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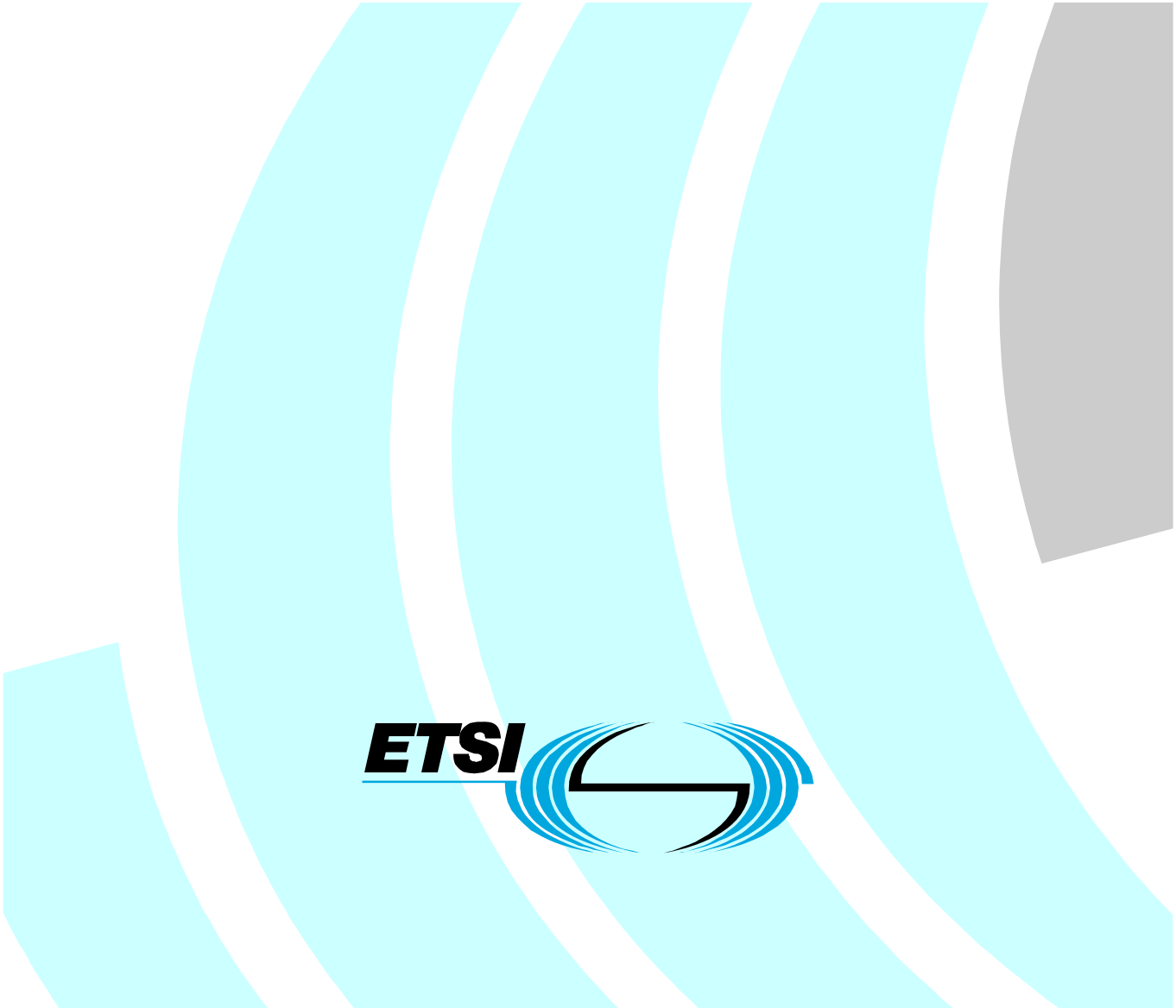
Technical Specification

Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 2: Integrated Broadband Cable and Television Networks



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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

Introduction

The present document is part 2 of a multi-part deliverable covering External Common Power Supply (CPS) for Customer Premises Network and Access Equipment. It represents a set of cohesive interwoven technical information that has jointly evolved to define solution of most efficient equipment, as defined below:

ES 202 874-1 [i.1] defines functional requirements for four different categories of CPS.

