

Inverter

Series PWS

Operation and maintenance manual



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GENERAL INFORMATION

IMPORTANT! Please read this operation and maintenance manual carefully before assembling and start up of this unit!

The operation and maintenance manual is part of this unit, i.e. it should be made available to each and every person concerned with the start up, maintenance or operation of the unit. The unit should be moved, mounted, started, operated and maintained only by skilled personnel. The local specifications for the prevention of accidents as well as the general guidelines according to IEC 364 should always be followed!

The functional description in the operation and maintenance manual correspond to those at the time of the publication. Technical design modifications or those of power ratings can be carried out by the supplier without announcing any revision or announcement. There is no responsibility for the constant revision of the operation and maintenance manual

The unit satisfies the EN- and VDE-standards applicable at the time of the publication. The CE symbol on the unit confirms the observation of the EG-guidelines for 73/23 EEC-Low voltage and for 89/339 EEC-EMV compatibility.

The units are delivered according to our delivery conditions. Rights to alterations in the technical details in this operation and maintenance manual as well as in the respective data sheets are reserved.

Claims about faulty goods have to be made as soon as possible after receipt of material. Packing note and invoice as well as the information about the type, serial number and damage description have to be transmitted to the supplier.

Warranty claims not be accepted in case of visible external influences (e.g. missing or loose screws, welding, loose sheets, etc.), which could be attributed to an unauthorised opening of the unit. The supplier is not responsible for applications of the unit, not intended by the manufacturer. The end user is responsible to take the necessary action for the prevention of damage to personnel and material. (see upper text section).

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1. General

The inverters type PWS have an output power of 0.5 to 5kVA per module and can operate in paralleling for higher output powers. Typical applications are AC power supply with input side battery and inverter.

The inverter transforms the input DC voltage in a sinusoidal output voltage. Various voltages and frequencies are possible.

The PWS is available for delivery as 19"-rack for mounting in 19" cabinets or as wall cabinet version. The connector is on back panel, operation elements and displays are on front panel (19"-rack version only).

Through the high overall efficiency the inverter needs for a 19"-full rack 4 or 5hu only. For the inverters several options are available. Following options are possible: built-in static switch, input filter acc. CCITT-standard, operation in paralleling and measurement instruments for output voltage and current. All options will be explained in this manual. If there are technical changes in the installation and operating at several options the text is special marked.

2. Type Range

PWS (19" – Rackversion)

Type designation PWS	Item-number	Input-voltage in V DC	Output-voltage in V AC	Output-power in VA / W
24-0.5	C10-1001	24	230	500 / 400
24-1.0	C10-1002	24	230	1000 / 800
24-1.5	C10-1003	24	230	1500 / 1200
24-2.0	C10-1004	24	230	2000 / 1600
24-2.5	C10-1005	24	230	2500 / 2000
24-3.0	C10-1006	24	230	3000 / 2400
108-0.5	C10-1031	108	230	500 / 400
108-1.0	C10-1032	108	230	1000 / 800
108-1.5	C10-1033	108	230	1500 / 1200
108-2.0	C10-1034	108	230	2000 / 1600
108-2.5	C10-1035	108	230	2500 / 2000
108-3.0	C10-1036	108	230	3000 / 2400
108-4.0	C10-1038	108	230	4000 / 3200
108-5.0	C10-1039	108	230	5000 / 4000
216-0.5	C10-1041	216	230	500 / 400
216-1.0	C10-1042	216	230	1000 / 800
216-1.5	C10-1043	216	230	1500 / 1200
216-2.0	C10-1044	216	230	2000 / 1600
216-2.5	C10-1045	216	230	2500 / 2000
216-3.0	C10-1046	216	230	3000 / 2400
216-4.0	C10-1048	216	230	4000 / 3200
216-5.0	C10-1049	216	230	5000 / 4000

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PWS (Wall cabinet version)

