Rev. E / March, 2022

SYSTEM DESCRIPTION

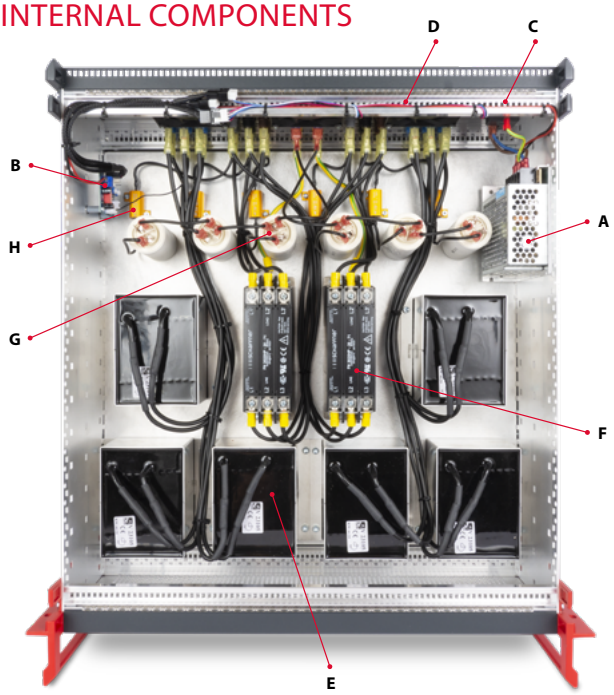
The passive filters box contains essential components for interfacing power converters with different types of loads. Individual connection sockets for 4 mm laboratory plugs enable simple connection / disconnection from / to external components. For instance, imperix type C enclosures offer similar connectivity for all types of power modules.

The system can be used for up to two inverters (three-phase), or within back-to-back configurations. The passive filters box essentially implements:

- 6x power inductors rated 2.2 mH / 32A.
- 2x EMC filters with star-connected capacitors.

The box is designed for mounting within 19" cabinets.

INTERNAL COMPONENTS



The filters box embeds the components listed in Table 1. The corresponding circuit schematics are shown in Figure 1 and Figure 2.

	Designation	Manufacturer	Part Number
A	Auxiliary power supply	Delta Electronics	PMT-12V35W1AA
B	Fuse	Bel Fuse Inc.	
C	Fan speed controller	CZB	CZB 672 1960
D	Cooling fan (3x)	Orion Fans	OD7020-12HHB10A
E	Inductor (6x, 2.2mH, 32A)	Hahn	V23105
F	EMC filter (2x)	Schaffner EMC Inc.	FN3025HP-30-71
G	Film capacitor (3x, 10µF)	Arcotronics / KEMET	C274AC35100SA0J
H	Damping resistor (3x, 1Ω)	Ohmite	HS25 1R0J

Table 1. **Main components of the passive filters box.**

MAIN ELECTRICAL SCHEMATIC

The main power circuits are designed for a flexible use within reconfigurable power converter systems. All elements are independent. For instance, inductors can be used for three-phase AC configurations as well as for DC/DC converter applications.

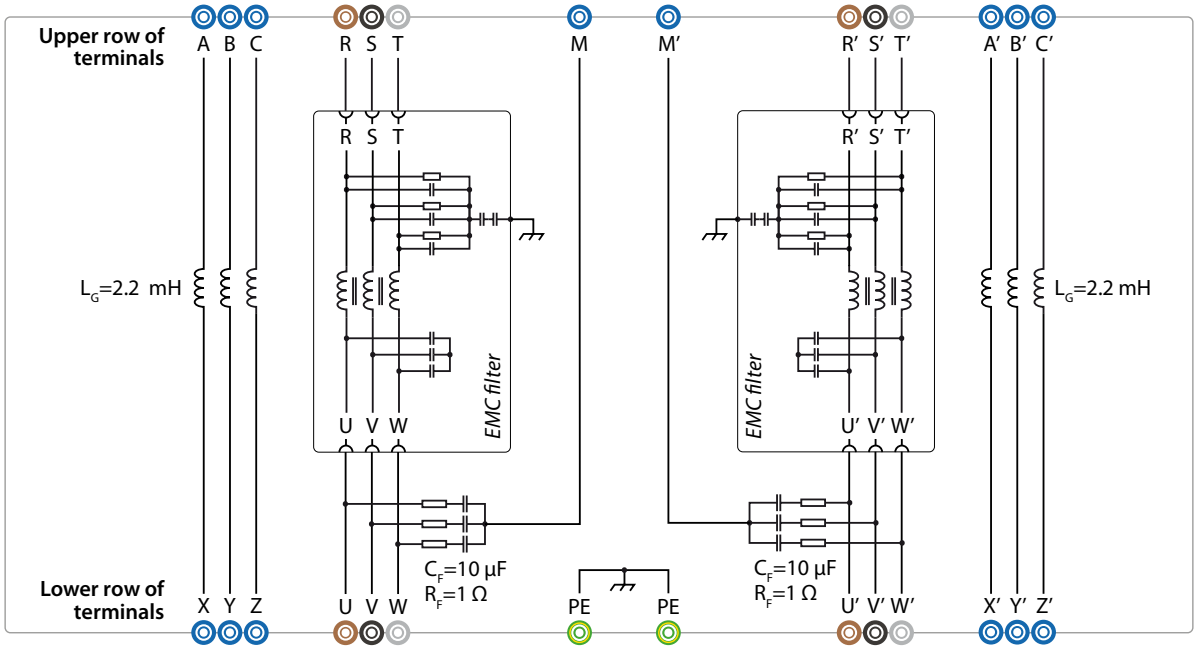
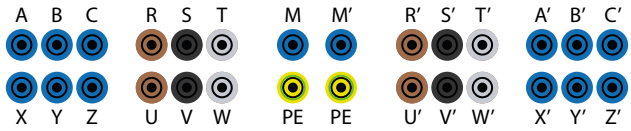