TS 102 874-2: "External Power Supply for Customer Premises Equipment".

TS 102 874-3 defines detailed implementation and operational aspects for CPS Type 1.

TS 102 874-4 defines detailed implementation and operational aspects for CPS Type 2.b.

TS 102 874-5: defines detailed implementation and operational aspects for CPS Type 2.c.

The intended applications of these CPS categories are specified in ES 202 874-1 [i.1].

The following table summarises the structure of the present document:

Table 1

CPS category	Functional requirements	Implementation aspects
Type 1: 5 V, 2 A	ES 202 874-1 [i.1]	TS 102 874-3
Type 2.a: 12 V, 1 A		TS 102 874-2
Type 2.b: 12 V, 2 A		TS 102 874-4
Type 2.c: 12 V, 5 A		TS 102 874-5

The present document specifies requirements for a high performance External Power Supply Unit for powering the Cable Customer Premises Equipment to a maximum voltage rating of 12 V. It specifies the input, output characteristics and performance requirements for a switching mode AC to DC power supply rated to a maximum 12 Vdc, and maximum 1 A.

The performance of Integrated Broadband Cable and Television Networks CPE such as Cable Modems, eMTAs, STBs has a dependency on the performance of the external power supply used to power the CPE.

Failure of a power supply result in loss of customer service, increased operations support and consequently increased costs to the provider of Integrated Broadband Cable and Television Network Services.

The present document specifies requirements for a low power DC output external power supply unit rated to a maximum of 12 Vdc and a maximum current of 1 Amp for use with a Cable CPE. The external power supply is specified to a performance level to ensure the overall performance of the system consisting the power supply and CPE is maintained at a high level.

Test are specified to verify the compliance of the external power supply against the requirements given by the present document.

The present document specifies design requirements and tests to ensure compliance of the power supply as well as reference to relevant European Directives including power efficiency on-load and no-load requirements given by European Commission Regulation No 278/2009 [1].

1 Scope

The present document describes the specification for a high performance External Power Supply Unit for powering the Cable Customer Premises Equipment to a maximum voltage rating of 12 Vdc.

The specifications define the input, output characteristics and performance requirements for a switching mode AC to DC power supply rated to a maximum 12 Vdc, and maximum 1 A.

The present document also specifies tests to verify the compliance of the external power supply.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] Commission Regulation (EC) No 278/2009 of 6 April 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies.

[2] CENELEC EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".

[3] CISPR 22: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurements".

[4] CENELEC EN 61000-3-2: "Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)".

[5] CENELEC EN 61000-4-2: "Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test".

[6] CENELEC EN 61000-4-4: "Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test".

[7] CENELEC EN 61000-4-5: "Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test".

[8] CENELEC EN 61000-4-11: "Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests".

[9] CENELEC EN 61000-4-12: "Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test".

[10] Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Restriction of Hazardous Substances (RoHS) Directive).

[11] Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE) and amendments.

[12] CENELEC EN 60950-1: "Information technology equipment - Safety - Part 1: General requirements".

[13] CENELEC EN 50075: "Flat Non-Wirable Two-Pole Plugs, 2,5 A 250 V, with Cord, for the Connection of Class II-Equipment for Household and Similar Purposes".

[14] Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (Low Voltage Directive (LVD)).

[15] Council Directive 93/68/EEC of 22 July 1993 (CE Marking Directive).

[16] Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC (EMC Directive).

