

APPLICATION NOTE

Switching and Protection solutions for 800VAC Recombiners in Photovoltaic plants

IEC Utility Scale



Are you searching for Switching & Protection solutions to protect and secure your AC Recombiners? Use our pre-configured and pre-tested Application Bundle to rapidly configure Utility Scale Photovoltaic plants with several string inverters.

What is an AC Recombiner?

If you want to connect several string inverters in parallel prior to connecting to an MV/LV transformer you need an AC Recombiner.

AC Recombiners are switchboards where switching and protective devices are installed along with auxiliary and/or communication circuits.

Why you need a Switching & Protection solution for AC Recombiners

Every feeder from the relative inverter requires adequate galvanic switching and protection against overcurrents.

Main benefits



Smarter protection

Increased power in your installation and reduced CAPEX using our full range of Low Voltage (LV) components up to 1000V AC and 1500 VDC for excellent performance at different temperature and humidity ratings.



Speeds up your projects

Design projects faster to preconfigured bundles comprising a coordinated range of products in compact sizes.



Safety

Avoid the risk of fire in your facility and loss of valuable assets by using a complete range of SPDs to protect the whole electrical system from lightning and surges. Reduce the risk of injuries due to arc flash thanks to our advanced arc flash mitigation solutions.

Main trends in string inverter architecture



Single MPPT String inverter architecture - Virtual Central Inverter

An MPPT maximizes the energy produced by the connected solar string at any time during its operation. Solar inverters designed with a single MPPT are capable of maximizing the output for one value of DC current, especially in homogeneous photovoltaic plants.

The architecture is similar to that of central inverter photovoltaic plants. DC combiners are required.

Highlights

- Reduced installation costs and time
- Ease of installation (specialized electricians are not required)
- Perfect on hilly ground and rugged land plots with difficult access to the area
- Connection and feed-in to the grid are faster and more progressive
- Easy to service and replace.



Solar plants are moving towards 800V on the AC side

Higher voltage ratings, up to 800VAC, make the whole system more efficient, especially for string inverter architecture where the cables between the inverters and MV/LV transformer are usually very long.

Highlights

- Enhanced sustainability
- Reduced Balance of System cost (e.g. AC side cabling)
- Higher power obtainable in the same enclosure (~30%) while maintaining the same current (fewer inverters per MW)
- 40-50 % savings on AC cables and components compared to 400VAC string inverters
- Typically used on a large Commercial & Industrial scale ($P > 500$ kW) where a dedicated MV/LV transformer is required by the design in any case.

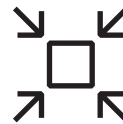


Multi MPPT (maximum power point tracker) for string inverter architecture

Multi-MPPT inverters improve total energy production when the PV generator features an asymmetric string configuration and shading is non-uniform. Multi-MPPT inverters are typically designed for higher AC voltage ratings and achieve cost savings involving the whole system.

Highlights

- Enhanced plant flexibility and efficiency
- Fusing not required on inverter DC source circuits
- DC combiner not required
- AC voltage distribution
- Simpler plant architecture comprising only 3 components: PV panels + solar inverters + MV/LV CSSs.



String Inverters with a higher power range up to 800V AC and 1500V DC, and higher AC/DC voltages

Fewer inverters can be used for solar systems thanks to string inverters with higher power ranges. This makes the string inverter configuration suitable for systems with a rated power range as well.

