

High Power Current Injection HPCI

- ▶ Petersen coil regulation with current injection
- ▶ Pulse locating during earth fault
- ▶ Construction set (C1)
- ▶ In control cabinet for indoor installation (C2)
- ▶ In control cabinet for outdoor installation (C3)
- ▶ In control cabinet as twin system (C6)



1. Use of the high power current injection

The high power current injection (HPCI – High Power Current Injection) is conceived for two applications.

- ▶ In faultless grid operation for accurate tuning of the Petersen coil (in combination with REG-DP(A))
- ▶ In a compensated grid (with Petersen coil) during single-phase fault for artificial injection of a current signal for a fast and explicit fault detection

Hence, the HPCI is a combination of conventional current injection and pulse locating.

The signals for pulse location can be freely selected and can be used with conventional pulse locating relays as well as with “fast pulse locating” in the EOR-D and EOR-3D.

1.1 Support of the REG-DP(A) in tuning the Petersen-coil

There are situations in the grid in which classic regulation cannot be used to successfully tune the Petersen coil.

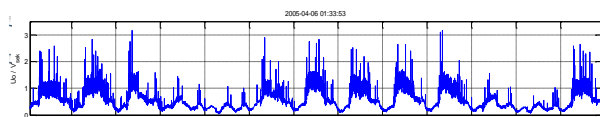


Figure 1 Flickering zero sequence voltage

- Flickering zero sequence voltage
- Very symmetrical grids (balanced)

We developed the optional current injection specifically for these cases.

The current injection creates a signal that is fed into the grid through the power auxiliary winding in the Petersen coil. The REG-DP calculates a resonance curve based on the grid's response (zero sequence voltage).

1.2 Support of the fault location of earth faults in compensated networks

With the HPCI a pulse signal can be injected during fault / earth fault.

It can be generated the conventional pulse pattern of 1 s to 1.5 s (symmetrical or unsymmetrical), as well as a fast pulse pattern.

The special feature is the possible combination of both signals.

The advantage is the possibility of simultaneous activation of conventional pulse locating relays and relays with “fast pulse location”.

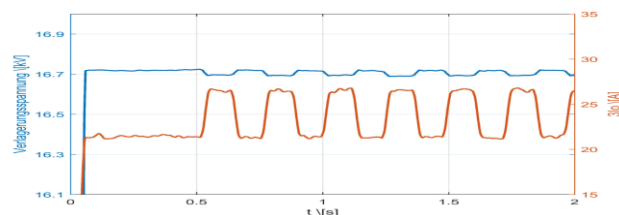


Figure 2 Pulse pattern within 1 second

We take care of it.

2. Four connections to retrofit the current injection

The following connections have to be established if the current feed-in is to be retrofitted:

- **Power supply 230 V AC** (pre-fuse 20 A slow-blow)
- **Communication connection** between REG-DP(A) (**COM3**) and CCI controller; 4-wire RS 485 shielded telephone cable; distance CCI to REG-DP up to 500 m
- **Connection to the power auxiliary winding** designed for 140 A (pulsed); voltage-proof up to 500 V AC, wire cross-section 25 mm²
- **U_{en} measurement** parallel to REG-DP(A)

