PCS100 STATCOM
Dynamic Reactive Power Compensation
Technical Catalogue

Introduction

Based around a low voltage converter platform, the PCS100 provides wide bandwidth performance with a flexible and highly reliable modular redundant power electronic configuration, correcting power factor and other disturbances for renewable generation such as wind, solar and traditional industrial applications.

The PCS100 STACOM is available in load capacities of 100kVAr to 10MVAr. New renewable generation such as wind and solar are an increasingly part of our electricity grid, but to meet grid connection requirements STATCOM products must often be fitted.

By injecting reactive current under fault conditions the STATCOM will help the system ride through fault events. During normal generation it can correct for voltage fluctuations and power factor. The PCS100 STATCOM utilises advanced control allowing it to damp voltage disturbances in the electricity network. This is very important when recovering from a fault, event or in maintaining power system stability.

This Technical Catalogue will guide the reader through the product selection and will give examples of system requirements and space required.

Power and productivity
for a better world™

ABB

The Company

We are an established world force in the design and manufacture of power electronics and power protection equipment.

As a part of ABB, a world leader in electrical technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

Quality Control

The products listed in this catalogue are manufactured in an ISO 9001 accredited facility.

Registration No. 2469

For more information…

Further publications for the PCS100 STATCOM are available for free download from www.abb.com/pcs100-power-converters or by scanning this code:

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1 Overview

1.1 System Overview

The PCS100 STATCOM range is part of a family of low voltage power converter products available from ABB. Based around the PCS100 converter platform the STATCOM product provides wide bandwidth performance with a flexible and highly reliable modular power electronic configuration.

New renewable generation such as wind and solar are becoming an increasingly important part of modern electricity grids, but to meet dynamic Grid Connection requirements STATCOM products must often be fitted. By injecting reactive current during a grid fault condition the STATCOM will help the generators ride through system fault events as required by the grid codes.

During normal grid conditions, or at an end users site, the PCS100 STATCOM can provide correction for voltage flicker, poor power factor and harmonic currents. The PCS100 STATCOM advanced control also allows it to damp voltage disturbances in the electricity network. This control feature is very important to maintain power system stability following events such as recovering from a fault or the switching of passive elements. For end user industrial loads such as arc furnaces and mesh grid welders the PCS100 STATCOM can be applied to compensate voltage flicker and current distortion problems that often accompany these processes.

1.2 User Benefits

- Small Dimensions (Footprint)
- High Reliability
- High Efficiency
- Low Cost of Ownership
- Commonality of Spares
- Low Maintenance
- Improves power quality and plant reliability
- Increases network stability and transmission capacity
- Delivers necessary grid compliance when connecting renewable energy
- Damps disturbances and oscillations in critical system configurations
- Modular design for highest availability
- THDi < 3%, sine filter in each power module
- Based on LV converter platform especially developed for power quality applications

1.3 Features

- Power Factor control
- Voltage regulation
- 5th and 7th Harmonic current compensation
- Negative sequence (unbalance) voltage or current compensation
- Active resonance damping
- Multiple system parallel control
- High and low voltage ride through

1.4 Applications

- PF correction, LVRT (low voltage ride through), HVRT (high voltage ride through), active resonance damping for wind & solar generators
- Voltage regulation and PF correction for remote grid support
- PF correction, voltage regulation, flicker compensation, active resonance damping for industrial grid

2   Control Features

A PCS100 STATCOM can be configured to operate in different modes depending on the application. Switching between modes is bump-less and the unit doesn't have to be stopped or restarted when changing. This means the PCS100 STATCOM is extremely flexible and suited to all common STATCOM applications.

2.1   Power Module Redundancy Feature

One unique feature critical to the reliability of the converted output supply is the built-in redundancy capability which is an intrinsic feature of the modular system design. In an unlikely event where a single inverter module encounters a fault and stops functioning, the master controller that oversees the inverter module will reduce the output capacity to the available remaining working inverter modules.

This reduction of capacity is transparent as typically the converter is not running at full load. The load will not be shed, but it will be transferred seamlessly to the remaining modules in the converter. To illustrate the function, a 2000kVAr STATCOM has 16 inverter modules; a module failure will result in the controller automatically transferring the load to the remaining 15 inverters. The maximum output of the converter is only reduced by 1/16 or 6.25%

The PCS100 Advanced Redundancy feature represents a further milestone of power electronics reliability and availability improvements.

- Reduces reactive power output in a failure only by a small fraction of the total system power.
- Enables built in n+1 configurations by adding a spare module to achieve breakthrough levels in power availability.
- Allows flexible planning of converter repair/faulty module replacement.

