APPLICATION NOTE

Switching & Protection solutions for ABB PCS100 ESS in Battery Storage applications

IEC Utility scale

Are you searching for Switching and Protection solutions to protect your Power Conversion System (PCS) and keep it running in your Utility Scale Battery Energy Storage System (BESS)?
For switching and to protect your BESS installation from faults, over current events and other hazards, the best product for your PCS can be easily found thanks to concrete examples.

What is a Power Conversion System (PCS)?
If you want your Utility scale BESS (battery energy storage system) installation to function efficiently, you need a Power Conversion System to convert the power from AC to DC and vice versa. The PCS, is a bi-directional inverter that enables the batteries to charge and discharge with precision control.

Why you need a Switching and Protection (S&P) solution
The PCS requires adequate protection and switching capability on the AC and DC side in order to switch the system - also in the load condition - and protect the entire electrical circuit from faults and overcurrent events.
Our switching and protective devices will also provide your PCS with communication connectivity to the BESS control system.

Main benefits

Smarter protection
Increases power in your installation and reduces CAPEX by using the full range of 1500 VDC LV components.

Safety
Avoids risk of fire in your facility and loss of valuable assets by using a complete range of SPD to protect the whole electrical system from lightning and surges.

Speeds up your projects
Reduces CAPEX and speeds up your projects by using a range of products in compact sizes able to provide excellent performance at different temperatures and humidity ratings.

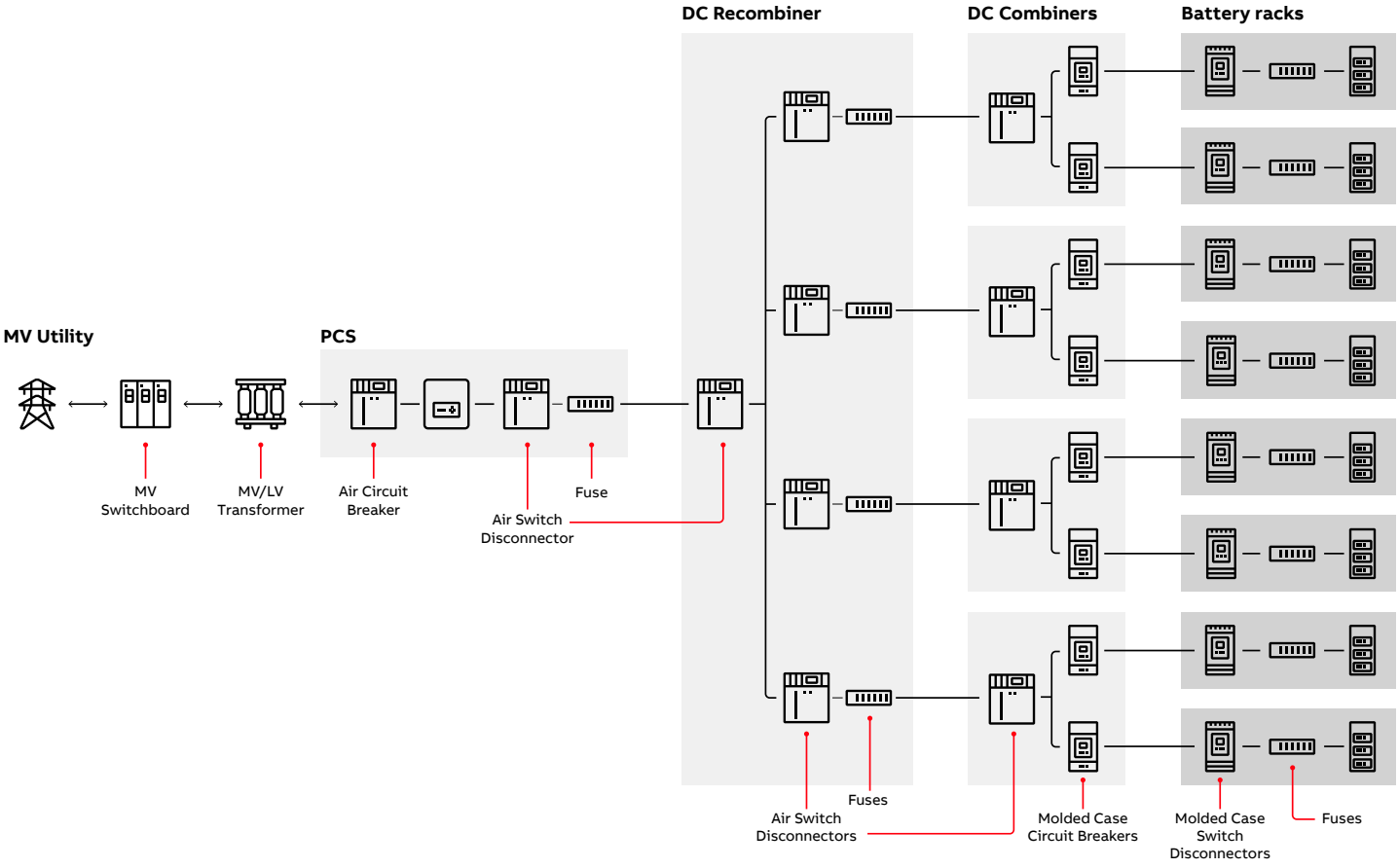
Smarter metering & monitoring
Maximizes power yield and cash generation by correct measurement of your BESS parameters.