2.1 Typical connection between REG-DP(A) and HPCI

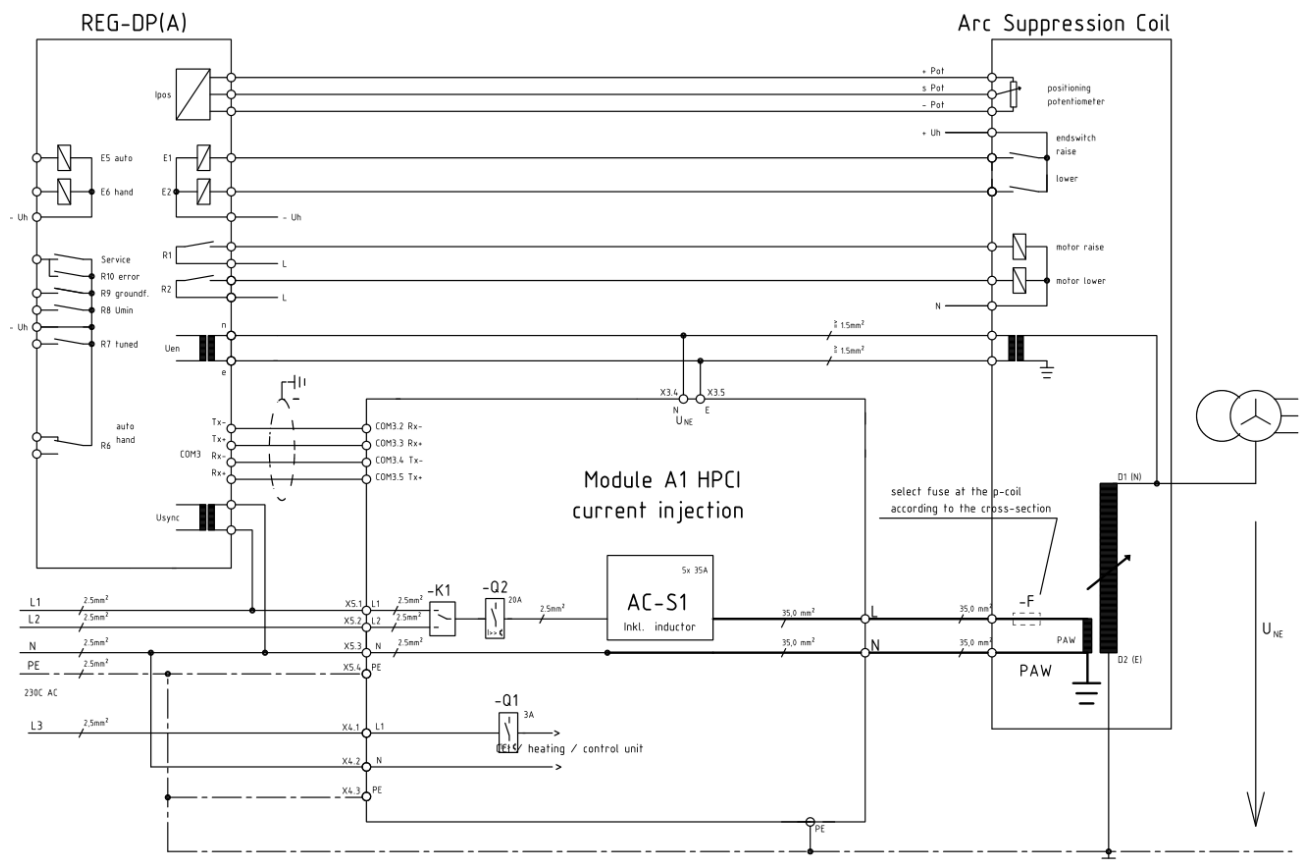


Figure 3 Connection of current injection (HPCI) to REG-DP(A) and Petersen coil



Please note the fuse at the power auxiliary winding!

In the HPCI all necessary fuses are included. But during the earth fault the power auxiliary winding provides the supply voltage of 500 V.



The supply cable of the power auxiliary winding must have a 100 A fuse!

3. Modular pulse power

The pulse power is offered in 17.5 kvar steps up to 70 kvar at 500 V. In the standard version the pulse power is 70 kvar.

The special version of 87.5 kvar is available on request.

The pulsing power can easily be upgraded in the future due to the assembly in form of an inductor shelf.



