

APPLICATION NOTE

Switching & Protection Solutions for 800VAC Combiner Boxes in Photovoltaic Plants

UL Utility scale



Are you searching for Switching & Protection solutions to protect and secure your 800VAC Combiner Boxes? Use our pre-configured Application Bundle to rapidly develop Utility-Scale Photovoltaic plants using 1500VDC string inverters.

What is an AC Combiner Box?

An AC combiner box (“combiner”) connects two or more string inverter output circuits in parallel, prior to an AC recombiner or switchboard.

AC combiner boxes reduce the number of output conductors for longer AC feeder or “home run” circuits. They also provide overcurrent protection as well as a disconnecting means for equipment and conductors. AC combiners are engineered to be rugged, yet low cost.

Why you need Switching & Protection solutions

Every inverter output circuit requires a UL listed disconnecting means and accompanying overcurrent protection.

The AC combiner provides this, as well as a main disconnecting means to safely isolate the equipment, thereby protecting users and service personnel.

Main benefits



Smarter protection

Increase power in your installation and reduce CAPEX using our full range of LV components up to 800VAC and 1500 VDC for excellent performance in harsh outdoor environments.



Speeds up your projects

Accelerate project development and deployment thanks to preconfigured bundles comprising a coordinated range of products in compact sizes.



Safety

Reduce the risk of property damage, fire, and electric shock using our complete range of protective devices, including disconnects, breakers, and Surge Protective Devices (SPDs).



Smarter metering and monitoring

Maximize your operations and increase plant yields with supplemental measurement and monitoring devices.

Main trends in string inverter architecture



Virtual Central Inverter

A single MPPT maximizes the energy from the strings. The inverter is capable of maximizing for one value of DC current and is therefore ideal for homogeneous photovoltaic plants. The architecture behaves similarly to a central inverter photovoltaic plant. DC combiner boxes are required.

Highlights

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



800VAC Reduces BoS Cost

Higher inverter output voltages, 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

- 40-50% savings on AC cables and components compared to 480VAC string inverters
- AC conductors do not need the additional 1.25 derate factor that [DC] PV source and output circuits require
- 100% UL 489 rated 800VAC MCCBs do not require the 1.25 derate factor, which helps reduce conductor size
- Using higher DC:AC ratios can increase nominal capacity utilization (FLA) of the inverter output circuit conductors.

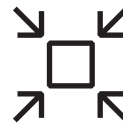


Multi-MPPT String Inverters

Multi-MPPT inverters improve total energy production when the PV generator features an asymmetric string configuration and shading is not uniform. Multi-MPPT inverters are typically designed for higher AC voltage ratings and achieve cost savings involving the whole system.

Highlights

- Increased plant flexibility and efficiency
- Eliminate DC combiner boxes and DC source circuit fusing
- Simpler design using AC low-voltage distribution
- Fewer total components: PV panels + solar inverters + MV/LV compact substation (CSS).



More Watts, Same Volume

Fewer inverters can be used at 800VAC due to their greater power density (W/m³). While remaining compact, this enables fewer, but larger amperage circuits to be used in the PV system. In addition, a wide range of inverter output circuit sizes is supported by ABB.