Utility Scale Battery Storage

Utility scale stationary battery storage systems, also known as grid-scale front-of-the-meter storage systems, play a key role in integrating variable energy resources while providing the required flexibility. Battery storage increases flexibility in power systems, enabling optimal use to be made of variable electricity sources such as photovoltaic and wind energy. Batteries can provide services for operating systems, defer investments in peak generation and grid reinforcement.

Key characteristics of BESS in a front-of-the-meter configuration:

- Direct connection to the AC Utility without the User's plant in parallel
- Grid support (ancillary services, fast power injection for peak requirements)
- Storage capacity typically ranging from just a few, to hundreds of MWh.

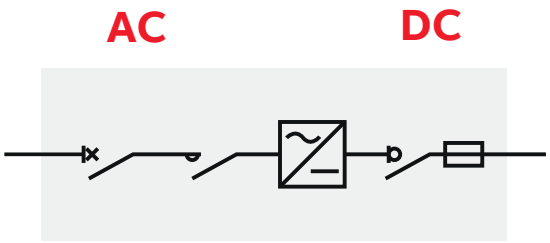


Power Conversion System

Fundamentals, main components & functionalities

Power is converted by an AC & DC Power Conversion System. This is a bi-directional inverter that enables the batteries to be charged/discharged with precision control.

The PCS requires appropriate protection and switching on the AC and DC side. In addition, the protection devices must provide communication connectivity with the BESS control system.



Main subsystem functionalities

- **AC Incoming or primary switching and protection**
  A disconnect function, overcurrent protection and interfaced protection are required since the PCS is connected directly to a utility line in the majority of cases. The PCS can be supplied with either a fused manual disconnect switch or circuit breaker suitably rated for the incoming line voltage. The primary current and voltage transformers provided are connected to a protective relay and power metering equipment.
- **Auxiliary power**
  To provide the PCS with control and auxiliary power, an auxiliary power circuit is included. This comprises a fused disconnect switch, auxiliary power transformer, an uninterruptible power supply (UPS) and a power source for external battery heaters, if required.
- **Converter Modules**
  The converter drive modules are the heart of the power conversion unit. The modules used in this application convert DC to three-phase AC and vice versa. To achieve the total output rating required under specified conditions, twelve to sixteen identical modules are used for each 1 MW battery input. The converter modules are specifically designed for custom applications where enhanced system flexibility is needed.
- **DC switching and protection**
  The DC section of the PCS enclosure can contain either fused DC disconnect switches or DC circuit breakers, depending on the requirements of the battery supplier.
- **Local control.**