Standard pulse power sufficient for 600 A grids

I.e.: In a 20 kV grid 70 kvar correlate with a pulse stroke of 6 A

The current stroke should be 1..2 % of the grid → the HPCI **standard version** is suitable for 20 kV grids with up to 600 A capacitive current

Number of inductors	Pulse power at 500 V	Pulse current 10 kV grid	Pulse current 20 kV grid
1	17.5 kvar	3 A	1.5 A
2	35.0 kvar	6 A	3 A
3	52.5 kvar	9 A	4.5 A
4	<u>70.0 kvar</u>	<u>12 A</u>	<u>6 A</u>
(5)	87.5 kvar	15 A	7.5 A

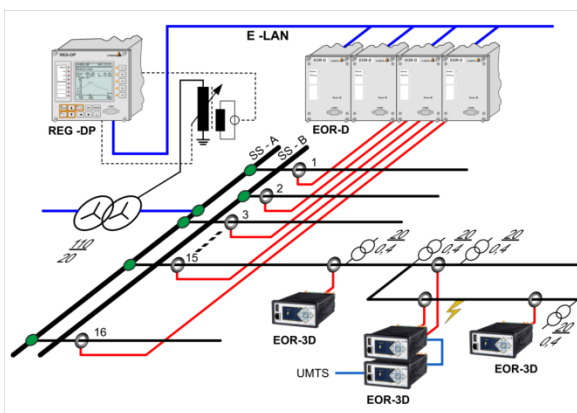


Figure 4 HPCI connected to Petersen coil; system solution with REG-DP(A), EOR-D and EOR-3D



Figure 5 HPCI twin system

4. SCADA / Communication

Connecting the HPCI unit via COM 3 to the regulator REG-DP(A), the connection to all common communication protocols is possible. The regulator features a system bus (E-LAN), whereby can be communicated with other system devices.

The following protocols are available (other protocols on request):

- IEC 60870 - 5 - 101 / 103 / 104
- IEC 61850
- DNP 3.0 via Ethernet
- DNP 3.0
- MODBUS RTU / MODBUS TCP

We take care of it.

5. Technical specifications

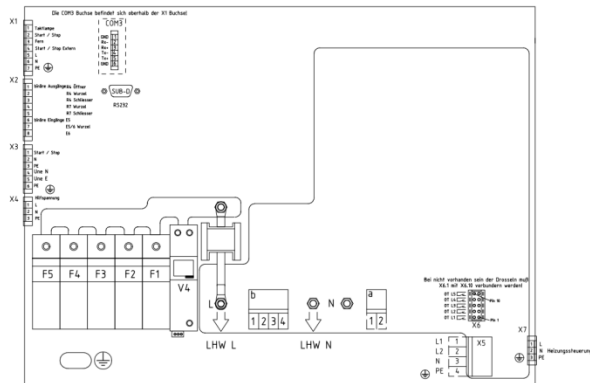


Figure 6 HPCI – Module detailed view

5.1.1 HPCI module

Current supply AC version

Nominal voltage (U_n)	230 V AC
Overload capacity	$1.3 \cdot U_n$
Overload capacity for 1s	$2 \cdot U_n$
Input power	$\leq 15 \text{ VA}$
Frequency	50/60Hz
Voltage drop (100%)	$< 50\text{ms}$

5.1.2 HPCI module measurement inputs

Voltage input U_{ne}

Voltage range U_{nom}	0...120V
Shape of the curve	Sinus
Frequency range	45...50...55 Hz
Input resistance	60 k Ω
Overload capacity permanent	$U_{nom} \cdot 1.2$

Current input (measurement I_{ci}) via internal current transformer

Internal current transformer (always installed)	100 / 5 A (Kl. 1) 1 VA
Current range of the internal transformer	0 .. 5 A
Shape of the curve	Sinus
Frequency range	45...50...55 Hz
Input power	$\leq 0.1\text{VA}$
Overload capacity permanent permanent	$I_{nom} \cdot 1.2$ 10A 30A 100A 500A

5.1.3 HPCI module binary inputs

Binary inputs E5...E6

Input voltage	AC and DC
H-level E5...E6	$> 65\text{V AC/DC}$
L-level E5...E6	$< 45\text{V AC/DC}$
Signal frequency	DC...65Hz
Input resistance E5, E6	ca. 100 k Ω
Potential isolation	optocoupler; all inputs internally isolated