[17] BS 1363-1 (1995): "13 A plugs, socket-outlets, adaptors and connection units. Specification for rewirable and non-rewirable 13 A fused plugs".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI ES 202 874-1 (V1.1.1): "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment: functional requirements".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
AWG	American Wire Gauge
CPE	Customer Premises Equipment
DC	Direct Current
EC	European Commission
EEC	European Economic Community
EMC	Electromagnetic Compatibility
eMTA	embedded Media Terminal Adaptor
ESD	ElectroStatic Discharge
IPR	Intellectual Property Rights
kV	kilo Voltage
LVD	Low Voltage Directive
mA	milli Ampere
ms	milliseconds
MTBF	Mean Time Between Failure
PLT	Power Line Telecommunications
RH	Relative Humidity
STB	Set Top Box

4 Electrical Specifications

4.1 Input Requirement

4.1.1 Input Voltages And Frequency

Table 2: Input voltage and frequency

Normal Voltages (Vac)	Voltage Variation Range (Vac)	Normal Frequency (Hz)	Frequency Variation Range (Hz)
100 to 240	90 to 264	50 to 60	47 to 63

The power supply shall be designed to meet the requirements and limits given in table 2.

4.1.2 Input Current

The AC input current shall not exceed 0,5 A, when operated at 100 to 240 Vac with no load to full load.

4.1.3 Inrush Current

The inrush current must be limited to 50 A when operated at 240 Vac.

4.1.4 Power Efficiency

The power supply shall comply with the European Commission Regulation No 278/2009 [1].

The requirement of annex I-b: "eco design requirements", must be met:

- No-load conditions shall not exceed 0,3 Watt.
- Average active efficiency 0,063 x $\ln(P_o)$ + 0,622 or better. ($\geq$ 77,85 % if P_o = 12 W)

4.1.5 Input Current Protection

A fuse with a rating equal to the rating of the power supply i.e. up to maximum of 1,0 A shall be installed on the input line side near the input connector to protect the power supply.

4.2 Output Requirement

4.2.1 Output Voltage, Current And Ripple

Under any combinations of line and load variation and environmental conditions, the output shall remain within the tolerance defined in table 3.

Table 3: Output voltage, current and ripple

Input normal voltage (Vac)	Output Nominal Voltage (Vdc)	Output Regulation	Minimum Load (A)	Maximum Load (A)	Maximum ripple (mVp-p)	Output power (W)
100 to 240	12	±5 %	0,0	1,0	120	12
NOTE 1: Output voltages are measured at the output connector. NOTE 2: Measurements are made with an oscilloscope of at least 20 MHz bandwidth. Output should be bypassed at the connector with a 0,1 µF ceramic disk capacitor and a 10 µF electrolytic capacitor to simulate system loading.						

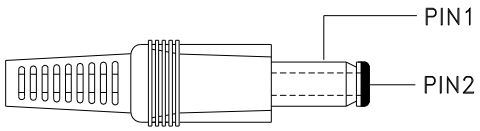
4.2.2 Short Circuit Protection And Over Current Protection

The power supply shall be protected from damage of a short circuit at the output or too high output current, irrespective of the duration of the existence of the fault and shall auto-recover when the fault is removed.

The power supply shall not activate the over current protection at start up, while the output is connected to a 2 200 µF electrolytic capacitor.

4.2.3 Output Over Voltage Protection

When 12 V output voltage reaches to its over - voltage protection trigger point the power supply shall be shutdown and output voltage shall not exceed 16 V Max. This include Control Loop failure.



PIN #	Output Level
1	RTN(-)
2	+12 V

Figure 1: Output polarity

4.3 Performance Requirement

4.3.1 Efficiency

With an input voltage 100 Vac / 50 Hz, the power supply shall provide an efficiency of at least 77,85 %, measured as the average of the efficiencies at 25 %, 50 %, 75 % and 100 % of the rated load.

4.3.2 Turn On Delay Time

The power supply shall switch on in less than 2,0 s at maximum load and 110 Vac / 60 Hz input. The measurement shall be made from the start of the input voltage, up to the moment the rated output voltage has been reached.

4.3.3 Hold-up Time

The hold-up time shall be a minimum of 10 ms at 110 Vac / 60 Hz and 100 % of the rated load. The measurement shall be made following AC voltage interrupt from the moment at which the input current ceases, to the moment the output voltage drops below the rated voltage minus 5 %.