2.2   Voltage Control Mode

The PCS100 STATCOM receives a voltage reference. The internal controller compares measured voltage (MV or LV level) and reference. If the voltage is below the reference, capacitive reactive power is injected. If the voltage is too high inductive Q will be delivered. Positive and negative droops and deadbands are available which can be used to allow multiple STATCOM systems to operate in parallel.

The droop parameter can also be used to act as an impedance compensation term to provide inferred voltage sensing through a known impedance.

2.3   Power Factor Mode

There are two variants of the PF mode. "Fixed PF" defines the signed PF, and "PF band" control the PF to within a +/- range. For example, a PF band of 1 and 0.9 means the PF will be controlled to stay between 1 and 0.9. Only if the PF gets out of this range does the STATCOM source or sink VArs.

The internal controller compares the measured power factor and reference and controls the power factor on the connection point to meet the reference. The unit delivers capacitive or inductive VAr's required to maintain the setpoint.

Power factor setpoints are specified as a signed value between 0 and 1, where a positive value specifies capacitive power factor, and a negative sign specifies an inductive power factor.

2.4   Controlled Reactive Power (Q-Feedback) Mode

The PCS100 STATCOM receives a reactive power reference and the unit injects reactive power to control the reactive power at the PCC measurement point to the reference. The signed reference defines inductive or capacitive reactive power.

2.5   Reactive Power (Q-Feedforward) Mode

The PCS100 STATCOM receives a reference proportional to the amount of reactive power needed from the inverters. The signed reference defines inductive or capacitive reactive current.

2.6   Harmonic Current Cancelation

In addition to the above operating modes, the PCS100 STATCOM can also selectively cancel up to two harmonic frequencies, typically the 5th and 7th harmonic.

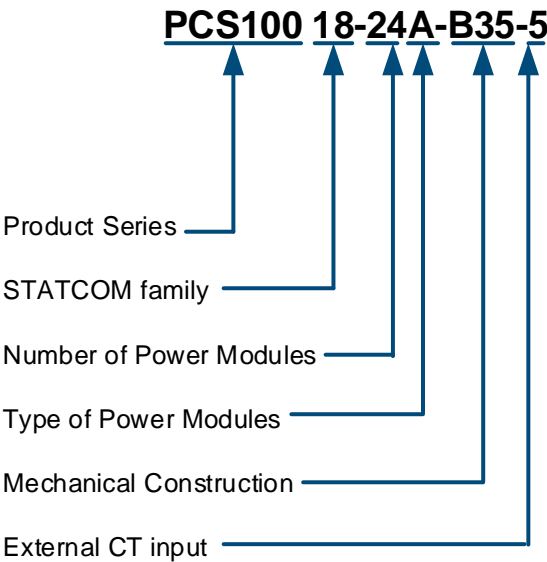## 2.7   Negative Sequence (Unbalance) Correction

In addition to the above operating modes, the PCS100 STATCOM can also selectively cancel negative sequence (unbalanced) voltage or current.

3 STATCOM Selection and Sizing

3.1 Type Code

The PCS100 STATCOM type code is given in the product tables. The type code is a unique code for the specific PCS100 STATCOM model and specifies all the components that are used to construct the model

The following diagram outlines the structure of the type code:

PCS100 18-24A-B35-5

- Product Series
- STATCOM family
- Number of Power Modules
- Type of Power Modules
- Mechanical Construction
- External CT input

3.1.1 Product Series

The PCS100 STATCOM is part of the PCS100 product line as shown below. Each product is tailored to address specific power quality problems:

| **PCS100 18-**	**PCS100 19-**	**PCS100 07-**	**PCS100 12-**	**PCS100 25-**
PCS100 STATCOM	PCS100 ESS	PCS100 AVC	PCS100 UPS-I	PCS100 RPC
Dynamic Reactive Power Compensation	Energy Storage Converter	Active Voltage Conditioner	Industrial UPS	Reactive Power Conditioner
Voltage correction,	Peak shaving,	Utility sag and surge correction,	Utility deep sag and surge correction,	Load created sag correction,
Power Factor correction,	Frequency regulation,	Load voltage regulation	Utility outage protection	Power Factor correction,
Reactive Power compensation	Micro grids,			Harmonic mitigation,
	Islanding,			Unbalance correction
	Power on demand			

3.1.2   Number of Power Modules

This is the number of PCS100 STATCOM inverter modules needed which is defined by the required reactive power in kVAr. Each module can deliver 125 kVAr reactive power at nominal voltage of 480V.

One single PCS100 STATCOM can have up to 32 Modules. In case a bigger system is requires multiple PCS100 STATCOMs can be connected in parallel but must be installed through separate transformers or multi winding transformers.