Typical features

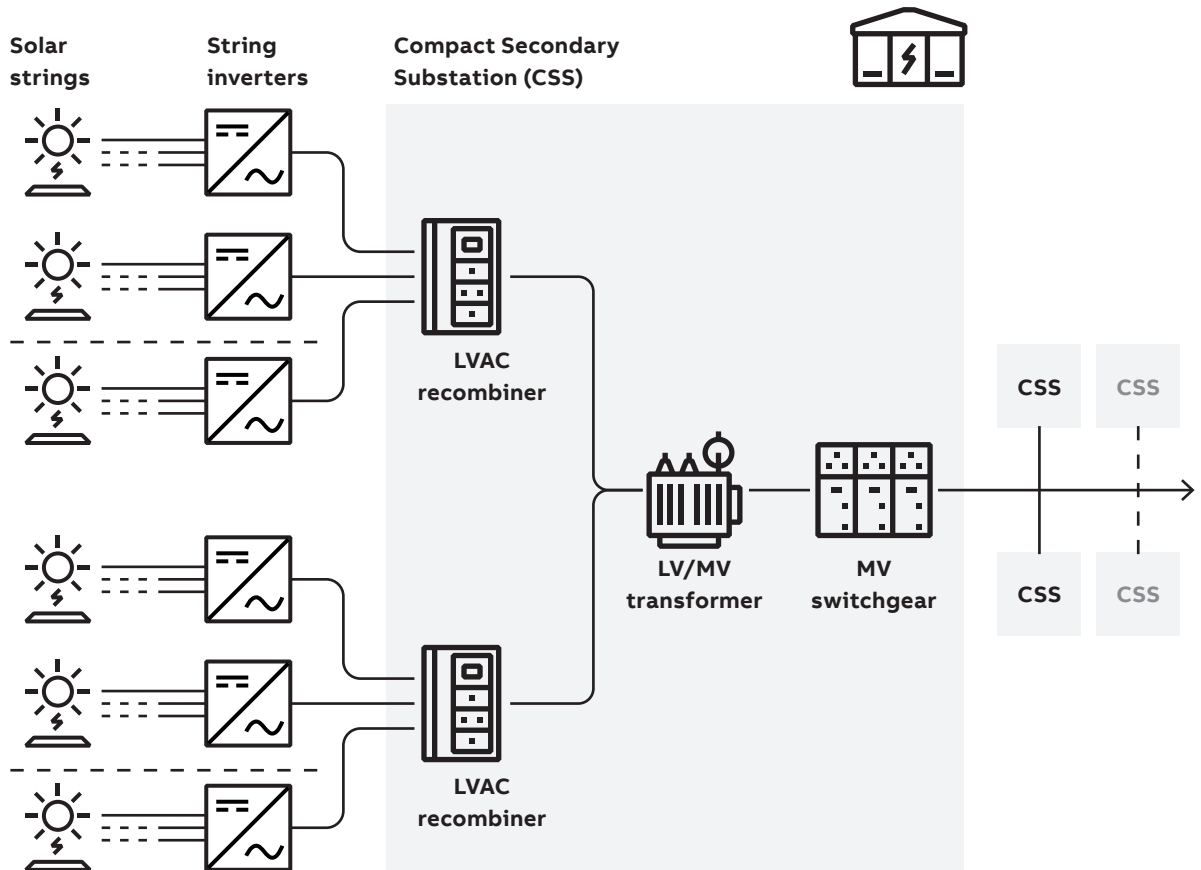
- DC input Voltage: 1500V DC
- AC output Voltage: 800V AC
- 100-350kW power range
- Output currents: 70-250A
- AC Protection nominal current: 160-250A
- AC main protection: breaker, Fuse switches.

AC Recombiners in String inverter architecture

Fundamentals, main components & functionalities

The power generated by solar strings and converted to AC by each string inverter is collected by the AC Recombiner. This is a switchboard where several string inverters are placed in parallel by the relative feeder.

Every feeder requires adequate switching and protection against overcurrents.



AC recombiner components

- AC switching and protection devices
- Insulation monitoring device
- Surge protection device for direct lightning
- Auxiliary circuits.

Optional components for AC recombiners

- Arc flash mitigation: Active, Passive or Preventive solutions
- Network analyzer
- Temperature monitoring relay.