4.3.4 Brown-out and recovery

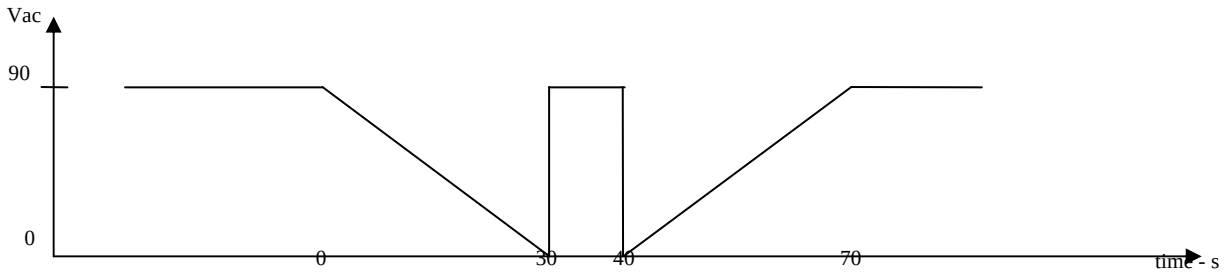


Figure 2: Input voltage brown-out and recovery

Input voltage: reduce the AC input voltage to 0 Vac in 30 s then immediately increase the AC input voltage to 90 Vac, hold up 10 s, then fall to 0 Vac, and then increase AC input to 90 Vac in 30 s. See figure 2. Repeat this 20 times. The power supply shall be considered to be compliant if it meets the following criteria:

- power supply must have clean ON/OFF and OFF/ON transition;
- power supply meets specifications after test;
- no permanent damage.

4.3.5 Dynamic Load

The power supply must be capable of a higher output current than the rated output current during a time interval as given below:

- High Load: 2,5 A / 30 ms.
- Low Load: 1 A / 1 s.
- Slew Rate: 0,1 A / μs.
- Output Voltage: > 9 Vdc.

4.3.6 Max Open Circuit Voltage

When the circuit of over voltage protection is invalidated, the output voltage must be 16 V maximum.

4.3.7 Overshoot at turn on / Turn off

The overshoot at turn on and turn off shall not exceed 10 % of the nominal voltage value.

4.3.8 Output transient response / Transient load slew

With an input voltage, output load, ambient temperature and slew rate as given below, the undershoot or overshoot of output shall be not less than 5 % of the output voltage.

Input voltage: 90 V ~ 264 Vac / 47 ~ 63 Hz, Output Load: 20 % to 80 %, 80 % to 20 %.

Ambient temperature: 25 °C ± 3 °C, Slew rate 1,0 A / μs, T1 = T2 = 0,5 ms.

4.3.9 Rise time

Rise time shall be less than 50 ms when measured from 10 % to 90 % of the output voltage at normal input voltage.

5 Operational and Storage Environmental Requirements

5.1 Temperature And Humidity

5.1.1 Operating Temperature and Humidity Range

All operational requirements shall be met within the temperature range of 0 °C to 40 °C and the relative humidity of 20 % to 90 %.

5.1.2 Storage Temperature and Humidity Range

The storage and the transport conditions shall meet the temperature range of -20 °C to 70 °C and a relative humidity of 20 % to 90 %.

5.2 Altitude

The power supply shall operate properly at any altitude up to 3 000 metre above sea level and withstand storage at 12 000 metre.

6 Requirements to European Standards

6.1 Power efficiency

The power supply shall meet the requirements of clause 4.1.1.

6.2 EMC Specification

6.2.1 CISPR Requirements

Power supply shall comply with the radiated and conducted emission requirements for CISPR 22 [3] Class B, as referred within EN 55022 [2].