Type designation PWS	Item-number	Input-voltage in V DC	Output-voltage in V AC	Output-power in VA / W
24-0.5	C10-3001	24	230	500 / 400
24-1.0	C10-3002	24	230	1000 / 800
24-1.5	C10-3003	24	230	1500 / 1200
24-2.0	C10-3004	24	230	2000 / 1600
24-2.5	C10-3005	24	230	2500 / 2000
24-3.0	C10-3006	24	230	3000 / 2400
108-0.5	C10-3031	108	230	500 / 400
108-1.0	C10-3032	108	230	1000 / 800
108-1.5	C10-3033	108	230	1500 / 1200
108-2.0	C10-3034	108	230	2000 / 1600
108-2.5	C10-3035	108	230	2500 / 2000
108-3.0	C10-3036	108	230	3000 / 2400
108-4.0	C10-3038	108	230	4000 / 3200
108-5.0	C10-3039	108	230	5000 / 4000
216-0.5	C10-3041	216	230	500 / 400
216-1.0	C10-3042	216	230	1000 / 800
216-1.5	C10-3043	216	230	1500 / 1200
216-2.0	C10-3044	216	230	2000 / 1600
216-2.5	C10-3045	216	230	2500 / 2000
216-3.0	C10-3046	216	230	3000 / 2400
216-4.0	C10-3048	216	230	4000 / 3200
216-5.0	C10-3049	216	230	5000 / 4000

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3. Storage

If the module will be storage after delivery you should select a dry, free of dust room with the specified storage temperature (look at technical specifications).

4. Installation

At mounting of the units on operation place following instructions and rules have to be observed:

- a) mount in dry, free of dust rooms only
- b) read the specifications about ambient conditions such as ambient temperature or rel. humidity
- c) big dust hood or aggressive chemical atmosphere are not allowed; dew and dust together can make short circuits an internal boards
- d) you need sufficient cooling air, above all at mounting in cabinets with several 19" subrack levels

Please check mains voltage before connecting the inverter (looking for nominal values on type label). For connection of DC input and AC output you have to use connector (X1) and (X2) on front panel. The DC input is protected against confusing the poles (unit don't switch on). The PWS will be delivered - acc. the order - with input and output fuses . If there no internal fuses the inverter needs external fuses in the input and output. The signaling contacts are on the connector X3.

The inverter operates at output power from 1.0kVA with temperature controlled fan cooling. The ambient temperature has to be smaller than 40 °C.

Please check the load power before connecting the module. A permanent overload is not allowed and decreases the inverter life time. Especially the inrush currents of loads are to be observed (for instance a normally computer monitor can have an inrush current about 50A!).

The connection of the none-fused earthed conductor is recommended.

The electrical connections have to be carried out acc. pin list in cap. 8.

Please use wires acc. VDE 0100 or equal standard. To decrease voltage losses on wires you should use bigger sizes of wires as specified. For instance a high voltage loss on battery wire can decrease the backup time.

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Following installation rules should be observed:

->*single inverter:*

- a) check if inverter is switched off
- b) connect DC input with open DC bushbar fuses
- c) connect AC loads
- d) close DC bushbar fuses
- e) switch on the unit with front side switch

->*inverter in paralleling:*

- a) check if inverters are switched off
- b) connect DC input with open DC bushbar fuses
- c) check wiring between inverters
- c) connect AC loads
- d) close DC bushbar fuses
- e) switch on the units with front side switch

->*inverter with built-in EUE/EMU*

- a) check if inverter is switched off
- b) connect DC input with open DC bushbar fuses
- c) connect AC bypass mains with open mains fuses
- d) connect AC loads
- e) close DC bushbar fuses
- f) close AC bypass mains fuses
- g) switch on inverter

5. Handling

All operating elements are in the front of the module. The inverter will be switched on with front side switch S1. Some LED's signalize the operation status of inverter. All signals and monitorings are described in the next capters. The output voltage and current will be shown by analog or digital instruments (option).

->*inverter in paralleling*

One unit operates as master and synchronize the other.

ATTENTION! The unit which transmitted the synchon signal to syn-chron bus as first unit will be the master. Is anything out of order on the master unit it switches off by itself and another unit become the master function. At system with static bypass switch the in-verters will be synchronized by the SBS unit.

6.2 Functional Description

The switched mode inverters of the PWS range display an advanced concept of converting DC voltages into frequency- amplitude-stable sinusoidal AC voltages . The combination of high frequency pulse width modulation and POWER-MOS transistors offers the advantage of outstanding dynamic behaviour combined with an efficiency reaching the present physical and technological limits of power conversion .

