Front Panels

Description

Front panels are available for 19" rack mounting of 3 U cassette type power supplies in *Schroff* system version (*Intermas* on request) and may be attached to the converter by means of countersunk screws.

An assembly kit, consisting of a front panel and a support bracket, enables arrangement of two standard cassettes with up to six output voltages in 6 U configuration.

All front panels are of colourless anodised aluminium and delivered with one or two grey plastic handles of 3 TE for easy pull-out and two or four hand-press insertable plastic retainers with captive screws for fixing to the rack.

Note: Front panel mounting or custom specific front panels are available on request.

Dimensions in accordance to DIN 41494-1 (IEC 60297):
Width: 1 TE = 5.08 mm (0.20")
Height: 1 U = 44.45 mm (1.750")
(In Europa often *HE* instead of *U* is used.)
Tolerances ±0.2 mm, unless otherwise specified

Schroff System for 3 U Rack

Q-, PC-, P-, R Series Front Panels in 4, 5 or 6 TE

This front panel available in three versions fits to all DC-DC converters of the Q-, P- and R-Families and to the AC-DC converters of the PC Series with case size Q.

Table 1: Q01 case front panel selection

X TE	X mm	Case size	Converter series	Type Part no.
4	20.0	Q01	Q	G04-Q01 HZZ 00835
		Q03	PC	
		Q04	P	G04-Q04 HZZ 00840
			R	
5	25.1	Q01	Q	G05-Q01 HZZ 00836
		Q03	PC	
		Q04	P	G05-Q04 HZZ 00841
			R	
6	30.2	Q01	Q	G06-Q01 HZZ 00839
		Q03	PC	
		Q04	P	G06-Q04 HZZ 00842
			R	

Note: For use of several units next to each other, we advise to pack them not too densely in order to assure good thermal management (see also relevant data sheet).

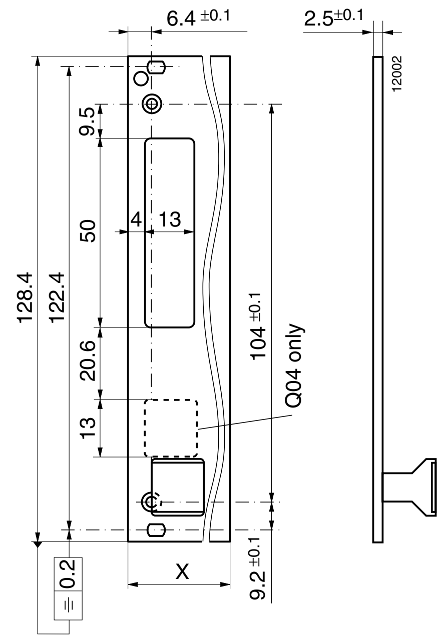

Fig. 1
Front panel for Q case size

Delivery contents:
Front panel, grey plastic handle, three countersunk screws, set of two plastic retainers with captive screws and assembly instructions.

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H- and M Series Front Panel in 8 TE

This front panel fits to all 50 Watt DC-DC and AC-DC converters of the 12...LH Series with case size H02 as well as to all AM...LM- and CMZ...LMZ Series versions with case size M02.

Table 2: H02 and M02 case front panel selection

TE	mm	Case size	Converter series	Type Part no.
8	40.3	M02	M	G08-M02 HZZ 00802
		H02	H	

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of two plastic retainers with captive screws and assembly instructions

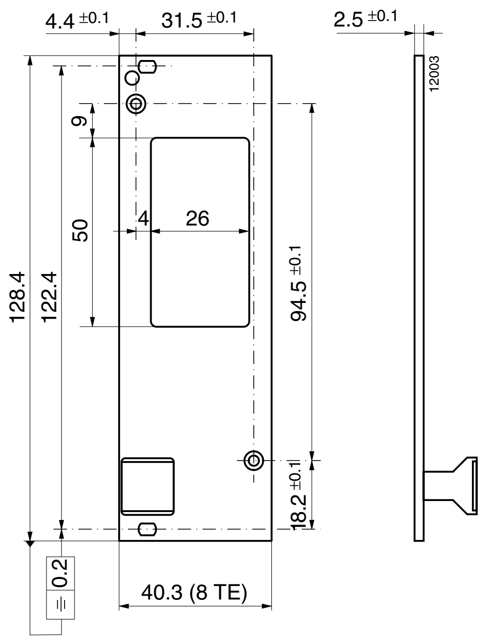


Fig. 2
Front panel for H02 and M02 case size

PSL- and SR 20E Series Front Panel in 8 TE

This front panel fits to all Switching Regulators of the PSL Series with case size L04 and to all 20 Watt DC-DC and AC-DC converters of the B...LSR Series with case size L01.

Table 3: L case front panel selection

TE	mm	Case size	Converter family	Type Part no.
8	40.3	L04	PSL [1]	G08-L HZZ 00805
		L01	SR20E	

[1] Exception: PSL with option D is part no. G08-L04-D, HZZ 00816

Note: This front panel is a compatible replacement for all earlier versions of the same size, published in any previous front panel data sheet.

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of two plastic retainers with captive screws and assembly instructions.

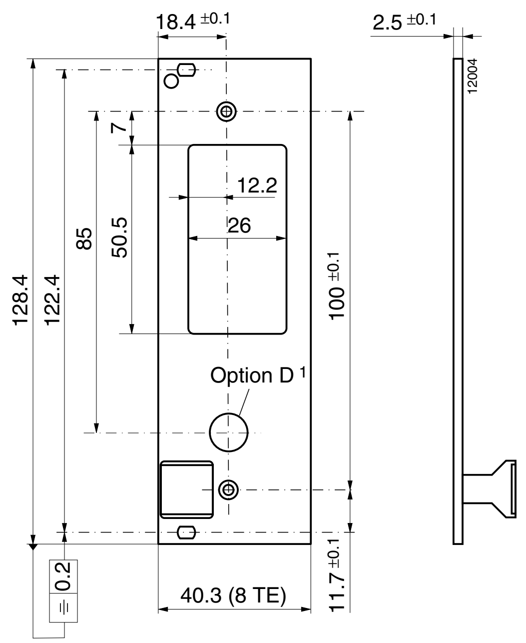


Fig. 3
Front panel for L01 and L04 case size

PSS and S Series Front Panels in 12 TE
PSK and K Series Front Panels in 16 TE

This front panel fits to all Switching Regulators of the PSS and PSK Series with case size S01 or K01 as well as to all 100...150 Watt DC-DC and AC-DC converters of the A...LS- and A...LK Series with case size S02 or K02 according to the selection table below:

Table 4: S and K case front panel selection

X TE	X mm	Case size	Converter series	Type Part no.
12	60.6	S01	PSS	G12-S HZZ 00845
		S02	S	
16	81.0	K01	PSK	G16-K HZZ 00831
		K02	K	

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of four plastic retainers with captive screws and assembly instructions.

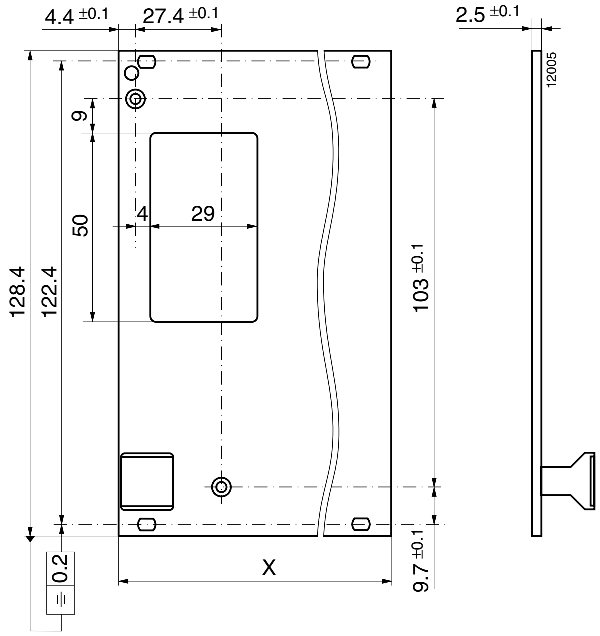


Fig. 4
Front panel for S01, S02, K01 and K02 case size

T Series Front Panel in 28 and 26 TE

This front panel fits to all 500 Watt AC-DC converters of the T Series with case size T01.

Table 5: T case front panel selection

X TE	X mm	Case size	Converter series	Type Part no.
28	141.9	T01	T	G28-T01 HZZ 00837

Delivery contents:
Front panel with two grey plastic handles, three counter-sunk screws, set of four plastic retainers with captive screws and assembly instructions.

Blind plates: to close a non fully equipped 19" rack (only one or two LTs mounted). Power-One offers 28 TE wide blind plates without hole.

G28-T01-blank met HZZ 00847 with metal screw retainers
G28-T01-blank plas HZZ 00848 with plastic screw retainers

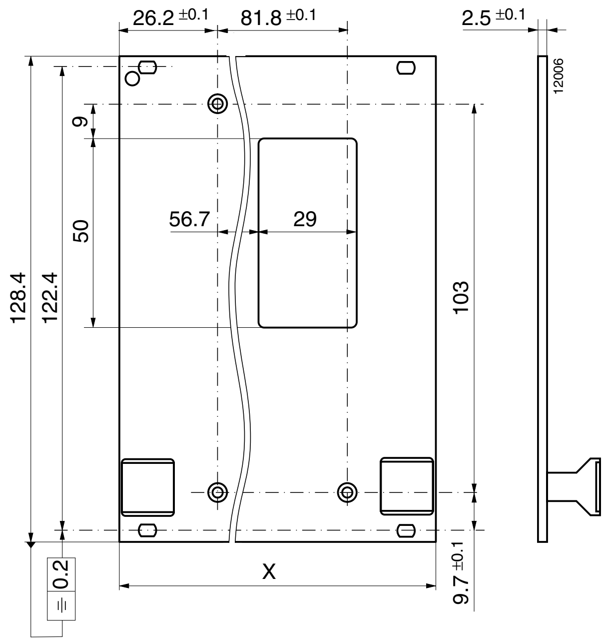


Fig. 5
Front panel for T01 case size

Intermas System for 3 U Rack

The major differences between the Intermas and the Schroff system front panels are the thickness (2 mm instead of 2.5 mm), the hole size for the plastic retainers and a small cut-out on each side (see figure: *Intermas system front panel*). All other dimensions are given in the relevant Schroff front panel drawings.

The following Intermas front panels are available on request:

Table 6: Intermas front panel selection

X TE	X mm	Case size	Converter series	Type Part no.
8	40.3	H02	H	F08-M02 HZZ 00702
		M02	M	
8	40.3	L01	PSL [1]	F08-L HZZ 00705
		L04	SR 20E	
12	60.6	S01	PSS	F12-S HZZ 00732
		S02	S	
16	81.0	K01	PSK	F16-K HZZ 00731
		K02	K	

[1] Exception: PSL with option D is type/part no. F08-L04-D, HZZ 00716

Delivery contents:
Front panel with grey plastic handle, two countersunk screws and assembly instructions.

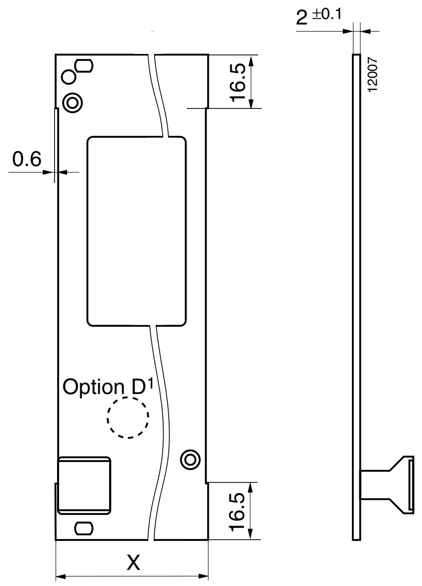


Fig. 6
Intermas system front panel (various case sizes)

Schroff System Kit for 6 U Rack

To configure Power-One Power Supplies for use in 6 U racks a special assembly kit has been created consisting of a double height front panel together with a support bracket for two converters as shown in figure 7.

All other dimensions are given in the relevant 3 U front panel drawings according to their case size. The assembly kit is available with the type designation according to the following table:

Table 7: 6 U assembly kit selection

X TE	X mm	Case size	Converter series	Type Part no.
5	25.1	Q01	Q	Kit-G05-6HE-Q01 HZZ 00838
		Q03	PC	
8	40.3	H02	H	Kit-G08-6HE-M02 HZZ 00804
		M02	M	
12	60.6	S01	PSS	Kit-G12-6HE-S HZZ 00833
		S02	S	
16	81.0	K01	PSK	Kit-G16-6HE-K HZZ 00832
		K02	K	

Delivery contents:
Double height front panel with two grey plastic handles, four countersunk screws, set of two plastic retainers with captive screws, a support bracket and assembly instructions.

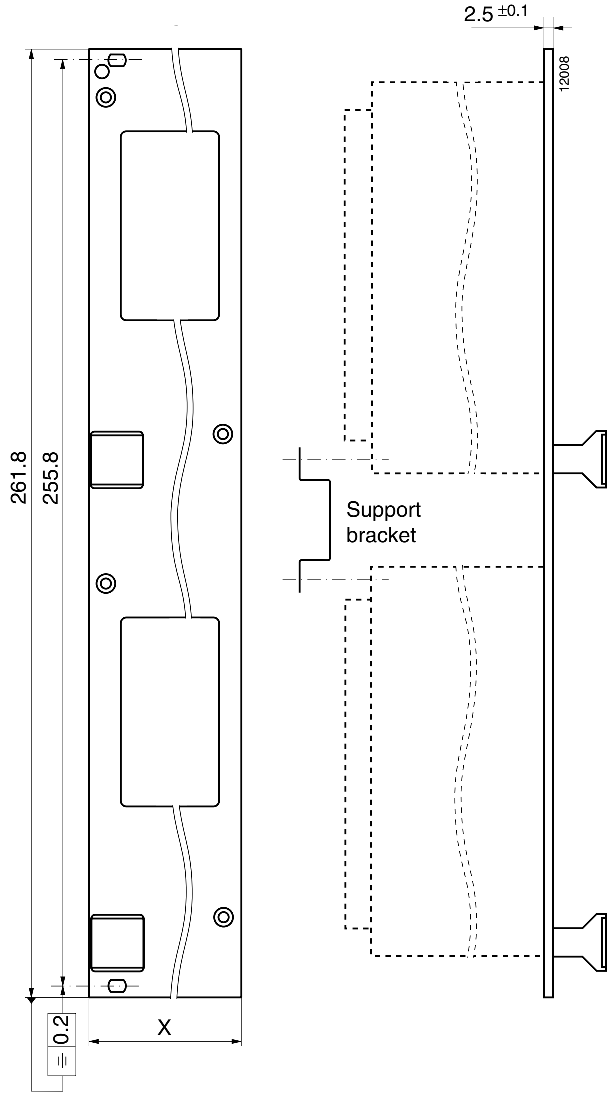


Fig. 7
Front panel for 6 U configuration (various case sizes)

Mounting Supports for Chassis-, DIN-Rail- and PCB Mounting

Description

Special mounting supports have been designed for the integration of power supplies into switch boards, control panels, printed circuit boards, etc. using adapters for Chassis-, DIN-Rail or PCB mounting.

The 19 inch cassette type DC-DC and AC-DC converters can also be chassis mounted with frontal access by means of a special *Chassis Mounting Plate*, attached to the converters.

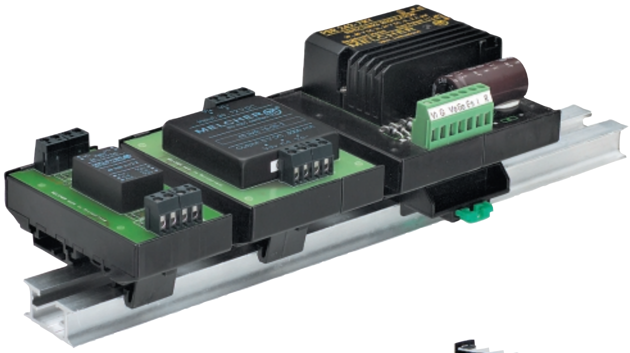
The *Universal Mounting Bracket* also fits to most of these cassette type converters, allowing for either vertical chassis- or DIN-Rail mounting.

A *Bracket Kit*, consisting of a PCB with screw terminal connectors and a bracket suitable for either Chassis- or DIN-Rail mounting, is available either for PCB mountable PSR and PSA Switching Regulators with option "Y" pins or for small DC-DC converters 1...15 Watt.

For isolation of the PCB-mountable converters from a double sided PCB, the use of *Isolation Pads* is recommended, as described below.

A *Flexible H11 PCB* allows for connection of casette type converters with H11 connector mounted on a printed circuit board to this board.

Note: All dimensions are in mm, with tolerances of ±0.2 mm unless otherwise specified.



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Chassis Mounting Plates

For chassis mounting of 19" cassette type converters where only frontal access to the mounting screws is given, special chassis mounting plate adapters are available according to the following table and figures 1 to 3.

Table 1: Mounting Plate survey

Case size	Converter series	Type Part. no.	Delivery content
K02	K [1]	Mounting plate K02 HZZ 01213	Mounting plate and 4 countersunk screws
S02	S [1]		
Q01	Q	Mounting plate Q HZZ 01215	
Q03	PC		
Q04	P		
Q01	Q	Mounting plate M HZZ 01210	Mounting plate, 4 countersunk screws and 4 washers
Q03	PC		
Q04	P		
M02	M		
H02	H		

