Basic and System Components/Devices – Minimum Requirements – Standardised solutions - Tests KNX System Conformance Testing

Basic Components

9

2

Summary

This document contains the minimum requirements for KNX Basic Components and standardised solutions.

This document is part of the KNX Specifications v2.1.

Version 01.03.01 is a KNX Approved Standard.

Document Updates

Version	Date	Modifications
1.0	2001.12.19	Approved Standard
1.1	2006.05.09	Approved Standard – removal of footnotes related to output voltage and overload from clause 3 – correction of references to Volume 4
1.2RfV	2008.11	Integration of AN029 (except for DPSU management and profiles – integrated in Volume 6 clause 8) – removal TP0, PL132 – updating of PSU requirements
1.2FV	2010.03	Resolution of Release for voting comments – readying for final voting
1.2AS	2010.04	Publication of AS version – no comments during final voting
1.3AS	2012.09	Update following publication of AN126
01.03.01	2013.10.23	Editorial updates for the publication of KNX Specifications 2.1.

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Contents

1 Preface

In the light of the multi-vendor philosophy within KNX, KNX has opted for a standardization of a number of crucial basic and system components/devices providing standardized interfaces not only to manufacturers but also installers and users. However, it is still possible to design non-standardized solutions.

In the following clauses, the underneath connotation is used:

No.	Abbreviation	Meaning
1	M	Minimum requirements for certification – the 'M' requirements are only a subset of the standardized/optional requirements respectively recommendations – devices not complying to at least these requirements cannot be certified
2	0	Optional requirement - when implemented, the KNX requirements shall be met
3	F	Recommendations (free to implement)
4	S	Feature of standardized solutions
5	VI	Visual inspection (test guidelines)

If the names of basic and system components/devices have been standardized respectively exclusively assigned to this type of products (e.g. BCU), non-standardized versions may not bear this same name. For the example given above, the system device would have to be named BAU or Bus Access Unit.

Note: For commercially available basic and system components/devices, consult the KNX Directory of KNX registered/certified solutions.

2 TP1 Centralised Power Supply Unit (PSU)

This paragraph deals with all information related to centralised Power Supply Unit (hereafter abbreviated PSU). Two types of centralised PSU are defined: with or without integrated bus choke. In this clause the requirements for the PSU without choke are given, while clause 4 contains the additional requirements for the type with integrated choke.

The requirements for the TP1 decentralised power supply unit are given in clause 6.

2.1 Communication Requirements

No.	Requirements	M
1	PSU and choke together shall act as a bus termination (for further details see choke specifications – clause 5).	M/S
2	The PSU bus output shall only be used for feeding the bus or bus devices. When an extra output is implemented it shall not affect the bus voltage in any way.	M/S
3	Two Power Supply Units shall be able to function together in one single bus line (physical segment). If one PSU is out of operation (e.g. missing mains), the other PSU shall not be affected by the idle one.	F/S

2.2 Electrical Safety

No.	Item	Requirements	M
1	General	The PSU shall comply with the requirements for group 1 devices as given in Volume 4/1 clause 3.4	F/S
2	Output voltage/ protection measure	The PSU shall generate a SELV (Safe Extra Low Voltage) with a typical voltage of 30 V DC (28 V-31 V)1.	M/S
3	Overload	The PSU shall be able to sustain any kind of overload. An independent overvoltage protection circuit shall be provided, limiting the output voltage to a level between 34 ± 1 V. The overvoltage protection shall be ensured by the manufacturer (no test specified).	M/S
4	Separation of terminals	Mains and bus terminals and/or sockets shall be located at opposite sides of the PSU.	F/S
5	non-SELV circuits/ terminals	Non-SELV circuits/terminals shall provide protective separation from bus circuits/terminals according to their respective rated insulation voltage. When galvanic connection between non-SELV circuits and bus circuits is required, the rules for protective impedances shall be applied (acc. IEC 1140).	M/S
6	Rated Insulation Voltage	RIV ≥ 250 V, Group 1 device	F/S

1 The KNX TP1 signal is a mixed voltage with a DC part of max. 31 V DC and an AC signal (10 kHz) with max. +13 V and min. –9 V (22 V peak-peak). This signal is within the SELV frame according to sub-clause 5.2.13 of EN 50178 (see also EN 60950).

No.	Item	Requirements	M
7	Safety transformer	A safety transformer shall be used in the power supply unit and shall comply with EN 60742 or EN 61558 in addition to the KNX requirements.	M/S
8	Terminal for connection to earth	If the terminal complies with the requirements for PE terminals it shall be marked with ⏚. The yellow-green wire shall be used for connection to PE. If the terminal does not comply with the requirements for PE terminals, it shall be marked with ⏚.	M/S
9	Protective impedance to earth	The protective impedance for symmetrical earthing of the bus line shall follow Figure 1. The dimensions of the used resistors shall be selected to comply with the clearances and creepage distances to ensure basic separation to earth. The optional capacitor (≤ 3,3 nF) shall withstand 1,5 kV impulse 1,2/50 (or 1 kV AC)	M/S

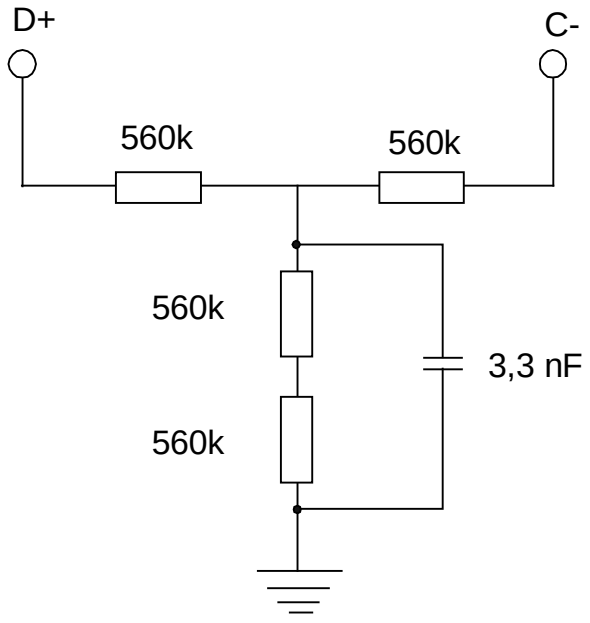


Figure 1: Protective Impedance for Use in TP1 PSU's

2.3 Environmental Conditions

As regards environmental data, requirements and tests, the PSU shall comply with Volume 4/1 clause 2.1. Additionally, the following requirements apply:

No	Item	Data and Requirements	M
1	ambient temperature range	3k5 (-5°C/+45°C)	F/S
2	life time	10 years according Volume 4/1 clause 2.5.3	M/S

2.4 EMC

As regards EMC, the requirements of Volume 4/1 clause 2.3 apply.

2.5 Mechanical, Dimensions, Constructional Features

No.	Requirements	M
1	When a PSU is equipped with LED's to indicate normal operation respectively overload (e.g. short circuit), they shall be green respectively red coloured. For more information on the conditions for overload, refer to Figure 3.	O/S
2	When a PSU is equipped with additional LED's indicating overvoltage or disturbances (e.g. caused by radiated interference), they shall be yellow- coloured.	O/S

2.6 Electrical Features

The PSU shall principally follow the U/I characteristic as shown in Figure 2.

No	Topic	Data and Requirements	M
1	output voltage [U_{PSU}]	28 V –31 VDC	M/S
2	output voltage ripple (idle)	≤ 100 mV (peak to peak) (DC to 1 MHz)	M/S
3	nominal output current [I_N]	160 mA / 320 mA / 640 mA / 960 mA/ 1280 mA	M/S
4	Operating current [I_O]	Normal operation: 0 mA < I_O < I_N; U_O=U_{PSU}	M/S
5	short circuit current[Is]	see Figure 3	M/S
6	DC output impedance	the output voltage (item 1) shall remain constant in the range as laid down under item 3 of this table.	M/S
7	hold up time (mains interrupt time) [tholdup]	under normal conditions (nominal input voltage output current), an interruption of the mains power of less/equal to 100 ms shall not affect the DC output voltage of the bus power supply unit.	M/S
8	Transient response (Dynamic behaviour)	ripple voltage < 0,2 V (peak to peak) during load changes	M/S
9	Symmetry to earth	The bus voltage shall be earth symmetrical (see Protective Impedance to earth): Figure 1 shows an example how this can be achieved.	M/S
10	leakage current – two parallel PSU	I ≤ 10 mA	O/S

The underneath figure shows the range for the PSU output characteristics: The graph J to L shows the static behaviour of the PSU

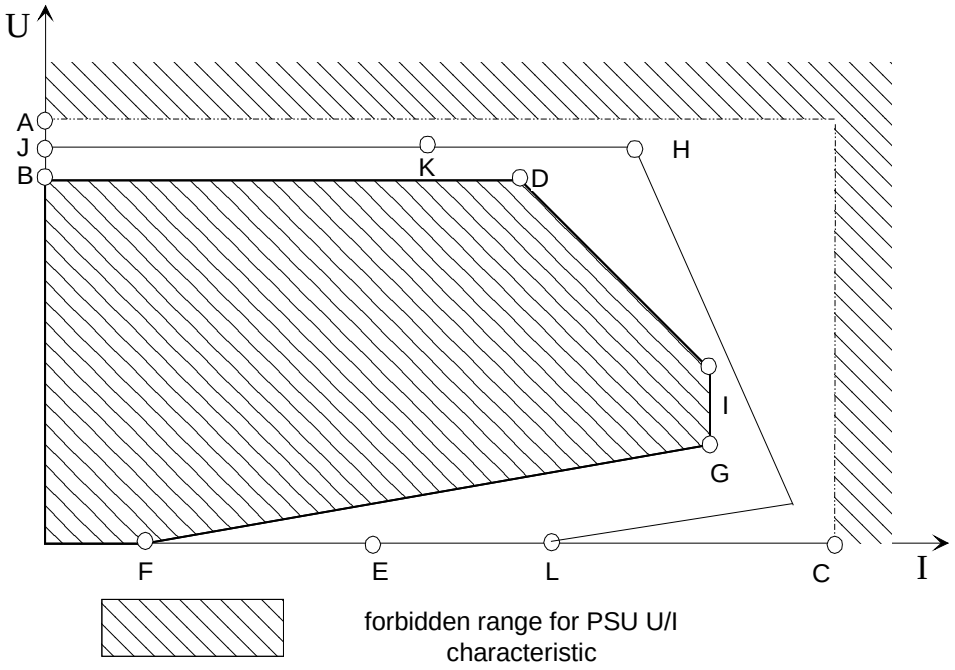


Figure 2: TP1 PSU U/I Characteristic (drawing not in scale!)

The letters in the above figure denote the following (see also requirements in clause 2.6):

A	=	upper voltage limit
B	=	lower voltage limit
C	=	maximum current limit
D	=	knee point
E	=	nominal current: up to E the minimum hold up time of the PSU is ensured.
F	=	0 V current
G/I	=	knee point
K	=	overload indication
H	=	activation of overload protection
J to K	=	normal operation range

IN/mA	A	B	C	D	E	F	G	I	K
160	item 1 of clause 2.6		1 A	0,35 A	0,16 A	0,1 A	10 V 0,35 A	18 V 0,35 A	0,30 A
320			1,0 A	0,70 A	0,32 A	0,2 A	10 V 0,7 A	18 V 0,7 A	0,50 A
640			1,5 A	1,2 A	0,64 A	0,4 A	10 V 1,3 A	18 V 1,3 A	0,90 A
960			2,25 A	1,6 A	0,96 A	0,6 A	10 V 2,0 A	18 V 2,0 A	1,3 A
1280			3,0 A	1,9 A	1,28 A	0,8 A	10 V 2,65 A	18 V 2,65 A	1,6 A

Figure 3: U/I Characteristic – values for different types of TP1 PSU

2.7 Testing

2.7.1 Environment

- Testing shall be carried out in an environment that does not influence the test results.
- Only calibrated test equipment shall be used.
- Test set-ups shall be as small as possible (if not specified otherwise) to avoid voltage drops along the wires and parasitic induction.
- The test shall be carried out in the temperature range stated for the product by the manufacturer in the data sheet.

2.7.2 Test Equipment

- PSU: Ajustable DC-Source ; 0-40 V; U_{PSU} (Ripple) < 100 mV
- Oscilloscope (BW min. 20MHz) : Standard Ri = 1 MΩ/20 pF
- Function Generator: Standard; Ri < 50 Ω
- Variable Resistors to simulate different loads
- Variable AC source to simulate tolerances of mains
- DC-Voltmeter Ri >10 MΩ/V
- LPF Bandwidth limitation [0-159kHz](see below)

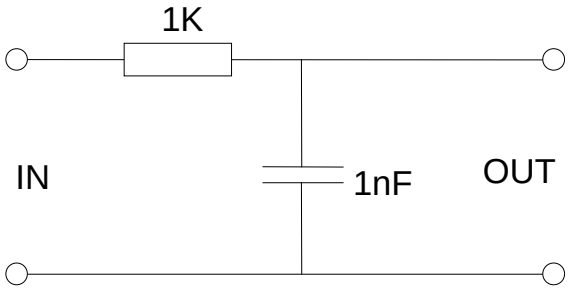


Figure 4: Lowpass Filter (fg = 159 kHz)

2.7.3 Testing of Output Voltage

- Test Setup:

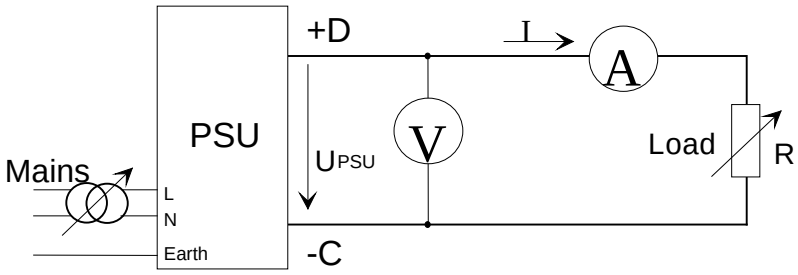


Figure 5: Test Setup U/I

- Testing:
  Voltage U_{PSU} shall be monitored during variation of Resistor R from
  Rmax = ∞ (idle state) to
  Rmin = (U_{PSU} / I_N) * 0,9
  Variation of mains from max. to min. voltage
- Requirements:
  according to item 1, clause 2.2 and 2.6.