6.2.2 AC Input Voltage Periodic & random disturbances

The power supply shall meet the requirement from EN 61000-4-11 [8]: half cycle at AC mains frequency per 10 half cycles for 25 repetitions at full rated load and AC mains input = 110 Vac.

6.2.3 Electrostatic Discharge (ESD)

The power supply shall meet EN 61000-4-2 [5]: ±15 kVAir Discharge, ±8 kV contact discharge.

6.2.4 Lightning Surge

The power supply shall meet:

- EN 61000-4-5 [7] with:
  - Differential Mode ±2 kV (2 ohms);
  - Common Mode ±4 kV (12 ohms);
  - L-N: 2 kV/2 ohms; L-PE: 4 kV/12 ohms; N-PE: 4 kV/12 ohms;
  - L,N-PE: 4 kV/12 ohms.

NOTE: PE is defined as outside of the DC barrel connector.

Following exposure of the power supply to the surges as given above it shall not suffer permanent damage.

6.2.5 Harmonic Current

The power supply shall meet the requirements of EN 61000-3-2 [4].

6.2.6 Harmonic Distortion Susceptibility

The power supply shall meet the requirements of EN 61000-3-2 [4].

6.3 Natural Environmental Requirements

The power supply shall meet the requirements of:

- RoHS (Restriction of Hazardous Substances) European Directive 2002/95/EC [10]; and
- WEEE Management Regulations (Waste Electrical and Electronic Equipment) European Directives 2002/96/EC [11] and amendments.

6.4 Product Safety

The power supply must meet the equipments of EN 60950-1 [12] Information technology equipment - Safety - Part 1: General requirements and equivalent safety standards for use in information technology equipment.

6.4.1 Safety Approval

The power supply shall be CE marked in accordance with CE Marking 93/68/EEC [15] and include a manufacturer's Declaration of Conformity Certificate identifying the standards the power supply was designed against for presumption of conformity and identify all the relevant EU Directives it is claimed by the manufacture to meet e.g. including but not limited to LVD Low Voltage Directive 2006/95/EC [14] and EMC Directive 2004/108/EC [16].

6.4.2 Leakage Current

The power supply shall have an AC leakage current of less than 0,25 mA when connected to 240 Vac / 50 Hz in conformance to EN 60950-1 [12].

6.4.3 Dielectric voltage withstand

The power supply shall withstand for 1 minute without breakdown the application of a 50 / 60 Hz 3 000 Vac (or 1 s without breakdown the application of a 50 Hz / 60 Hz 3 600 Vac or 5 090 Vdc) supply voltage applied between both input line and output.

7 Reliability

7.1 Burn-in

All power supplies shall be burned-in for 2 hours under nominal input and 70 % ~ 80 % load at an ambient temperature of 40 °C.

7.2 MTBF Calculation

The MTBF, Mean-Time-Between-Failures, shall be calculated and reported for each quality class offered.

For each quality class offered the electrolytic capacitor life shall be calculated using the ELNA formula for Electrolytic Capacitor Life Calculation.

7.3 Quality classes

The reliability of the power supply is dependent on the quality of the components used in the power supply design. Higher quality parts should be used to improve equipment reliability.

Six quality classes are specified: Q1 - Q6. Each class is defined by the failure percentage in the first year and the failure percentage per year in year 2 to 10, see table 4.

The power supply shall provide details of its build according to one of the quality classes as given in table 4.

Table 4: List of quality classes

Quality class	Allowed percentage failure in the first year (%)	Allowed percentage failure per year in year 2 -10 (%)
Q1	2,00	1,00
Q2	1,00	0,50
Q3	0,80	0,40
Q4	0,60	0,30
Q5	0,40	0,20
Q6	0,20	0,10

7.4 Long Term Reliability

The construction of the power supply shall be of appropriate build to ensure its normal use without fault for a period of ten years. The power supply is considered to have not met this requirement when its allowed percentage of failure of the quality class is exceeded within the ten year period.