5.1.4 HPCI module binary outputs

Relay outputs R4 and R7

max. switching frequency	$\leq 1\text{kHz}$
Contact load	AC:250 V, 5 A ($\cos \varphi = 1.0$) AC:250 V, 3 A ($\cos \varphi = 0.4$) DC-switching power: 250 V _{DC} : $\leq 75 \text{ W}$ 30 V _{DC} : $\leq 150 \text{ W}$
Switching operations	$> 10^5$ electrical
Potential isolation	Isolated from all device-internal potentials

5.1.5 HPCI module fuses

Thermal fuses Q1 and Q2

Type	Thermal switch (resettable)
Norm	IEC 60934
Mounting form	Flush-mount version
U_{nom}	240 V AC
I_{nom}	at 23 °C Q1 = 3 A Q2 = 20 A

fuses F1 to F5 at the HPCI module

Type	Safety fuse
Norm	IEC 60269-2
Mounting form	$\varnothing 22 \times 58 \text{ mm}$
U_{nom}	690 V AC
I_{nom}	40 A

We take care of it.

Terminal X2	Description	Meaning
X2:1	R4 NC	Break contact relay R4 (change over contact); free programmable
X2:2	R4 contact	Common contact relay R4
X2:3	R4 NO	Make contact relay R4 (change over contact) ; free programmable
X2:4	R5 contact	Common contact relay R5
X2:5	R5 NO	Make contact relay R5, free programmable
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X2:6	E5	Binary input 5, free programmable
X2:7	E5 / E6	Common of binary input 5 and 6
X2:8	E6	Binary input 6, free programmable

Terminal X3	Description	Meaning
X3:1	Start / Stop	Voltage supply for external button (phase conductor)
X3:2	N	Voltage supply for external button (neutral conductor)
X3:3	PE	External connection for protective earth conductor
X3:4	Une N	Measuring input for Une, connecting N
X3:5	Une E	Measuring input for Une, connecting E
X3:6	PE	Earthing connection for Une measuring, if used

Terminal X4	Description	Meaning
X4:1	L	Auxiliary voltage supply HPCI Module Phase (L); 230 V AC 50 Hz ● Fused internally with a 3 A fuse (Q1)
X4:2	N	Auxiliary voltage supply HPCI Module neutral conductor (N)
X4:3	PE	Auxiliary voltage supply HPCI Module protective earth conductor (PE)

Terminal X5	Description	Meaning
X5:1	L1	Voltage supply power unit HPCI Module Phase (L1), 230 V AC 50 Hz ● Fused internally with a 20 A fuse (Q2)
X5:2	L2	Auxiliary voltage supply HPCI Module (L2), 230 V AC 50 Hz ● Fused internally with a 20 A fuse (Q2)
X5:3	N	Auxiliary voltage supply HPCI Module neutral conductor (N)
X5:4	PE	Auxiliary voltage supply HPCI Module protective earth conductor (PE)

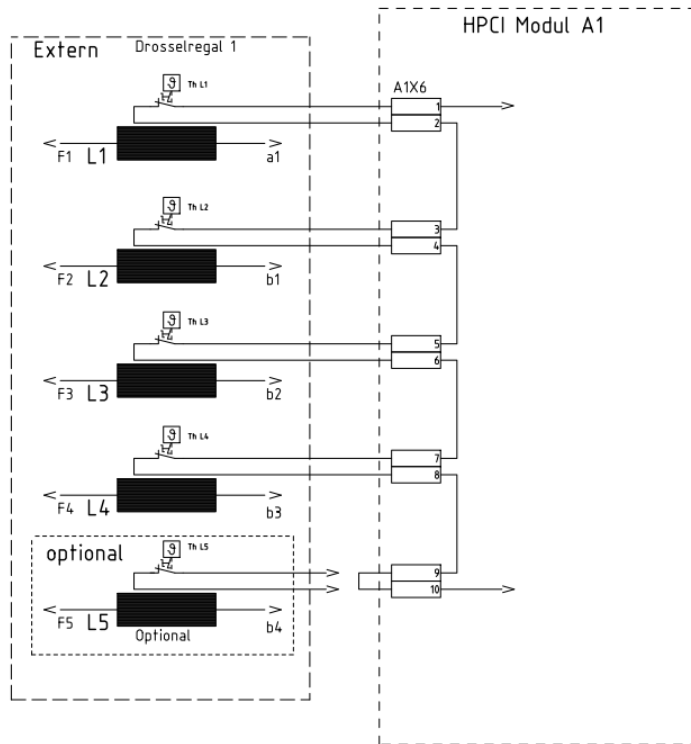
- Connecting the thermal circuit breaker of the installed inductors



Must be short-circuited, if not used!