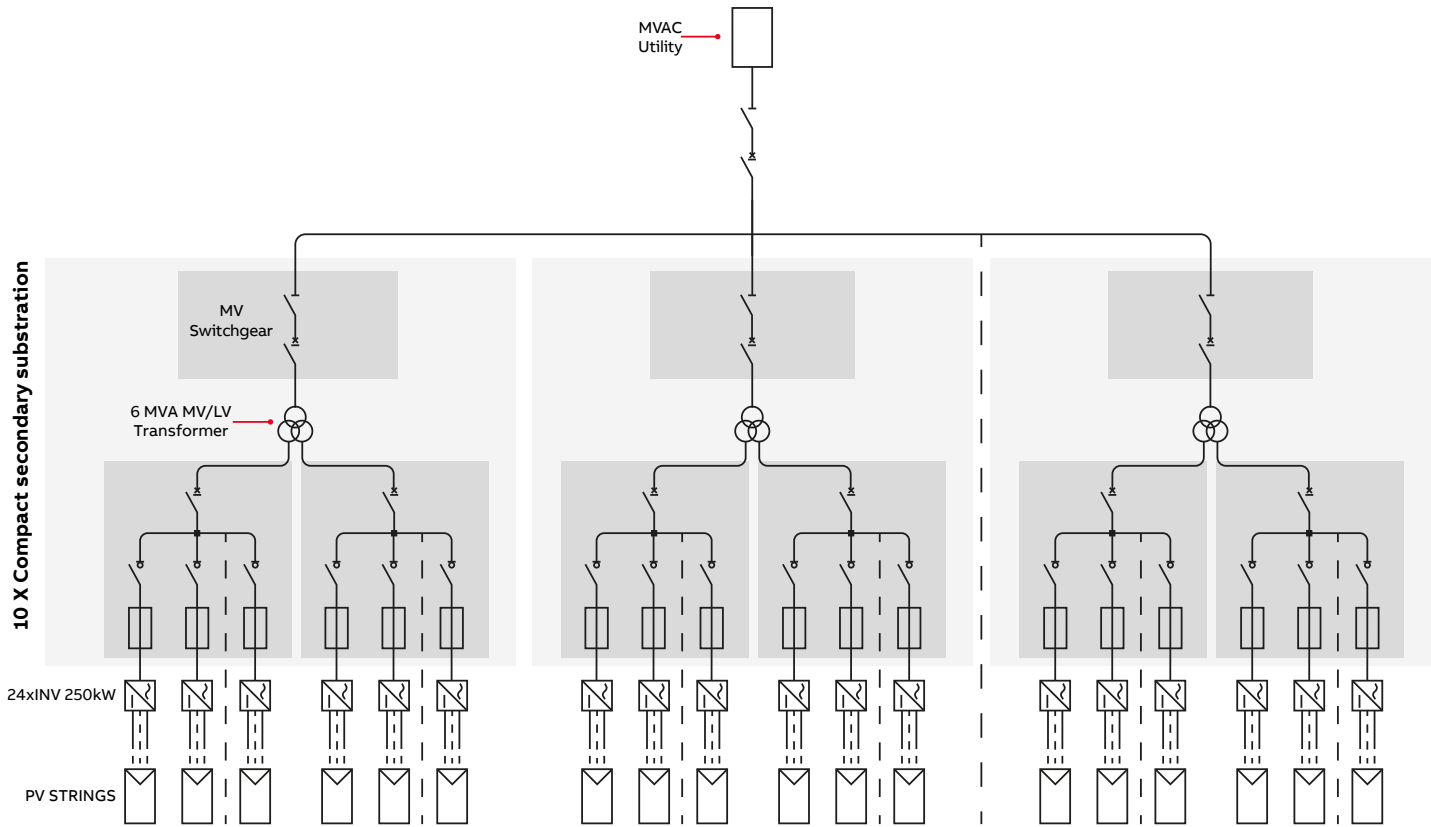


Switching and protection solutions for 800VAC Recoinbiners in Utility scale Photovoltaic plants

Scenario #1

Discover our Switching & Protection solutions for easy 800VAC recombiner configuration considering a 60MW Photovoltaic plant with 10 compact secondary substations each comprising 24 x 250kW string inverters.

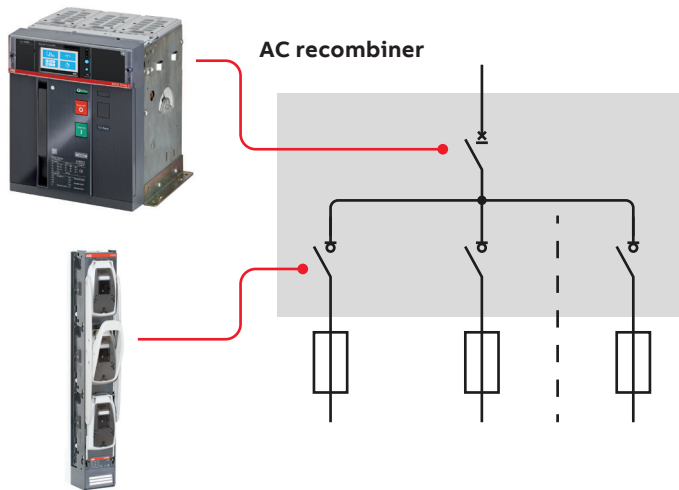
2 recombiners, 24 x 250kW string inverters per Compact Secondary Substation (CSS)



Specifications of system electrical quantities

Input data	IEC
Rated power of system [MW]	60
MV/LV transformer rated power [MVA]	6 (Y/DD)
N. Compact SubStations	10
Inverter rated power [kW]	250
N. inverters per AC combiner	12
N. AC combiners per CSS	2
Rated DC voltage [V]	1500
Rated MVAC voltage [kV]	15
Rated LVAC voltage [V]	800
Rated LVAC inverter current [A]	200
Rated LVAC bus current [A]	2406
Short circuit current LVAC bus [kA]	50
Short circuit current LVAC feeders [kA]	53