8 Mechanical Specification

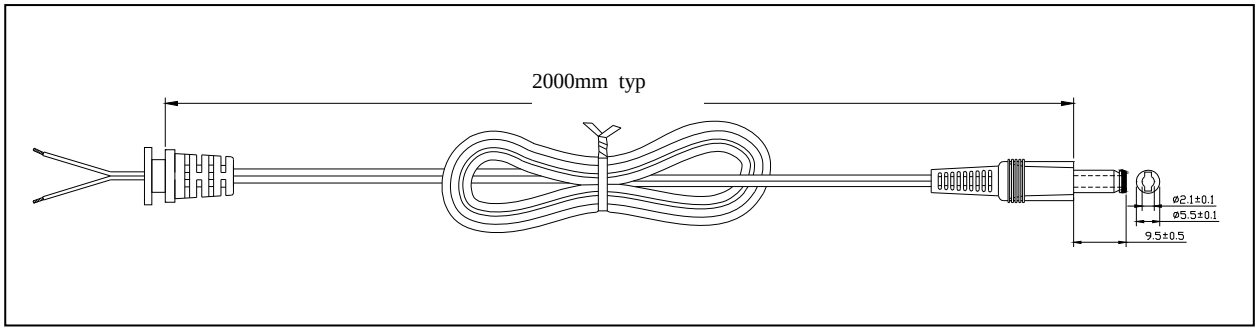
8.1 AC plug

The 230 VAC plug must form part of the main housing of the power supply or be part of a fixed cord of the main housing of the power supply.

The AC plug of the power supply shall comply with EN 50075 or [13] BS 1363-1 [17] Plugs for household and similar general purposes - Flat non-rewirable plugs, 2,5 A 250 V with cord for Class II equipment, but without the cord.

8.2 DC cord

The DC cord must comply with the data below with typical cord length of 2 meters.



NOTE: cable: UL 2468 style: 80 °C, 300 V, 2 conductors 22AWG plug: Ø 5,5 x 2,1 x 9,5 mm (tuning fork cannelure entire insulation) black unit: mm.

Figure 3: DC cord

8.3 Label specification

The power supply shall be affixed with a label, with appropriate wording in the language specific for the intended country for deployment, stating the power supply compliance with the appropriate European regulations.

9 PLT filters to limit interference and improve coexistance

Within the customer premises the power supply may be used where data transmission over powerlines (PLT) is in use. To minimize the interference with PLT communications where the power wires themselves act as the data transmission medium and use the spectral region up to 50 MHz (up to 240 MHz is proposed), the switched mode power supplies that are connected to the power wires can significantly impair the characteristics of the communication channel in this band (the "PLT band"). As a result, the attainable bit rate of the PLT communications is reduced.

The main disturbance introduced by the power supply is caused by variations in the input impedance (the impedance looking into the AC supply terminals) of the power supply within the PLT band. The input impedance can vary with time at the frequency of the supply voltage. Because the input impedance changes when the supply voltage exceeds a threshold, the result is a time-varying impedance at 50 Hz or 60 Hz.

It should be noted that various PLT technologies have mechanisms to counteract cyclo-stationary noise (additive noise in synchronism with the supply voltage) and these mechanisms can partially counteract the impedance variation.

Power Supplies should be designed so as to minimise time varying impedance changes.

One potential technique for amelioration of the power supply in this regard is the introduction of filter circuits at the AC input. Figure 4 is an example of such a filter circuit.

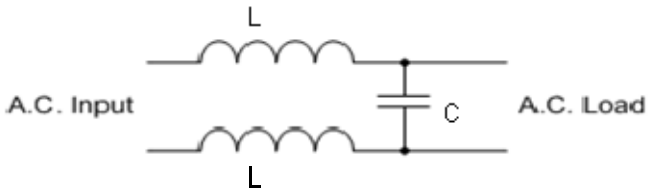


Figure 4: Example of how to improve coexistence between CPS and PLT technology

In addition it is generally undesirable for CPE equipment to receive PLT transmissions where such transmissions impair the performance of the CPE.