3.1.3   Type of Power Module

The PCS100 STATCOM modules (A-Type) incorporates an LC sine filter, cooling fan, circuit protection and RFI filtering as shown below
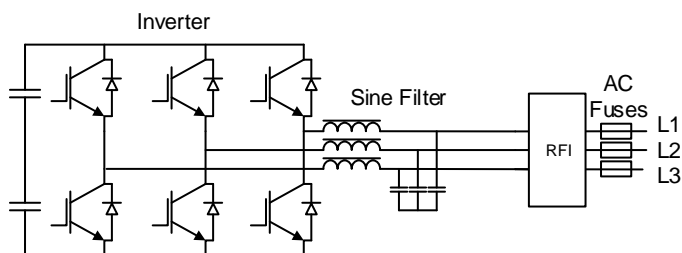
3.1.4   Mechanical Construction

Bxx – standard rack solution with 1000mm sections containing up to 8 modules each.
Cxx – customized solution, the following numbers are serial numbers for solutions

3.1.4.1 Width of Rack System

Number of 1000mm sections (max. 8 modules per 1000mm)

Possible combinations for racks: 1-8 modules = B**1**x,
9-16 modules = B**2**x,
17-24 modules = B**3**x,
25-32 modules = B**4**x,

3.1.5   Termination Side

The location of the AC power terminals when viewed from the front.
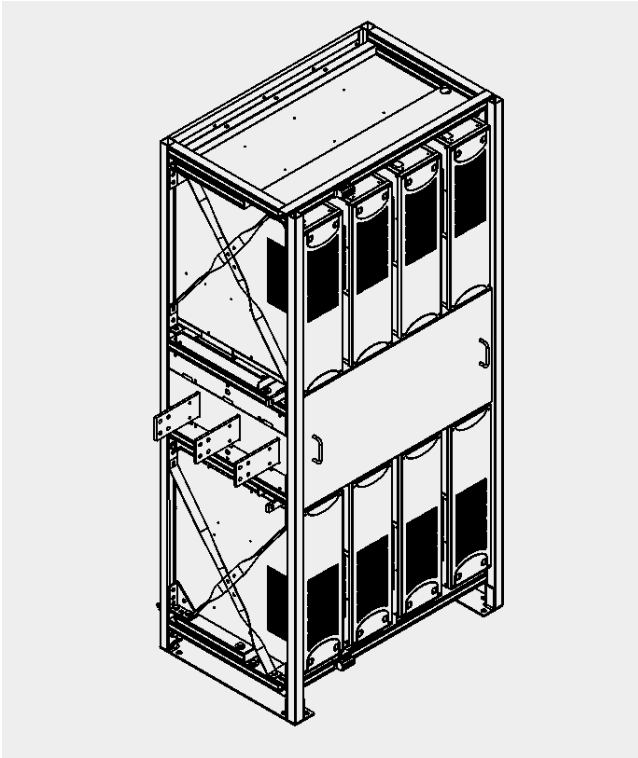
Possible termination: left termination = Bx**5**,
right termination = Bx**6**,
centre termination = Bx**B**, or Bx**C** (bigger rack on right hand side)
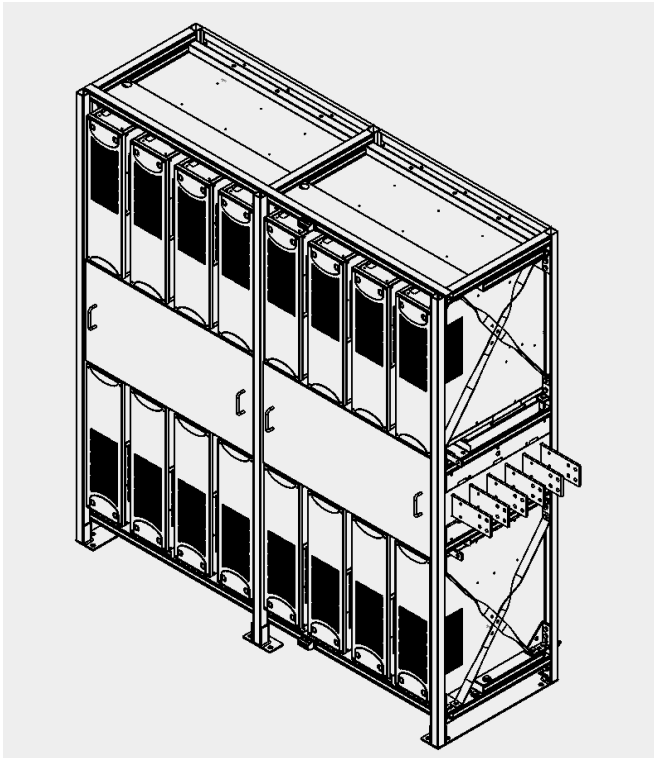
3.1.6   External CT Input