Fig. 3a shows a schematic drawing of the sine wave synthesis . This is realised by pulse width modulation , which means the DC input voltage is being chopped into high frequent impulses , the duration of each pulse depending on the momentary input voltage as well as on the momentary value of the output voltage that has to be generated . The reference waveform is stored in an EPROM which is located on the PWS control board . As the momentary input voltage value directly effects the pulse duration (change in modulation grade) , output voltage is kept continuous without using the control loops . Two independent control loops provide an exact keeping of the waveform even at non-linear load as well as an outstanding static and long term output voltage continuity . As the high switching frequency of 25.6 kHz is synchronised with the 50 Hz output frequency an input voltage deviation is compensated within 40 microseconds and a dynamic output voltage deviation , caused by for example changing load , is compensated within 300 microseconds .

Fig. 3b shows a schematic drawing of the inverter power stage . One half of the power stage (T1 , T2) is toggle switched with a frequency equal to the inverter output frequency and leads to a periodic polarity change for the half-cycle sine-waves that have been generated by the other half of the power stage (T3 , T4) by means of pulse width modulation . This low frequent AC voltage generated by the so-called bridge power stage is transformed to the desired output voltage level by the inverter`s main transformer Tr1 . The inductor L1 reduces the high frequency current components of the modulation voltage , the filter capacitor C2 on the transformer secondary together with stray-paths in the inverter transformer reduces the high frequency voltage component of the output voltage . The DC input capacitor C1 reduces the AC component of the input current and stores energy which is fed back when driving non-resistive loads at the inverter output . Impedance at the output is fed back by 100% to the DC voltage source or the capacitors , in order to keep the inverter efficiency .

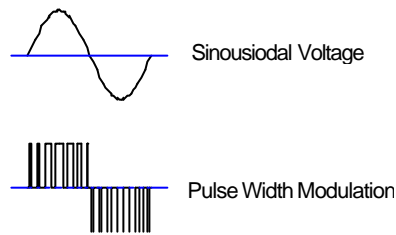
Fig. 3c shows a schematic drawing of the feedback and control circuitry . The output voltage is measured with voltage transformer Tr2 , the output current with current transformer Tr3. Both signals are fed to the analogue processor to achieve the following regulation effects :

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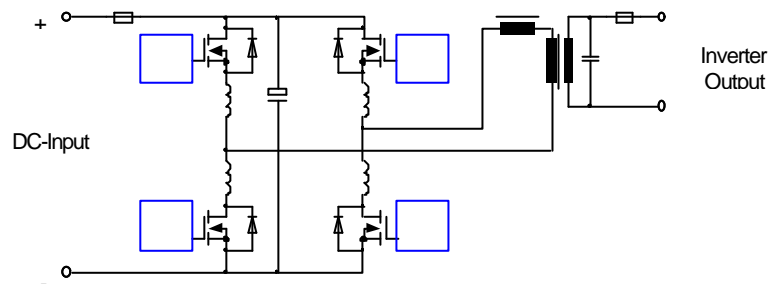
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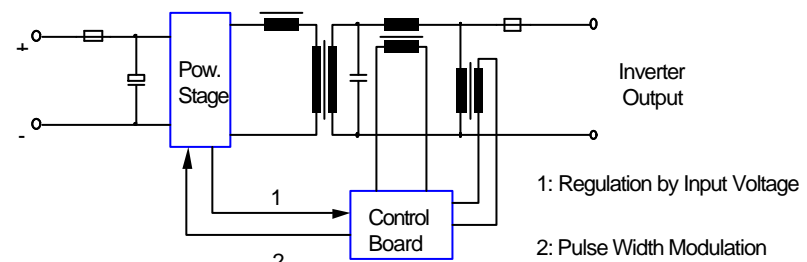
- a) Dynamic output voltage regulation , recovery time < 0.3 ms
- b) Static output voltage regulation and adjustment , recovery time < 40 ms
- c) Creation of a DC voltage proportional to the output voltage (average or optional TRMS) to drive a digital display and creation of an overload failure signal
- e) Dynamic output current limitation (in case of load crest factors exceeding 4 , the output waveform is slightly flattened to extend periodic current flow duration . Because of this the inverter can be driven with any crest factors up to its nominal performance while the output ripple only slightly increases .)