2.7.4 Testing of Output Voltage Ripple

- Test Setup:

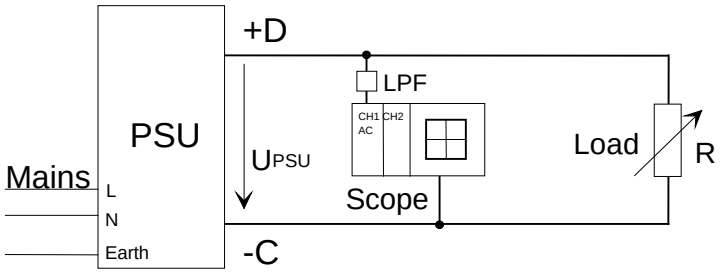


Figure 6: Test Set-up for Voltage Ripple

- Testing:
  U_{PSU} shall be monitored with an Oscilloscope (use LPF) during variation of Resistor R from Rmax = ∞ (idle state) to
  Rmin = U_{PSU} / I_N
  Channel display: AC. Reading out peak-peak value

- Requirements:
  U_{PSU} shall be lower or equal than the value of item 2 of clause 2.6.

2.7.5 Testing of two parallel PSUs, Leakage Current

- Test Setup:

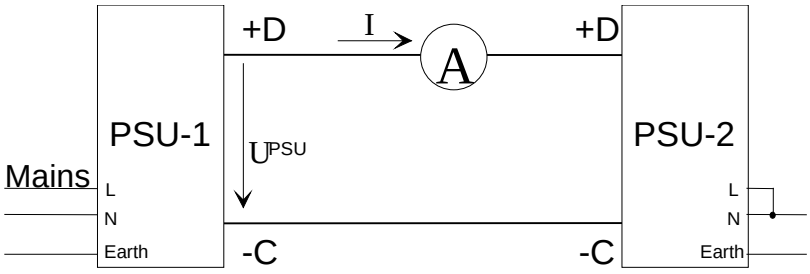


Figure 7: Test Set-up of two parallel PSUs, Leakage Current

- Testing:
  The leakage current shall be measured
- Requirements:
  The current I shall be lower or equal than the value of item 10 of clause 2.6.

2.7.6 Testing of PSU's Dynamic Behavior

- Test Setup:

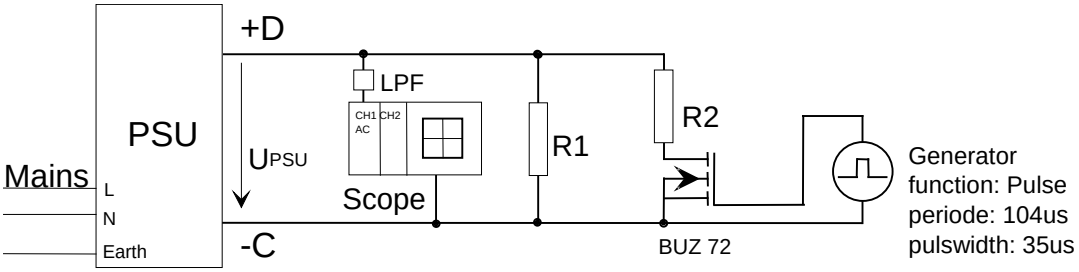


Figure 8: Test Setup for Dynamic Behaviour

- Testing:
  R1 = ∞ (idle state) to Rmin = [U_{PSU} / I_N] * 0,9 (I_{NOM})
  R2 = 140Ω (I_{Pulse} ≈ 200mA); the transistor behaves like a switch
  U_{PSU} shall be monitored with an Oscilloscope.
  Channel display: AC. Reading out differential voltage of pulse and pause.
- Requirements:
  U_{PSU} (AC) shall be in the limit given in item 8 of clause 2.6.

2.7.7 Testing of PSU's Hold-Up Time

- Test Setup:

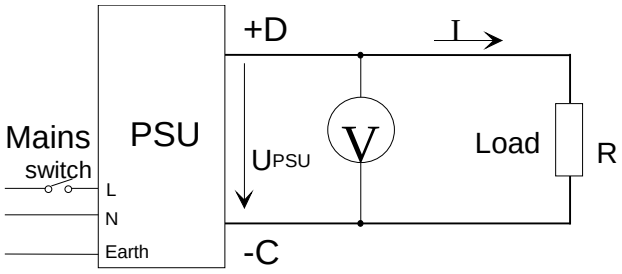


Figure 9: Test Setup for Hold Up Time

- Testing:
  Switch closed; R= (U_{PSU} / I_N) * 0,9
  Switch open, measure time till U_{PSU} drops below 95% of original value
- Requirements:
  t_{holdup} shall be more or equal than the value of item 7 of clause 2.6.

2.7.8 Testing of U/I Characteristic

- Test Setup:
  see Figure 5
- Testing:
  Voltage U_{PSU} and current I shall be monitored during variation of Resistor R from
  Rmax = ∞ (idle state) to
  Rmin = 0 (short circuit)
- Requirements:
  resulting graph shall comply with U/I characteristic in Figure 2.

2.8 Functional Safety

Under consideration

2.9 Interfaces, Connectors

No.	Requirements	M
1	Data rail connection	F/S
2	In case of a data rail type design, the dimensions of the PSU shall be in accordance to DIN 43880 (CLC TC23E Report R023-01) and shall allow snapping the device onto the DIN rail of which the dimensions correspond to those laid down in Volume 9/1, Connector Type 6.1	O/S
3	In case of data rail connection, the connection to the bus shall be ensured either • by means of Type 6.1 Connector connected to the outer tracks of the data rail or • by the red/dark-gray Type 5.1 Connector (Bus-Connector) • or both	O/S
4	In case of other than data-rail connection the connection to the bus shall be ensured by the red/dark-gray Type 5.1 Connector (Bus-Connector) only.	O/S
5	Additional (choke) outputs shall only use the red/dark-gray Type 5.1 connector.	O/S

6	Additional auxiliary non-SELV outputs shall not use KNX standardized Connector Types.	M/S

2.10 Marking

No.	Requirements	M
1	The function of the LED's shall be clearly indicated both on the device itself and in the manufacturer's data sheet.	O/S
2	The PSU shall be labelled according to the example in Figure 10. The technical data shall contain: input voltage range, the AC symbol, frequency, nominal DC output voltage, nominal output current, temperature range and the PSU symbol. The manufacturer's data sheet shall moreover contain details on maximum mains power consumption, short circuit mains protection and maximum output current.	M/S
3	All outputs for bus voltage shall be marked with the polarity.	M/S
4	Additional auxiliary non-SELV outputs shall be clearly marked with voltage, power, etc.	M/S

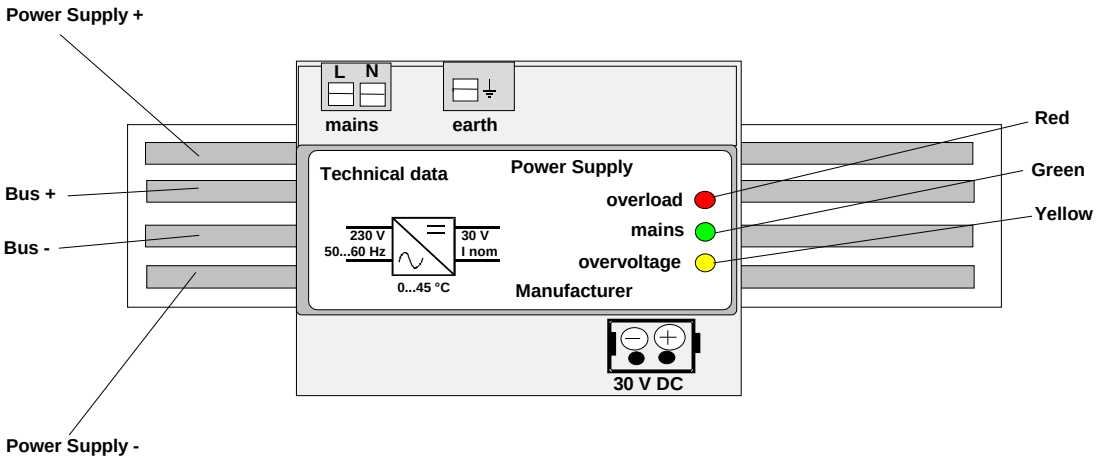


Figure 10: Example of Electrical Connection and Labeling of PSU

2.11 Installation

No.	Requirements	M
1	When a PSU without integrated bus choke is used, an additional external choke shall closely be mounted to the PSU and connected to feed a twisted pair physical segment.	
2	Such PSU shall not be connected to the Bus without choke	
3	Two PSUs may be mounted in parallel and used with one choke	
4	Unused connections of the PSU and choke shall not impair protective separation. If necessary they shall be protected by additional appropriate covers.	M/S
5	The cable length between PSU and device shall be less than or equal 350m.	

2.12 Symbols

The following symbols are defined for installation schematics:

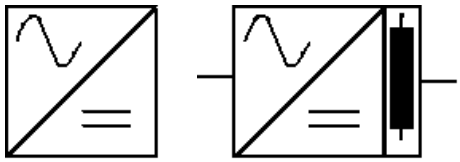


Fig. 9/2- 27: PSU Symbols

3 Battery Back-up system

No.	Requirements	M
1	If either a battery backup system is charged from the bus or from the mains, it shall comply with the electrical data as laid down in clause 2.6 above. The effect on the behaviour of the PSU resulting from this battery backup system shall be clearly stated in the manufacturer's data sheet.	O

4 PSU with integrated Choke

For choke specific requirements consult paragraph 5.

No.	Requirements	M
1	A PSU with integrated choke is a Group 1 device	O
2	The connection to data rail shall be ensured by Type 6.1 connector to inner tracks of the data rail.	O
3	When the PSU with integrated choke is equipped with an intermediate connection point for 30 V DC it shall be clearly marked both with '30 V DC' and the polarity. In this case Connector Type 5.1 Yellow/White shall be used for connection.	O

5 TP1 Choke

The choke connects the bus with the PSU. The principle of connection is shown in Figure 11. The choke ensures de-coupling of power feeding and data signalling.

The choke plays an essential role in the generation of analogue data signals.
During the equalization part it restores the energy as used in the active part of the 0-bit.

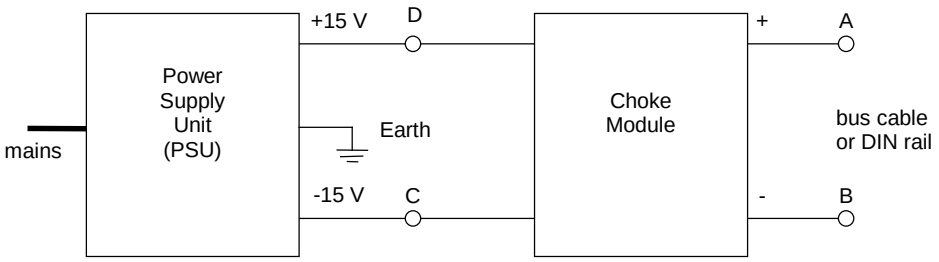


Figure 11: Connection of Choke Module

5.1 Communication

No.	Requirements	M
1	The output impedance of the choke shall be matched to the standard bus-cable impedance.	M/S

5.2 Electrical Safety

No.	Item	Requirements	
1	General	The choke shall comply with the requirements for group 2 devices as given in Volume 4/1 clause 3.5	M/S
2	protection measure/nominal voltage	SELV (Safe Extra Low Voltage) (21 V-31 V).	M/S
3	Rated Insulation Voltage	RIV ≥ 250 V, Group 2 device	F/S
4	Creepage distance (KNX standard) between bus contacts and outer surface when mated (Usage class B – basic insulation)	min 3 mm	M/S
5	Clearance distance (KNX standard) between bus contacts and outer surface when mated (Usage class B – basic insulation)	min 3 mm	M/S

5.3 Climatic Conditions

As regards environmental data, requirements and tests, the choke shall comply with Volume 4/1 clause 2.1. Additionally, the following requirements apply:

No	Topic	Data and Requirements	M
1	ambient temperature range	3k5 (-5°C/+45°C)	F/S
2	life time	10 years according Volume 4/1 clause 2.5.3	M/S

5.4 EMC

As regards EMC, the requirements of Volume 4/1 clause 2.3 apply.