ABB offering (IEC)



Main components

Emax E2.2H/E9 2500 Ekip Touch LSIG FHR 3p + Ekip Measuring package main circuit breaker fixed version $I_n=2500A$ for protection and isolation, equipped with Ekip com Modbus TCP communication module, with YO/YC and motor to open/close remotely

InLineII ZLBM3-3P-M12 feeder fuse switch disconnecter $I_e=630A$ for protection and isolation

CM-IWM.11 Insulation monitoring relay to detect the first ground fault in IT AC systems even with large leakage capacity

OVR T1-T2 12.5-440s P TS QS to protect against overvoltages from the AC Utility

Optional components

TVOC-2-48C Arc monitor with HMI-COM + **CSU-2LV** low voltage current sensing unit + **RELT Module** Ekip Signalling 2k-3 for Arc Flash Mitigation

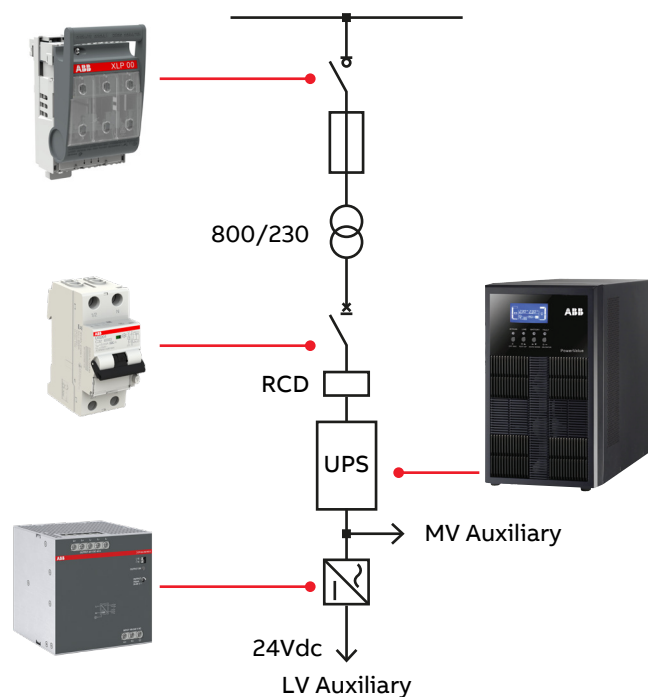
M4M 20 Ethernet network analyzer with Modbus TCP/IP communication protocol for electrical measuring and power monitoring

CM-TCN.011S temperature monitoring relay to measure the temperature inside the recombining

Emax 2 advanced power and frequency protection packages

Auxiliary components

12 inverter feeders per combiner



Auxiliary components

Easyline XLP00 fuse switch-disconnector $I_e=125A$, to protect 800/230 transformer against shortcircuits

DS201 C32 A30 miniature circuit breaker and residual current device, $I_n=32A$, $I_{\Delta n}=30mA$, for auxiliary circuit switching and protection against both overcurrents electric shocks

PowerValue 11T G2 UPS $A_n=6kVA$ to supply auxiliary circuits (MV relay included) in an AC Utility outage

