and, except for the interests of Tenant under the Ground Lease, no such person has any interest, right or claim in and to the Site or the Easement Areas or the applicable portion(s) thereof. There are no claims or judgments, pending or (to Landlord's knowledge) threatened suits, actions, arbitrations or proceedings, or any governmental investigations affecting the Site or the Easement Areas or the applicable portion(s) thereof, and no notice of proposed condemnation or other taking or notice of violation of any ordinances, laws, or regulations have been received by Landlord with respect to the Site or the Easement Areas or the applicable portion(s) thereof.

(iii) Each of the representations and covenants made by Landlord shall be true and correct in all respects on the date of Closing and shall survive the Closing. Landlord shall indemnify Tenant and Tenant's Parties for, and hold it harmless from, any claims, damages, liabilities, costs and expenses (including reasonable attorney's fees), arising from or under, or by reason of any breach of, Landlord's representations or covenants.

24. Miscellaneous.

24.1 Notices. Any notice, consent or other formal communication required or permitted to be given by a Party pursuant to the terms of this Agreement shall be in writing and shall be deemed delivered (a) when delivered personally or by email, unless such delivery is made (i) on a day that is not a business day in the place of receipt or (ii) after 5:00 p.m. local time on a business day in the place of receipt, in either of which cases such delivery will be deemed to be made on the next succeeding business day, (b) on the next business day after timely delivery to a reputable overnight courier and (c) on the business day actually received if deposited in the U.S. mail (certified or registered mail, return receipt requested, postage prepaid), addressed as follows (or to such other address or having such other contact information as either Party may hereafter specify for such purpose by like notice to the other Party from time to time):

(a) if to Tenant, addressed to:

_____ LLC

Attention: _____

Email: _____@_____

Phone: (____) ____ - _____

With a copy to:

Attention: _____
Email: _____@_____
Phone: (____) ____-_____

(b) if to Landlord, addressed to:

Email:

or to such other address as either Party shall from time to time designate in writing to the other Party.

24.2 Counterparts; Signatures. This Ground Lease may be executed in counterparts. All executed counterparts shall constitute one agreement, and each counterpart shall be deemed an original. The Parties hereby acknowledge and agree that facsimile signatures or signatures transmitted by electronic mail in so-called “pdf” format shall be legal and binding and shall have the same full force and effect as if an original of this Ground Lease had been delivered. Landlord and Tenant (i) intend to be bound by the signatures on any document sent by facsimile or electronic mail, (ii) are aware that the other Party will rely on such signatures, and (iii) hereby waive any defenses to the enforcement of the terms of this Ground Lease based on the foregoing forms of signature.

24.3 Amendments. Neither this Ground Lease nor any of the terms hereof may be terminated, amended, supplemented, waived or modified orally, but only by an instrument in writing signed by the Party against which the enforcement of the termination, amendment, supplement, waiver or modification shall be sought.

24.4 Headings, etc. The headings of the various Articles and Sections of this Ground Lease are for convenience of reference only and shall not modify, define, expand or limit any of the terms or provisions hereof.

24.5 Successors and Assigns. The terms of this Ground Lease shall be binding upon, and inure to the benefit of, the Parties hereto and their respective successors and permitted assigns.

24.6 Confidentiality. Landlord and Tenant each agree to use commercially reasonable efforts to keep confidential, and not publicly disclose, the terms of this Ground Lease and any information provided by Landlord to Tenant or by Tenant to Landlord in relation to the transaction contemplated hereby; provided, however, that either Party may disclose the existence and terms of this Ground Lease to: (a) its consultants, agents, architects, independent contractors, or attorneys in connection with

the execution of this Ground Lease, (b) any bona fide potential purchaser or lender of the Facility who agrees to keep such information confidential, (c) any third party to whom both Parties hereto have given their prior written consent for such a disclosure, or (d) governmental, administrative, regulatory or judicial authorities in the investigation of the compliance of the Site, the Facility and/or the Easement Areas with applicable legal requirements; and provided, further, that the non-disclosure obligations contained in this Section 24.6 shall not apply to any such information that (i) is or becomes generally available to the public other than as a result of a disclosure by Tenant or Landlord, or their employees, agents or representatives, or (ii) Landlord or Tenant is compelled to disclose pursuant to any judicial, statutory or regulatory authority. The provisions of this Section 24.6 shall survive the termination of this Ground Lease.

24.7 Attorneys' Fees. If either Party commences an action or proceeding against the other Party arising out of or in connection with this Ground Lease, or institutes any proceeding in a bankruptcy or similar court which has jurisdiction over the other Party or any or all of its property or assets, the prevailing Party in such action or proceeding and in any appeal in connection therewith shall be entitled to have and recover from the unsuccessful Party reasonable attorneys' fees, court costs, expenses and other costs of investigation and preparation. If such prevailing Party recovers a judgment in any such action, proceeding, or appeal, such attorneys' fees, court costs and expenses shall be included in and as a part of such judgment.

24.8 Interpretation. The Parties acknowledge that this Ground Lease, as executed, is the product of negotiations between Landlord and Tenant and that it shall be construed fairly, in accordance with its terms, and shall not be construed for or against either Party. No inferences as to the intention of the Parties shall arise from the deletion of any language or provisions of this Ground Lease.

24.9 Memorandum of Lease. Concurrently with the execution of this Ground Lease, Landlord and Tenant shall execute, acknowledge before a notary public, in recordable form, and deliver a short form memorandum of lease in the form of Exhibit D, attached hereto and incorporated herein, which shall be recorded by Tenant in the Official Records.

24.10 Severability. If any term or provision of this Ground Lease is, to any extent, determined by a court of competent jurisdiction to be invalid or unenforceable, the remainder of this Ground Lease shall not be affected thereby, and each remaining term and provision of this Ground Lease shall be valid and enforceable to the fullest extent permitted by law.

24.11 Time is of the Essence. Time is of the essence of this Ground Lease and each and every provision of this Ground Lease.

24.12 Consent and Approvals. Any consent or approval that a Party is obligated to give to the other Party shall not be unreasonably withheld or delayed, subject to any specific provision to the contrary contained in this Ground Lease.

24.13 Entire Agreement. This Ground Lease, including any exhibits and attachments hereto, constitutes the entire agreement between Landlord and Tenant relative to the matters and transactions contemplated herein. Landlord and Tenant agree hereby that all prior or contemporaneous oral or written agreements, or letters of intent, between and among themselves or their agents including any leasing agents and representative, relative to such matters and transactions including that certain Option to Lease between Landlord and _____, LLC dated _____ are merged in or revoked by this Ground Lease.

24.14 Broker's Commission. Tenant represents and warrants that it has not dealt with any broker or agent in connection with this Ground Lease and Tenant agrees to indemnify and save Landlord harmless from any claims made by any brokers or agents claiming to have dealt with Tenant. Landlord represents and warrants that it has not dealt with any brokers or agents in connection with this Ground Lease, and Landlord agrees to indemnify and save Tenant harmless from any claims made by any brokers or agents claiming to have dealt with Landlord. The terms and provisions of this Section 24.14 shall survive the termination or earlier expiration of this Ground Lease.

24.15 WAIVER OF JURY TRIAL. TO THE EXTENT PERMITTED BY LAW, THE PARTIES HEREBY WAIVE ANY AND ALL RIGHTS THAT THEY MAY NOW OR HEREAFTER HAVE UNDER THE LAWS OF THE UNITED STATES OF AMERICA OR ANY STATE, TO A TRIAL BY JURY OF ANY AND ALL ISSUES ARISING DIRECTLY OR INDIRECTLY IN ANY ACTION OR PROCEEDING RELATING TO THIS GROUND LEASE OR ANY TRANSACTIONS CONTEMPLATED HEREBY OR RELATED HERETO. IT IS INTENDED THAT THIS WAIVER SHALL APPLY TO ANY AND ALL CAUSES OF ACTION, DEFENSES, RIGHTS, CLAIMS AND/OR COUNTERCLAIMS, WHETHER IN CONTRACT, TORT OR OTHERWISE, IN ANY SUCH ACTION OR PROCEEDING. THE PARTIES UNDERSTAND THAT THIS WAIVER IS A WAIVER OF A CONSTITUTIONAL SAFEGUARD, AND THE PARTIES BELIEVE THAT THERE ARE SUFFICIENT ALTERNATE PROCEDURAL AND SUBSTANTIVE SAFEGUARDS, INCLUDING A TRIAL BY AN IMPARTIAL JUDGE, THAT ADEQUATELY OFFSET THE WAIVER CONTAINED HEREIN.

24.16. No Joint Venture. Neither this Ground Lease nor anything contained herein shall be deemed to make Landlord in any way or for any purpose a partner, joint venturer, or associate in any relationship with Tenant other than that of Landlord, as Landlord of the property subject to this Ground Lease, and Tenant, as Tenant of this Ground Lease, nor shall this Ground Lease or any provision thereof be construed to authorize either to act as an agent for the other except as expressly provided in this Ground Lease.

IN WITNESS WHEREOF, the Parties hereto have caused this Ground Lease to be duly executed by their respective officers thereto duly authorized as of the day and year first above written.

OWNER:

TENANT

_____, LLC

By: _____

Name:

Title:

By: _____

Name: _____

Title: _____

EXHIBIT A
To Ground Lease

Located in _____ County, _____, and more particularly described as follows:

.

EXHIBIT B
To Ground Lease

Form of Easement

Prepared by and please return to:

EASEMENT AGREEMENT

THIS EASEMENT AGREEMENT (“Agreement”) is made this ____ day of _____, 201__, by _____ (“Grantor”) to and for the benefit of _____ LLC, a _____ limited liability company (“Grantee”).

RECITALS

A. Grantor owns certain real property (the “Servient Estate”) located in the County of _____, State of _____ and more particularly described in Exhibit A attached hereto and incorporated herein by this reference.

B. Grantee leases certain real property (the “Dominant Estate”) located adjacent to the Servient Estate in the County of _____, State of _____ pursuant to that certain Ground Lease and Easement Agreement (the “Ground Lease”) between Grantor as Landlord and Grantee as Tenant, dated as of _____, a memorandum of which was recorded on _____ in the Official Records of _____ County, _____ (the “Official Records”) and more particularly described in Exhibit B attached hereto and incorporated herein by this reference. Capitalized terms not otherwise defined herein shall have the meaning given in the Ground Lease.

C. Grantee intends to engineer, construct and install solar photovoltaic systems (the “Systems”) in order to provide electrical energy and related services generated by the Systems.

D. In order to facilitate construction, installation, operation and maintenance of the Systems, Grantor desires to grant to Grantee an easement for access, utility lines, water pipelines, telecommunications lines, pole usage, equipment pads for switching stations and related purposes, subject to the terms and conditions of the Agreement.

NOW, THEREFORE, for good and valuable consideration, the receipt and legal sufficiency of which are hereby acknowledged, the Parties agree as follows.

AGREEMENTS

1. GRANT OF EASEMENT. For good and valuable consideration paid by Grantee, the receipt and sufficiency of which Grantor hereby acknowledges, upon and subject to the terms, conditions, restrictions and reservations set forth herein, Grantor hereby grants to Grantee, for the benefit of the Dominant Estate, an appurtenant, non-exclusive easement (the “Easement”) on, over, under and through the Easement area in the location more particularly described in attached Exhibit C for the purposes of constructing, placing, operating, maintaining, reconstructing, replacing, rebuilding, upgrading, removing, inspecting, patrolling, modifying and/or repairing (a) equipment pads for switching station facilities related to or necessitated by Grantee’s Systems located on the Dominant Estate; (b) surface and subsurface utilities related to or necessitated by Grantee’s Systems located on the Dominant Estate, which utilities may include, without limitation, electrical facilities and components and transmission lines, water pipelines, communications lines, telephone lines, fire lines, gas lines, storm drainage, sewer lines and fiber optic lines and related facilities; and (c) parking areas and roads for vehicular and pedestrian access, ingress and egress consisting of paved roads and associated utilities, facilities, fixtures and appurtenances, in, over, under and upon the Easement area, by Grantee and each Person in the group consisting of Grantee, all of Grantee’s Affiliates, and each of their respective directors, officers, employees, contractors, agents, successors, sublessee, licensees, invitees and assigns (collectively, the “Grantee Group”), together with the right of ingress and egress over the Servient Estate to access the Easement area.

2. CERTAIN COVENANTS.

2.1 Use and Maintenance of the Easement. Grantee shall use and maintain the Easement so as not to unreasonably interfere with Grantor’s use of the Servient Estate, provided, however, Grantee and each Person in the Grantee Group shall be permitted to use the Easement in a manner not inconsistent with the uses identified herein. Grantor shall be responsible to maintain the Easement in good condition, in accordance with prudent industry standards; provided, that Grantee shall repair damage to the Easement area or other portions of the Servient Estate to the extent caused by the use of the Easement by any Person in the Grantee Group. Grantor shall have the right to use the Servient Estate in any manner not inconsistent with the Easement and the rights granted to Grantee under this Agreement.

2.2 Compliance with Laws by Grantee. Grantee and any Person in the Grantee Group shall comply in all material respects with all federal, state or local acts, statutes, laws, ordinances, codes, rules, regulations, orders or other applicable legislative or administrative actions of any governmental authority having jurisdiction (“Laws”) (including Environmental Laws) relating to the Servient Estate and such party’s activities thereon.

2.3 Compliance with Laws by Grantor. Grantor and any Person in the Grantor Group shall comply in all material respects with all Laws (including Environmental Laws) relating to the Servient Estate and such party’s activities thereon.

2.4 Manner of Performance of Work. When possible, Grantee shall perform all installation, maintenance, repair and replacement work permitted or required to be performed by Grantee hereunder at such times, and in such a manner, so as to minimize any unreasonable interference with Grantor's use of the Servient Estate. Upon completion of any such work, Grantee shall restore the affected area to its former condition insofar as reasonably practicable.

2.5 Indemnity and Insurance.

(a) Indemnification by Grantee. Grantee shall indemnify, defend and hold harmless the Grantor Group from and against all Losses suffered or incurred by any such Person by reason of, resulting from, whether directly or indirectly, or arising out of (1) the nonfulfillment or nonperformance of any covenant or agreement of any Person within the Grantee Group in this Agreement, or (2) the negligence or willful misconduct of any Person within the Grantee Group in connection with the transactions contemplated by this Agreement.

(b) Indemnification by Grantor. Grantor shall indemnify, defend and hold harmless the Grantee Group from and against all Losses suffered or incurred by any such Person by reason of, resulting from, whether directly or indirectly, or arising out of (1) the nonfulfillment or nonperformance of any covenant or agreement of any Person within the Grantor Group in this Agreement, (2) the negligence or willful misconduct of any Person within the Grantor Group in connection with the transactions contemplated by this Agreement, or (3) the inaccuracy of any representation or warranty of Grantor contained in this Agreement.

(c) Insurance Coverage. The provisions of Article 10 of the Ground Lease are incorporated herein by reference as if fully set forth and shall govern the Parties' rights to, as well as apply to, insurance coverage under this Agreement.

2.6 Removal of Improvements. The provisions of the Ground Lease are incorporated herein by reference as if fully set forth and shall govern the Parties' rights to, as well as apply to the removal of, all improvements, articles of personal property and all business and trade fixtures, machinery and equipment owned or installed by Grantee or the Grantee Group on the Easement or the portions of the Servient Estate utilized in conjunction with the Easement.

2.7 Covenants Run with the Lands. The covenants of the Parties made in this Agreement shall be deemed to be covenants running with, binding upon, benefiting and burdening the land pursuant to applicable law. This Agreement or a memorandum thereof shall be recorded in the real property records of _____ County, _____.

3. TERM, TERMINATION AND REMEDIES.

3.1 Term and Termination of Easements. The term of this Agreement, the Easement and other rights granted hereunder (and the corresponding respective

obligations of the Parties) (collectively, the “Easement Interests”) shall continue in full force and effect from the full execution of this Agreement until the date on which Grantee’s rights as a tenant under the Ground Lease (as the same may be extended) terminate or expire (the “Easement Term”). Within thirty (30) days of the end of the Easement Term, Grantee shall execute, acknowledge and deliver to Grantor a release or any other document, in a form reasonably acceptable to Grantor, as may be reasonably necessary to confirm the termination of the Easement Interests granted in this Agreement and to eliminate this Agreement as an encumbrance on the title of the Servient Estate.

3.2 Remedies. In the event of a default under this Agreement by either Party, the non-defaulting Party shall send written notice pursuant to Section 5.12 hereof of such default to the defaulting Party, and unless such default is cured within sixty (60) days of the date of such written notice, the non-defaulting Party shall be entitled to all remedies (other than termination of this Agreement and the Easement herein granted) available at law or in equity for the defaulting Party’s failure to comply with the provisions of this Agreement, including, without limitation, injunctive relief. In addition, if such default is not cured within such sixty (60) day period, then the non-defaulting Party shall have the right to cure such default, in which case all costs reasonably incurred by the non-defaulting Party in effecting such cure shall be paid by the defaulting Party within thirty (30) days after demand therefor.

4. OWNER’S HAZARDOUS MATERIALS REPRESENTATION. To Grantor’s actual knowledge, (a) neither Grantor, nor any third party, has engaged in the generation, use, manufacture, treatment, transportation, storage, or disposal of any Hazardous Materials on or affecting the Easement area in violation of any Environmental Laws or in a manner which would require corrective action pursuant to any Environmental Laws; and (b) neither Grantor, nor any third party, has received any notice of any material violation of any Environmental Laws with respect to the Easement area (including groundwater on, in, or under the Easement area) about which a governmental authority would require corrective action.

5. MISCELLANEOUS.

5.1 Successors and Assigns. This Agreement shall be binding on and shall inure to the benefit of the Parties, their respective heirs, successors (by merger, consolidation or otherwise), assigns, devisees, administrators and representatives. This Agreement may only be assignable as permitted in, and consistent with, Article 22 of the Ground Lease, which Article 22 is incorporated herein by reference as if fully set forth.

5.2 Amendments. No change, amendment or modification of this Agreement shall be valid or binding upon the Parties unless such change, amendment or modification shall be in writing and duly executed by both Parties.

5.3 Captions. The captions contained in this Agreement are for convenience and reference only and in no way define, describe, extend or limit the scope or intent of this Agreement or the intent of any provision contained herein.

5.4 Severability. The invalidity of one or more phrases, sentences, clauses or sections contained in this Agreement shall not affect the validity of the remaining portions of this Agreement so long as the material purposes of this Agreement can be determined and effectuated.

5.5 No Waiver. Any failure of either Party to enforce any of the provisions of this Agreement or to require compliance with any of its terms at any time during the pendency of this Agreement shall in no way affect the validity of this Agreement, or any part hereof, and shall not be deemed a waiver of the right of such Party thereafter to enforce any and each such provision. Any consent or approval given pursuant to this Agreement shall be limited to its express terms and shall not otherwise increase the obligations of the Party giving such consent or approval or otherwise reduce the obligations of the Party receiving such consent or approval.

5.6 Further Assurances. Each Party agrees to execute and deliver all further instruments and documents, and take any further action that may be reasonably necessary to effectuate the purposes and intent of this Agreement.

5.7 Drafting Interpretations. Preparation of this Agreement has been a joint effort of both the Parties and the resulting document shall not be construed more severely against one of the Parties than against the other by reason of authorship of this document.

5.8 Governing Law. This Agreement shall be governed by, construed and enforced in accordance with the laws of the State of _____.

5.9 Survival. Notwithstanding any provision of this Agreement to the contrary, expiration or other termination of this Agreement shall not relieve the Parties of obligations that by their nature should survive such expiration or termination, including promises of indemnity and payment obligations.

5.10 No Joint Venture. Neither this Agreement nor anything contained herein shall be deemed to make Grantor in any way or for any purpose a partner, joint venturer or associate in any relationship with Grantee other than that of Grantor, as Grantor of the Easement, and Grantee, as grantee of the Easement, nor shall this Agreement or any provision thereof be construed to authorize either to act as agent for the other except as expressly provided in this Agreement.

5.11 Attorneys' Fees. In the event that Grantor or Grantee fails to perform any of its obligations under this Agreement or in the event a dispute arises concerning the meaning or interpretation of any provision of this Agreement, the defaulting Party or the Party not prevailing in such dispute, as the case may be, shall pay any and all reasonable costs and expenses incurred by the other Party in enforcing or establishing its rights hereunder, including, without limitation, court costs and reasonable counsel fees. The right of Grantor or Grantee, as the case may be, to all costs and expenses incurred by it in enforcing or establishing its rights hereunder pursuant to the provisions of this Section 5.11 shall include, without limitation, all costs and expenses incurred by Grantor or Grantee, as the case may be, including, without limitation, court costs and reasonable

counsel fees, in the enforcement of all obligations of Grantor or Grantee, as the case may be, under this Agreement or otherwise with respect to the Easements, whether or not legal action was commenced, and including all such costs and expenses incurred in an action or participation in, or in connection with, a case or proceeding under Chapter 7 or 11 of the Bankruptcy Code, or any successor statute thereto.

5.12 Notices. Any notice, consent or other formal communication required or permitted to be given by a Party pursuant to the terms of this Agreement shall be in writing and shall be deemed delivered (a) when delivered personally or by email, unless such delivery is made (i) on a day that is not a business day in the place of receipt or (ii) after 5:00 p.m. local time on a business day in the place of receipt, in either of which cases such delivery will be deemed to be made on the next succeeding business day, (b) on the next business day after timely delivery to a reputable overnight courier and (c) on the business day actually received if deposited in the U.S. mail (certified or registered mail, return receipt requested, postage prepaid), addressed as follows (or to such other address or having such other contact information as either Party may hereafter specify for such purpose by like notice to the other Party from time to time):

If delivered to Grantee: _____, LLC

Attention: _____
Phone: (____) ____ - ____
Email: _____@_____

With a copy to: _____

Attn: _____
Phone: (____) ____ - ____
Email: _____@_____

If delivered to Grantor:

Email: _____

5.13 Documents Included. This Agreement consists of this document and the Exhibits attached hereto in accordance with the provisions hereof, which are specifically incorporated herein and made a part hereof by this reference.

5.14 Counterparts; Signatures. This Agreement may be executed in counterparts. All executed counterparts shall constitute one agreement, and each counterpart shall be deemed an original. The Parties hereby acknowledge and agree that

facsimile signatures or signatures transmitted by electronic mail in so-called “pdf” format shall be legal and binding and shall have the same full force and effect as if an original of this Assignment had been delivered. Grantor and Grantee (i) intend to be bound by the signatures on any document sent by facsimile or electronic mail, (ii) are aware that the other Party will rely on such signatures, and (iii) hereby waive any defenses to the enforcement of the terms of this Agreement based on the foregoing forms of signature.

6. FINANCING PARTIES

(a) Grantee may at any time elect to finance all or any portion of the Facility (as defined in the Ground Lease) with one or more financial institutions, leasing companies, institutions or affiliates or subsidiaries thereof (each a “Financing Party,” collectively, the “Financing Parties”) and in connection therewith Grantee may enter into various agreements and execute various documents relating to such financing, which documents may, among other things, assign this Agreement to a Financing Party and/or grant a mortgage and/or security interest in Grantee’s interest in this Agreement (such documents, “Financing Documents”). Grantor acknowledges notice of the foregoing and consents to the foregoing actions and Financing Documents described above, and Landlord agrees to execute, and agrees to cause any and all of Grantor’s lenders to execute, such subordination agreements, consents, estoppels and other acknowledgements of the foregoing as Grantee or the Financing Parties may reasonably request. Landlord agrees that if requested by Grantee, Landlord will furnish the Financing Parties with a counterpart of each notice or other document delivered by Landlord to Grantee in connection with this Agreement.

(b) If the Financing Parties (or their designee) or another Person shall succeed to the rights of Grantee under this Agreement through possession or foreclosure action, delivery of a deed (or assignment of this Agreement) in lieu of foreclosure or otherwise, Grantor shall recognize the Financing Parties (or their designee) or such other Person (the Financing Parties, their designees, or such Person, a “Successor-Grantee”), as Grantee under this Agreement and Grantor and/or such Successor-Grantee shall promptly execute and deliver any instrument that either may reasonably request to evidence such recognition as Grantee under this Agreement. Furthermore, this Agreement shall continue in full force and effect upon all terms, conditions and covenants as are set forth in this Agreement. If the Successor-Grantee is one or more of the Financing Parties, such party shall not be personally liable to Grantor for the performance of its obligations hereunder except to the extent of its interest in the Facility.

(c) In the case of termination of this Agreement for any reason including rejection in bankruptcy, Grantor shall give prompt notice thereof to the Financing Parties. Grantor, on written request of the Financing Parties made any time within ninety (90) days after the giving of such notice by Grantor (and upon cure by the Financing Parties of all monetary defaults of Grantee), shall promptly execute and deliver a solar skyway easement to the Financing Parties or their nominee, for the remainder of the term of this Agreement upon all of the terms and conditions contained in this Agreement (subject to any changes as the parties may mutually agree) which new easement shall require the Financing Parties or their nominee to cure promptly all other non-monetary defaults of Grantee that are continuing as of the date of such new lease, are reasonably susceptible of cure and of which the Financing Parties or their nominee has

received notice and a reasonable opportunity to cure once the Financing Parties or their nominee has obtained possession of the Easement).

(d) Notwithstanding anything to the contrary contained in this Agreement, Grantor agrees that any delivery of a deed or assignment of this Agreement pursuant to foreclosure proceedings, or by deed or assignment in lieu of foreclosure or otherwise to the Financing Parties or to any successors or assigns of the Financing Parties (including any purchaser of the easement estate) in and to the Easement Area upon or following a foreclosure pursuant to the Financing Documents (or delivery of a deed or assignment of this Agreement in lieu of foreclosure) shall not be subject to the prior written consent of Grantor.

(e) Grantor agrees that without the prior written consent of the Financing Parties, Grantor shall not (x) accept a surrender of this Agreement, (y) permit the subordination of this Agreement to any mortgage encumbering the fee estate of the Site, or Grantor's interest in this Agreement, or (z) in the event of any bankruptcy of Grantee, file any application seeking to reject this Agreement under the United States Bankruptcy Code. Any such purported action without the Financing Parties' consent shall be void.

(f) Grantor shall consider in good faith (and, where customary, accept) any modifications or amendments to this Agreement reasonably requested by the Financing Parties in connection with the financing or refinancing of the Facility from time to time. In addition, Grantor shall promptly execute any additional documentation (including any non-disturbance and attornment agreement), as may be mutually agreed upon in form and substance, that is reasonably requested by the Financing Parties.

(g) The provisions of this Article 6 are for the benefit of the Financing Parties as well as of Grantor and Grantee, and shall be enforceable by each. Grantor hereby agrees that none of the Financing Parties shall be obligated to perform any obligation hereunder or shall have any obligation or liability to Grantor with respect to this Agreement, except as provided in this Article 6 or in any other agreement or instrument entered into (i) by a Financing Party and Grantor in connection with the mortgaging, encumbrance pledge and/or collateral assignment of this Agreement by Grantee or (ii) by a Financing Party or its designee in connection with the assumption of interests, rights and obligations hereunder.

[SIGNATURES BEGIN ON FOLLOWING PAGE]

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement as of the date first above written.

GRANTOR:

Signed, sealed and delivered as to all signatories in the presence of:

_____[SEAL]

Name: _____

Title: _____

Unofficial Witness

Notary Public

My commission expires:

[NOTARY PUBLIC]

GRANTEE:

_____, LLC

[SEAL]

Signed, sealed and delivered as to all signatories in the presence of:

By: _____

Name: _____

Title: _____

Unofficial Witness

Notary Public

My commission expires: _____

[NOTARY PUBLIC]

EXHIBIT A TO THE EASEMENT AGREEMENT

Description of Servient Estate

Located in _____ County, _____, and more particularly described as follows:

EXHIBIT B TO THE EASEMENT AGREEMENT

Description of Dominant Estate

Located in _____ County, _____, and more particularly described as follows:

EXHIBIT C TO THE EASEMENT AGREEMENT

Description of Easement

See attached

EXHIBIT C
To Ground Lease

Form of Solar Skyway Easement

Prepared by and please return to:

STATE OF _____

COUNTY OF _____

SOLAR SKYWAY EASEMENT AGREEMENT

THIS SOLAR SKYWAY EASEMENT AGREEMENT (this "Agreement"), is made this _____ day of _____, 201____, by and between _____ (the "Grantor"), and _____, LLC, a _____ limited liability company ("Grantee").

W I T N E S S E T H:

WHEREAS, Grantor is the owner of [that certain tract/those certain tracts] of land identified and described as the "Grantor's Property" on Exhibit A attached hereto and incorporated herein by this reference (the "Grantor's Property"); and

WHEREAS, Grantee is the lessee of an approximately _____ acre portion of Grantor's Property under the terms of a Ground Lease and Easement Agreement between Grantor and Grantee dated as of _____, 20__ (the "Ground Lease") (such portion being herein referred to as the "Premises"), and as said Premises is more particularly described on Exhibit B attached hereto and incorporated herein; and

WHEREAS, Grantee has constructed or will construct certain solar photovoltaic electric generating facility improvements (the "Solar Power Facility") on the Premises; and

WHEREAS, in connection with the efficient operation of the Solar Power Facility, it is necessary that Grantee maintain the unobstructed passage of sunlight through an area surrounding the Solar Power Facility; and

WHEREAS, subject to the terms of this Agreement, Grantor has agreed to grant to Grantee the solar skyway easement herein described through, over, upon and across the remainder of Grantor's Property which is not included within the Premises (the "Solar Skyway Easement Area").

NOW, THEREFORE, FOR AND IN CONSIDERATION of the above premises and for other good and valuable consideration, the receipt and legal sufficiency of which are hereby acknowledged, Grantor hereby conveys, grants and warrants to Grantee a solar skyway easement over, across and above the Solar Skyway Easement Area in accordance with the following terms.

1. Grant of Solar Skyway Easement. Grantor hereby agrees that no structure, vegetation, activity (including, without limitation, the emission of suspended particulate matter, smoke, fog or steam or other air-borne impediments to insolation), or land use of Grantor shall cast a shadow on any solar energy collector of Grantee located on the Premises unless such structure, vegetation, activity, or land use exists on the effective date of this easement and is not required to be removed or is excepted by the terms of this instrument.

Upon and subject to advance written notice to Grantor the following rights are also granted to Grantee: to enter said Solar Skyway Easement Area and to remove from the Solar Skyway Easement Area, now or at any time during the term of the Ground Lease, as such term may be extended, trees, structures or other obstructions that may impair or reduce the electric power output of the Solar Power Facility and trees of any species that Grantee determines will grow at maturity to a height that will materially impair or reduce the electric power output of the Solar Power Facility; to trim or remove and to keep trimmed or remove dead, diseased, weak or leaning trees, limbs or branches which, in the opinion of the Grantee, might interfere with or fall upon the Solar Power Facility. Further, Grantor shall not allow any third party claiming by or through Grantor to take any action, or fail to take any action, which would result in any shading of the Solar Power Facility solar collectors that materially impairs or reduces the electric power output of the Solar Power Facility.

If Landlord becomes aware of any potential development or other activity on adjacent or nearby properties that has a reasonable likelihood of diminishing the insolation on or at the Premises, Landlord shall cooperate with Tenant's efforts to prevent interference with insolation on or at the Premises, including, without limitation, undertaking efforts to obtain, at Tenant's sole expense, solar skyway easements from adjacent property owners.

2. Title to Property. Grantor warrants to Grantee, its successors and assigns, that Grantor is the sole owner of good, marketable and insurable fee simple title to the Grantor's Property as described herein, has the right to grant and convey the aforesaid solar skyway easement, and will warrant and defend its right to so grant said easement against the lawful claims of all persons.

3. Running with the Land. The burdens and benefits of this easement are transferable and shall run with the land to subsequent grantees of the Grantor and the Grantee. This solar skyway easement shall remain in effect until the Ground Lease is terminated, and Landlord's sole remedy for any alleged breach of this Agreement by Grantee shall be to seek an action in money damages (without any right to seek termination of this Agreement). This Agreement or a memorandum thereof shall be recorded in the real property records of _____ County, _____.

4. Financing Parties.

(a) Grantee may at any time elect to finance all or any portion of the Facility (as defined in the Ground Lease) with one or more financial institutions, leasing companies, institutions or affiliates or subsidiaries thereof (each a “Financing Party,” collectively, the “Financing Parties”) and in connection therewith Grantee may enter into various agreements and execute various documents relating to such financing, which documents may, among other things, assign this Agreement to a Financing Party and/or grant a mortgage and/or security interest in Grantee’s interest in this Agreement (such documents, “Financing Documents”). Grantor acknowledges notice of the foregoing and consents to the foregoing actions and Financing Documents described above, and Landlord agrees to execute, and agrees to cause any and all of Grantor’s lenders to execute, such subordination agreements, consents, estoppels and other acknowledgements of the foregoing as Grantee or the Financing Parties may reasonably request. Landlord agrees that if requested by Grantee, Landlord will furnish the Financing Parties with a counterpart of each notice or other document delivered by Landlord to Grantee in connection with this Agreement.

(b) If the Financing Parties (or their designee) or another Person shall succeed to the rights of Grantee under this Agreement through possession or foreclosure action, delivery of a deed (or assignment of this Agreement) in lieu of foreclosure or otherwise, Grantor shall recognize the Financing Parties (or their designee) or such other Person (the Financing Parties, their designees, or such Person, a “Successor-Grantee”), as Grantee under this Agreement and this Agreement shall continue in full force and effect upon all terms, conditions and covenants as are set forth in this Agreement. If the Successor-Grantee is one or more of the Financing Parties, such party shall not be personally liable to Grantor for the performance of its obligations hereunder except to the extent of its interest in the Facility.

(c) In the case of termination of this Agreement for any reason including rejection in bankruptcy, Grantor shall give prompt notice thereof to the Financing Parties. Grantor, on written request of the Financing Parties made any time within ninety (90) days after the giving of such notice by Grantor (and upon cure by the Financing Parties of all monetary defaults of Grantee), shall promptly execute and deliver a solar skyway easement to the Financing Parties or their nominee, for the remainder of the term of this Agreement upon all of the terms and conditions contained in this Agreement (subject to any changes as the parties may mutually agree) which new easement shall require the Financing Parties or their nominee to cure promptly all other non-monetary defaults of Grantee that are continuing as of the date of such new lease, are reasonably susceptible of cure and of which the Financing Parties or their nominee has received notice and a reasonable opportunity to cure once the Financing Parties or their nominee has obtained possession of the Solar Skyway Easement Area).

(d) Notwithstanding anything to the contrary contained in this Agreement, Grantor agrees that any delivery of a deed or assignment of this Agreement pursuant to foreclosure proceedings, or by deed or assignment in lieu of foreclosure or otherwise to the Financing Parties or to any successors or assigns of the Financing Parties (including any purchaser of the easement estate) in and to the Solar Skyway Easement Area upon or following a foreclosure pursuant to the Financing Documents (or delivery of a deed or assignment of this Agreement in lieu of foreclosure) shall not be subject to the prior written consent of Grantor.