[1] Option B1 necessary

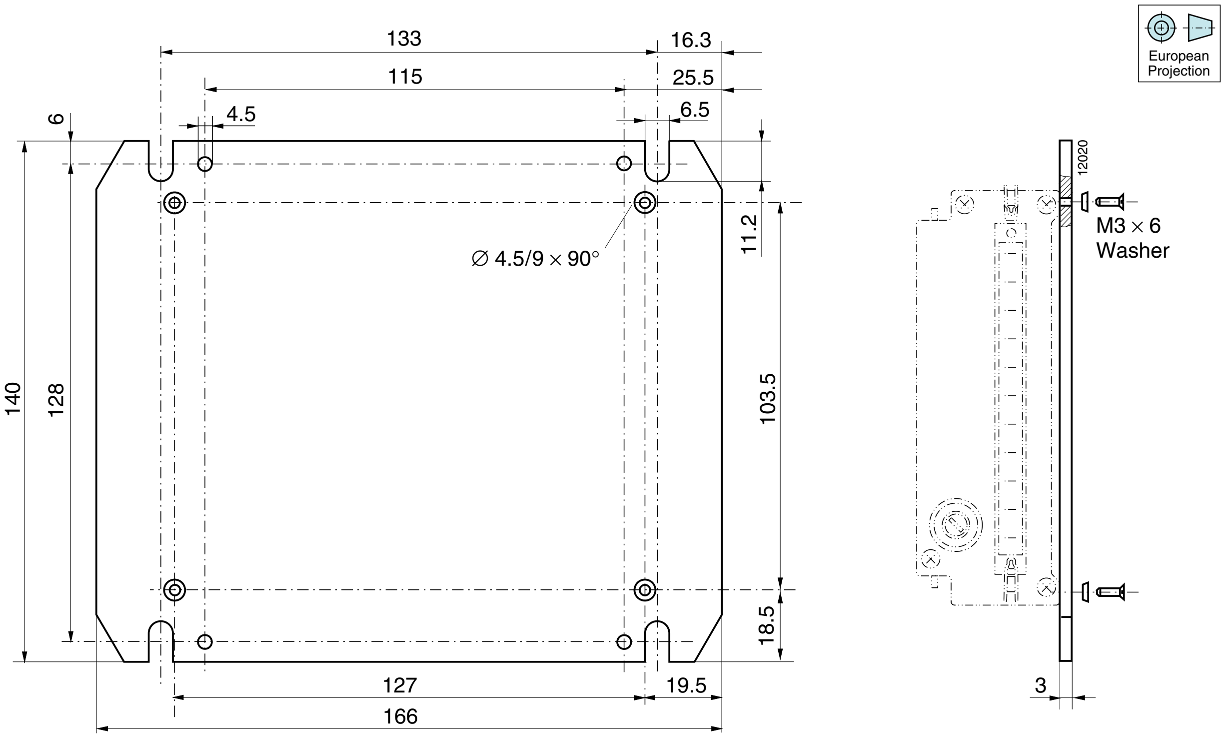


Fig. 1
Mounting plate M
Aluminium, black finish

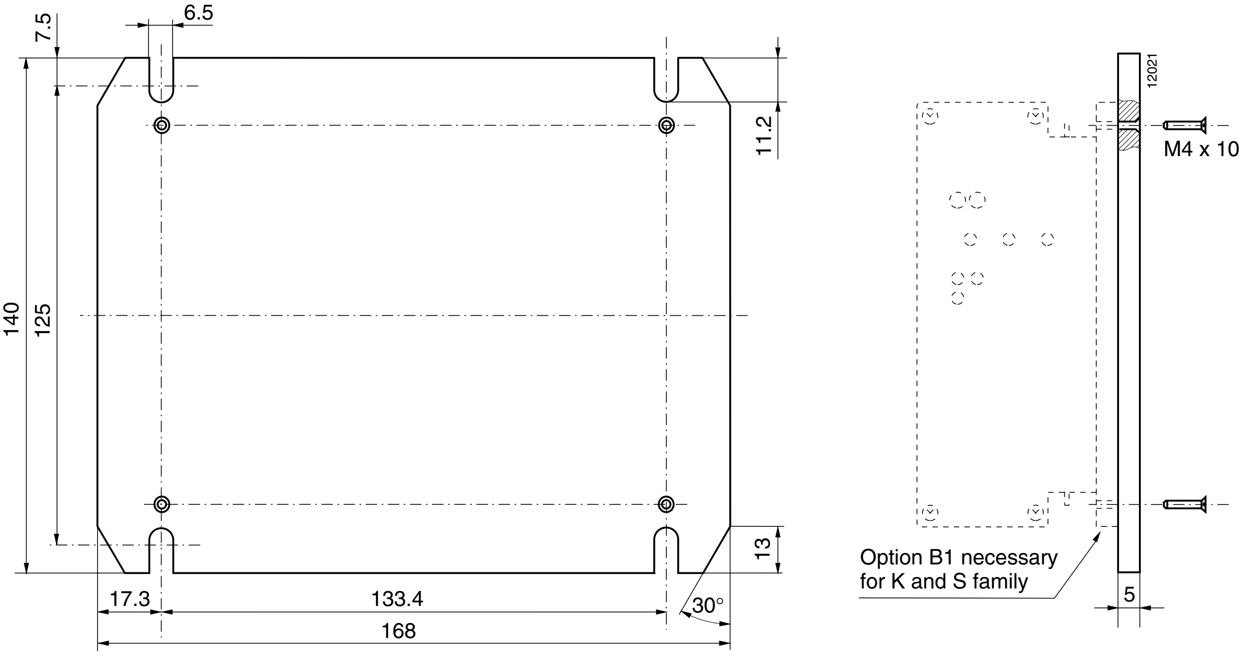


Fig. 2
Mounting plate K02
Aluminium, black finish

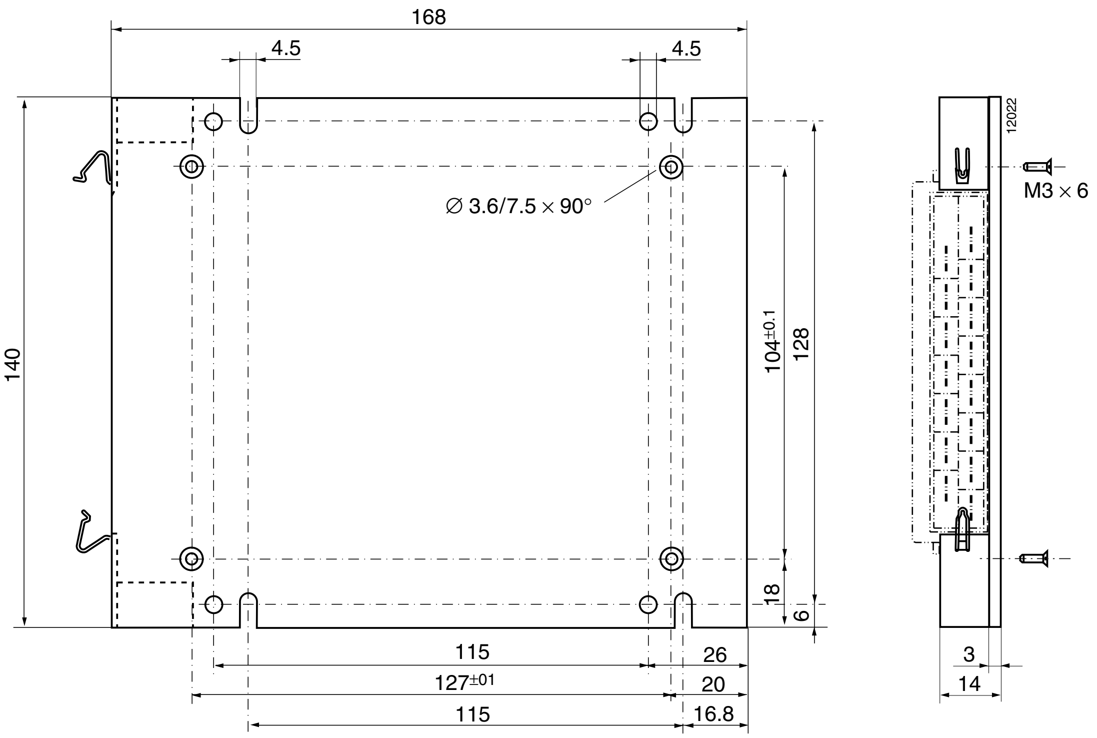


Fig. 3
Mounting plate Q with integrated connector retention facility
Aluminium, black finish

Note: Details on Connector Retention Clip V are given in section: *Mating Connectors*.

DIN- and Chassis Mounting Brackets

PCB mounting as well as cassette type converters can be chassis- and/or DIN-Rail mounted by means of Mounting Bracket adapters. For selection and part numbers refer to table below.

Note: Customized adapters for other case sizes are available upon request.

Each part number gives a direct indication of the kind of mounting, the type of converter, i.e. the case size or the output power as well as the possible pinnings and options according to the relevant converter data. The adaptors are divided into two mechanical types: *CMB* and *DMB*.

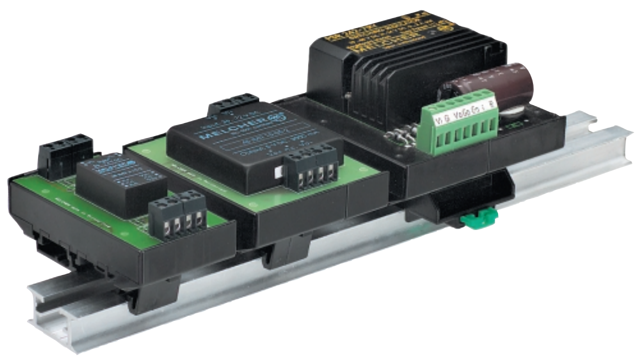


Table 2: Mounting Bracket survey

A1 [mm]	A2 [mm]	Converter case size	Converter series	Chassis-mounting Part no.	DIN-mounting Part no.	Delivery content
95.0	90.0	A01	PSR, PSA ($U_{i\,max}$ 40, 60, 80 V)	CMBA01-iRY/80 HZZ 00607	DMB A01-iRY/80 HZZ 00606	PCB, screw teminal blocks, 4 diodes, capacitor C1 and C- or D-bracket with screws
			PSA ($U_{i\,max}$ 144 V)	CMBA01-iRY/144 HZZ 00609	DMB A01-iRY/144 HZZ 00608	
72.5	67.5	2"×2"	IMR 6, IMR 15 IMP 6, IMP 12	CMB2×2-BCFG HZZ 00605	DMB 2×2-BCFG HZZ 00603	PCB, screw teminal blocks, and C- or D-bracket
50.0	45.0	DIL 24	IMP 3 IMX 4 Option K	CMB3W-123 HZZ 00604	DMB 3W-123 HZZ 00602	
72.5	67.5	1"×2"	IMX 7 IMS 7	CMB IMS/X 7 HZZ 00617	DMB IMS/X 7 HZZ 00613	See Basic Kit C/DMB IMX/S 7

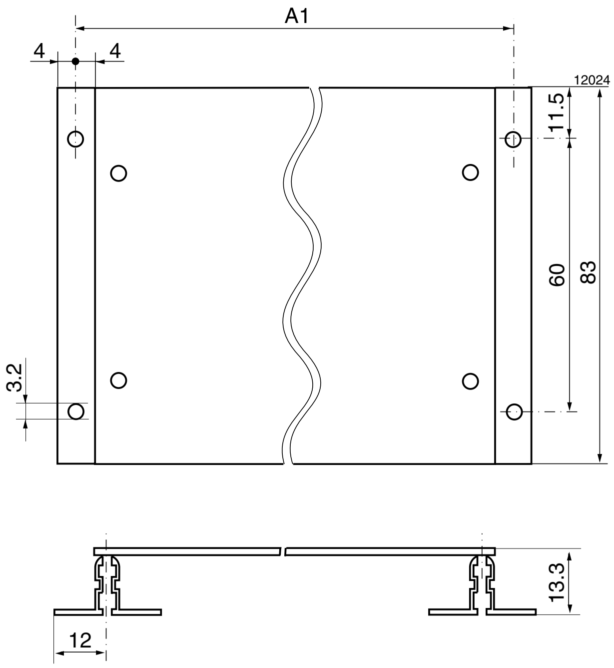


Fig. 4
"CMB" chassis mounting bracket dimensions
Bracket: Aluminium, black finish

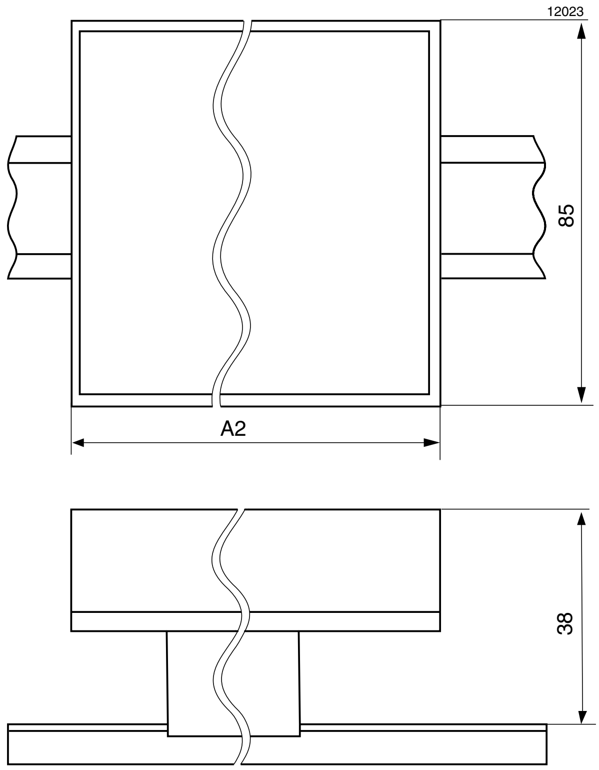
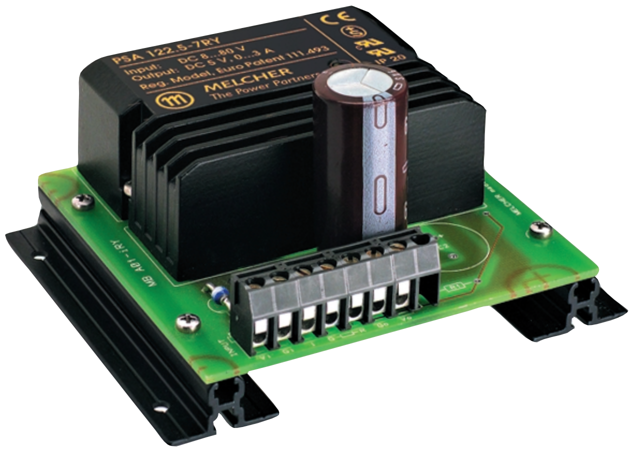


Fig. 5
"DMB" DIN-rail mounting bracket dimensions
Bracket: Polycarbonate, black

CMB: Chassis Mounting Bracket

The kit consists of a PCB for the converter, a set of screw terminals allowing for easy electrical connection and two aluminium profiles, attached to the PCB by means of four screws, which serve as the chassis mounting bracket. Four different versions according to table 2 are available.

Details on the layout of the PCB's and diagrams are given in the description below.



DMB: DIN-Rail Mounting Bracket

The DMB kit differs from the "CMB" version by a bracket suited for DIN-rail mounting (according to EN 50022, including Hat- and C-rail). The black plastic body of the bracket holds the PCB by means of a snap-in device. Four different versions according to table 2 are available.

Details on the layout of the PCB's and diagrams are given in the description below.

C/DMBA01-.. Electrical Description

This bracket is designed for non-isolated Switching Regulators of the PSR and PSA series in the A01 case size, equipped with "Option Y" pins and giving output voltages between 5 V and 48 V. Technical details, i.e. max. input voltage etc. are described in the relevant PSR and PSA data and further information is given in the application notes. The use of the optional inhibit- and R-functions (external output voltage adjustment with R1) is possible and the device can be driven either from a DC-source or from a transformer secondary voltage.

– DC-input: Consider the forward voltage drop across the rectifier diodes (also providing reverse polarity protection). Capacitor C1 compensates the negative converter input impedance in case of long connection wires to the module.

– AC-input: The recommended transformer secondary voltage is 48 V_{rms} for PSR and 72 V_{rms} for PSA ($U_{i\,max}$ 144 V)

Exception: Input voltage for PSR 54 (PSA 55) is 20 V_{rms}. PSR 54 (PSA 55) and PSR 362 require an additional capacitor (C2) of at least 470 µF.

12025

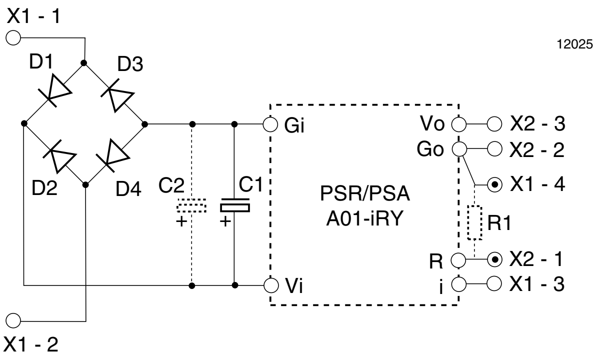


Fig. 6a
C/DMBA01- .. circuit diagram

12026

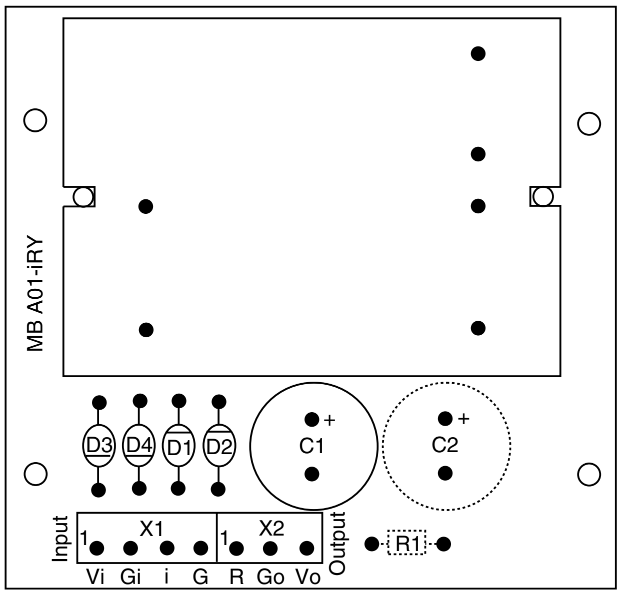


Fig. 6b
C/DMBA01- .. print layout

C/DMB2×2-BCFG Electrical Description

This bracket allows the mounting of isolated DC-DC converters of series IMR 6, IMR 15, IMP 6 and IMP 12 in 2" by 2" cases with either one or two output voltages of 5, 12 or 15 V. The technical details are given in the relevant IMR 6, IMR 15, IMP 6, IMP 12.

Depending on the application input transient protection may be incorporated (e.g. an appropriately dimensioned Transzorb diode D1).

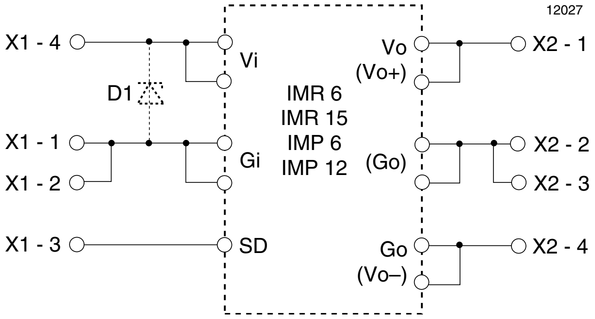


Fig. 7a
C/DMB2×2-BCFG circuit diagram

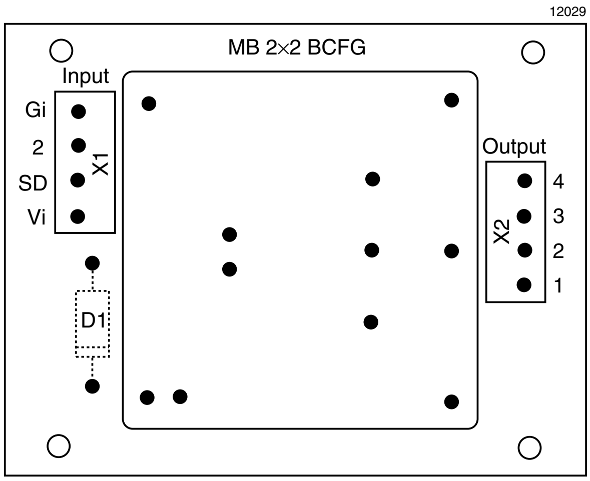


Fig. 7b
C/DMB2×2-BCFG print layout

C/DMB3W-123 Electrical Description

This bracket is designed for galvanically isolated DC-DC converters of the IMP 1, IMP 3 and IXP 3 series in DIL 24 cases with one or two output voltages of 5, 12 or 15 V. The pin configuration of the converter groups single, double, and dual and all technical converter details are described in the relevant data.

Depending on the application input transient protection may be incorporated (e.g. an appropriately dimensioned Transzorb diode D1) .

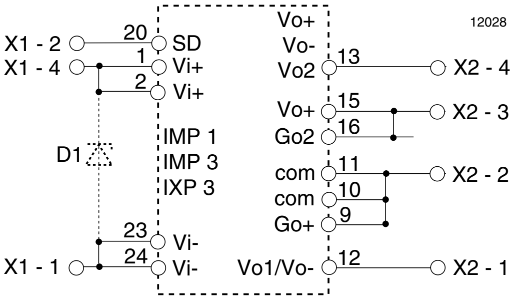


Fig. 8a
C/DMB3W-123 circuit diagram for all pin configurations

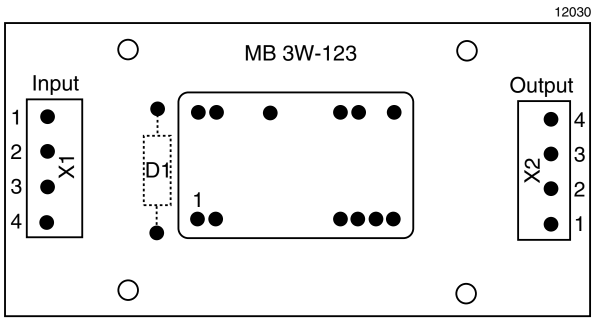


Fig. 8b
C/DMB3W-123 print layout

Basic Kit CMB IMX/S 7

For use with 1"× 2" DC-DC converter types:
IML 10, IMS 7 and IMX 7
Part No.: HZZ 00617

The basic kit contains the following:
- Two mounting rails, 83 mm
- Four screws M 2.5 x 6
- Four nuts M 2.5
- PCB ZGN 09601 A
- Three 2-pole terminal blocks (2× for X1 terminal, 1× for X3 terminal)
- One 3-pole terminal block for X2 terminal
- Three wire jumpers 5.08 mm (positions B1, B4, B5)
- One wire jumper 10.16 mm (position D1)
- Six wire jumpers 6.8 mm (positions L2, L4, L6)
- Circuit diagram no. YSK 25300 S3 01

Basic Kit DMB IMX/S 7

For use with 1"× 2" DC-DC converter types:
IML 10, IMS 7 and IMX 7
Part No.: HZZ 00613

The basic kit contains the following:
- DIN-mounting support for 35 mm DIN-rail systems
- PCB ZGN 09601 A
- Three 2-pole terminal blocks (2× for X1 terminal, 1× for X3 terminal)
- One 3-pole terminal block for X2 terminal
- Three wire jumpers 5.08 mm (positions B1, B4, B5)
- One wire jumper 10.16 mm (position D1)
- Six wire jumpers 6.8 mm (positions L2, L4, L6)
- Circuit diagram no. YSK 25300 S3 01

Mounting Instructions for Basic Kit

Single output units IML 10, IMS 7 and IMX 7

- Solder the wire jumpers into positions as below:
  1. D1 (10.16mm)
  2. B1 (5.08 mm) , inhibit.
     Note: This jumper should be fitted if the inhibit is not actively used. An open inhibit disables the converter.
  3. L2-A and L2-B, L6-A and L6-B (6.8mm)
  4. L4-A and L4-B (6.8mm), only necessary if remote R-input is used.
- Solder terminal blocks
  5. X1: Position Vi+/ Vi–, 2-pole terminal block
  6. X1: Position i/n.c., 2-pole terminal block (only necessary in the case of remote inhibit)
  7. X3: Position Vo+/ Vo–, 2-pole terminal block
  8. X2: Position n.c, R, Vo–, 3-pole terminal block (only necessary in the case of remote *U*o adjustment by e.g. an external voltage source)
- Solder the selected DC-DC converter
- Mount PCB onto rails by using the 4 screws and nuts or snap PCB onto the DIN mounting support.
- Perform function test

Double output units IML 10, IMS 7 and IMX 7

- Solder the wire jumpers into positions as below:
  1. D1 (10.16mm)
  2. B1 (5.08 mm), inhibit
     Note: This jumper should be fitted if the inhibit is not actively used. An open inhibit disables the converter.
  3. L2-A and L2-B, L6-A and L6-B, L4-A and L4-B (all 6.8mm)
- For applications with the 2 outputs in parallel:
  4. Place/solder jumpers B4 and B5, (5.08mm)
- Solder terminal blocks
  5. X1: Position Vi+/ Vi–, 2-pole terminal block
  6. X1: Position i/R (Trim), 2-pole terminal block (only necessary in the case of remote inhibit or output voltage trimming by an external voltage source)
  7. X3: Position Vo1+/ Vo1–, 2-pole terminal block
  8. X2: Position n.c/Vo2+/Vo2–, 3-pole terminal block
- Solder the selected DC-DC converter
- Mount PCB onto rails by using the 4 screws and nuts or snap PCB onto the DIN mounting support.
- Perform function test

Application specific circuitry

The assembly C/DMB IMX/S 7 offers a variety of additional external circuitries which may be implemented onto the PCB ZGN 09601 A. See circuit diagram YSK 25300 S3 /01. Please also consult the IMS/X 7 data sheet.

Depending upon the application the following pheripheral additions can be made:

- Reverse polarity protection by a series diode D1.
- Improved input transient protection according to IEC/EN 61000-4-5, level 2, by chokes L1 or L2-A, L2-B (EMC version) and capacitor C1.
- Remote inhibit.
  Note: If the inhibit is not actively used the inhibit has to be connected to Vi– by jumper B1.
- External output voltage trimming/adjustment

  Single output units:

  a) U_o – adjustment in the range of 70/75...100% of $U_{o\,nom}$ by resistors RX3 or RX4 or combinations of RX3/RX4.

  b) U_o – adjustment in the range of 100...105% of $U_{o\,nom}$ by resistors RX1 or RX2 or combinations of RX1/RX2.