Figure 1. Electrical schematic of the main power section. Both sides are symmetrical.

REAR PANEL CONNECTORS



Connector type: 4 mm safety laboratory plugs (banana)

MAIN ELECTRICAL SPECIFICATIONS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Operating AC voltage	Three-phase, line-to-line	0	400	440	V (rms)
Operating AC current	Phase	0		30	A (rms)
Total inductance	1kHz, 1Vrms	2.0	2.2	2.4	mH
Output filter capacitance	C_F	0.95	10	1.05	µF
Output filter resistance	R_F	0.95	1	1.05	Ω

Table 2. Electrical specifications of the main power circuits.

AUXILIARY CIRCUIT SCHEMATIC

The auxiliary circuit is exclusively used for powering the cooling fans. It is entirely independent and isolated from the main power circuits.

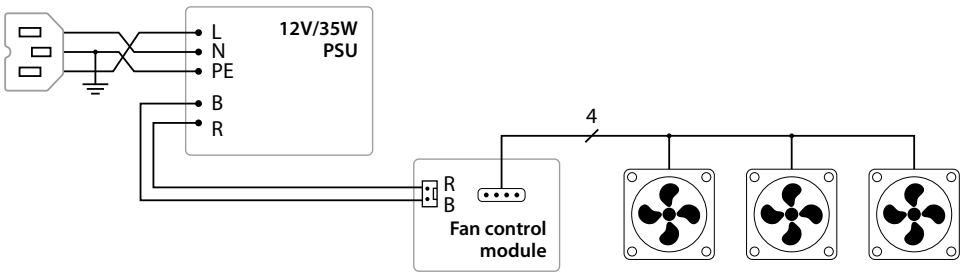


Figure 2. Electrical schematic of the auxiliary cooling circuit.

AUXILIARY CIRCUIT SPECIFICATIONS

Characteristic	Test conditions	Specification
Operating AC voltage	50-60 Hz	1~ 90–264 V (rms)
Operating AC current	110 VAC	< 0.3 A (rms)
CE conformity	230VAC	EMC directive 2014/30/EU Low-voltage directive 2014/35/EU RoHS directive 2011/65/EU + 2015/863 +2017/2102
EMC emissions (conducted and radiated)	CISPR32, FCC part 15	Class B (residential)
EMC immunity (conducted and radiated)	IEC 61000-4-2 to -6	EN61000-6-2 (industrial)

Table 3. Electrical specifications of the auxiliary cooling circuit.

INSTALLATION INSTRUCTIONS

HANDLING

Use the front handles as well as proper caution when moving the equipment. Risk of injury exists in case of fall on the lower limbs.

EARTHING

Careful earthing is essential for the proper operation of the EMC filter, as well as for personnel safety. The enclosure is electrically bonded to the protective earth conductor of the auxiliary power inlet. It is also available on the two yellow/green (PE) 4 mm safety sockets (banana).

CABLES CROSS-SECTION

Electric cables of sufficient section should always be used. Typically, a current density < 5A/mm^2 is recommended. For long connections or when a risk of fire is present, < 3A/mm^2 should be observed.

OVER-CURRENT PROTECTION

For some applications, such as when using this product for interfacing a power converter to the AC mains, fuse(s) or circuit breaker(s) must be present upstream, so that personnel safety is guaranteed at all times, and that risks or fire are mitigated.

PRODUCT SAFETY

FCC Compliance Statement

This device is exempted from compliance with Part 15 of the FCC Rules, pursuant CFR47 §15.103(c) regarding industrial, commercial or medical test equipment.
CAUTION Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canadian Compliance Statement

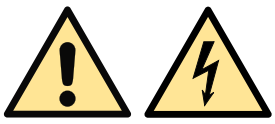
This digital apparatus is exempted from compliance with Canadian ICES-003, pursuant article 1.5.1(d). / Cet appareil numérique est exempté de conformité à la norme NMB-003 du Canada, ainsi que stipulé par l'article 1.5.1(d).