Standard: Bxx-**5** = 5 A CT inputs
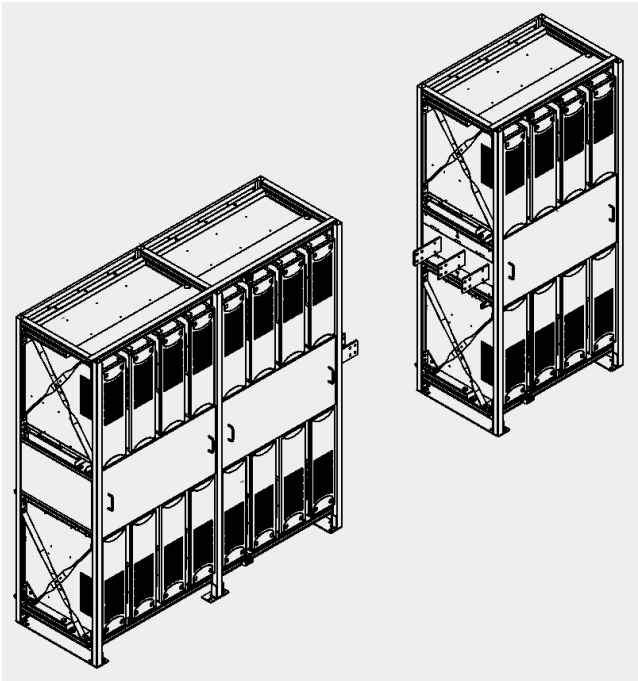Optional: Bxx-**1** = 1 A CT inputs
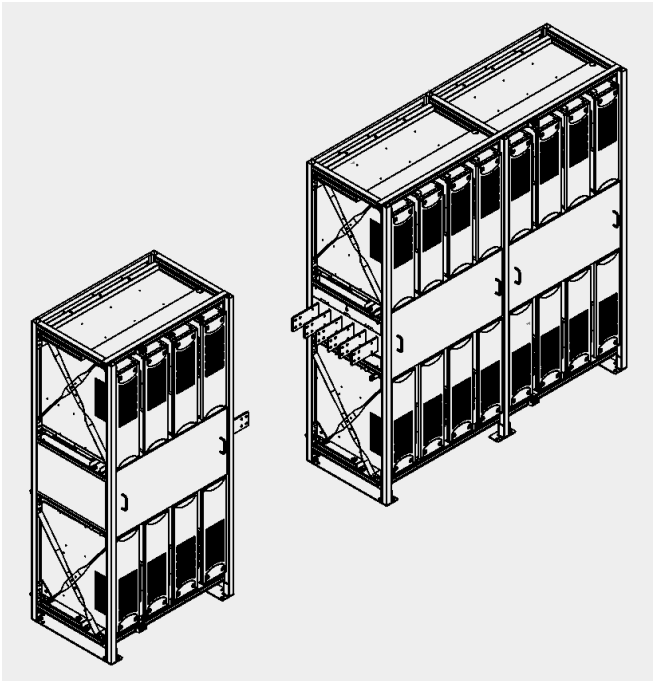
3.2 Examples of PCS100 STATCOM Rack Type Codes
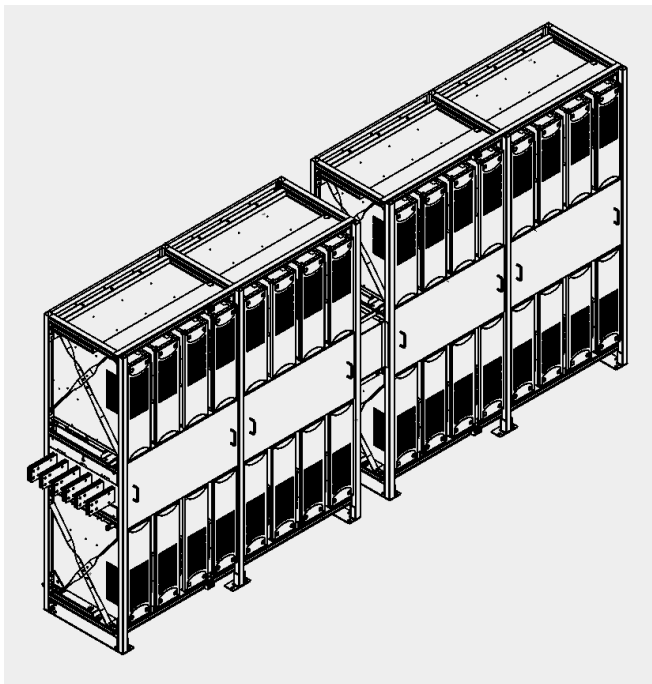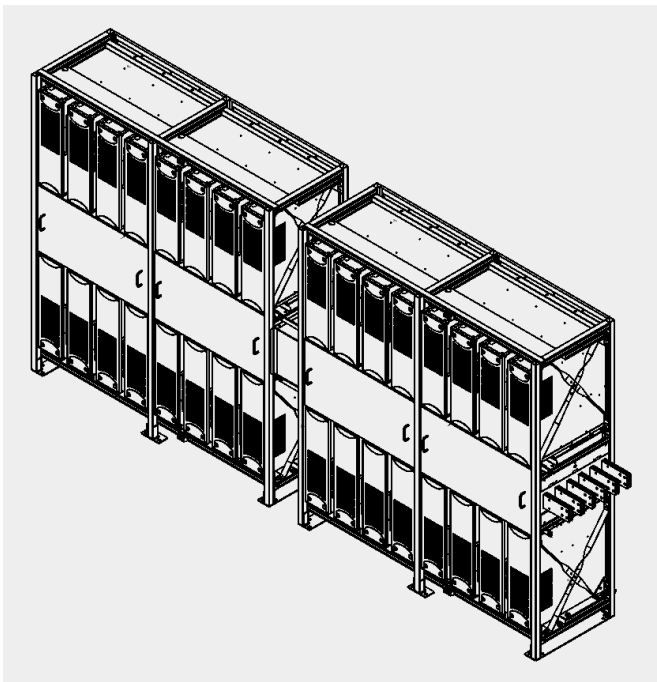