  Double output units:

  a) U_o – trimming by resistor R2 in the range of 100...105% of $U_{o\,nom}$

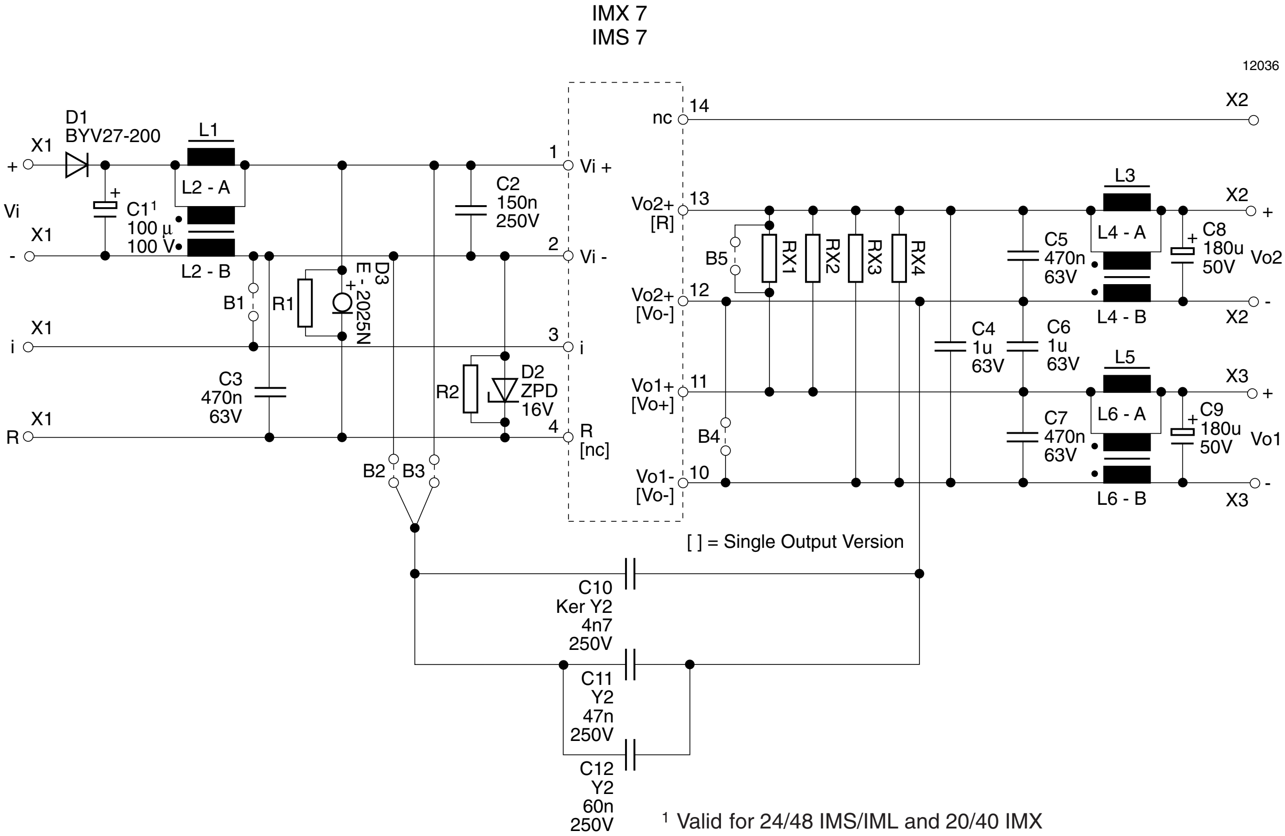
  b) U_o – trimming in the range of 70/75...100% of $U_{o\,nom}$ by a current diode together with a Zener diode D2 applicable for 24/48 IMS 7 and 20/40 IMX 7 types.
- Reduced output ripple (by approx. factor 5) by using chokes L3/L5 together with electrolytic capacitors C8/C9.
- Improved electromagnetic emission EN 55022, level B, lead length to load 1 m. (Level A for 110 IMX 7 types)

  This requires all capacitors and output chokes as per circuit diagram YSK 25300 S3 /01 whereby the coupling capacitor C10 connected to Vi– via jumper B2 is foreseen for 24/48 IMS/L types and 20/40/70 IMX 7 types.

  For 110 IMX 7 types the coupling capacitor C11 or C12 should be used connected to Vo+ via jumper B3.

  Note:
  - For single output units or double output units with the 2 outputs in parallel one filter set (L5 or L6-A/L6-B) together with C7 and C9 is sufficient.
  - Wire jumpers B2 and B3 should not be mounted together onto the PCB as this would cause a short circuit.
  - The coupling capacitors C10 or C11/12 should be Y2 ceramic types to maintain the outputs SELV

Application specific assemblies are available on request.



[1] Valid for 24/48 IMS/IML and 20/40 IMX
for 70 IMX use 150 V type
for 110 IMX use 200 V type

Fig. 9a
C/DMB IMX/S 7 circuit diagram

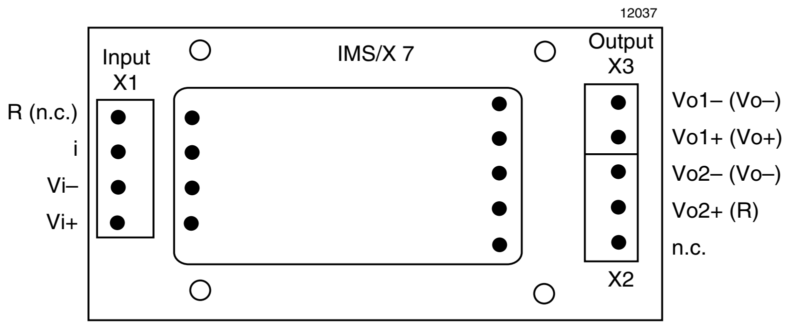


Fig. 9b
C/DMB IMX/S 7 arrangement of the terminals on the PCB

Note: Where the pin/terminal designations for single output units deviate from double output units they are shown in brakets.

Universal Mounting Bracket (DIN- and Chassis Mounting)

UMB-LHMQ

A special Universal Mounting Bracket has been designed for vertical or upright chassis- and DIN-Rail mounting of the 19" cassette type converters shown in table below.

Table 3: Mounting Bracket survey

Converter case size	Converter series	Chassis-mounting	DIN-mounting	Delivery content	Part number
L01, L04 H02, M02 Q01, Q03, Q04	SR, PSL H, M Q, PC, P	UMB-LHMQ	UMB-LHMQ	Alu-profile, two screws and a DIN-rail clamp with screw	HZZ00610

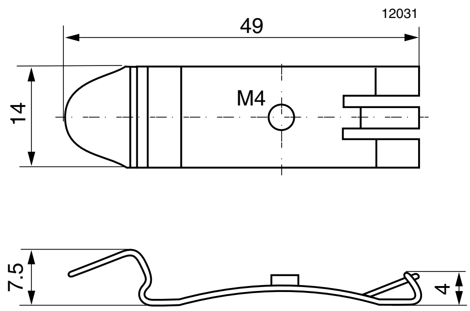


Fig. 10
DIN-rail clamp
Steel, galvanized

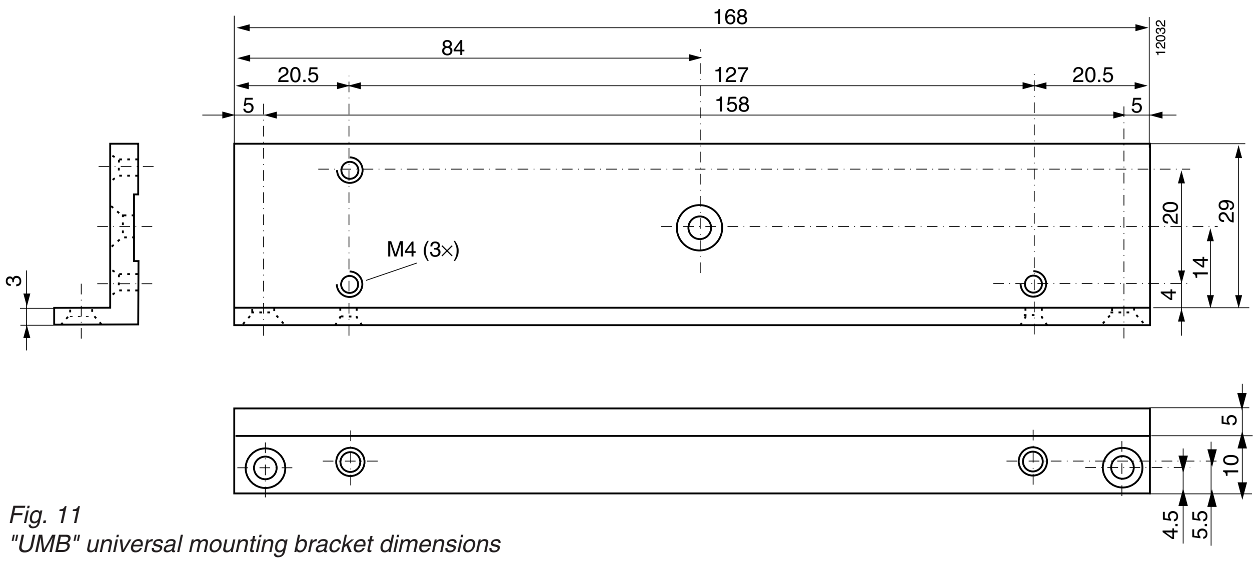


Fig. 11
"UMB" universal mounting bracket dimensions
Aluminium, untreated

UMB-W... (Shock resistant, DIN- and Wall Mounting)

For the DIN-rail snap-fit "Convert" Front End Line, two different mounting bracket sets are available on request. One set for wall mounting, the other for an additional shock resistant fixing to the DIN-rail in applications with higher vibration levels.

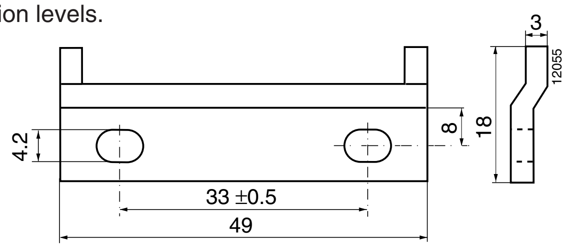


Fig. 12

Table 4: Mounting Bracket survey

Converter case	Converter series	Wall-mounting	DIN-mounting Shock resistant	Delivery content	Part number
W01	W	UMB-W		Two clamps, four countersunk screws M4, washers and spring washers	HZZ 00618
			UMB-WDIN	in preparation	

DMB-K/S, DMB-MHQ

By means of these DMB mounting kits, the S, K, PSS, PSK (DMB-K/S) and the M, H, Q (DMB-MHQ) converters can be adapted to the DIN rail. The kit consists of two aluminium brakets to be mounted on each side of the converter, including a clamp. The DMB-K/S kit contains two different sets of screws for the adaption of the brakets either to S/PSS or K/PSK converter types. The design of the kit is made such that the fixture is very tight and as a result the assembly can also be used for mobile applications.

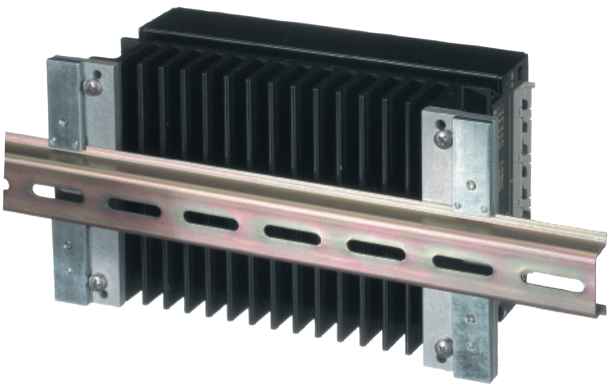


Table 5: Mounting bracket survey

Case size	Converter series	Type	Part number
S01 S02 K01 K02	PSS S PSK K	DMB-K/S	HZZ 00615
M02 H02 Q01	M H Q	DBM-MHQ	HZZ 00619

CMB-S

This mounting kit allows for chassis mounting of the S and PSS converters, if access is only possible from the front of the chassis. (If space conditions are very tight, option B1 or B can be used in place of the heat sink. Please refer to the description of the respective converter.)

This kit uses parts of the DMB-K/S kit since it consists of the same two brakets but without the clamps and fitted the other way round on the heat sink.

Table 6: Mounting bracket survey

Case size	Converter series	Type	Part number
S01 S02	PSS S	CMB-S	HZZ 00616

Isolation Pads for PCB Mounting

In applications where PCB mounting converters are placed on top of double sided boards, the use of Isolation Pads is recommended. These fibre pads avoid short circuits and provide excellent protection against possible damage to tracks. For selection and part numbers refer to table below.

Table 7 : Isolation Pad survey

Case size	Converter series	Isolation pad	Dimensions [mm]	Part number
A01	PSR, PSA	Isolation A	70 × 50 × 0.3	HZZ 01203
B02	PSB	Isolation B	107 × 71 × 0.3	HZZ 01205
C01 C03	xSR 20 PSC	Isolation C	152 × 86 × 0.3	HZZ 01206
2"×2"	IMR 6/15	Isolation 2"×2"	53 × 53 × 0.3	HZZ 01207

PCB-Tags for PCB Mounting

DC-DC and AC-DC converters in C01 case and Switching Regulators either in B02 or C03 cases may also be mounted directly onto PCB's. The connection between the converters' fast-on pins and the PCB can be easily made by means of PCB-Tags.

Type: PCB Tag
Delivery content: 10 pieces
Part number: HZZ01204

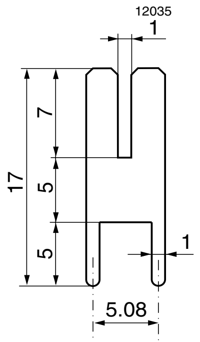
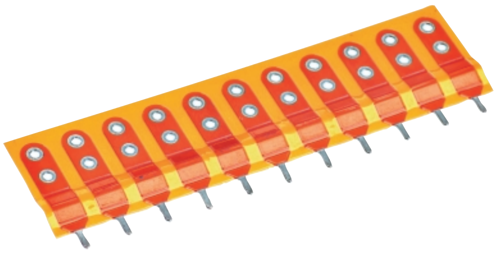


Fig. 13
PCB-Tag

Flexible H11 PCB

If cassette type converters with male H11 connectors (used for example in H or M series) are mounted on wiring boards, the connection between the wiring board and the male converter connector may be made using the special H11 Flexi-PCB together with the female STV-H11-FB/CO connector (see also: *Female connector* data).

Type: H11 Flexi-PCB
Part number: HZZ01208



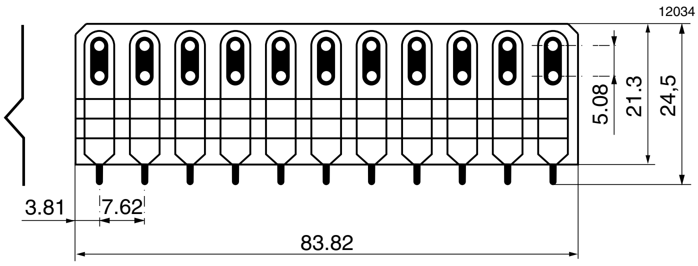


Fig. 14
H11 Flexi-PCB

Rack Systems

Complete 19" rack with side walls, transversal rails and mounting flanges. Six guiding rails are included for set up of a system with up to three T units together with a back plane, BPF or BPD type (T units and back plane not included).

The guiding rails shall be fixed to the rack by the delivered screws (12 screws M2.5 x 12 and 12 nuts).

The rack can also be used for different 19" cassette type converters like Q, M, K ect. (additional guiding rails may be necessary).

Part no.: MQB 02002
Size: 19"/3 U/84 TE

19" and 23" (IEC 60297-1, -2 and -3)

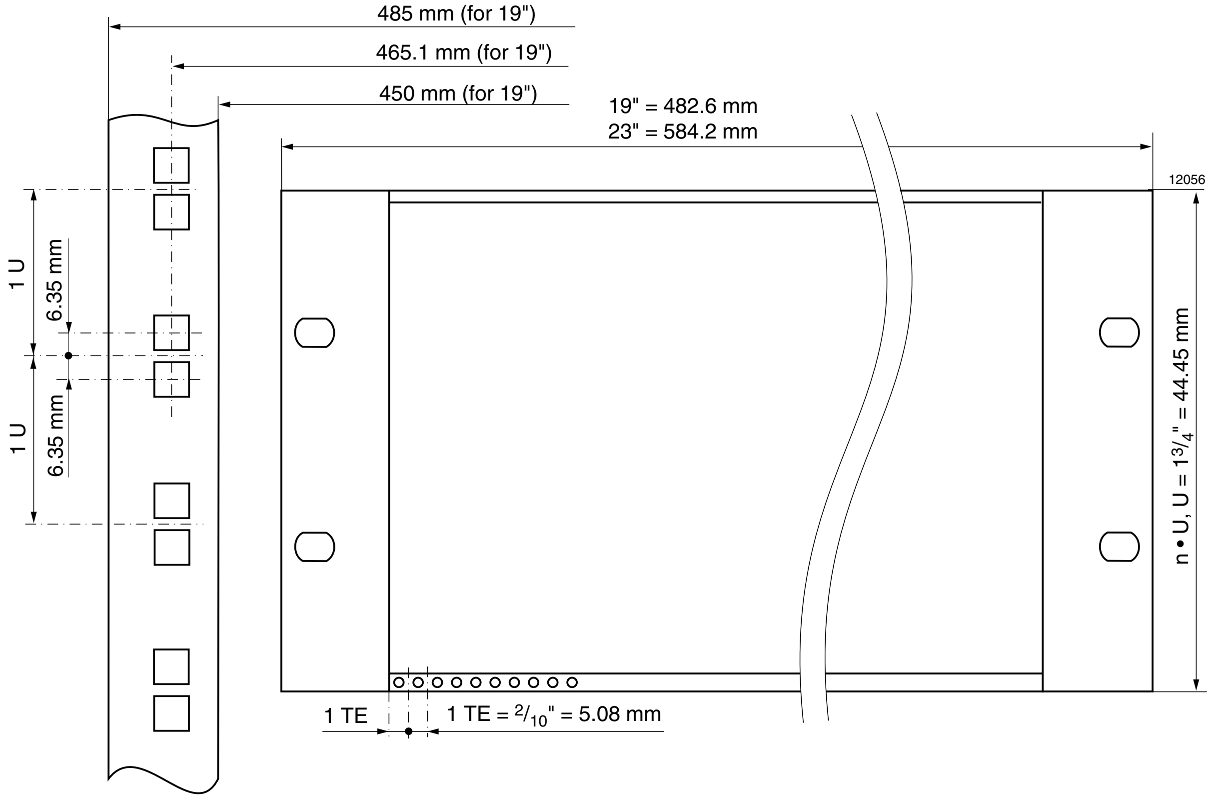


Fig. 1
19" and 23" rack systems

Dimensions in accordance to DIN 41494-1 (IEC 60297):
Width: 1 TE = 5.08 mm (0.20")
Height: 1 U = 44.45 mm (1.750")
(In Europa often *HE* instead of *U* is used.)
Tolerances ±0.2 mm, unless otherwise specified

Metric (IEC 60917)

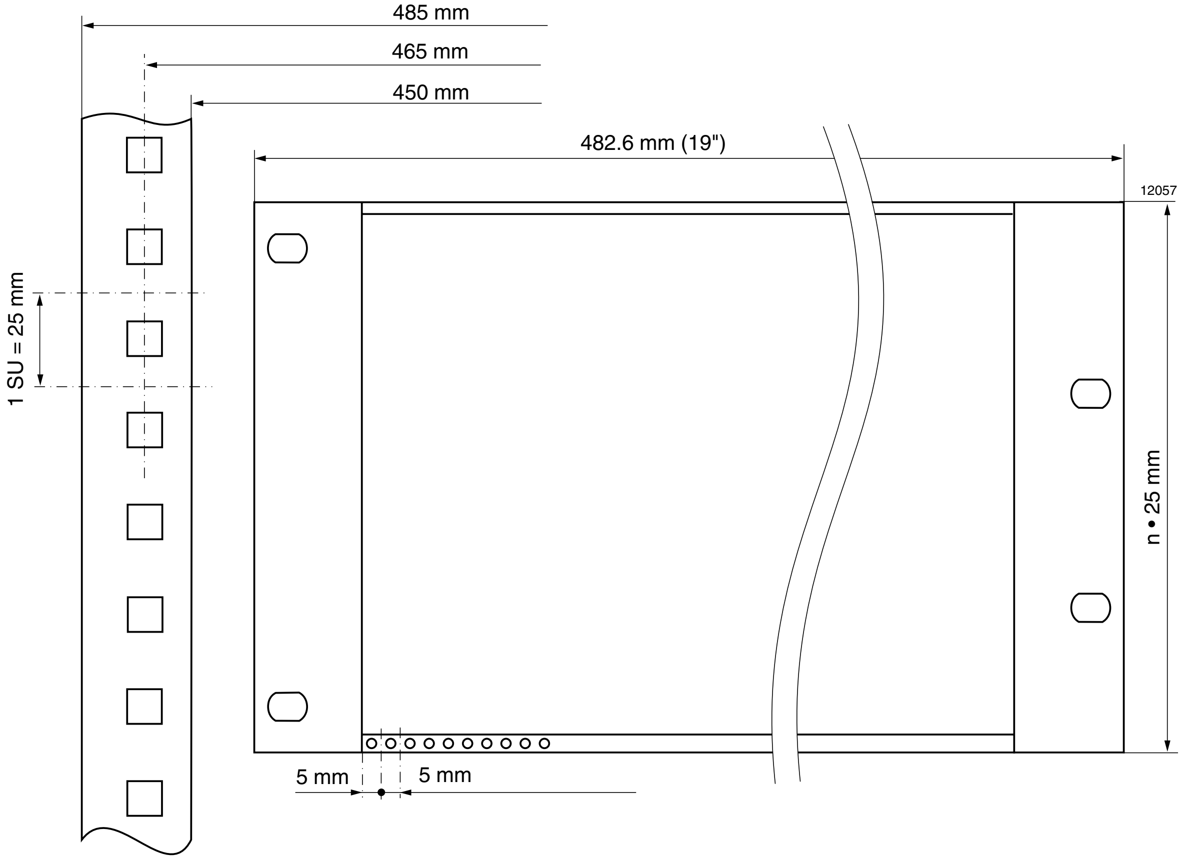
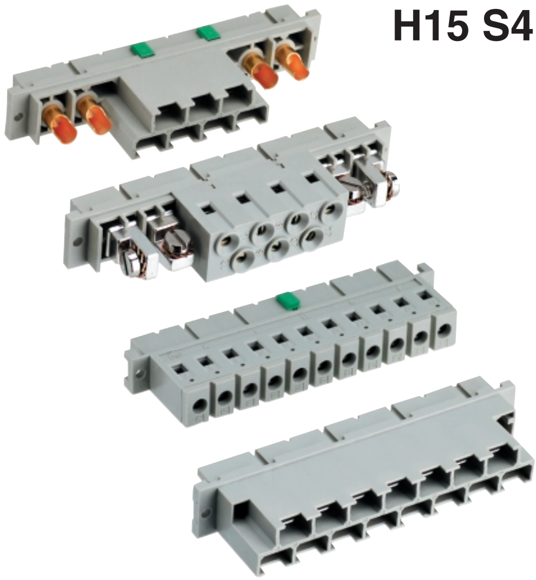


Fig. 2
Metric rack systems

Mating Connectors

H11
H15
H15 S4



Description

All 19" cassette type converters are equipped with either H11-, H15-, H15 S2 or H15 S4 male connectors. Mating female connectors are available as accessories according to the following tables. The four H-type connector versions are specially designed for power supply applications, capable of handling high operating currents. The connectors have an integrated code key system allowing many coding possibilities. Modules with high output current normally use two contacts in parallel to keep the voltage drop across the connector as low as possible.