No.	Requirements	M
1	In order to improve noise immunity and decrease radiation on the bus, the choke shall be electrical symmetrical designed.	F/S

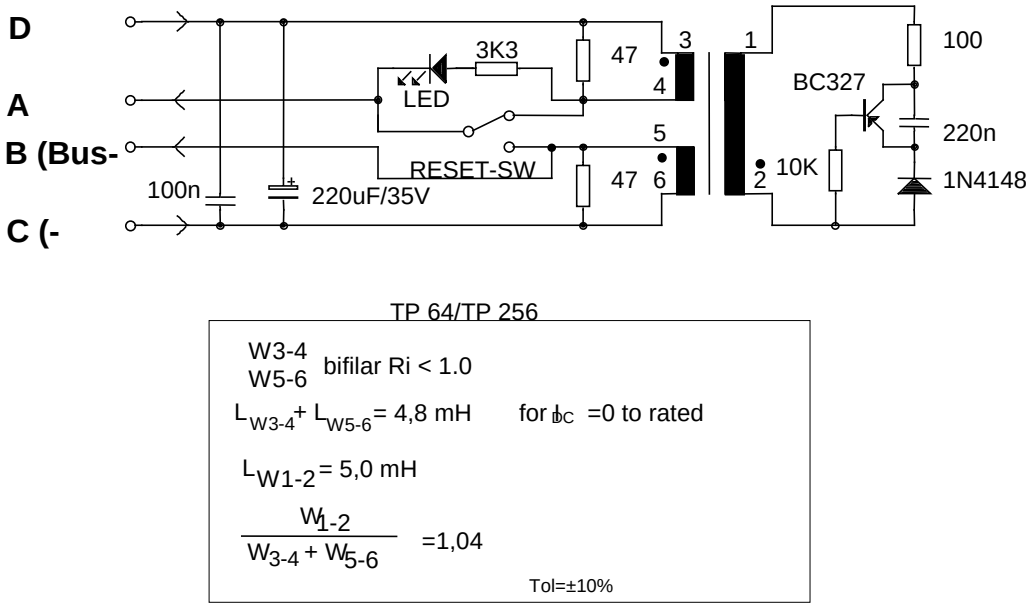


Figure 12: Electrical Circuit of a Choke Module TP (informative)

5.5 Mechanical, Dimension, Constructional

No.	Requirements	M
1	The choke shall be equipped with a reset switch or reset push button, which cuts off the PSU from the bus line and short-circuits the bus	F/S
2	The reset status caused by a reset switch or reset push button shall be indicated by means of an extra LED. It shall be red coloured.	F/S

5.6 Electrical

No	Topic	Data and Requirements	M
1	input voltage	See PSU output voltage.	
2	maximum current	3 A for stand-alone chokes matching the maximum current of the PSU for integrated chokes	M/S
3	nominal current	for stand-alone chokes $I_N \geq 1000$ mA and $I_N \geq$ the current at point C (see Figure 2) of the used PSU(s) For integrated chokes: Matching the U/I Characteristic of the used PSU for $U_{PSU} \geq 20V$	M/S
4	DC voltage drop UDA = UBC (for nominal load)	$\leq 0,75$ V for $I_N \leq 640$ mA $\leq 1,25$ V for $I_N \geq 640$ mA	M/S
5	reset switch or reset push button	shall be able to carry and switch 3 A	O/S

5.7 Testing

5.7.1 Environment

- Testing shall be carried out in an environment that does not influence the test results.
- Only calibrated test equipment shall be used.
- Test set-ups shall be as small as possible (if not specified otherwise) to avoid voltage drops along the wires and parasitic induction.
- The test shall be carried out in the temperature range stated for the product by the manufacturer in the data sheet.

5.7.2 Test Equipment

- PSU: Ajustable DC-Source ; 0-40 V; U_{PSU} (Ripple) < 100 mV
- Oscilloscope (BW min. 20MHz) : Standard Ri = 1 MΩ/20 pF
- Function Generator: Standard; Ri < 50 Ω
- Variable Resistors to simulate different loads
- Current Probe (galvanic separated)
- DC-Voltmeter Ri >1 MΩ/V
- Isolated Amplifier

5.7.3 Testing of Static Parameters

- Test Set-up:

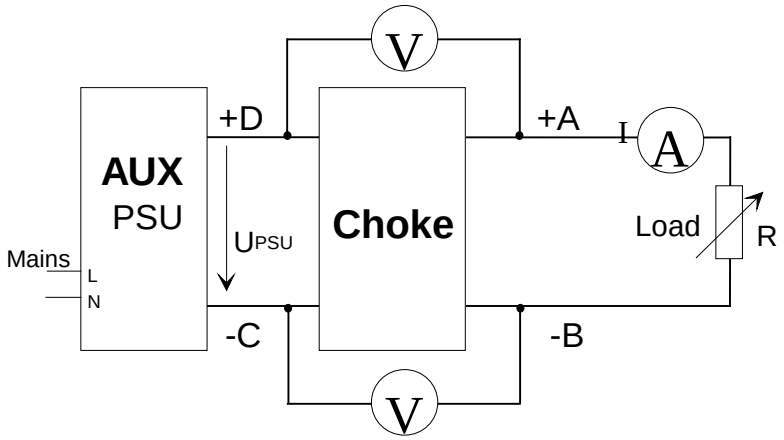


Figure 13: Test Setup Voltage Drop

- Testing:
  a) The voltages (U_{CB}) and (U_{DA}) shall be measured at U_{PSU} =29 V DC
  Rmax = ∞ (idle state) to
  Rmin = (U_{PSU} / I_N) * 0,9
  b) I=I_M (Adjusted by R), (Resistor R =12Ω ; U_{PSU} = 29 V DC)
- Requirements:
  a) U_{CB} = U_{DA} (tolerance ± 5%)
  U_{CB} = U_{DA} (Voltages shall be lower or equal than the value of item 4 in table of clause 5.6)
  b) no damage after this test

5.7.4 Testing of Dynamic Parameters

- Test Setup:

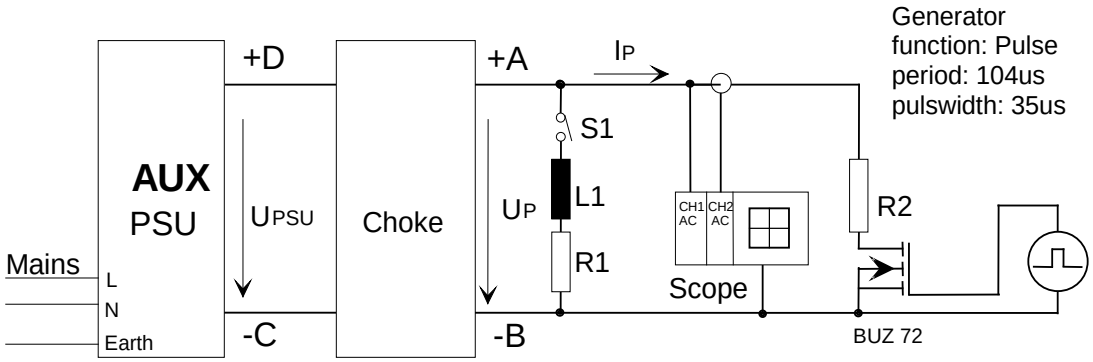


Figure 14: Test Setup for Dynamic Behaviour

- Testing:
  U_P shall be tuned to 29V DC
  U_P and I_P shall be monitored with an Oscilloscope
  R2 = 220Ω
  R1 = (U_P/ I_N) * 0,9
  L1 = 4,8 mH (at rated DC current), Ri < 2Ω
  Requirements:
  Point A to D of the registered wave forms (S1 open/closed) shall comply to the values as stated in underneath figures and tables.

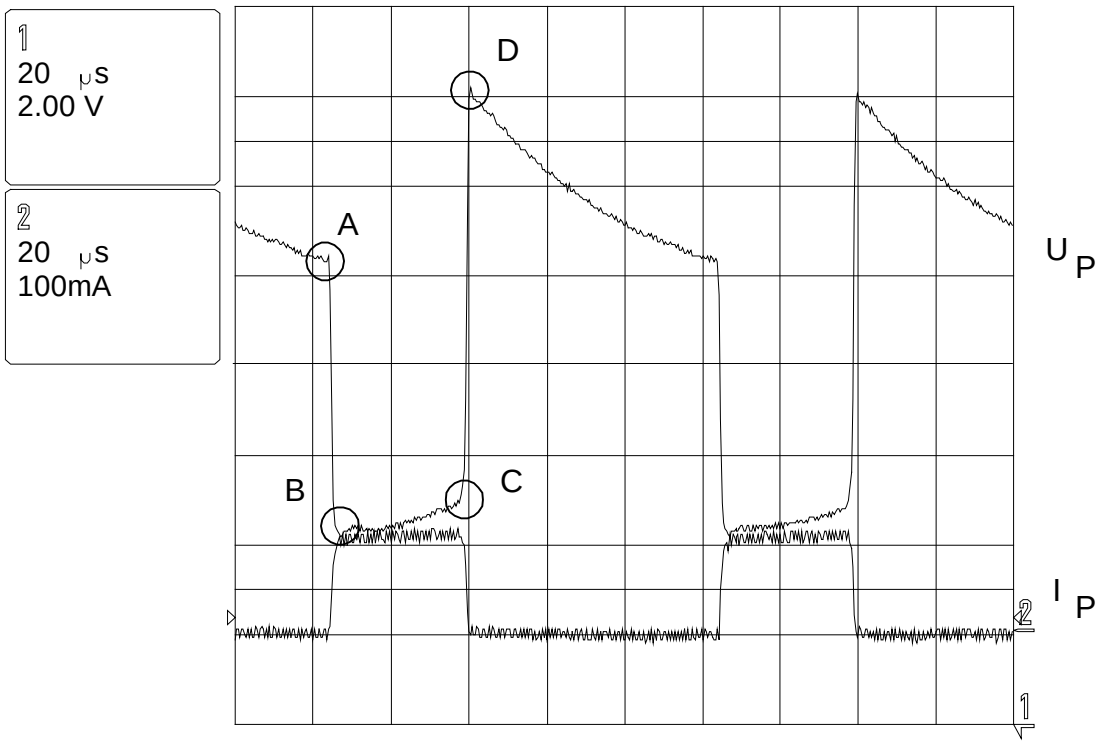


Figure 15: Voltage and Current of Choke (S1 = open)

Point	Voltage
A	30 V (± 5%)
B	24,2 V (± 5%)
C	24,4 V (± 5%)
D	34 V (± 5%)
current IP	105mA (+/- 10%)

Figure 16: Electrical Data of Choke (S1 = open)

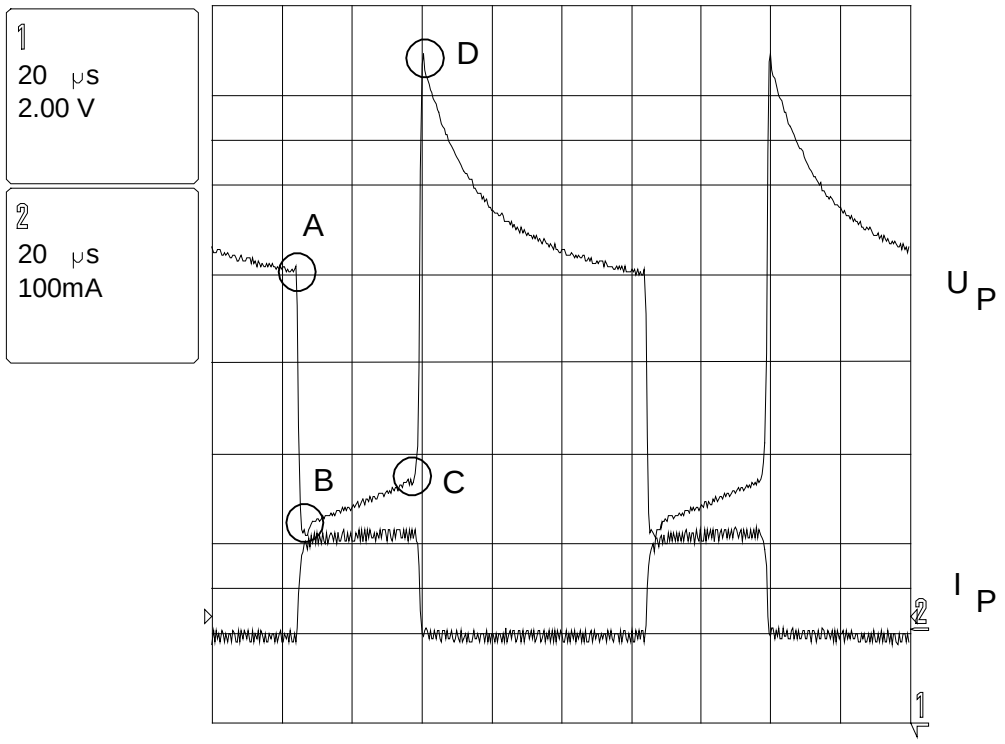


Figure 17: Voltage and Current of Choke (S1 = close)

Point	Voltage
A	29,5 V (+/- 5%)
B	24,3 V (+/- 5%)
C	25,4 V (+/- 5%)
D	36 V (+/- 5%)
current IP	105mA (+/- 10%)

Figure 18: Electrical Data of Choke (S1 = close)

5.7.5 Testing of Symmetry

Test shall be carried out in accordance with Handbook Volume 4/2 EMC Test Set-ups clause 3.3 and 4.3.