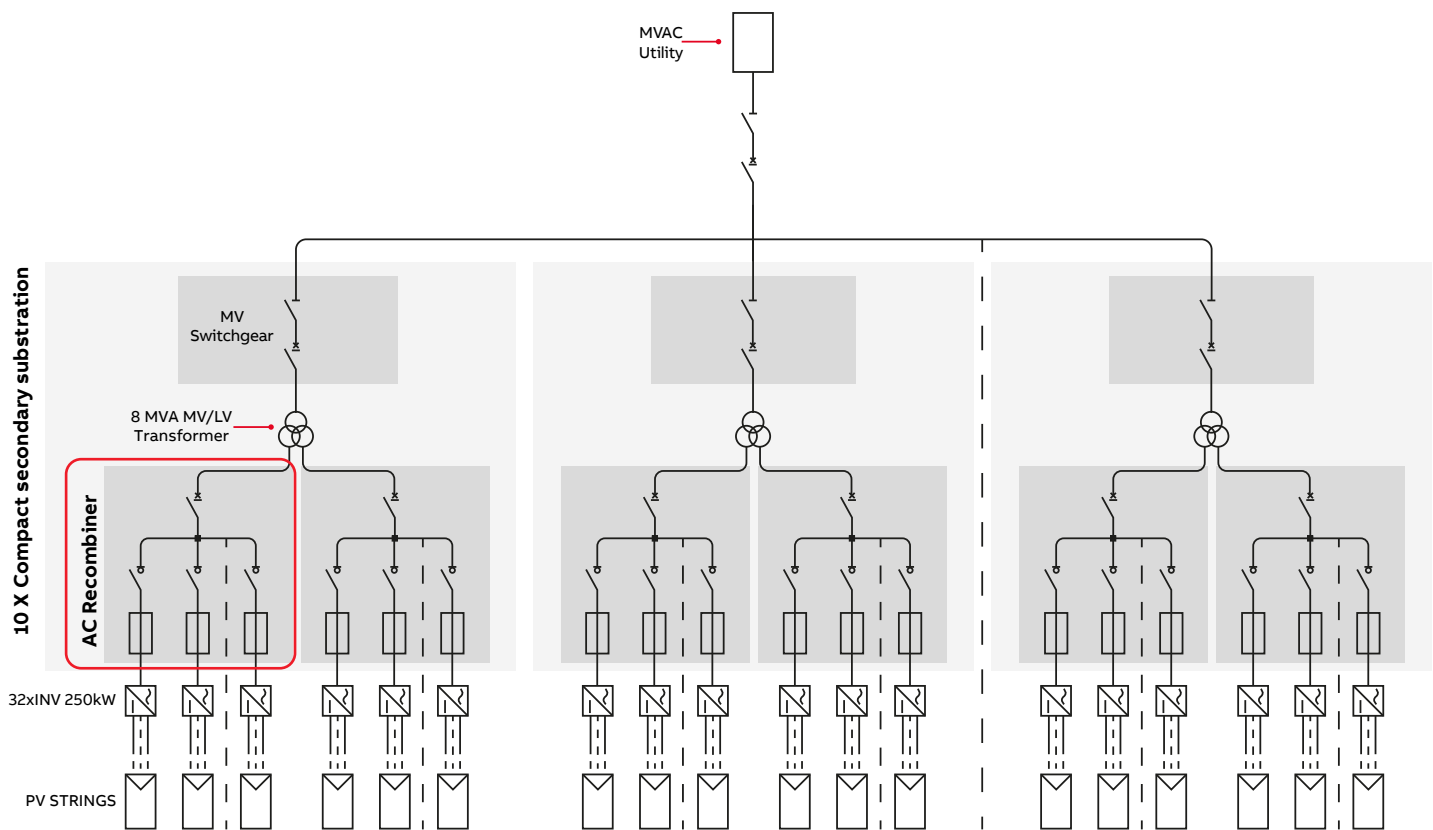
CP-S.1 24/40.0 power supply for 24VDC supply to the auxiliary circuits

Switching and protection solutions for 800VAC Recombiners in Utility scale Photovoltaic plants

Scenario #2

Discover our Switching & Protection solutions for easy 800VACrecombiner configuration considering a 80MW Solar system with 32 x250kW string inverters in parallel.

2 recombiners, 32 x 250kW string inverters per Compact Secondary Substations (CSS)

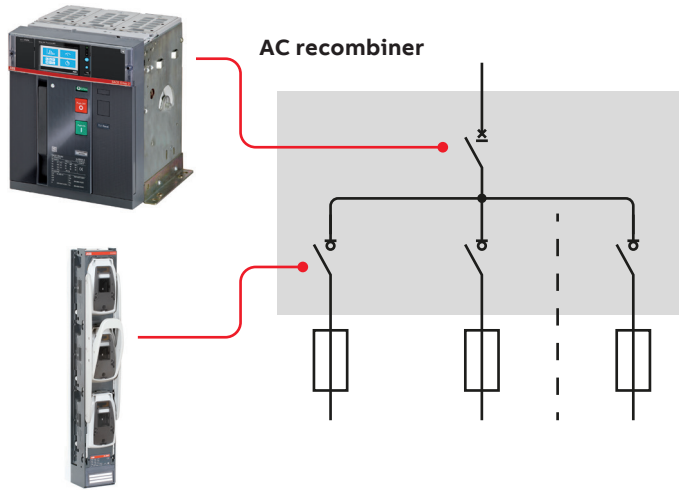


Specifications of system electrical quantities

Input data	IEC
System rated power [MW]	80
MV/LV transformer rated power [MVA]	8 (Y/DD)
N. Compact SubStaions (CSS)	10
Rated inverter power [kW]	250
N. inverter per AC combiner	16
N. AC combiners per CSS	2
Rated DC voltage [V]	1500
Rated MVAC voltage [kV]	15
Rated LVAC voltage [V]	800
Rated LVAC inverter current [A]	200
Rated LVAC bus current [A]	3208
Short circuit current LVAC bus [kA]	50
Short circuit current LVAC feeders [kA]	55