Picture 1
PWM-Principle



Picture 2
Schematic Block Diagram - Inverter Power Stage



Picture 3
Schematic Block Diagram - Controlling Principle

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6.2.1 Safe Electrical Decoupling

Through the special construction, the internal wiring of the inverter and its parts and the HF transformer there is a safe electrical decoupling between primary(input) and secondary(output) part of the unit.

6.2.2 Input

If there is no internal input fuse the inverter needs an external fuse at input side.

The input has a switch on current limitation to limit the inrush current to the level of nominal input current.

6.2.3 Output

The output is permanent short circuit proof and supplies a short circuit current of 2 to $3 \times I_{nom}$ at 2,5sec.. The inverter can be overloaded for a short time (look at technical specifications), but it doesn't switch off. That's why the customer is responsible for the correct load on output. Overload for a long time can overheat the inverter and so decrease the life time of the unit.

6.2.4 Dynamic Regulation of Output Voltage

At load changes between 10% and 90% I_{nom} / 90% and 10% I_{nom} the dynamic voltage difference is < 3 % and will be regulated in < 1,5 ms to static voltage level.

6.2.5 RFI Suppression

Inverter types PWS fulfill the standards EN 55011/55022 class „B“.

6.2.6 Adjustment of Output Voltage

The nominal adjustments of output voltage, of output current and also of monitoring thresholds you can find in technical specifications of inverter.

The output voltage can be adjusted with the front side potentiometer. At adjusting the output voltage can be measured on test contacts on front panel (transformation 1:100, 1V=100V). A additional voltage check on output terminals of the inverter is recommended.

6.3 Monitoring

6.3.1 Input Voltage Monitoring

The input voltage is monitored permanently. The actual values will be compared with internal monitoring thresholds.

The monitoring thresholds are adjusted over resistor values on the inverter control board.

1. signal "Uo<" (red LED) ; if inverter output voltage lower than 85% of U_{nom} (+/-2%)
The inverter switch off itself without delay. The inverter switch on again if the input voltage is in the correct range ($>103\% U_{nom}$, +/-2%). The hysteresis and delay time protect the unit for an oscillation of automatic switch off; for instance if a discharged battery will be deloaded through inverter switch off.
2. signal "Uo>" (red LED) ; if inverter input voltage higher than 128% (+/-2%) of U_{nom}
The inverter switch off itself without delay time (protection against overvoltage). The inverter switch on again if the input voltage is lower than 125% (+/-2%) of U_{nom} .

6.3.2. Output Voltage Monitoring

The inverter output voltage will be transmitted to the control unit by a transformer and compared to internal adjusted values.

If there is a correct output voltage the green LED "Uo O.K." is on. If the output voltage is lower than 90% of nominal value , for instance by overload or short circuit, the inverter switch off with a delay time of appr. 2,5sec.

Then the red LED „Error“ is on.

The inverter is permanent short circuit proof.

6.3.3 Monitoring of Overheating

signal "T>" (red LED) ; if temperature on inverter power stage is higher than 90°C. High ambient temperature, to small cooling , permanent overload (appr. 20-25%) or an defect fan can overheat the unit. The inverter switch off without delay. The inverter switch on again if the temperature is decreased to 20-30K.

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6.3.4 Signals

All operation modes and errors will be displayed with LED's on front panel. In addition the collective failure signal has relay contacts on connector X3. The allowed relay contact loading is:

$U_{nom}=110V\ DC \rightarrow I \leq 0,45\ A\ DC$

$U_{nom}=60V\ DC \rightarrow I \leq 1\ A\ DC$

$U_{nom}=24V\ DC \rightarrow I \leq 8\ A\ DC$

The supply of the LED's will be produced by the inverter control board
(20pole ribbon connector).