H11 Connector

This connector has eleven contacts in one vertical column marked 2 to 32. Mating and mounting conditions are according to DIN 41612. The connector contacts are hard-silver-plated and correspond to quality class 1, with respect to electrical and mechanical life time.

Table 1: H11 Connector Survey

Female connector type	Part no.	Description of terminals	Integrated coding
STV-H11-F/CO	HZZ 00101	Faston straight 6.3 × 0.8 mm	yes
STV-H11-FS/CO	HZZ 00104	Faston straight 6.3 × 0.8 mm, solderable (short moulding)	yes
STV-H11-FSR/CO	HZZ 00102	Screw terminals, 90°, 2.5 mm^2 (AWG 13) max,	yes
STV-H11-FB/CO [1]	HZZ 00103	Solder pin 5.2 mm, ∅ 1.6 mm	yes
STV-H11-FBER/CO [2]	HZZ 00113	Solder pin 4.3 mm, ∅ 1.0 mm	yes
STV-H11-FP/CO [2]	HZZ 00111	Press fit 6.5 mm, ∅ 1.0 mm	yes
STV-H11-FBG/CO [2]	HZZ 00199	Solder pin 5.2 mm, ∅ 1.6 mm, gold-plated contacts	yes

[1] See also matching Flexi-PCB for PCB mounting of converters (see *Mounting Supports*)
[2] Available on request

This connector type (male version) is used in the following converter series (case size):
H (H02), M (M02), SR (L01) and PSL (L04).

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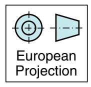
Extraction Tool for High Current Contacts	6
Connector Retention Clip V	6
Connector Retention Braket CRB	7
Cable Hood	7
Cable Hood Retention Bracket CHRB	7

Mechanical Dimensions

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified



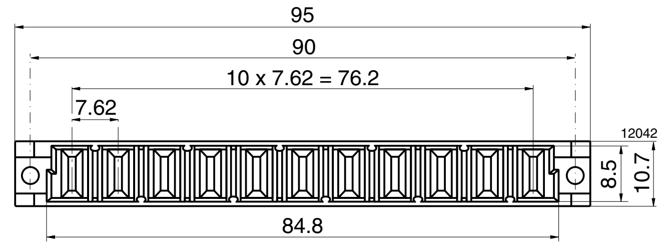


Fig. 1
H11 frontal view, relating to figures below

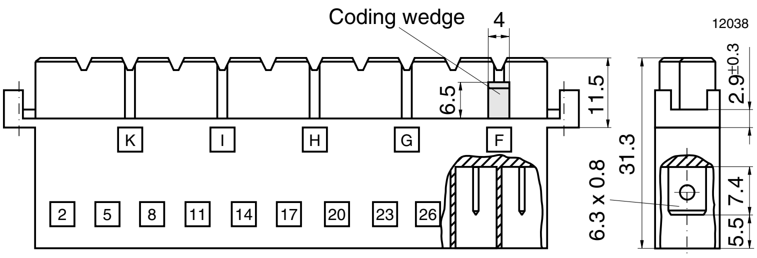


Fig. 2
STV-H11-F/CO,
Faston cable terminals 6.3 × 0.8 mm

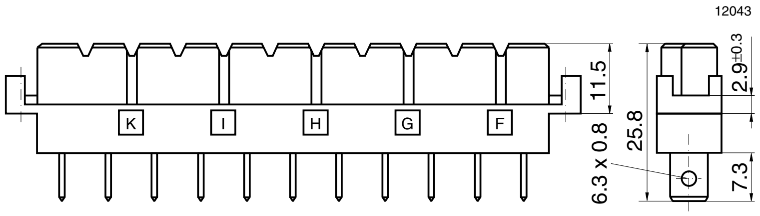


Fig. 3
STV-H11-FS/CO,
Faston cable terminals 6.3 × 0.8 mm,
solderable (short moulding)

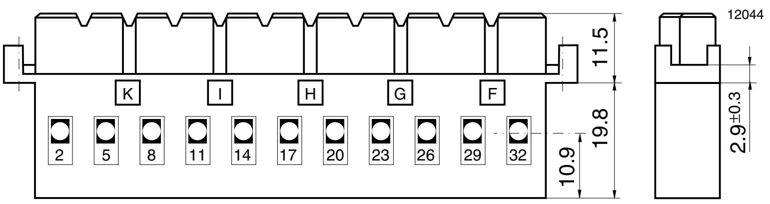


Fig. 4
STV-H11-FSR/CO,
screw terminals (max. 2.6 mm²/AWG 13)

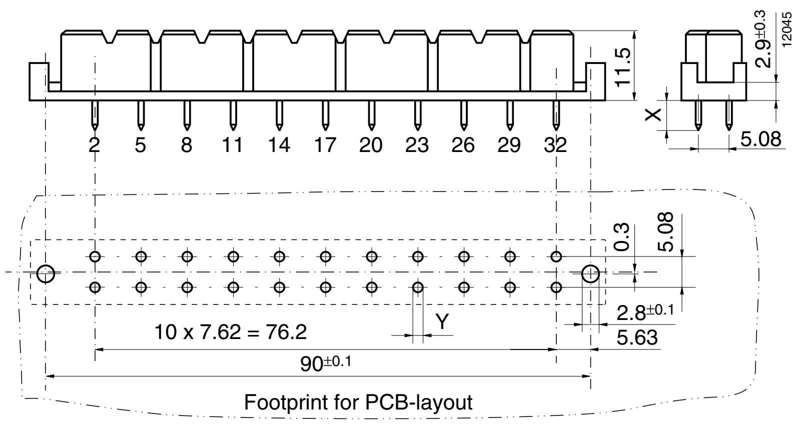


Fig. 5

STV-H11-FB/CO, soldering pins — *X = 5.2 Y = Ø 1.6*

STV-H11-FBG/CO, soldering pins — *X = 5.2 Y = Ø 1.6*

STV-H11-FBER/CO, soldering pins — *X = 4.3 Y = Ø 1.0*

STV-H11-FP/CO, press insert pins — *X = 6.5 Y = Ø 1.0*

H15 Connector

This connector has fifteen contacts in two vertical columns marked 4 to 32 and is designed to meet DIN 41612. The connector contacts are hardsilver-plated and correspond to quality class 1, with respect to electrical and mechanical life time.

This connector type (male version) is used in the following converter series (case size):

PSS (S01), S (S02), Q (Q01) and for PSK (K01) and K (K02) only for output current ≤18 A.

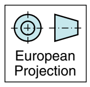
Table 2: H15 Connector Survey

Female connector type	Part no.	Description of terminals	Integrated coding
STV-H15-F/CO	HZZ 00106	Faston straight 6.3 × 0.8 mm	yes
STV-H15-FSR	HZZ 00107	Screw terminals, 90°, 2.5 mm^2 (AWG 13) max.	no
STV-H15-FB/CO	HZZ 00112	Solder pin 4.0 mm, ∅ 1.6 mm	yes
STV-H15-FP/CO [1]	HZZ 00117	Press fit 4.5 mm, ∅ 1.0 mm (double pin version)	yes
STV-H15-FBG/CO [1]	HZZ 00197	Solder pin 4.0 mm, ∅ 1.6 mm, gold-plated contacts	yes
STV-H15-FWS/CO	HZZ 00114	Solder pin 10.1 mm, ∅ 1.6 mm, 90° bent contacts	yes

[1] Available on request

Mechanical Dimensions

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified



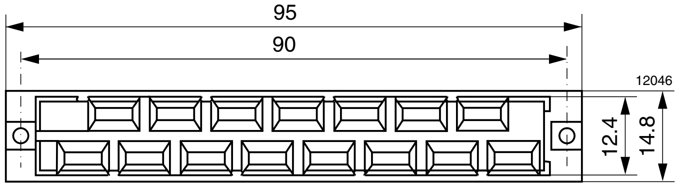


Fig. 6
H15 frontal view, relating to figures below

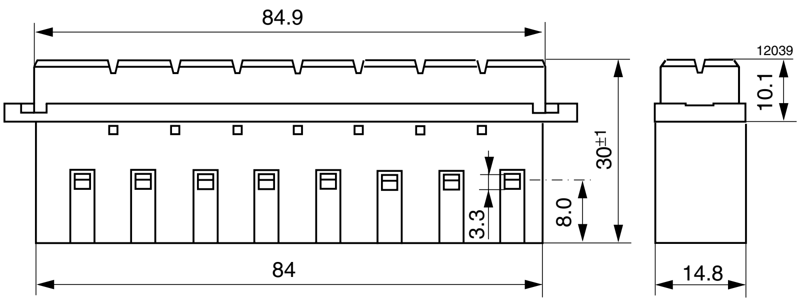


Fig. 7
STV-H15-FSR, Screw terminals, no coding
STV-H15-F/CO, Faston cable terminals 6.3 × 0.8 mm (identical dimensions, but not shown)

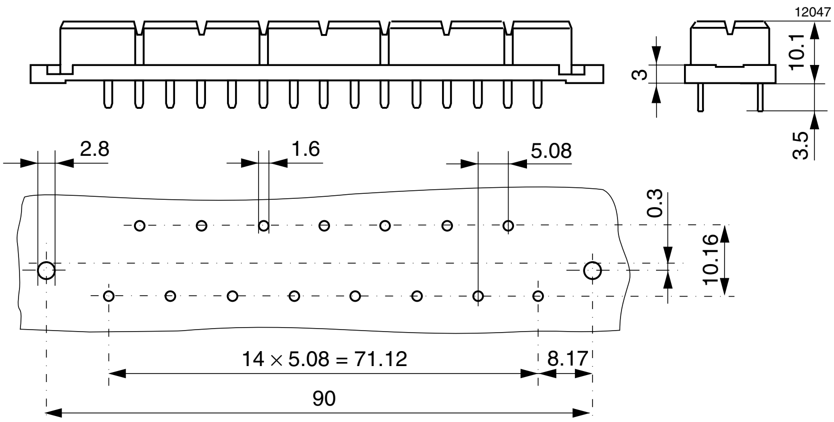


Fig. 8
STV-H15-FB/CO, soldering pins

Footprint for PCB-layout

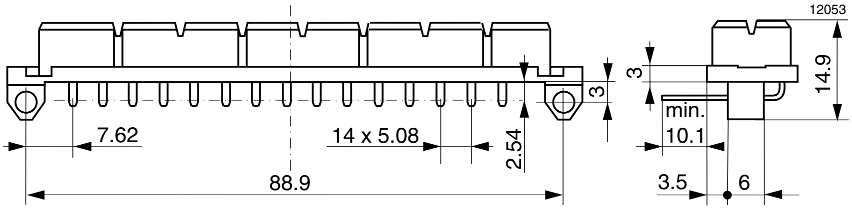


Fig. 9
STV-H15-FWS/CO
Solder pins for pcb mounting

H15 S2, H15 S4 Connector

This special connector is a derivative of the H15 having seven standard contacts as above, combined with two (H15 S2) or four (H15 S4) high current contacts according to DIN 41626. The high current contacts are specially designed to handle currents from 20 A up to 40 A. They correspond to quality class 1, with respect to electrical and mechanical life time. The contact material is high quality Beryllium-Copper (CuBe treated) with a gold-plated surface.

To install the high current contacts carefully follow the assembly instructions. It is extremely important to solder cables, screw cable terminals or heat shrink sleeves to high current jacks first, before inserting them into the moulding. Paralleled converters should preferably be interconnected on current bars or at a star point.

Using screw versions, the two outer high current jacks may be inserted at a 90° angle in order to prevent possible short circuits between the cable terminals, especially in applications with high vibration environment. Heat shrink sleeves might be necessary for further isolation purposes or to keep clearance and creepage distances at specified levels.

An Extraction Tool allows removal of the high current contacts for replacement (see: *Extraction Tool*).

Caution: The use of an adequate cable strain relief device (e.g. Cable Hood etc.) is essential in order to protect the high current contact jacks from damage. Never screw, solder or manipulate these contacts when the connector is plugged into the male connector! The use of highly flexible cables is strongly recommended.

This connector type (male version) is used in the following converter series (case size):

PSK (K01), K (K02) and P with output current ≥20 A.

Table 3: H15 S2/S4 Connector Survey

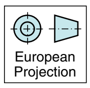
Female connector type	Part no.	Description of terminals coding	Integrated
STV-H15 S2-F/CO	HZZ 00115	11 Faston straight 6.3 × 0.8 mm, set of 2 solder jacks [1]	yes
STV-H15 S2-FSF/CO	HZZ 00116	11 Faston straight 6.3 × 0.8 mm, set of 2 screw jacks [1]	yes
STV-H15 S4-F/CO	HZZ 00105	7 Faston straight 6.3 × 0.8 mm, set of 4 solder jacks [1]	yes
STV-H15 S4-FSF/CO	HZZ 00110	7 Faston straight 6.3 × 0.8 mm, set of 4 screw jacks [1]	yes
STV-H15 S4-FLS/CO	HZZ 00109	7 screw terminals, 90°, 2.5 mm^2, set of 4 solder jacks [1]	yes
STV-H15 S4-FSR/CO	HZZ 00108	7 screw terminals, 90°, 2.5 mm^2, set of 4 screw jacks [1]	yes

[1] Spare set of high current jacks are available on request

Delivery content: H15 S2 (S4) moulding, two (four) high current jacks and assembly instructions. Screw versions also include four M4 screws with washers and heat shrink sleeves.

Mechanical Dimensions

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified



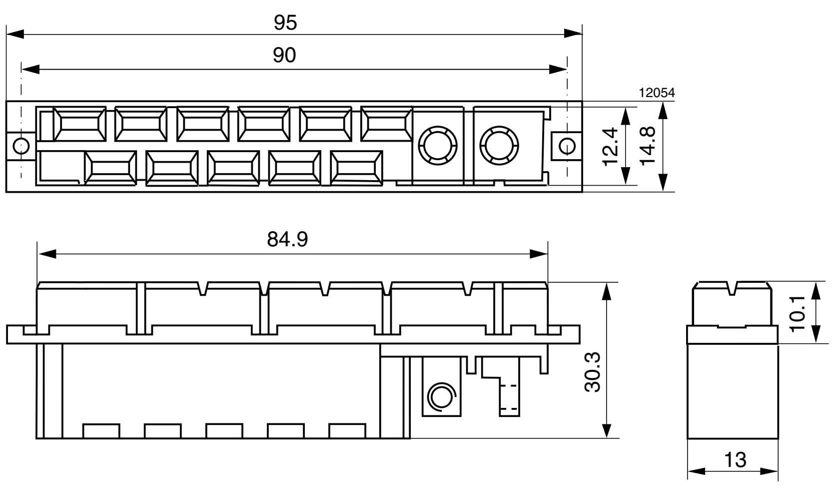


Fig. 10
STV-H15 S2-FSF/CO
Faston cable terminals and two high current screw terminals (solder terminals see H15 S4)

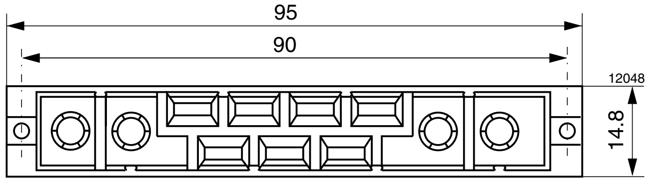


Fig. 11
H15 S4 frontal view, relating to figures below

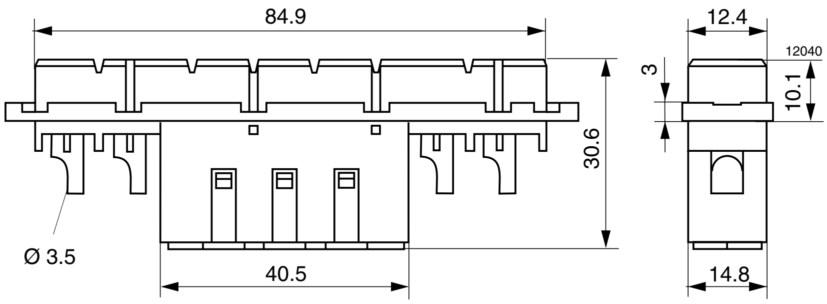


Fig. 12
STV-H15 S4-FLS/CO, screw terminals and four high current soldering terminals

STV-H15 S4-FSR/CO, screw terminals and four high current screw terminals (not shown)

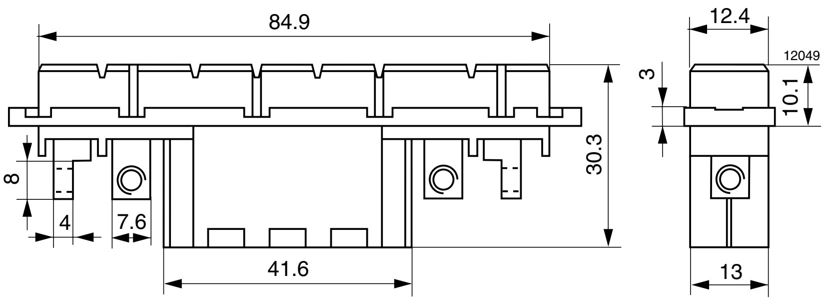


Fig. 13
STV-H15 S4-FSF/CO, Faston cable terminals and four high current screw terminals

STV-H15 S4-F/CO Faston cable terminals and four high current soldering terminals (not shown)

Technical Data

Table 4: Connector data

Type	**H11**	**H15**	**H15 S2/H15 S4** Standard	High current
Mechanical data				
Number of poles	11	15	11/7	2/4
Mating cycles	500	500	500	500
Insertion/withdrawal forces max.	80 N	90 N	90 N	10/1.6 N
Electrical data				
Clearance distance contact/ground	≥4.5 mm	≥4.5 mm	≥4.5 mm	
Creepage distance contact/contact	≥8.0 mm	≥8.0 mm	≥8.0 mm	
Test voltage V_{rms}	3100	3100	3100	
Operation voltage V AC	500	500	500	
Operation current per contact T_A 20°C T_A 70°C T_A 95°C	20 A 17 A 14 A	15 A 12 A 9 A	15 A 12 A 9 A	40 A 35 A 25 A
Contact resistance	≤8 mΩ	≤8 mΩ	≤8 mΩ	≤1 mΩ
Isolation resistance at 100 V DC	≥10^{12} Ω	≥10^{12} Ω	≥10^{12} Ω	
Miscellaneous data				
Operating temperature	–55...125°C	–55...125°C	–55...125°C	
Contact surface	6 µm Ag	6 µm Ag	6 µm Ag	1.3 µm Au
Moulding material	PBTP/PC	PBTP/PC	PBTP	
Flammability	UL 94V-0/UL 94 V-1	UL 94 V-0/UL 94 V-1	UL 94 V-0	
Approvals				

Code Key System

An efficient coding system is of great importance and cannot be valued highly enough in complex electronic systems. Since power supplies handle high currents and voltages any false connection could not only be extremely dangerous but also quite costly.