PCS100 18-08A-**B15**-5

PCS100 18-16A-**B26**-5

PCS100 18-24A-**B3B**-5

PCS100 18-24A-**B3C**-5

PCS100 18-32A-**B45**-5

PCS100 18-32A-**B46**-5

Further information about available rack layouts is available on document:
2UCD000420E103, PCS100 ESS/STATCOM RACK Busbar Options.

4 PCS100 STATCOM Model Range

Different model ratings are defined by the number of power modules used to construct the system. The table below summarizes the PCS100 STATCOM product range. Ratings are for a typical PCS100 STATCOM system with;

- 480Vac +/- 10% voltage
- 40°C max ambient temperature

Note: Operation at other voltages will affect the power rating. Consult the factory for the exact rating according to your operating conditions.

Dimensions H x W x D (mm)	Weight kg	Rated power kVA @460V	Rated reactive Current A	Heat dissipation kW (Typical)	Airflow (m³/min)	Number of PCS100 STATCOM Modules	Type Code
2200x1041x703	557	478	600	11.5	40	4	PCS100 18-04A-B1x-z*
2200x1041x703	628	598	750	14.4	50	5	PCS100 18-05A-B1x-z*
2200x1041x703	700	717	900	17.3	60	6	PCS100 18-06A-B1x-z*
2200x1041x703	771	837	1050	20.1	70	7	PCS100 18-07A-B1x-z*
2200x1041x703	842	956	1200	23.0	80	8	PCS100 18-08A-B1x-z*
2200x2041x703	1015	1076	1350	25.9	90	9	PCS100 18-09A-B2x-z*
2200x2041x703	1081	1195	1500	28.8	100	10	PCS100 18-10A-B2x-z*
2200x2041x703	1152	1315	1650	31.6	110	11	PCS100 18-11A-B2x-z*
2200x2041x703	1224	1434	1800	34.5	120	12	PCS100 18-12A-B2x-z*
2200x2041x703	1295	1554	1950	37.4	130	13	PCS100 18-13A-B2x-z*
2200x2041x703	1366	1673	2100	40.3	140	14	PCS100 18-14A-B2x-z*
2200x2041x703	1437	1793	2250	43.1	150	15	PCS100 18-15A-B2x-z*
2200x2041x703	1508	1912	2400	46.0	160	16	PCS100 18-16A-B2x-z*
2200x(1041+2041)x703	1852	2032	2550	48.9	170	17	PCS100 18-17A-B3y-z*
2200x(1041+2041)x703	1923	2151	2700	51.8	180	18	PCS100 18-18A-B3y-z*
2200x(1041+2041)x703	1994	2271	2850	54.6	190	19	PCS100 18-19A-B3y-z*
2200x(1041+2041)x703	2065	2390	3000	57.5	200	20	PCS100 18-20A-B3y-z*
2200x(1041+2041)x703	2136	2510	3150	60.4	210	21	PCS100 18-21A-B3y-z*
2200x(1041+2041)x703	2208	2629	3300	63.3	220	22	PCS100 18-22A-B3y-z*
2200x(1041+2041)x703	2279	2749	3450	66.1	230	23	PCS100 18-23A-B3y-z*
2200x(1041+2041)x703	2350	2868	3600	69.0	240	24	PCS100 18-24A-B3y-z*
2200x(2041+2041)x703	2523	2988	3750	71.9	250	25	PCS100 18-25A-B4C-z*
2200x(2041+2041)x703	2589	3107	3900	74.8	260	26	PCS100 18-26A-B4C-z*
2200x(2041+2041)x703	2660	3227	4050	77.6	270	27	PCS100 18-27A-B4C-z*
2200x(2041+2041)x703	2732	3346	4200	80.5	280	28	PCS100 18-28A-B4C-z*
2200x(2041+2041)x703	2803	3466	4350	83.4	290	29	PCS100 18-29A-B4C-z*
2200x(2041+2041)x703	2874	3585	4500	86.3	300	30	PCS100 18-30A-B4C-z*
2200x(2041+2041)x703	2945	3705	4650	89.1	310	31	PCS100 18-31A-B4C-z*
2200x(2041+2041)x703	3016	3824	4800	92.0	320	32	PCS100 18-32A-B4C-z*