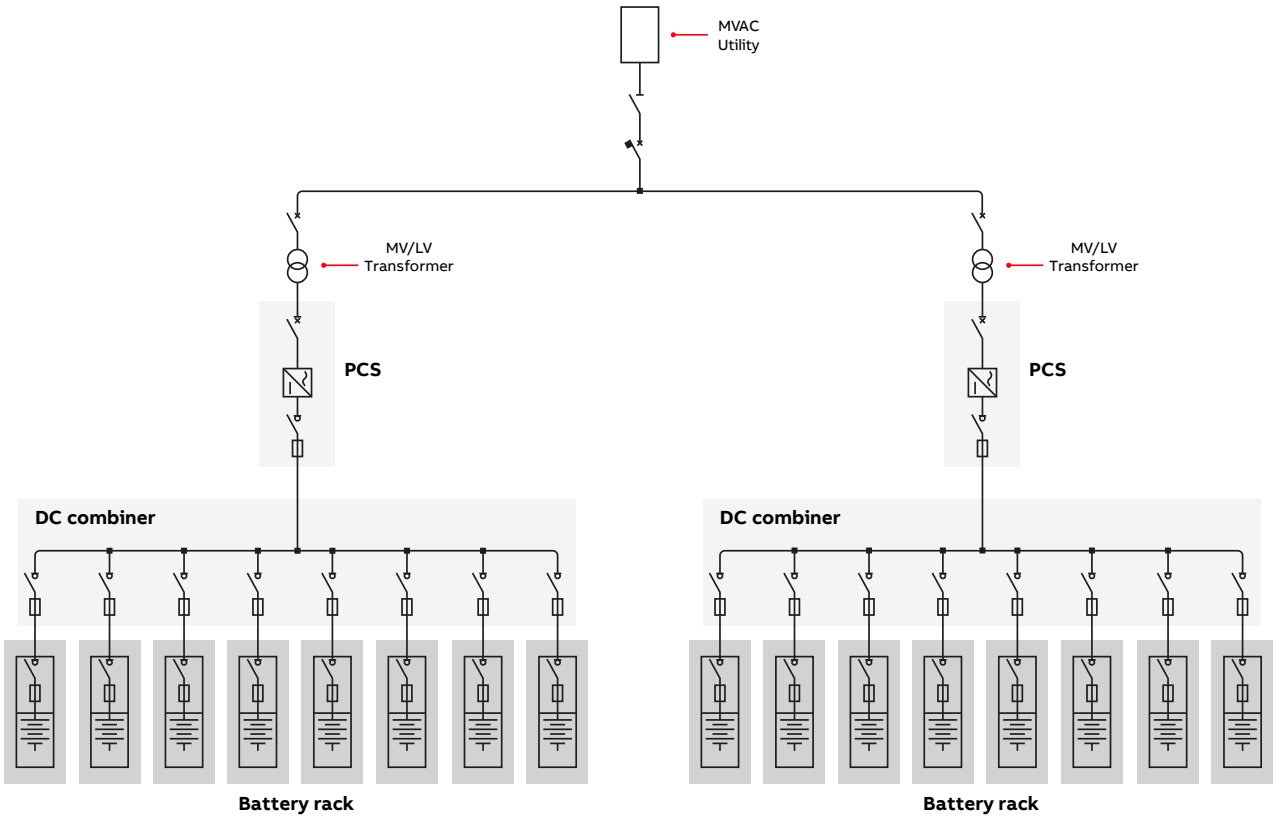
Additional subsystem functionality

- **ARC flash mitigation:**
  Active, Passive & Preventive solutions. Surge protection device on the AC and DC side, against direct lightning.

Switching & Protection solutions for ABB PCS100 ESS in Utility Scale BESS

Discover our Switching & Protection solutions for easy PCS configuration considering 2MWh BESS architecture with two 2MWh main system modules in parallel.

Single-line diagram of 2x2 MWh modules in Utility scale



The electrical design of a single system module has been created considering the system architecture and 2 equal main system modules.

The main electrical quantities have been summarized in the following table to allow the related PCS modules and the switching and protection devices to be selected.