This integrated polarizing system allows effortless coding by the simple insertion of Coding Wedges into the female connector mouldings. The corresponding counter-parts, i.e. the coding tabs of the male moulding just have to be broken off to match the right female part. Major advantages are high mechanical stability and ease of handling. The H11 connectors have 10 and the H15 connectors have 8 coding positions. Using 4 coding wedges results in 210 (H11) respectively 70 (H15) different coding possibilities. Coding wedges are available as accessories to female connectors with the following part number:

Description: Coding wedge (Codierkeil)
Delivery content: 5 pcs.
Part Number: HZZ 00202

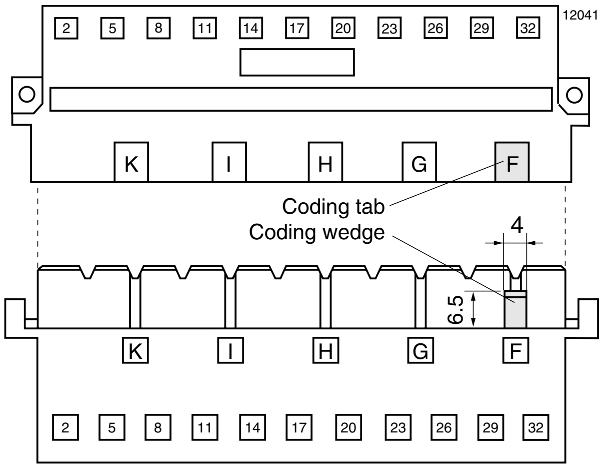


Fig. 14
Integrated code key system

Extraction Tool for High Current Contacts

High current plugs and jacks can be disassembled from the moulding by means of a special Extraction Tool (H15 S2, H15 S4). Holding the extraction tool over the centre of the connector's female contact the outer part of the extraction tool should be fed between the moulding and the outside of the female contact itself. This releases the spring clip fixing the contacts, in order to pull the contacts out of their moulding for replacement. If the operation is performed correctly very little force is required. Extreme care should be taken since incorrect procedure and excessive force could damage the tool and/or connector.

This tool is available as an accessory for both screw or solder high current contacts.

Note: In order to avoid damage never manipulate high current contacts when plugged-in!

Description: Extraction Tool
Part Number: HZZ 00150

Fig. 15
Extraction tool

Connector Retention Clip V

The retention clip V is an accessory which guarantees secure connection even under severe vibration, as for example in mobile applications. One connector retention system fits to almost all units and all of the aforementioned connector types.

The following converter series are delivered with pre-punched holes in the back plate for fast field-mounting of retention clips:

H, M, K, PSK, S, PSS and T (Q series only in combination with Mounting Plate Q, see Mounting Supports)

Description: Retention Clips V
Delivery content: 2 pcs.
Part Number: HZZ 01209

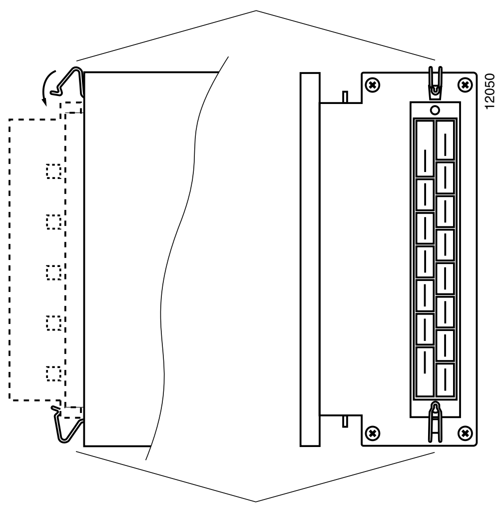


Fig. 16
Connector retention clip

Connector Retention Bracket CRB

An alternative to the above mentioned retention clip V is the connector retention bracket. They are attached to the back plate by one screw each with a torque of 20 to 30 Ncm.

Table 5: Connector Retention Bracket Survey

Connector series	Type Part number	Delivery content
H, M K, PSK S, PSS T	CRB-HKMS HZZ 01216	2 brackets 2 screws 2 washers
Q, P PC	CRB-Q HZZ 01217	

Cable Hood

A cable connector housing or Cable Hood is available for all female H15, H15 S2 and H15 S4 type connectors with faston connectors (Not suited for screw terminals). It serves as a strain relief, isolates connections and protects cables.

Description: KSG-H15/H15 S4
Delivery content: Housing shell, cable duct with covers, cable clip, cable boot and screws
Part number: HZZ 00141

If using the cable hood together with retention clips a special version is available, where both sides of the hood are slightly modified in order to allow for insertion of the clips. The cable hood with retention clips has been tested to withstand vibrations according to IEC 86-2-6: 5 g, 6 directions, 2.5 hours per axis.

Description: KSG-H15/H15 S4-V
Delivery content: Housing shell, cable duct with covers, cable clip, cable boot and screws
Part Number: HZZ 00142

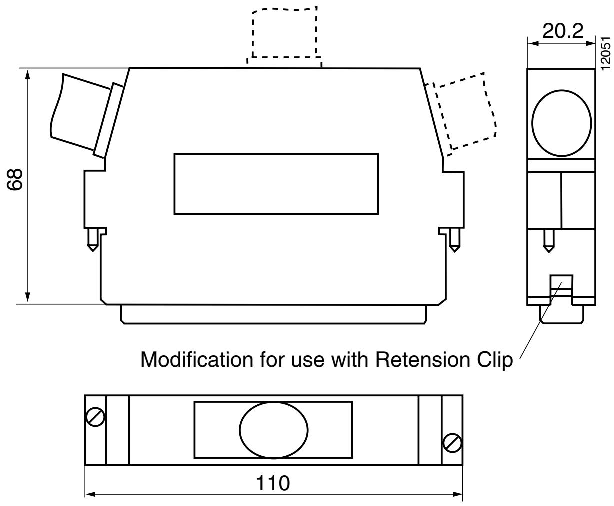


Fig. 17
Cable hood for H15 and H15 S4 connectors

Cable Hood Retention Bracket CHRB

The cable hood can also be fixed to the converter case with two U-shaped cable hood retention brackets.

Description: CHRB-KSG
Delivery content: Two brackets with two screws
Part number: HZZ 01218

Temperature Sensors

Description

Power-One offers a wide range of battery charger systems for power requirements of 50 Watt up to 8000 Watt.

For this purpose Power-One supplies temperature sensors and adapted power supplies. The batteries (lead acid batteries) are charged according to the battery temperature and the ambient temerature. If the battery is fully charged it is maintained at the float charge voltage which represents the optimum point for maximum available energy in case of need and optimum life expectancy of the battery. The type of sensor needed is defined mainly by three parameters: The nominal battery voltage (e.g. 24 V or 48 V), the temperature coefficient of the battery (e.g. –3.0 mV/K/cell) and the nominal floating charge voltage per cell of the battery at 20°C (e.g. 2.27 V/cell). The latter two are defined in the specifications of the battery given by the respective battery manufacturer.

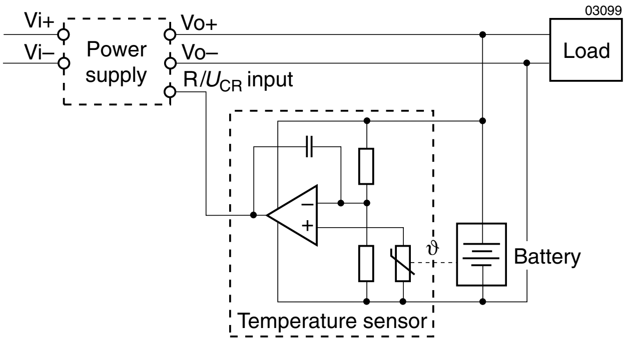


Fig. 1
Functional description

Temperature Sensors for T and U units

T and U units feature a cell voltage selector switch (feature Z) to set the required floating charge voltage at 20°C directly at the unit. If this Z switch is used the 2.23 V/cell sensor types should be selected in any case as a basis and the selection criteria are only the temperature coefficient of the battery and the nominal battery voltage. If for example a 24 V battery is used which has a cell voltage of 2.27 V/cell and a temperature coefficient of –3.5 mV/K/cell, the sensor type is S24-2.23-35-02. The setting on the Z switch of the T or U unit should be 2.27.

For units without the Z selector switch a sensor according to both criteria should be selected. In our example it would be S24-2.27-35-02.

For further details please consult the T or U datasheet.

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Description	1
Temperature Sensors for T and U units	1
Mechanical Dimensions	2
Temperature Sensors for M, H, S, K, KP, PSx, LW, OK Units	3
Mechanical Dimensions	3
Fail Safe Operation	4

Table 1: Type survey T sensors

Nominal battery voltage [V]	Sensor type	Part no.	Cell voltage [mV]	Temp. coefficient [mV/K/cell]	Cable length [m]
24	S24-2.23-30-02	MQC02052	2.23	–3.0	2
24	S24-2.23-35-02	MQC02053	2.23	–3.5	2
24	S24-2.23-45-02	MQC02051	2.23	–4.5	2
36	S36-2.23-30-02	MQC02081	2.23	–3.0	2
36	S36-2.23-35-02	MQC02082	2.23	–3.5	2
36	S36-2.27-35-02	MQC02083	2.27	–3.5	2
48	S48-2.23-30-02	MQC02008	2.23	–3.0	2
48	S48-2.23-35-02	MQC02009	2.23	–3.5	2
48	S48-2.23-40-02	MQC02013	2.23	–4.0	2
48	S48-2.23-45-02	MQC02012	2.23	–4.5	2
48	S48-2.27-30-02	MQC02010	2.27	–3.0	2
48	S48-2.27-35-02	MQC02007	2.27	–3.5	2
48	S48-2.27-45-02	MQC02006	2.27	–4.5	2

Other types for different cell voltages or temperature coefficients are available upon request.

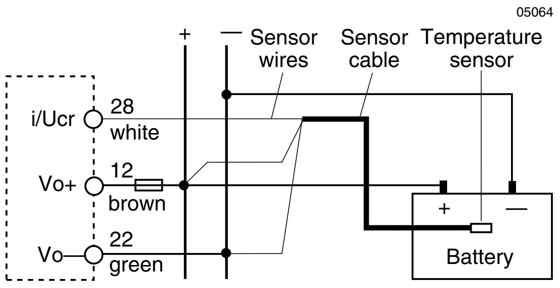


Fig. 2:
Connection to the T unit.

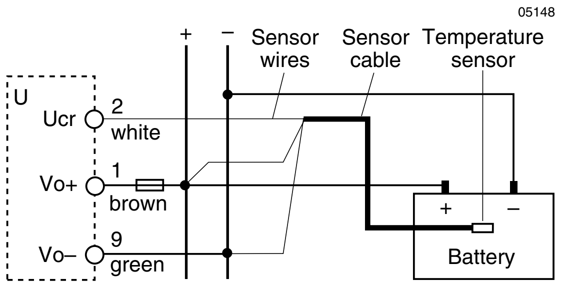


Fig. 3:
Connection to the U unit.

Mechanical Dimensions

All dimensions in mm, tolerances ±0.3 mm unless otherwise specified.

European Projection

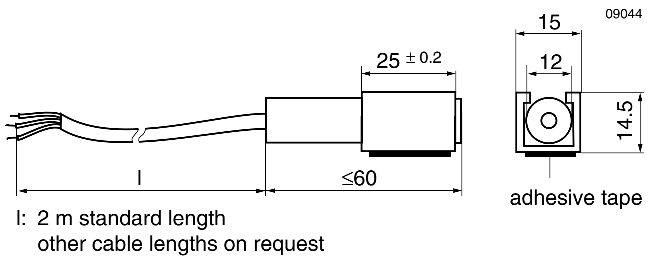


Fig. 4
T and U temperature sensor with mounting fixture.

Temperature Sensors for M, H, S, K, KP, PSx, W, OK Units

With M, H, S, K, KP, PSx, W and OK units the sensor signal acts on the R pin to adjust the output voltage relative to the battery temperature and the ambient temperature. As these units in contrast to the T and U units do not feature a cell voltage selector switch (Z switch) the sensor selection criteria is in every case both the cell voltage and the temperature coefficient (beside the nominal battery voltage).

If the application uses for example a 48 V battery with a cell voltage of 2.23 V/cell and a temperature coefficient of –3.0mV/K/cell the sensor S-KSMH48-2.23-30-2 should be selected.

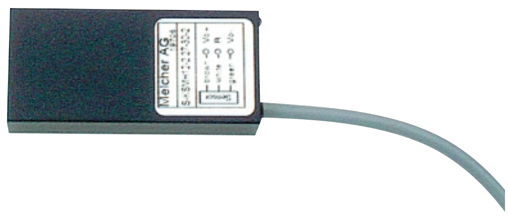


Table 2: Type survey S-KSMH sensors

Nominal battery voltage [V]	Sensor type	Part no.	Cell voltage [mV]	Temp. coefficient [mV/K/cell]	Cable length [m]
12	S-KSMH12-2.27-30-2	MQC03005	2.27	-3.0	2
24	S-KSMH24-2.27-35-2	MQC03002	2.27	-3.5	2
24	S-KSMH24-2.27-30-2	MQC03004	2.27	-3.0	2
48	S-KSMH48-2.27-35-2	MQC03001	2.27	-3.5	2
48	S-KSMH48-2-27-30-2	MQC03003	2.27	-3.0	2

Other types for different cell voltages or temperature coefficients are available upon request.

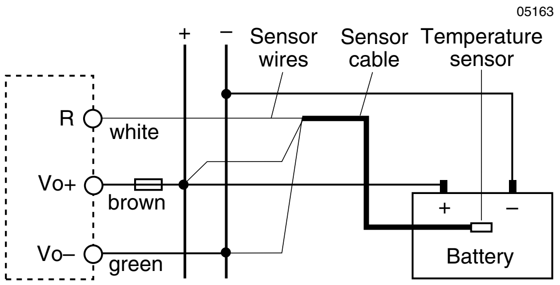
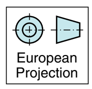


Fig. 5
Connection to a M, H, S, K, KP, LW or OK unit.

Mechanical Dimensions

All dimensions in mm, tolerances ±0.3 mm unless otherwise specified.



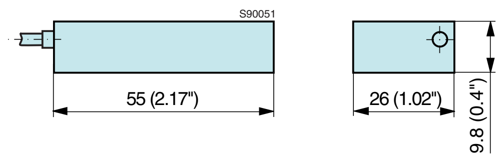


Fig. 6
S-KSMH temperature sensor.

Fail Safe Operation

To prevent overcharging of the battery but still maintain a minimum charging in case of interruption of the sensor signal cable to the power supply, Power-One has designed units with a special nominal output voltage setting. These units differ from the respective standard units described in the datasheet in the nominal output voltage and output current settings. Without the sensor connected to the R pin the output voltage will be higher than the nominal battery voltage to avoid a discharging of the battery but still lower than the theoretically needed float charge voltage. As soon as the sensor is connected to the R pin the output voltage will be set to the correct value.

Table 3:

Nominal battery voltage [V]	**Output voltage setting** (20°C) [V]
12	12.84
24	25.68
36	38.52
48	51.36
60	64.2

Tabel 4: Special units for battery charging

U_{batt} [V]	P_o 50 Watt	P_o 70 Watt	P_o 100 Watt	P_o 150 Watt	P_o 250 Watt
12	LM 1781-7R	LH 1781-2R	LS 4740-7R	LK 4740-7R	
24	LM 1782-7R	LH 1782-2R	LS 5740-7R	LK 5740-7R	LKP 5740-6R
36	LM 1783-7R	LH 1783-2R			
48	LM 1784-7R	LH 1784-2R	LS 5740-7R	LK 5740-7R	LKP 5740-6R
60	LM 1785-7R	LH 1785-2R			

Higher power requirements can be covered by paralleling of these units. Complete microprocessor controlled systems of un-interuptable power suplies (UPS) are realized by our Applications Center. Please consult your local Power-One representant.

Filters and Ring Core Chokes

FP Series
L Series
LP Series

Description

These Filters and chokes are designed to reduce input interference and/or output ripple voltages occurring in applications with switched mode power supplies. Since all our filters contain a Moly Permalloy Powder (MPP) ring core they feature very low DC losses as well as high DC magnetisation and operate perfectly at the input and/or output of switching regulators ensuring effective filtering even at elevated DC current levels. These special characteristics allow the chokes to be operated at DC currents which considerably exceed the rated current, by accepting a corresponding gradual loss of inductance (unlike ferrite core chokes where inductance rapidly decreases above a certain DC magnetising level).

In applications where switching regulators have long supply lines, filters and chokes are used in order to prevent oscillations caused by their negative input impedance. For further information refer also to switching regulator data for "Option L", and to section: *Technical Information: Installation & Application*.

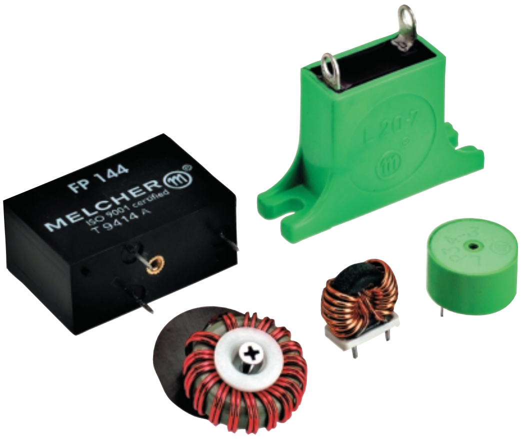


Table 1a: Type survey of FP filter blocks

Filter type	Part number	Matching switching regulator type
FP 38	HZZ 00903	PSR 54 PSA 55 PSA 5A2 PSA 5A5 PSA 123 PSA 153
FP 80	HZZ 00904	PSR 53 PSR 122.5 PSR 152.5 PSR 242 PSR 362 PSA 242.5
FP 144	HZZ 00905	PSA 121.5 PSA 151.5 PSA 241.5 PSA 361 PSA 481

Table 1b: Type survey ring core chokes

Type	Inductivity	I_{Ln}	Single coil	Symm. coil	Part number
LP 34-3	34 µH	3 A	•		HZZ 00501
L 20-7	20 µH	7 A	•		HZZ 00502
LP 20-7	20 µH	7 A	•		HZZ 00503
LP 183	2 × 183 µH	8 A		•	HZZ 00504

Filter Blocks FP Types

The filter blocks contain, in addition to a MPP ring core, a capacitor and an attenuation resistor, capable of handling the high ripple currents seen at the input of switching regulators. This forms a complete external filter system optimised to prevent oscillations and to reduce superimposed interference voltages and currents, specially designed for use in PCB applications together with switching regulators in an A01 case size. For selection of filters refer to the type survey.

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Description 1
Filter Blocks FP Types 1
Low-Loss Ring Core Chokes L/LP-Series 3
Mechanical Dimensions 5

Electrical Data Filter Blocks

General Condition: $T_A = 25\,°C$ unless otherwise specified

Table 2: Filter blocks FP

Characteristics		Conditions	FP 38 min	FP 38 typ	FP 38 max	FP 80 min	FP 80 typ	FP 80 max	FP 144 min	FP 144 typ	FP 144 max	Unit
I_{Fn}	Rated current	$L = 0.75\ L_o$		4			4			2		A DC
U_{Fn}	Rated voltage	$T_{C\,min}...T_{C\,max}$	5		40	5		80	15		144	V DC
R_F	Ohmic resistance		18	20	22	18	20	22	90	95	100	mΩ
L_o	No load inductance	$I_L = 0,\ T_{C\,min}...T_{C\,max}$	30	34	38	30	34	38	88	100	112	µH
T_A	Ambient temperature	$I_F = I_{Fn}$	–40		80	–40		80	–40		95	°C
T_C	Case temperature		–40		92	–40		92	–40		98	
T_S	Storage temperature		–40		100	–40		100	–55		100	

For currents $I_F > 4$ A the following derating takes place: $T_{A\,max} = 100 - 1.3 \bullet I_F^2$ [°C], $T_{C\,max} = 100 - 0.49 \bullet I_F^2$ [°C]

Input Interference Reduction

An AC ripple current can be measured at the input of any switching regulator, even if they are equipped with an input filter. Depending on the types of filters used, common and/or differential mode interferences can be reduced. They will also help to further increase the surge and burst immunity of the power supplies.

The FP filters considerably increase the source impedance of the regulators superimposed interference, to a value which is normally high in comparison to the impedance of the source (Z_{Line}). The interference currents are therefore practically independent of their source impedance. The filter will reduce these currents by approximately 25 dB at a frequency of 150 kHz.

The interference voltages at the filter input are due to the remaining interference currents flowing through the source impedance. The resulting interference voltage reduction can be seen in the following figure. For frequencies above the regulator switching frequency the attenuation will increase (up to 2 MHz approx.).

Parallel operation: When several switching regulator inputs are connected in parallel, each regulator should be equipped with a separate input filter. Interconnections should only be made in front of the filter or at its input Uii (i. e. the central ground point should be before or at the filter and under no circumstances at the regulator input).

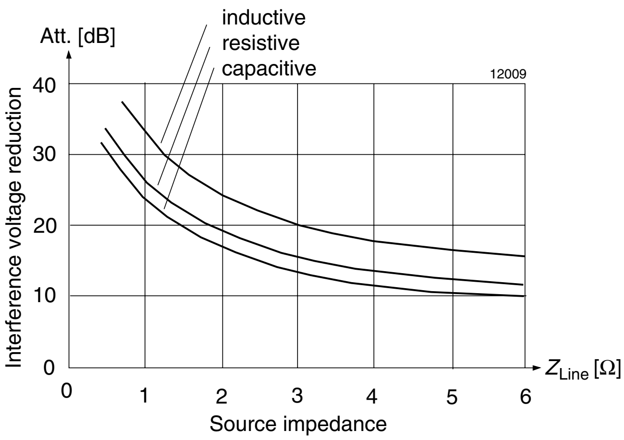


Fig. 1
Interference voltage reduction with FP filters at f = 150 kHz

Reduction of Output Ripple

Even though switching regulators have an inherently low output ripple, certain sensitive applications need even further reduction. In such cases, the filters designed to reduce disturbances at the input, can also be used for reducing the ripple on the output voltage (even better results with regard to the ripple and dynamic control deviation can be achieved by using low-loss ring core chokes in combination with an external capacitor, see below).

The output ripple can be reduced by the use of filter blocks by about 24 dB. The formula for the ripple u_R at the load R_L is as follows:

$$u_R = 0.063 \bullet u_o$$

(Ripple voltage u_o is given for specific regulators in the corresponding data section).

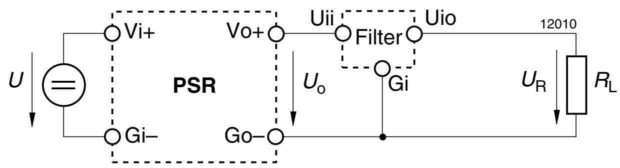


Fig. 2
Reduction of voltage interference by FP filters

Consider, that the filter not only affects the output ripple but can also influence the voltage across the load R_L in the event of load changes. The static load regulation increases with the ohmic resistance of the choke i.e. 24 mV/A for the FP 38 and FP 80 filters and 95 mV/A for the FP 144 filter.