Table 4-1: PCS100 STATCOM model range

*Note: **to complete the Type Code**

Place **5** for *left hand termination* or **6** for *right hand termination* in place of **x**.

Place **B** for *center termination (2m rack on the right)*
or **C** for *center termination (2m rack on the left)* in place of **y**.

Place **5** for *5A CT input* or **1** for *1A CT input)* in place of **z**.

5 Technical Specification

5.1 Model Range

Rating	100 – 4800 kVAr Note: Higher power available by paralleling multiple PCS100 units.

5.2 Utility

Rated Voltage	480 V
Voltage tolerance	± 10%
Nominal frequency	50 Hz or 60 Hz
Frequency tolerance	± 10%
Power system	3 phase Centre ground referenced (TN-S)
Overvoltage category	III
Fault capacity	65 kA
Overload capability	200% overload for 2 seconds* 150% overload for 30 seconds* Note: * from 75% preload Refer to document 2UCD180000E019 PCS100 STATCOM Overload.

5.3 Performance

Efficiency	>98%

5.4 Standards and Certifications

Quality	ISO 9001
Marking	CE c UL us Note: UL for modules, refer to 2UCD200000E025, UL recognized PCS100 components
Safety	IEC 62103
Electromagnetic compatibility	Emissions CISPR 11 Class A, Group 1 Immunity IEC 61000-6-2
Performance	IEEE 519 IEEE 1031-2000

5.5 Environmental

Operating temperature range	0°C to 50°C
Temperature derating	Above 40° C, derate at 2% load per °C to a maximum of 50°C
Operating altitude	< 1000 m without derating
Capacity derating with altitude	1% every 100 m above 1000 m 2000 m maximum
Inverter Cooling	forced ventilation
Humidity	< 95%, non-condensing
Pollution degree rating	2
Noise	< 85dBA @ 2 m

5.6 Protection rating

rack rating	IP20 / NEMA 1
HMI (GDM) panel IP rating	IP54 (from front)

5.7 Service

MTTR	30 min typical by module exchange
Diagnostics	Non-volatile event & service log
Remote monitoring	Optional secure connection to ABB

5.8 User Interface

|	
User Interface	8.4" color touch panel
Touch panel	Full parameter control
Control inputs	Digital Inputs 10 digital inputs Start / Stop / Reset (Master Module) and 7 programmable inputs (Extended I/O board). 24 Vdc with internal or external supply, PNP & NPN Input Impedance 25 kΩ Maximum delay 10 ms Analogue Inputs 2 analog inputs (extended I/O board) -10…+10 V, Rin > 200 kΩ 0…20 mA, Rin = 100 Ω Maximum delay 2 ms Resolution 0.1 % Accuracy ± 2% PTC input 2 PTC inputs
Control outputs	Digital Outputs 7 relay outputs, 250 V/1~, 30 V DC (1A) Running, warning, fault relays (Master Module) 4 programmable outputs (extended I/O board) Analogue Output 2 analog outputs (extended I/O board) -10…+10 V 0…20 mA, load < 500 Ω Maximum delay 50 ms) Accuracy ± 2 %

5.9 Serial Coms

SCADA interface	Ethernet, Modbus TCP/IP
RS485	Modbus RTU

6 PCS100 Components of Rack System

Racks are available for easy containerization and are available to accredited integrators.

The racks have two different footprints of 1000mm x 800mm per section for 1-8 modules and 2000mm x 800mm for 9-16 modules. Empty slots will be covered by a blanking plate. The modules are installed in 2 levels with AC busbars running between the 2 levels. Busbars can be terminated to either end of the rack. Usually a termination cabinet containing AC breakers is installed by the system integrator.