Typical features

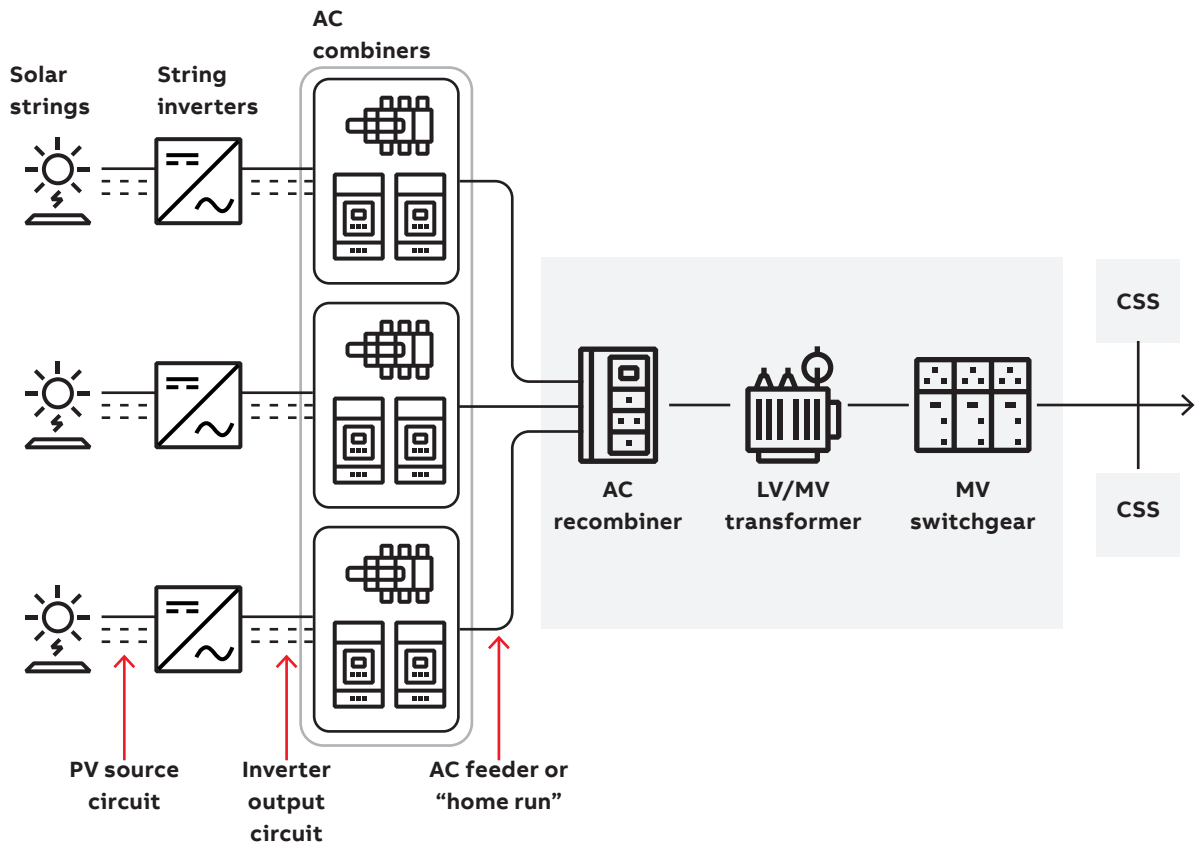
- DC input voltage: 1500VDC
- AC output voltage: 800VAC
- 100-275kW (333kW soon)
- Output currents: 70-200A
- AC protection nominal current: 80-300A
- AC circuit protection: breaker, fuse + disconnect
- Certifications: UL, IEC, CCC.

AC Combiner Boxes in String Inverter architecture

Fundamentals, main components & functionalities

The power generated by solar strings is converted to AC by each string inverter and collected by the AC Combiner Box. An AC combiner box ("combiner") connects two or more string inverter output circuits in parallel, thereby reducing the number of output

conductors for longer AC feeder or "home run" circuits. They also provide overcurrent protection as well as a disconnecting means for equipment and conductors.



AC combiner components

- Load-break rated, main disconnect switch for safe equipment isolation
- AC switching and protective devices (MCCB, or disconnect + fuse) for "branch" or inverter output circuit protection
- Surge protective device (SPD) for safely managing overvoltage
- Auxiliary circuits.

Optional components for AC combiners

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

Primary Functional Requirements

- Combining of two or more inverter output circuits
- Overcurrent protection (OCPD) and disconnect for inverter output circuits
- Main switch provides an equipment disconnecting means and complete isolation for ungrounded, non-isolated PV inverters
- Surge protection to protect against voltage spikes, caused by switching or indirect lightning strikes, for example.