ABB offering (IEC)

16 inverter feeders per combiner



Main components

Emax E4.2S/E10 4000 Ekip Touch + Measuring LSIG FHR 3p main circuit breaker fixed version $I_n=4000A$ for protection and isolation, equipped with Ekip com Modbus TCP communication module and with the YO/YC and motor to open/close remotely. E10 version is needed as it suitable for usage in IT systems (with isolated neutral) at 800V.

InLineII ZLBM3-3P-M12 feeder fuse switch disconnect $I_e=630A$ for protection and isolation

CM-IWM.10 Insulating monitoring relay to detect the first ground fault in IT AC systems even with large leakage capacity

OVR T1-T2 12.5-440s P QS to protect against overvoltages coming from the AC Utility

Optional components

TVOC-2-48C Arc monitor with HMI-COM + **CSU-2LV** low voltage current sensing unit + **RELT Module** Ekip Signalling 2k-3 for Arc Flash Mitigation

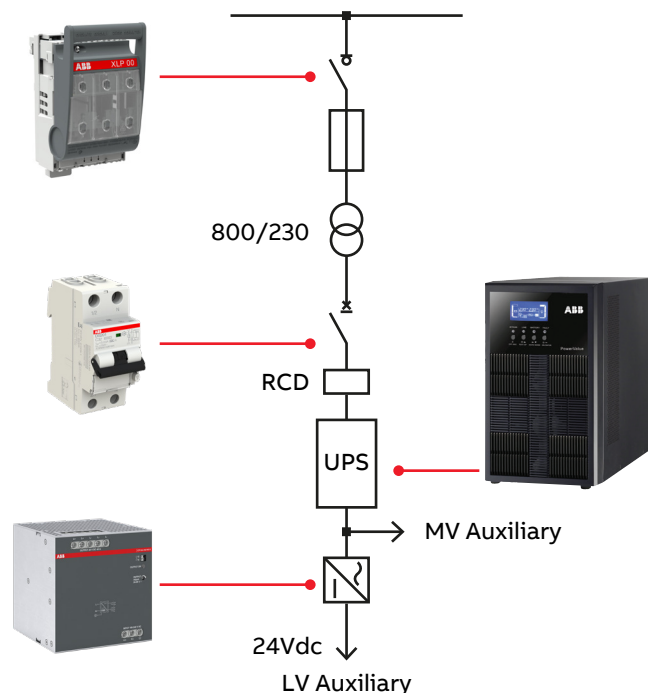
M4M 20 Ethernet network analyzer with Modbus TCP/IP communication protocol for electrical measuring and power monitoring

CM-TCN.011S temperature monitoring relay to measure the temperature inside the recombiners

Emax 2: advanced power and frequency protections packages

Auxiliary components

16 inverter feeders per combiner



Auxiliary components

Easyline XLP00 fuse switch-disconnector $I_e=125A$, to protect the 800/230 transformer against shortcircuits

DS201 C32 A30 miniature circuit breaker and residual current device, $I_n=32A$, $I_{\Delta n}=30mA$, for auxiliary circuit switching and protection against both overcurrents electric shock

PowerValue 11T G2 UPS $A_n=6kVA$ to supply the auxiliary circuits (MV relay included) in case of AC Utility outage

CP-S.1 24/40.0 power supply to supply at 24Vdc the auxiliary circuits

Bill of materials

ABB's offering for 60MW string inverter configuration (IEC)

Main components

Device	Part number	Quantity per AC combiner	Total quantity
E2.2H/E9 2500 Ekip Touch LSIG FHR 3p *	1SDA104359R1	1	20
Ekip Measuring package for E2	1SDA107525R1	1	20
Motor-M E2.2 24-30V AC/DC	1SDA073722R1	1	20
YO E1.2..E6.2 24V AC/DC	1SDA073668R1	1	20
YC E1.2..E6.2 24V AC/DC	1SDA073681R1	1	20
Ekip Supply 24-48V DC	1SDA074173R1	1	20
Ekip Com Modbus TCP	1SDA074151R1	1	20
ZLBM3-3P-M12	1SEP620013R3000	12	240
CM-IWM.11	1SVR470670R1100	1	20
4 (four) OVR T1-T2 12.5-440s P TS QS	2CTB815710R2900	4	80