GDM

Interface assembly
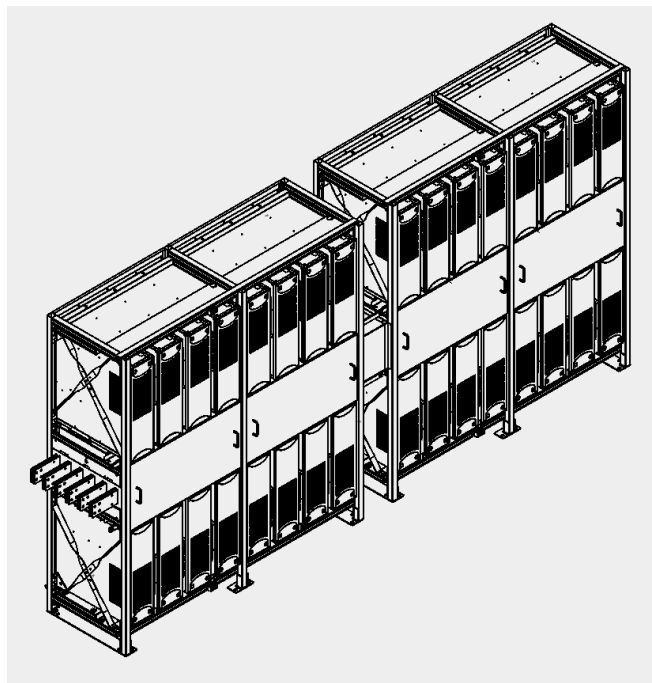
Master Module

32 module rack

The master controller for each system is built on a baseplate for integration into a control cabinet. Aux supply of 230Vac and 26.5Vdc must be provided by the integrator.

Note: More information about the required auxiliary power can be found in document 2UCD000420E003, 26.5Vdc Power Supply for PCS100 Rack Systems
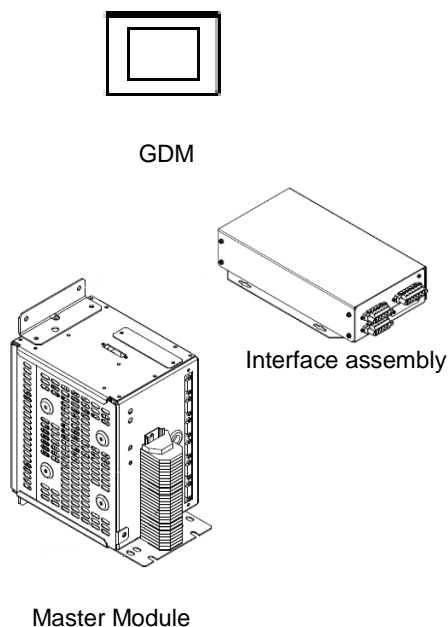
7 Power Module Type

All PCS100 products use the same LV power modules which employ IGBT's and integrated sinusoidal filters. The AC power connections of each module are protected by high speed semiconductor fuses allowing simple paralleling of modules to achieve the required power rating.

To meet high voltage ride through requirements it may be necessary to reduce the AC coupling voltage at the module. In this case the power capacity is reduced accordingly.
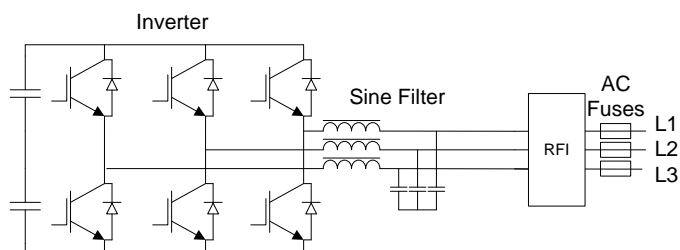

The PCS100 STATCOM and must be connected to the grid via coupling transformer as the PCS100 STATCOM modules have an LC filter to keep the losses minimal.

8   Typical Installations

Each mode has different sensor requirements. In any application the PCS100 can accommodate an optional transformer (eg MV-LV) between the control-point and the unit.

Voltage, Reactive Current and Voltage-Imbalance Modes
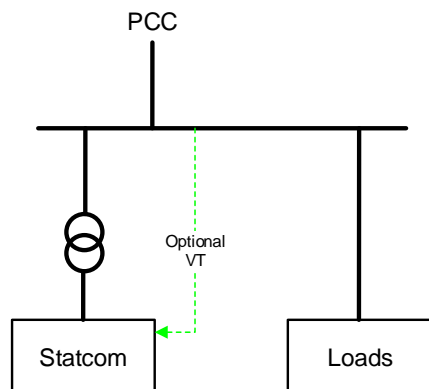
These modes only require VT feedback. Feedback can be from internal VT or external Point of Common Coupling.