Specifications of electrical quantities of each 1200 V DC rated module

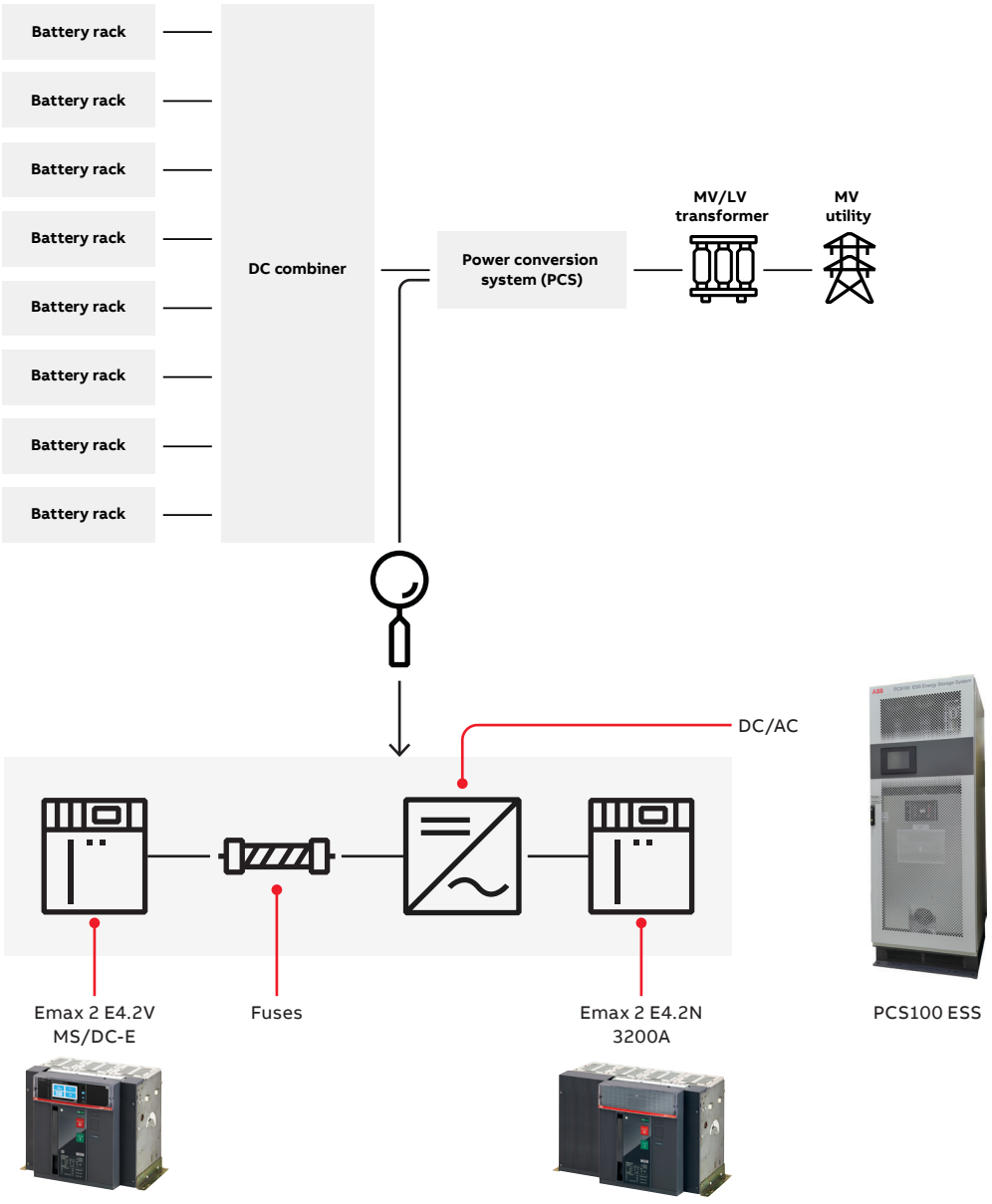
Input data		Single inverter per module
Rated power	[MW]	2
Rated stored energy	[MWh]	2
Rated DC voltage	[V] +12%	1200
Rated AC voltage	[V] +10%	528
Rated AC current	[A]	2703
Prospective AC short circuit current	[kA]	50
Rack rated current	[A]	330
Rack short circuit current	[kA]	12
N. containers		1
N. racks per combiner		8
DC bus max current	[A]	2640
DC bus short circuit current	[kA]	96
DC recombiner box		NO

ABB offering

AC side (incoming)
An **Emax 2 E4.2N 3200A Ekip Hi-touch rated at 690VAC** with the double G function is installed on the AC side (with a toroid installed on the transformer neutral point ground connection) in order to guarantee “Source ground return” protection.

Power Conversion System
PCS100 ESS C-Type, PCS100 19-26C-B4C (Iac=2730A)
The inverter drive modules are the heart of the power conversion unit. PCS100 ESS modular design and advanced control maximize the availability, value and performance of both large and small energy storage systems in a variety of applications. PCS100 ESS allows both real power (P) and reactive power (Q) to be controlled, thereby enabling it to cover a wide range of system requirements.