5.7.6 Testing of Reset

- Test Set-up:

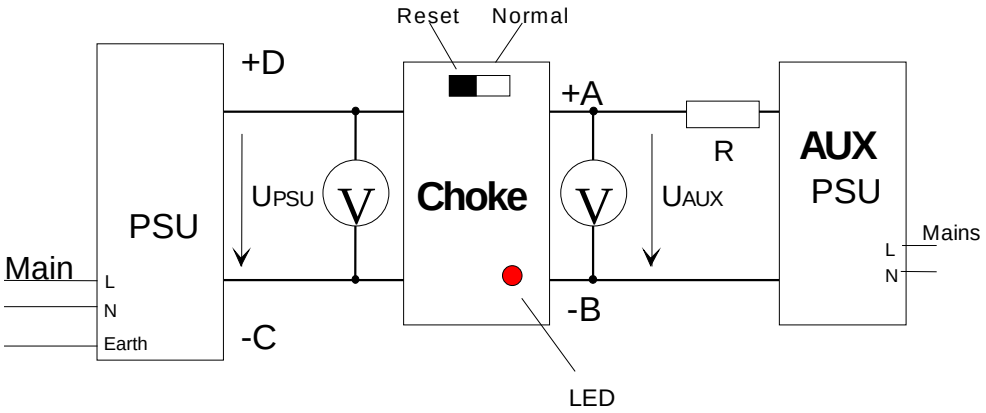


Figure 19: Test Setup

- Testing:
  U_{AUX} shall be tuned to 10V DC ; R = 3,3Ω (I ≈ 3A)
  Switch or push button to reset position

- Requirements:
  U_{PSU} ≥ 28V (reset switch or reset push button/U_{PSU} not measured)
  U_{Aux} < 0,5V
  LED (red) shall illuminate.
  no damage of reset switch or reset push button and choke module after this test

5.8 Functional Safety

Under consideration

5.9 Interfaces/ Connectors

No.	Requirements	M
1	In case of DIN-rail type design, the dimensions of the choke shall be in accordance with EN 43880 and allow snapping the device onto the DIN rail.	O/S
2	When stand-alone (not integrated in a PSU), data rail connecting is recommended.	O/S
3	In case of data rail contacting, connection to the bus shall be ensured by KNX Connector type 6.1. The outer tracks shall be connected to the choke input (PSU); the inner tracks to the choke output (Bus).	F/S
4	In case of non-data-rail contacting, the choke input and output shall be equipped with KNX Connector type 5.1. The input of the choke shall be equipped with white/yellow and the output with red/dark gray connectors.	O/S

5.10 Marking

No.	Requirements	M
1	Labelling on the choke shall contain at least the following data: manufacturer, the product name, maximum current and symbol. The wording ‘reset’ next to the reset LED as well as additional labelling of the reset button is recommended. Input, Output and polarity shall be clearly labelled in case of a non-data-rail type design. An example of electrical connection and labelling of the choke is shown in Figure 20.	M/S

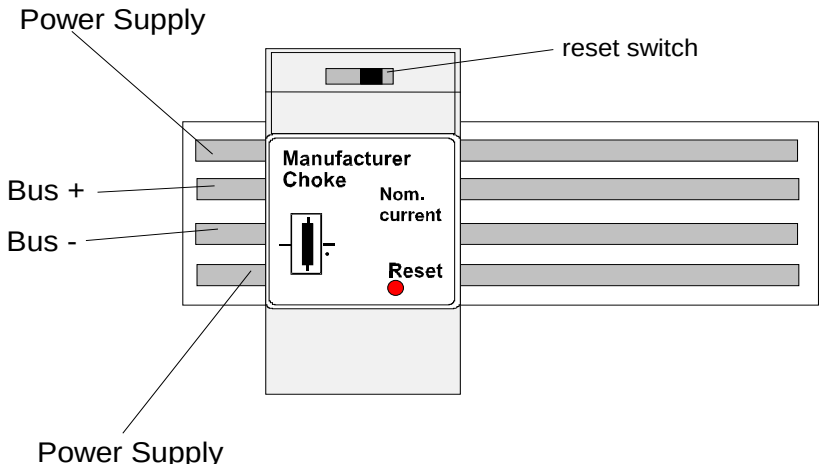


Figure 20: Example of Electrical Connection and Labelling of Choke

5.11 Installation

No.	Requirements	M
1	A reset time of at least 20 s is recommended to the user, to ensure that all bus devices within a segment are reset	
2	The reset switch or reset push button shall not be directly accessible, e.g. in case of DIN-rail mounting protected by means of the distribution board cover, if a cover is not provided by the device.	O/S
3	A maximum of two chokes may be mounted in one bus line. The minimum distance between the chokes shall be at least 200 m.	M/S

5.12 Symbols

The following symbols are defined for installation schematics:

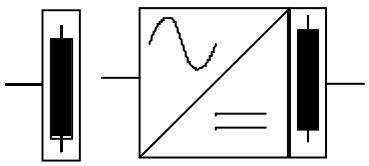


Figure 21: Symbol for Standalone Choke resp. Power Supply + Choke

6 TP1 Decentralized Power Supply Unit (DPSU)

6.1 Scope

This paragraph deals with all information related to Decentralized Power Supply Unit (hereafter abbreviated DPSU) with integrated bus choke.

This specification is valid for DPSUs up to 80 mA nominal output current. If needed in the future, DPSUs with higher output current would be specified in a separate clause.

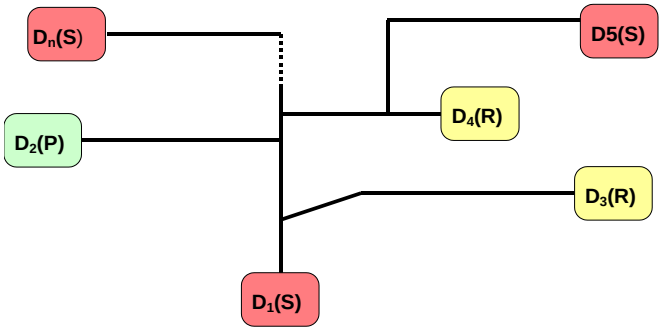
6.2 Introduction

This document specifies a cost-effective solution to power the TP1 bus line. Instead of the centralized bus power supply, the bus is powered in a distributed way by some devices which contain each a Decentralized Power Supply Unit (DPSU). One DPSU provides less power than a standard central bus power supply and only a few devices with limited power consumption can be fed by one DPSU.

Up to eight DPSUs may be activated together in one single bus line (physical segment). Devices with DPSU feature can allow to disable the DPSU manually (e.g. by jumper or configuration of a parameter). Activation of more than eight DPSUs in one single bus line does not have a destructive effect (no over-current protection necessary) but damping of the signal increases and communication may be disturbed.

DPSUs can be located at any point of the bus line. There are no limitations concerning minimal cable distances between two DPSUs or DPSU and standard central PSU.

Each DPSU has a fan-in value according to clause 6.10.9 “Testing of Dynamic Parameters and Busload”.



(S): device with DPSU
(R): device remotely powered from the bus
(P): passive device (neither DSPU nor powered from the bus)

Figure 22 - TP1 network with multiple DPSUs

The usage of DPSU instead of a central bus power supply on a TP1 network is appropriate in the following cases:

- small system with few devices, or
- short distances between devices: limited total cable length is dependent on the number of devices with DPSU, or
- only a few devices to be powered from the bus: total available average supply current is limited and dependent on the number of devices with DPSU.

Application examples for DPSU operation:

- Simple heating system in a single family home with one heating zone. Such a heating system may consist in its simplest form of one heating controller with DPSU (S) and one room unit (R).
- Single family home heating system with individual room control. Such a heating system may consist of one boiler controller with DPSU (S) and has per individually controlled room one room unit/controller with DPSU (S) and some radiator valve actuators (P).

Several types of DPSU with different power capability (supply current) are specified. Different types of DPSU can be mixed in one single bus line. It is also possible to combine DPSU with up to two Standard Power Supply Units.

The number and types of necessary DPSU depends on:

- the needed total supply current for the devices to be fed from the bus, and
- the required total cable length.

DPSU is usually part of a communicating device but stand alone DPSU devices (without micro-controller, not communicating) are also possible.

NOTE Some technical requirements and test setup are different for DPSU and central PSU (as specified in 2.7). These differences are intentional and have technical reasons.

- Unlike central PSU, the DPSU shall always include the choke module.
- There shall be no minimum cable distance between DPSUs. Therefore the output impedance of DPSU is higher to distribute the load more uniformly.
- DPSUs and central PSU may be operated in parallel. The specified typical output voltage of DPSU is lower in comparison with central PSU. This decreases the probability that DPSUs are working in the limiting part of the output characteristics because central PSU is feeding the bus devices.

6.3 Communication Requirements

Table 1 – Communication Requirements for DPSU

Nr.	Requirements	M
1	DPSU with integrated choke shall act as a bus termination.	M/S
2	The DPSU bus output shall only be used for feeding the bus or bus devices.	M/S
3	Eight Decentralized Power Supply Units shall be able to function together in one single bus line (physical segment).	M/S
4	It shall be possible to switch off resp. to unlink the DPSU from the bus, e.g. by an electronic or a mechanical switch. If one DPSU is out of operation, the other DPSUs and PSUs shall not be affected by the idle one. This feature shall be stated in the datasheet of the product.	O/S
5	Eight Decentralized – and two Standard Power Supply Units are able to function together in one single bus line (physical segment). This feature shall be stated in the datasheet of the product. Mandatory feature if the DPSU cannot be switched off according to item 4. Optional feature if the DPSU can be switched off according to item 4.	 M O
6	It shall be possible to place DPSU at any point of the bus line (no minimal cable distance between two DPSU or between DPSU and standard central PSU). If one DPSU is out of operation (e.g. missing mains), the other PSUs/DPSUs shall not be affected by the idle one	M/S

6.4 Integrated TP Choke

The integrated choke connects the bus with the output voltage of the PSU. The principle of connection is shown in Figure 23. The choke ensures decoupling of power feeding and data signalling.

The choke plays an essential role in the generation of analogue data signals. During the equalisation part it restores the energy as used in the active part of the 0-bit.

The dimension shall be done so, that the requirements of 6.10.9 “Testing of Dynamic Parameters and Busload” are fulfilled. Otherwise the implementation is free. An example is shown in Figure 24.

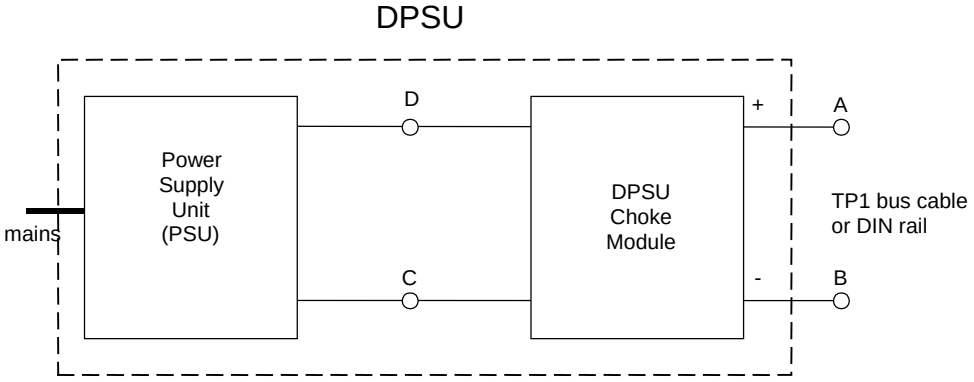
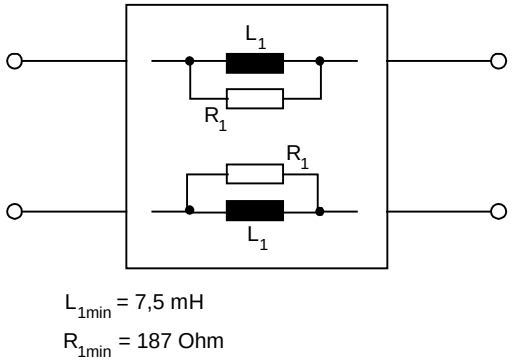


Figure 23 - Example Internal Connection of DPSU



L_{1min} = 7,5 mH

R_{1min} = 187 Ohm

Figure 24 - DPSU Choke Module

6.5 Electrical Safety

acc. to EN60950 max. leakage current 125 μA (max. 250 μA at reverse connection N-L)

acc. to EN50491-3 safety separation

acc. to IEC60664-1 over-voltage category III; pollution degree 2

Nr.	Item	Requirements	M
1	General	The DPSU shall comply with the requirements for group 1 devices as given in Volume 4/1 clause 3.4.	F/S
2	Output voltage/ protection measure	The DPSU shall generate a SELV (Safe Extra Low Voltage) with a typical voltage of 29 V DC (21 V to 31 V). NOTE In a configuration with PSUs and DPSUs in parallel, without the maximum number of bus devices, a typical voltage of 29 V decreases the probability that the DPSUs are working in the limiting part of the output characteristic because the central PSUs are feeding the bus devices.	M/S
3	Overload	The DPSU shall be able to sustain any kind of overload. An independent overvoltage protection circuit shall be provided, limiting the output voltage. The overvoltage protection has to be guaranteed by the manufacturer. There is no test specified.	M/S
4	Separation of terminals	Mains and bus terminals and/or sockets shall be located at opposite sides of the DPSU.	F/S
5	non-SELV circuits/ terminals	Non-SELV circuits/terminals shall provide protective separation from bus circuits/terminals according to their respective rated insulation voltage. When galvanic connection between non-SELV circuits and bus circuits is required, the rules for protective impedances shall be applied (acc. IEC 1140). (EN50491-3) PELV circuits shall provide basic separation.	M/S
6	Rated Insulation Voltage	RIV ≥ 250 V, Group 1 device	F/S
7	Safety transformer	A safety transformer shall be used in the power supply unit and shall comply with EN 60742 or EN 61558 in addition to the KNX requirements.	M/S
8	Terminal for connection to earth	If the terminal complies with the requirements for PE terminals it shall be marked with ⏚. The yellow-green wire shall be used for connection to PE. If the terminal does not comply with the requirements for PE terminals, it shall be marked with ⏚.	M/S
9	General	The choke shall comply with the requirements for group 2 devices as given in Volume 4/1 clause 3.5	M/S