Annex A (informative): Tests Plans and Procedures

The test procedure in this annex is intended to not represent tests for mass-production test procedure. Nevertheless every power supply selected at random, even though it might not be fully tested in the mass-production, it should pass all the tests given in this clause.

The values given in the reported results in this annex are for example only and should be replaced with the required data from the actual results relating to the power supply under test with the same accuracy.

A.0 Overview of Tests

Table A.1 presents an over view of the tests. The description of each test and test detail is given in the subsequent clauses.

Table A.1: Overview tests

NO	Test Item	Test at temperature °C						Pass/ Fail
		-40	0	25	40	50	70	
1	Performance Test		yes	yes	yes			PASS
2	Switcher Power Supply Loop Stability Test		yes	yes	yes			PASS
3	Thermal Profile, Internal				yes			PASS
4	Thermal Profile, External			yes				PASS
5	Life Test				yes			PASS
6	Dynamic Load Switching Test				yes			PASS
7	Output Trans Response-Load Slew&step			yes				PASS
8	AC input inrush current Test			yes				PASS
9	Turn-on delay Test			yes				PASS
10	Output Hold-up time Test							PASS
11	Rise time & Overshoot Test			yes				PASS
12	Output Transient Response /Deviation Test			yes				PASS
13	Dynamic Load Test			yes				PASS
14	Brown Out and Recovery Test			yes				PASS
15	Temperature Storage Test	yes					yes	PASS
16	Humidity Storage Test					yes		PASS
17	Power Cycle Test			yes				PASS
18	Shipping Test			yes				PASS
19	Single Drop Test			yes				PASS
20	Non-operational Vibration Test			yes				PASS
21	Short Circuit Protection Test			yes				PASS
22	Over Voltage Protection Test			yes				PASS
23	Over Current Protection Test			yes				PASS
24	Construction, Appearance and Weight			yes				PASS
25	Surface Tolerance To Cleaners			yes				PASS
26	Hi-pot Test			yes				PASS
27	Dielectric Withstand Test			yes				PASS
28	Leakage Current Test			yes				PASS
29	DC Mains Cord set and Plug Test			yes				PASS
30	Energy Star Compliance Test			yes				PASS
31	Capacitive Load Test			yes				PASS
32	Max Open Circuit Voltage Test			yes				PASS
33	ESD Immunity Test			yes				PASS
34	Surge Immunity Test (EN 61000-4-5 [7])			yes				PASS
35	Conduction Test			yes				PASS
36	Radiation Test			yes				PASS
37	Harmonic Test			yes				PASS
38	EFT Test			yes				PASS
39	Dip Test			yes				PASS
40	Surge Immunity Test (EN 61000-4-12 [9])			yes				PASS

A.1 Performance test

A.1.1 Test purpose

To verify the product basic functions. Delivery result report 1.

A.1.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.1.3 Test Condition

- Input voltage: 90 Vac / 264 Vac.
- Input Frequency: 47 Hz ~ 63 Hz.
- Output Load: 0 %, 25 %, 50 % and 100 % of the rated load.
- Ambient temperature: see table A.1.
- Ambient humidity: 95 % RH.

A.1.4 Test Criteria

The electric performance should meet the specification.