Typical Application

The example in figure *Reduction of voltage interference by FP filters* shows a switching regulator operating from a battery ($R_i < 0.5\ \Omega$) with long supply lines (e.g. 2 m). The resulting superimposed interference voltage U_{SL} may be measured at the regulators input. The connection of a filter in front of the power supply will reduce this interference accordingly:

1. The regulator's source impedance is mainly inductive because of the low battery impedance and the long supply lines. It can be calculated as follows:

   $|Z_{Line}| \cong 2\pi \cdot f_S \cdot L_{Line} \cdot 2\,l$

   $|Z_{Line}| \cong 2\pi \cdot (150 \cdot 10^3) \cdot 10^{-6} \cdot 2 \cdot 2 \cong 3.8\ \Omega$

   f_S: Switching frequency (150 kHz)

   L_{Line}: Supply line inductance (typically 1µH/m)

   l: Length of single supply line (twice for positive and negative path)

2. This example shows, that with an inductive source impedance of 3.8 Ω, the insertion of the filter results in an interference voltage reduction of approx. 18 dB (see fig.: *Interference voltage reduction with FP filters at f = 150 kHz*).
3. The original superimposed interference voltage will be reduced by a factor of approx. 8:

   $U_{SF} = U_{SL} \cdot 10^{-18/20}$ [V]

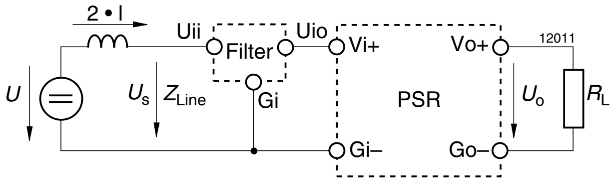


Fig. 3
Reduction of voltage interference by FP filters

Low-Loss Ring Core Chokes L/LP-Series

The ring core chokes, in combination with a capacitor, may easily be used for application specific LC filters at the input or output of switched mode power supplies. All chokes are suitable for PCB mounting. They are either moulded into plastic cases or isolated from the PCB by means of an isolation pad.

Series L/LP 20-7 and LP 34-3 are intended for use as differential mode filters and the current compensated choke LP 183 enables attenuation of common mode interference.

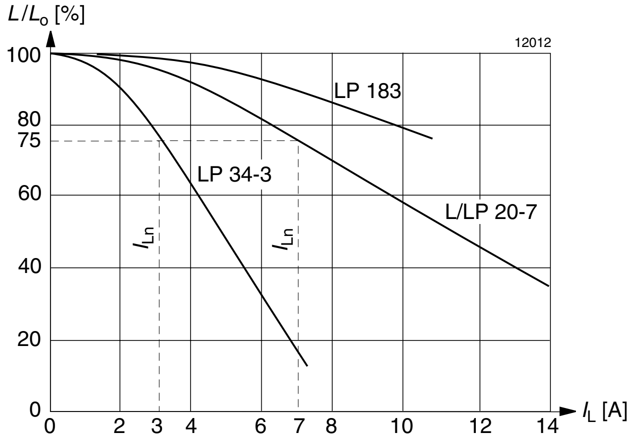


Fig. 4
Choke inductance versus current

Electrical Data Ring Core Chokes

General Condition: $T_A = 25\,°C$ unless otherwise specified

Table 3: Ring core chokes

Characteristics		Conditions	L 20-7/LP 20-7 min	typ	max	LP 34-3 min	typ	max	LP 183 min	typ	max	Unit
I_{Ln}	Rated current [1]	$L = 0.75\ L_o$		7			3			8		A DC
R_L	Ohmic resistance		5	5.5	6	18	20	22	2×2.9	2×4.2	2×5.5	mΩ
L_o	No load inductance	$I_L = 0,\ T_{C\,min}...T_{C\,max}$	18	20	22	30	34	38	2×95	2×183	2×245	µH
Δ_{Tl}	Current specific case temp. increase [1]			0.082			0.68			0.19		K/A²
T_A	Amb. temperature [1]	$I_L = I_{Ln}$	–40		106	–40		104	–40		98	°C
T_C	Case temperature		–40		110	–40		110	–40		110	
T_S	Storage temperature		–40		110	–40		110	–40		110	

[1] If the choke is not operating at the rated current I_{Ln}, the maximum ambient temperature $T_{A\,max}$ and the maximum direct current $I_{L\,max}$ change according to the following equations:
$$I_{L\,max} = \sqrt{\frac{T_{C\,max} - T_{A\,max}}{\Delta_{Tl}}} \qquad T_{A\,max} = T_{C\,max} - I_{L\,max}^2 \cdot \Delta_{Tl}$$

Input Interference Reduction

Using L- or LP-series chokes together with an additional external capacitor a similar attenuation can be achieved as with filter blocks. The capacitor between the choke and the converter input is necessary in order to avoid possible oscillations caused by the negative input impedance of the regulator. This phenomenon could cause the input voltage to leave the specified regulator input range. The relatively high ripple current flowing through the capacitor must be considered for the design. Refer also to: *Technical Information: Installation & Application*.

The current compensated choke LP 183 has a high permeability ring core with two identical separate windings. The normal operating current will only see the small stray inductance between the windings. However common mode interference will be blocked by the full inductance of the choke.

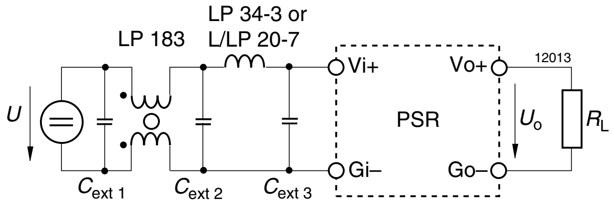


Fig. 5
L/LP type chokes and capacitors used as input filter

Typical Application

A voltage drop $U_{rGo} = r_{Go} \bullet (I_o - I_i)$ is produced across the ground loop resistance r_{Go}. It is superimposed upon the regulators output voltage U_o and generates the voltage $U_R = U_o - U_{r\,Go}$ across the load resistance R_L. Without an input inductance L_e the current I_i in the input circuit has a relatively high AC component with a basic frequency f_s (regulator's switching frequency of approx. 150 kHz). This alternating current produces an AC voltage component across r_{Go} which is superimposed upon U_{RL}.

To prevent this phenomenon, an inductance L_e can be inserted into the input circuit. This causes the AC component of the input current to be supplied entirely from the input capacitor C_e; thus, I_i is a pure direct current. C_e should be wired as close as possible to the regulator's input terminals Vi+ and Gi–.

L_e and C_e additionally provide protection against input transients and reduce radio interference voltages.

External connection of Gi– and Go– or connection via a common ground is not recommended. The internal voltage drop U_{rG} in the regulator would be superimposed on the output voltage.

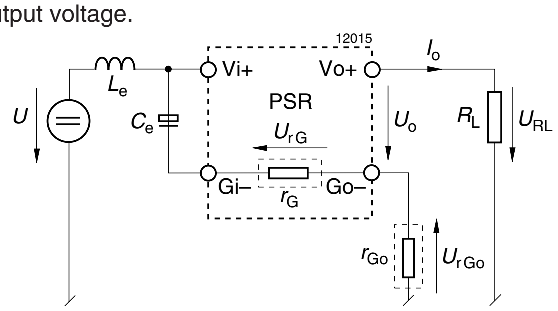


Fig. 6
Reduction of superimposed interference voltages in grounded power supply systems, caused by ground loops

Reduction of Output Ripple

Even though switching regulators have an inherently low output ripple, certain sensitive applications need even further reduction. In such cases, the low-loss ring core chokes designed to reduce disturbances at the input can also be used for reducing the ripple on the output voltage. The chokes in combination with an external capacitor can achieve even better results than the Filter Blocks with regard to the ripple and dynamic regulation.

The formula for the remaining output ripple at the load R_L is calculated as follows:

$U_R = u_o \bullet Z_{Cex}/Z_{LD}$

u_o: Output ripple of the regulator

Z_{Cex}: The impedance of the capacitor at the regulator's switching frequency (150 kHz) corresponds to the equivalent series resistance (ESR) of the capacitor (please refer to the corresponding data sheet).

$Z_{LD} = 2\,\pi \bullet f_S \bullet L_D$

f_S: 150 kHz (regulator switching frequency)

Through the use of a common mode choke LP 183, the common mode noise at the output can also be further reduced.

Consider that the filter not only affects the output ripple but can also influence the voltage U_R across the load R_L in the event of load changes. The static regulation increases with the ohmic resistance of the choke, i.e. 6 mV/A for the choke L/LP 20-7 and 20 mV/A for the LP 34-3.

The dynamic regulation is dependent on the size of the capacitor. Generally, the bigger C_{ex} the smaller is the dynamic, however, recovery will be slower.

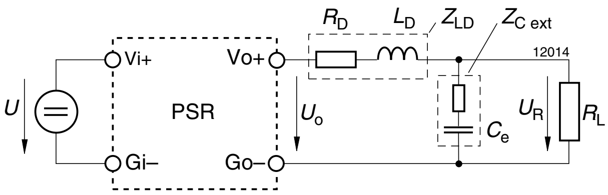
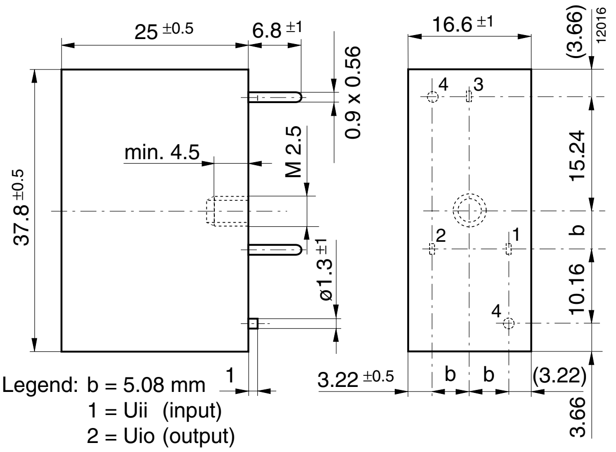


Fig. 7
Low-loss ring core choke with external capacitor (C_{ex} approx. 1000 µF) used as output filter

Mechanical Dimensions

Dimensions in mm. Tolerances ±0.2 mm unless otherwise specified

European Projection



Legend: b = 5.08 mm
1 = Uii (input)
2 = Uio (output)
3 = Gi (ground)
4 = Positioning pins

Fig. 8
Filter blocks FP weight 30 g

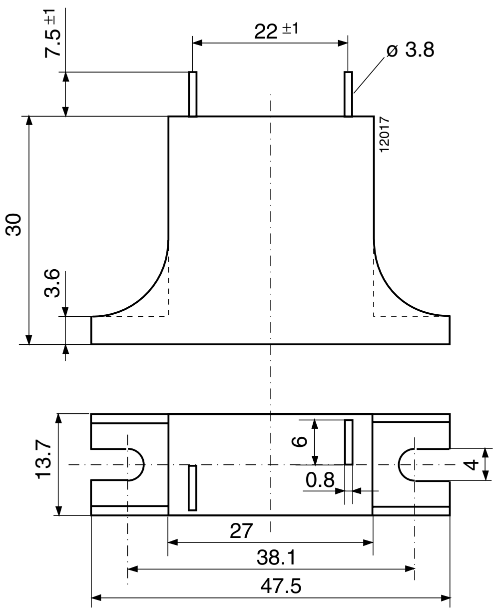


Fig. 9
Differential mode choke L 20-7, weight 30 g

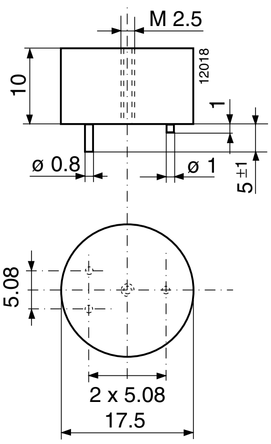


Fig. 10
Differential mode choke LP 34-3, weight 7 g

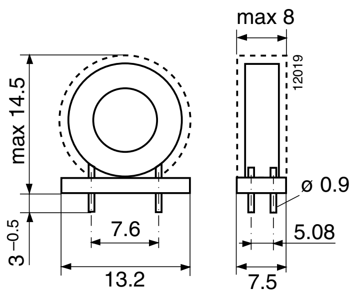


Fig. 11
Common mode choke LP 183, weight 7 g

Back Planes for the T Series

BPD Series BPF Series

19"/3U Rack-Systems

- Easy configuration of telecom rectifiers, battery chargers and power bus systems
- Provides controller function
- 1.6 kW maximum power
- Single or triple phase connection
- Redundant configuration possible

Summary

The back plane types BPF 1000 and BPD 1000 have been designed for fast and simple set-up of 19" rack mounted power supply systems powered by AC-DC converters of the T series. Battery charger systems, telecom rectifiers and modular power bus systems can easily be configured with n+1 redundancy if required. Three T units can be plugged into one back plane providing up to 1.6 kW output power.

Since for such applications the status of the power bus is of importance rather than the output status of a single AC-DC converter, T units with option D should be choosen enabling remote bus voltage sensing.

The back plane concept allows system assembly in next to no time. When fitted in the rack all input and output terminals are readily accessible from the rear. The AC input is designed for single or 3-phase operation. The monitoring signals and the control signal inputs and outputs are available from a screw terminal strip. System specific signal combination is possible with different jumper settings. The back plane fulfills in this way the function of a controller unit.

The layout of the back plane and the hot plug-in capability of the AC-DC converters allow system expansion under load (e.g. from 550 W up to 1.6 kW) by simply inserting further T units into the rack. Larger system power extension is just a matter of interlinking the DC output rails and signal outputs of two or more racks.

The back planes are available in 2 basic versions:

– BPD 1000
  A front-end version, fitted with decoupling diodes in each positive line to the DC bus, for systems with 2 or more T units in parallel or n+1 redundancy.
– BPF 1000
  A battery charger version, in which each output is fitted with a fuse in the positive line to the DC bus, for battery charging or rectifier systems with two or more T units in parallel or n+1 redundancy.

For minimum electromagnetic emission at the input, both the BPD and the BPF versions are fitted with input filters. Should project specific requirements demand enhanced hold-up time or lower output ripple (low frequency ripple) than specified for the individual AC-DC converters, both basic back plane versions are available with additional output capacitors.

Important: The neccessity to provide a cover over the live parts at the mains input (High Voltage) or over the DC bus bars (Energy Danger), preventing accidental contact during installation, start-up of a system or maintenance, depends on the final installation as well as on the applicable safety requirements. However, it is the responsibility of the installer or user to provide such a safety cover to assure the compliance with the relevant and applicable safety standards.

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Type Survey and Key Data

Table 1: Type survey

AC Input 85...255 V AC 1 or 3 phase (Y)	**Input filters** [1]	**Output capacitors** (reduced 100 Hz output ripple) [2]	**Preload**	**Application**
BPD 1002 BPD 1003	x x	– 90 mF	– –	Front-end, fitted with diodes
BPF 1004 BPF 1007 BPF 1006	x x x	– 50 mF 90 mF	x x x	Battery charger, fitted with fuses
BPF 1037 (Δ) [3]	x	50 mF	x	BPF 1007 in Δ configuration
19" Rack, 3 U				Rack for systems with up to 3 T units

[1] See also: *Electromagnetic Compatibility*.
[2] Please refer to: *Dimensioning Example of a Battery Charger System in Single Phase Connection*
[3] Only for LT units and 120/208 V mains. See fig.: *Mains input arrangement*.

Functional Description

The back plane is divided into 3 sections, each one fitted with an H15 female connector for one T unit, with the mains input section and the DC output section separated from each other.

The layout of the standard back planes gives the user the flexibility to operate the system either in single phase or in 3-phase (Y) configuration. Connection to the mains is achieved via the 6-pole connector (X1). With the wire jumpers B10/20/30 in Y-position (standard configuration) each T unit is connected between its defined input line and the neutral. (Changing of the configuration by the customer is not recommended.) An input filter, provided in the supply line to each T unit minimizes the conducted noise at the input of the system. The positive output of each T unit is separately fed to the common power bus and is decoupled depending upon the back plane type, either by a fuse (F11/21/31) or by a decoupling diode (D11/21/31). The fuses (cartridge type) are externally accessible from the frontside. The BPF versions are fitted with a common preload (R25). Additional output capacitors (up to 3 per output,10 mF each) further reduce the low frequency output ripple and provide enhanced hold-up time.

All relevant monitoring signals as well as control signal inputs and outputs are accessible at the signal terminal strip (X5). The jumper strip (X3) allows system specific signals according to different jumper settings. An auxilliary circuit (protected by a fuse F1, rated T1A, 250 V, 5 × 20 mm) allows a relay to be directly driven for system specific control functions.

Each T unit provides an individually adjustable power down signal enabling bus status monitoring at different voltage levels. The threshold values can be set at the soldering tabs D_{set} (R13/14, R23/24 and R33/34).

Note: If a power system is operated with 3 T units per backplane, connection to the mains in a 3-phase configuration (Y or Δ) will provide equal load distribution on the input lines. Furthermore the low frequency ripple at the output of the T units is compensated to zero as long as all 3 T units are in operation.

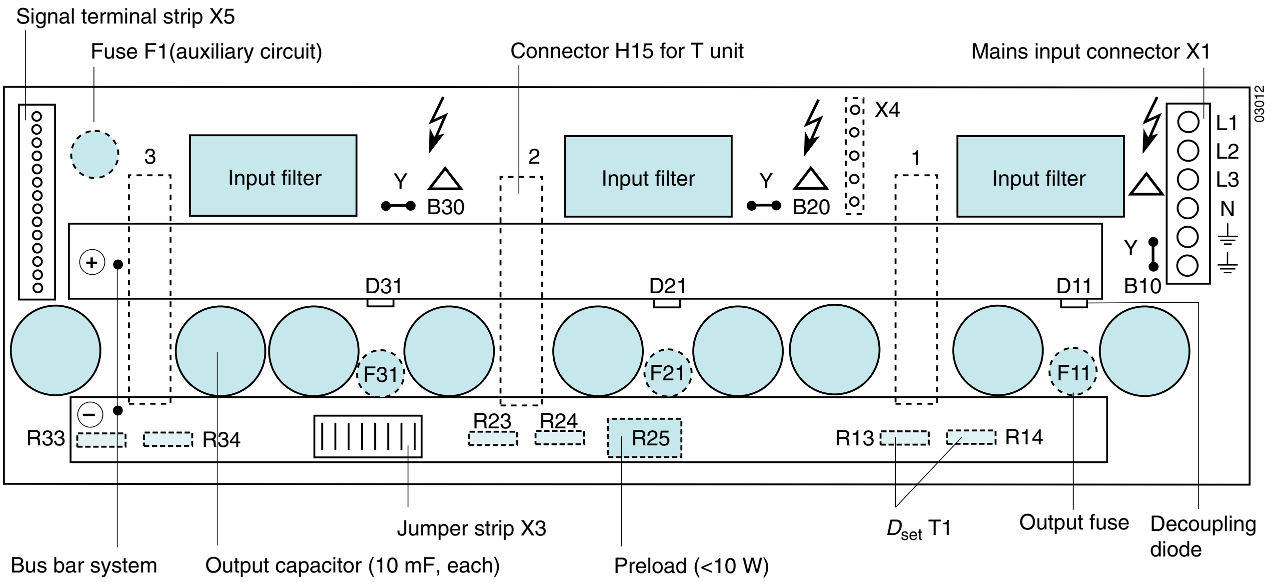


Fig. 1
Back plane, view from the rear

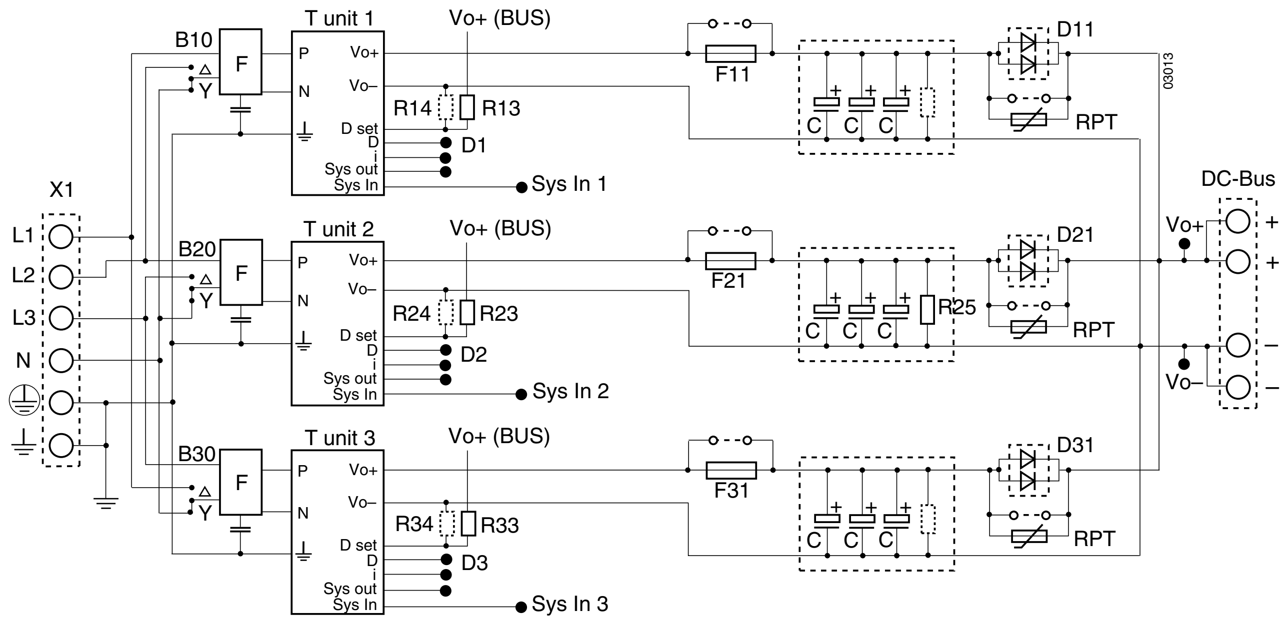


Fig. 2
Block diagram of back plane
F11, 21, 31 fitted to BPF types. D11, 21, 31 fitted to BPD types.