DC side
An **Emax 2 E4.2V MS/ DC-E 1500V DC 3200A** switch-disconnector is provided on the DC side of the PCS, combined with the PCS fuses.
The switch-disconnector is equipped with a YU undervoltage release in order to open remotely.



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Catalog

PCS100 ESS C-Type

- Modular design providing high reliability and short mean time to repair (MTTR)
- Grid fault detection
- Islanding and anti-islanding options
- Ratings from 100 kVA to 4000 kVA and
- Voltages from 150 VAC to 480 VAC
- Allows a range of energy storage devices to be coupled to the grid
- Dynamic real power control (P)
- Dynamic reactive power control (Q)
- Generator emulating control mode
- Grid stabilization features including synthetic inertia and active damping
- Low voltage ride through (LVRT)
- Voltage and frequency dynamic envelope/ regulation functions

General data	
AC rating	150A - 4800A D-type module
	105A - 3360A C-type module

Utility side (AC)	
Rated voltage	150 - 480 V +/- 10%
Nominal frequency	50 Hz or 60 Hz +/- 5%
Power system	3-phase center ground referenced (TN-S) - coupling transformer required
	3-phasefloating system (IT) - insulation monitoring required
Overvoltage category	III - 4kV (IEC 60664)
Fault capacity	25 kA (cabinet), 65 kA (rack)
Achievable efficiency	98%
Overload capability	200% for 2 seconds
	150% for 30 seconds
	120% for 600 seconds
Circuit protection	Circuit breaker or fuse (not included)
Voltage harmonic compatibility	IEC 61000-2-4 Class 2 (Utility THDv < 8%)
Power module voltage harmonic distortion	THDv < 2.5% for linear loads

Energy Storage Side (DC)	
Rated voltage	+/- 125 VDC up to +/- 560 VDC (250 up to 1120 VDC) for C-type
	+/- 125 VDC up to +/- 410 VDC (250 up to 820 VDC) for D-type
Supply earth referencing	DC center referenced
Overvoltage category	II (IEC 60664)
	4 kV D-type module
	6 kV C-type module
Maximum voltage to ground	+/- 600 VDC
Circuit protection	Circuit breaker or fuse (not included)

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Catalog IEC

Emax 2 E4.2N 3200A Ekip Hi-touch rated at 690VAC

- Icu=66, 85, 100, 150kA@440V; 66, 85, 100kA@690V
- Icw= 42, 66, 85, 100kA (1s)
- 4.000A switchboards with 600 mm(3p) or 800mm (4p) in width
- Fully rated neutral in 4p

Icu 440 V AC	Version	630	800	1000	1250	1600	2000	2500	3200	4000
150	V									
100	H									
85	S									
66	N									
50	C									
42	B									

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Catalog

Emax 2 E4.2V MS/DC-E 1500V DC 3200A

- Fixed or withdrawable execution
- Insulation of one polarity or both polarities
- Supply & load terminals on top side or bottom side
- Orientable terminals: horizontal or vertical
- Provided with shorting busbars (jumpers)
- Fully compatible with standard Emax2 accessories

Common data		
Rated service voltage Ue	[V]	1500
Rated insulation voltage Ui	[V]	1500
Rated impulse withstand voltage Uimp	[kV]	12
Number of poles		4
Version		Fixed - Withdrawable
Suitable for isolation according to		IEC 60947-3
Utilization category		DC22A, DC-PV2 (Annex D)

SACE Emax2 MS/DC-E for IEC			E4.2		
Performance levels			S	H	V
Rated uninterrupted current Iu @ 40°C		[A]	1600	1600	1600
		[A]	2000	2000	2000
		[A]	2500	2500	2500
		[A]	3200	3200	3200
		[A]	4000	4000	4000
Rated short-time withstand current Icw	(1s)	[kA]	65	85	100
Rated short-circuit making capacity (peak value) Icm	1500 V	[kA]	65	85	100
Dimensions	H - Fixed	[mm]	371		
	D - Fixed		270		
	W - Fixed 4p		510		
	H – Withdrawable	[mm]	425		
	D – Withdrawable	[mm]	393		
	W – Withdrawable 4p	[mm]	551		

Rate this document

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