(e) Grantor agrees that without the prior written consent of the Financing Parties, Grantor shall not (x) accept a surrender of this Agreement, (y) permit the subordination of this Agreement to any mortgage encumbering the fee estate of the Site, or Grantor's interest in this Agreement, or (z) in the event of any bankruptcy of Grantee, file any application seeking to reject this Agreement under the United States Bankruptcy Code. Any such purported action without the Financing Parties' consent shall be void.

(f) Grantor shall consider in good faith (and, where customary, accept) any modifications or amendments to this Agreement reasonably requested by the Financing Parties in connection with the financing or refinancing of the Facility from time to time. In addition, Grantor shall promptly execute any additional documentation (including any non-disturbance and attornment agreement), as may be mutually agreed upon in form and substance, that is reasonably requested by the Financing Parties.

(g) The provisions of this Article 4 are for the benefit of the Financing Parties as well as of Grantor and Grantee, and shall be enforceable by each. Grantor hereby agrees that none of the Financing Parties shall be obligated to perform any obligation hereunder or shall have any obligation or liability to Grantor with respect to this Agreement, except as provided in this Article 4 or in any other agreement or instrument entered into (i) by a Financing Party and Grantor in connection with the mortgaging, encumbrance pledge and/or collateral assignment of this Agreement by Grantee or (ii) by a Financing Party or its designee in connection with the assumption of interests, rights and obligations hereunder.

5. Governing Law. This Agreement is to be governed, construed and enforced in accordance with the laws of the State of _____.

6. Binding Effect. Grantor hereby represents and warrants that it has the right, power and authority to enter into this Agreement and to grant the easements in accordance with the terms and conditions hereof. This Agreement shall be binding upon and inure to the benefit of the Parties hereto, their successors and assigns.

7. Severability. If any term, covenant or condition of this Agreement, or any application thereof to any person or circumstance shall, to any extent, be invalid or unenforceable, such provision, or the application of such term, covenant or condition, to persons or circumstances other than those as to which it is held invalid or unenforceable, shall be deemed severable, and the remainder thereof shall not be affected thereby, and each term, covenant or condition of this Agreement shall be valid, and may be enforced to the fullest extent permitted by law.

8. Amendment to Agreement. This Agreement may be amended only by a writing executed by each of the Parties hereto, or their applicable successors or assigns, and properly recorded in the real property records of _____ County, _____.

9. Remedies for Breach. The terms and conditions of this Agreement shall be enforceable by actions for specific performance or injunction, in addition to any other remedies available at law.

10. No Waiver. No delay or omission by any Party in exercising any right or power accruing upon any noncompliance or failure of performance by the other Party under the provisions of this Agreement shall impair any such right or power or be construed to be a waiver thereof.

11. Counterparts. This Agreement may be executed in counterparts all of which taken together shall be deemed one original when executed by all Parties.

TO HAVE AND TO HOLD the easements hereinabove described unto Grantee, its successors and assigns, for the aforesaid uses and purposes.

IN WITNESS WHEREOF, Grantor has duly executed this Agreement as of the day and year first above written.

GRANTOR:

Signed, sealed and delivered as
to all signatories in the presence of:

_____ [SEAL]

Name: _____

Title: _____

Unofficial Witness

Notary Public

My commission expires:

[NOTARY PUBLIC]

[SIGNATURES CONTINUE ON FOLLOWING PAGE]

GRANTEE:

_____, LLC [SEAL]

Signed, sealed and delivered as
to all signatories in the presence of:

By: _____

Name: _____

Title: _____

Unofficial Witness

Notary Public

My commission expires:

[NOTARY PUBLIC]

EXHIBIT A TO SOLAR SKYWALK EASEMENT AGREEMENT

Grantor's Property

[To Be Supplied]

EXHIBIT B TO THE SOLAR SKYWALK EASEMENT AGREEMENT

Premises

Located in _____ County, _____, and more particularly described as follows:

EXHIBIT D
To Ground Lease

Form of Memorandum of Lease

Prepared by and please return to:

STATE OF _____

MEMORANDUM OF LEASE

COUNTY OF _____

_____, as LANDLORD, having an address of _____, hereby leases to _____, LLC, a _____ limited liability company, as TENANT, having an address of c/o _____, LLC, _____, Attention: _____, for a term beginning on _____, 20__, and continuing for a maximum period of thirty-five (35) years, including extensions and renewals, the following property:

Those certain premises situated in _____ County, _____, consisting of approximately _____ () acres of land located at _____, as said premises are more particularly described on Exhibit A and incorporated herein by reference.

The provisions set forth in a written Ground Lease and Easement Agreement between the Parties dated the ____ day of _____, 20__, (the "Lease") are hereby incorporated in this Memorandum. In addition to the terms hereinabove set forth, the Lease contains numerous other terms, covenants and provisions, including without limitation a right of first offer in favor of Tenant, and notice is hereby given that reference should be had to the Lease directly with respect to the details of such terms and conditions.

[Signatures Begin on Following Page]

Signed, sealed and delivered as
to all signatories in the presence of:

Unofficial Witness

Notary Public

My commission expires:

[NOTARY PUBLIC]

Signed, sealed and delivered as
to all signatories in the presence of:

Unofficial Witness

Notary Public

My commission expires:

[NOTARY PUBLIC]

LANDLORD:

[SEAL]

Name: _____

Title: _____

TENANT:

_____, LLC [SEAL]

By: _____

Name: _____

Title: _____

EXHIBIT A TO MEMORANDUM OF LEASE

Located in _____ County, _____, and more particularly described as follows:



Michael McNeley <michael.mcneley@galeheaddev.com>

ASO Level 0/1 – Customer Participation Confirmation & Payment for Study, WO 2339086

Khederian, Melanie A <melanie.khederian@eversource.com>
To: "michael.mcneley@galeheaddev.com" <michael.mcneley@galeheaddev.com>
Cc: ASOstudyinquiry <ASOstudyinquiry@eversource.com>

Wed, Dec 18, 2019 at 12:44 PM

Dear DG Applicant,

As you are aware, your project will require a Level 0/1 ASO study. For planning purposes, these studies typically take about 3 months from commencement. As presented during the December 12th ASO Study Customer Kickoff meeting, Eversource is requesting that you opt in or opt out of the study within 10 business days of receiving this notice (January 6th). If you choose to opt in, payment for the ASO study fee must be provided by January 20th.

Please respond to this email verifying if you will be opting in or opting out. If no response is provided, Eversource will consider that an opt out. Payment must be made by **January 20, 2020** and the cost for your project is **\$2,520.00**.

Depending on the final number of projects that opt in to the Level 0/1 studies, the cost per customer in the study may fluctuate.

Please mail checks to:

Eversource Energy

Attention: DG Group, ASO Study Fee

c/o WO _____

247 Station Drive SW340

Westwood, MA 02090-9230

If you have any questions, please reach out to ASOStudyInquiry@eversource.com.

Thank you,

Melanie

Melanie Khederian
Account Executive Distributed Generation
Eversource Energy
508-790-9035 - Office

617-775-9119 - Cell
Melanie.Khederian@eversource.com

After Receipt of First Bill please contact the Business Center for Billing Questions 800-340-9822

Outage Reporting 800-592-2000

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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 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 AI_4
- ABB 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 Gridshield (32-pin and 42-pin versions)
- Eaton NOVA-TS or NOVA-STS Triple-Single
- Eaton NOVA NX-T
- Tavrida OSM AI_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 AI_2
- Siemens SDR Three-Phase

Certification

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

Product Overview or Functional Overview

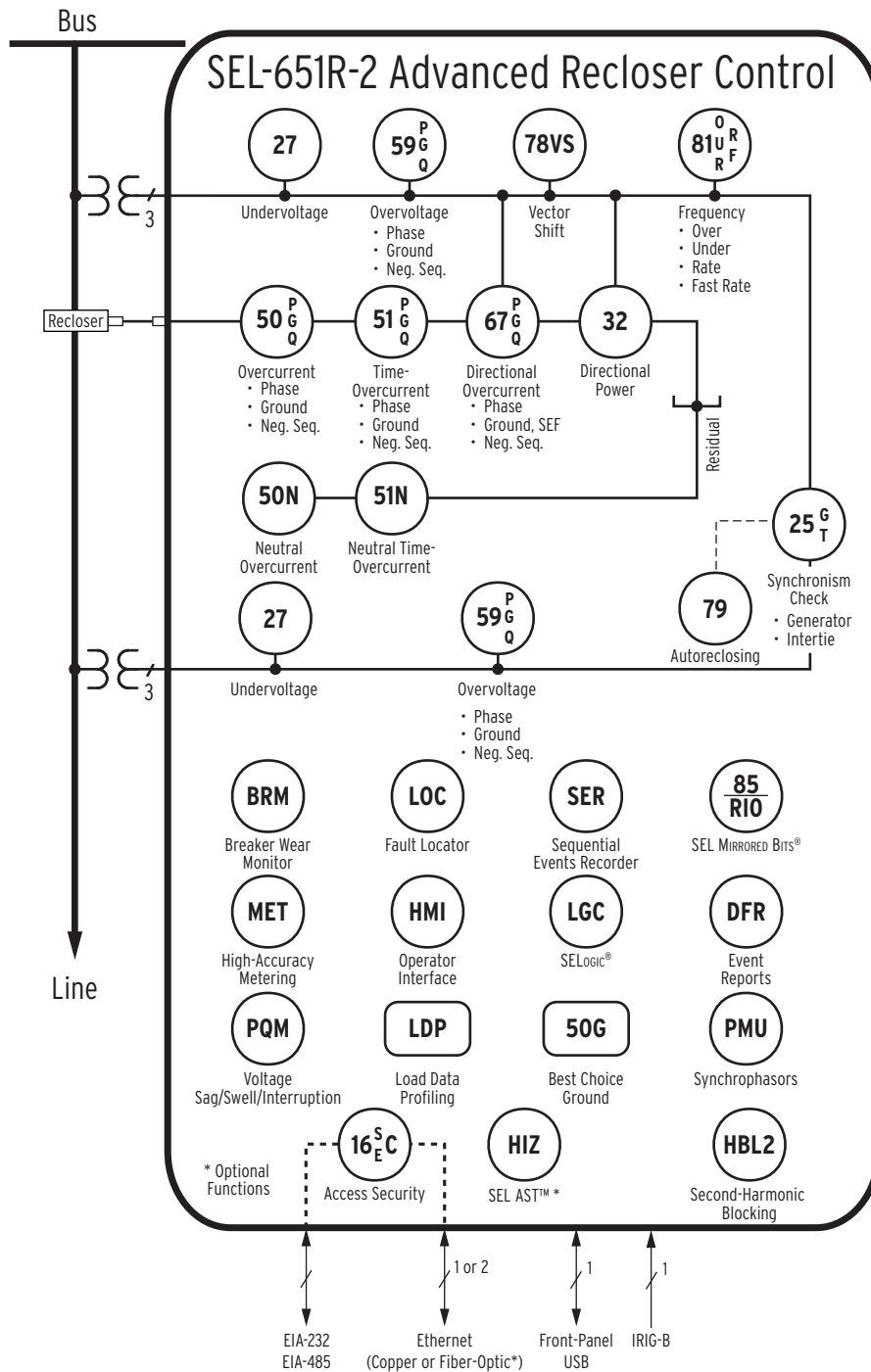


Figure 1 Functional Diagram

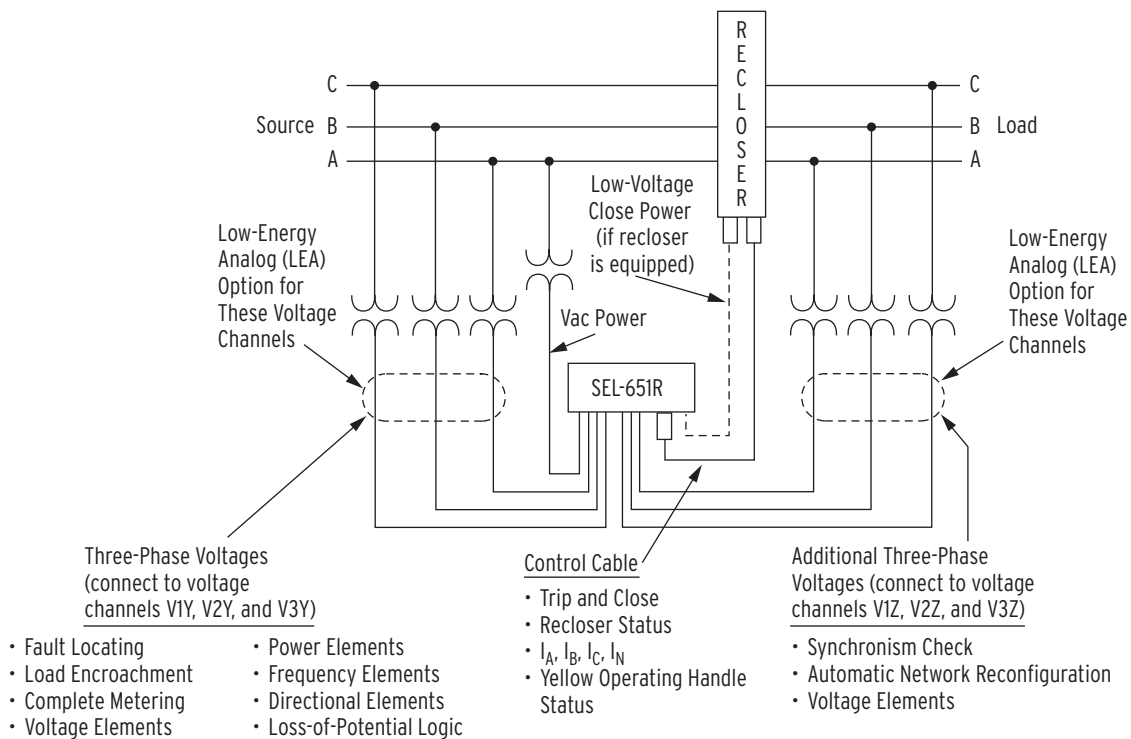


Figure 2 Connect Three-Phase Load and Source Voltages to SEL-651R-2

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.

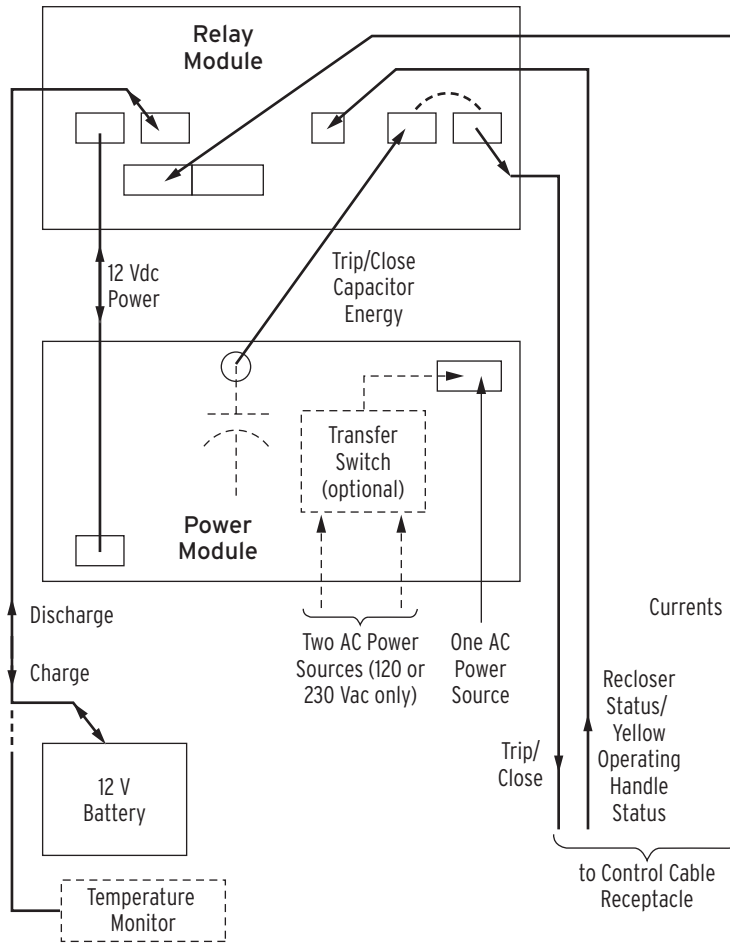


Figure 3 Major Interconnections Between SEL-651R-2 Components

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).

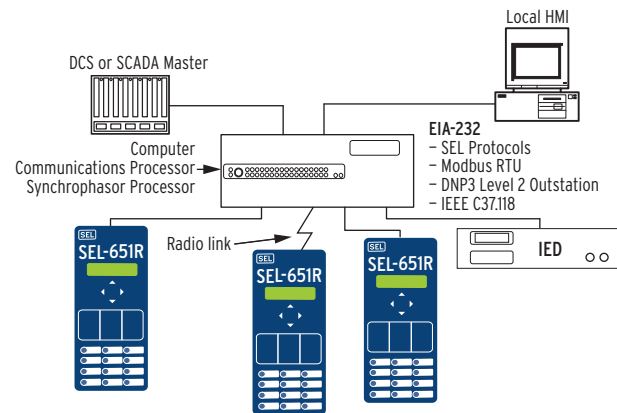


Figure 4 Typical Serial Communications Architecture

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*).

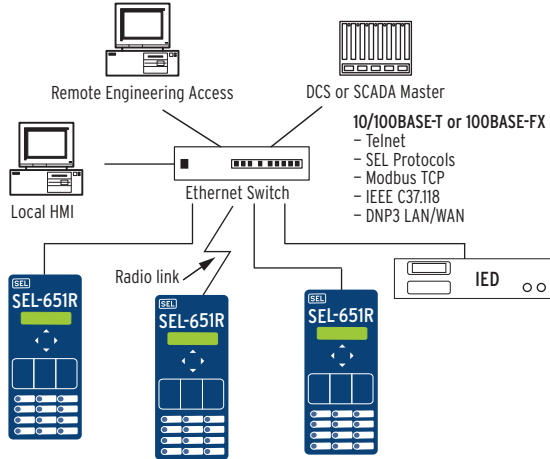


Figure 5 Typical Ethernet Communications Architecture

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.

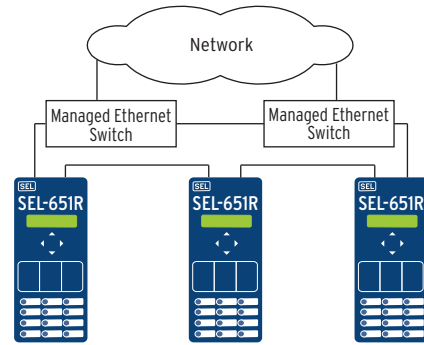


Figure 6 Self-Healing Ring Using Internal Ethernet Switch

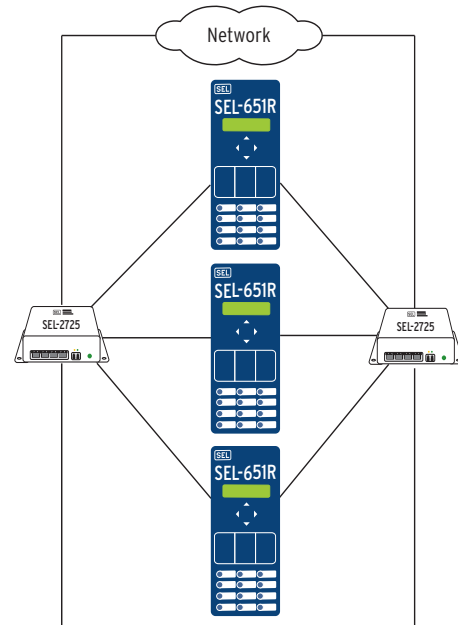


Figure 7 Failover Network Topology

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 pro-

grammable 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.

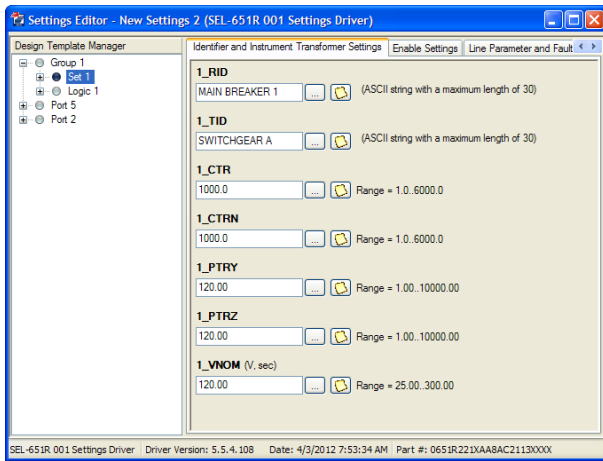


Figure 8 Example Application Designs

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.

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

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.

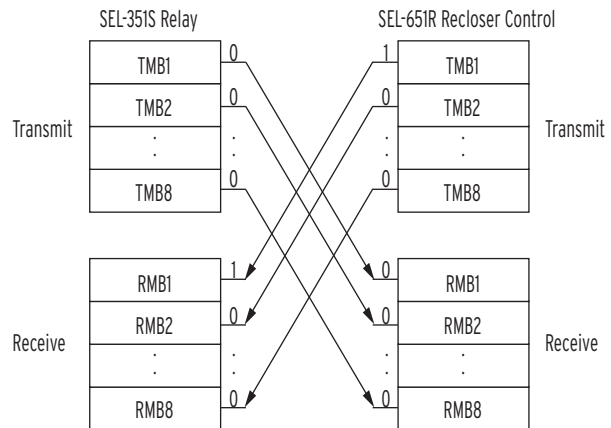


Figure 9 MIRRORED BITS Transmit and Receive Bits

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.

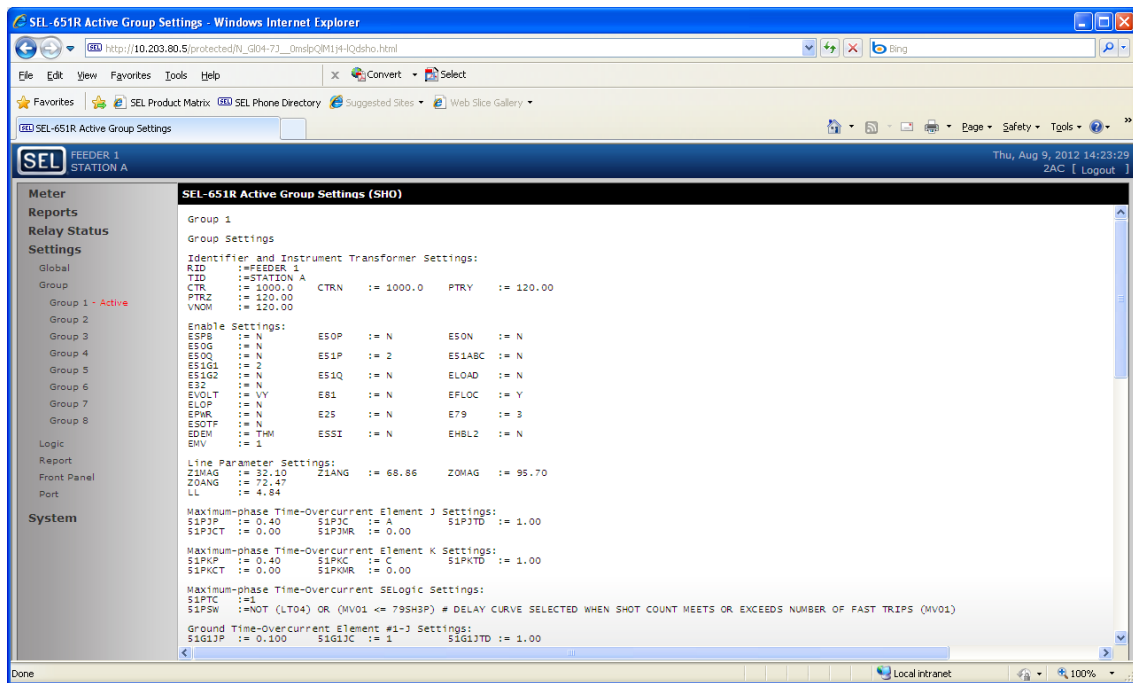


Figure 10 Settings Display Webpage

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.

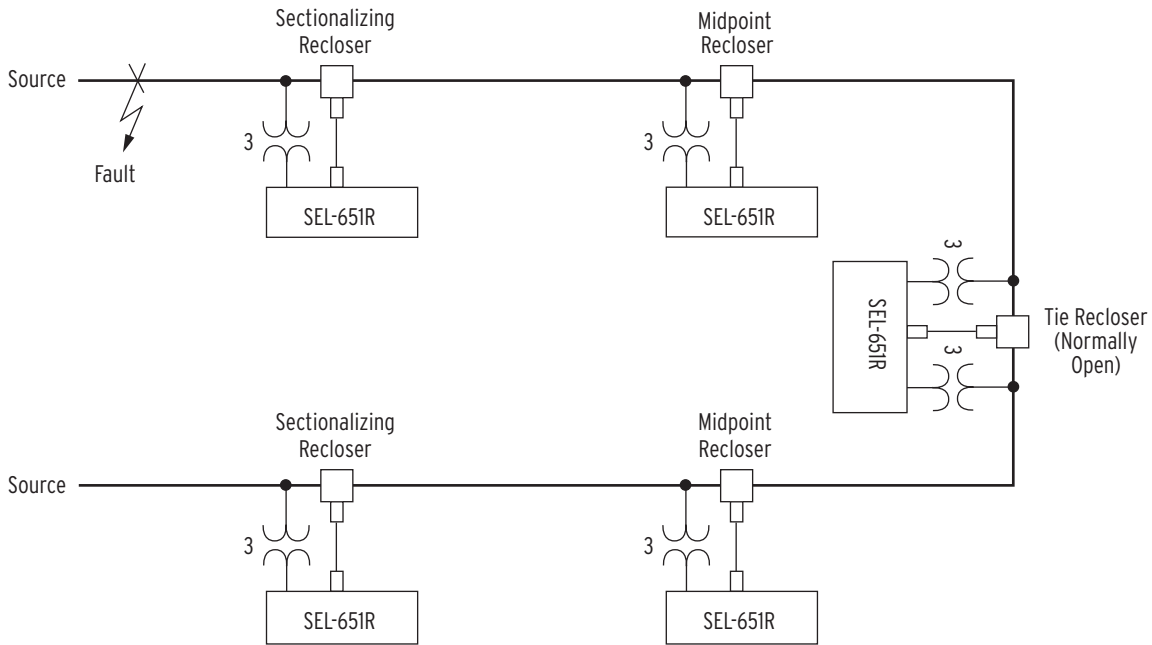


Figure 11 Simple Automatic Network Reconfiguration

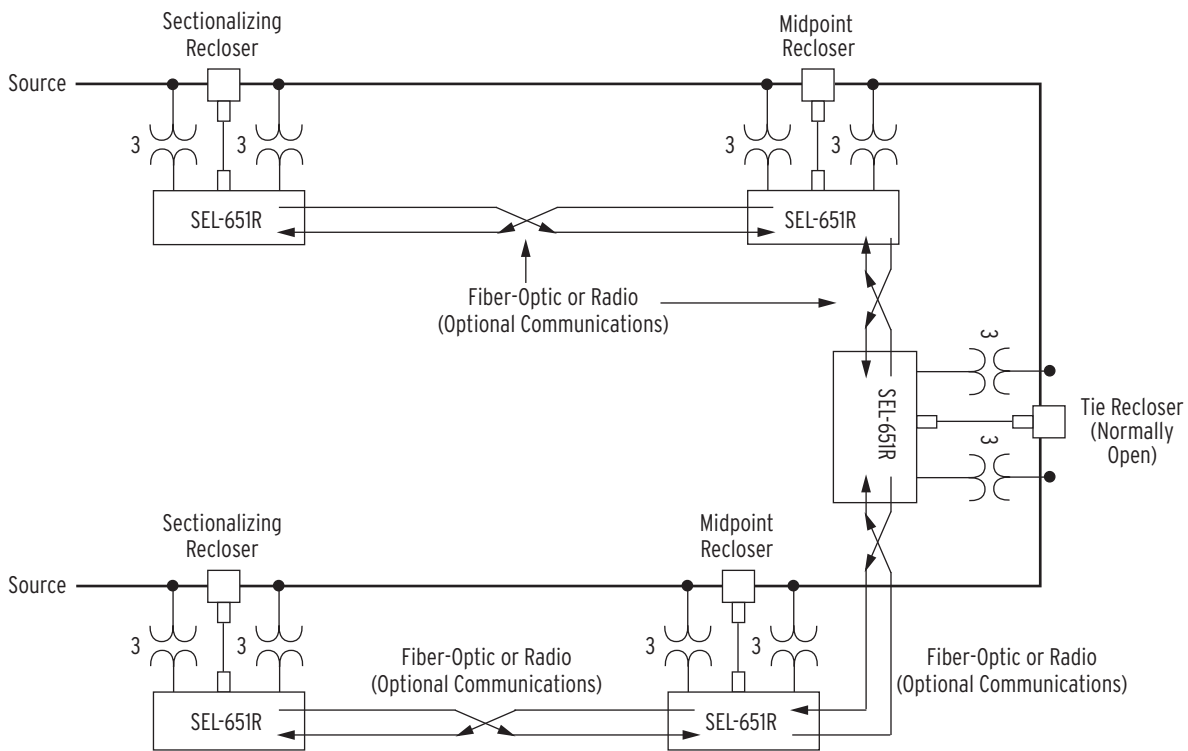


Figure 12 Advanced Automatic Network Reconfiguration

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, consul-

tants, microgrid owners, and DER owners use these turn-key recloser solutions at the Point of Common Coupling (PCC) as defined in IEEE 1547. *Figure 13* demonstrates autosynchronization 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.

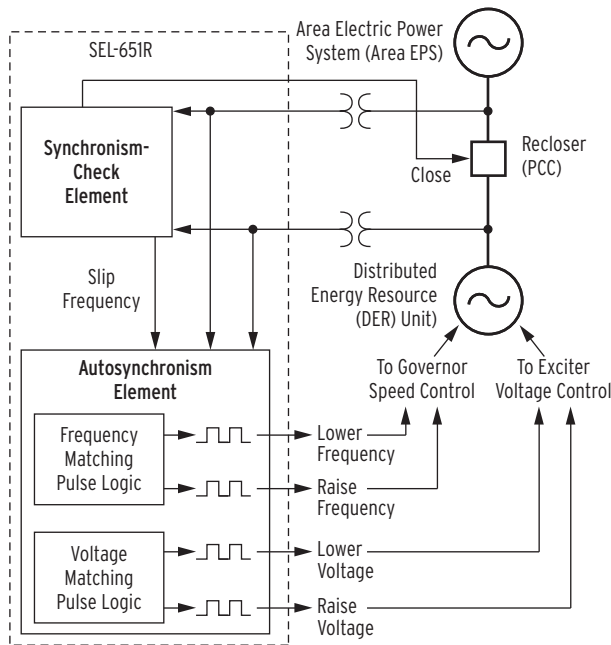


Figure 13 Distributed Energy Resource Intertie

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.

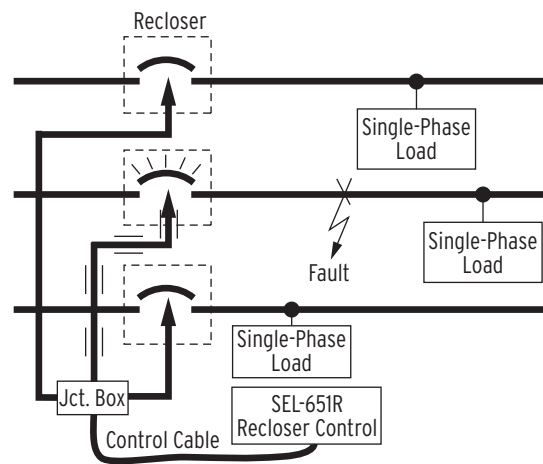


Figure 14 Single-Phase Tripping Isolates Only the Faulted Phase

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.

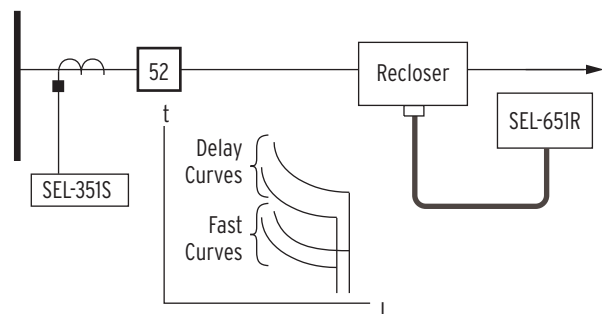


Figure 15 Coordinate the SEL-651R-2 With Other Devices

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.

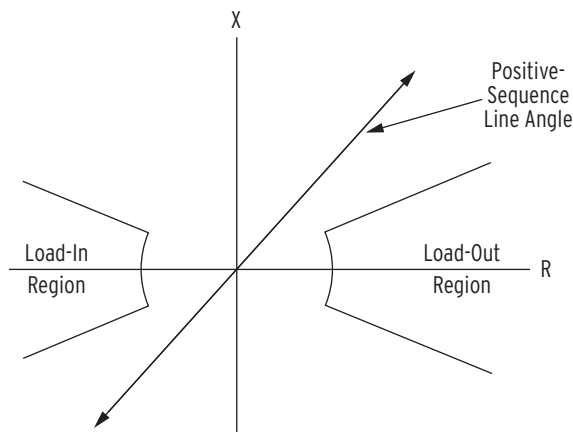


Figure 16 Load-Encroachment Logic Defines Load Zones (No Trip Zones)

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 ($DF = \text{FREQ} - \text{NFREQ}$) and the rate-of-change of frequency (DFDT) to detect islanding conditions.

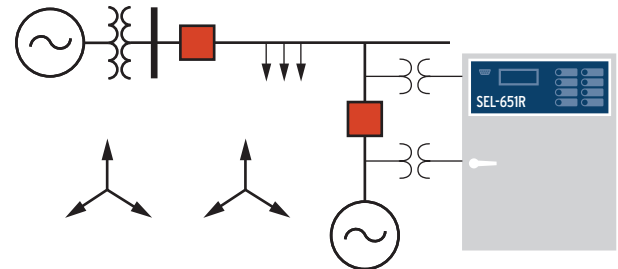


Figure 17 Fast Islanding Detection

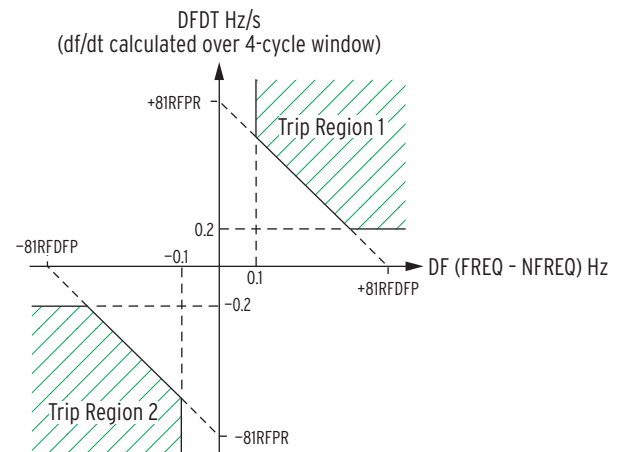


Figure 18 81RF Characteristics

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. 81RDFDP (in Hz) and 81RFPR (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 pre-fault information. This feature contributes to efficient line crew dispatch and fast service restoration. The fault locator requires three-phase voltage inputs.