If less than 5 inductors are installed at the HPCI, the free contact must be bridged. If not, over temperature is reported.

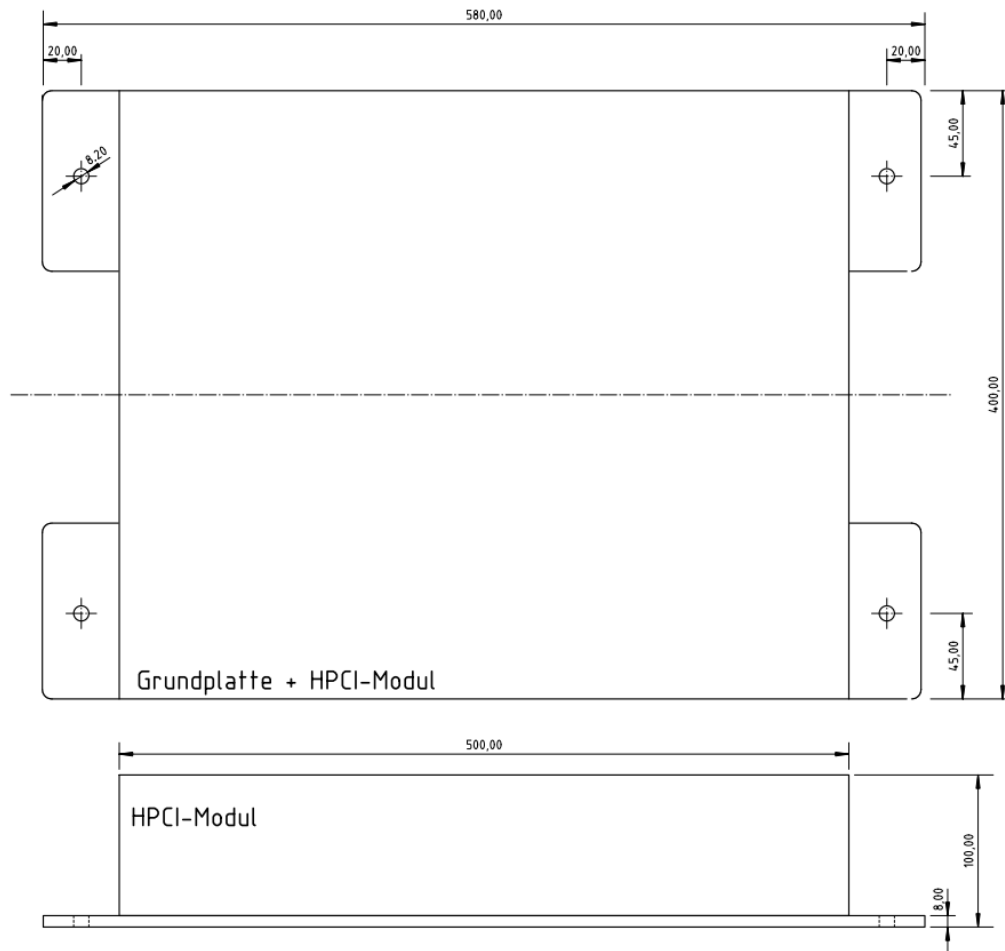


Terminal X6	Description	Meaning
X6:1	TH	Output signal to NC contact of inductor 1 <ul style="list-style-type: none"> + 5 V DC, when contact is open 0 V, when NC contact of thermal circuit breaker is connected
X6:2	TH	Return signal of NC contact of inductor 1
X6:3	TH	Output signal to NC contact of inductor 2
X6:4	TH	Return signal of NC contact of inductor 2
X6:5	TH	Output signal to NC contact of inductor 3
X6:6	TH	Return signal of NC contact of inductor 3
X6:7	TH	Output signal to NC contact of inductor 4
X6:8	TH	Return signal of NC contact of inductor 4
X6:9	TH	Output signal to NC contact of inductor 5
X6:10	TH	Return signal of NC contact of inductor 5

We take care of it.