Display	Color	Operation mode
Operation	green	inverter operates, internal voltage supply O.K.
Uo O.K.	green	inverter output voltage O.K.
Ui>	red	input voltage high ; inverter switched off
Ui<	red	input voltage low ; inverter switched off
Alarm	red	output voltage distortion, short circuit, high overload
T>	red	overheating/overload of inverter by overload or bad cooling
Collective Failure	red	collective failure, delay time appr. 20sec., relay contact on X3; all single errors included

7. Operation in Paralleling

At operation in paralleling of several modules it is important to check the connections of SYNC-BUS wires between the modules. Every inverter can operate as master or slave. A synchron bus (SYNC-BUS) transmits the synchronization signal to every inverter. The inverter who supplies at first its own synchron signal on this bus will be the master and synchronize all other units. If the master will be switched off or there is an error on it another module in paralleling takes over the master function.

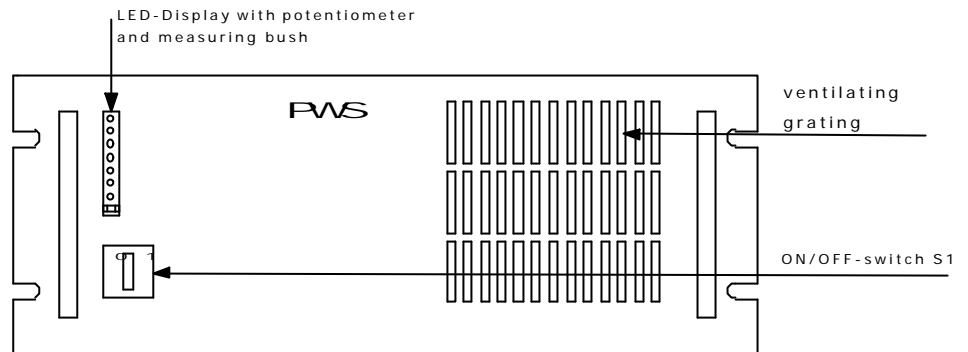
The inverter output relay switch on itself if the internal voltage is O.K. and the output voltage has the correct value. On this way defect modules switch off itself and will be disconnected from AC bus automatically.

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8. Operation Elements and Connectors

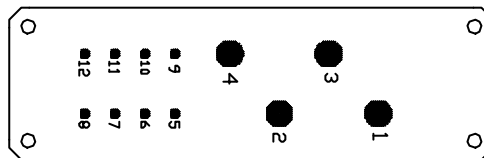
8.1 Front View / Operation Elements



8.2 Connector X1 (single Inverter)

Connector X1 (HAN-K4/8):

Picture 8.2:
connector X1



Pin	Function
1	L+ (DC-INPUT)
2	N (NEUTRAL)
3	L- (DC-INPUT)
4	L1 (Phase L)
5	not used
6	SYNC-GND ¹⁾ synchronization ground for paralleling
7	SYNC-SIG ¹⁾ synchronization bus for paralleling
8	SYNC-STAT ²⁾ control wire from SBS
9	not used
10	coll. failure: COM*
11	coll. failure: NC*
12	OLP – BUS ³⁾

*collective failure exist: COM and NC open

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- 1) Connection between the single inverters for paralleling (connect all pin 6 (SYNC-GND), pin 7 (SYNC-SIG) off all inverters.
- 2) Connection with external EUE (in addition to 1) (connect all pin 8 of all inverters with the pin 8 of the EUE).
- 3) Connection (option OLP) together with EUE. (Connect pin 12 of all inverters with pin 11 of the EUE).

See also the included circuit diagram, if option are used!

8.3 Connector X1 (Inverter with internal EUE)

See picture 8.2.

Pin	Function
1	L+ (DC-INPUT)
2	N (NEUTRAL)
3	L- (DC-INPUT)
4	L1 (Phase L)
5	not used
6	collective failure EUE: COM*
7	collective failure EUE: NC
8	collective failure EUE: NO
9	not used
10	coll. failure inverter: COM*
11	coll. failure inverter: NC
12	coll. failure inverter: NO

*collective failure exist: COM and NC open

9. Maintenance

The inverter is maintenance free.

But we recommend a yearly inspection with following checks:

Please check:

- operates the fan correctly,
- there are mechanical damages,
- dust hood in the unit
- clean heat sink and cooling

Attention! Dust together with dew or water can destroy the internal circuits by short circuits.