Nr.	Item	Requirements	M
10	Creepage distance (KNX standard) between bus contacts and outer surface when mated (Usage class B – basic insulation)	min. 3 mm	M/S
11	Clearance distance (KNX standard) between bus contacts and outer surface when mated (Usage class B – basic insulation)	min. 3 mm	M/S

6.6 Environmental conditions

As regards environmental data, requirements and tests, the DPSU shall comply with Volume 4/1 clause 2.1. Additionally, the following requirements apply:

Nr.	Item	Data and Requirements	M
1	ambient temperature range	3k5 (-5°C to 55°C) (-5°C to 45°C for flush-mounting)	F/S
2	life time	10 years according Volume 4/1 clause 2.5.3	M/S

6.7 EMC

As regards EMC the requirements according to EN50491-5-2 apply with the exception of:

EMC immunity acc. to EN61000-6-1	
electrostatic discharge	acc. to EN61000-4-2 4/8 kV (Contact-/Air-Discharge) Crit. B n. EN61000-6-1
RF-fields	acc. to EN61000-4-3 3 V/m 80 MHz to 1 GHz, Crit. A
fast transients (burst)	acc. to EN61000-4-4 1 kV/ 1 kV(mains, bus), Crit. B
Surge	acc. to EN61000-4-5 2 kV common mode / 1 kV differential mode, Crit. B
RF-voltage	acc. to EN61000-4-6 0,15 MHz to 80 MHz 3Vrms 80 % AM 1kHz, Crit. A
voltage dips a. voltage interruptions	acc. to EN61000-4-11 ΔV 30 %; Δt 300 ms performance criteria B ΔV 100%; Δt 100 ms performance criteria B
EMC emission acc. to EN61000-6-3	
radio emission interference voltage	acc. to EN55022 class B
radio emission interference field strength	acc. to EN55022 class B

The exceptions apply due to the home environment.

In addition all requirements of Part 4/2 apply.

6.8 Mechanical, Dimensions, Constructional Features

Nr.	Requirements	M
1	If a DPSU is equipped with LEDs to indicate normal operation respectively overload (e.g. short circuit), they shall be green respectively red coloured. For more information on the conditions for overload, refer to Table 2.	O/S
2	If a DPSU is equipped with additional LEDs indicating overvoltage or disturbances (e.g. caused by radiated interference), they shall be yellow coloured.	O/S
3	The DPSU shall be equipped with a reset switch or reset push button, which short-circuits the bus. If a reset switch is used, additionally the DPSU shall be cut off from the bus line.	O/S
4	The reset status caused by a reset switch shall be indicated by means of an extra LED. It shall be red coloured.	O/S

6.9 Electrical Features

The DPSU shall principally follow the U/I characteristic as shown in Table 2.

No	Topic	Data and Requirements	M
1	output voltage [U_{DPSU}]	27 V to 31 V DC for DPSU (choke module included), see points A, B in Table 2. NOTE 1 DPSUs and central PSU may be operated in parallel. The specified minimum output voltage of DPSU is lower in comparison with central PSU. This decreases the probability that DPSUs are working in the limiting part of the output characteristics because central PSU is feeding the bus devices.	M/S
2	output voltage ripple (idle)	≤ 100 mV (peak to peak) (DC to 1 MHz)	M/S
3	nominal output current [I_N]	3 different DPSU types: 25 mA, 40 mA, 80 mA	M/S
4	Operating current [I_O]	Normal operation : 0 mA < I_O < I_N; U_O = U_{DPSU}	M/S
5	short circuit current[I_s]	see Table 2.	M/S
6	DC output impedance	min. 10 Ω NOTE There is no minimum cable distance between DPSUs. Therefore a minimum output impedance is needed to distribute the load more uniformly	M/S
7	hold up time (mains interrupt time) [tholdup]	Under normal conditions [nominal input voltage, nominal output current], an interruption of the mains power of less/equal to 100 ms shall not affect the DC output voltage of the bus power supply unit according to EN 50090-2-2 performance criterion B. NOTE Performance criterion B allows transmission errors during test, but the equipment shall continue to operate as intended after the test. The manufacturer shall specify the nominal output current in the manufacturer data sheet.	M/S
8	Transient response (Dynamic behaviour)	|ripple voltage| ≤ 0,2 V (referring to idle voltage)	M/S

No	Topic	Data and Requirements	M
10	leakage current – two parallel DPSUs	I ≤ 10 mA	M/S

The underneath figure shows the range for the DPSU output characteristics: The graph J to L shows the static behaviour of the DPSU.

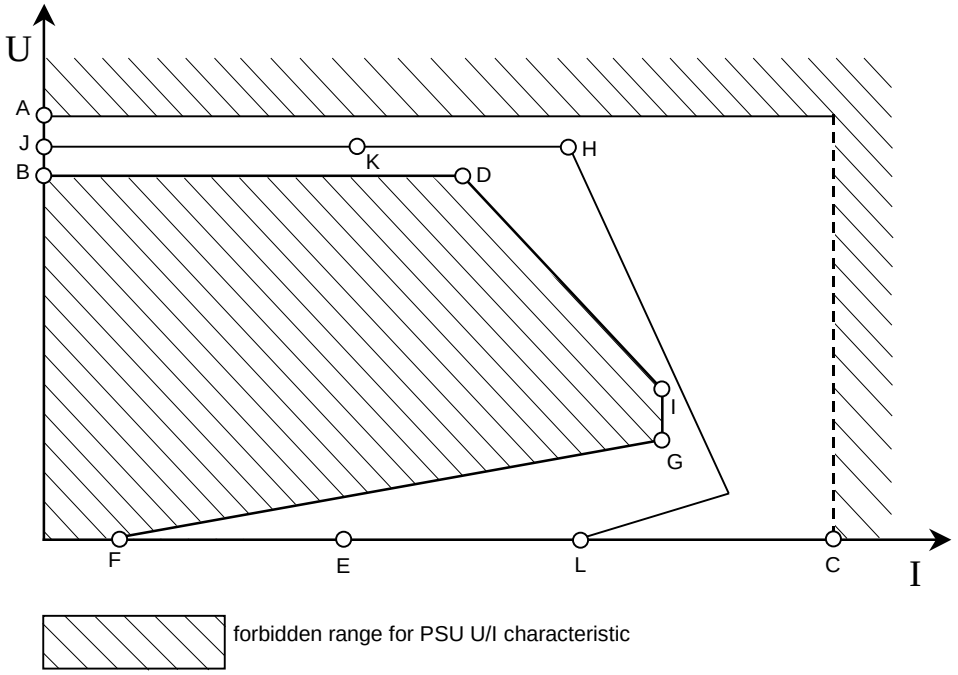


Figure 25 - TP1 DPSU U/I Characteristic (drawing not in scale!)

The letters in the above figure denote the following (see also requirements in clause 6.9):

A = upper voltage limit (see item 1 of 6.9)

B = lower voltage limit (see item 1 of 6.9)

C = maximum current limit

D = knee point

E = nominal current: up to E the minimum hold up time of the DPSU is ensured.

F = 0 V current

G/I = knee point

K = overload indication

H = activation of overload protection

J to K = normal operation range

Table 2 - U/I Characteristic – values for different types of TP1 DPSUs

I_N (mA)	Point								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**I**	**K**
25	item 1 [a)]	item 1 [a)]	145 mA	50 mA	25 mA	10 mA	13 V 55 mA	18 V 55 mA	50 mA
40	item 1 [a)]	item 1 [a)]	145 mA	80 mA	40 mA	25 mA	13 V 85 mA	18 V 85 mA	75 mA
80	item 1 [a)]	item 1 [a)]	350 mA	160 mA	80 mA	50 mA	13 V 175 mA	18 V 175 mA	150 mA
[a)] Limits of output voltage [U_{DPSU}] as specified in item 1 in 6.9.									

Special requirement for DPSU with I_N = 80 mA

The maximum resulting short circuit current of multiple DPSUs and central PSU on the same line shall not exceed 3 A. If 8 DPSUs with the max. short circuit current of 350 mA (Point 'C') are combined with one central PSU, the maximum limit of 3 A is exceeded. This restriction shall be considered for planning of an installation. The actual max. short circuit current shall be indicated in the product datasheet for each DPSU product.

6.10 Testing

6.10.1 Environment

- Testing shall be carried out in an environment that does not influence the test results.
- Only calibrated test equipment shall be used.
- Test set-ups shall be as small as possible (if not specified otherwise) to avoid voltage drops along the wires and parasitic induction.
- The test shall be carried out in the temperature range stated for the product by the manufacturer in the data sheet.

6.10.2 Test Equipment

- DPSU: Adjustable DC-Source ; 0 V to 40 V; U_{DPSU} (Ripple) < 100 mV
- Oscilloscope (BW min. 20 MHz) : Standard Ri = 1 MΩ/20 pF
- Function Generator: Standard; Ri < 50 Ω
- Variable Resistors to simulate different loads
- Variable AC source to simulate tolerances of mains
- DC-Voltmeter Ri >10 MΩ/V
- LPF Bandwidth limitation [0-159 kHz](see below)

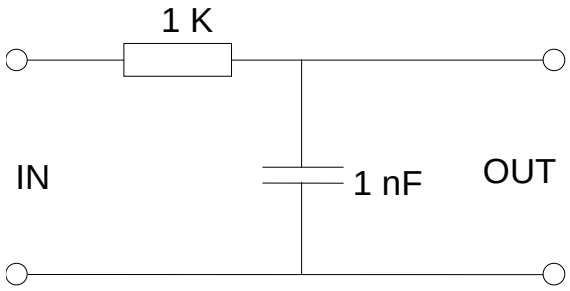


Figure 26 - Low pass Filter (fg = 159 kHz)

6.10.3 Testing of Output Voltage

- Test Setup:

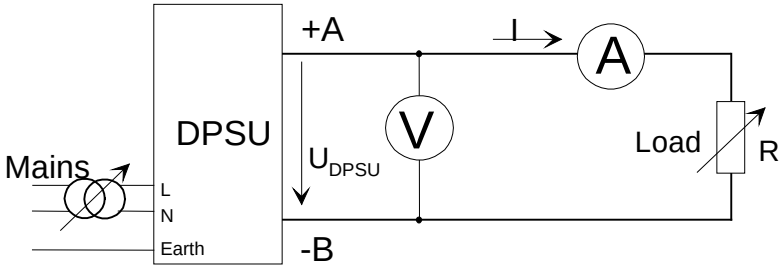


Figure 27 - Test Setup U/I

- Testing

  Voltage U_{DPSU} shall be monitored during variation of Resistor R from
  Rmax = ∞ (idle state) to
  Rmin = (U_{DPSU} / I_D)*0,9
  Variation of mains from max. to min. voltage

- Requirements

  According to 6.9, item 1.

6.10.4 Testing of Output Voltage Ripple

- Test Setup:

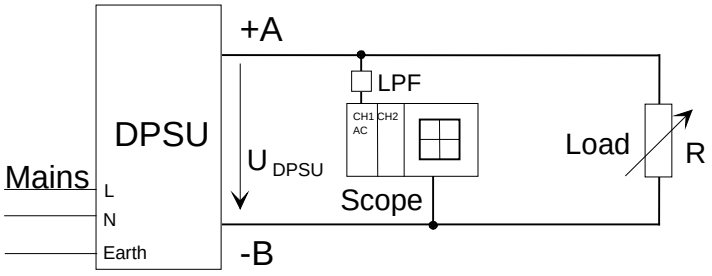


Figure 28 - Test Set-up for Voltage Ripple

- Testing

  U_{DPSU} shall be monitored with an oscilloscope (use LPF) during variation of Resistor R from
  Rmax = ∞ (idle state) to
  Rmin = U_{DPSU} / I_D
  Channel display: AC. Reading out peak-peak value

- Requirements

  U_{DPSU} shall be lower or equal than the value of item 2 of 6.9.

6.10.5 Testing of DPSU's Dynamic Behaviour

- Test Setup:

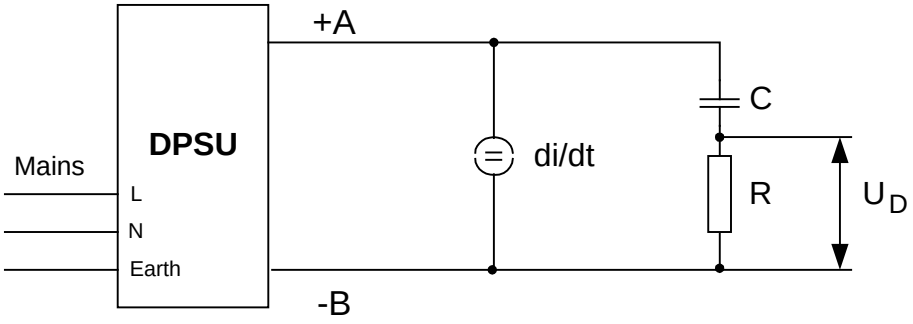


Figure 29 - Test Setup for Dynamic Behaviour

NOTE The test setup is different from central PSU as specified in 2.7 because DPSUs always include the "choke module". Since the output voltage is tested after the "choke module" a different test setup is needed

- Testing

  R = 10 kΩ
  C = 100 nF
  n = nominal number of
  di/dt = I_N(mA) / 10 (mA) * 0,5 * 2 mA/ms; start from 0 mA
  Testing Period: 5 ms
  UD shall be monitored with an Oscilloscope.
  Channel display: DC

- Requirements

  UD shall be in the limit given in item 8 of clause 6.9.