ENVIRONMENTAL CONDITIONS

This product is designed for use within an indoor-conditioned environment (IEC 60721-3-3).

Characteristic	Conditions
Operating temperature	15–35°C
Storage temperature	0–60°C
Operating relative humidity	10–75° RH, non condensing
Overvoltage category	OVC II
Mechanical protection	IP20
Altitude	< 2000 m
Air pollution degree	PD 2

Table 4. Storage and operating conditions.



Caution, hazardous voltage inside. Risk of electrical shock! Do not open cover when supplied with dangerous voltages.

When using this product with three-phase mains voltage, suitable circuit breaker(s) or fuse(s) must be used (PSCC < 6kA).

This product is designed for use within electric research laboratories (or similar test facilities) by trained personnel only.
Applicable safety regulations must be observed at all times.

Disregarding this warning or other relevant instructions may lead to severe injury and/or cause serious damage.

APPLICATION EXAMPLES

CONNECTION TO GRID THROUGH AN ISOLATION TRANSFORMER

This straightforward scenario implements an isolation transformer between the power converter and the grid. In this configuration, the EMC filter + LC filters are recommended to be connected as shown. Common-mode currents circulate between the filter and the converter enclosure only. Residual current protective devices (RCD) can be used without trouble.

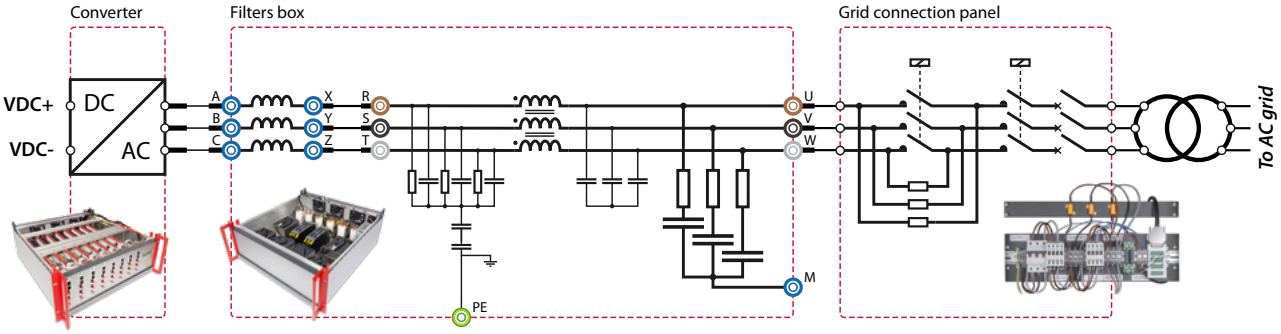


Figure 3. **Filter topology for a connection to the grid with an isolation transformer.**

TRANSFORMER-LESS CONNECTION TO GRID

This scenario provides increased filtering performance, and hence can be implemented in a transformer-less configuration, even if a conventional RCD is used (~20mA). In this case, a direct feedback path is arranged to the converter DC bus, so that common-mode current do not circulate through the grounding. Besides, the EMC filter is connected differently, so that ground currents are reduced to a negligible level.

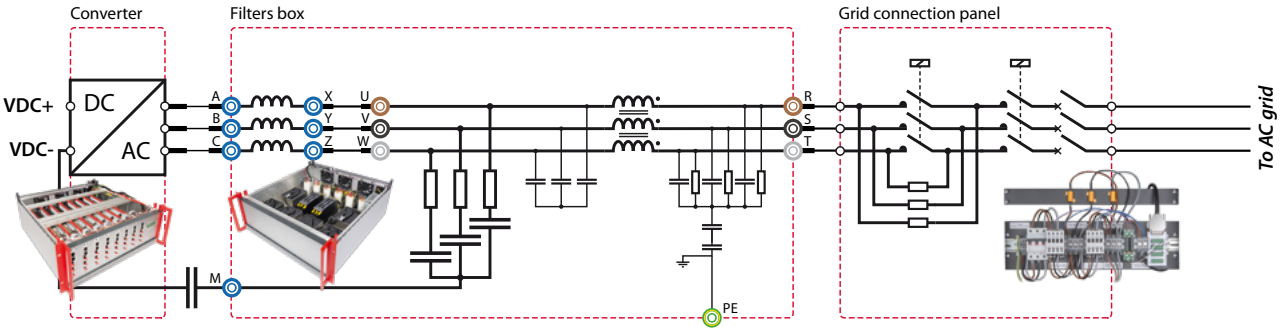


Figure 4. **Filter topology for a transformer-less connection to the grid.**

Other application examples can be browsed at imperix.com/doc

About us

Imperix is a company established in Sion, Switzerland. Its name is derived form the Latin verb *imperare*, which stands for "controlling" and refers to the company's main business : the control of power electronic systems. Imperix commercializes hardware and software solutions for the fast implementation of prototyping and pilot systems in the fields of power electronics, energy storage, smart grids and related systems.

Note

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This publication is not intended to form the basis of a contract.