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)

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.

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 pre-fault, 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.

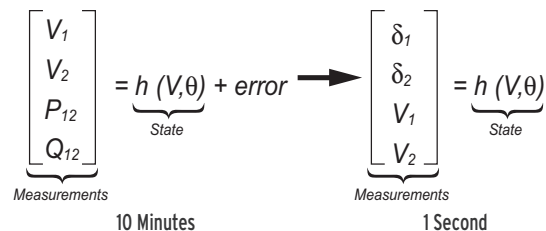


Figure 19 Synchrophasor Measurements Turn State Estimation Into State Measurement

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

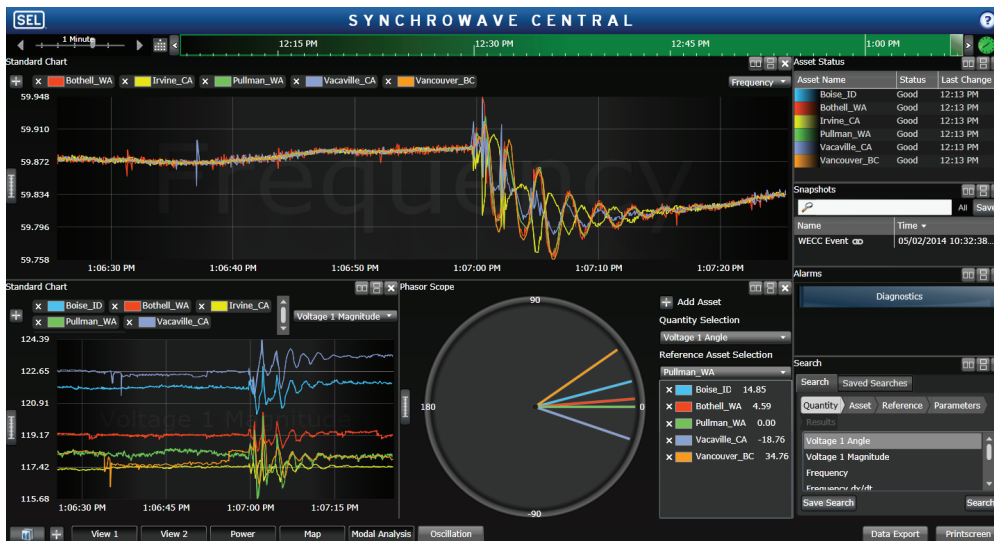


Figure 21 SEL-5078-2 SYNCHROWAVE Central Real-Time, Wide-Area Visualization Tool

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

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

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. Pre-determined set points are available for traditional reclosers, following recommendations for reclosers in ANSI C37.61-1973.

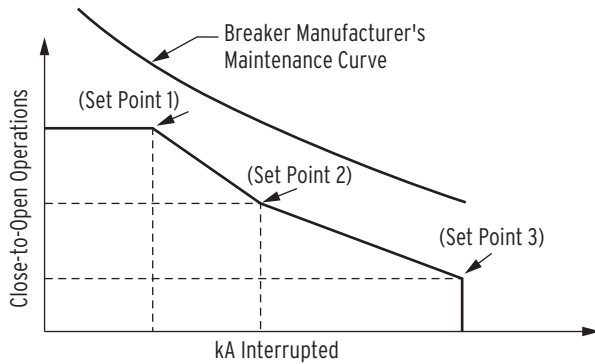


Figure 22 Recloser Contact Wear Curve and Settings

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

Table 4 Available Metering Quantities (Sheet 2 of 2)

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

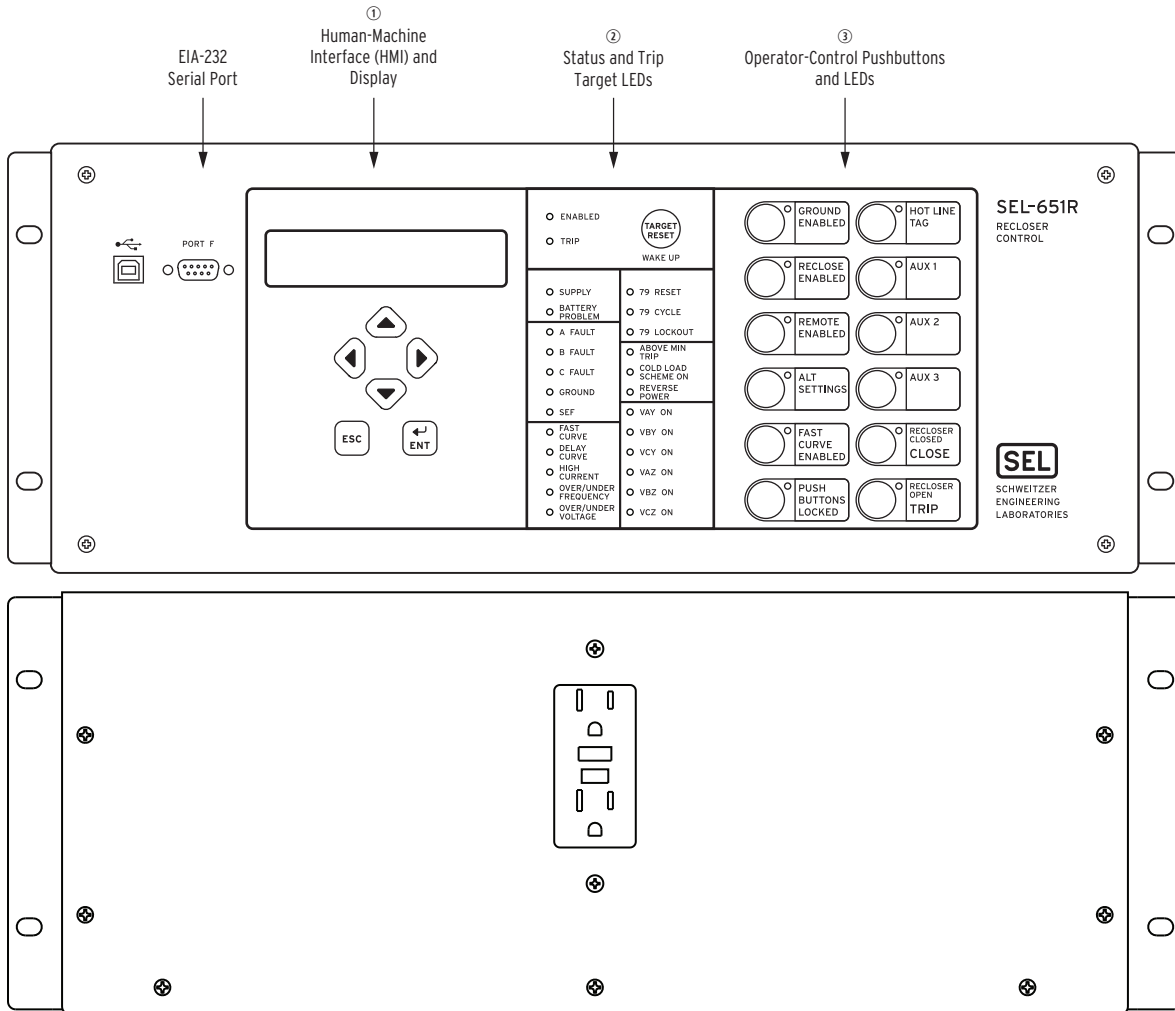


Figure 23 Front View of SEL-651R-2 Relay and Power Modules (Dual-Door Enclosure)

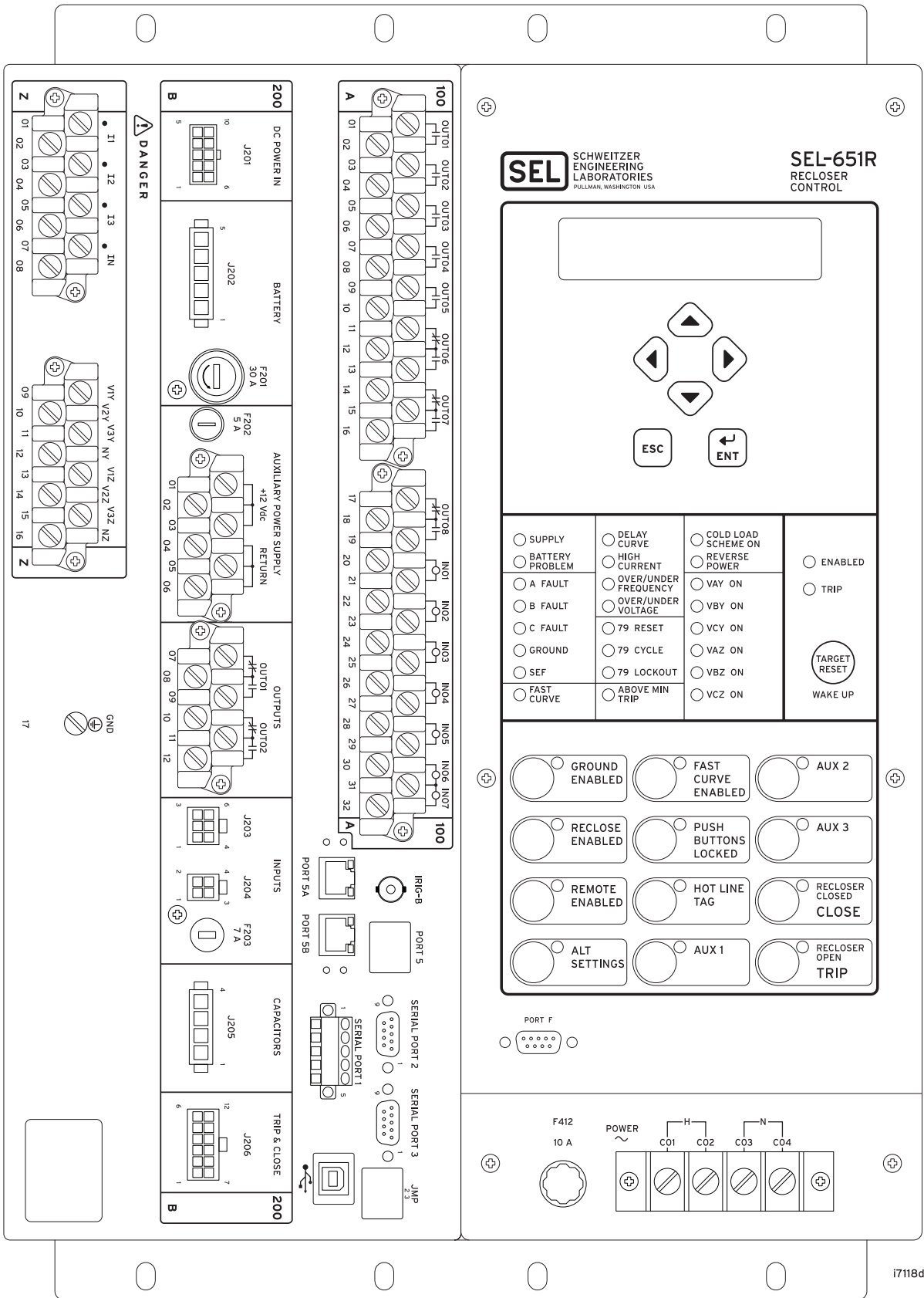


Figure 24 Front View of SEL-651R-2 Relay and Power Modules (Single-Door Enclosure)

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

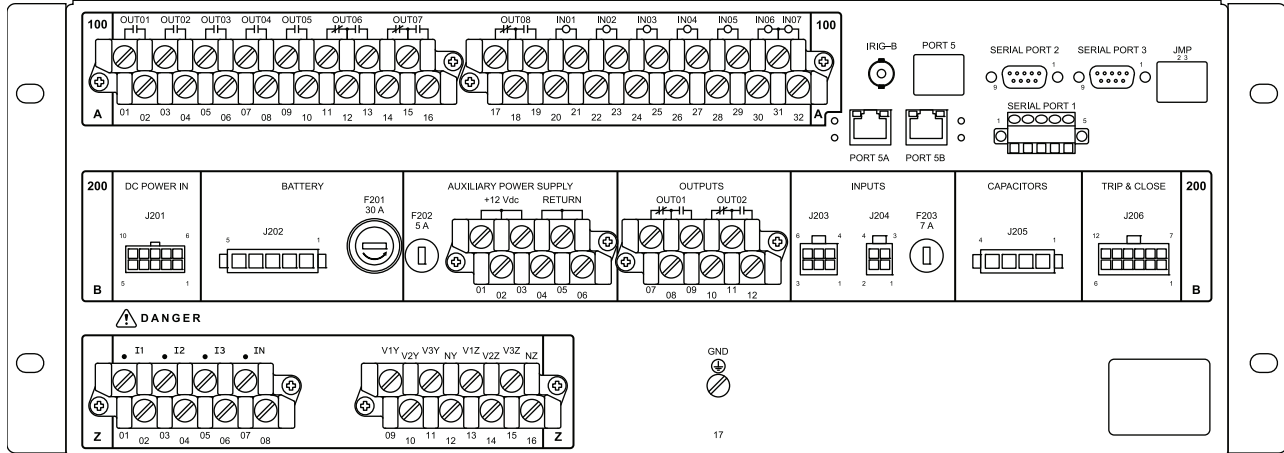


Figure 25 Rear View of the SEL-651R-2 Relay Module

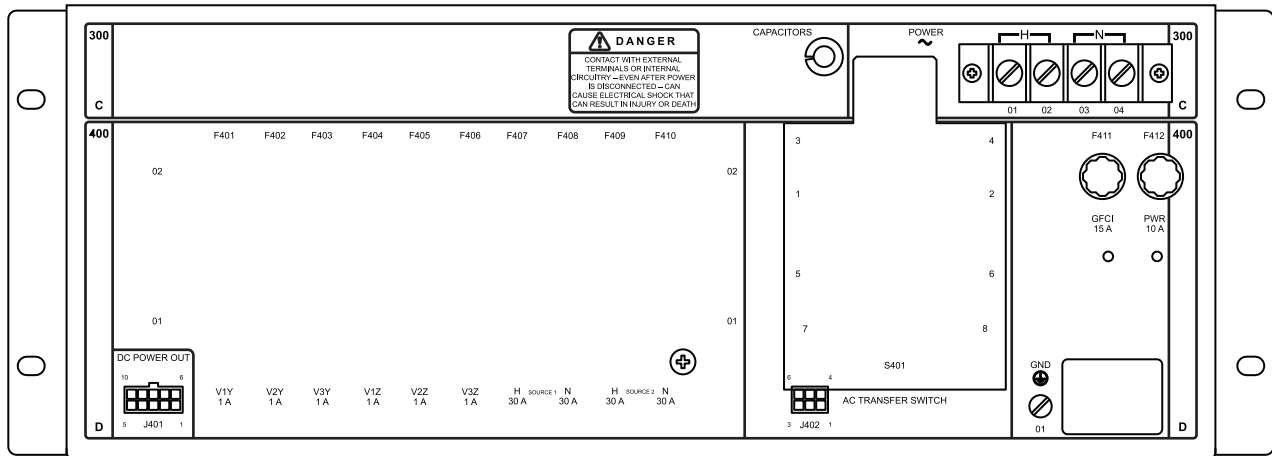


Figure 26 Rear View of the SEL-651R-2 Power Module (Dual-Door Enclosure)

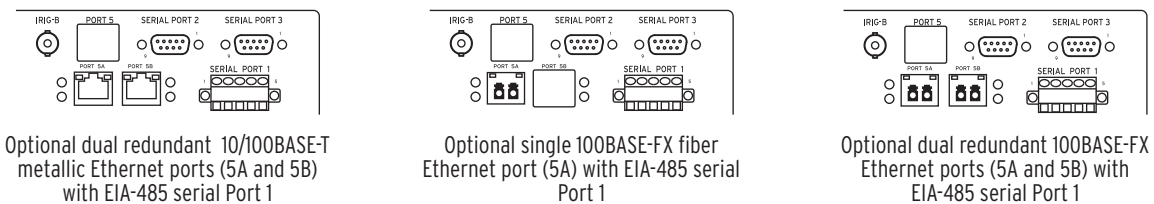


Figure 27 SEL-651R-2 Rear-Panel Communications Port Configurations

Enclosure Dimensions

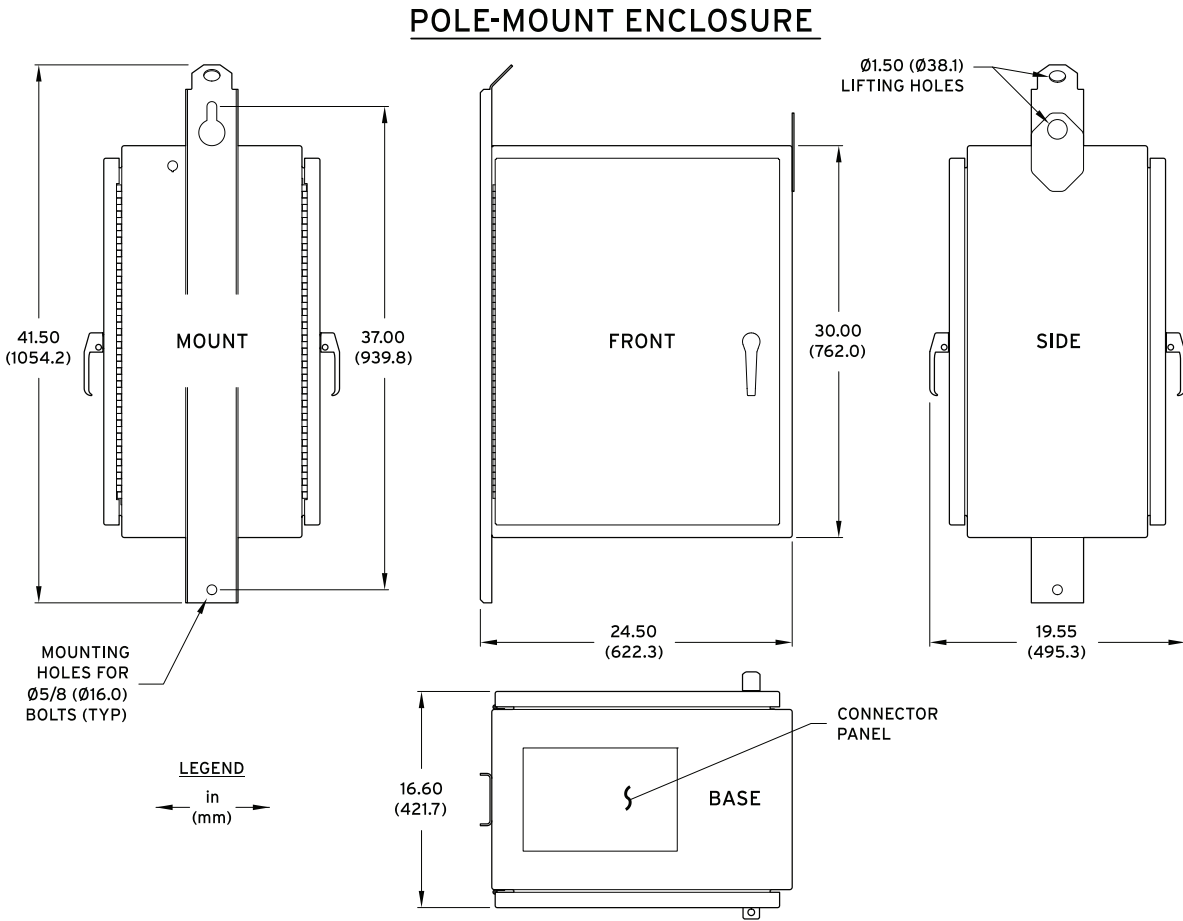


Figure 28 SEL-651R-2 Dimensions and Mounting Drill Plan (Dual-Door Enclosure)

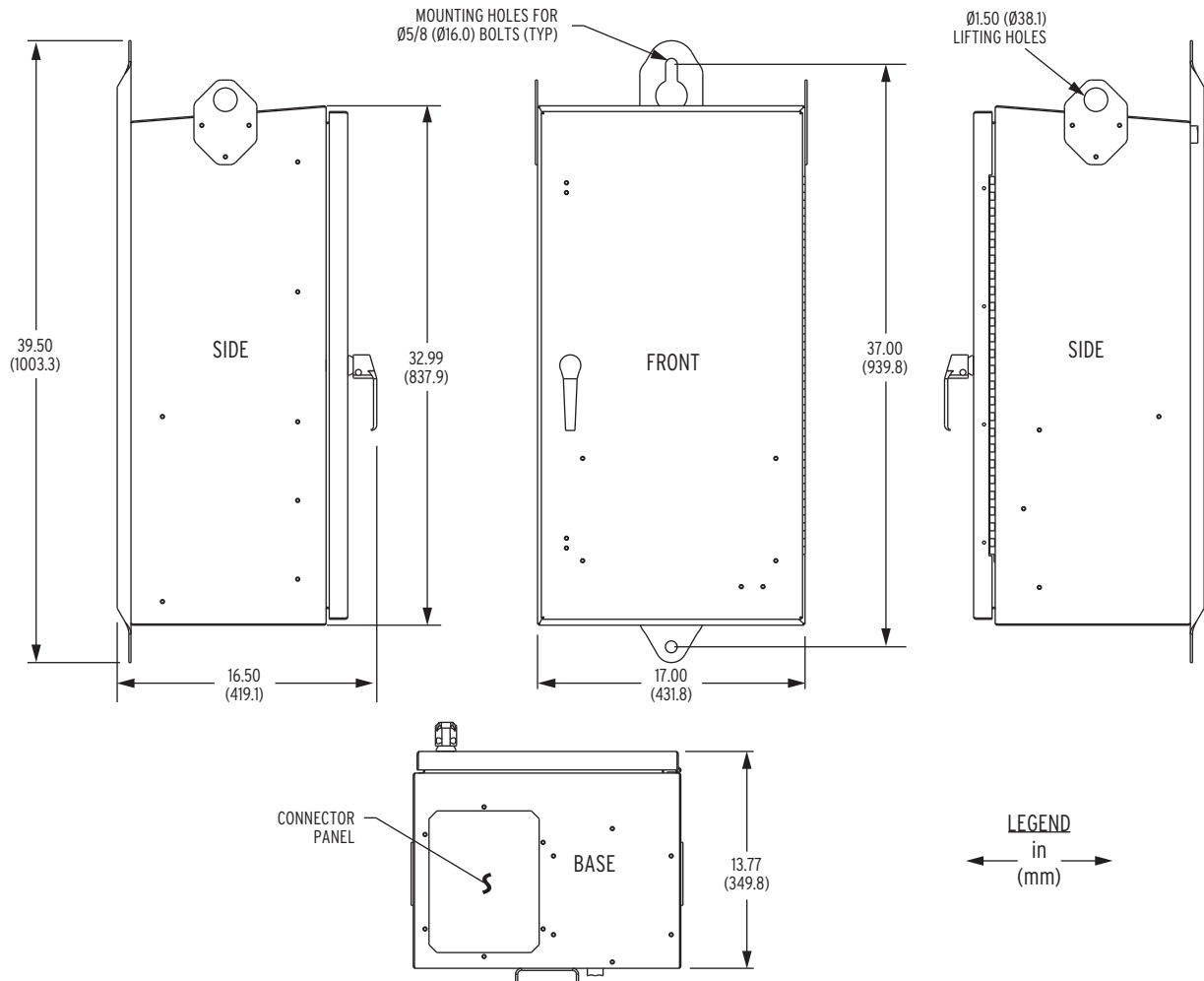


Figure 29 SEL-651R-2 Dimensions and Mounting Drill Plan (Single-Door Enclosure)

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 (PT):

300 V_{L-N} continuous (ideally connect voltage no higher than 240 Vac nominal, thus providing 60 Vac margin for accurately measuring overvoltage conditions); 600 Vac for 10 s.

Burden:

<0.03 VA @ 67 V
<0.06 VA @ 120 V
<0.80 VA @ 300 V

8 V LEA:

8 V_{L-N} continuous (ideally connect voltage no higher than 6.5 Vac nominal, thus providing 1.5 Vac margin for accurately measuring overvoltage conditions); 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 (ideally connect voltage no higher than 29.6 Vac nominal, thus providing 7.4 Vac margin for accurately measuring overvoltage conditions); 250 Vac for 10 s.
Burden:	Relay Input Z = 165 kΩ
Common Mode Voltage	
Operation:	3 Vac
Without Damage:	53 Vac
Lindsey SVM I LEA:	200 V _{L-N} continuous (ideally connect voltage no higher than 160 Vac nominal, thus providing 40 Vac margin for accurately measuring overvoltage conditions); 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 (ideally connect voltage no higher than 6.79 Vac nominal, thus providing 1.7 Vac margin for accurately measuring overvoltage conditions); 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_{nY} or V_{nZ} (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 ² t < 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 ² t < 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 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-STS 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 k Ω 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 μ s

Synchrophasor Reports (e.g., **MET PM, EVE P, CEV P**): ± 10 μ s

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 μ s 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 $\pm 3\%$ of setting
Ground: ± 0.001 A plus $\pm 3\%$ of setting (IN < 4.7 A)
 ± 0.010 A plus $\pm 3\%$ of setting (IN ≥ 4.7 A)
Neutral: ± 0.001 A plus $\pm 3\%$ of setting
Transient Overreach: $\pm 5\%$ 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 $\pm 0.1\%$ 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 $\pm 3\%$ of setting
Ground: ± 0.001 A plus $\pm 3\%$ of setting (IN < 4.7 A)
 ± 0.010 A plus $\pm 3\%$ of setting (IN ≥ 4.7 A)
Neutral: ± 0.001 A plus $\pm 3\%$ 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 $\pm 4\%$ 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 $\pm 0.1\%$ 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 $\pm 1\%$ of setting
Phase-to-Phase: ± 1 V plus $\pm 2\%$ of setting
Sequence: ± 1.5 Vac plus $\pm 3\%$ of setting @ 12.5–300 Vac

8 V LEA Maximum^a
Phase: ± 10 mV plus $\pm 1\%$ of setting
Phase-to-Phase: ± 20 mV plus $\pm 2\%$ of setting
Sequence: ± 30 mVac plus $\pm 3\%$ of setting @ 0.33–8.00 Vac

Eaton NOVA LEA^a
Phase: ± 60 mV plus $\pm 1\%$ of setting
Phase-to-Phase: ± 120 mV plus $\pm 2\%$ of setting
Sequence: ± 180 mVac plus $\pm 3\%$ of setting @ 1.55–37.09 Vac

Lindsey SVM1 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°, 0.1-degree increment
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, 0.01 s 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 Time:	See Equation 4.7 in the <i>SEL-651R-2 Instruction Manual</i> .
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 SVM I LEAs ±0.2% (0.71–8.49 V), ±0.5° for Siemens SDR LEAs
VABY, VBCY, VCAZ, 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 SVM I 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 SVM I 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% ($V_{\text{phase}} > 50 \text{ Vac}^d$, $I_{\text{phase}} > 0.1 \text{ A}$)
-----------------------------	--

Real (MW)

MWA, MWB, MWC, MW3P:	±0.7% @ PF = 1, ±1.0% @ PF > 0.87 ($V_{\text{phase}} > 50 \text{ Vac}^d$, $I_{\text{phase}} > 0.1 \text{ A}$)
-------------------------	---

Reactive (MVAR)

MVARA, MVARB, MVARC, MVAR3P:	±0.7% @ PF = 0, ±1.0% @ PF < 0.50 ($V_{\text{phase}} > 50 \text{ Vac}^d$, $I_{\text{phase}} > 0.1 \text{ A}$)
---------------------------------	---

Energy

Megawatt Hours (In and Out)

MWhA, MWhB, MWhC, MWh3P:	+1.2% @ PF = 1, ($V_{\text{phase}} > 50 \text{ Vac}^d$, $I_{\text{phase}} > 0.1 \text{ A}$)
-----------------------------	---

Megavar Hours (In and Out)

MVARhA, MVARhB, MVARhC, MVARh3P:	+1.2% @ PF = 0, ($V_{\text{phase}} > 50 \text{ Vac}^d$, $I_{\text{phase}} > 0.1 \text{ A}$)
-------------------------------------	---

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, $10 \text{ Hz} \leq F_s \leq (2 \cdot \text{NFREQ})$.

Current Range: (0.2–2.0) • I_{nom} ($I_{\text{nom}} = 1 \text{ A phase}$,
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 SVM I 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% $V_{\text{phase}} > 50 \text{ Vac}^d$ 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
($V_{\text{phase}} > 50 \text{ Vac}^c$, $I_{\text{phase}} > 0.1 \text{ A}$)

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 AI_2:	27 kV, 12.5 kA interrupting, 600 A continuous
Tavrida OSM AI_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_AI_2(630_150_2)

Voltage Rating:	27 kV
Current Break Rating:	12.5 kA
Continuous Current Rating:	630 A

ABB 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
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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 SVM1 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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This product is covered by the standard SEL 10-year warranty. For warranty details, visit selinc.com or contact your customer service representative.

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BEG500KTL-U

Specification

■ Introduction

In order to meet Energy storage market requirement, BYD developed 500kVA PCS (Power Conversion System) with years' experiences. This PCS is usually used for medium to large energy storage power station with high efficiency, reliable operation, high stability, and supplied for the following services: peak load shifting, adjustable reactive power etc.

■ PCS Topology

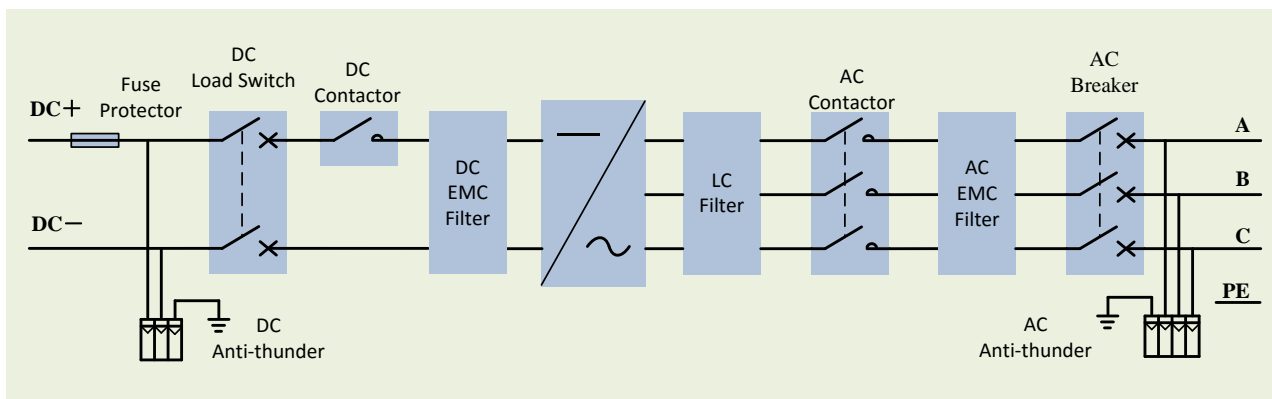


Figure 1: PCS Topology

■ System Parameters

No.	Item	Parameter	Remark
1	Type	BEG500KTL-U	
Parameters at DC side			
2	DC Voltage range	780~1000Vdc	
3	Max. DC current	700A	
Parameters at AC side			
4	Nominal AC voltage	480Vac	
5	Max.AC current	600A	
6	AC power	500kW	
7	Nominal Grid Frequency	60Hz	
8	Power Factor	0.95 (leading) ~0.95 (lagging)	
9	THD	<5%	at nominal power
System parameter			
10	Isolation Method	Transformer less	



BEG500KTL-U

Specification

11	Max. Efficiency	97.5%	
12	Nominal power	97%	
13	Enclosure Protection Grade	IP20 (indoor)	
14	Allowable Environment Temperature	-25~+55℃	Nominal output under 50℃
15	Allowable Relative Humidity	5~95% (no frozen)	
16	Allowable Max. Altitude	6000m	Power derating over 3000m
17	Noise	<75dB	
18	Cooling	Air cooling	
19	Fresh Air Consumption	10000m ³ /h	
20	Display	Touch screen	
21	Communication Interface	RS485/Ethernet	
保护功能			
22	Short-circuit Protection	√	
23	Over-load Protection	√	
24	DC Over-voltage and Under-voltage Protection	√	
25	Grid Monitoring	√	
26	Insulation Monitoring	√	
27	Over-temperature Protection	√	
28	DC Reverse Polarity Protection	√	
29	Islanding Protection	Active and Passive Detection	
Mechanical Parameter			
30	Dimension (W/L/D) (mm)	2000/600/2150	
31	Weight (kg)	1700	
Reference Standard			
32	Safety	UL 1741-2 nd Ed (January 28, 2010)	
33	On-grid	IEEE 1547 (2003) IEEE 1547.1(2005)	

BEG500KTL-U

Specification

■ Performance features

- Wide DC voltage input range, max. voltage is 1000V
- Output harmonic wave is small, max. efficiency is up to 97.5%
- Very short switch time of charging and discharging at full power
- Adjustable reactive power
- Active power derating
- Thin-film capacitor design improve the system service life

■ Topology

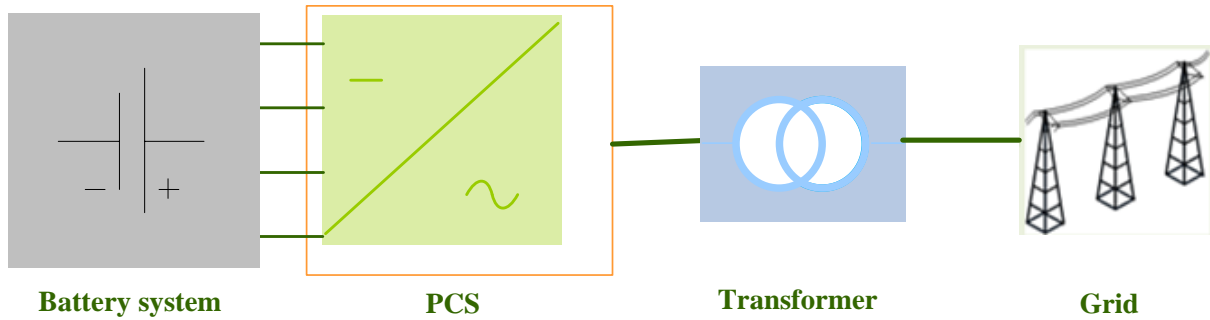


Figure 2: System Application



BYD Power Conversion System

500kw PCS Specification

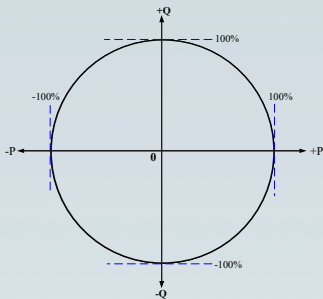


Introduction

In order to meet Energy storage market requirement, BYD successfully developed 500kVA PCS (Power Conversion System) with years' experiences. This PCS is usually used for medium to large energy storage power station with high efficiency, reliable operation, high stability, and supplied for the following services: peak load shifting, adjustable reactive power etc.