6.10.6 Testing of two parallel DPSUs, Leakage Current

- Test Setup:

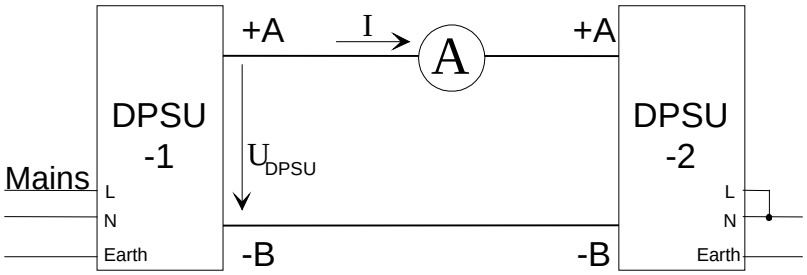


Figure 30 - Test Set-up of two parallel DPSUs, Leakage Current

- Testing

  The leakage current shall be measured.

- Requirements

  The current I shall be lower than or equal to the value of item 10 of 6.9.

6.10.7 Testing of DPSU's Hold-Up Time

- Test Setup

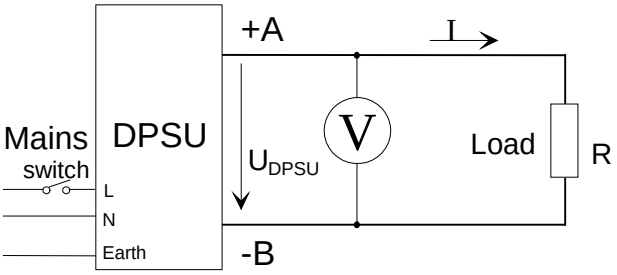


Figure 31 - Test Setup for Hold Up Time

- Testing

  Switch closed: $R = (U_{DPSU} / I_{DPSU}) * 0,9$

  Switch open measure time till U_{DPSU} drops below 95 % of original value

- Requirements

  t_{holdup} shall be more than or equal to the value of item 7 of 6.9.

6.10.8 Testing of U/I Characteristic

- Test Setup

  See Figure 25.

- Testing

  Voltage U_{DPSU} and current I shall be monitored during variation of resistor R from
  Rmax = ∞ (idle state) to
  Rmin = 0 (short circuit)

- Requirements

  The resulting graph shall comply with U/I characteristic for DPSU;
  no damage after this test.

6.10.9 Testing of Dynamic Parameters and Busload

NOTE The test setup and test values are tailored to the specific nature of DPSU and are different from central PSU as specified in 2.7.

- Test Setup

  U_a = 6 V
  $U_{DC} = U_{DPSU} - U_a$
  S1 on/off switching time ≤ 2 µs

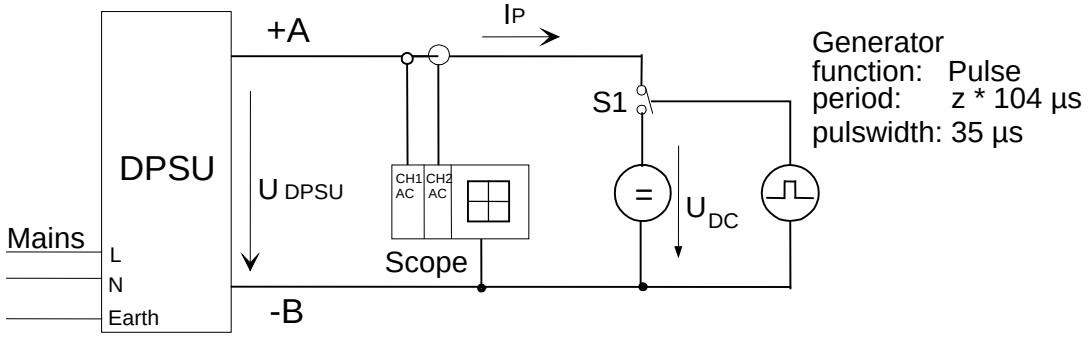


Figure 32 - Test Setup for Dynamic Behaviour

Testing Dynamic Parameters

U_{DPSU} and I_P shall be monitored with an oscilloscope.

- Requirements

  Point A to C of the registered wave forms (z = 10) shall comply to the values as stated in underneath figures and tables.

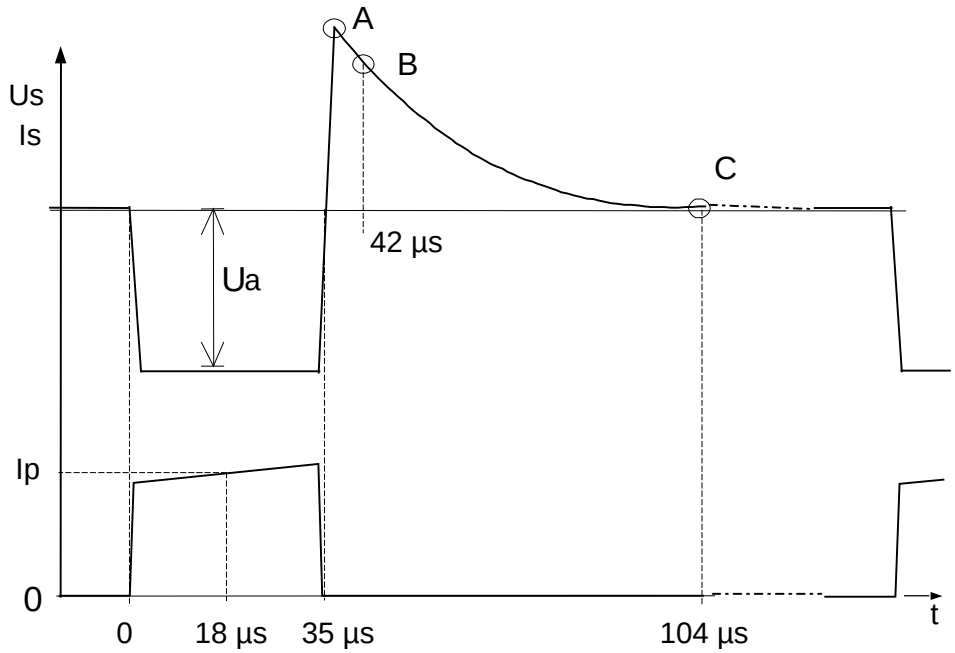


Figure 33 - Voltage and Current of Choke

Table 3 - Electrical Data of Choke (z = 10, see Figure 32)

Point	Voltage
A	U_{DPSU} + 4,15 V
B	U_{DPSU} + 3,8 V
C	U_{DPSU} + 0,7 V ($>U_{DPSU}$)
Tolerances: ±5 % e.g. Tolerance at Point A: ±(29 V + 4,15 V)*5/100 ≅ 1,66 V	

Testing Dynamic Busload

- Test Setup

  U_{DPSU} and I_P shall be monitored with an oscilloscope. I_P is measured 18 µs after the start of the pulse.
  z = 10, see Figure 32.

- Requirements

  8,5 mA ≤ I_P ≤ 23 mA
  Busload (TP256) = IP / 1 mA (fan-in value related to transmission)
  (e.g. IP = 10 mA ⇒ One DPSU represents the same busload as 10 TP256 bus devices regarding the transmission technique).

6.10.10 System Test

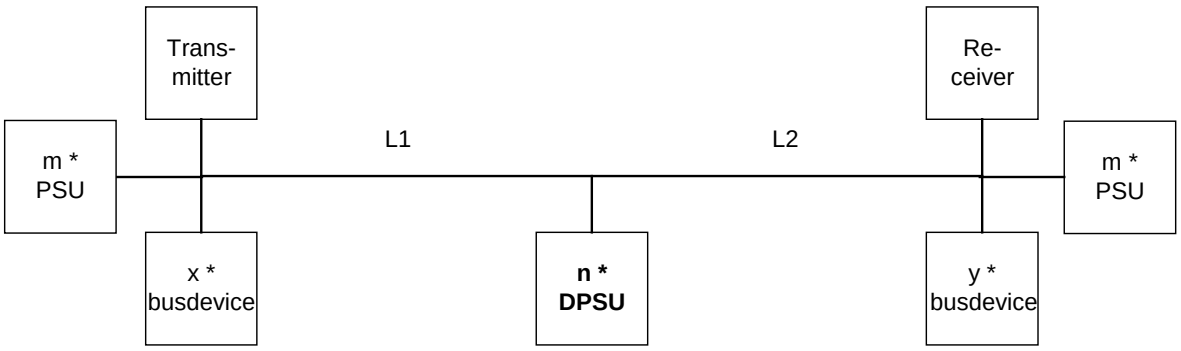


Figure 34 - Test Set-up of System Test

6.10.10.1 Minimum Number of Devices

- Test Setup

  m = 0
  n = 1; x = 1; y = 1
  L1 = L2 = max. distance from DPSU
  Transmitter is sending normal group telegrams.
  Telegrams shall be monitored with a busmonitor.
  Test shall be done with maximum and minimum dc-bus-load at each bus device.

- Requirements

  The receiver shall be able to receive the telegrams.
  No telegram repetitions shall occur.

6.10.10.2 Maximum Number of Devices

- Test Setup

  m = 0
  n = 8
  x = max. number of devices divided by 2;
  y = max. number of devices divided by 2
  L1 = L2 = max. distance from DPSU (e.g. 175 m up to 350 m)
  Transmitter is sending normal group telegrams.
  Telegrams shall be monitored with a busmonitor.
  Test shall be done with maximum and minimum dc-bus-load at each bus device.

- Requirements

  The receiver shall be able to receive the telegrams.
  No telegram repetitions shall occur.

6.10.10.3 Maximum Number of Devices and PSUs

- Test Setup

  m = 1
  n = 8
  x = max. number of devices divided by 2;
  y = max. number of devices divided by 2
  L1 = L2 = max. distance from DPSU (e.g. 175 m up to 350 m)
  Transmitter is sending normal group telegrams.
  Telegrams shall be monitored with a busmonitor.
  Test shall be done with maximum and minimum dc-bus-load at each bus device.

- Requirements

  The receiver shall be able to receive the telegrams.
  No telegram repetitions shall occur.

6.10.11 Testing of Symmetry

Test shall be carried out in accordance with Volume 4/2 EMC Test Set-ups clause 3.3 and 4.3.

6.10.12 Testing of Reset

- Test Set-up:

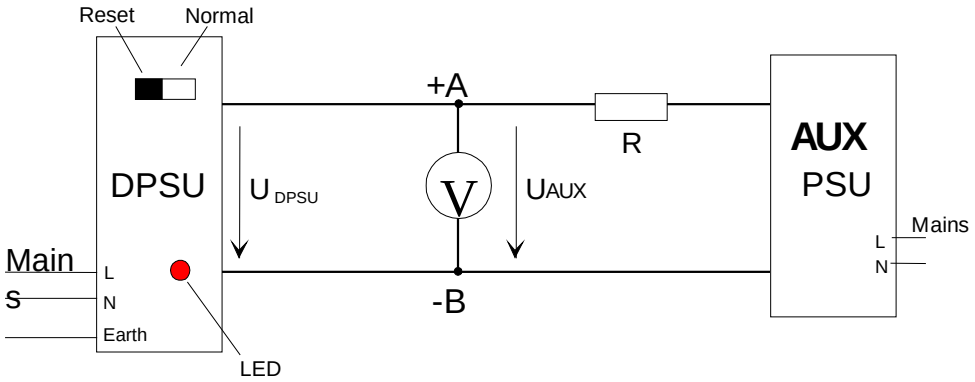


Figure 35 - Test Setup

- Testing

  U_{AUX} shall be tuned to 10 V DC ; R = 3,3 Ω (I ≈ 3 A)
  Switch to reset position/push reset push button.

- Requirements

  U_{AUX} < 0,5 V
  LED (red) shall illuminated (reset switch).
  No damage of reset switch/reset push button and choke module after this test.

6.11 Functional Safety

Under consideration.