Mains Input Section

Connection to the Mains

Connection to the mains shall be made via the 6-pole screw terminal connector (X1), located on the right hand side of the back plane (view from the rear).

For single phase operation the terminals (L1, L2 and L3) at the female connector X1 should be connected together. The T-series has two AC input voltage ranges. The LT units are optimized for the 230 V mains, the UT units for the 120 V mains. (See also: *T series*)

Table 2: Mains input arrangement

Mains voltage Phase-Earth/Phase-Phase	Single phase L, N, ⏚	3-phase (Y) L1, L2, L3, N, ⏚	Phase - phase (Δ) L1, L2, ⏚	3-phase (Δ) L1, L2, L3, ⏚
230/400 V	LT types	LT types	Not allowed	Not allowed
120/208 V		LT types UT types	LT types only External fuses required	With special back plane BPF 1037 and LT types only

Single-phase/3-phase (Y) Configuration

Standard back plane version (Y-configuration)

The layout of the standard back planes allows operation of the system either in single phase or in 3-phase (Y) configuration. In both configurations each T unit on the back plane is connected between its defined phase and neutral. For single phase operation the AC-input terminals (L1, L2 and L3) should be connected together at the female connector. Connections to neutral and to ground are mandatory. (See also fig.: *Single phase configuration* as well as fig.: *3-phase (Y) configuration*.) Equal load distribution on the input lines at 3-phase configuration will compensate the low frequency ripple at the output to zero.

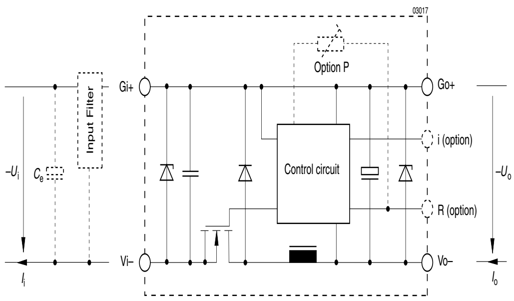


Fig. 3
Single phase configuration L, N
230 V mains: LT-types

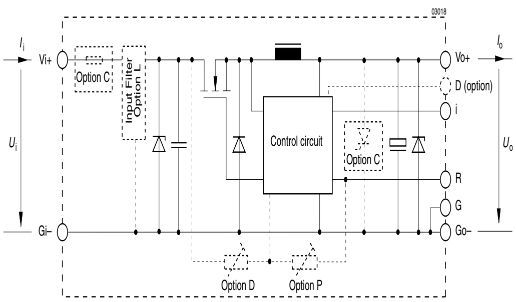


Fig. 4
3-phase (Y) configuration L1, L2, L3, N
230/400V mains: LT-types
120/208V mains: UT-types, LT-types [1]

[1] Reduced output power with LT types

Phase to Phase Configuration

With standard back plane version (Y-configuration)

For LT units exclusively

The layout of the standard back planes also allows phase to phase connection at low mains voltage 208 V e.g. USA, providing full output power from the LT units. In such cases one of the two input lines (L1 or L2) should be connected to the N-terminal at the AC input connector instead of the neutral line. The neutral line is not connected. For safety reasons an external fuse should be fitted in each input line. Connection to the ground is mandatory.

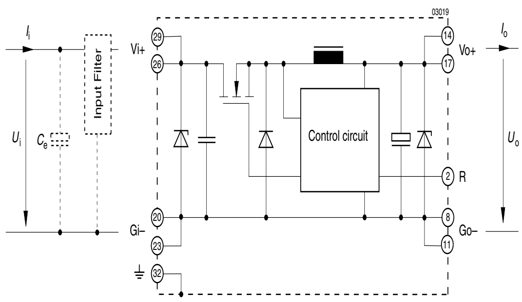


Fig. 5
Phase to phase configuration L1, L2
120/208 V mains (e.g. USA): LT types only.
Not applicable for UT types.

3-phase (Δ) Configuration
With special back plane version BPF 1037 (Δ-configuration) for LT units exclusively

Low mains 120/208 V

The input section of the 3 LT units is wired in a Δ-connection enabling full output power of the LT units at low mains input voltage 120/208 V.

Back planes in 3-phase (Δ) configuration are available on request. Modifications to the back plane in the field from "Y" to "Δ"-configuration (and vice versa) are not recommended. Maximum nominal input voltage: 230 V_{rms} + 10%, phase to phase. Higher input voltages may damage the LTs as well as the back plane. Connection to the mains should strictly be done according to fig.: *3-phase (Δ) configuration*. Wrong connection at the input may damage the LT units as well as the back plane. An external fuse needs to be installed into each input line.

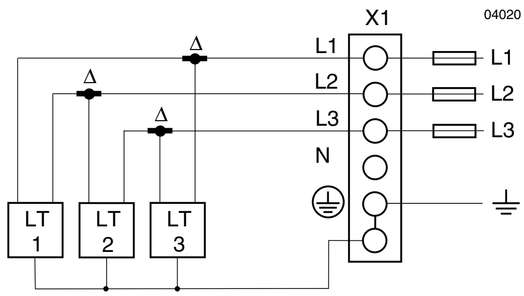


Fig. 6
3-phase (Δ) configuration, L1, L2, L3
120/208 V mains (e.g. USA) LT types only.
Not applicable for UT types.

Output Section

Power Bus

The back plane is fitted with a generously dimensioned bus bar system. Each bus bar (4 mm thick Alu alloy profile, identified with its polarity) is fitted with 2 captive nuts (M 6) serving as connection points to the load as well as to the battery system. Depending upon the application either the positive or the negative pole of the battery may be earthed.

For application specific requirements such as reduced ripple current, reduced low frequency ripple voltage, enhanced hold-up time or heavy pulse loads, the back planes are available with additional output capacitors (see table: *Type Survey)*. The output capacitors are mounted between the positive and the negative bus rails.

Front-end Version

To provide maximum system reliability especially with n+1 redundant systems, each positive output path is fitted with a decoupling diode mounted onto the positive bus rail. The diodes D11, D21 and D31 prevent a possible Power Down on the power bus in the case of a short-circuit across the output of one of the T units. To maintain the signalling functions of the T unit(s) in the case of a single inhibit or a single mains phase failure, a PTC in parallel to the decoupling diode allows a small reverse current from the DC bus supplying the control functions of the affected T unit.

Battery Charger Version

Direct battery charging or powering battery buffered systems require an adequate float charge voltage over the specified temperature range. Decoupling diodes should be avoided due to their voltage drop, affecting the float charge voltage of the battery. To maintain system redundancy adequatedly rated fuses (F11, F21 and F31, rated F20A minimum, 250 V, 6.3 × 32 mm each) are mounted in each positive output line. In the case of a short circuit across the output of one of the T units the relevant fuse will blow, interrupting the reverse short circuit current supplied by the battery and the remaining T units.

Power Down Signal (D1, D2, D3)

The power down signal monitors the voltage level of the bus bar system. Depending upon the application it may be advantageous to use the power down signal D1 and D2 in a redundant configuration and the third signal (D3) as a separate warning signal at a higher threshold level. For such a configuration the jumpers of X3 should be set in the positions ∑D - D1 and ∑D - D2. (See fig.: *Jumper strip (X3), Signal meshing.*)

For individual adjustment of the power down level see also: *System Integration*.

Inhibit

The output of a T unit may be enabled or disabled by the inhibit input signal. Moreover the output voltage can be controlled with an external temperature sensor connected to this input. If just the inhibit function is used, the units can be individually inhibited. If the output voltage is temperature controlled the same sensor signal should control all units in the rack and the jumpers of X3 should be set in all 3 inhibit positions, ∑i – i1, ∑i – i2 and ∑i – i3 (See fig.: *Jumper strip (X3), Signal meshing*).

System Good Signal (Sys In 1, 2, 3/Sys Out 1, 2, 3)

The System Good signal can be used either for status monitoring of each individual T unit or as a combined signal for status monitoring of the whole system. For overall system status monitoring jumpers should be set in the positions Si1-So2, Si2-So3 (See fig. *Jumper strip (X3), Signal meshing*).

The System Good input of the first T unit in a system (T3) should be referenced to the negative output. This can be done either on the jumper strip X3 with a jumper in position ⊥-Si3 (See fig.: *Jumper strip (X3), Signal meshing.*) or directly at the terminal strip X5, by connecting Sys In 3 to Vo–. (See also: *System Integration.*)

Interface for Remote Signalling and Control

A signal terminal strip (X5) allows interfacing with the customer‘s control system.

Each of the signals can be made available as an individual signal or as a combined signal.

Table 3: Terminal strip X5

Connector X5	Signal allocation	Description
1	Vo–	Supply Vo-
2	Sys In 3	Sys Good input T3
3	Sys In 2	Sys Good input T2
4	Sys In 1	Sys Good input T1
5	Sys Out 3	Sys Good output T3
6	Sys Out 2	Sys Good output T2
7	Sys Out 1	Sys Good output T1
8	i3/Ucr	Inhibit T3/Ucr
9	i2/Ucr	Inhibit T2/Ucr
10	i1/Ucr	Inhibit T1/Ucr
11	D3	Power Down T3
12	D2	Power Down T2
13	D1	Power Down T1
14	Vo+	Supply Vo+

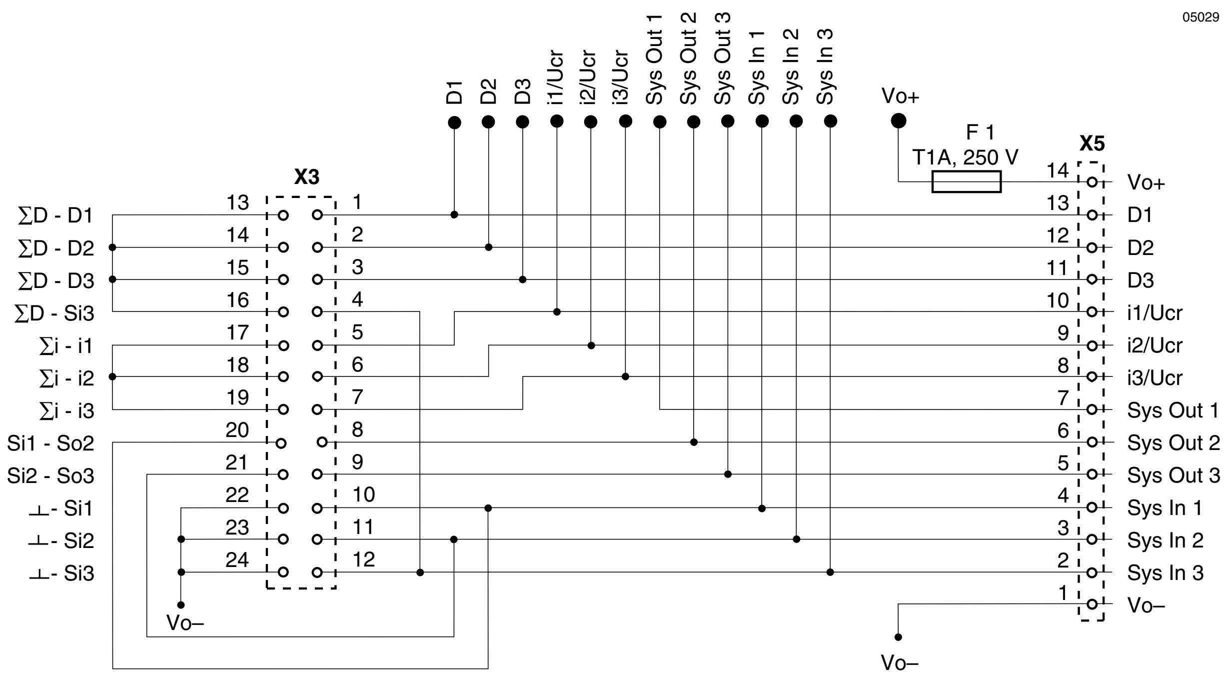


Fig. 7
Jumper strip (X3), signal meshing

Electromagnetic Compatibility (EMC)

Conducted Emission

The battery charger units can be operated in 3 different modes, depending on the load:
- Output voltage regulation
- Output power limitation
- Output current limitation

See also data sheet: *T series*.

In output voltage regulation mode, the conducted noise at the input of the T units is below level B according to CISPR 11/22/EN 55011/55022.

In output power and output current limitation mode, e.g. in the case of charging heavily discharged batteries, the conducted noise may be above level B, but below level A

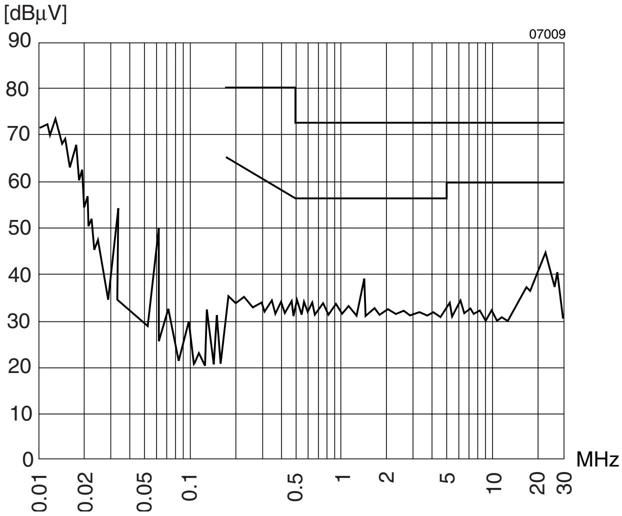


Fig. 8
Typical disturbance voltage (quasi-peak) at the input of a back plane fittet with 3 LT units, input filters and 5 additional output capacitors (10 mF each) according to CISPR11/22 and EN 55011/22, measured at $U_{i\ nom}$ and $I_{o\ nom}$.

Radiated Emission

To keep the radiated noise of the T units as low as possible they should be mounted into a conductive chromatized 19" rack, fitted with front panels and the back plane earth connected to the rack.

For integration into non-conductive 19" racks, special front panels with conductive nuts are available on request.

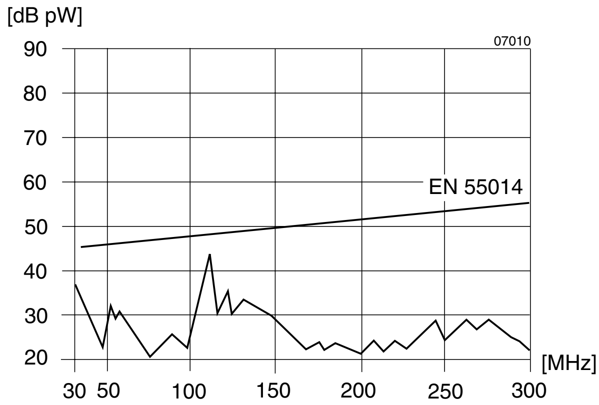


Fig. 9
Typical radiated electromagnetic power (quasi peak) at system input and output of a back plane fitted with 3 LT units, input filters and 5 additional output capacitors (10 mF each) according to CISPR 14 and EN 55014, measured at $U_{i\ nom}$ and $I_{o\ nom}$.

System Integration

Mains Input Voltage Monitoring

The T unit interprets a mains failure as a system error, indicated by the red Error LED together with a System Good failure signal. Should a dedicated mains failure identification be required this signal would have to be established externally.

Available signals/signal combinations (Please also refer to the: *T series* data sheet):

The T unit provides two open collector signals, System Good and Power Down.

The System Good signal monitors the operational function of a single T unit. In case of reduced available output power due to a mains failure, a T unit failure or inhibit, the signal changes from low to high impedance.

In systems with battery back-up or with n+1 redundancy the failure of one single unit does not cause a failure of the system as the required output power is still available either from the battery or from the remaining T units. To indicate the status of the whole system, the System Good signals of all 3 units should be connected in series on the back plane.

The System Good output can be combined with similar outputs of other DC-DC converters such as CQ units, integrating the additional information into the overall system status signal.

If only the system status of the T unit is to be monitored, Sys In should be wired to Vo–.

The Power Down signal monitors the output voltage level of the bus bar system. The threshold levels of the 3 possible signals can be individually adjusted by means of resistors R 13/14...R 33/34 (see: *T series* data sheet) and be used for:

- Save data
- Disconnecting the load or part of it
- Performing a battery test

In systems with battery back-up it may be desirable to extend system operation in case of long term mains failures by disconnecting an uncritical part of the load at a certain bus voltage level, triggered by one of the 3 possible power down signals. The 2 remaining signals can be set to the low battery discharge level to get a redundant signal (wired AND) for finally disconnecting the critical part of the load.

Note: The Power Down signal has an enlarged hysteresis of approximately 6 V for T 1740 units and 3.5 V for T 1240 units.

The Power Down signal(s) can be combined with the System Good signal to give a wired AND (see: *T series* data sheet). In such cases the resulting alarm only becomes active as a result of a mains failure or a converter failure together with a heavily discharged battery.

Battery Selection

When selecting a battery, the following aspects should be considered:

1. Batteries are normally specified at 20°C.
   Steady operation at higher temperatures will shorten the life time of a battery. For every 10 K temperature increase the battery lifetime is halved.
2. Worst case considerations with regard to the necessary battery capacity should include operation at the lowest possible temperature and highest possible discharge current, since under such conditions a substantial capacity drop has to be expected.
3. The capacity of a battery deteriorates with time. Therefore decisions on battery capacity should be based upon 20% ageing loss.
4. Consult the battery manufacturer for correct layout of the battery system.

Selecting the Right Battery and Back Plane Configuration

As mentioned in the T series data sheet the power factor correction at the input of the T unit generates a ripple voltage at the output of twice the input frequency, causing a ripple current into the connected battery.

For most battery types the low frequency ripple current should not exceed 5 A_{rms} per 100 Ah (0.05 C). Some manufacturers (with newer battery technology) specify 10 A_{rms} per 100 Ah (0.1 C).

Excessive ripple current can increase the battery temperature and reduces the battery lifetime. For a single phase system additional output capacitors may be necessary depending upon the selected battery type.

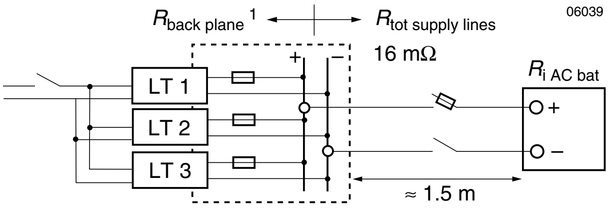
Note: With the T units symmetrically connected to a 3-phase (Y) mains supply the low frequency output ripple is virtually zero, only a high frequency ripple and noise of <100 mV_{pp} at the switching frequency of 65.5 kHz remains.

Dimensioning Example of a Battery Charger System in Single Phase Connection

Battery charger system in single phase connection:
230 V, 50 Hz, load: 1 kW, battery back-up: 3 h

Battery charger:
3 LT 1740 , n+1 redundant configuration, 1.6 kW

Conditions:
T_A = –10...40°C for both, charger and battery



[1] The resistance on the back plane ($R_{back\ plane}$) is already taken into account in the following two graphs.

Fig. 10
System set-up

Battery specification (at 20°C):
- 24 cells, 2.23 V/cell, float charge voltage 53.5 V
- Permissible ripple current $I_{rms\ bat}$: 0.05 C (5% of battery capacity)
- Temperature coefficient –3 mV/K per cell
- Max. discharge current 20 A
- Capacity at –10°C and 0.2 C discharge: 70%

Calculation of battery size:
Load 20 A, back-up 3 h, ageing loss 20% therefore ageing factor 0.8, derating factor for temperature and discharge current 0.7

Q_{bat} [Ah] $= I_{load} \bullet t_{back\text{-}up} / (f_{ageing} \bullet f_{TA/discharge})$
= 20 [A] • 3 [h] /(0.8 • 0.7) = 107 [Ah]
next closest battery configuration: 120 Ah or 95 Ah

Decision: Battery with 95 Ah ($R_{i\ DC}$: 28 mΩ)

Calculation of the ripple current:
The ripple current to the battery can either be measured or calculated. The diagrams allow a good estimation of the relationship between the ripple current to the battery $I_{rms\ bat}$ and the load current I_{Load} of a given system resistance R_{Sys}. The system resistance is the sum of the resistance of the supply and the AC resistance of the battery.
The AC resistance is defined as the relationship between the AC voltage and the AC current to the battery measured with a capacitively coupled 100 Hz AC source.
In the example the system resistance is:
$R_{Sys} = R_{supply\ rms} + R_{i\ AC\ bat}$
= 16 mΩ + 16 mΩ = 32 mΩ

Permissible ripple current:
$I_{rms\ bat}$ = 0.05 • 95 Ah = 4.75 A_{rms}

Calculated ripple current:
With 3 LT 1740 without capacitance on the back plane
$I_{rms\ bat} = I_{load}$ • factor y = 19 A • 0.198 = 3.76 A_{rms} = 0.04 C

With 3 LT 1740 and 50 mF on the back plane
$I_{rms\ bat}$ = 19 A • 0.16 = 3.04 A_{rms} = 0.032 C

With 3 LT 1740 and 90 mF on the back plane
$I_{rms\ bat}$ = 19 A • 0.13 = 2.47 A_{rms} = 0.026 C

All three examples give a value below the permissible ripple current.

Additional capacitance on the back plane not only reduces the AC ripple on the battery, but stabilizes the output voltage during fast load changes.

Where the ripple current should be reduced even more, the system resistance R_{Sys} could be increased with a special choke set into the battery supply line. For further information please contact Power-One.