At big dust hood you can blow out the unit with dry compressed air.

The times between this checks depends on ambient conditions of the installed module.

10. Trouble Shooting

All works should be done by qualified personnel.

10.1 No Output Voltage

- DC input voltage O.K.?
- front panel switch or input fuse is on?
- green LED „Operation“ is on?
- DC input voltage is connected by defusing the poles?
- DC input fuse (on DC bushbar) O.K.?
- signaling LED's $U_{i>}$ or $U_{i<}$ on ?
- short circuit or overload on output?
- output fuse O.K.?

If no error was found but the module still don't operate, please send back for repair!

10.2 Distortion of Output Voltage

- overload on output? - check and reduce the load!
- big inrush current by load?
- distortions by load jumps or current peaks?
- adjustment of voltage value U_o not correct? adjust the correct value

If no error was found but the module still don't operate, please send back for repair!

11. Technical Data - PWS

11.1 General technical data

Input voltage	acc. type list
Input voltage range	+20/- 15%
Input current	acc. type list
Inrush current	≤ nominal input current
RFI Suppression	acc. EN 55011/EN55022 class "B"
Immunity	acc. EN 61000-4 part 2-5
Insulation voltage	acc. EN60950
Input ripple	≤ 2mVpp psophometr. (CCITT-A-filter), <200mV _{pp} , ≤100mV _{eff} ; option DC-filter only;
Output power factor range	0ind - 1 - 0cap.
Output voltage	230V AC +/- 0,5%* ; Sinousiodal
Output Power	acc. type list (at cos phi=0.8)
Output frequency	50Hz +/-0,05%
Ripple factor	≤ 3%, typ. ≤ 1%
Overall efficiency	85-91%, depends on type
Crestfactor	≤ 2,5
Dynamic output voltage changes	≤ 3 % at load jumps between 10 % - 100 % - 10 % of nominal current (regulation time t ≤ 0,3ms);
Short circuit ability	permanent short circuit proof, short circuit current: 2-2,5 x nominal output current at 2,5sec

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Monitoring: DC input voltage	($U_{i<}$, $U_{i>}$) with switch off and automatic switch on again; AC output voltage (U_o O.K.) ; Overtemperature ($T>$) and overload without switch off
Overload ability	160% at 1min. / 130% at 10min. without switch off
LED signals	Operation, U_o O.K., $U_{i<}$, $U_{i>}$, Alarm, $T>$ and Collective Failure
Relay contacts	Collective Failure
Operation in paralleling (option)	up to 10 inverters possible
Noise level	$\leq 30\text{dB(A)}$ at 1m distance
Construction	19"-rack or wall cabinet
Protection (mech.)	IP 20
Cooling	forced fan cooling (output power $\geq 1\text{kVA}$)
Ambient temperature	operation: $0-40^\circ\text{C}$; storage: $-30-+50^\circ\text{C}$
max. installation high	1000m over ZZ
max. rel. humidity	85% without dew
Connections	screw terminals on front
Painting	RAL7032 (front panel only)

Options

- input and output fuses;
- measurement instruments U_o/I_o as analog or digital version;
- paralleling option;
- DC-input filter (acc. CCITT-A; 24-60V range only);
- relay board ;
- Static Bypass Switch EUE;
- Electromechanic Switch EMU

* At paralleling operation of inverters the dynamic and static distortion of output voltage is higher than in single applications (symmetric chokes at output side; static: $\pm 5\%$, dynamic: $\pm 10\%$).