6.12 Interfaces, Connectors

No.	Requirements	M
1	Data rail connection	F/S
2	In case of a data rail type design, the dimensions of the DPSU shall be in accordance to EN 43880 and shall allow snapping the device onto the DIN rail of which the dimensions correspond to those laid down in Part 9/1 “Cables and Connectors”, Connector Type 6.1	O/S
3	In case of data rail connection, the connection to the bus shall be ensured either: • by means of Type 6.1 Connector connected to the inner tracks of the data rail • by the red/dark-grey Type 5.1 Connector (Bus-Connector) • or both	O/S
4	In case of other than data-rail connection the connection to the bus shall be ensured by the red/dark-grey Type 5.1 Connector (Bus-Connector) only.	O/S
5	Additional (choke) outputs shall only use the red/dark-grey Type 5.1 connector.	O/S
6	Additional auxiliary non-SELV outputs shall not use KNX standardized Connector Types.	M/S
7	When the DPSU is equipped with an intermediate connection point for 29 V DC it shall be clearly marked both with “29 V DC” and the polarity. In this case Connector Type 5.1 Yellow/White shall be used for connection.	O

6.13 Marking

No.	Requirements	M
1	The function of the LED’s shall be clearly indicated both on the device itself and in the manufacturer’s data sheet.	O/S
2	The DPSU shall be labelled according to the example in Figure 36. The technical data shall contain: input voltage range, the AC symbol, frequency, nominal DC output voltage, nominal output current, temperature range and the DPSU symbol. The manufacturer’s data sheet shall moreover contain details on maximum mains power consumption, short circuit mains protection and maximum output current.	M/S
3	All outputs for bus voltage shall be marked with the polarity.	M/S
4	Additional auxiliary non-SELV outputs shall be clearly marked with voltage, power, etc.	M/S

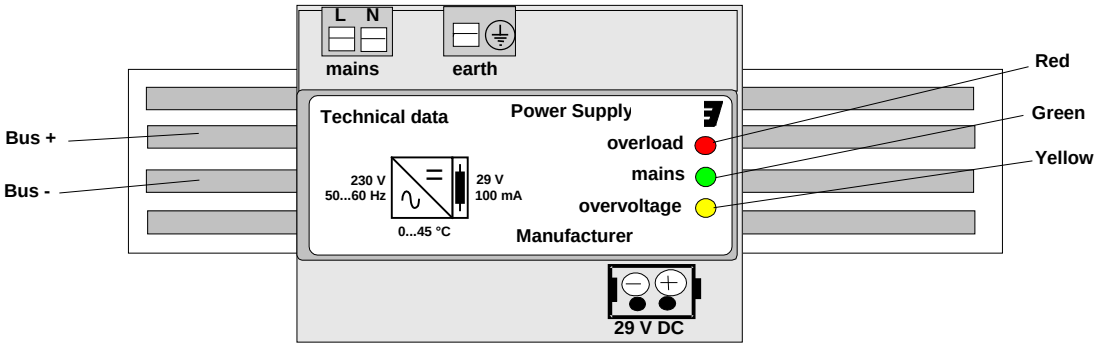


Figure 36 - Example of electrical connection and labelling of DPSU

6.14 Installation

No.	Requirements	M
1	Restrictions with regards to the installation guidelines for standard DPSUs: - The maximum allowed distance between two devices shall be between 350 m and 700 m - The maximum cable length shall be between 350 m and 1000 m - If DPSUs used in parallel with one or two standard PSUs the standard installation guidelines have to be applied.	M
3	Unused connections of the DPSU and choke shall not impair protective separation. If necessary they shall be protected by additional appropriate covers.	M/S
4	The cable length between DPSU and device shall be less than or equal 350 m.	M
5	The reset switch (also recommended for reset push button) shall not be directly accessible, e.g. in case of DIN-rail mounting protected by means of the distribution board cover, if a cover is not provided by the device.	O/S
6	A reset time of at least 20 s is recommended to the user, to ensure that all bus devices within a segment are reset.	O/S

e.g.

Number of DPSUs	max. Distance		max. cable length
	DPSU - Device	Device - Device	
1	350 m	350 m	350 m
2	350 m	700 m	700 m
3 ... 8	350 m	700 m	1000 m

6.15 Symbols

The following symbols are provided for installation schematics.

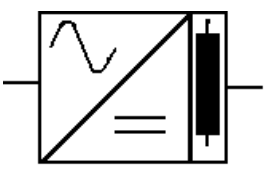


Figure 37 - DPSU Symbols

6.16 Battery Back-up system

No.	Requirements	M
1	If either a battery backup system is charged from the bus or from the mains, it shall comply with the electrical data as laid down above. The effect on the behaviour of the DPSU resulting from this battery backup system shall be clearly stated in the manufacturer's data sheet.	O

7 PL110 Filter

7.1 Communication Requirements

The filter device in PL110 KNX-Installations is used to physically separate several PL110 networks from each other by blocking the RF-signal. This filter also provides a minimum RF-impedance necessary for powerline modem operation.

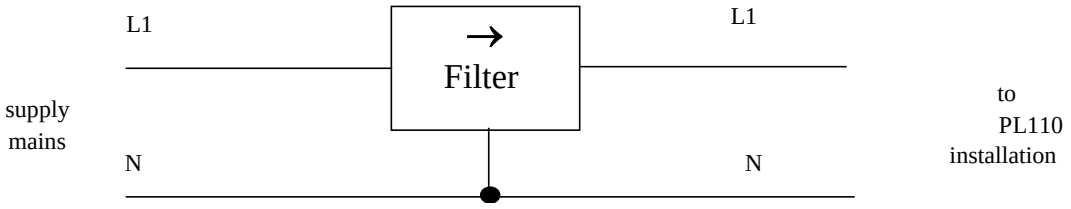


Figure 38 - Usage of Filter

7.2 Electrical Safety

No.	Item	Requirements	M
1	General	The PL110 filter shall comply with the requirements for group 1 devices as given in Volume 4/1	M/S
2	protection class according EN 60529	IP20	M/S
3	rated insulation voltage	≥ 250 V AC, group 1 device	M/S
4	Clearance and creepage distance between mains and accessible surface when mounted	3 mm (Usage Class B/basic insulation)	M/S

7.3 Environmental Conditions

As regards environmental data, requirements and tests, the filter shall comply with Volume 4/1 clause 2.1. Additionally, the following requirements apply:

No.	Item	Requirements	M
1	Ambient temperature range operation	3k5 (-5°C/+45°C)	F/S
2	ambient temperature range no-operation	-25 °C/+70 °C	F/S
3	Relative humidity (non-condensing)	5 % to 93 %	F/S
4	Life time	> 10 years	M/S

7.4 EMC

The requirements of Volume 4/1 clause 2.3 (and in future part 4 of EN 50065) apply.

7.5 Mechanical Dimensions, Constructional Features

No.	Requirements	M
1	Din rail mounted construction	F/S

7.6 Electrical Features

No.	Item	Requirements	M
1	Operating voltage	250 V AC ± 10 %, 50 Hz	M/S
2	Power-consumption	< 4,5 W @ 63 A	M/S
3	Filter frequency range	95 kHz to 125 kHz	M/S
4	Attenuation without external load	≤ 25 dB @ 105 kHz ≤ 30 dB @ 110 kHz ≤ 25 dB @ 115 kHz	M/S

7.7 Testing

7.7.1 Filter RF-Impedance

The PL110 filter´s RF-impedance shall have a minimum value in order not to decrease signal level on the 230V-line.

For easier measuring a voltage-drop test is performed instead of a direct meassurement of the impedances.

7.7.1.1 Test Preparation

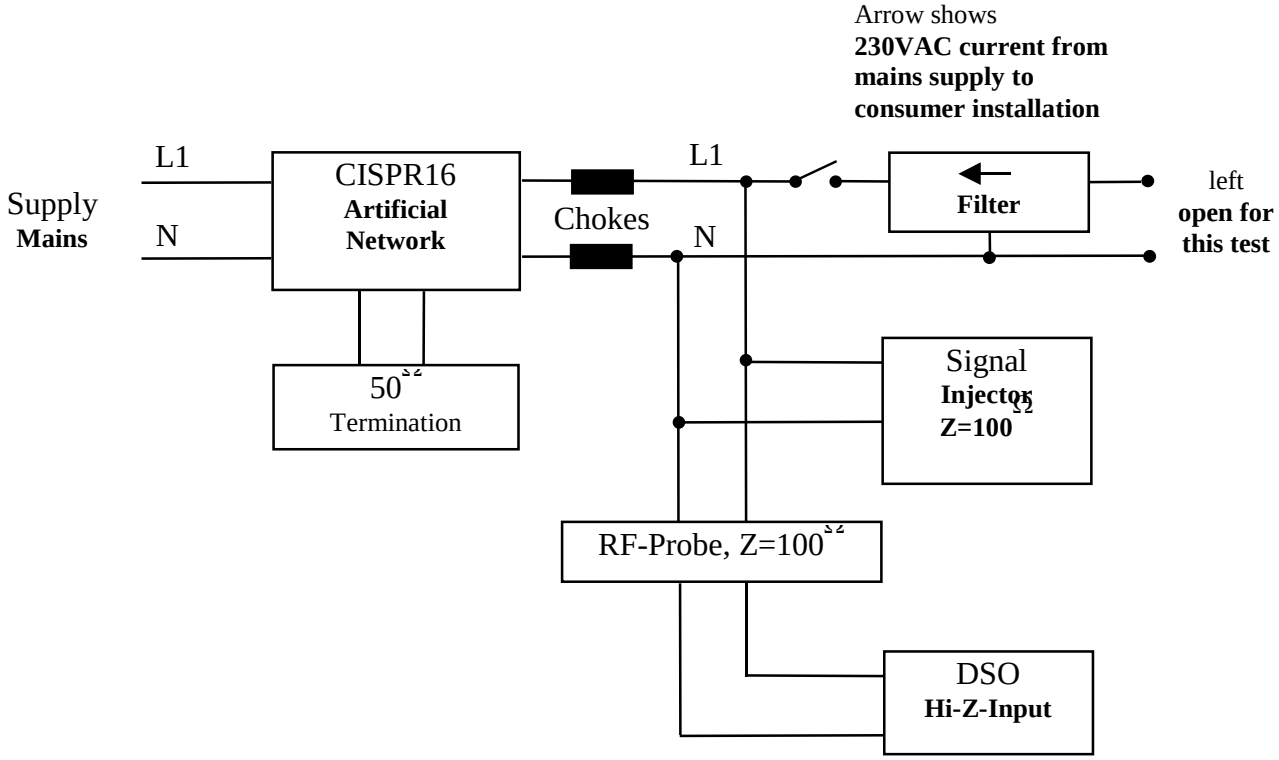


Figure 39 - Test circuit filter impedance

Note: The chokes are 3,5 mH, 20 turns on Siemens T38 ferrite, R16 toroid each.

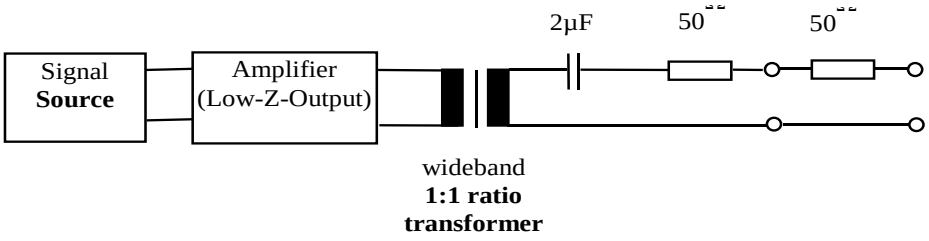


Figure 40 - Signal-Injector according to EN50065-2

Note: The wideband transformer suitable for frequencies from 80kHz to 150kHz consists e.g. of a Siemens R25/10 toroid, N27 ferrite, with 2x20 turns / 2x1,2mH.

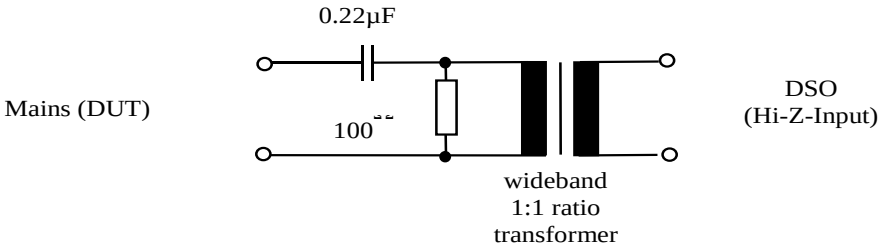


Figure 41 - Example for a 100 Ω RF-Probe

Parts-List	Resistor	100Ω/0,6W, 1% tolerance
	Capacitor	0,22µF / 250VAC, X7-quality, 10% tolerance
	Wideband-Transformer	Siemens R16 toroid,
		T38 ferrite
		2 x 12 turns, 1mH each
		10% tolerance

7.7.1.2 Testing

With the signal injector several monofrequent sinusodial signals are coupled on the mains line behind the CISPR16 artificial network. The chokes provide an impedance-decoupling between the filter and the artificial network.

First the chokes, the signal-injector and the RF-Probe are connected to the artificial mains network as shown in 4.1. The amplitude of the signal injector has to be adjusted to **1V peak-peak** at the RF-Probe for each frequency while the **230V AC** mains supply is **ON**.

If the 230VAC causes interference the envelope signal is used for measuring.

Secondly the device under test (DUT) in receiving mode is connected to the mains as shown above. The level of the injected signal with and without the DUT connected shall be recorded.

Test-Description:

Both the signal-injector and the RF-probe have an inpedance of 100 Ω each at 110 kHz. If the connected filter has an Impedance of 100 Ω the signal seen at the DSO shows one third of the amplitude of the signal-injector without any load. If the measured signal is below one third of the unloaded injector the impedance of the DUT is less than 100 Ω.

Notes

To check the test-setup a calibration can be made using a 100 Ω/0,5 W-resistor in series with a 0,47 µF/250 V AC X7-capacitor instead of using the DUT. This test should be made with and without 230 V mains supply at the artificial network.

The RF-probe shown above does not have any spike-protection! It is recommended to disconnect the probe from the DSO before switching the mains supply or before connecting / disconnecting the filter or switching the mains supply on or off.