5.3 Dimensions and weight

5.3.1 HPCI module



- weight: 15 kg
- housing: stainless steel

5.3.2 Inductors (inductivity) 17,5 kvar

Dimensions	Weight	inductivity	current	Operation mode
W x H x D 230 x 125 x 425 mm	27 kg	46 mH	16 A @ 230 V AC (50 Hz) 35 A @ 500 V AC (50 Hz)	See notes below



Note: Thermal characteristics of the inductors

- For thermal reasons permanent pulse operation ≤ 30 minutes is possible
- After a cool down period of 20 minutes, further permanent pulse operation is possible for 10 minutes
- No limitations for pulse patterns up to 20 cycles (equates to 50 s)

5.3.3 Complete control cabinet HPCI for indoor installation 70 kvar



Pulse cabinet without REG-DP(A)!

An application as separate pulse cabinet is possible. Therefore the control unit at the cabinet door must be existent.

5.3.3.1 Hardware HPCI – single system

The single system is designed for the connection to a REG-DP(A).

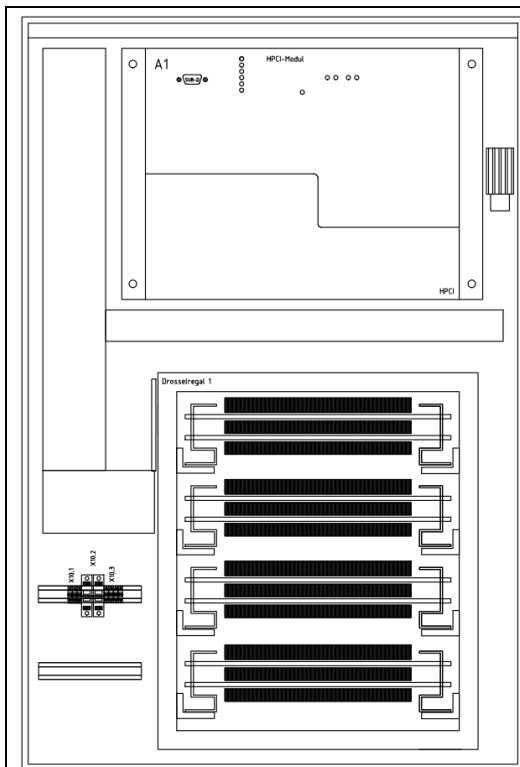


Figure 8 HPCI interior view

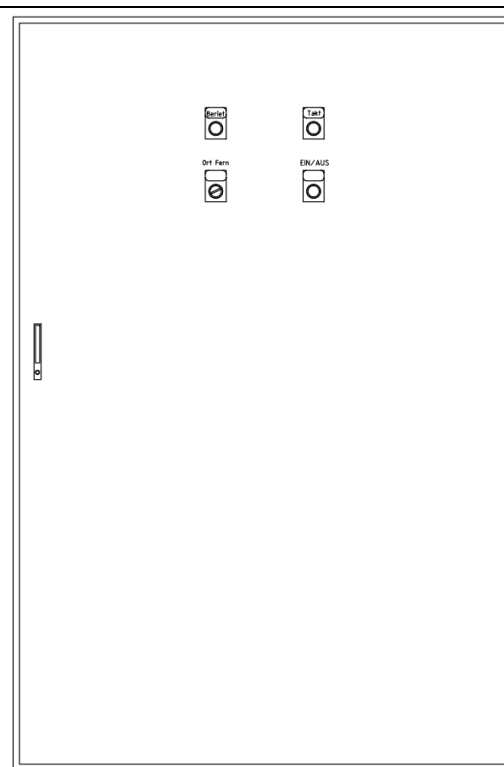


Figure 9 HPCI exterior view with optional control unit

Dimensions	Weight	inductivity	current	Operation mode
W x H x D 800 x 1200 x 500 mm base 200 mm	203 kg [235 kg]	4 x 46 mH [5 x 46 mH]	16 A @ 230 V AC (50 Hz) 140 A @ 500 V AC (50 Hz) [175 A @ 500 V AC (50 Hz)]	See notes at 5.3.2

We take care of it.