Reactive Power Capability

The PCS independently controls the real power (P) and reactive power (Q). Providing independent control of the real and reactive power allows the system operator to use the reactive capacity of the PCS during times where the real power demand is low, providing voltage support or power factor compensation. The reactive power capacity of the PCS as defined below. Independent values for P, Q and S power limits can be programmed into the PCS.



Performance Characteristics

- Small current harmonic, Maximum efficiency is as high as 97.5%
- Wide DC input voltage range, the highest voltage is up to 1000V
- Very short switch time of charging and discharging at full power
- Adjustable reactive power
- Active power derating
- Thin film capacitor design improve the service life of the system



BYD Power Conversion System

500kw PCS Specification

System Parameter

	Type	BEG500KTL-U	Remark
DC Side Parameter	DC Voltage	780~1000Vdc	
	Max. DC Current	700A	
AC Side Parameter	Nominal AC Voltage	480Vac	
	Max. AC Current	600A	
	Nominal Power	500kW	
	Nominal Grid Frequency	60Hz	
	Power Factor	-1~1	
	THD	<5%	@Nominal Power
	Active Power Accuracy	±5kW	
	Reactive Power Accuracy	±5kvar	
	Response Time	Within 200ms	
System Parameter	Insulation Method	Without Transformer	
	Max. Efficiency	97.5%	
	Nominal Efficiency	97%	
	Enclosure Protection Grade	IP20 (Indoor)	
	Permissible Environment Temperature	-25~+50 C	
	Permissible Humidity	5~95%	No condensing
	Permissible Altitude	≤2000m	
	Noise	<75dB	
	Cooling Method	Smart Forced Wind Cooling	
	Fresh Air Consumption	10000m ³ /h	
	Display	HMI	
	Communication Interface	RS485/Internet	
	Communication protocol	Modbus TCP/IP	
	Dimension (W×D×H)	2000mm×600mm×2150mm	
Weight	1700kg		
Protect Function	Short Cut Protection	√	
	Over Load Protection	√	
	DC Over/Under Voltage Protection	√	
	Grid Monitoring	√	
	Over Temperature Protection	√	
	Direct Current Electrode Positive Protection	√	
Function	P/Q	√	
	Island Protection	Active and passive detection	
Reference standards and certification	Safety	UL 1741-2nd Ed (January 28, 2010)	
	On-Grid	IEEE 1547 (2003) IEEE 1547.1(2005)	

SG125HV

String Inverter for 1500 Vdc System



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 °C
- Patented anti-PID function

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

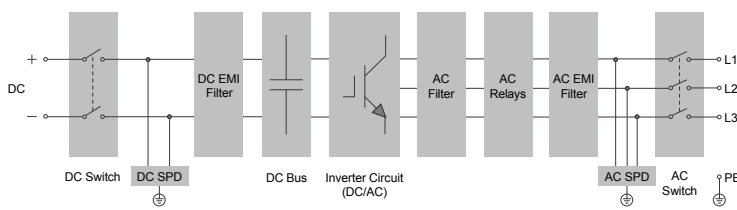
EASY O&M

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

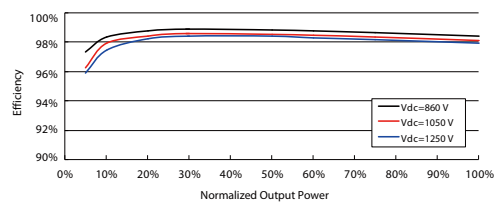
GRID SUPPORT

- 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	250 A
Output (AC)	
AC output power	125 kVA @ 50 °C
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 % I _n
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	No
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	-30 to 60 °C (> 50 °C derating) -22 to 140 °F (> 122 °F 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 mm ² 350 Kcmil)
AC connection type	OT or DT terminal (Max. 185 mm ² 350 Kcmil)
Compliance	UL1741, UL1741SA, IEEEE1547, IEEEE1547.1, 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, EN50549,VDE-AR-N 4110:2018, VDE-AR-N 4120:2018, UNE 206007-1:2013, P.O.12.3, UTE C15-712-1:2013, CEI 0-16:2017, IEC 61683, PEA, NTCO
Grid Support	LVRT, HVRT, ZVRT, active & reactive power regulation, PF control, soft start/stop



Three-phase pad-mounted compartmental type transformer



General

At Eaton, we are constantly striving to introduce new innovations to the transformer industry, bringing you the highest quality, most reliable transformers. Eaton's Cooper Power series Transformer Products are ISO 9001 compliant, emphasizing process improvement in all phases of design, manufacture, and testing. In order to drive this innovation, we have invested both time and money in the Thomas A. Edison Technical Center, our premier research facility in Franksville, Wisconsin. Such revolutionary products as distribution-class UltraSIL™ Polymer-Housed Evolution™ surge arresters and Envirotemp™ FR3™ fluid have been developed at our Franksville lab.

With transformer sizes ranging from 45 kVA to 12 MVA and high voltages ranging from 2400 V to 46 kV, Eaton has you covered. From fabrication of the tanks and cabinets to winding of the cores and coils, to production of arresters, switches, tap changers, expulsion fuses, current limit fuses, bushings (live and dead) and molded rubber goods, Eaton does it all. Eaton's Cooper Power series transformers are available with electrical grade mineral oil or Envirotemp™ FR3™ fluid, a less-flammable and bio-degradable fluid. Electrical codes recognize the advantages of using Envirotemp™ FR3™ fluid both indoors and outdoors for fire sensitive applications. The bio-based fluid meets Occupational Safety and Health Administration (OSHA) and Section 450.23 NEC Requirements.

EATON

Powering Business Worldwide

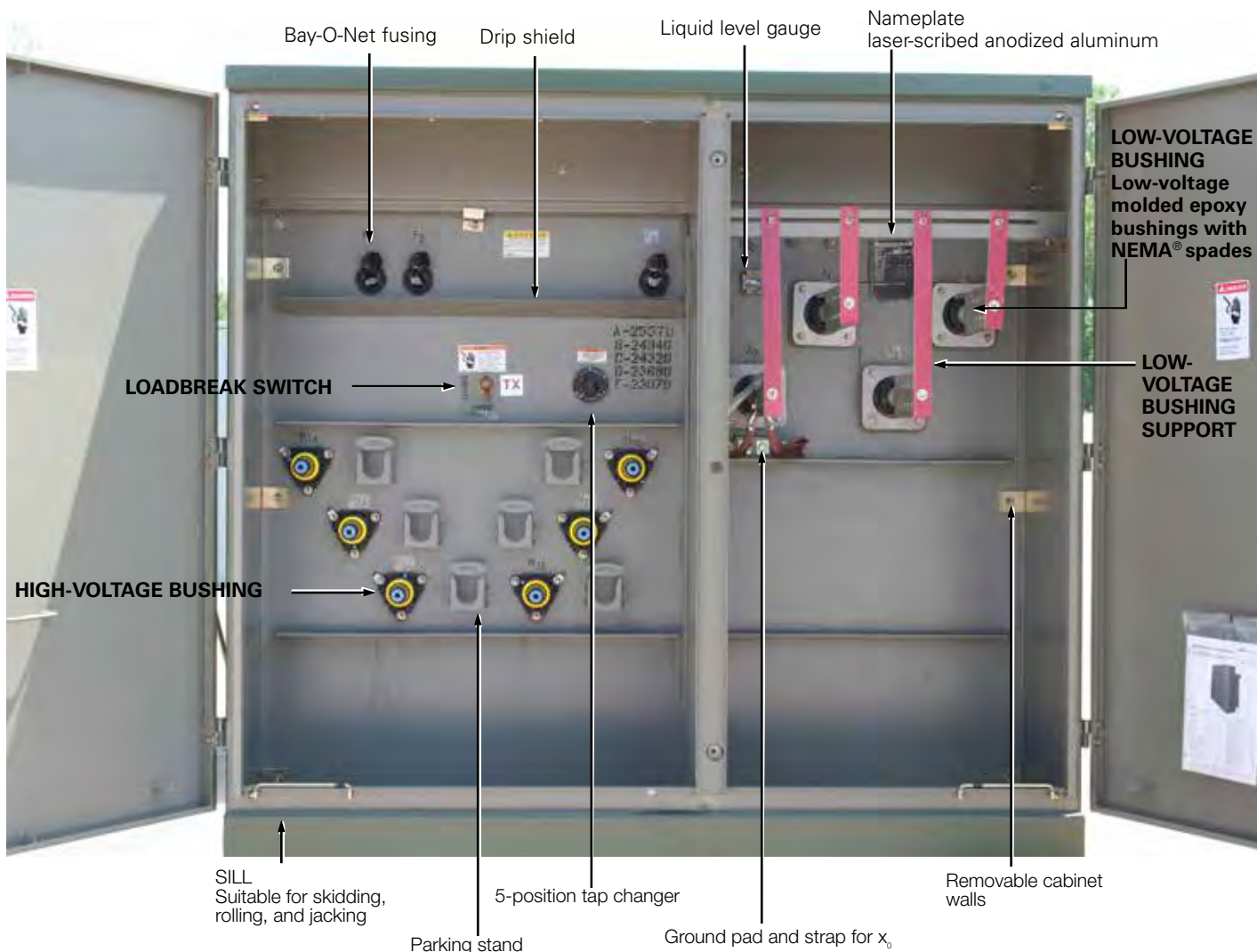


Figure 1. Three-phase pad-mounted compartmental type transformer.

Table 1. Product Scope

Type	Three Phase, 50 or 60 Hz, 65 °C Rise (55 °C, 55/65 °C), 65/75 °C, 75 °C
Fluid Type	Mineral oil or Envirotemp™ FR3™ fluid
Coil Configuration	2-winding or 4-winding or 3-winding (Low-High-Low), 3-winding (Low-Low-High)
Size	45 – 10,000 kVA
Primary Voltage	2,400 – 46,000 V
Secondary Voltage	208Y/120 V to 14,400 V
Specialty Designs	Inverter/Rectifier Bridge
	K-Factor (up to K-19)
	Vacuum Fault Interrupter (VFI)
	UL® Listed & Labeled and Classified
	Factory Mutual (FM) Approved®
	Solar/Wind Designs
	Differential Protection
	Seismic Applications (including OSHPD)
	Hardened Data Center

Table 2. Three-Phase Ratings

Three-Phase 50 or 60 Hz

kVA Available¹

45, 75, 112.5, 150, 225, 300, 500, 750, 1000, 1500, 2000, 2500, 3000, 3750, 5000, 7500, 10000

¹Transformers are available in the standard ratings and configurations shown or can be customized to meet specific needs.

Table 3. Impedance Voltage

Rating (kVA)	Low-voltage rating		
	≤ 600 V	2400 Δ through 4800 Δ	6900 Δ through 13800GY/7970 or 13800 Δ
45-75	2.70-5.75	2.70-5.75	2.70-5.75
112.5-300	3.10-5.75	3.10-5.75	3.10-5.75
500	4.35-5.75	4.35-5.75	4.35-5.75
750-2500	5.75	5.75	5.75
3750	5.75	5.75	6.00
5000		6.00	6.50

Note: The standard tolerance is ± 7.5%

Table 4. Audible Sound Levels

Self-Cooled, Two Winding kVA Rating	NEMA® TR-1 Average
	Decibels (dB)
45-500	56
501-700	57
701-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63
3001-4000	64
4001-5000	65
5001-6000	66
6001-7500	67
7501-10000	68

Table 5. Insulation Test Levels

KV Class	Induced Test 180 or 400 Hz 7200 Cycle	kV BIL Distribution	Applied Test 60 Hz (kV)
1.2	Twice Rated Voltage	30	10
2.5		45	15
5		60	19
8.7		75	26
15		95	34
25		125	40
34.5		150	50

Table 6. Temperature Rise Ratings 0-3300 Feet (0-1000 meters)

	Standard	Optional
Unit Rating (Temperature Rise Winding)	65 °C	55 °C, 55/65 °C, 75 °C
Ambient Temperature Max	40 °C	50 °C
Ambient Temperature 24 Hour Average	30 °C	40 °C
Temperature Rise Hotspot	80 °C	65 °C

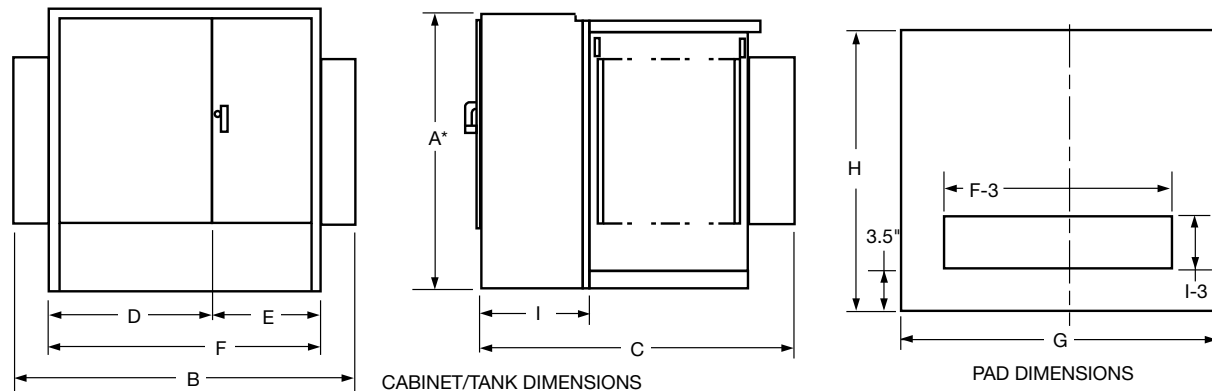


Figure 2. Transformer and pad dimensions.

* Add 9" for Bay-O-Net fusing.

Table 7. Fluid-filled—aluminum windings 55/65 °C Rise¹

65° Rise	DEAD-FRONT—LOOP OR RADIAL FEED—BAY-O-NET FUSING OIL FILLED—ALUMINUM WINDINGS										Gallons of Fluid	Approx. Total Weight (lbs.)
	OUTLINE DIMENSIONS (in.)											
kVA Rating	A*	B	C	D	E	F	G	H	I			
45	50	68	39	42	26	68	72	43	20	110	2,100	
75	50	68	39	42	26	68	72	43	20	115	2,250	
112.5	50	68	49	42	26	68	72	53	20	120	2,350	
150	50	68	49	42	26	68	72	53	20	125	2,700	
225	50	72	51	42	30	72	76	55	20	140	3,150	
300	50	72	51	42	30	72	76	55	20	160	3,650	
500	50	89	53	42	30	72	93	57	20	190	4,650	
750	64	89	57	42	30	72	93	61	20	270	6,500	
1000	64	89	59	42	30	72	93	63	20	350	8,200	
1500	73	89	86	42	30	72	93	90	24	410	10,300	
2000	73	72	87	42	30	72	76	91	24	490	12,500	
2500	73	72	99	42	30	72	76	103	24	530	14,500	
3000	73	84	99	46	37	84	88	103	24	620	16,700	
3750	84	85	108	47	38	85	88	112	24	660	19,300	
5000	84	96	108	48	48	96	100	112	24	930	25,000	
7500	94	102	122	54	48	102	100	126	24	1,580	41,900	

¹ Weights, gallons of fluid, and dimensions are for reference only and not for construction. Please contact Eaton for exact dimensions.

* Add 9" for Bay-O-Net fusing.

Table 8. Fluid-Filled—Copper Windings 55/65 °C Rise¹

65° Rise	DEAD-FRONT—LOOP OR RADIAL FEED—BAY-O-NET FUSING OIL FILLED—COPPER WINDINGS										Gallons of Fluid	Approx. Total Weight (lbs.)
	OUTLINE DIMENSIONS (in.)											
kVA Rating	A*	B	C	D	E	F	G	H	I			
45	50	64	39	34	30	64	69	43	20	110	2,100	
75	50	64	39	34	30	64	69	43	20	115	2,350	
112.5	50	64	49	34	30	64	69	53	20	115	2,500	
150	50	64	49	34	30	64	69	53	20	120	2,700	
225	50	64	51	34	30	64	73	55	20	140	3,250	
300	50	64	51	34	30	64	75	55	20	160	3,800	
500	50	81	53	34	30	64	85	57	20	200	4,800	
750	64	89	57	42	30	72	93	61	20	255	6,500	
1000	64	89	59	42	30	72	93	63	20	300	7,800	
1500	73	89	86	42	30	72	93	90	24	410	10,300	
2000	73	72	87	42	30	72	76	91	24	420	11,600	
2500	73	72	99	42	30	72	76	103	24	500	14,000	
3000	73	84	99	46	37	84	88	103	24	720	18,700	
3750	84	85	108	47	38	85	88	112	24	800	20,500	
5000	84	96	108	48	48	96	100	112	24	850	25,000	
7500	94	102	122	54	48	102	100	126	24	1,620	46,900	

¹ Weights, gallons of fluid, and dimensions are for reference only and not for construction. Please contact Eaton for exact dimensions.

* Add 9" for Bay-O-Net fusing.

Standard features

Connections and neutral configurations

- Delta - Wye: Low voltage neutral shall be a fully insulated XO bushing with removable ground strap.
- Grounded Wye-Wye: High voltage neutral shall be internally tied to the low voltage neutral and brought out as the H0X0 bushing in the secondary compartment with a removable ground strap.
- Delta-Delta: Transformer shall be provided without a neutral bushing.
- Wye-Wye: High voltage neutral shall be brought out as the H0 bushing in the primary compartment and the low voltage neutral shall be brought as the X0- bushing in the secondary compartment.
- Wye-Delta: High voltage neutral shall be brought out as the H0 bushing in the primary compartment. No ground strap shall be provided (line to line rated fusing is required).

High and low voltage bushings

- 200 A bushing wells (15, 25, and 35 kV)
- 200 A, 35 kV Large Interface
- 600 A (15, 25, and 35 kV) Integral bushings (dead-front)
- Electrical-grade wet-process porcelain bushings (live-front)

Tank/cabinet features

- Bolted cover for tank access (45-2500 kVA)
- Welded cover with hand hole (>2500 kVA)
- Three-point latching door for security
- Removable sill for easy installation
- Lifting lugs (4)
- Stainless steel cabinet hinges and mounting studs
- Steel divider between HV and LV compartment
- 20" Deep cabinet (45-1000 kVA)
- 24" Deep cabinet (1500-7500 kVA)
- 30" Deep cabinet (34.5/19.92 kV)
- Pentahead captive bolt
- Stainless steel 1-hole ground pads (45-500 kVA)
- Stainless steel 2-hole ground pads (750-10,000 kVA)
- Parking Stands (dead-front)

Valves/plugs

- One-inch upper filling plug
- One-inch drain plug (45-500 kVA)
- One-inch combination drain valve with sampling device in low voltage compartment (750-10,000 kVA)
- Automatic pressure relief valve

Nameplate

- Laser-scribed anodized aluminum nameplate



Figure 3. Drain valve with sampler.



Figure 4. Automatic Pressure relief valve.



Figure 5. Liquid level gauge.



Figure 6. External Gauges.



Figure 7. External visible break with gauges.

Optional features

High and low voltage bushings

- 200 A (15, 25 kV) bushing inserts
- 200 A (15, 25 kV) feed thru inserts
- 200 A (15, 25 kV) (HTN) bushing wells with removable studs
- High-voltage 600 A (15, 25, 35 kV) deadbreak one-piece bushings
- Low voltage 6-, 8-holes spade
- Low voltage 12-, 16-, 20-holes spade (750-2500 kVA)
- Low voltage bushing supports

Tank/cabinet features

- Stainless steel tank base and cabinet
- Stainless steel tank base, cabinet sides and sill
- 100% stainless steel unit
- Service entrance (2 inch) in sill or cabinet side
- Touch-up paint (domestic)
- Copper ground bus bar
- Kirk-Key provisions
- Nitrogen blanket
- Bus duct cutout

Special designs

- Factory Mutual (FM)
- UL® Classified
- Triplex
- High altitude
- K-Factors
- Step-up
- Critical application
- Modulation transformers
- Seismic applications (including OSHPD)

Switches

- One, two, or three On/Off loadbreak switches
- 4-position loadbreak V-blade switch or T-blade switch
- Delta-wye switch
- 3-position V-Blade selector switch
- 100 A, 150 A, 300 A tap changers
- Dual voltage switch
- Visible break with VFI interrupter interlock
- External visible break (15, 25, and 35 kV, up to 3 MVA)
- External visible break with gauges (15, 25, and 35 kV, up to 3 MVA)

Gauges and devices

- Liquid level gauge (optional contacts)
- Pressure vacuum gauge (optional contacts and bleeder)
- Dial-type thermometer (optional alarm contacts)
- Cover mounted pressure relief device (optional alarm contacts)
- Ground connectors
- Hexhead captive bolt
- Molded case circuit breaker mounting provisions
- External gauges in padlockable box

Overcurrent protection

- Bay-O-Net fusing (Current sensing, dual sensing, dual element, high amperage overload)
- Bay-O-Net expulsion fuse in series with a partial range under-oil ELSP current limiting fuse (below 23 kV)
- Cartridge fusing in series with a partial range under-oil ELSP current limiting fuse (above 23 kV)
- MagneX™ interrupter with ELSP current-limiting fuse
- Vacuum Fault Interrupter (VFI)
- Visible break window
- Fuse/switch interlock

Valves/plugs

- Drain/sampling valve in high-voltage compartment
- Globe type upper fill valve

Overvoltage protection

- Distribution-, intermediate-, or station-class surge arresters
- Elbow arresters (for dead-front connections)

Metering/fan/control

- Full metering package
- Current Transformers (CTs)
- Metering Socket
- NEMA® 4 control box (optional stainless steel)
- NEMA® 7 control box (explosion proof)
- Fan Packages

Testing

- Customer test witness
- Customer final inspection
- Zero Sequence Impedance Test
- Heat Run Test
- ANSI® Impulse Test
- Audible Sound Level Test
- RIV (Corona) Test
- Dissolved Gas Analysis (DGA) Test
- 8- or 24-Hour Leak Test

Coatings (paint)

- ANSI® Bell Green
- ANSI® #61 Light Gray
- ANSI® #70 Sky Gray
- Special paint available per request

Nameplate

- Stainless steel nameplate

Decals and labels

- High voltage warning signs
- Mr. Ouch
- Bi-lingual warning
- DOE compliant
- Customer stock code
- Customer stenciling
- Shock and arc flash warning decal
- Non-PCB decal

Construction

Core

The three-legged, step-lap mitered core construction is manufactured using a high-quality cutting machine. For maximum efficiency, cores are precisely stacked, virtually eliminating gaps in the corner joints.

Five-legged wound core or shell-type triplex designs are used for wye-wye connected transformers, and other special transformer designs.

Cores are manufactured with precision cut, burr-free, grain-oriented silicon steel. Many grades of core steel are available for optimizing core loss efficiency.

Coils

Pad-mounted transformers feature a rectangular coil configuration with wire-wound, high-voltage primaries and sheet-wound secondaries. The design minimizes axial stress developed by short circuits and provides for magnetic balancing of tap connections.

Coils are wound using the highest quality winding machines providing exacting tension control and conductor placement for superior short-circuit strength and maximum efficiency.

Extra mechanical strength is provided by diamond pattern, epoxy-coated paper insulation, used throughout the coil, with additional epoxy at heavy stress points. The diamond pattern distribution of the epoxy and carefully arranged ducts, provide a network of passages through which cooling fluid can freely circulate.

Coil assemblies are heat-cured under calculated hydraulic pressure to ensure performance against short-circuit forces.

Core and coil assemblies

Pad-mounted transformer core and coil assemblies are braced with heavy steel ends to prevent the rectangular coil from distorting under short-circuit conditions. Plates are clamped in place using presses, and welded or bolted to form a solid core and coil assembly. Core and coil assemblies exceed ANSI® and IEEE® requirements for short-circuit performance. Due to the rigidity of the design, impedance shift after short-circuit is comparable to that of circular wound assemblies.

Tanks

Transformer tanks are designed for high strength and ease of handling, installation, and maintenance. Tanks are welded using precision-cut, hot rolled, pickled and oiled steel. They are sealed to protect the insulating fluid and other internal components.

Transformer tanks are pressure-tested to withstand 7 psig without permanent distortion and 15 psig without rupture.

Tank finish

An advanced multi-stage finishing process exceeds IEEE Std C57.12.28™-2014 standards. The eight-stage pre-treatment process assures coating adhesion and retards corrosion. It converts tank surfaces to a nonmetallic, water insoluble iron phosphate coating.

The paint method consists of two distinct layers of paint. The first is an epoxy primer (E-coat) layer which provides a barrier against moisture, salt and corrosives. The two-component urethane final coat seals and adds ultraviolet protection.

Vacuum processing

Transformers are dried and filled with filtered insulating fluid under vacuum, while secondary windings are energized. Coils are heated to drive out moisture, ensuring maximum penetration of fluid into the coil insulation system.

Insulating fluid

Eaton's Cooper Power series transformers are available with electrical-grade mineral insulating oil or Envirotemp™ FR3™ fluid. The highly refined fluids are tested and degassed to assure a

chemically inert product with minimal acid ions. Special additives minimize oxygen absorption and inhibit oxidation. To ensure high dielectric strength, the fluid is re-tested for dryness and dielectric strength, refiltered, heated, dried, and stored under vacuum before being added to the completed transformer.

Eaton's Cooper Power series transformers filled with Envirotemp™ FR3™ fluid enjoy unique fire safety, environmental, electrical, and chemical advantages, including insulation life extending properties.

A bio-based, sustainable, natural ester dielectric coolant, Envirotemp™ FR3™ fluid quickly and thoroughly biodegrades in the environment and is non-toxic per acute aquatic and oral toxicity tests.

Building for Environmental and Economic Sustainability (BEES) total life cycle assessment software, utilized by the US Dept. of Commerce, reports its overall environmental performance impact score at 1/4th that reported for mineral oil. Envirotemp™ FR3™ fluid has also earned the EPA Environmental Technology Verification of transformer materials.

With a fire point of 360 °C, Envirotemp™ FR3™ fluid is FM Approved® and Underwriters Laboratories (UL®) Classified "Less-Flammable" per NEC® Article 450-23, fitting the definition of a Listed Product per NEC®.



Figure 8. VFI transformer with visible break.

Pad-mounted VFI transformer

Eaton's Cooper Power series VFI transformer combines a conventional distribution transformer with the proven Vacuum Fault Interrupter (VFI). This combination provides both voltage transformation and transformer over current protection in one space saving and money saving package. The pad-mounted VFI transformer protects the transformer and provides proper coordination with upstream protective devices. When a transformer fault or overload condition occurs, the VFI breaker trips and isolates the transformer.

The three-phase VFI breaker has independent single-phase initiation, but is three-phase mechanically gang-tripped. A trip signal on any phase will open all three phases. This feature eliminates single-phasing of three phase loads. It also enables the VFI breaker to be used as a three-phase load break switch.

Due to the resettable characteristics of the VFI breaker, restoring three-phase service is faster and easier.

The sealed visible break window and switch is an option that can be installed to provide visible break contact. This feature provides enhanced safety and allows an operator to see if the loadbreak switch contacts are in an open or closed position before performing maintenance.

Envirotran™ FM Approved special protection transformer

Eaton's Cooper Power series Envirotran™ transformer is FM Approved and suitable for indoor locations. Factory Mutual Research Corporation's (FMRC) approval of the Envirotran transformer line makes it easy to comply with and verify compliance with Section 450.23, 2008 NEC, Less-Flammable Liquid-Filled Transformer Requirements for both indoor and outdoor locations.

Envirotran FM Approved transformers offer the user the benefit of a transformer that can be easily specified to comply with NEC, and makes FM Safety Data Sheet compliance simpler, while also providing maximum safety and flexibility for both indoor and outdoor installations.

Because the "FM Approved" logo is readily visible on the transformer and its nameplate, NEC compliance is now easily verifiable by the inspector.

Envirotran FM Approved transformers are manufactured under strict compliance with FMRC Standard 3990 and are filled with FM Approved Envirotemp™ FR3™ fluid, a fire-resistant dielectric coolant.

**Special application transformers****Data Center transformer**

With focus rapidly shifting from simply maximizing uptime and supporting demand to improving energy utilization, the data center industry is continually looking for methods to increase its energy efficiency and reliability. Utilizing cutting edge technology, Eaton's Cooper Power series Hardened Data Center (HDC) transformers are the solution. Designed with special attention given to surge protection, HDC liquid-filled transformers provide superior performance under the harshest electrical environments. Contrary to traditional dry-type units, HDC transformers provide unsurpassed reliability, overloadability, operational life, efficiency, thermal loading and installed footprint. These units have reliably served more than 100 MW of critical data center capacity for a total of more than 6,000,000 hours without any reported downtime caused by a thermal or short-circuit coil failure.

The top priority in data center operations is uninterrupted service. Envirotran HDC transformers from Eaton, having substantially higher levels of insulation, are less susceptible to voltage surges. Eaton has experienced zero failures due to switching transients. The ANSI® and IEEE® standard impulse withstand ratings are higher for liquid-filled transformers, making them less susceptible to insulation failure. The Envirotran HDC transformer provides ultimate protection by increasing the BIL rating one level higher than standard liquid-filled transformer ratings. The cooling system of liquid-filled transformers provides better protection from severe overloads—overloads that can lead to significant loss of life or failure.

Data center design typically includes multiple layers of redundancy, ensuring maximum uptime for the critical IT load. When best in class transformer manufacturing lead times are typically weeks, not days, an unexpected transformer failure will adversely affect the facility's reliability and profitability. Therefore, the ability to determine the electrical and mechanical health of a transformer can reduce the probability of costly, unplanned downtime. Routine diagnostic tests, including key fluid properties and dissolved gas analysis (DGA), can help determine the health of a liquid-filled transformer. Although sampling is not required for safe operation, it will provide the user with valuable information, leading to scheduled repair or replacement, and minimizing the duration and expense of an outage. With a dry-type transformer, there is no reliable way to measure the health or likelihood of an impending failure.

Solar transformer

As a result of the increasing number of states that are adopting aggressive Renewable & Alternative Energy Portfolio Standards, the solar energy market is growing—nearly doubling year over year. Eaton, a key innovator and supplier in this expanding market, is proud to offer its Cooper Power series Envirotran transformers specifically designed for Solar Photovoltaic medium-voltage applications. Eaton is working with top solar photovoltaic developers, integrators and inverter manufacturers to evolve the industry and change the way we distribute power.

In accordance with this progressive stance, every Envirotran Solar transformer is filled with non-toxic, biodegradable Envirotemp™ FR3™ dielectric fluid, made from renewable seed oils. On top of its biodegradability, Envirotemp™ FR3™ fluid substantially extends the life of the transformer insulation, saving valuable resources. What better way to distribute green power than to use a green transformer. In fact, delaying conversion to Envirotran transformers places the burden of today's environmental issues onto tomorrow's generations. Eaton can help you create a customized transformer, based on site specific characteristics including: temperature profile, site altitude, solar profile and required system life. Some of the benefits gained from this custom rating include:

- Reduction in core losses
- Improved payback on investment
- Reduction in footprint
- Improved fire safety
- Reduced environmental impact

For the solar photovoltaic industry, Eaton is offering standard step up transformers and dual secondary designs, including 4-winding, 3-winding (Low-High-Low) and 3-winding (Low-Low-High) designs.

Wind transformer

Eaton is offering custom designs for renewable energy power generation. Eaton manufactures its Cooper Power series Generator Step-Up (GSU) transformers for installation at the base of every wind turbine. Additionally, grounding transformers are available for wind power generation.

DOE efficiency

The United States Department of Energy (DOE) has mandated efficiency values for most liquid type, medium voltage transformers. As a result, all applicable Eaton's Cooper Power series transformers 2500 kVA and below conform to efficiency levels as specified in the DOE ruling "10 CFR Part 431 Energy Conservation Program."

Underwriters Laboratories® (UL®) Listed and Labeled/Classified

The Envirotran transformer from Eaton can be specified as UL® Listed & Labeled, and/or UL® Classified. Underwriters Laboratories (UL®) listing is a verification of the design and construction of the transformer to the ANSI® and IEEE® standards. UL® listing generally is the most efficient, cost-effective solution for complying with relevant state and local electrical codes. UL® Combination Classification/Listing is another way in which to comply with Section 450.23, 2008 NEC® requirements. This combines the UL® listed transformer with a UL® Classified Less-Flammable Liquid and complies with the use restrictions found within the liquid Classification.



K-Factor transformer

With a drastic increase in the use of ferromagnetic devices, arcing devices, and electric power converters, higher frequency loads have increased significantly. This harmonic loading has the potential to generate higher heat levels within a transformer's windings and leads by as much as 300%. Harmonic loading has the potential to induce premature failure in standard-design distribution transformers.

In addition to standard UL® "K-Factor" ratings, transformers can be designed to customer-provided specifications detailing precise loading scenarios. Onsite measurements of magnitude and frequency, alongside harmonic analysis of the connected load can be performed by Eaton engineers or a third party consultant. These field measurements are used to determine exact customer needs and outline the transformer specifications.

Eaton will design harmonic-resistant transformers that will be subjected to the unique harmonic loads. These units are designed to maintain normal temperature rise under harmonic, full-load conditions. Standard UL® "K-Factor" designs can result in unnecessary costs when the "next-highest" K-Factor must be selected for a calculated design factor. To save the customer these unnecessary costs, Eaton can design the transformer to the specific harmonic spectrum used in the application. Eaton's Cooper Power series K-factor transformers are filled with mineral oil or Envirotemp™ FR3™ fluid and enjoy the added benefits of dielectric cooling such as higher efficiencies than dry-type transformers.

Modulation transformer

Bundled with an Outboard Modulation Unit (OMU) and a Control and Receiving Unit (CRU), a Modulation Transformer Unit (MTU) is designed to remotely achieve two way communication.

The use of an MTU reduces travel time and expense versus traditional meter reading performed by high voltage electricians. Additionally, with MTU it is possible to manage and evaluate energy consumption data, providing reduced metering costs and fewer tenant complaints.

An MTU utilizes existing utility infrastructure, therefore eliminating the need to engineer and construct a dedicated communication network.



Figure 9. Modular transformer.