11.2 Specific Technical Data – Inverter Type PWS

Input Voltage In V DC	Output Power in kVA	Efficiency in %	Input Current in A DC	Output Current in A AC	Fuses (Input/ Output) in A	Size 19"-rack (STD/EUE/EMU)	Size Wall Cabinet (STD/EUE/EMU)
24	0,5	85	19,6	2,17	25/4	1/1/1	1/2/2
24	1,0	85	38,8	4,35	50/6	1/1/1	2/2/2
24	1,5	86	58,2	6,52	80/10	2/2/2	2/2/2
24	2,0	86	77,6	8,7	100/10	2/3/3	2/3/3
24	2,5	86	96,9	10,9	125/16	2/3/3	4/4/4
24	3,0	86	116,3	13,0	125/16	2/3/3	4/4/4
108	0,5	89	4,2	2,17	6/4	1/1/1	1/2/2
108	1,0	90	8,2	4,35	10/6	1/1/1	2/2/2
108	1,5	90	12,4	6,52	16/10	1/1/1	2/2/2
108	2,0	90	16,3	8,7	20/10	1/1/1	2/2/2
108	2,5	91	20,4	10,9	25/16	1/1/1	2/2/2
108	3,0	91	24,2	13,0	35/16	2/2/2	2/2/2
108	4,0	91	32,2	17,4	50/20	2/3/3	5/5/5
108	5,0	91	39,9	21,7	50/25	3/3/3	5/5/5
216	0,5	89	2,1	2,17	4/4	1/1/1	1/2/2
216	1,0	90	4,1	4,35	6/6	1/1/1	2/2/2
216	1,5	90	6,2	6,52	10/10	1/1/1	2/2/2
216	2,0	91	8,2	8,7	10/10	1/1/1	2/2/2
216	2,5	91	10,2	10,9	16/16	1/1/1	2/2/2
216	3,0	91	12,1	13,0	16/16	2/2/2	2/2/2
216	4,0	91	16,1	17,4	20/20	2/3/3	5/5/5
216	5,0	91	20,0	21,7	25/25	3/3/3	5/5/5

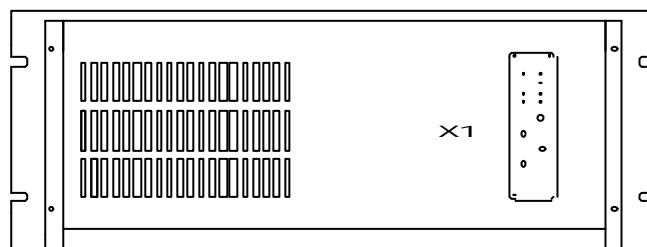
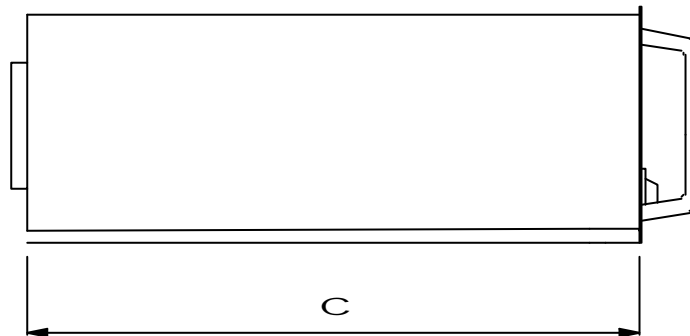
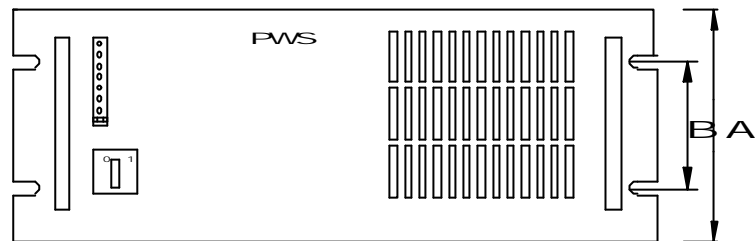
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12. Construction View / Dimensions

12.1 Construction View / Dimensions at 19"-rack version

Size	19"-rack dimens.	A in mm	B in mm	C in mm
1	4HE x 460mm tief	177	101.7	460
2	5HE x 460mm tief	221	146.1	460
3	5HE x 525mm tief	221	146.1	525



482,6

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12.2 Construction View / Dimensions at wall cabinet version

Size	Dimensions (hxwxd) in mm	A in mm	B in mm	C in mm	D in mm	E in mm
1	400x400x210	400	466	365	400	210
2	600x400x210	600	666	365	400	210
3	600x600x210	600	666	565	600	210
4	600x600x300	600	666	565	600	300
5	800x600x300	800	866	565	600	300

Holes of wall brackets : 8,5x12,5mm