* Always provided with external outlet: External VTs are needed to handle 800V

Optional components

Device	Part number	Quantity per AC combiner	Total quantity
ZLBM3-3P-M12-EFM	1SEP620013R3001	12	240
ZLBM Auxiliary switch NO	1SEP619555R0001	12	240
RELT Ekip Signalling 2k-3	1SDA074169R1	1	20
TVOC-2-48C	1SFA664001R1004	1	20
CSU-2LV	1SFA664002R5001	1	10
TVOC-2-DP2	1SFA664003R1020	1	10
TVOC-2-OP2	1SFA664004R1020	1	10
M4M 20 Ethernet	2CSG204471R4051	1	10
CM-TCN.011S	1SVR750740R0110	1	20
Power Protection for Emax 2	1SDA105230R1	1	20

Auxiliary components

Device	Part number	Quantity per AC combiner	Total quantity
XLP00	1SEP101890R0001	1	20
DS201 C32 A30	2CSR255180R1324	1	20
CP-S.1 24/40.0	1SVR320861R1000	1	20
UPS POWERVALUE 11T G2 6KVA B2	4NWP100163R0002	1	20

Note: Only main components has been listed, other accessories may be needed to adapt and finalize the proposal for a real installation.

APPLICATION FINDER

We've made it simpler for you to set up your project!

Click here to find the reference architecture that best fits your needs and download the Bill of Materials.



ABB's offering for 80MW string inverter configuration (IEC)

Main components

Device	Part number	Quantity per AC combiner	Total quantity
E4.2S/E10 4000 Ekip Touch LSIG FHR 3p *	1SDA121095R1	1	20
Ekip Measuring package for Emax 2	1SDA107525R1	1	20
Motor-M E2.2 24-30V AC/DC	1SDA073722R1	1	20
YO E1.2..E6.2 24V AC/DC	1SDA073668R1	1	20
YC E1.2..E6.2 24V AC/DC	1SDA073681R1	1	20
Ekip Supply 24-48V DC	1SDA074173R1	1	20
Ekip Com Modbus TCP	1SDA074151R1	1	20
ZLBM3-3P-M12	1SEP620013R3000	16	320
CM-IWM.10	1SVR470670R1000	1	20
4 pcs of OVR T1-T2 12.5-440s P QS	2CTB815710R2900	4	80

* Always provided with external outlet: External VTs are needed to handle 800V

Optional components

Device	Part number	Quantity per AC combiner	Total quantity
ZLBM3-3P-M12-EFM	1SEP620013R3001	16	320
ZLBM Auxiliary switch NO	1SEP619555R0001	16	320
RELT Ekip Signalling 2k-3	1SDA074169R1	1	20
TVOC-2-48C	1SFA664001R1004	1	20
CSU-2LV	1SFA664002R5001	1	10
TVOC-2-DP2	1SFA664003R1020	1	10
TVOC-2-OP2	1SFA664004R1020	1	10
M4M 20 Ethernet	2CSG204471R4051	1	10
CM-TCN.011S	1SVR750740R0110	1	20
Power Protection for Emax 2	1SDA105230R1	1	20

Auxiliary components

Device	Part number	Quantity per AC combiner	Total quantity
XLP00	1SEP101890R0001	1	20
DS201 C32 A30	2CSR255180R1324	1	20
CP-S.1 24/40.0	1SVR320861R1000	1	20
UPS POWERVALUE 11T G2 6KVA B2	4NWP100163R0002	1	20

Note: Only main components has been listed, other accessories may be needed to adapt and finalize the proposal for a real installation.

APPLICATION FINDER

We've made it simpler for you to set up your project!
Click here to find the reference architecture that best fits your needs and download the Bill of Materials.