Inverter/rectifier bridge

Eaton complements its range of applications for transformers by offering dual winding designs. These designs are intended for connection to 12-pulse rectifier bridges.

Product attributes

To set us apart from other transformer manufactures, Eaton includes the following guarantees with every three-phase pad-mounted transformer.

Engineered to order (ETO)

Providing the customer with a well developed, cost-effective solution is the number one priority at Eaton. Using customer specifications, Eaton will work with the customer from the beginning to the end to develop a solution to fit their needs. Whether it is application specific, site specific, or a uniquely specified unit, Eaton will provide transformers with the best in class value and performance, saving the customer time and money.

Made in the U.S.A.

Eaton's three-phase pad-mounted transformers are produced right here in the United States of America. Our manufacturing facilities are positioned strategically for rapid shipment of products. Furthermore, should the need arise, Eaton has a broad network of authorized service repair shops throughout the United States.

Superior paint performance

Protecting transformers from nature's elements worldwide, Eaton's E-coat system provides unrivaled transformer paint life, and exceeds IEEE Std C57.12.28™-2014 and IEEE Std C57.12.29™-2005 standards. In addition to the outside of the unit, each transformer receives a gray E-coat covering in the interior of the tank and cabinet, providing superior rust resistance and greater visibility during service.

If the wide range of standard paint selections does not suit the customer's needs, Eaton will customize the paint color to meet their requirements.

Rectangular coil design

Eaton utilizes a rectangular coil design. This winding technique results in a smaller overall unit footprint as well as reducing the transformer weight. The smaller unit size does not hinder the transformer performance in the least. Units have proven short circuit withstand capabilities up to 10 MVA.

Testing

Eaton performs routing testing on each transformer manufactured including the following tests:

- **Insulation Power Factor:** This test verifies that vacuum processing has thoroughly dried the insulation system to required limits.
- **Ratio, Polarity, and Phase Relation:** Assures correct winding ratios and tap voltages; checks insulation of HV and LV circuits. Checks entire insulation system to verify all live-to-ground clearances.
- **Resistance:** This test verifies the integrity of internal high-voltage and low-voltage connections; provides data for loss upgrade calculations.
- **Routine Impulse Tests:** The most severe test, simulating a lightning surge. Applies one reduced wave and one full wave to verify the BIL rating.
- **Applied Potential:** Applied to both high-voltage and low-voltage windings, this test stresses the entire insulation system to verify all live-to-ground clearances.
- **Induced Potential:** 3.46 times normal plus 1000 volts for reduced neutral designs.
- **Loss Test:** These design verification tests are conducted to assure that guaranteed loss values are met and that test values are

Effective July 2015

within design tolerances. Tests include no-load loss and excitation current along with impedance voltage and load loss.

- Leak Test: Pressurizing the tank to 7 psig assures a complete seal, with no weld or gasket leaks, to eliminate the possibility of moisture infiltration or fluid oxidation.

Design performance tests

The design performance tests include the following:

- Temperature Rise: Our automated heat run facility ensures that any design changes meet ANSI® and IEEE® temperature rise criteria.
- Audible Sound Level: Ensures compliance with NEMA® requirements.
- Lightning Impulse: To assure superior dielectric performance, this test consists of one reduced wave, two chopped waves and one full wave in sequence, precisely simulating the harshest conditions.

Thomas A Edison Research and Test Facility

We are constantly striving to introduce new innovations to the transformer industry, bringing you the highest quality transformer for the lowest cost. Eaton's Cooper Power series Transformer Products are ISO 9001 compliant, emphasizing process improvement in all phases of design, manufacture, and testing. We have invested millions of dollars in the Thomas A. Edison Technical Center, our premier research facility in Franksville, Wisconsin affirming our dedication to introducing new innovations and technologies to the transformer industry. This research facility is fully available for use by our customers to utilize our advanced electrical and chemical testing labs.

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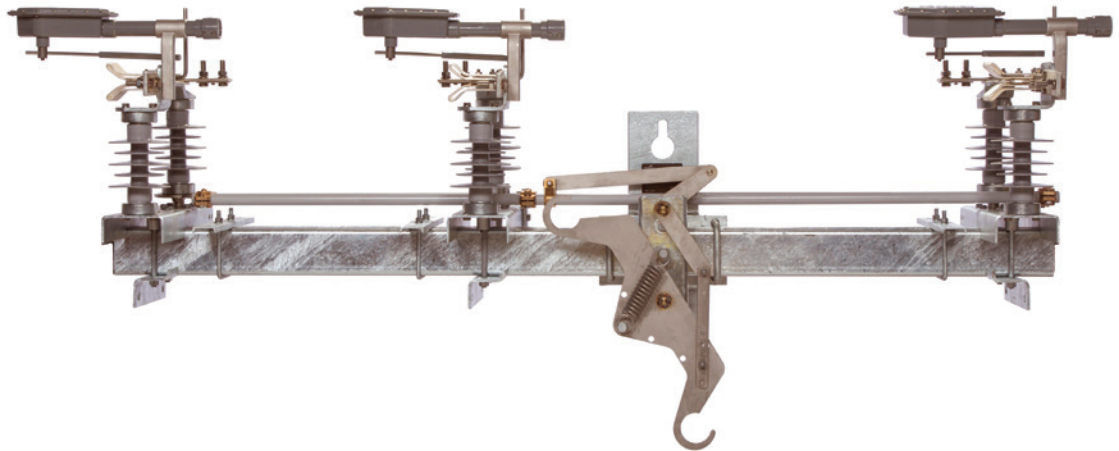
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For Eaton's Cooper Power series three-phase transformer product information call 1-877-277-4636 or visit: www.eaton.com/cooperpowerseries.

M-Force™ three-phase switch



Description

Eaton's Cooper Power™ series M-Force™ switch is a distribution-class, gang-operated, factory unitized three-phase overhead loadbreak switch. The M-Force switch is offered in distribution voltage classifications of 15.5 kV, 27 kV, and 38 kV. The M-Force switch may be used for line sectionalizing, paralleling, by-passing, or isolating.

M-Force stands for "Magnetic Force." Eaton has the only reverse loop contacts found on distribution-class sidebreak switches; a contact usually reserved for higher priced transmission switches. The reverse loop contacts utilize high current magnetic forces for added reliability. The reverse loop design allows for high contact pressure to be maintained during fault conditions. This feature prevents pitting and distorting of the switch blade and contacts even under severe momentary overload.

EATON

Powering Business Worldwide

Basic concept

Current-carrying conductors that are parallel to each other and have current flowing in the same direction, attract each other due to the magnetic forces acting on them (See Figure 1A).

Current-carrying conductors that are parallel to each other and have current flowing in the opposite direction, repel due to the magnetic forces acting on them (See Figure 1B).

Current flows through the two parallel inner segments of the reverse loop contacts in the same direction, thus these two segments attract each other, initiating contact pressure. Current flow through the inner segment and the outer segment is in opposite directions, which causes a repelling force that amplifies the contact pressure.

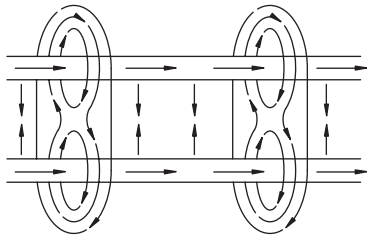


Figure 1A. Current flowing in same direction.

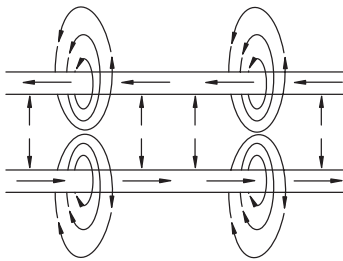


Figure 1B. Current flowing in opposite direction.

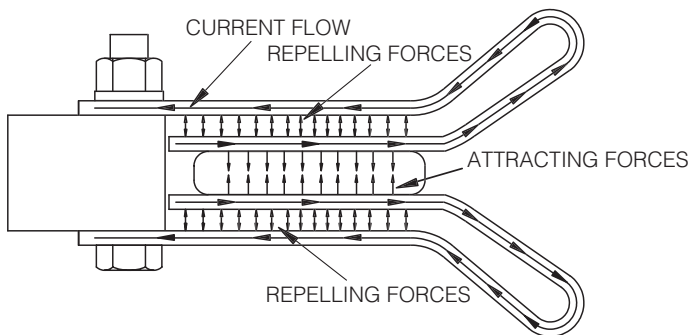


Figure 2. Magnetic forces acting on contacts.

Design features

Reverse loop contacts

The reverse loop contacts utilize high current magnetic forces for added reliability. The reverse loop contacts were adapted from Eaton's Cooper Power series KPF Line Tension Switch and have been field-proven for over 80 years. The reverse loop design allows for high contact pressure to be maintained during fault conditions. This feature prevents pitting and distorting of the switch blade and contacts even under severe momentary overload. These contacts originally designed for high voltage transmission switches also maintain extremely cool temperatures even under the rated full load. The max temperature rise allowed per IEEE Std 1247™-2005 standard for the blade and contact area is 65 °C. The max temperature rise observed on the reverse loop contact area was 38 °C, less than half of the allowed temperature. These types of test results, along with the proven field performance, undoubtedly make the Reverse Loop Contacts found in the M-Force switch the premiere choice in the industry.

Insulators

The M-Force switch comes standard with polymer (silicone rubber) insulators. These non-porcelain insulators offer exceptional dielectric and mechanical characteristics adding to the reliability of the M-Force switch, while lowering the weight. The M-Force switch can be provided in cycloaliphatic epoxy and porcelain housings. Insulators come standard with 2.25" bolt circles at 15 and 25 kV. Insulators require a 3.00" bolt circle at 35 kV.

Extended bearing assembly

The stainless steel shaft on the rotating insulator bearing assembly has been extended to four inches. This extra length will prevent horizontal movement of the rotating insulator during operation which ensures proper blade/contact alignment which is essential for smooth operation. Another feature of the bearing assembly is the oil-impregnated bushings that provide maintenance-free operation for the life of the switch.

Insulated Reliabreak™ arm

The Reliabreak™ Pick-up Arm on the M-Force switch is insulated on one side, which isolates the interrupter from the current path during a close operation. This feature allows for a wide range of adjustments between the Reliabreak arm and the blade catch finger. This increased tolerance removes the possibility of misalignment during operation which ensures proper load interruption.

Positive locking dead-end brackets

The dead-end brackets on the M-Force switch are of a positive locking design. This design allows for dead-ending at an angle without any distortion of the brackets. This allows for a more flexible switch that can be used in a wider variety of installation requirements.

New inter-phase clamps

The inter-phase control rod clamps on the M-Force switch are designed with a jam nut through the side of the casting which locks the clamps after factory alignment. This feature eliminates any possibility of accidental slippage of the control mechanism which ensures proper operation even under icy conditions.

Optional ice shields

The standard M-Force switch is capable of operating under a 3/8" ice build up. With the optional ice shields the M-Force switch is capable of opening and closing with a 3/4" ice build up.

The unique shields are designed to prevent ice from building up between the contact clips as well as removing the ice from the blade during the closing operation. Per IEEE Std C37.34™-1994, a chopping action is allowed during the close operation to break the ice. Due to the shearing action of the M-Force Ice Shields, the closing operation can be accomplished with one motion. No chopping is needed.

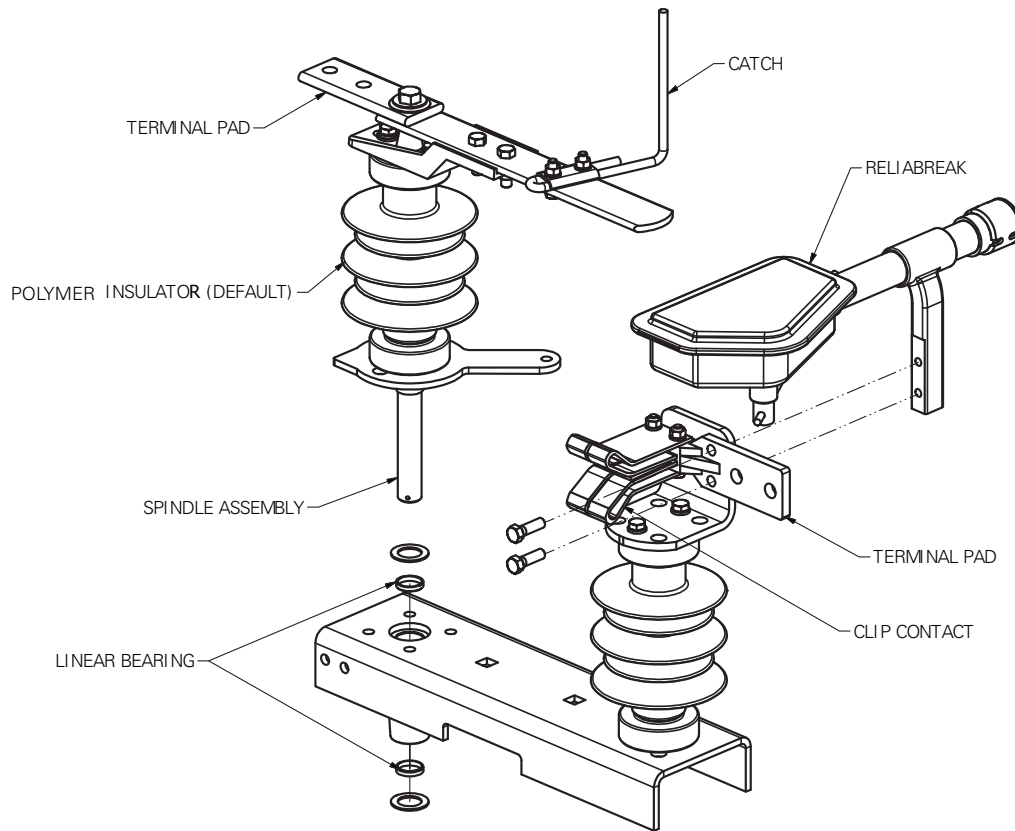


Figure 3. Illustration of M-Force switch.

M-Force switch dimensional data

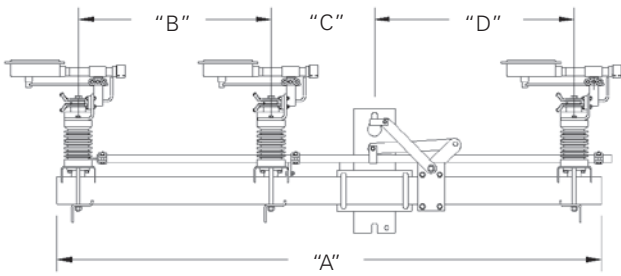


Figure 4. Horizontal switch configuration.

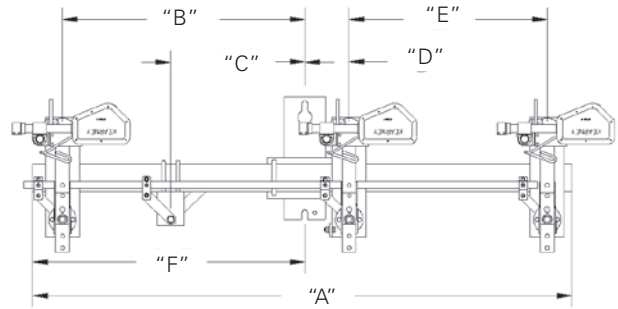


Figure 6. Vertical switch configuration.

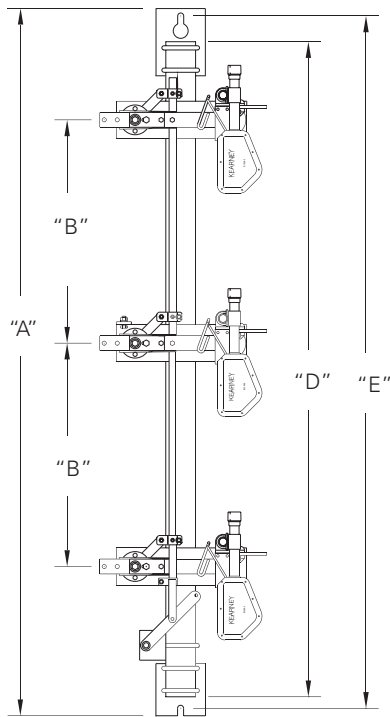


Figure 5. Phase-over-phase switch configuration.

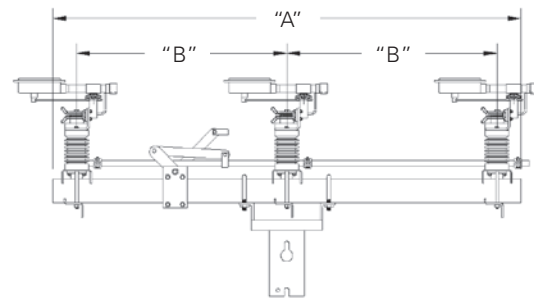


Figure 7. Horizontal Pole top switch configuration.

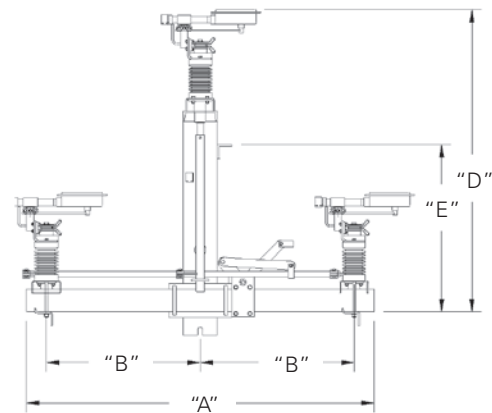


Figure 8. Triangular switch configuration.

Table 1. Dimensional Information

Dim.	Horizontal						Vertical (Riser)						Phase-over-Phase			Triangular		
	Standard			G095			Standard			G095			15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV
	15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV	15.5 kV	27 kV	38 kV
A	79"	88"	119"	97"	108"	126"	79"	88"	97"	108"	119"	126"	95"	104"	126"	61"	73"	79"
B	28"	33"	42"	28"	33"	42"	35.5"	40"	45"	49.5"	56"	54.5"	30"	34.5"	45.5"	27"	33"	36"
C	15"	15"	18"	24"	24"	24"	19.5"	19.5"	19.5"	19.5"	19.5"	19.5"	N/A	N/A	N/A	N/A	N/A	N/A
D	29"	33"	52"	38"	43.5"	52.5"	6.5"	6.5"	6.5"	22"	22.5"	22.5"	88"	97"	119"	58"	61"	73"
E	N/A	N/A	N/A	N/A	N/A	N/A	29"	33.5"	45"	29"	33.5"	42"	93"	102"	124"	34"	34"	42"
F	N/A	N/A	N/A	N/A	N/A	N/A	39.5"	45"	48.5"	53.5"	59.5"	58"	N/A	N/A	N/A	N/A	N/A	N/A

Horizontal Pole Top

Dim.	15.5 kV	27 kV	38 kV
A	79"	79"	97"
B	36"	36"	45"

Phase unit dimensions

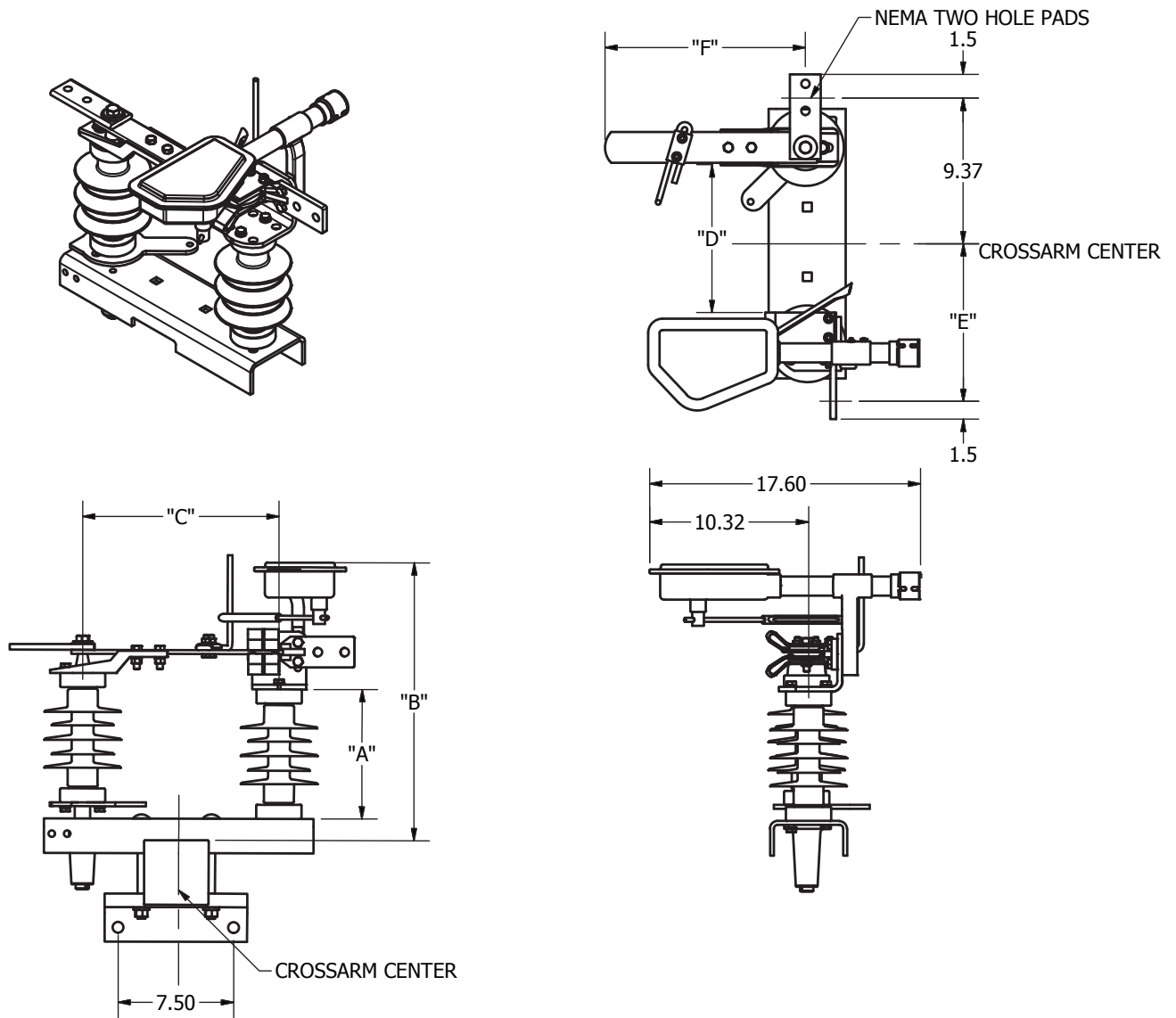


Figure 9. Phase unit breakdown.

Table 2. Phase Unit Dimensions

Dim.	Voltage Class	15.5 kV	27 kV	38 kV
	Insulator Material	2.25" Bolt Circle	2.25" Bolt Circle	3.00" Bolt Circle
A	Polymer	8.4"	10.8"	18.0"
	Epoxy	7.0"	10.0"	14.0"
	Porcelain	8.0"	10.0"	18.0"
B	B = A + 10.00"			
C	12.8"			
D	9.5"			
E	10.0"			
F	13.0"			

Technical specifications

Table 3. Insulator Creep Distances

	2.25" Bolt Circle Insulators		3.00" Bolt Circle Insulators
	15.5 kV	27 kV	38 kV
Polymer Insulators	20.2"	28.0"	37.00"
Epoxy Insulators	18.3"	22.70"	37.69"
Porcelain Insulators	14.0"	17.38"	37.00"

Table 4. Electrical Characteristics

	Max	BIL	Cont. Current	Loadbreak	Momentary*	3 Second	Fault Close (ASM)
14.4 kV	15.5 kV	110 kV	900 A	50 @ 600 A/10 @ 900 A	40 kA Asy. rms	25 kA Sym. rms	1 @ 20 kA, 3 @ 15 kA
25 kV	27 kV	150 kV	900 A	50 @ 600 A/10 @ 900 A	40 kA Asy. rms	25 kA Sym. rms	1 @ 20 kA, 3 @ 15 kA
34.5 kV	38 kV	200 kV	900 A	10 @ 900 A	40 kA Asy. rms	25 kA Sym. rms	1 @ 20 kA, 3 @ 15 kA

* Momentary peak current is 65 kA.

Contacts

- The stationary contact is constructed of silver-plated hard drawn copper in a reverse loop configuration
- The reverse loop design ensures that pressure is applied to the blade when subjected to high fault currents

Blade

- The blade is constructed of silver-plated hard drawn copper of solid blade buss design
- The blade does not use a truss type design that requires backup springs to insure contact pressure
- The blade and contact design are self-wiping and capable of 20,000 mechanical operations without detrimental wear

Reliabreak interrupter

- The internal mechanism of the interrupter is manufactured from non-ferrous components ensuring long term resistance to corrosion in all environments
- The interrupter mechanism can handle 2500 successful mechanical operations
- The interrupter is capable of 10 successful 900 A interruptions or 50 successful 600 A interruptions at 15.5 kV and 27 kV
- The body of the interrupter is manufactured from UV stabilized Lexan® 103 material
- The interrupter operating arm is made of stainless steel (304) with UV stabilized Lexan® 103 insulation molded permanently onto the arm

Phase units

- All current-carrying parts are manufactured from copper
- Terminal pads are NEMA® two hole, silver or tin-plated
- The rotating insulator stack incorporates oil-impregnated bronze bearings to ensure maintenance free operation for life of the switch
- The spindle is manufactured from stainless steel and is supported by bushings spaced at four inches to eliminate rocking of the insulator and to ensure proper blade and contact alignment
- Each phase unit is secured to the crossarm with locking spacers to eliminate distortion of the phase unit base
- Dead-end brackets incorporate locking tabs that will eliminate movement under side forces present when conductor is dead-ended at an angle
- The switch is capable of opening or closing under a 3/8" ice layer without ice shields. The switch shall be capable of opening or closing under a 3/4" ice layer with ice shields.
- Insulator bolt pattern comes standard as 2.25" for 15 kV and 25 kV and 3.00" for 35 kV.

Table 5. Shipping Weights and Dimensions (2.25" Bolt Circle Polymer Insulators Standard, 3.00" on 35 kV)

	Voltage Class	15.5 kV		27 kV		38 kV	
		Crossarm	Steel	Fiberglass	Steel	Fiberglass	Steel
Horizontal Upright	Crate L" x W" x H"	94" x 27" x 34"	94" x 27" x 34"	104" x 30" x 38"	104" x 30" x 38"	134" x 37" x 41"	134" x 37" x 41"
	Weight	381 lbs.	347 lbs.	414 lbs.	380 lbs.	478 lbs.	444 lbs.
Horizontal Pole Top	Crate L" x W" x H"	94" x 27" x 34"	94" x 27" x 34"	94" x 27" x 34"	94" x 27" x 34"	134" x 37" x 41"	134" x 37" x 41"
	Weight	377 lbs.	343 lbs.	410 lbs.	376 lbs.	474 lbs.	440 lbs.
Phase over Phase	Crate L" x W" x H"	100" x 27" x 34"	100" x 27" x 34"	110" x 30" x 38"	110" x 30" x 38"	140" x 37" x 41"	140" x 37" x 41"
	Weight	462 lbs.	428 lbs.	495 lbs.	461 lbs.	559 lbs.	525 lbs.
Vertical Riser	Crate L" x W" x H"	94" x 27" x 34"	94" x 27" x 34"	104" x 30" x 38"	104" x 30" x 38"	134" x 37" x 41"	134" x 37" x 41"
	Weight	402 lbs.	368 lbs.	435 lbs.	401 lbs.	499 lbs.	465 lbs.
Triangular	Crate L" x W" x H"	93" x 27" x 73"	94" x 27" x 73"	93" x 30" x 73"	93" x 30" x 73"	199" x 37" x 85"	99" x 37" x 85"
	Weight	471 lbs.	437 lbs.	504 lbs.	470 lbs.	568 lbs.	534 lbs.

Note: G095 spacing and special switch options will cause slight variations.

Table 6. Weight Adders

	15.5 kV		27 kV		38 kV
	2.25" B.C.	3.00" B.C.	2.25" B.C.	3.00" B.C.	3.00" B.C.
Polymer Insulators	–	14 lbs.	–	3 lbs.	–
Epoxy Insulators	9 lbs.	41 lbs.	14 lbs.	54 lbs.	57 lbs.
Porcelain Insulators	54 lbs.	114 lbs.	57 lbs.	164 lbs.	199 lbs.

Table 7. M-Force Three-Phase Switch Catalog Number Configuration

	M	1	H	11	T	R	2	?
<p>Voltage Class</p> <ul style="list-style-type: none"> 1 - 15.5 kV/110 kV BIL 2 - 27 kV/150 kV BIL 3 - 38 kV/200 kV BIL <p>Mounting Configuration</p> <ul style="list-style-type: none"> H- Horizontal Upright (Standard Option) A- Horizontal Pole Top P- Phase over Phase R- Vertical Riser G- Horizontal Upright (G095 Spacing) S- Vertical Riser (G095 Spacing) T- Triangular U- Underhung (G095 Spacing) <p>Control Rod and Mechanism</p> <p>Reciprocating Mechanism</p> <ul style="list-style-type: none"> 11 - 28' Round Pipe 1.0" O.D. (Standard Option) 21 - 28' Round Fiberglass 41 - 28' 1" Pipe w/Fiberglass Top Section 51 - 28' Pipe w/Cycloaliphatic Insulator <p>Torsional Mechanism</p> <ul style="list-style-type: none"> A2- 28' 1.5" Pipe (Steel Universal Section) B2- 28' 1.5" Pipe (Fiberglass Universal Section) C2- 28' 1.5" Pipe (Cycloaliphatic Insulator) <p>None</p> <ul style="list-style-type: none"> 03- Hookstick operated (no control rod) <p>Crossarm Options</p> <ul style="list-style-type: none"> T - Steel with Single Point Lift (Standard Option) S - Steel with Two Point Lift G - Fiberglass with Single Point Lift F - Fiberglass with Two Point Lift <p>Insulator Material</p> <ul style="list-style-type: none"> R - Polymer (Standard Option) C - Cycloaliphatic Epoxy P - Porcelain 	<p>Options (See Page 9 for details) Note: More than one may be chosen. Append codes in alphanumeric order.</p> <ul style="list-style-type: none"> B - Provisions for Crossarm Support Bracket C - Captive Hardware on Terminal Pads (Incompatible with Option U below) E - Extension Links (14") F - Bonded Reciprocating Control Handle (Standard on Torsional Controls) G - Reciprocating Handle with Interlocks H - Lightning Arrester Brackets I - Steel Interphase Rod J - Provisions for Neutral Wire K - Provisions for Sensors R - Additional Nameplate on Handle S - Ice Shields (3/4" Ice Break on Open or Close Operation) T - Grounding Connector on Crossarm Mounting Bracket U - Terminals, Copper, #2-500 MCM (Incompatible with Option C above) V - Pole Mounting Band 1 - Extra 7' of Control Rod 2 - Extra 14' of Control Rod <p>Insulator Bolt Pattern</p> <ul style="list-style-type: none"> 2 - 2.25" Bolt circle for 15 and 27 kV switches 3 - 3.00" Bolt circle for 35 kV switches <p>Consult factory for other bolt circle options.</p>							

Coastal M-Force Switches

Coastal M-Force switches utilize a corrosion-resistant fiberglass crossarm as a sturdy base for three robust phase units. Stainless steel components and bell crank assembly allow the switch to maintain reliable operation after exposure to salt, moisture and other environmental contaminants.

Coastal M-Force Three-Phase Switch Catalog Number Configuration

CM1 H 03 F R 2 H

CODE	VOLTAGE CLASS
1	15 kV/110 kV BIL
2	25 kV/150 kV BIL
3	35 kV/200 kV BIL

CODE	MOUNTING CONFIGURATION
H	Horizontal Upright (Standard Option)
R	Vertical Riser
P	Phase-over-Phase
G	Horizontal Upright (G095 Spacing)
S	Vertical Riser (GO95 Spacing)

CODE	OPERATING MECHANISM
03	Hookstick Bell Crank, no Rod

CODE	CROSSARM OPTIONS
F	Fiber Glass with Two Point Lift

CODE	OPTIONS - MORE THAN ONE MAY BE CHOSEN
C	Captive Hardware
H	Lightning Arrester Brackets
K	Provisions for Neutral Sensors
S	Ice Shield Kit
T	Ground Connector on Crossarm

Example: CM1H03SR2H – Coastal M-force, 15kV/110kV BIL, Hookstick/Bellcrank operation, Fiberglass crossarm with single point lift, silicone rubber insulator, 2.25" BC, Lightning arrester brackets

CODE	INSULATOR BOLT PATTERN
2	15 or 25 kV
3	35 kV

CODE	INSULATOR MATERIAL
R	Polymer

Definition of options

B-Provisions for crossarm support brackets

The "B" option supplies two adjustment mounting brackets on crossarm. This allows the customer to install support brackets/alley arms to the crossarm. The support brackets are not included.

C-Captive hardware on terminal pads

This option provides two 1-3/4" captive stainless steel studs on each NEMA® two-hole pad. These are usually used in conjunction with compression terminals. This option is incompatible with Option U.

E-Extension links

This option provides two 14" extension links on each conductor dead-end bracket, six per switch.

F-Bonded control handle

This option provides a grounding strap and connector that is attached to the manual operating handle. This is a standard feature on torsional control designs.

G-Reciprocating handles with interlocks

This option provides manual interlocks on switches and is available on switches sold in pairs only. When ordered with this option, end user information such as; utility name, contact person, address, and phone number will have to be provided prior to order input as required by the manufacturer of the interlocks.

H-Lightning arrester brackets

This option provides provisions for the mounting of six lightning arresters per switch.

I-Steel interphase rod

This provides a 1" O.D. steel interphase rod. The standard rod is UV inhibited fiberglass.

J-Provisions for neutral wire

This option provides a hole and spacing for a pin type insulator to be located on the crossarm to accommodate the neutral wire.

K-Provisions for sensors

This option provides longer phase unit bases that will accept sensors to be easily mounted if the manual switches are to be retrofitted for SCADA with a motor operator at a later date.

R-Additional nameplate on handle

This option provides a nameplate fixed to the manual control handle in addition to the nameplate mounted on the switch crossarm.

S-Ice shields

This option provides ice shields on each switch clip contact. This allows the switch to be opened or closed under a 3/4" ice build up.

T-Grounding connector

This option provides a grounding lug on the crossarm mounting bracket. This allows for the utility to ground the switch base to the pole ground.

U-Terminals

This option provides connectors on each two-hole NEMA® pad with a conductor range of #2-500 MCM. This option is incompatible with Option C.

V-Pole mounting band

This option provides the additional support of adjusting pole bands that are attached to the pole mounting bracket.