5.3.3.2 Hardware HPCI – twin system (C6)

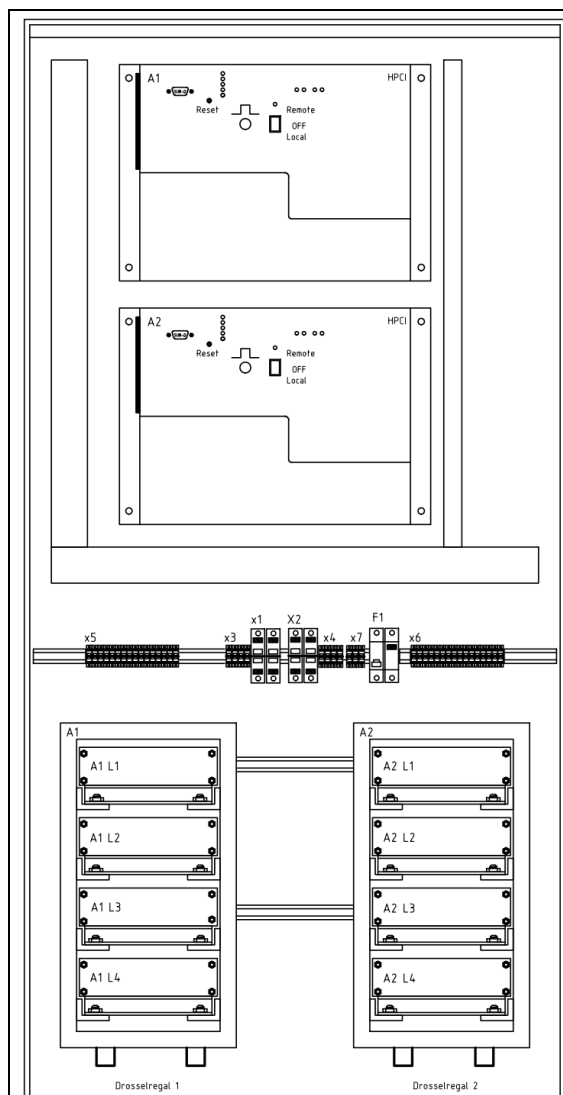


Figure 10 HPCI Interior view

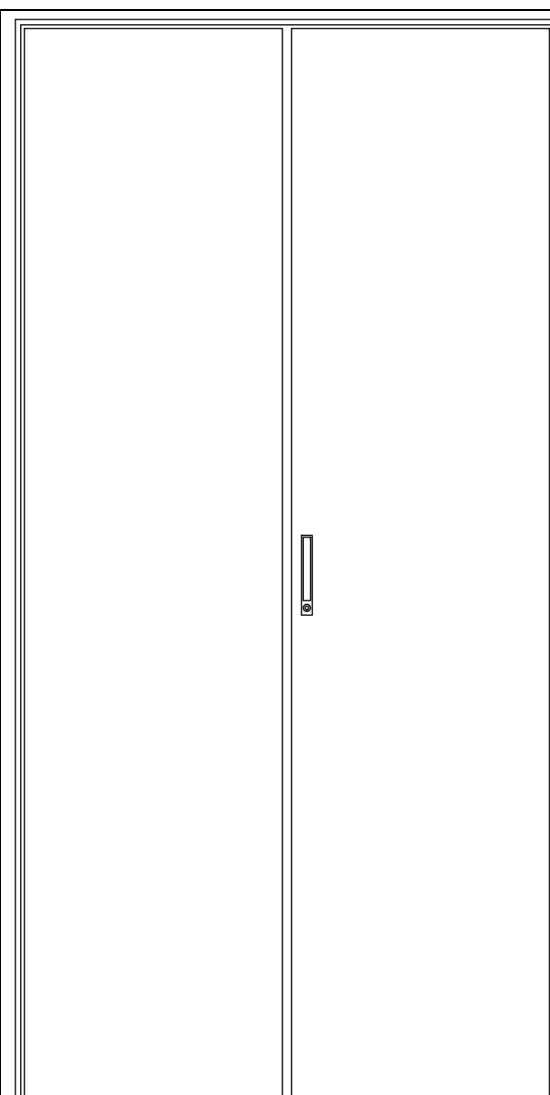


Figure 11 HPCI exterior view

Dimensions	Weight	inductivity	current	Operation mode
B x H x T 1000 x 2000 x 600 mm Base: on request Ordering Code: C6	390 kg	system A1: 4 x 46 mH system A2: 4 x 46 mH	system A1: 16 A @ 230 V AC (50 Hz) 140 A @ 500 V AC (50 Hz) system A2: 16 A @ 230 V AC (50 Hz) 140 A @ 500 V AC (50 Hz)	See notes at 5.3.2
B x H x T 1000 x 2000 x 600 mm Base: on request Ordering Code: C9	460 kg	system A1: 5 x 46 mH system A2: 5 x 46 mH	system A1: 16 A @ 230 V AC (50 Hz) 175 A @ 500 V AC (50 Hz) system A2: 16 A @ 230 V AC (50 Hz) 175 A @ 500 V AC (50 Hz)	See notes at 5.3.2

Order specifications

Feature	Code
<p>High power current injection (HPCI)</p> <p>In support of the regulation of a Petersen-coil with REG-DP(A) and for pulse current injection during earth fault</p> <p>Conventional pulse location (symmetrical or unsymmetrical pulse), fast fault location with EOR-D and EOR-3D;</p> <p>Standard: pulsing power 70 kvar at 500 V at the power auxiliary winding</p> <p>Supply voltage 230 V AC</p>	HPCI
<p>Mounting form</p> <ul style="list-style-type: none"> <p>Construction set single system</p> <p>consisting of SCR-power controller unit in stainless steel housing</p> <p>for installation in control cabinet; 4 inductivities / inductors inclusive</p> <p>with 70 kvar power at 500 V</p> <p>mounting shelf for inductors