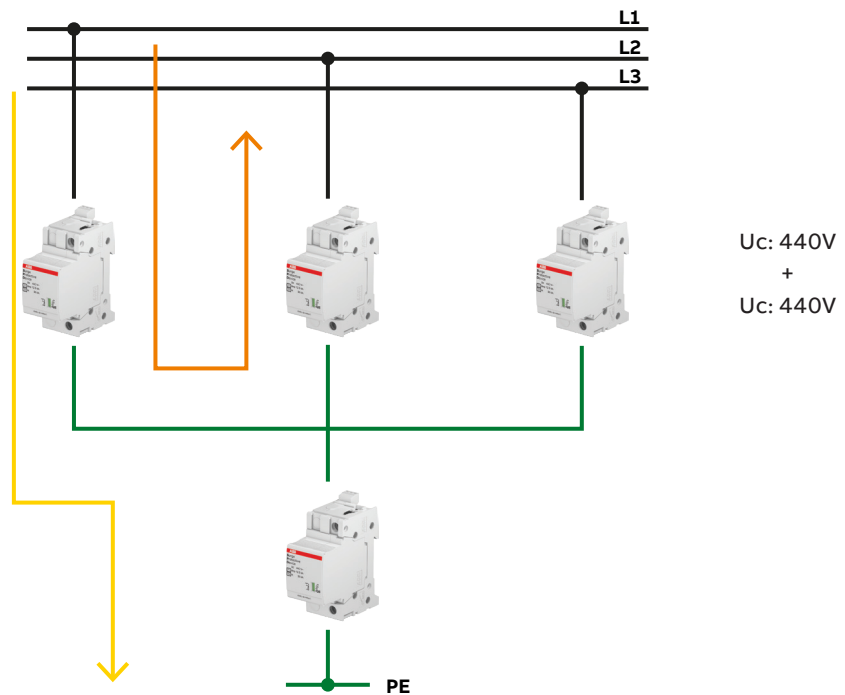
Surge protection devices

OVR T1-T2 12.5-440s P TS QS Surge protection devices up to 440VAC in series

Using OVR for Power collection panels up to 800VAC:

- protection mode L-N/L-PE
- single line protection (3-4 pcs required)
- Test class II
- Maximum discharge current I_{max} 120KA

- Integrated thermal disconnecter
- End of life indicator back up protection: gG gL Fuse or C curve MCB $I < 50A$
- IEC 61643-11
- 4 (four) OVR T1-T2 12.5-440s P TS QS codes 2CTB815710R2900



UniPack - Compact Secondary Substation (CSS)



The EcoFlex eHouse portfolio covers a wide range of designs applicable to Solar plants for the purpose of enclosing the application and completing the solution. Sturdy design and construction makes EcoFlex eHouse easy to transport and install. Typical configurations include up to 40kV medium voltage (MV) switchgear, transformers and low voltage switchgear.

Benefits:



- **Economical eHouse** and substation package solutions in various ratings



- **Speed up your project** by using EcoFlex pre-engineered modular designs, to be combined to suit specific project needs



- **Reduce the overall cost of work on site** by opting for delivery of a pre-tested complete solution with minimal site installation requirements



- **Minimize your transport costs** by choosing standard ISO transport and lifting methods



Product offering


Emax 2:






WEB PAGE

CATALOG

InLine II:




WEB PAGE

CATALOG


Insulation monitoring relays:






WEB PAGE

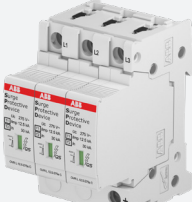
CATALOG



Temperature monitoring relays:





WEB PAGE

CATALOG



OVR:




WEB PAGE

CATALOG

TVOC-2:




WEB PAGE

CATALOG


CP.S1 power supply:






WEB PAGE


CATALOG



Miniature circuit breaker:





WEB PAGE

CATALOG


Easyline XLP00:





WEB PAGE

CATALOG



M4M:




WEB PAGE

PowerValue:





WEB PAGE

CATALOG


To discover more

—

APPLICATION FINDER




Find the reference architecture tailored to your needs and speed up your project thanks to our new Application Finder Tool!




—

CONTACT US




Do you have a similar project and you are searching for the right Application configuration?
Contact us to talk to our experts!




—

RATE US



Your opinion matters! Let us know if you found the document useful and how can we improve!



—
ABB S.p.A.
Electrification Business Area
Smart Power Division
5, Via Pescaria
I-24123 Bergamo - Italy
Phone: +39 035 395.111

new.abb.com/low-voltage

—
We reserve the right to make technical changes and modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB AG declines all and every liability for potential errors or possible lack of information in this document.

We reserve all rights to this document and to the subject matter and illustrations contained therein. All reproduction, disclosure to third parties or utilization of these contents – in whole or in part – is forbidden without the prior written consent of ABB AG. Copyright© 2023 ABB
All rights reserved