1-One additional control rod

2-Two additional control rods

Control rod options

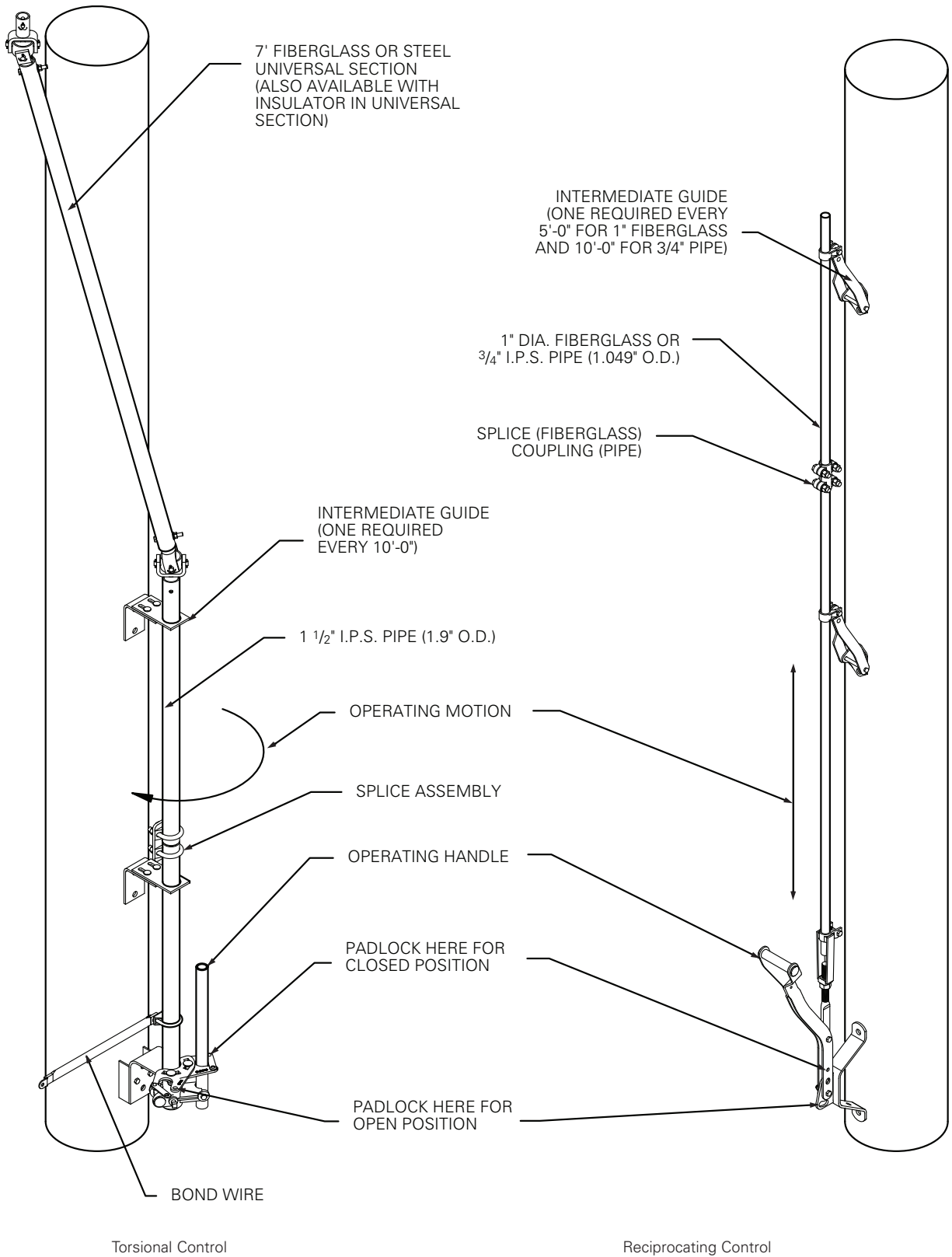


Figure 10. Torsional and Reciprocating control rod options.

Note: The standard length of control rod is 28'. Extra 7' lengths are available (see page 8 for options).

When one section of fiberglass is ordered for reciprocating control, the top section will be designated as that segment.

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

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

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NX Horizon

Smart Solar Tracking System

Serving as the backbone on over 35 gigawatts of solar power plants around the world, the NX Horizon™ smart solar tracker system combines best-in-class hardware and software to help EPCs and asset owners maximize performance and minimize operational costs.

Flexible and Resilient by Design

With its self-aligning module rails and vibration-proof fasteners, NX Horizon can be easily and rapidly installed. The self-powered, decentralized architecture allows each row to be commissioned in advance of site power, and is designed to withstand high winds and other adverse weather conditions. On a recent 838 megawatt project in Villanueva, Mexico, these design features allowed for the project to go online nine months ahead of schedule.

TrueCapture and Bifacial Enabled

Incorporating the most promising innovations in utility scale solar, NX Horizon with TrueCapture™ smart control system can add additional energy production by up to six percent. Further unlocking the advantages of independent-row architecture and the data collected from thousands of sensors across its built-in wireless network, the software continuously optimizes the tracking algorithm of each row in response to site terrain and changing weather conditions. NX Horizon can also be paired with bifacial PV module technology, which can provide even more energy harvest and performance. With bifacial technology, NX Horizon outperforms conventional tracking systems with over 1% more annual energy.

Quality and Reliability from Day One

Quality and reliability are designed and tested into every NX Horizon component and system across our supply chain and manufacturing operations. NextTracker is the leader in dynamic wind analysis and safety stowing, delivering major benefits in uptime and long-term durability. NX Horizon is certified to UL 2703 and UL 3703 standards, underscoring NextTracker's commitment to safety, reliability and quality.

Features and Benefits

5 years in a row

Global Market Share Leader (2015-18)

35 GW

Delivered on 5 Continents

Best-in Class

Software Ecosystem and
Global Services

Up to 6%

Using TrueCapture Smart
Control System



GENERAL AND MECHANICAL

Tracking type	Horizontal single-axis, independent row.
String voltage	1,500 V _{DC} or 1,000 V _{DC}
Typical row size	78-90 modules, depending on module string length.
Drive type	Non-backdriving, high accuracy slew gear.
Motor type	24 V brushless DC motor
Array height	Rotation axis elevation 1.3 to 1.8 m / 4'3" to 5'10"
Ground coverage ratio (GCR)	Configurable. Typical range 28-50%.
Modules supported	Mounting options available for virtually all utility-scale crystalline modules, First Solar Series 6 and First Solar Series 4.
Bifacial features	High-rise mounting rails, bearing + driveline gaps and round torque tube.
Tracking range of motion	Options for ±60° or ±50°
Operating temperature range	SELF POWERED: -30°C to 55°C (-22°F to 131°F) AC POWERED: -40°C to 55°C (-40°F to 131°F)
Module configuration	1 in portrait. 3 x 1,500 V or 4 x 1,000 V strings per standard tracker. Partial length trackers available.
Module attachment	Self-grounding, electric tool-actuated fasteners.
Materials	Galvanized steel
Allowable wind speed	Configurable up to 225 kph (140 mph) 3-second gust
Wind protection	Intelligent wind stowing with symmetric dampers for maximum array stability in all wind conditions
Foundations	Standard W6 section foundation posts

ELECTRONICS AND CONTROLS

Solar tracking method	Astronomical algorithm with backtracking. TrueCapture™ upgrades available for terrain adaptive backtracking and diffuse tracking mode
Control electronics	NX tracker controller with inbuilt inclinometer and backup battery
Communications	Zigbee wireless communications to all tracker rows and weather stations via network control units (NCUs)
Nighttime stow	Yes
Power supply	SELF POWERED: NX provided 30 or 60W Smart Panel AC POWERED: Customer-provided 120-240 V _{AC} circuit

INSTALLATION, OPERATIONS AND SERVICE

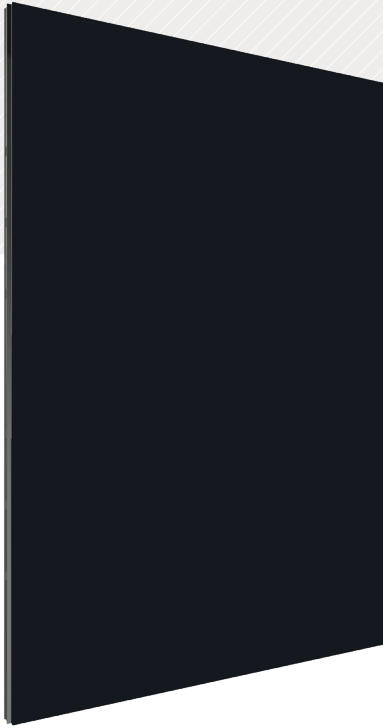
PE stamped structural calculations and drawings	Included
Onsite training and system commissioning	Included
Installation requirements	Simple assembly using swaged fasteners and bolted connections. No field cutting, drilling or welding.
Monitoring	NX Data Hub™ centralized data aggregation and monitoring
Module cleaning compatibility	Compatible with NX qualified cleaning systems
Warranty	10-year structural, 5-year drive and control components.
Codes and standards	UL 3703 / UL 2703 / IEC 62817



First Solar Series 6 CuRe

NEXT GENERATION THIN FILM SOLAR TECHNOLOGY

MODULE DATASHEET



440-470 Watts
Up to 19.0% Efficiency

HIGH-POWER PV MODULES

First Solar Series 6 CuRe photovoltaic (PV) modules set a new industry benchmark for lifetime energy production, optimized design and environmental performance. Series 6 CuRe modules are optimized for every stage of your application, significantly reducing balance of system, shipping, and operating costs.



HIGHEST LIFETIME ENERGY

- More real-world energy produced per nameplate watt: Improved temperature coefficient (-0.28%/C) from Series 6 (-0.32%/C) coupled with superior spectral response and shading behavior vs. c-Si
- Up to 10% more lifetime energy vs. the leading bifacial c-Si module, and up to 14% more than traditional c-Si modules
- Anti-reflective coated glass enhances energy production



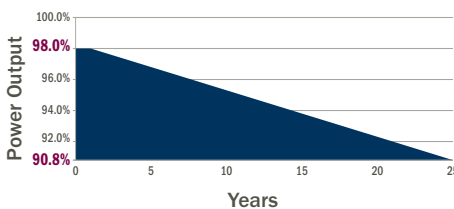
INNOVATIVE MODULE DESIGN

- Under-mount frame provides the cleaning and snow-shedding benefits of a frameless module while protecting edges against breakage
- Innovative SpeedSlots™ combine the robustness of bottom mounting with the speed of top clamping while utilizing fewer fasteners to achieve fastest installation times and lowest mounting hardware costs
- Dual junction box optimizes module-to-module connections and eliminates need for wire management

INDUSTRY'S BEST WARRANTED DEGRADATION RATE¹

98.0% WARRANTY START POINT

0.3% WARRANTED ANNUAL DEGRADATION RATE



- 25-Year Linear Performance Warranty
- 10-Year Limited Product Warranty
- Industry's First and Only Hidden Cell Cracking Warranty



BEST IN-CLASS RELIABILITY & DURABILITY

- Manufactured under one roof with 100% traceable QA/QC
- Independently tested and certified for reliable performance that exceeds IEC standards in high temperature, high humidity, extreme desert and coastal applications
- Inherently immune to and warranted against hidden cell cracking power loss
- Durable glass/glass construction with market-leading hail impact certification



BEST ENVIRONMENTAL PROFILE

- Fastest energy payback time in the industry
- Produced using up to 6x less carbon and up to 24x less water than c-Si
- Global PV collection and recycling services available through First Solar or customer-selected third-party

FIRST SOLAR SERIES 6 CuRe

MODEL TYPES AND RATINGS AT STANDARD TEST CONDITIONS (1000W/m ² , AM 1.5, 25°C) ²								
NOMINAL VALUES		FS-6440-C FS-6440A-C	FS-6445-C FS-6445A-C	FS-6450-C FS-6450A-C	FS-6455-C FS-6455A-C	FS-6460-C FS-6460A-C	FS-6465-C FS-6465A-C	FS-6470-C FS-6470A-C
Nominal Power ³ (-0/+5%)	P _{MAX} (W)	440.0	445.0	450.0	455.0	460.0	465.0	470.0
Efficiency (%)	%	17.8	18.0	18.2	18.4	18.6	18.8	19.0
Voltage at P _{MAX}	V _{MAX} (V)	184.7	185.7	186.8	187.8	188.8	189.8	191.1
Current at P _{MAX}	I _{MAX} (A)	2.38	2.40	2.41	2.42	2.44	2.45	2.46
Open Circuit Voltage	V _{OC} (V)	220.0	220.4	221.1	222.0	222.9	223.8	224.3
Short Circuit Current	I _{SC} (A)	2.55	2.56	2.57	2.58	2.59	2.60	2.61
Maximum System Voltage	V _{SYS} (V)	1500 ⁵						
Limiting Reverse Current	I _R (A)	5.0						
Maximum Series Fuse	I _{CF} (A)	5.0						

RATINGS AT NOMINAL OPERATING CELL TEMPERATURE OF 45°C (800W/m ² , 20°C air temperature, AM 1.5, 1m/s wind speed) ²								
Nominal Power	P _{MAX} (W)	332.4	336.0	339.9	343.6	347.3	351.3	355.0
Voltage at P _{MAX}	V _{MAX} (V)	173.1	174.1	175.2	176.2	176.3	177.4	179.3
Current at P _{MAX}	I _{MAX} (A)	1.92	1.93	1.94	1.95	1.97	1.98	1.98
Open Circuit Voltage	V _{OC} (V)	209.0	209.3	210.0	210.9	211.8	212.6	213.1
Short Circuit Current	I _{SC} (A)	2.06	2.06	2.07	2.08	2.09	2.10	2.10

TEMPERATURE CHARACTERISTICS		
Module Operating Temperature Range	(°C)	-40 to +85
Temperature Coefficient of P _{MAX}	T _K (P _{MAX})	-0.28%/°C [Temperature Range: 25°C to 75°C]
Temperature Coefficient of V _{OC}	T _K (V _{OC})	-0.25%/°C
Temperature Coefficient of I _{SC}	T _K (I _{SC})	+0.04%/°C

MECHANICAL DESCRIPTION	
Length	2009mm
Width	1232mm
Thickness	49mm
Area	2.47m ²
Module Weight	34.5kg
Leadwire ⁶	2.5mm ² , 720mm (+) & Bulkhead (-)
Connectors	MC4-EVO 2 or alternate
Bypass Diode	N/A
Cell Type	Thin film CdTe semiconductor, up to 271 cells
Frame Material	Anodized Aluminum
Front Glass	Heat strengthened
Back Glass	Heat strengthened
Encapsulation	Laminate material with edge seal
Frame to Glass Adhesive	Silicone
Load Rating ⁷	2400Pa

PACKAGING INFORMATION			
Modules Per Pallet	27	Pallet Dimensions (L x W x H)	2200 x 1300 x 1164mm (86 x 51 x 45.8in)
Pallet Weight	1032kg	Pallets per 40' Container	18

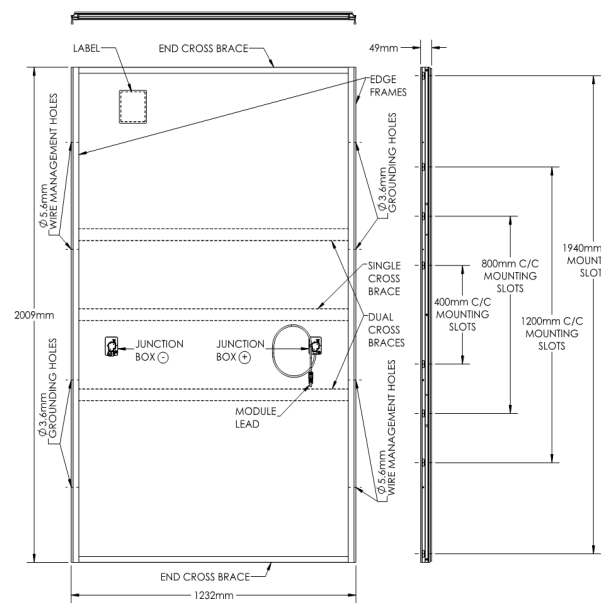
Disclaimer
 The information included in this Module Datasheet is subject to change without notice and is provided for informational purposes only. No contractual rights are established or should be inferred because of user's reliance on the information contained in this Module Datasheet. Please refer to the appropriate Module User Guide and Module Product Specification document for more detailed technical information regarding module performance, installation and use.

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CERTIFICATIONS AND TESTS
IEC ⁴
61215:2016 & 61730-1:2016 ⁵ , CE 61701 Salt Mist Corrosion 60068-2-68 Dust and Sand Resistance
UL ⁴
UL 61730 1500V Listed ⁵
REGIONAL CERTIFICATIONS ⁴
MCS SII InMetro FSEC BIS MyHijau
EXTENDED DURABILITY TESTS ⁴
ANSI/CAN/CSA-C450-18 Long-Term Sequential Thresher Test PID Resistant
QUALITY & EHS
ISO 9001:2015 ISO 14001:2015 ISO 45001:2018



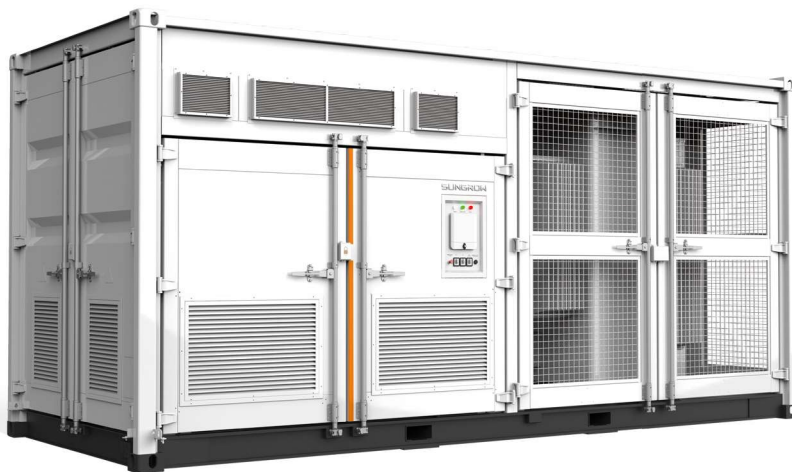
MECHANICAL DRAWING



- Install in portrait only
- Limited power output and product warranties subject to warranty terms and conditions
 - All ratings ±10%, unless specified otherwise. Specifications are subject to change
 - Measurement uncertainty applies
 - Testing Certifications/Listings pending
 - IEC 61730-1: 2016 Class II | ULC 1703 1000V listed (CANADA)
 - Leadwire length from junction box exit to connector mating surface
 - 1000Pa tentative design load rating for 1940mm mounting slots. Alternate or project-specific load ratings can be met with additional support, subject to evaluation

SG2500U-MV

Turnkey Station for North America 1500 Vdc System - MV Transformer Integrated



High Yield

- Advanced three-level technology, max. inverter efficiency 98.8%, inverter CEC efficiency 98.5 %
- Effective cooling, 1.1 overload capacity, no derating up to 122 °F
- Max. DC/AC ratio more than 1.5



Easy O&M

- Integrated current, voltage and MV parameters monitoring function for online analysis and fast trouble shooting
- Modular design, easy for maintenance
- Convenient external LCD



Saved Investment

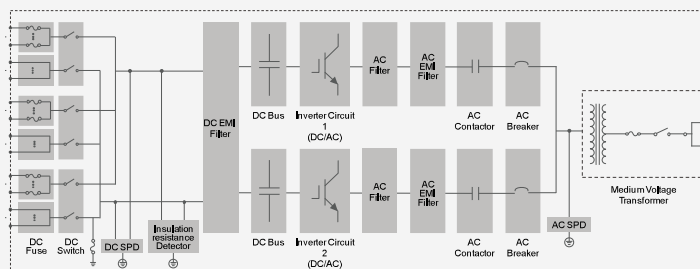
- Low transportation and installation cost due to 20-foot container design
- 1500V DC system, low system cost
- Integrated MV transformer and LV auxiliary power supply



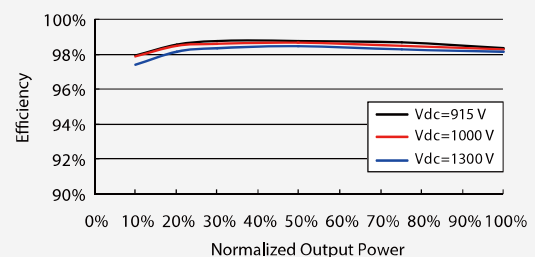
Grid Support

- Complies with UL 1741, UL 1741 SA, IEEE 1547, Rule 21 and NEC 2014/2017
- Grid support including L/HVRT, L/HFRT, power ramp rate control, active and reactive power support

Circuit Diagram



Inverter Efficiency Curve



Input (DC)

	SG2500U-MV
Max. PV input voltage	1500V
Min. PV input voltage / Startup input voltage	800 V / 840 V
MPP voltage range for nominal power	800 – 1300 V
No. of independent MPP inputs	1
No. of DC inputs	18 – 21
Max. PV input current	3508 A
Max. DC short-circuit current	4800 A
PV array configuration	Negative grounding

Output (AC)

AC output power	2750 kVA @ 45 °C (113 °F) / 2500 kVA @ 50 °C (122 °F)
Max. inverter output current	2886 A
AC voltage range	34.5 kV
Nominal grid frequency / Grid frequency range	60 Hz / 55 – 65 Hz
THD	< 3 % (at nominal power)
DC current injection	< 0.5 % I _n
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading – 0.8 lagging
Feed-in phases / Connection phases	3 / 3

Efficiency

Inverter max. efficiency / Inverter CEC efficiency	98.8 % / 98.5 %
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Transformer

Transformer rated power	2500 kVA
Transformer max. power	2750 kVA
LV / MV voltage	0.55 kV / 34.5 kV
Transformer vector	Dy1
Transformer cooling type	ONAN (Oil Natural Air Natural)
Oil type	Mineral oil (PCB free) or degradable oil on request

Protection

DC input protection	Load break switch + fuse
Inverter output protection	Circuit breaker
AC MV output protection	Load break switch + fuse
Overvoltage protection	DC Type II / AC Type II
Grid monitoring / Ground fault monitoring	Yes / Yes
Insulation monitoring	Optional
Overheat protection	Yes

General Data

Dimensions (W*H*D)	6058*2896*2438 mm 238.5"*114.0"*96.0"
Weight	18 T 39683.2 lb
Degree of protection	NEMA 3R
Auxiliary power supply	120 Vac, 5 kVA / Optional: 480 Vac, 30 kVA
Operating ambient temperature range	-30 to 60 °C (> 50 °C derating) -22 to 140 °F (> 122 °F derating)
Allowable relative humidity range (non-condensing)	0 – 95 %
Cooling method	Temperature controlled forced air cooling
Max. operating altitude	1000 m (standard) / > 1000 m (optional) 3280.8 ft (standard) / > 3280.8 ft (optional)
Display	Touch screen
Communication	Standard: RS485, Ethernet; Optional: optical fiber
Compliance	UL 1741, IEEE 1547, UL1741 SA, NEC 2014/2017
Grid support	Night SVG function (optional), L/HVRT, L/HFRT, active & reactive power control and power ramp rate control, Volt-var, Frequency-watt

ST2740KWH-D1250HV +SG2500U

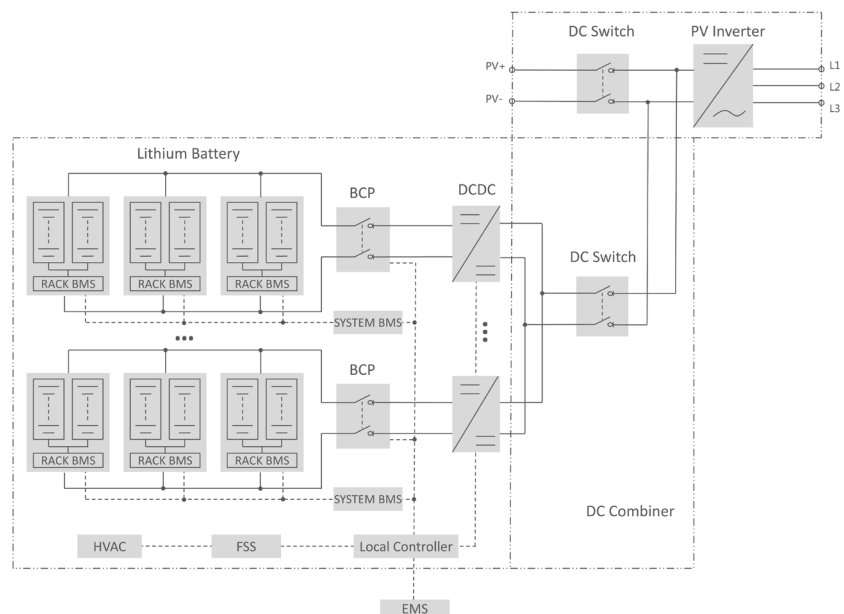
Storage System



SYSTEM FEATURES

- 1500V DC coupled PV+ESS system
- Compact mechanical design, minimized footprint
- High efficient system with safe and long lifecycle lithium-ion battery
- Integrated local controller, HVAC and FSS to enable unified communication and ensure system safety

CIRCUIT DIAGRAM



System Type	ST2740KWH-D1250HV+SG2500U
PV Data	
Max. PV input voltage	1,500 V
MPPT voltage range for nominal power	800 ~ 1,300 V
Number of DC inputs	24
Max. PV input current	5,228 A
DCDC Data	
Cell type	Samsung SDI Mega E2, 3.68 V / 94 Ah
Configuration of system	264S30P
Battery capacity (BOL)	2740kWh
Battery voltage range	844 ~ 1,095 V
Battery Data	
Working voltage range	500 ~ 1,500 V
Nominal power	250 KW * 5
Max. current	344 A * 5
AC Data	
AC output power	2,750 kVA @ 45 °C (113 °F) / 2,500 kVA @ 50 °C (122 °F)
Max. AC output current	2,886 A
Nominal AC voltage	550 V
AC voltage range	484 ~ 605 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 ~ 65 Hz
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading ~ 0.8 lagging
Feed-in phases / Connection phases	3 / 3
General Data	
Dimensions (W * H * D) of battery unit	12,192 * 2,896 * 2,438 mm / 480.0" * 114.0" * 96.0"
Weight (with / without battery) of battery unit	37 T / 16.5 T 81,571 lbs / 36,376 lbs
Dimensions (W * H * D) of PV inverter	2,991 * 2,896 * 2,438 mm / 117.8" * 114.0" * 96.0"
Weight of PV inverter	6.9 T / 15,211.9 lbs
Degree of protection	IP 54 / NEMA 3R
Operating temperature range	-30 to 50 °C / -22 to 122 °F
Relative humidity	0 ~ 95 % (non-condensing)
Max. working altitude	2,000 m / 6,562 ft
Cooling concept of battery unit	Heating, Ventilation and Air Conditioning
Fire suppression system of battery unit	FM-200 extinguishment system
Communication interfaces	RS485, Ethernet
Communication protocols	Modbus RTU, Modbus TCP
Compliance	UL9540

SG125HV

String Inverter for 1500 Vdc System



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 °C
- Patented anti-PID function optional



Easy O&M

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



Saved Investment

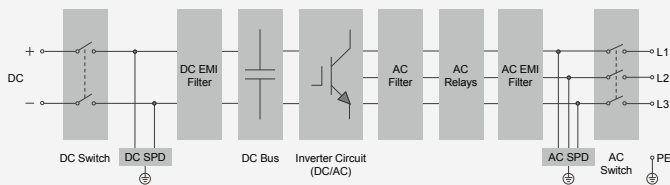
- DC 1500V, AC 600V, low system initial investment
- 1 to 5MW power block design for lower AC transformer and labor cost
- Max.DC/AC ratio up to 1.5



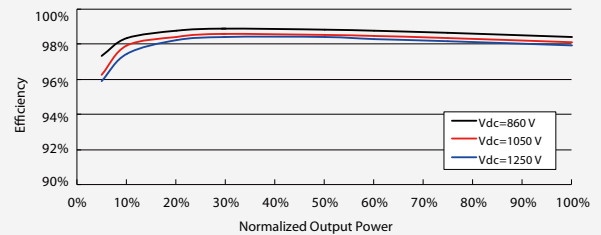
Grid Support

- 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



Input (DC)**SG125HV**

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	125000 VA @ 50 °C
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 / AC switch	Yes / Yes
Night SVG function	No
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 °C (> 50 °C derating) -13 to 140 °F (> 122 °F 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 mm ² 350 Kcmil)
AC connection type	OT or DT terminal (Max. 185 mm ² 350 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	LVRT, HVRT, ZVRT, active & reactive power regulation, PF control, soft start/stop
Type designation	SG125HV-10



SG2500U

Turnkey Station for North America 1500 Vdc System



High Yield

- Advanced three-level technology, max. efficiency 98.8%, CEC efficiency 98.5 %
- Effective cooling, 1.1 overload capacity, no derating up to 122 °F
- Max. DC/AC ratio more than 1.5



Easy O&M

- Integrated current and voltage monitoring function for online analysis and fast trouble shooting
- Modular design, easy for maintenance
- Convenient external LCD



Saved Investment

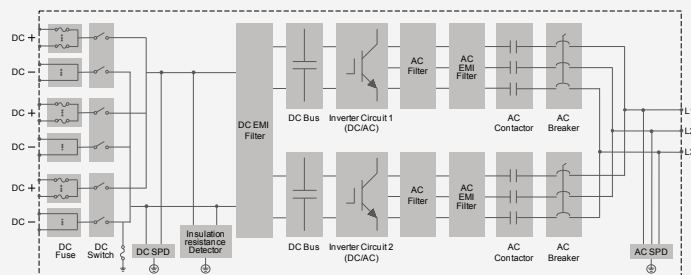
- Low transportation and installation cost due to 10-foot container design
- 1500V DC system, low system cost
- Integrated LV auxiliary power supply



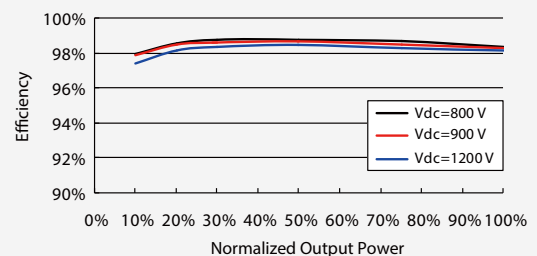
Grid Support

- Complies with UL 1741, UL 1741 SA, IEEE 1547, Rule 21 and NEC 2014/2017
- Grid support including L/HVRT, L/HFRT, power ramp rate control, active and reactive power support

Circuit Diagram



Efficiency Curve



Input (DC)**SG2500U**

Max. PV input voltage	1500V
Min. PV input voltage / Startup input voltage	800 V / 840 V
MPP voltage range for nominal power	800 – 1300 V
No. of independent MPP inputs	1
No. of DC inputs	18 – 21
Max. PV input current	3508 A
Max. DC short-circuit current	4800 A
PV array configuration	Negative grounding

Output (AC)

AC output power	2750 kVA @ 45 °C (113 °F) / 2500 kVA @ 50 °C (122 °F)
Max. AC output current	2886 A
Nominal AC voltage	550 V
AC voltage range	484 - 605 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 – 65 Hz
THD	< 3 % (at nominal power)
DC current injection	< 0.5 % I _n
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 / CEC efficiency	98.8 % / 98.5 %
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Protection

DC input protection	Load break switch + fuse
AC output protection	Circuit breaker
Overvoltage protection	DC Type II / AC Type II
Grid monitoring / Ground fault monitoring	Yes / Yes
Insulation monitoring	Optional
Night SVG function	Optional
Overheat protection	Yes

General Data

Dimensions (W*H*D)	2991*2896*2438 mm (117.8"*114.0"*96.0")
Weight	6.9 T (15211.9 lbs)
Isolation method	Transformerless
Degree of protection	NEMA 3R
Auxiliary power supply	120 Vac, 5 kVA / Optional: 480 Vac, 30 kVA
Operating ambient temperature range	-30 to 60 °C (> 50 °C derating) (-22 to 140 °F (> 122 °F derating))
Allowable relative humidity range (non-condensing)	0 – 95 %
Cooling method	Temperature controlled forced air cooling
Max. operating altitude	4000 m (> 2000 m derating) (13123 ft (> 6561 ft derating))
Display	Touch screen
Communication	Standard: RS485, Ethernet; Optional: optical fiber
Compliance	UL 1741, IEEE 1547, UL1741 SA, NEC 2014/2017, CSA C22.2 No.107.1-01
Grid support	Night SVG function (optional), L/HVRT, L/HFRT, active & reactive power control and power ramp rate control, Volt-var, Frequency-watt





Viper[®]-5

Solid Dielectric, Three Phase Reclosers

Providing electronic three phase overcurrent protection for systems rated through 38kV, 800A continuous current, 12.5kA symmetrical interrupting



- Reliable performance
- Control flexibility including SEL-351 series, SEL-651R2, GE controls and more
- Operator safety with mechanical block
- Maintenance-free operation
- Overhead, substation and dead-front padmount designs
- Ease of installation
- Three internal current transformers
- Up to six internal voltage sensors
- Smart Grid/Lazer[®] solutions
- RUS accepted

G&W Engineered to order. Built to last.

Viper-S

Viper-S solid dielectric, three phase reclosers combine the time proven reliability of electronically controlled, vacuum fault interrupters with the maintenance benefits of a solid dielectric insulated device. The reclosers are designed for three phase automatic or manual trip operation providing overcurrent protection for systems rated up to 38kV maximum, 800A continuous, and 12.5kA rms symmetrical interrupting.

FEATURES

Reliable Performance - Viper-S reclosers utilize G&W's time proven epoxy system to fully encapsulate the vacuum interrupters. This system provides excellent insulation properties while providing fully shielded, void-free construction. All modules are UV protected and 100% factory tested for partial discharge. The Viper-S recloser utilizes the latest in magnetic actuator technology. The interrupter and actuator assembly are tested annually for 10,000 mechanical operations to ensure a long service life. If main power is lost, the recloser has enough stored energy to trip once, after the control sends the trip command, within a 24 hour period.

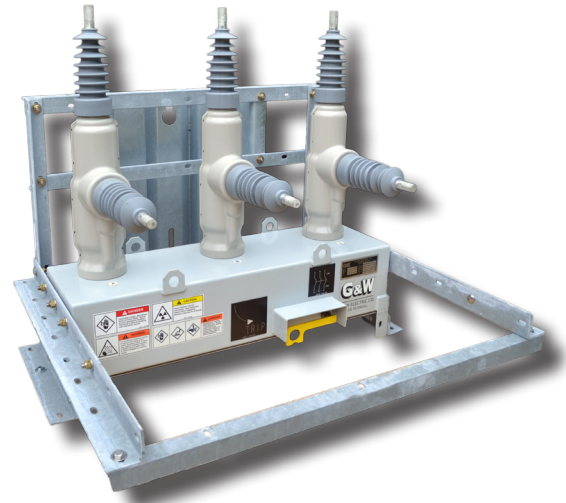
Control Flexibility - Viper-S reclosers are designed to work with a variety of different controls including SEL-351 series, SEL-651R2, GE controls and more.