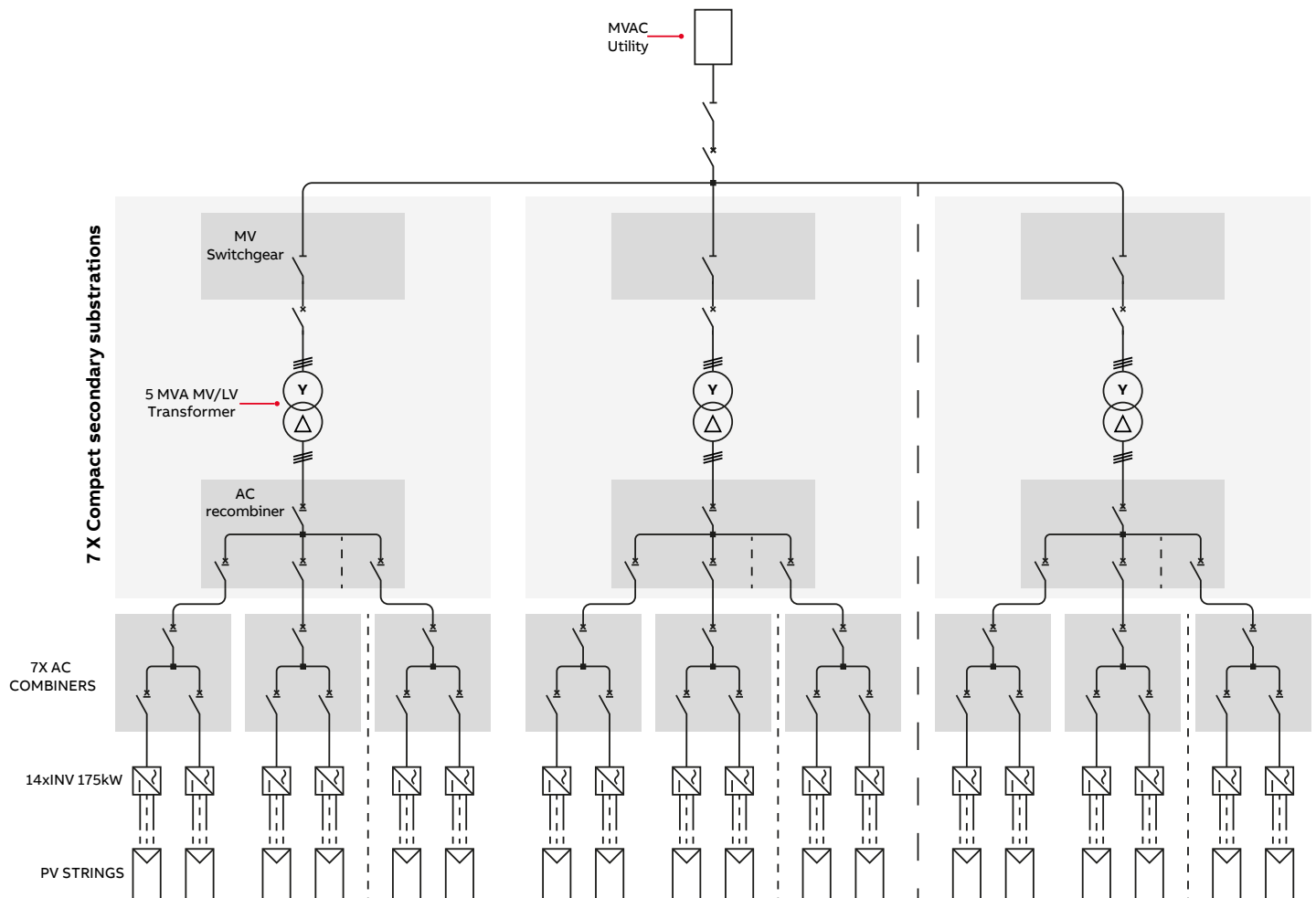
Secondary Optional Requirements

- Monitoring: where any drop in PV plant performance may represent a significant economic loss
 - Voltage, current or temperature monitoring
 - Communication: for communicating parameters to centralized monitoring system
- Remotely-operated: when remote control is required.

Switching and Protection Solutions for 800VAC Combiner Boxes in Utility Scale Photovoltaic Plants

Discover our Switching & Protection solutions for 800VAC combiner configuration considering an 18MW Photovoltaic plant with 7 compact secondary substations each comprising 14 x 175kW string inverters.