7.7.1.3 Requirements

The test is carried out at

100kHz
105kHz
110kHz
115kHz
120kHz

For each frequency the injected signal shall not drop below **0,3 V peak/peak** with connected filter.

7.7.2 DC-Filter-Impedance

To determine the maximum power-dissipation of the Filter a voltage-drop-test is performed.

7.7.2.1 Test Preparation

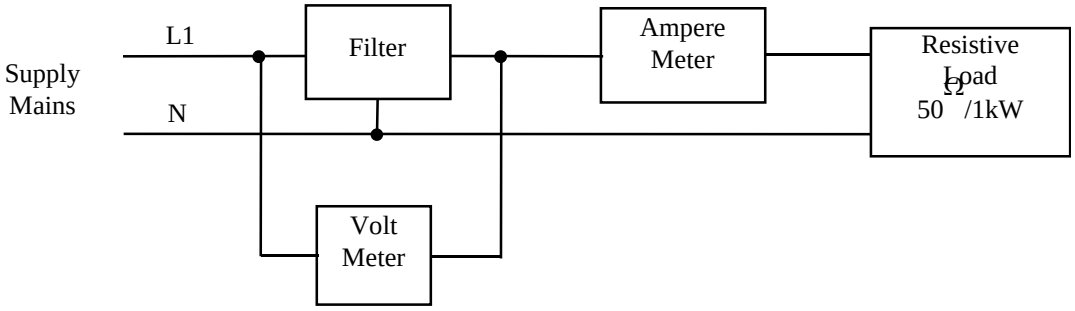


Figure 42 - Test set-up for DC-Impedance-Test

7.7.2.2 Testing

A voltage-drop-test is made for determination of the DC-resistance and hence the maximum power-dissipation at maximum 230VAC-current.

Filter-Resistance: $R_{filter} = U_{filter} \times I_{filter}$

Power-Dissipation: $P_{filter} = R_{filter} \times (I_{filter})^2$

7.7.2.3 Requirements

With the maximum current of **63 A** the power-dissipation shall be below **4,5 W.**

7.7.3 Filter Attenuation

A filter is necessary to separate different powerline-installations e.g. two residential buildings from one other.

7.7.3.1 Test Preparation

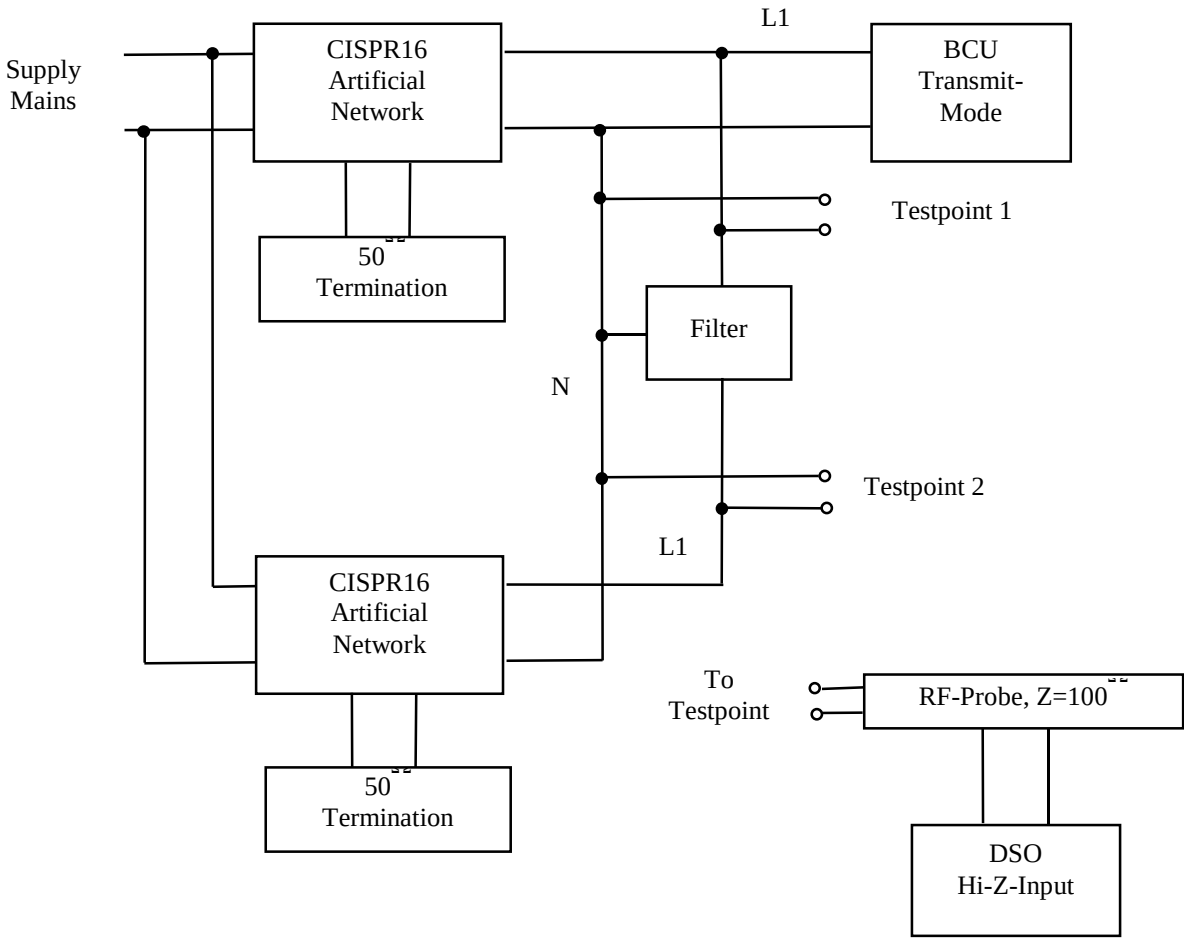


Figure 43 - Test Circuit Filter Attenuation

7.7.3.2 Testing

The transmitter is continuously sending messages. With the analyser / DSO the RF-signal-level on both sides of the filter shall be recorded.

The attenuation is calculated as: $a=20(\log(U_{\text{before filter}}/U_{\text{after filter}}))$; [a]=1dB;

7.7.3.3 Requirements

The attenuation of the filter shall be more than **30dB @105kHz** and **@115kHz.**

7.8 Functional Safety

To be completed

7.9 Interfaces, Connectors

No.	Requirements	M
1	Screw terminals for phase L1 input, L1 output and Neutral.	F/S
2	Terminals for L1 input an L1 output for 10 to 25 mm²	F/S
3	Terminal for N for 2x 2,5 mm²	F/S

7.10 Marking

No.	Requirements	M
1	An arrow, indicating the direction from the mains supply to the consumer installation, shall be provided on the label to ensure correct mounting.	F/S
2	Rated voltage, Rated current, KNX-mark, CE-mark, Manufacturer mark	F/S

7.11 Installation

No.	Requirements	M
1	The filter shall be located between the main fuse and the leakage current protector, typically before the last fuses.	
2	In a three-phase system, one filter per phase shall be installed.	
3	In order to ensure correct functionality, the device shall be mounted in the way indicated by the arrow on the label	F/S
4	DIN-rail according EN 50022	F/S

7.12 Symbols

The following symbols are defined for installation schematics:

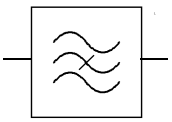


Figure 44 - Symbol for PL110 Filter

8 PL110 Phase Coupler

8.1 Communication Requirements

The phase-coupler is an additional device used in PL110 installations to improve the signal-coupling between the mains phases in a 3-phase installation network.

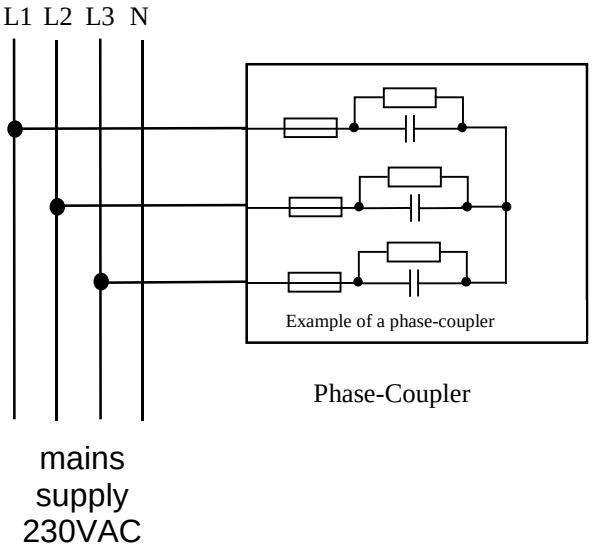


Figure 45 - Usage of the Phase Coupler

8.2 Electrical Safety

No.	Item	Requirements	M
1	General	The PL110 phase coupler shall comply with the requirements for group 1 devices as given in Volume 4/1	M/S
2	protection class according EN 60529	IP20	M/S
3	rated insulation voltage	≥ 400 V AC, group 1 device	M/S
4	Clearance and creepage distance between mains and accessible surface when mounted	3 mm (Usage Class B/basic insulation)	M/S

8.3 Environmental Conditions

As regards environmental data, requirements and tests, the phase coupler shall comply with Volume 4/1 clause 2.1. Additionally, the following requirements apply:

No.	Item	Requirements	M
1	Ambient temperature range operation	3k5 (-5°C/+45°C)	F/S
2	ambient temperature range no-operation	-25 °C/+70°C	F/S
3	Relative humidity (non-condensing)	5% to 93%	F/S
4	Life time	> 10 years	M/S

8.4 EMC

The requirements of Volume 4/1 clause 2.3 apply.

8.5 Mechanical Dimensions, Constructional Features

No.	Requirements	M
1	Din rail mounted construction	F/S

8.6 Electrical Features

No.	Item	Requirements	M
1	Operating voltage	3 x 400 V ± 10 %, 50 Hz	M/S
2	Power-consumption	< 1 W	M/S
3	Modem frequency range	95 kHz to 125 kHz	M/S

8.7 Testing

8.7.1 Test Preparation

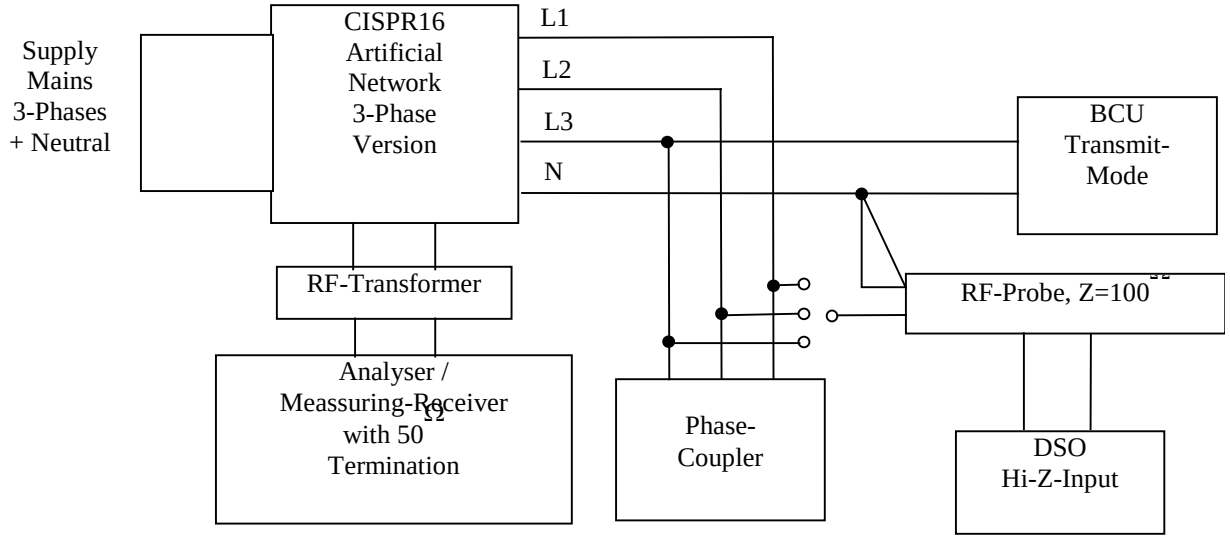


Figure 46 - Test Circuit Phase Coupler

8.7.2 Testing

The transmitter is continuously sending messages. With a mounted phase coupler, the RF-signal is coupled to the remaining phases L2 and L3. Since the transmission method works symmetrically referred to protective ground, the measurement ports of the artificial network are not used because they are unsymmetrical. Therefore the RF-signal is measured by a RF-probe between every Phase (one at a time) and neutral.

Note: The RF-probe is described in clause 7.7. An error of –1 dB is to be considered in the frequency-range from approx. 80 kHz to 150 kHz.

8.7.3 Requirements

The attenuation of RF-signal on the coupled phases must be lower than **3 dB**.

8.8 Functional Safety

To be completed

8.9 Interfaces, Connectors

No.	Requirements	M
1	Screw terminals for three phases L1, L2, L3.	F/S
2	Terminals for 2 X 1,5 mm² or 1 X 2,5 mm²	F/S

8.10 Marking

No.	Requirements	M
1	Rated voltage, KNX-mark, CE-mark, Manufacturer mark	F/S

8.11 Installation

No.	Requirements	M
1	The phase-coupler shall be located between the main fuses and the leakage-current protector, typically before the last fuses.	

8.12 Symbols

The following symbols are defined for installation schematics:

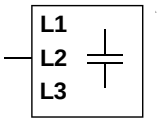


Figure 47 - Symbol