inclusive</p> <p>Single system in control cabinet for indoor installation</p> <p>consisting of construction set as in C1, completely mounted in the control cabinet</p> <p>(control unit in cabinet door for pulsing on request)</p> <p>dimensions: W x H x D ca. 800 x 1200 x 500 mm plus 200 mm base</p> <p>Single system in control cabinet for outdoor installation</p> <p>consisting of construction set as in C1, completely mounted in the control cabinet</p> <p>Control cabinet with roof and heating</p> <p>dimensions: W x H x D ca. 800 x 1200 x 500 mm</p> <p>ATTENTION! Please order BASE separately and specify type with order</p> <p>Single system in control cabinet for indoor installation</p> <p>consisting of construction set as in C1, completely mounted in the control cabinet</p> <p>(control unit in cabinet door for pulsing on request)</p> <p>dimensions: W x H x D ca. 800 x 2000 x 600 mm; base on request</p> <p>Twin system in control cabinet for indoor installation</p> <p>Consisting of two construction sets as in C1, completely mounted in the control cabinet</p> <p>(two control units in cabinet door for pulsing on request)</p> <p>dimensions: W x H x D ca. 1000 x 2000 x 600 mm; base on request</p> <p>HPCI system with other pulsing power as standard on request</p> <p>Please indicate pulsing power in 17.5 kvar – steps</p> <p>Maximal possible pulsing power of 87.5 kvar</p> 	<p>C1</p> <p>C2</p> <p>C3</p> <p>C5</p> <p>C6</p> <p>C9</p>

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