**Single-line diagram of 18 MW plant utilizing 7 compact secondary substations
(1 CSS = 7x combiners + 14x 175kW string inverters)**



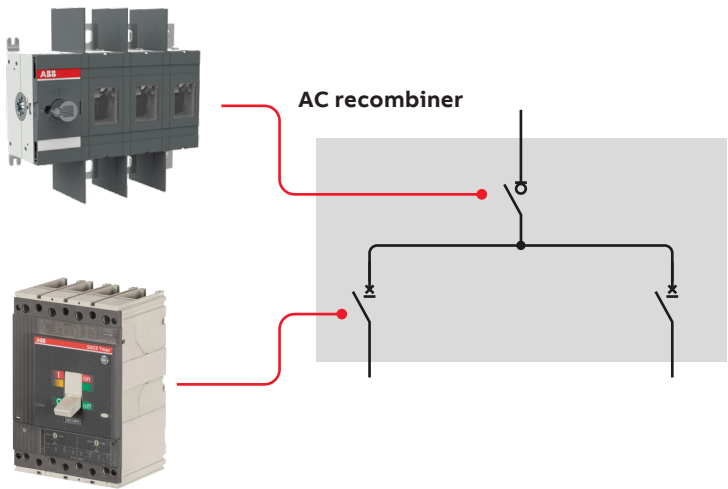
Specifications of system electrical quantities

Input data	UL
Rated power of system [MW]	18 (17.2)
MV/LV transformer rated power [MVA]	2.5 (wye-delta)
N. Compact SubStations (CSS)*	7
Inverter rated power [kW]	175
N. inverters per AC combiner	2
N. AC combiners per CSS	7
N. AC recombiners per CSS	1
Rated DC voltage [V]	1500
Rated MVAC voltage [kV]	15
Rated LVAC voltage [V]	800
Rated LVAC inverter current [A]	127
Rated LVAC recombiner feeder current [A]	254
Rated LVAC bus current [A]	1778
Short circuit current LVAC bus [kA]	50
Short circuit current LVAC feeders [kA]	54

* While string inverter systems are more common in plants totaling less than 5MW, AC, the 2.5 MW compact substation can be used and duplicated, from 2.5 MW to 5 MW and beyond, depending on the user's specific system requirements.

ABB offering (UL)

800VAC Combiner Box



Main components

OT400U03-1000 3P 5W 200A NF UL98C 1000V main switch-disconnector for manual switching and isolation.
Note: In = 300A at 800VAC
Tmax T4V-HA 250 UL TMA 150-1500 3p FF Thermal-magnetic feeder circuit breaker, adjustable version, In=150A (100% rated)
ABB OVR T2 3L 40-440 P TS U + OVR T2 40-440 P TS U connected in series for protection up to 800V AC under UL 1449 4th edition

Optional components

KT5S8 SOR-C T4-T5-T6 24...30 VAC/DC shunt release for T4V-HA branch circuit protection, **OR**
KT5U4 UVR-C T4-T5-T6 110..127VAC - 110..125VDC undervoltage release for controlled branch circuit disconnection
KT5AS3-AU AUX-C 3Q 1SY 24V DC auxiliary contacts for inverter output circuit status monitoring

Bill of materials

Parameters considered	
18 MW 800VAC string inverter PV plant	7x combiner boxes per CSS
7x 2.5 MW compact secondary substations (CSS)	14x 175 kW 800VAC string inverters per combiner

Main Components

Part number	Description	US Product Code	Quantity per CSS	Total quantity
1SCA159824R1001	3P SW 200A NF UL98C 1000V (800VAC/300A)	OT400U03-1000	7	49
1SDA083676R1	T4V-HA250 UL TMA150-1500 3PFF 800VAC	T4P8VQ150TW	14	98
2CTB802345R2900 + 2CTB802341R2900	OVR SPD 3P 40KA 440V P TS 3RD ED + “SPD, OVR, 40KA, 440V, PLG, W/AUX, 3RD ED”	OVRT23L40440PTSU + OVRT240440PTSU	7 + 7	49 + 49

Optional Components

Part number	Description	US Product Code	Quantity per CSS	Total quantity
1SDA054915R1	AUX-C 3Q 1SY 24V DC	KT5AS3-AU	14	98
1SDA054870R	SOR-C T4-T5-T6 24...30 VAC/DC	KT5S8	14	98
OR				
1SDA054890R1	UVR-C T4-T5-T6 110..127VAC - 110..125VDC	KT5U4	14	98

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.








Product offering



OTxxxU03-1000:





WEB PAGE

CATALOG



Tmax HA 800VAC:




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CATALOG

OVR SPDs:




WEB PAGE

CATALOG

To discover more

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APPLICATION FINDER

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

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Do you have a similar project and you are searching for the right Application configuration?
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