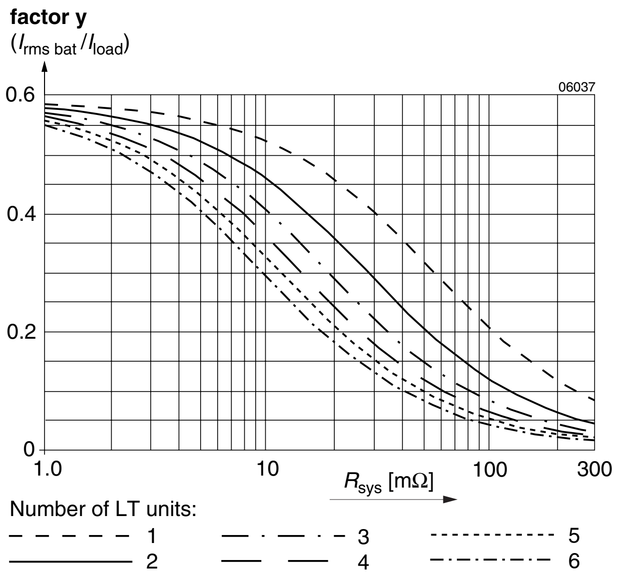


Fig. 11
$I_{rms\ bat}/I_{load}$ versus system resistance (R_{sys}). Up to 6 T units in parallel, without additional output capacitors

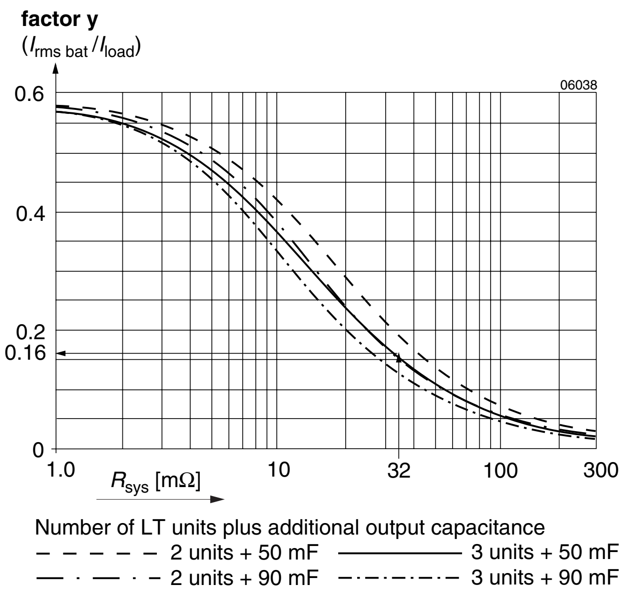
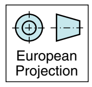


Fig. 12
$I_{rms\ bat}/I_{load}$ versus system resistance (R_{sys}). 2 and 3 T units in parallel, with additional output capacitors

Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



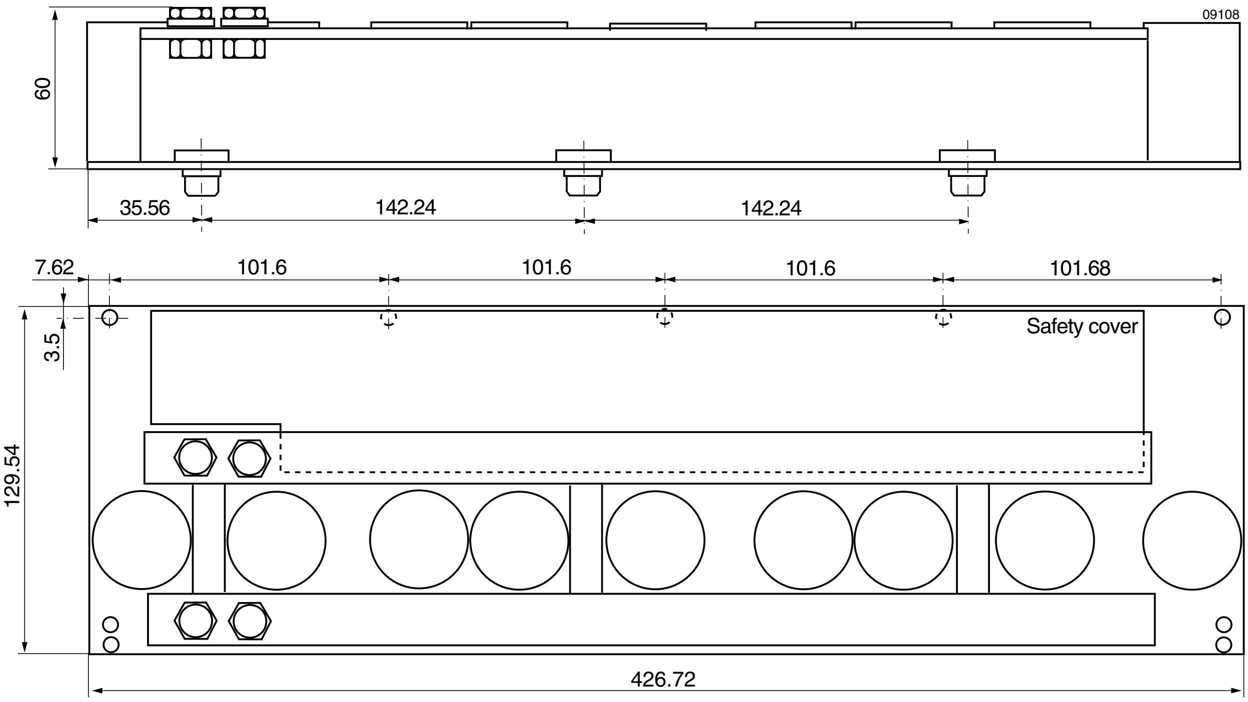


Fig. 13
Back plane for 19" rack, weight: 1.7 kg

Safety and Installation Instructions

Transportation

For transportation use standard Power-One packaging material.

Racks fitted with back planes are not designed for transportation with the T series AC-DC converters fitted into the racks.

Connector Pin Allocation

The power output is provided via the two bus bars, the positive one designated Vo+, the negative one Vo–. The following pin allocation tables define the electrical potentials and the physical pin positions on the connectors of the back planes.

Table 4: Pin allocation of the mains input connector X1

Pin no.	Electrical determination	Pin designation
1	Input phase 1	L1
2	Input phase 2	L2
3	Input phase 3	L3
4	Input neutral	N
5	Protective earth	⏚
6	Protective earth	⏚

Input connector X1 is provided with a matching male connector at delivery. Standard configuration: Pins 1, 2 and 3 are interconnected (for single phase operation).

Table 5: Pin allocation of the signal terminal strip X5

Pin no.	Electrical determination	Pin designation
1	Supply negative (return potential)	Vo–
2	Sys good input of T unit no. 3	Sys In 3
3	Sys good input of T unit no. 2	Sys In 2
4	Sys good input of T unit no. 1	Sys In 1
5	Sys good output of T unit no. 3	Sys Out 3
6	Sys good output of T unit no. 2	Sys Out 2
7	Sys good output of T unit no. 1	Sys Out 1
8	Inhibit or Ucr of T unit no. 3	i3/Ucr
9	Inhibit or Ucr of T unit no. 2	i2/Ucr
10	Inhibit or Ucr of T unit no. 1	i3/Ucr
11	Power down of T unit no. 3	D3
12	Power down of T unit no. 2	D2
13	Power down of T unit no. 1	D1
14	Supply positive	Vo+

The signal terminal strip X5 is provided with a matching female connector at delivery.

The jumper strip X3 is provided with 7 jumpers at delivery.

The pin allocation of the jumper strip is described in fig. Jumper strip (X3), signal meshing.

Installation Instruction

The BPD/BPF series back planes are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. Installation must strictly follow the national safety regulations in compliance with the enclosure, mounting, creepage, clearance, casualty, markings and segregation requirements of the end-use application. See also: *Technical Information: Installation and Application.*

Caution: It is the responsibility of the design engineer and of the installer to define and apply a safety concept for the whole system which is provided with a Power-One back plane. The following are under the aspects which have to be considered:

- Consult the T-series AC-DC converters data sheet prior to connecting the system to the mains.
- The necessity to provide a cover over the live parts at the mains input (hazardous voltage) or over the DC-bus bars (energy hazard), preventing accidental contact during installation, start-up of a system or maintenance, depends on the final installation as well as on the applicable safety requirements.
- Service should be carried out by qualified personnel only.
- Fuses should be replaced with the same types only.
- The earth terminal on the back plane must be connected to safety ground.
- Back planes in 3-phase (Δ) configuration are available on request. Modifications to the back plane in the field from "Y"- to "Δ"-configuration (and vice versa) are not recommended.
- The maximum nominal input voltage is 230 V_{rms} +10%. Higher input voltages may damage the T series AC-DC converters as well as the back plane.
- Empty spaces in a rack should be covered by a dummy front panel.

Caution: Prior to handling, the back plane must be disconnected from mains and from other sources (e.g. batteries). Check for hazardous voltages and hazardous energy before and after altering any connections. Hazardous energy levels may be present at the output terminals even after the mains input voltage has been disconnected from the unit. This is indicated by the red error LEDs of the T series AC-DC converters. It is the responsibility of the installer to prevent an unwanted short-circuit across the output of the back plane, of the battery and of each T series AC-DC converter. In case of a short circuit across the output of a T unit, all LEDs will be off, although the mains may be present.

The back planes are intended for stationary applications. They shall be installed in 19" racks according to DIN 41494.

Install the back planes vertically, the mains input connector X1 being on the right hand side of the back plane (view from the back) and make sure that there is sufficient air flow available for convection cooling of the T-series AC-DC converters.

Mechanical fixing shall be made via 10 screws M2.5 × 10 and 10 nuts M2.5. When mounting a back plane to a rack, fit two T units into the H 15 female connectors on the back plane prior to fixing the back plane to the rack. This ensures correct positioning of the female connectors on the back plane with respect to the given position of the male connectors of the T units in the rack. With the back plane improperly positioned, the connectors of the T units and the female connectors on the back plane may be damaged. In order to maintain correct positioning, use all the available mounting holes.

Connection to the supply system shall be made via the 6-pole screw terminal connector X1 according to: *Connector Pin Allocation* and *Mechanical Data.*

The connector X1 of the back planes (class I equipment) is provided with two protective earth terminals (⏚), which are reliably connected with the protective earth pins of the connectors for the T units. For safety reasons it is essential to connect at minimum one of these terminals with the protective earth of the supply system. Since the earth leakage current exceeds 3.5 mA, the system must be permanently connected or it must be pluggable equipment type B according to IEC/EN 60950. The earth connection must be performed before connecting the supply.

To maintain good electrical connection, the AC input, earth and signal to the terminal strip wiring should be secured, using tie wraps, to prevent stress upon the wires and the connectors.

Refer to *Mains Input Section* to ensure that phase and neutral configuration matches with the back plane and T series AC-DC converter types. Wrong connection at the input may damage the T series AC-DC converters as well as the back plane. Standard back planes are designed for a 3-phase system in Y connection with a phase to neutral voltage of 230 V or 120 V where connection to neutral is mandatory. Integration into a 3-phase system in Δ configuration (120/208 V and without connection to neutral) is only possible with LT AC-DC converters together with the special back plane BPF 1037.

For safety reasons, a mains switch for line interruption is required.

The back plane does not provide any input fuses. The input fuses of the T series AC-DC converters in the connection from the L terminal are designed to protect the units in case of overcurrent and may not be able to satisfy all customer requirements. An external input fuse suitable for the application and in compliance with the local requirements in the wiring to each phase and to the neutral terminal may therefore be necessary to ensure compliance with local requirements. A second fuse in the wiring to each input terminal is needed if:

- Standard back planes are used in phase to phase configuration
- Local requirements demand an individual fuse in each source line
- Neutral to earth impedance is high or undefined
- Phase and neutral of the mains are not defined or cannot be assigned to the corresponding terminals (L to phase and N to neutral).

Important: Do not open the modules, or guarantee will be invalidated.

Additional Information for Installation of Battery Charger Systems:

Reverse polarity connection of the battery may damage the battery, the back plane(s) and the battery chargers.

Prior to putting a system into operation, check whether the position of the cell voltage selector switch of each T series AC-DC converter corresponds to the required battery cell voltage.

For battery maintenance please contact the battery manufacturer.

Exchanging a battery should always include the whole battery bank. New batteries should be of the same type, with the same cell voltage and temperature coefficient.

For expansion of battery systems contact the battery manufacturer.

For battery location and connection please refer to VDE 0510, part 2.

In battery charger systems, safety standards demand that a battery can be completely disconnected from the power system including the battery system ground. Depending upon the project specific requirements, disconnecting may either occur by a manually operated switch with fuses, or automatically by means of a circuit breaker.

Caution: Care should be taken during system set-up or after maintenance when connecting a battery to the power bus of a back plane (BPF types) fitted with fuses. The T series AC-DC converter system with the back planes should be switched to the mains prior to connecting the battery to the power bus, since the reverse current from the battery into the uncharged output capacitors of the T units and the back plane may damage the fuses.

Make sure that there is sufficient air flow available for convection cooling. This should be verified by measuring the case temperature of each T series AC-DC converter when the complete back plane is installed and operated in the end-use application. The maximum specified case temperature $T_{C\ max}$ of the T series AC-DC converters must not be exceeded.

Ensure that a unit failure (e.g. by an internal short-circuit) does not result in a hazardous condition. See also: *Safety of operator accessible output circuit.*

Standards and approvals

All back planes correspond to class I equipment.

They have been designed in accordance with UL 1950, CAN/CSA C22.2 No. 950-95 and IEC/EN 60950 standards. Safety approvals are not provided.

The units have been evaluated for:
- Building in
- Basic insulation between input and earth, based on 250 V AC
- Double or reinforced insulation between input and output, based on 250 V AC
- Operational insulation between output and earth
- The use in a pollution degree 2 environment
- Connecting the input to a primary circuit with a maximum transient rating of 2500 V (overvoltage class III based on a 110 V primary circuit, overvoltage class II based on a 230 V primary circuit).

Troubleshooting

See also: *T series* AC-DC converters data sheet *Functional Features.*

- All T-series AC-DC converters are operating, all Sys OK LEDs are OFF.
  – Sys In is not referenced to Vo–
- 3-phase AC input, Y-configuration. One T unit indicates Error.
  – single T unit failure or
  – single T unit inhibit or
  – single phase mains failure
- All System OK LEDs are OFF, all T units indicate Error.
  – mains failure or
  – all T units inhibited, e.g. battery test or less likely
  – all T units have a failure
- The red Error LED of one of the T units is ON.
  – T unit with Error LED ON has an overtemperature, the output is automatically re-enabled when the temperature drops below the limit.
- The red Error LED flickers.
  – overvoltage disturbance from the mains.
- One of the T units has all LEDs OFF.
  – short circuit across output of a T unit.
- All Sys OK LEDs ON, at one T unit the Uo OK LED is ON. The remaining T unit are below the threshold level of the power down signal with the LED Uo OK OFF.
  – a fuse on the back plane damaged, relevant T unit with Uo OK ON.
- All LEDs at the T units are OFF, mains is apparent.
  – short circuit across the power bus
- Single phase AC input. Only one T unit is in operation.
  – wire jumpers on mains input connector X1 not connected to L2/ L3 input terminals
- All Sys Good and Uo OK LEDs are ON, no output power.
  – output not connected to the system
- All T units are operating. One or several T units indicate Error with the Uo OK LEDs OFF although the bus voltage is present.
  – Dset not referenced to Vo+

Protection Degree

The protection degree of the back planes is IP 00.

Isolation

The electric strength test is performed as factory test in accordance with IEC/EN 60950 and UL 1950 and should not be repeated in the field. Power-One will not honour any guarantee claims resulting from electric strength field tests.

The electric strength test is performed as factory test in accordance with IEC/EN 60950 and UL 1950. Nor this test nor the insulation resistance measuring should be repeated in the field. Power-One will not honour any guarantee claims resulting from field tests with high voltages.

Important: The backplane must carry the safety covers, which prevent from touching conductive parts. Such covers are mounted on both sides of the printed circuit board and over the bus bars. Removing the protection covers will provoke danger of high voltage or high energy impact! Testing by applying AC voltages will result in high and dangerous leakage currents flowing through the Y-capacitors (see fig.: *Block diagram of back plane*).

Table 6: Isolation

Characteristic		Input to earth	Input to output	Output to earth	Unit
Electric strength test voltage	Required according to IEC/EN 60950	1.5	3.0	0.5	kV_{rms}
		2.1	4.2	0.7	kV DC
	Actual factory test 1 s	2.8	4.2	1.4	
	AC test voltage equivalent to actual factory test	2.0	3.0	1.0	kV_{rms}
Insulation resistance at 500 V DC		>300	>300	>300	MΩ

For creepage distances and clearances refer to: *Technical Information: Safety.*

Leakage Currents in AC-DC operation

Leakage currents flow due to internal leakage capacitance and RFI suppression Y-capacitors. The current values are proportional to the mains voltage and nearly proportional to the mains frequency. They are specified at the maximum operating input voltage, where phase, neutral and protective earth are correctly connected as required for class I equipment.

Under test conditions, the leakage current flows through a measuring instrument (MI) as described in fig.: *Measuring instrument for earth leakage current tests*, which takes into account impedance and sensitivity of a person touching unearthed accessible parts. The current value is calculated by dividing the measured voltage by 500 Ω. If inputs and/or outputs of back planes are connected in parallel, their individual leakage currents are added.

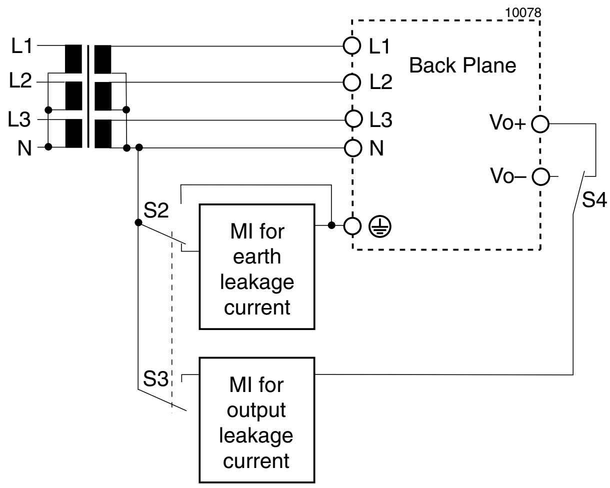


Fig. 15
Test set-up for leakage current tests on class I equipment in phase to phase or 3-phase configuration of back planes fitted with LT units.

S2/3 select either the earth or output leakage current measurements, S4 selects the leakage current measurements of either the positive or negative output.

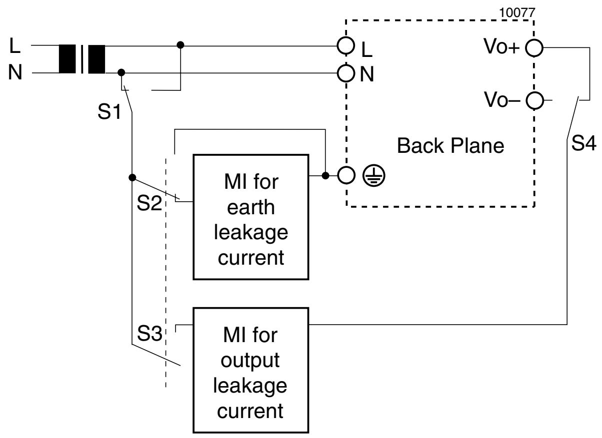


Fig. 14
Test set-up for leakage current tests on class I equipment in single phase configuration.

S1 is used to simulate the interchanging of phase and neutral, S2/3 select either the earth or output leakage current measurements, S4 selects the leakage current measurement of either the positive or negative output.

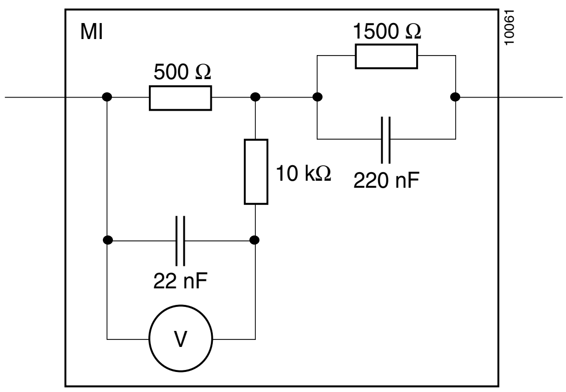


Fig. 16
Measuring instrument (MI) for earth leakage current tests according to IEC/EN 60950, Annex D.

Table 7: Leakage currents in single phase configuration (= worst case)

Characteristic		Back plane without T unit	Back plane with one T unit	Back plane with two T units	Back plane with three T units	Unit
Earth leakage current	Permissible according to IEC/EN 60950	5% of the input current per phase [1]				–
	Specified value at 255 V, 50 Hz [2]	2.6	4.4	6.2	7.9	mA
	Specified value at 127 V, 60 Hz [2]	1.6	2.6	3.7	4.7	
Output leakage current	Permissible according to IEC/EN 60950	0.25	0.25	0.25	0.25	
	Specified value at 255 V, 50 Hz	–	<0.1	<0.1	<0.1	
	Specified value at 127 V, 60 Hz	–	<0.1	<0.1	<0.1	

[1] If the value exceeds 3.5 mA, equipment must be pluggable equipment type B or permanently connected, according to IEC/EN 60950.
[2] In best case configuration (3-phase), earth leakage currents compensate to 0 mA.

Safety of operator accessible output circuit

If the output circuit of an AC-DC converter is operator accessible, it shall be an SELV circuit according to IEC/EN 60950 related safety standards.

The following table shows a possible installation configuration, compliance with which causes the output circuit of the AC-DC converter to be an SELV circuit according to IEC/EN 60950 up to a configured output voltage of 56.5 V.

However, it is the sole responsibility of the installer to assure the compliance with the relevant and applicable safety regulations. More information is given in: *Technical Information: Safety*.

Table 8: Safety concept leading to an SELV circuit

Conditions	AC-DC converter	Installation	Result
Supply voltage	Grade of isolation between input and output, provided by the AC-DC converter	Measures to achieve the resulting safety status of the output circuit	Safety status of the AC-DC converter output circuit
Mains ≤250 V AC	Double or reinforced	Installation according to the applicable standards	SELV circuit