Power Factor, Current-Imbalance, and Harmonics Feedback Modes
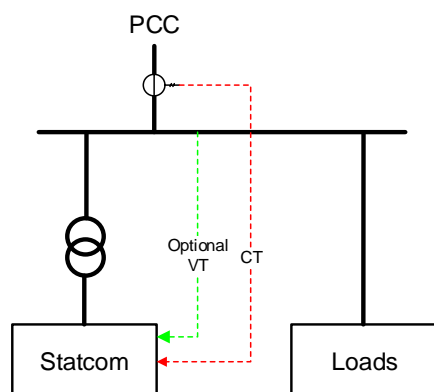
These modes only require both VTs and CTs located at the Point of Common Coupling.

9   Sizing

The sizing of a STATCOM is depending on the application. Based on the needed VAr amount and the grid requirements the number of modules required can be defined.

Applications like repetitive flicker (e.g. welder or crasher) or LVRT (low voltage ride through) support can often be targeted by using the overload capability of the system.

Power Factor Control

PF control very seldom requires dynamic behaviour. Therefore most PF applications can be solved with passive elements switched together with main loads. For cost reasons only the dynamic part of the PF fluctuations should be targeted by a STATCOM. Switching limitations for the passive elements may cause the need for a STATCOM. The relation between displacement PF and power can be described by the following equations:

$$\text{Total power } S = \sqrt{P^2 + Q^2}$$

$$\text{Power factor } pf = P/S = \cos\varphi$$

with: S = apparent power, P= real power & Q = reactive power.

Voltage Control
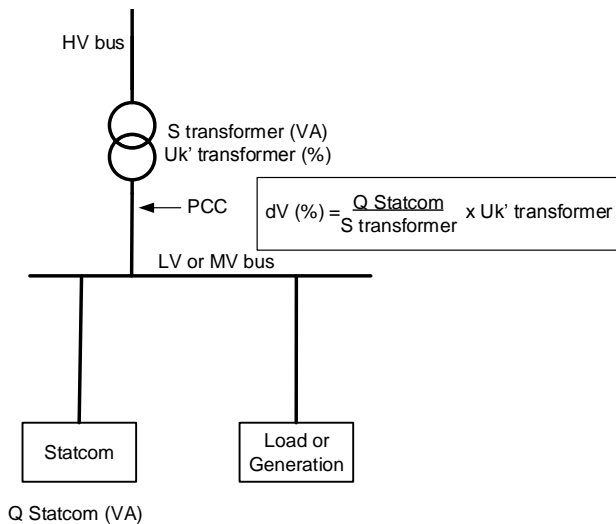
A STATCOM delivers reactive current only. Therefore the potential voltage support is limited by the impedance and power rating of the next coupling transformer. If we have a wind farm at 33 kV and the coupling transformer to the HV is e.g. rated with 50 MVA & uk'= 10% we can achieve a maximum voltage support of 10% by using a 50 MVA STATCOM. Most voltage fluctuations are only short term events. Therefore we often can use overload capability of the STATCOM (e.g. LVRT support for a wind farm).

HV bus

S transformer (VA)
Uk' transformer (%)

PCC

$$dV\ (\%) = \frac{Q\ Statcom}{S\ transformer} \times Uk'\ transformer$$

LV or MV bus

Statcom

Load or Generation

Q Statcom (VA)

9.1   PCS100 STATCOM Sizing tool

ABB provides a Windows PC application for sizing the PCS100 STATCOM. The tool will calculate the size of the STATCOM required from inputting the reactive power kVAr, environmental data etc and will size the STATCOM accordingly.

The output of the sizing tool will be the reactive power and reactive current capability graph in relation to the voltage and number of PCS100 STATCOM modules.

The file can be saved as a csv file and emailed to the factory for peer review or stored as a record for future reference.
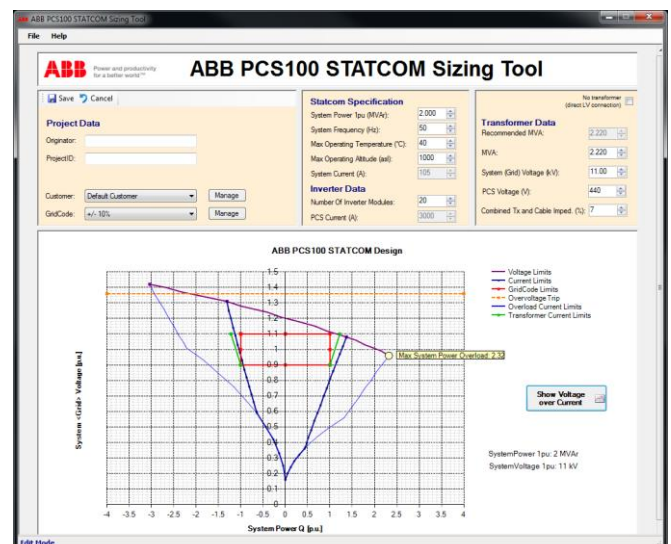
Notes

Contact us

To find the contact person for your region please refer top our webpage:

www.abb.com/pcs100-power-converters

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