Operator Safety - Vacuum interrupters are sealed within a solid dielectric insulation. A hookstick operable manual trip and lockout handle prohibits operation either from the control or remotely. A mechanical blocking device further assures against accidental close. An open and closed contact indicator verifies contact position. Contact status and lockout condition can also be verified at the control.

Maintenance-free - Solid dielectric insulation provides a maintenance-free installation. Electronic equipment associated with the operation of the magnetic actuator is located inside the Viper-S tank.

Ease of Installation - Mounting bracket with key hole and lifting provisions provide ease of installation. Site-ready designs provide all accessories including mounting bracket, arresters and voltage transformers preassembled prior to shipment significantly reducing installation time. The control cable brings all current, the handle status and trip/close information into the control.

Application Flexibility - Units are designed for overhead, substation and padmount applications. Pole mounted units can be equipped with either horizontal or vertical insulators. Removable silicone insulators are standard for overhead applications. This feature permits easy field replacement if an insulator is damaged. Higher external BIL rated insulators can also be retrofitted if necessary.



▲ 15kV Viper-S recloser with polemount center bracket and surge arrester provisions.

Smart Grid / Lazer® Automation Solutions - The Viper-S is automation ready, simplifying conversion for any future automation requirements. A multi-ratio current transformer is encapsulated within the module. The current transformer is provided with 1000/500:1 ratios. A 400/200:1 dual ratio CT option is also available for lower current detection. Inputs to the control are field changeable.

CT accuracy is +/-1%. Capacitive voltage sensors encapsulated within each module permit voltage reading for network reconfiguration while eliminating the need for add-on sensors and cabling. When Low Energy Analog Voltage Sensors (LEA VS) are used, accuracy is +/-2% over the temperature range -20°C (-4°F) through +40°C (104°F) when tested as a system. The accuracy is +/-4% from -60°C (-76°F) through +65°C (149°F). The phase angle accuracy is +/-1° throughout the full temperature range. Two voltage ratios are available: a 10,000:1 for applications above 13.8 kV L-G and a 2,500:1 ratio below that voltage. External voltage and current sensors can also be used depending on application requirements.

Complete Lazer automation packages are available offering a pre-engineered solution for applications requiring intelligent automatic switching and power restoration. The packages feature one or more protective relays, equipped with distribution and communication capabilities. Available communication devices include fiber optic transceivers and wireless radio. The typical control paired with the Viper-S is the SEL-351R4.

CATALOG NUMBERS

Voltage Class	Catalog Number
15.5kV	VIP378ER-12S
27kV	VIP388ER-12S
38kV	VIP398ER-12S

Approximate weight less bracket = 325 lbs. (148 kg).

OPERATION OPTIONS

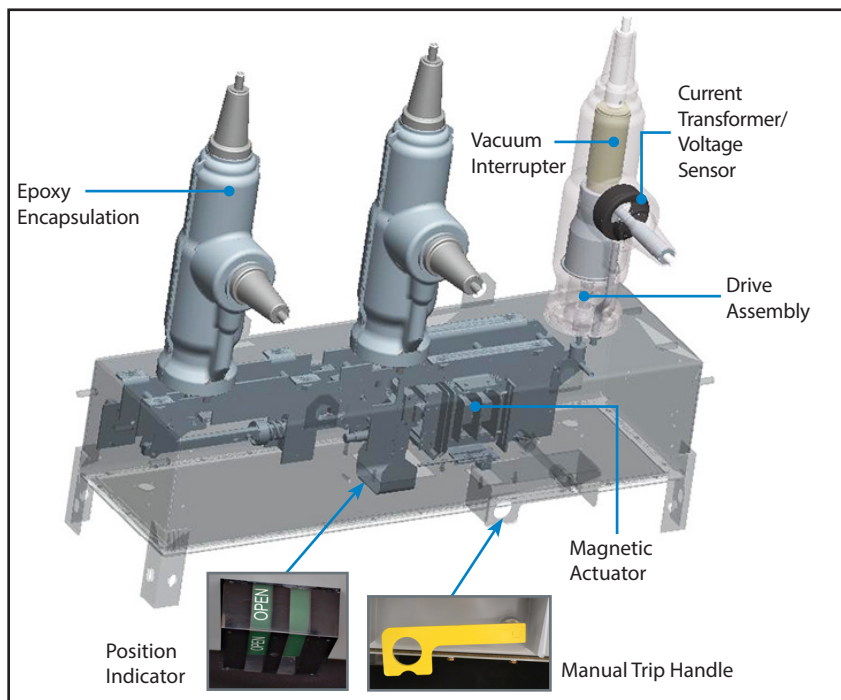
Dead-line Operation - Permits using the batteries located in the control for operation of the recloser when main control power is lost. A remote status signal reports the operational status of the interrupter power supply permitting remote indication of the control's capability to open or close the recloser.

Custom Relay Solutions (CRS) - The CRS option permits using 48VDC or 125VDC control logic voltage as an alternative to traditional 14-pin SEL, Cooper and GE controls which use 24VDC for control logic. Recloser power is not affected. This flexibility reduces installed cost for retrofit projects by limiting the need to change relays or replacing the input/output boards.

Internal Voltage Sensing - Permits voltage reading for network reconfiguration applications and provides a secondary analog 120V AC output accepted by most relays such as the SEL-351R family. Up to 3 or 6 optional internal voltage sensors are available. LEA VS can be used when the Viper-S is paired with the SEL-651R2.

MANUAL TRIP OPERATION

Operation of the hookstick operable manual trip handle trips and locks out the recloser. A contact position indicator is provided indicating open or closed status of the contacts. Module contact status is also displayed at the control. Operation of the manual trip handle disables any local or remote closing operation until the handle is reset. A mechanical blocking device further assures against accidental close. The handle is operable from ground level. Once reset, the recloser can be closed from the control.



CONTROL CONNECTIONS

The traditional 14-pin recloser control connector design is the same as other Cooper reclosers permitting easy change out of previously installed controls and/or reclosers.



▲ 14-pin with 2-pin AC cable connectors.

CONTROL CAPABILITIES

Various style controls are available depending upon application requirements. Typical control settings include:

- Minimum trip for phase, ground and sensitive ground faults.
- Numerous pre-programmed and user-defined time current curves for sensing phase or ground faults.
- Three independent recloser interval times. Capable of up to four shots to lockout.
- Reset time.
- Sequence coordination.
- Cold load pickup.
- Advanced parameters. Refer to control specifications for more details.



▲ Schweitzer SEL-351R control

◀ Isometric view of the Viper-S without insulators.

Viper-S

CONTROL POWER VIPER-S

Many of today's reclosers require two to three cables between the control and the recloser to provide AC power to the recloser, control signals and commands, and in many cases, deadline operation. Now there is a cleaner, more efficient way to do the same tasks using G&W's Control Power Viper-S.

The Control Power Viper-S provides a single cable solution for all current, control, breaker status, and auxiliary power to operate the Viper-S. This package uses the power from the control to operate the Viper-S through a four-shot sequence. The power in the recloser control is backed up by batteries and provides an excellent solution for applications requiring deadline operation.

The Control Power Viper-S paired with the SEL-651R2 provides deadline operation which the 14-pin connector cannot provide. The Control Power Viper-S provides a more economical solution compared to the traditional SEL-651R2 14-pin configuration. This is accomplished by utilizing the SEL-651R2 power source to drive the Viper-S magnetic actuator and eliminate the AC/DC power supply within the Viper-S. The Control Power Viper-S has less electronics in the recloser than traditional 14-pin reclosers on the market today.

FEATURES

The Control Power Viper-S utilizes the same magnetic actuators, with integrated trip spring, and the proven solid dielectric encapsulated dead tank modules with screw-on silicone insulators. The Viper-S has been upgraded to proficiently meet the growing demand of the SEL-651R2 recloser control for mechanically ganged applications.

The Control Power Viper-S provides an alternative source of reclosers to use with existing recloser controls in the field.

With the addition of the 19-pin interface, the Viper-S is now compatible with many of the popular recloser controls. The chart of controls is a non-exhaustive list. Other relays can be integrated with the Viper-S using our Custom Relay Solution for 48 or 125 VDC I/O applications. Please contact your G&W representative for more details.



▲ Traditional configuration: 2-pin AC, 14-pin for control, and 8-pin 120VAC Voltage sensing connectors.



▲ Control powered solution: 8-pin quick-disconnect for LEA Voltage Sensors and 19-pin connector with integrated dead-line operation control.



▲ GE R650 recloser control with 14 pin interface

Viper-S Recloser Control Comparison Chart*			
Manufacturer	Control	Connectors Accepted	
		14-pin	19-pin
SEL	351R/ 651RA	•	
	751-751A	•	
	651R2	•	•
Cooper	Form 6	•	•
	Form 5	•	•
	Form 4D	•	•
	Form 4C	•	•
	FXB	•	
GE	URC	•	
	R650	•	
Beckwith	M-7679	•	

*Special applications with SEL-311L; GE-845; and more. Consult factory for more information.

INTERFACE CONFIGURATIONS

The Viper-S come with various interface configurations depending on the control used. The tables below give additional details of the connectors for each of the following configurations:

Viper-S, Traditional 14-pin, SEL-351R/651RA*		
Configuration	Type	Description
Required	14-pin, multi-turn	Control
	2-pin, multi-turn	AC (heaters, cap charging)
Optional	6-pin, multi-turn	Dead-line operation
	8-pin, multi-turn	Three 120VAC internal VS
	Hard-wired or connectorized	Additional aux. contacts

*Note: For additional compatible controls with these configurations see table on page 4.

Viper-S, 14-pin, SEL-651R2*		
Configuration	Type	Description
Required	14-pin, multi-turn	Control
	2-pin, multi-turn	AC (heaters, cap charging)
Optional	4-pin, 1/4 turn	3 LEA VS
	8-pin, 1/4 turn	3 or 6 LEA VS
	8-pin, multi-turn	Three 120VAC internal VS
	Hard-wired or connectorized	Additional aux. contacts

*Note: No Dead-line operation available with this configuration, use the 19-pin Control Powered version instead.

Viper-S, 19-pin, Custom Relay Solution (CRS)		
48 VDC or 125 VDC control powered		
Configuration	Type	Description
Required	19-pin, multi-turn	Control
	6-pin, multi-turn	AC: heaters* & DC: cap charging
Optional	8-pin, multi-turn	Three 120VAC internal VS
	Hard-wired or connectorized	Additional aux. contacts
Compatible controls with these configurations:		
SEL	351, 351S and 751A	

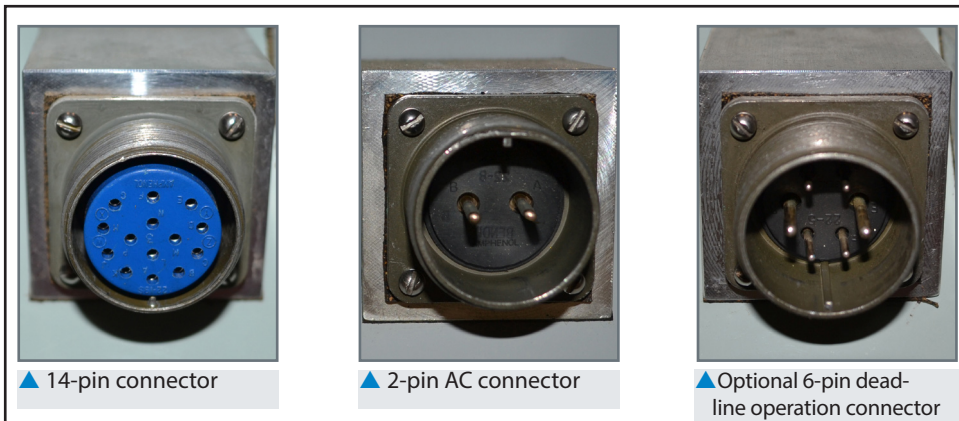
*Note: If AC is not available, optional heaters can work on DC. Mostly used for substation applications where only DC is available.

Viper-S, 19-pin, Control Powered SEL-651R2		
Configuration	Type	Description
Required	19-pin, multi-turn	Control*
Optional	4-pin, 1/4 turn	3 LEA VS
	8-pin, 1/4 turn	3 or 6 LEA VS
	8-pin, multi-turn	Three or Six 120VAC internal VS
	Hard-wired or connectorized	Additional aux. contacts

*Note: Control cable includes AC for heaters and dead-line operation feature if battery is provided.

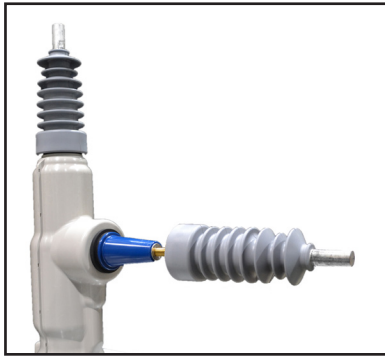
VS = Voltage Sensors
LEA = Low Energy Analog

Traditional 14-pin configuration



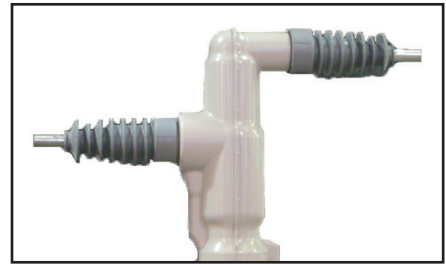
19-pin configuration





Insulator Flexibility

Polemounted units can be equipped with either horizontal or vertical insulators. Removable silicone insulators are standard for overhead applications. This feature permits easy field replacement if an insulator is damaged. Higher external BIL rated insulators can also be retrofitted if necessary. 3 or 6 internal VS are available in either L or Z modules.

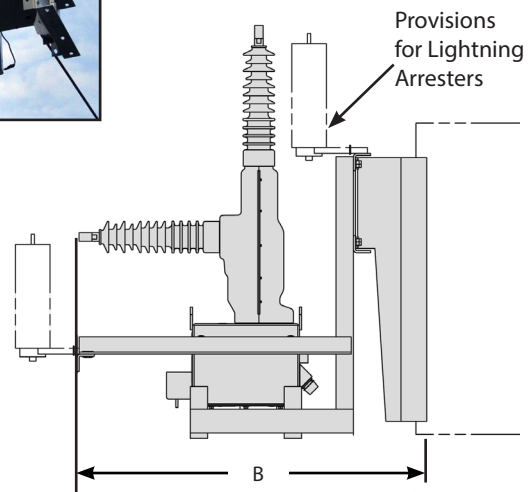
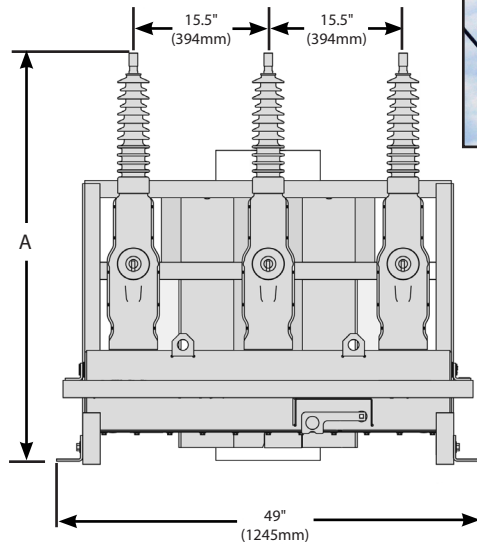


▲ Shown with horizontal insulator configuration (Z module)

Polemount Center Bracket*



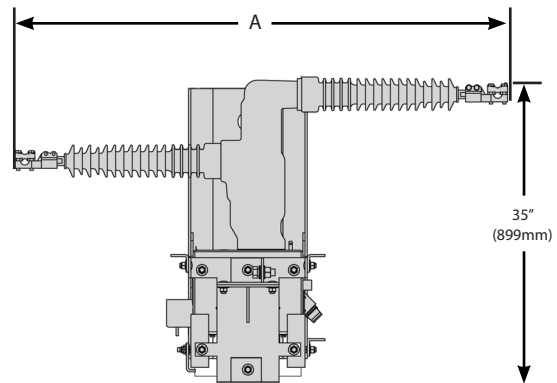
Approx. Dimensions*- ins. (mm)			
	15.5kV	27kV	38kV
A	42 (1067)	47 (1204)	51 (1295)
B	39 (991)	44 (1118)	48 (1219)



Polemount Alley-Arm*

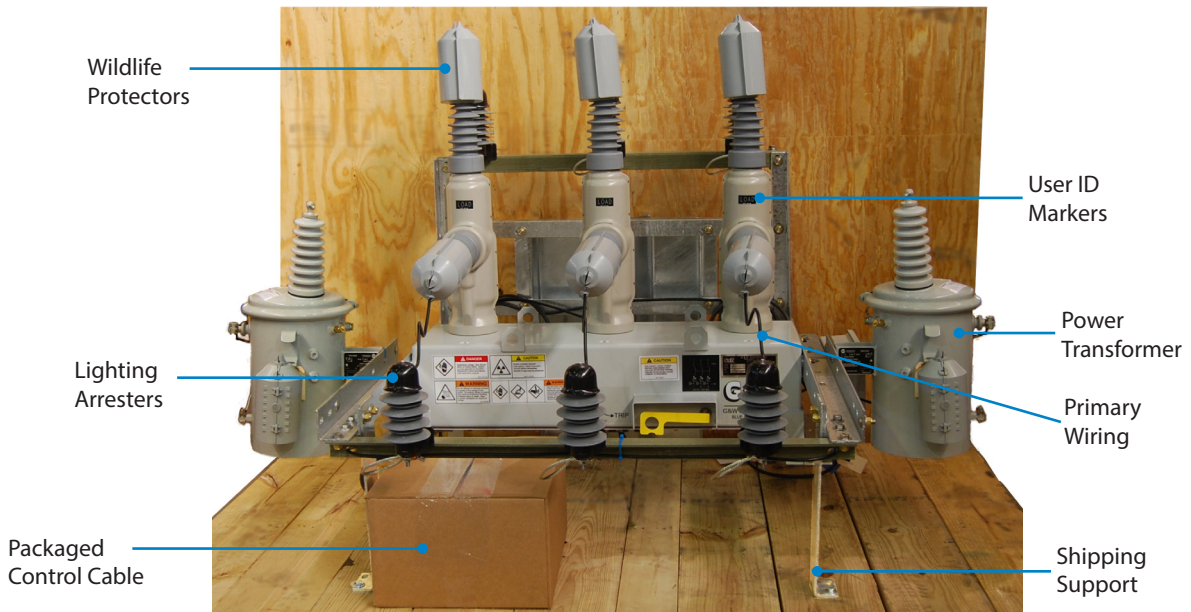
Horizontal Side Mounting Brackets with "Z" modules are ideal for overhead configurations where all three phase conductors are on one side of the pole.

Approx. Dimensions*- ins. (mm)			
	15.5kV	27kV	38kV
A	42 (1067)	50 (1270)	58 (1473)

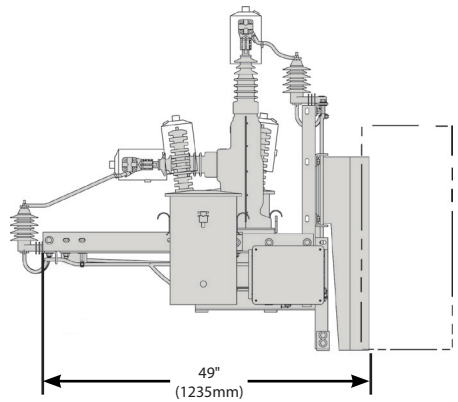
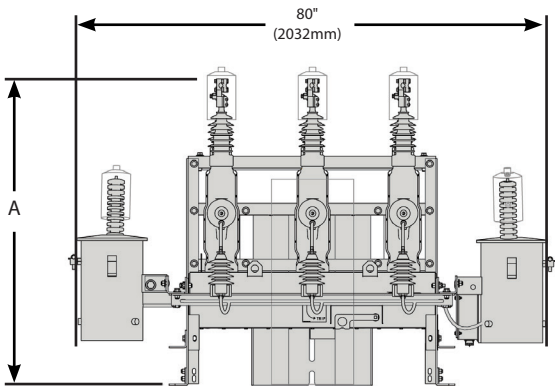


Polemount Site-Ready Assembly*

Preassembly of all auxiliary equipment significantly reduces recloser preparation time for product installation in the field. Includes potential transformers or voltage transformers, arresters, aerial lugs, terminal/junction boxes, wildlife protectors and all associated wiring. Control cables are connectorized on both ends and cut to length for a cleaner installation. User identification markers can be applied to each unit prior to shipment further reducing installation time.



Approx. Dimensions*- ins. (mm)			
	15.5kV	27kV	38kV
A	54 (1378)	58 (1473)	62 (1575)



* Dimensions are approximate. Do not use for construction. Galvanized steel bracket is standard. Stainless steel is available.

Substation Mount Recloser*



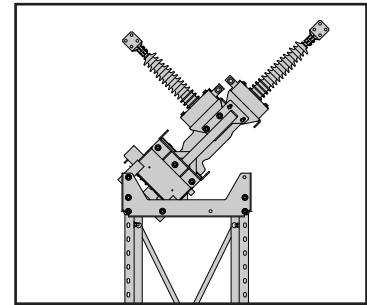
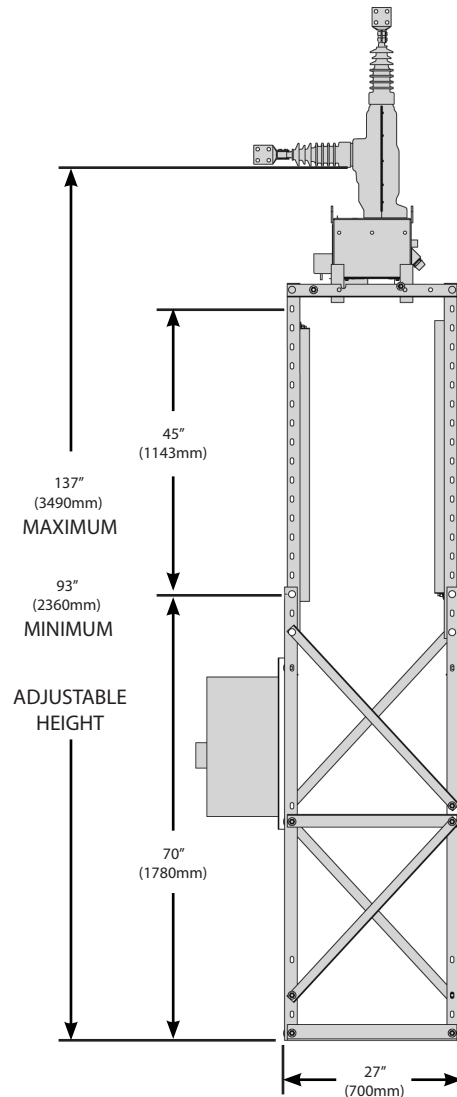
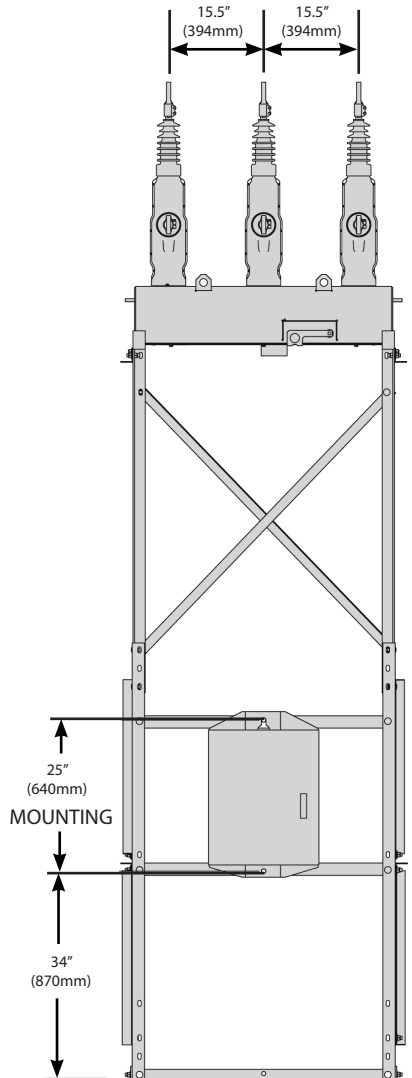
▲ 45° angle mounting for applications requiring the same load and line side connector height.

Substation frames are adjustable. Standard frames are galvanized. Stainless steel is available. Custom frames available including conversion for direct replacement of existing reclosers.

Dead-tank construction makes it ideal for substation circuit breaker applications and ensures the shielded solid dielectric module is grounded to earth potential.

For applications where extended creepage is required, larger insulators can be applied up to 940mm of creepage distance and 150kV BIL. External bushing CTs can be mounted at the base of the insulator where they can be used for metering or relay protection schemes like bus differential. The mechanism housing for substation applications is rated IP46 for maximum protection from water intrusion.

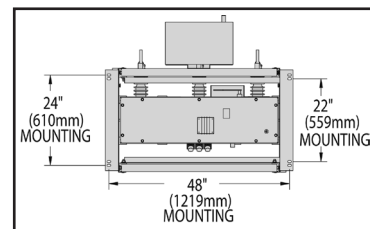
Externally mounted CTs - provide current monitoring on both the load and line side. Individual CTs and cabling are available.



▲ Viper-S substation mount shown with CTs.



▲ Custom mounted frame required for replacement of previously installed oil filled equipment.



Bottom View

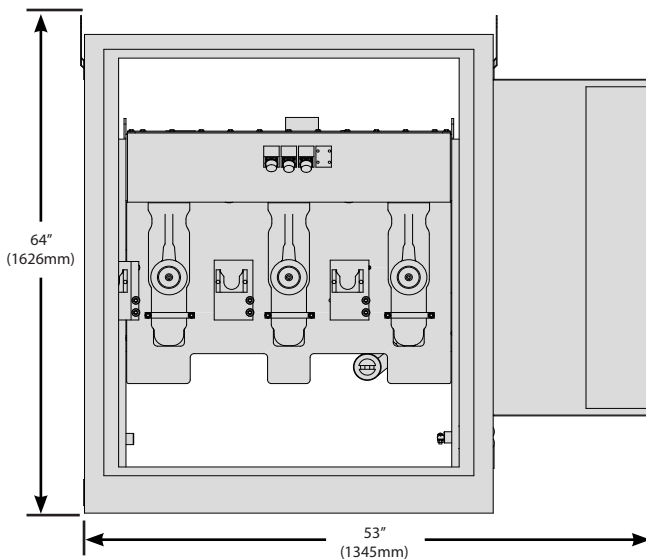
PADMOUNT APPLICATIONS

For applications where space is limited at the substation or where underground feeders require protection, Viper-S solid dielectric reclosers can provide an ideal solution using a dead-front padmount design. The padmounted Viper-S can be used as a breaker or as a tie-switch. Padmount applications can be considered for fenceless substations. In this configuration, the cable connections can be provided with either a standard IEEE 600A apparatus or 200A deepwell interface for elbow connectors. Separate compartments are provided for accessing the cables and operators. Controls can be mounted directly to the recloser frame or within a separate adjacent low voltage enclosure. Up to six internal LEA voltage sensors can be provided on padmounted designs with Z or C modules, perfect for tie points on FDIR schemes and automatic transfers.



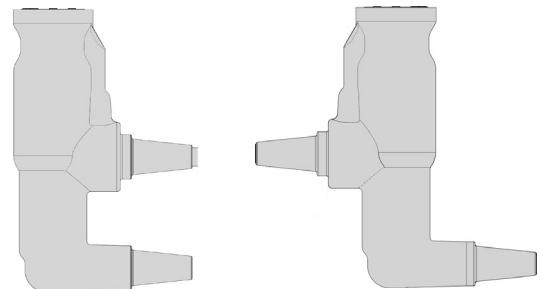
Padmount Reclosers with Front / Back Access*

Padmount Reclosers are available with "Z" Modules for cable entrances front and back, or with "C" Modules for cable entrances in front. A galvanized steel enclosure is standard. 304 and 316 stainless steel are available. Photo above shows C module design. Drawing below shows Z module design.



Padmounted Viper-S used in place of a circuit breaker in a solar generation intertie application ▶

MODULE CONFIGURATIONS



"C" Module

"Z" Module



* Dimensions are approximate. Do not use for construction.

Typical Specifications

A. GENERAL

This specification covers the requirements for an electronically controlled, mechanically ganged solid dielectric vacuum recloser for use on distribution systems through 38kV. The recloser shall be manufactured by G&W Electric Company designated as Viper-S solid dielectric recloser. Recloser configuration shall be (check one):

- Polemount, center
- Polemount, side horizontal (alley-arm)
- Polemount, facing pole
- Substation, 90° mount
- Substation, 45° mount
- Padmount, dead-front
- Phase-over-phase

B. DESIGN RATINGS AND STANDARDS

Reclosers shall be designed, tested and built per IEEE C37.60 and IEC 62271-111 standards. Certified test reports shall be provided. The recloser shall be rated: (select column):

Voltage Class (kV)	15	25	35
Max System Voltage (kV)	15.5	27	38
BIL (kV)	110	125	150
Continuous Current (A)	800A*	800A*	800
8 Hr. Overload, at 20° C	960	960	960
60Hz Withstand, kV rms Dry, 1 min	50	60	70
60Hz Withstand, kV rms Wet, 10 sec	45	50	60
Interrupting Rating RMS (kA)	12.5	12.5	12.5
Making Current, RMS, asym, KA	20	20	20
Peak, asym (kA)	32	32	32
Short Circuit Current, kA sym, 3 second	12.5	12.5	12.5
Mechanical Operations	10k	10k	10k
Temperature range, -60°C to +65°C (-76°F to 150°F)			

*Consult factory for higher continuous current up to 1000A.

C. RECLOSER CONSTRUCTION

C1: Mechanism Enclosure

The magnetic actuator and corresponding linkage assembly shall be housed within a light gray painted stainless steel tank. A contact position indicator easily visible from the ground, a mechanical counter and air vent shall be provided.

C2. Operating Mechanism

The operating mechanism shall utilize a magnetic actuator for opening and closing of the vacuum interrupters. The magnetic actuator shall be powered by capacitors located in the recloser tank. The manual trip and lockout handle shall be made of stainless steel for maximum corrosion resistance. Vacuum interrupter contact position indication shall be accomplished using green (open) and red (closed) indicators located on the bottom of the tank and through LEDs inside the control.

C3. Vacuum Interrupters

Interruption of the fault or load currents shall be accomplished through vacuum interrupters located inside the solid dielectric modules.

C4. Solid Dielectric Modules

The solid dielectric modules shall utilize a time-proven solid dielectric epoxy insulation to fully encapsulate each of the three vacuum interrupters. The solid dielectric modules shall be fully shielded and incorporate a high impact poly-carbonate, track resistant, UV stable covering. The modules shall be dead tank or dead front technology and shall conduct a fault to ground through their external surface in case of a flash over. The operating temperature range shall be -60°C to +65°C. A 1000/500:1 or a 400/200:1 dual ratio current transformer and optional voltage sensor(s) shall be integrally molded into each module. CT accuracy shall be +/-1%. Modules shall be molded with one (1) source side and one (1) load side, IEEE apparatus bushing interfaces. The bushing interfaces shall accommodate either connection of an underground cable elbow for padmount applications or silicone insulators for pole top and substation applications.

C5. Bushings

Bushing types shall be (check one):

For Overhead design:

- Air insulated, removable silicone insulators over an IEEE bushing interface

For Riser Pole:

- Air insulated, silicone insulators on one side and elbow connectors on the other side.

For Padmount design:

- 600A apparatus bushing
- 200A deep well bushing

D. OPERATION

Monitoring of the circuit shall be accomplished using internal multi-ratio current transformers and voltage sensors. The unit shall be powered by an external 120/240 VAC or 48/125 VDC source. In the event main power is lost, the unit shall have trip/close operating capabilities through the battery located in the control.

The magnetic actuator shall use a permanent magnet to hold a solenoid plunger in the closed position while maintaining a charge on the opening spring. Trip/close operation shall be accomplished by energizing the trip coil which generates a magnetic flux in the opposite direction and releases the trip spring. The trip spring guarantees an open gap of the contacts inside the vacuum interrupter resulting in a fail-safe operation.

Recloser sequencing, tripping and overcurrent sensing, shall be an automatic function of the electronic control. Manual trip and lockout shall be provided by an external, hook-stick operable handle. Operation of the manual trip handle shall activate a mechanical block device, disabling any local or remote closing operation until the handle is reset.

E. SMART GRID / LAZER® AUTOMATION

The recloser shall be automation ready simplifying conversion for any future automation requirements. Up to 6 optional LEA (Low Energy Analog) capacitive voltage sensors shall be encapsulated within each recloser module permitting voltage reading for network reconfiguration while eliminating the need for add-on external sensors and cabling. LEA voltage sensing accuracy is +/-2% over the temperature range -20°C (-4°F) through +40°C (+104°F) when tested as a system. The accuracy is +/-4% from -40°C (-40°F) through +65°C (+149°F). The phase angle accuracy is +/-1° throughout the full temperature range. Two voltage ratios are available: a 10,000:1 for applications above 13.8 kV L-G and a 2,500:1 ratio below that voltage. External voltage and current sensors can also be used depending on application requirements.

F. PADMOUNT ENCLOSURE

Enclosures shall be made of 12 gauge galvanized or stainless steel and manufactured to IEEE C37.72 and C57.12.28 standards. The enclosure shall be mounted independently to facilitate cable installation, if desired or for future replacement. Enclosures shall be tamper-resistant incorporating hinged access door(s) with penta-head locking bolts(s) and provisions for padlocking. The enclosure shall be provided with lifting provisions and painted with a Munsell 7.0GY3.29/1.5 green finish. Front cable connections or front/back cable connections shall be available. 3 or 6 voltage sensors shall be internal to the modules.

G. ELECTRONIC CONTROLS

The standard recloser control shall be the Schweitzer model SEL-351R4, SEL-351R3 Falcon, or SEL-651RA. The 351 family of controls shall be used when up to (4) 0-300 VAC voltage inputs will be monitored. The SEL-651R2 shall be the control used for up to 6 voltage inputs. Other traditional 14-pin and 19-pin interfaces controls shall also be available upon request.

H. FACTORY PRODUCTION TESTS

Each individual recloser shall undergo a mechanical operation check verifying contact trip/close velocity, travel profile, timing and phase synchronicity. The recloser shall be AC hi-pot tested one minute phase-to-phase, phase-to-ground and across the open contacts. Circuit resistance shall be checked on all phases. Time overcurrent tests shall be conducted to verify minimum pick up level performance. System testing shall be performed on each Viper-S with their respective matching control and any other site-ready add-on such as lightning arrester and potential transformers.

I. STANDARD COMPONENTS

The following shall be included as standard:

1. Lifting provisions
2. Grounding provisions
3. Mechanical counter
4. Manual trip and lockout handle with true mechanical block
5. SEL-351R recloser control and associated control cable
6. Fail-safe mechanically ganged operations
7. Dead Tank solid dielectric epoxy modules with up to six internal voltage sensors and three dual ratio CT's
8. Arrester mounting provisions (overhead applications only)
9. Field changeable silicone insulators
10. AC connectorized cable for heaters and power source to the magnetic actuator circuitry
11. Galvanized center polemount frame

J. OPTIONS

The following options shall be supplied:

(Check as necessary)

- NEMA 2-hole aerial lugs
- NEMA 4-hole aerial lugs
- Clamp style aerial lugs (#2- 500 kcmil)
- Clamp style aerial lugs (250-750 kcmil)
- 4/0 brass eyebolt ground lug
- Stainless steel polemount center bracket with arrester provisions on the load and source side.
- Stainless steel polemount side bracket (a.k.a. alley-arm frame) with arrester provisions on the load and source side.
- Galvanized steel substation frame.
- Polemount site-ready assembly
- Lightning arresters
- Dead-front padmounted design with stainless steel enclosure.
- External 1.0 KVA oil potential transformer for 120 VAC supply power with hardware to mount on standard frame
- External 0.75 KVA solid dielectric voltage transformer (0.3% accuracy) for 120 VAC supply power with hardware to mount on standard frame
- High impact, UV stable wildlife protectors for source and load insulators
- External CTs for current monitoring
- Six internal voltage sensors

G&W offers a complete line of smart distribution voltage equipment including:

Lazer® Automation

- Multiple levels of protection
- Open, flexible communication
- Pre-engineered, factory tested
- Transfer, loop, and network applications



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- Submersible vault and padmount
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- Integral Visible Break Designs



SF6 Insulated Switchgear

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- Submersible vault and padmount
- Smart Grid / Lazer® solutions
- Load and Fault Interrupting



Solid Dielectric Reclosers

- To 38kV, 12.5kA interrupting
- To 27kV, 16kA interrupting
- Overhead, substation and padmount
- Smart Grid / Lazer® solutions
- Single phase and three phase
- Six voltage sensing available



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GW02-2018
Aug. 2018

**Decommissioning Plan
Freetown Solar Project
Bristol County,
Massachusetts**



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Project No: 195602122
August 2, 2021

**DECOMMISSIONING PLAN
FREETOWN SOLAR ENERGY PROJECT, BRISTOL COUNTY, MASSACHUSETTS**

This document entitled Decommissioning Plan Freetown Solar Energy Project, Bristol County, Massachusetts, was prepared by Stantec Consulting Services Inc. ("Stantec") for the use of Freetown East PV I, LLC (the "Client"), and the applicable regulatory agencies. Any reliance on this document by any other third party is strictly prohibited. The material in this document reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in this document are based on conditions and information existing at the time this document was published and do not take into account any subsequent changes.



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1.0 INTRODUCTION

Freetown East PV I, LLC (Freetown Solar), a subsidiary of Longroad Energy Holdings, LLC (Longroad), is proposing to construct the Freetown Solar Project in Bristol County, Massachusetts. The proposed Freetown Solar Project (the Project) is to be located within the Township of Freetown, Massachusetts. The Project will occupy approximately 23 acres of land (within perimeter fencing) and will have a maximum nameplate generating capacity of up to 4.5 megawatts (MW) alternating current (AC). Major components of the Project include solar modules, racking/tracking system, inverters, transformers, and an overhead transmission line. Solar modules being considered include the First Solar Series 6 panels (425-475 watt) or other similar models.

This Decommissioning Plan (Plan) provides a description of the decommissioning and restoration phase of the Project. Start-of-construction is planned for late 2022, with a projected Commercial Operation Date in early 2023. The decommissioning phase is assumed to include the removal of Project facilities, including perimeter fencing; solar arrays and associated racking/trackers, foundations, and steel piles; inverters and transformers; access and internal roads; electrical collection system; and the Project substation and associated generation tie-in transmission line (Figure 1).

This Plan includes an overview of the primary decommissioning Project activities: dismantling and removal of facilities, and restoration of land. A summary of estimated costs and revenues associated with decommissioning the Project are included in Section 4.0. The summary statistics and estimates provided are based on a 4.5-MW_[AC] Project array design.

1.1 SOLAR FARM COMPONENTS

The main components of the Project include:

- Solar panels and racking system
- Foundations and steel piles
- Transformers and inverters
- Electrical cabling and conduits (underground)
- Perimeter fencing
- Site access and internal roads
- Transmission generation tie-in line (overhead)

1.2 TRIGGERING EVENTS AND EXPECTED LIFETIME OF PROJECT

Project decommissioning may be triggered by events such as the end of a power purchase agreement or when the Project reaches the end of its operational life. The Project will be considered to be abandoned if the Project is non-operational for a period of twelve (12) consecutive months. If properly maintained, the expected lifetime of a solar project is approximately 40 years with an opportunity for a project lifetime of 50 years or more with equipment replacement and repowering. Depending on market conditions and Project viability, the solar arrays may be retrofitted with updated components (e.g., panels, frame, tracking system, etc.) to extend the life of the Project. In the event that the modules are not retrofitted, or at the end of the Project's useful life, the panels and associated components will be decommissioned and removed from the Project site.

Components of the solar facility that have resale value may be sold in the wholesale market. Components with no resale value will be salvaged and sold as scrap for recycling or disposed of at an approved offsite licensed solid waste disposal facility (landfill). The resale value of components has not been considered in this Plan; however, the salvage value of the material scrap value has been estimated in Section 4. Decommissioning activities will include removal of the arrays and associated components as listed in Section 1.1 and described in Section 2.

1.3 DECOMMISSIONING SEQUENCE

Per Article 11 – Section 11.28.M.2 of the Town of Freetown Zoning By-Laws, Project facilities and components will be removed within 150 days of a Project which has reached the end of its useful life or has been abandoned. Monitoring and site restoration may extend beyond this period to ensure successful revegetation and rehabilitation. The anticipated sequence of decommissioning and removal is described below; however, overlap of activities is expected.

- Reinforce access roads, if needed, and prepare site for component removal
- Install temporary fencing and best management practices (BMPs) to protect sensitive resources
- De-energize solar arrays
- Dismantle panels and racking
- Remove frame and internal components
- Remove structural foundations and backfill sites
- Remove inverters and transformers
- Remove electrical cables and conduits
- Remove above ground transmission line unless retained for future use

DECOMMISSIONING PLAN

FREETOWN SOLAR ENERGY PROJECT, BRISTOL COUNTY, MASSACHUSETTS

- Remove access and internal roads and grade site
- De-compact subsoils (if required), restore and revegetate disturbed land to pre-construction conditions to the extent practicable

2.0 PROJECT COMPONENTS AND DECOMMISSIONING ACTIVITIES

The solar facility components and decommissioning activities necessary to restore the Project area, as near as practicable, to pre-construction conditions are described within this section.

2.1 OVERVIEW OF SOLAR FACILITY SYSTEM

Freetown Solar anticipates utilizing approximately 12,612 solar modules, with a total nameplate generating capacity of up to 5.80 MW Direct Current (DC) (approximately 4.5 MW_[AC]) on the approximately 23-acre site. Statistics and cost estimates provided in this Plan are based on a First Solar Series 6 425 to 475-watt or similar module.

Electrical cabling will be removed, regardless of depth. Access roads may be left in place if requested and/or agreed to by the landowner. Public roads damaged or modified during the decommissioning and reclamation process will be repaired upon completion of the decommissioning phase.

Estimated quantities of materials to be removed and salvaged or disposed of are included in this section. Most of the materials described have salvage value; although, there are some components that will likely have none at the time of decommissioning. All recyclable materials, salvaged and non-salvage, will be recycled to the furthest extent possible. All other non-recyclable waste materials will be disposed of in accordance with state and federal law in an approved licensed solid waste facility.

Table 1 presents a summary of the primary components of the Project included in this decommissioning plan.

Table 1 Primary Components of Solar Farm to be Decommissioned

Component	Quantity	Unit of Measure
Solar Modules (approximate)	12,612	Each
Racking System (full equivalent racks)	162	Each
Steel Piles	1,806	Each
Inverters and Transformers	2	Each
Underground Collection Cables	4,650	Lineal Foot (estimated)
Perimeter Fencing (approximate)	8,200	Lineal Foot (estimated)
Internal Access Roads (approximate)	4,475	Lineal Foot (estimated)
Above Ground Transmission Line	0.09	Lineal mile (estimated)

2.2 SOLAR MODULES

Freetown Solar is considering the First Solar Series 6 (425-475-watt) module or similar model for the Project. Each module assembly (with frame) has a total weight of approximately 76.1 pounds. The modules are approximately 79 inches long and 49 inches in width and are mainly comprised of non-metallic materials such as silicon, mono- or poly-crystalline glass, composite film, plastic, and epoxies, with an anodized aluminum frame.

At the time of decommissioning, module components in working condition may be refurbished and sold in a secondary market, yielding greater revenue than selling as salvage material. The revenue associated with the potential sale of modules has not been used in the calculation of net decommissioning cost.

2.3 RACKING SYSTEM AND SUPPORT

The solar modules will be mounted on a fixed tilt racking system, such as the Titan racking manufactured by APA Solar Racking. For purposes of cost estimating, equivalent racking approximately 32 meters (105 feet) in length, supporting 48 solar modules in two-in-portrait format, were assumed. Smaller racks will be employed at the edges of the layout, to efficiently utilize available space. The racking system is mainly comprised of galvanized and stainless steel; steel piles that support the system are comprised of structural steel.

The solar arrays will be deactivated from the surrounding electrical system and made safe for disassembly. Liquid wastes, including oils and hydraulic fluids will be removed and properly disposed of or recycled according to regulations current at the time of decommissioning. Electronic components, and internal electrical wiring will be removed and salvaged. The steel piles will also be removed and salvaged.

2.4 INVERTERS

Freetown Solar proposes to use the Sungrow transformer-integrated inverters to be located within the arrays. The inverters will be deactivated, disassembled and removed. Depending on condition, the equipment may be sold for refurbishment and re-use. If not re-used, they will be salvaged or disposed of at an approved solid waste management facility. All oils, lubricants, and hazardous materials will be collected and disposed of at a licensed facility.

2.5 ELECTRICAL CABLING AND CONDUITS

The Project's underground electrical collection system will be placed at a depth of three feet (36 inches) or greater below the ground surface. In compliance with Section 11.28 of the Town of Freetown Zoning By-Laws, all below-surface Project components will be removed from the site.

2.6 PERIMETER FENCING, SITE ACCESS AND INTERNAL ROADS

The Freetown Solar site will include a chain-link security fence around the perimeter of the site. An access road will allow access to the substation and solar facility. Access roads will be located within the array to allow access to the equipment. The access roads will be approximately 20 feet wide and total approximately 4,475 linear feet (0.85 miles). The access road lengths may change with final Project design. To be conservative, the decommissioning estimate assumes that all access roads will be completely removed.

During installation of the Project site access road subgrade conditions will be stabilized by placement of geogrid reinforced granular fills over soft ground. This Plan assumes that eight inches of compacted gravel will be placed over geotextile fabric. The estimated quantities of these materials are provided in Table 2.

Table 2 Typical Access Road Construction Materials

Item	Quantity	Unit
Geotextile	9,944	Square Yards
Gravel or granular fill; 8-inch deep	2,210	Cubic Yards

Decommissioning activities include the removal and stockpiling of aggregate materials onsite for salvage preparation. It is conservatively assumed that all Geogrid and aggregate materials will be removed from the Project site and hauled up to five miles from the Project area. Following removal of aggregate and Geogrid, the access road areas will be graded, de-compacted with deep ripper or chisel plow (ripped to 18 inches), back-filled with native subsoil and topsoil, as needed, and land contours restored as near as practicable to preconstruction conditions.

3.0 LAND USE AND ENVIRONMENT

3.1 CURRENT LAND USE

The proposed solar facility is predominantly located on woodland located east of MA-24 (Fall River Expressway). The area east of the Project area is woodland and residential.

The areas of the site that are disturbed by Project facilities and activities will be restored and revegetated in consultation with the owner(s) of the Property at the time of decommissioning and in compliance with regulations in place at that time.

3.2 RESTORATION, REVEGETATION AND SURFACE WATER DRAINAGE

Project sites that have been excavated and backfilled will be graded as needed to provide proper site drainage. Topsoil, if held in reserve from project construction, will be placed on disturbed areas and seeded with appropriate perennial vegetation to be determined in consultation with the landowner at the time of decommissioning. Soils compacted during de-construction activities will be de-compacted, as necessary, to restore the land to pre-construction land use.

Surface water conditions at the Project site will be reassessed prior to the decommissioning phase. Freetown Solar will obtain the required water quality permits from the Massachusetts Department of the Environmental Protection (MASSDEP) and the U.S. Army Corps of Engineers (USACE), if needed, before decommissioning of the Project. Storm water permits required at the time of decommissioning will be obtained. Work will be completed to comply with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act (WPA) Regulations (310 CMR 10.00), as well as conditions agreed upon by Freetown Solar and Plymouth County, or as directed by regulations in effect at the time of decommissioning.

3.3 MAJOR EQUIPMENT REQUIRED FOR DECOMMISSIONING

The activities involved in decommissioning the Project include removal of the Project components: solar modules, racking, foundations and piles, inverters, transformers, access roads, and electrical cabling and conduits. Restoration activities include back-filling of pile and foundation sites; de-compaction of subsoils; grading of surfaces to pre-construction land contours and revegetation of the disturbed areas.

Equipment required for the decommissioning activities is similar to what is needed to construct the solar facility and may include, but is not limited to: small cranes, low ground pressure (LGP) track mounted excavators, backhoes, LGP track bulldozers, LGP off-road end-dump trucks, front-end loaders, deep rippers, water trucks, disc plows and tractors

**DECOMMISSIONING PLAN
FREETOWN SOLAR ENERGY PROJECT, BRISTOL COUNTY, MASSACHUSETTS**

to restore subgrade conditions, and ancillary equipment. Standard dump trucks will be required to transport material removed from the site to disposal facilities.

4.0 DECOMMISSIONING COST ESTIMATE SUMMARY

Expenses associated with decommissioning the Project will be dependent on labor costs at the time of decommissioning. For the purposes of this report 2021 average market values were used to estimate labor expenses. Fluctuation and inflation of the labor costs were not factored into the estimates.

4.1 DECOMMISSIONING EXPENSES

Project decommissioning will incur costs associated with disposal of components not sold for salvage, including materials which will be disposed of at a licensed facility, as required. Decommissioning costs also include backfilling, grading and restoration of the proposed Project site as described in Section 2. Table 3 summarizes the estimates for activities associated with the major components of the Project.

Table 3 Estimated Decommissioning Expenses

Activity	Unit	Number	Cost per Unit	Total
Overhead and management (includes estimated permitting required)	Lump Sum	1	\$24,000	\$24,000
Solar modules; disassembly and removal	Each	12,612	\$4.00	\$50,448
Racking system disassembly and removal	Each	162	\$275	\$44,550
Steel pile/post removal	Each	1,806	\$12.50	\$22,575
Inverters	Each	2	\$1,700	\$3,400
Access road excavation and removal	Lump Sum	1	\$10,240	\$10,240
Remove below surface electrical cabling	Linear Feet	4,650	\$0.40	\$1,860
Remove above ground transmission line	Lump Sum	1	\$8,000	\$8,000
Perimeter fence removal	Linear Feet	8,200	\$2.80	\$22,960
Topsoil replacement and rehabilitation of site	Lump Sum	1	\$75,100	\$75,100
Public road repairs	Lump Sum	1	\$7,000	\$7,000
Total estimated decommissioning cost				\$270,133

4.2 DECOMMISSIONING REVENUES

Revenue from decommissioning the Project will be realized through the sale of the solar facility components and construction materials. As previously described, the value of the decommissioned components will be higher in the early stages of the Project and decline over time. Resale of components such as solar panels is expected to be greater than salvage (i.e., scrap) value for most of the life of the Project, as described below. For purposes of this report, only estimated salvage values were considered in net revenue calculations, as this is the more conservative estimate strategy.

Modules and other solar plant components can be sold within a secondary market for re-use. A current sampling of reused solar panels indicates a wide range of pricing depending on age and condition (\$0.10 to \$0.40 per watt). Future pricing of solar panels is difficult to predict at this time, due to the relatively young age of the market, changes to solar panel technology, and the ever-increasing product demand. A conservative estimation of the value of solar panels at \$0.10 per watt would yield \$580,000. Increased costs of removal, for resale versus salvage, would be expected in order to preserve the integrity of the panels; however, the net revenue would be substantially higher than the estimated salvage value.

The resale value of components such as racking, may decline more quickly; however, the salvage value of the steel that makes up a large portion of the racking is expected to stay at or above the value used in this report.

The market value of steel and other materials fluctuates daily and has varied widely over the past five years. Salvage value estimates were based on an approximate five-year-average price of steel and copper derived from sources including on-line recycling companies and United States Geological Survey (USGS) commodity summaries. The price used to value the steel used in this report is \$204 per metric ton; aluminum at \$0.40 per pound; silicon at \$0.40 per pound and glass at \$0.05 per pound.

The main material of the racking system and piles is assumed to be salvageable steel. The main components of the solar modules are glass and silicon with aluminum framing. A 50 percent recovery rate was assumed for all panel components, due to the processing required to separate the panel components. Alternative and more efficient methods of recycling solar panels are anticipated before this Project is decommissioned, given the large number of solar facilities that are currently being developed. Table 4 summarizes the potential salvage value for the solar array components and construction materials.

Table 4 Estimated Decommissioning Revenues

Item	Unit of Measurement	Quantity per Unit	Salvage Price per Unit	Total Salvage Price per Item	Number of Items	Total
Panels - Silicon	Pounds per Panel	1.9	\$0.40	\$0.760	12,612	\$9,585
Panels - Aluminum	Pounds per Panel	3.0	\$0.40	\$1.200	12,612	\$15,134
Panels - Glass	Pounds per Panel	28.5	\$0.05	\$1.425	12,612	\$17,972
Racking System and Posts	Metric tons per MW _[DC]	43.2	\$204	\$8,812.80	5.80	\$51,114
Total Potential Revenue						\$93,805

* Revenue based on salvage value only. Revenue from used panels at \$0.10 per watt could raise \$580,000 as resale versus the estimated salvage revenue.

4.3 DECOMMISSIONING COST SUMMARY

The following is a summary of the net estimated cost to decommission the Project, using the information detailed in Sections 4.1 and 4.2. Estimates are based on 2021 prices, with no market fluctuations or inflation considered.

The following table represents the total estimated net decommissioning cost.

Table 5 Net Decommissioning Summary

Item	Cost/Revenue
Decommissioning Expenses	\$270,133
Potential Revenue – salvage value of panel components and recoverable materials	\$93,805
Net Decommissioning Cost	\$176,328

4.4 FINANCIAL MECHANISM/ASSURANCE

Freetown Solar has indicated that it will comply with Section 11.28.M.3 of the Town of Freetown Zoning By-Laws:

Proponents of large-scale ground-mounted solar photovoltaic projects shall provide a form of surety, either through escrow account, bond or otherwise, to cover the cost of removal in the event the town must remove the installation and remediate the landscape, in an amount and form determined to be reasonable by the Site Plan Review Authority, but in no event to exceed more than 125percent of the cost of removal and compliance with the additional requirements set forth herein, as determined by the project proponent. Such surety will not be required for municipally or state-owned facilities. The project proponent shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for calculating increased removal costs due to inflation.

FIGURES

DECOMMISSIONING PLAN
FREETOWN SOLAR ENERGY PROJECT, BRISTOL COUNTY, MASSACHUSETTS

Figure 1 Project Layout

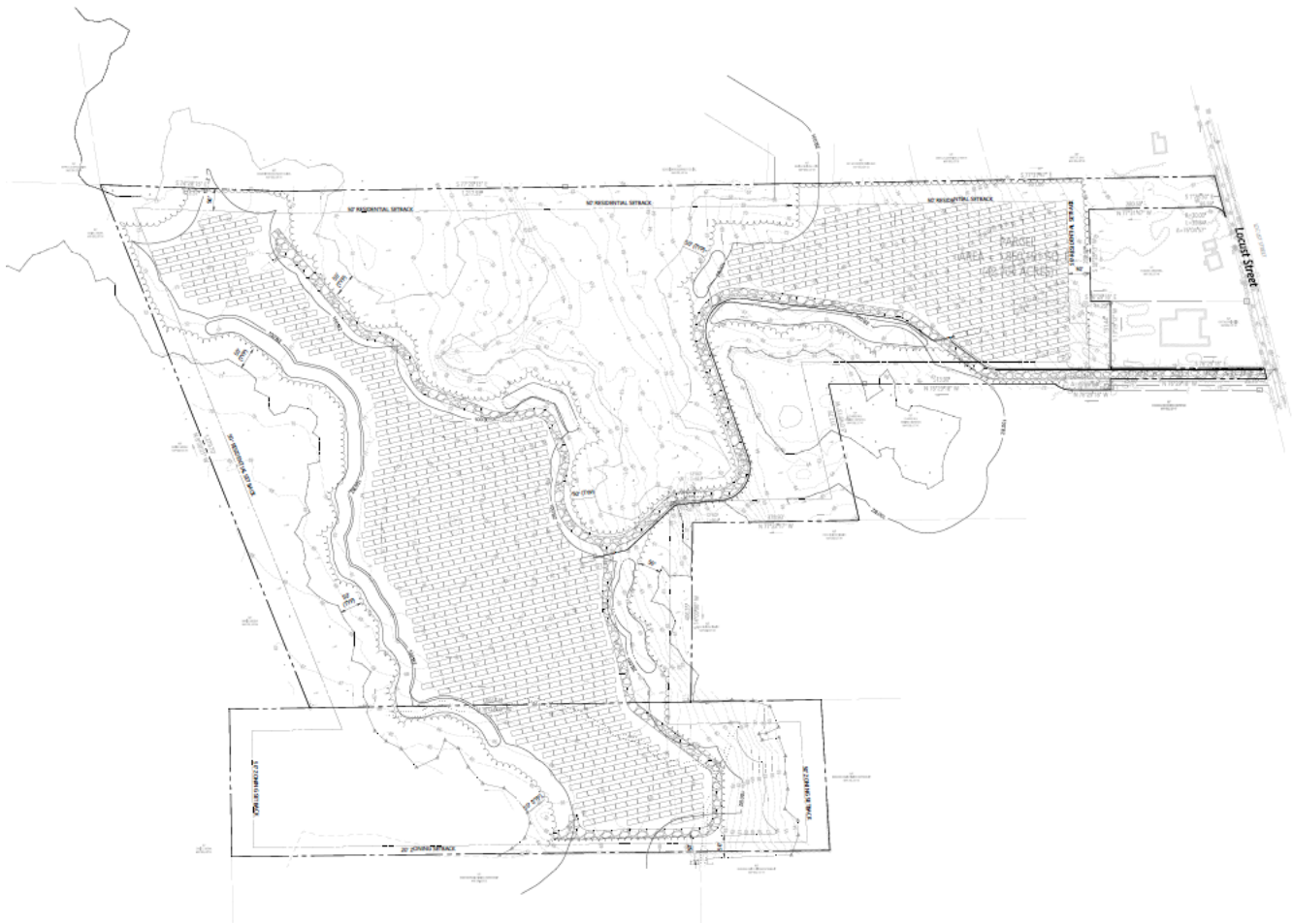


Exhibit 26-2

Draft Decommissioning Bond

BOND # _____
Surety Company
Annually Renewable Decommissioning Bond

KNOW ALL MEN BY THESE PRESENTS: That _____ (hereinafter called the "Principal"), and Surety Company (hereinafter called the "Surety"), are held and firmly bound unto _____ (hereinafter called the "Obligee"), initially in the full and just sum of _____ (\$00.00), the payment of which sum, well and truly to be made, the said Principal and Surety bind themselves, and each of their heirs, administrators, executors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has or will construct a commercial solar photovoltaic facility ("Solar Farm"), as that term is currently defined by the _____ (Property); and

WHEREAS, the Principal has been authorized to construct a Solar Farm by virtue of a legislative enactment by the Obligee and by other administrative approvals of Boards of the Obligee, all of which are conditioned upon the requirement that the Principal file security to cover the cost of decommissioning all facilities/structures which are part of the "Solar Farm" at the Property; and

WHEREAS, the Obligee has agreed to accept a bond guaranteeing the performance of said decommissioning pursuant to the terms and conditions of that certain bond agreement entered into between Obligee and Principal in connection with the Solar Farm (the "Bond Agreement").

NOW, THEREFORE, UPON EXECUTION BY THE PRINCIPAL AND SURETY AND UPON ACCEPTANCE BY THE OBLIGEE, THIS OBLIGATION SHALL BECOME EFFECTIVE AND SHALL REMAIN IN FULL FORCE AND EFFECT PURSUANT TO THE FOLLOWING EXPRESS PROVISIONS:

1. This bond is for the term beginning _____ and ending _____. The bond may be extended for additional terms at the option of the surety, by continuation certificate executed by the Surety. Neither non-renewal by the surety, nor failure, nor inability of the Principal to file a replacement bond shall constitute a loss to the Obligee recoverable under this bond.
2. This Bond shall terminate prior to the term set forth above only upon receipt by Surety of an express, written statement by Obligee that the Solar Farm has been dismantled, in accordance with the decommissioning plan referenced and incorporated into the Bond Agreement, to the Obligee's satisfaction and that the Bond may be released by Surety.
3. In the event of default by the Principal, Obligee shall deliver to Surety by certified mail, a written statement of the facts of such default, within thirty (30) days of the occurrence. In the event of default, the Surety will have the right and opportunity, at its sole discretion, to either cure the default; or to tender to the Obligee funds sufficient to pay the cost of completion less the balance of the Contract price up to an amount not to exceed the penal sum of the bond. In no event shall the Surety be liable for fines, penalties, liquidated damages, or forfeitures assessed against the Principal.
4. No claim, action, suit or proceeding, except as hereinafter set forth, shall be had or maintained against the Surety on this instrument unless same be brought or instituted upon the Surety within one year from termination or expiration of the bond term.
5. No right of action shall accrue on this bond to or for the use of any person or corporation other than the Obligee named herein or the heirs, executors, administrator or successors of Obligee.
6. The aggregate liability of the surety is limited to the penal sum stated herein regardless of the number or amount of claims brought against this bond and regardless of the number of years this bond remains in force.
7. If any conflict or inconsistency exists between the Surety's obligations or undertakings as described in this bond and as described in the underlying document, then the terms of this bond shall prevail.
8. Nothing in this bond shall be construed to waive, release, or otherwise modify in any way the rights and obligations of Obligee or Principal under the Bond Agreement or any of the terms or conditions of the Bond Agreement.
9. This bond shall not bind the Surety unless the bond is accepted by the Obligee. The acknowledgement and acceptance of this bond is demonstrated by signing where indicated below. If this obligation is not accepted by way of signature of the Obligee below, this bond shall be deemed null and void.

Signed and sealed this _____ day of _____, 2020.

PRINCIPAL:

_____ (seal)

(name & title)

SURETY:

Surety Company (seal)

Attorney-in-Fact

THE ABOVE TERMS AND CONDITIONS OF THIS BOND HAVE BEEN REVIEWED AND ACCEPTED BY THE (OBLIGEE).

ACKNOWLEDGED AND ACCEPTED BY OBLIGEE:

BY: _____

PRINTED NAME/TITLE: _____

DATE: _____

PLEASE RETURN A COPY OF ACCEPTED BOND TO:



CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

8/31/2020

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement.

PRODUCER: Alliant Insurance Services, Inc. 131 Oliver St 4th Fl Boston, MA 02110
CONTACT NAME: Jennyflore.Salvant@alliant.com
INSURER(S) AFFORDING COVERAGE: Lloyd's of London, Phoenix Insurance Company, Travelers Casualty Company of Connecticut, Travelers Indemnity Company of Connecticut

COVERAGES CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES.

Table with columns: INSR LTR, TYPE OF INSURANCE, ADDL INSD, SUBR WVD, POLICY NUMBER, POLICY EFF (MM/DD/YYYY), POLICY EXP (MM/DD/YYYY), LIMITS. Rows include Commercial General Liability, Automobile Liability, Umbrella Liability, Workers Compensation and Employers' Liability, and Commercial Property.

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

CERTIFICATE HOLDER and CANCELLATION sections. Includes text: 'SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.' and a signature.

ESS System Specifications	
Battery Modules	LITHIUM-ION
Battery Energy Rating	5.48MWH
DC-DC Converters	10 X SUNGROW SD250HV (EACH UNIT RATED AT 250KW)
DC Power Rating	2.5MW
PV System Specifications	
PV Modules	15,741 x 400W LG
DC Rating at STC	6.3MW
Inverters	2 X SUNGROW SG2500U, 550VAC, UL1741SA (2 X FACTORY DERATED TO 2.249MW)
TOTAL AC Rating	4.498MW
DC/AC Ratio	1.4

PROPOSED INVERTER SETTING		
ANSI #	PICKUP (%V / V _{L-L} , Hz)	DELAY (CYCLES : SECONDS)
27	50% / 275V	66 : 1.1
27	88% / 484V	120 : 2
59	110% / 605V	120 : 2
59	120% / 660V	9.6 : 0.16
81/U	56.5Hz	9.6 : 0.16
81/U	58.5Hz	18000 : 300
81/O	61.2Hz	18000 : 300
81/O	62.0Hz	9.6 : 0.16

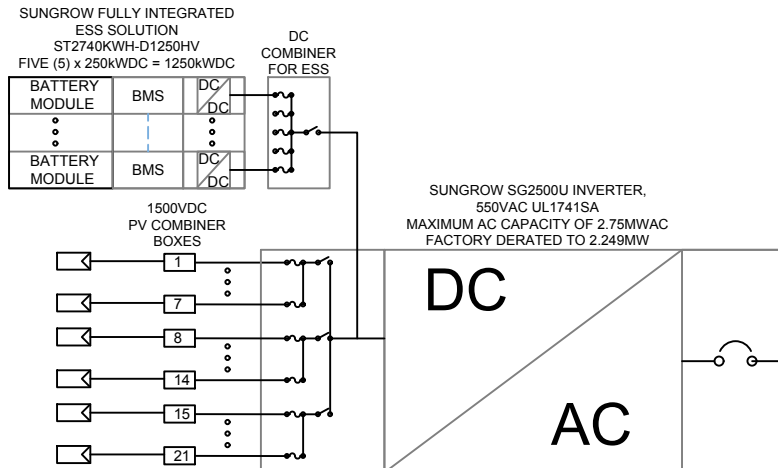
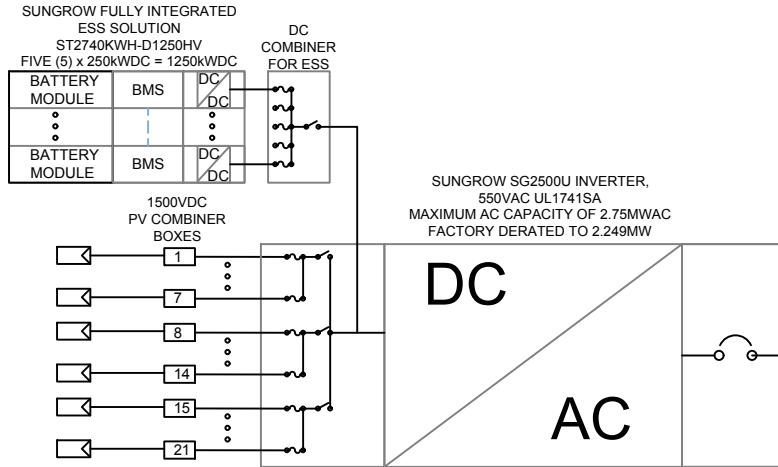
1. SET LOW VOLTAGE AND FREQUENCY RIDE-THROUGH PER ISO-NE SRD.
2. THE INVERTER SHALL NOT CONNECT OR RETURN TO SERVICE FOLLOWING A TRIP UNTIL DETECTING 5 MINUTES OF HEALTHY UTILITY VOLTAGE AND FREQUENCY.

ANSI #	V/A/W (%)
27	50
27	88
59	110
59	120
50	1500
51	140
32	100
81/U	
81/U	
81/O	
81/O	

1. TOTAL CLEARING TIME INCLUDING
2. THE RELAY WILL BE PROGRAMMED TO
FAILS OR DUE TO RELAY HARDWARE
3. AUTO-RESTORATION: RELAY PREVENTS
INTERCONNECTION UPON THE SYSTEM
FREQUENCY WILL BE SUPERVISED
COMMAND IS INITIATED. AUTO-RESTORATION
OR MANUAL OPEN.

ESS AND INVERTER NOTES:

- ENERGY STORAGE SYSTEM UL 9540 LISTED.
- TRANSFORMERS MUST COMPLY WITH SUNGROW INVERTER TECHNICAL REQUIREMENTS.



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REVISIONS				
REV	DESCRIPTION	DATE	DESIGN	REVIEWED
5	Updated Primary winding from Delta to Wye-Gnd	11-30-2020	AF	TM
4	ADD ANSI 32 ELEMENT	10-31-2019	LC	JB
3	UPDATED PER UTILITY COMMENTS	10-22-2019	LC	JB
2	INVERTER CHANGE	04-18-2019	KR	MH
1	ISSUED FOR UTILITY SUBMISSION	04-02-2019	KR	JB
0	ISSUED FOR REVIEW	03-29-2019	RW	JB



4

Construction Schedule

FREETOWN SOLAR-CONST. SCHEDULE		20XX											
Activity		J	F	M	A	M	J	J	A	S	O	N	D
Preconstruction/Engineering													
Geotech Investigation & Pile Load Tests													
Preliminary Engineering													
Finalize EPC Contracting													
Civil & Structural*													
Vegetation Clearing													
Grading/Roads													
Perimeter Fence Install													
Struct - Pile Installation													
Struct - Equipment Fdns													
Struct - Rack Installation													
Planting/Restoration/Reseeding													
Electrical (Plant)**													
MV Collection/Inverter Install													
DC Install (wire and equipment)													
Module Deliveries													
Module Install													
DC Wiring													
Battery System Install													
Testing & Commissioning													
Electrical (Overhead Line)													
Vegetation Clearing/Access													
Set Structures/String Conductor													
Planting/Reseeding/Restoration													
Plant Completion/Operations Handoff													

**Civil stormwater controls, BMP's, and maintenance are monitored and performed throughout construction period.
 *typical schedule assumes primary construction effort during summer months, but adjustable based on project constraints and timing.

5

Supplemental Plans & Reports (Under Separate Cover)

Site Plans
Stormwater Report