A.1.5 Results report examples

A.1.5.1 Test A

Input voltage: 90 Vac
Frequency: 47 Hz
Temperature: 0 °C
Relative Humidity: 95 %

Table A.2

ITEM serialnr	0 % Load			25 % Load				50 % Load				100 % Load			
	IO (mA)	VL (V)	VR-P (mV)	IP (mA)	VL (V)	VR-P (mV)	Eff (%)	IP (mA)	VL (V)	VR-p (mV)	Eff (%)	IP (mA)	VL (V)	VR-p (mV)	Eff (%)
1#	5,0	12,24	13,2	78,3	12,18	17,8	78,1	148,9	12,12	21,6	79,4	292,6	12,00	29,6	76,9
2#	4,8	12,23	14,0	77,9	12,14	78,3	79,1	150,0	12,10	22,1	79,2	292,8	12,01	30,1	77,8
3#	5,2	12,23	12,2	78,2	12,16	17,6	78,6	148,8	12,11	21,8	79,6	292,6	12,02	29,8	78,1
4#	4,6	12,24	13,6	77,6	12,14	17,9	78,5	148,3	12,12	21,6	79,7	292,0	12,00	29,6	79,1
5#	4,9	12,22	12,8	78,0	12,14	17,8	78,8	149,2	12,11	21,8	79,4	292,3	11,99	30,6	76,8
6#	5,1	12,21	13,1	78,3	12,16	18,4	78,4	148,6	12,13	20,9	79,0	292,1	12,00	30,0	77,8
7#	4,6	12,24	14,0	77,8	12,16	18,3	78,3	148,3	12,10	21,4	79,3	292,4	12,01	29,8	76,9
8#	4,5	12,20	12,6	78,3	12,15	18,5	78,6	149,2	12,12	22,0	79,6	292,0	11,98	29,7	78,5
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11#	5,0	12,22	13,1	77,9	12,18	17,7	77,9	149,3	12,10	22,4	79,8	292,3	12,02	29,8	76,9
12#	5,3	12,21	12,5	77,6	12,14	18,2	78,4	149,6	12,12	21,6	79,4	292,0	12,01	30,1	77,6
13#	4,9	12,20	14,0	78,3	12,16	17,4	78,6	149,6	12,11	22,3	79,7	292,0	12,01	29,7	78,4
14#	5,1	12,23	12,8	78,5	12,16	18,5	78,3	149,8	12,10	21,8	79,3	292,5	12,01	29,5	77,8
15#	4,6	12,21	13,1	78,4	12,17	18,0	78,6	150,2	12,13	22,4	79,8	291,6	11,96	30,1	76,9
16#	4,8	12,24	14,0	78,0	12,15	17,6	79,1	148,6	12,11	21,6	79,5	291,8	11,99	29,8	78,5
17#	5,1	12,22	12,6	77,9	12,14	17,7	78,1	149,3	12,10	22,3	79,2	292,4	12,00	29,1	77,9
18#	4,9	12,21	12,6	77,6	12,14	18,2	77,9	148,3	12,10	20,9	79,6	291,6	11,98	29,7	76,9
19#	5,1	12,24	13,4	78,0	12,16	17,9	78,4	149,2	12,12	21,4	79,5	291,8	12,01	30,3	78,5
20#	4,6	12,20	12,9	78,3	12,16	17,8	78,5	149,0	12,10	22,0	79,8	292,9	11,99	30,1	77,9
21#	4,5	12,23	13,1	77,8	12,17	18,4	78,8	148,6	12,11	21,6	79,8	292,0	12,01	29,8	78,5
22#	4,8	12,24	12,5	78,3	12,15	18,3	78,4	149,3	12,10	21,8	79,4	291,7	12,00	29,7	76,9
23#	4,7	12,22	14,0	78,4	12,15	18,5	78,3	149,6	12,12	22,4	79,7	291,6	12,02	30,3	77,6
24#	5,0	12,21	12,8	78,0	12,18	18,0	78,6	149,8	12,11	21,6	79,3	292,3	12,01	30,6	78,4
25#	5,3	12,20	13,1	77,9	12,17	17,6	79,1	150,2	12,10	21,6	79,8	291,6	12,01	29,8	77,8
26#	4,9	12,23	14,0	77,6	12,15	17,7	78,1	148,6	12,12	22,3	79,8	292,0	12,01	30,1	78,4
27#	5,1	12,22	13,6	78,3	12,15	17,6	77,9	149,3	12,10	21,8	79,4	291,7	11,96	29,7	77,8
28#	4,8	12,21	12,8	78,3	12,18	17,7	78,3	149,8	12,11	22,4	79,7	291,6	12,03	29,5	76,9
29#	4,7	12,24	13,1	78,4	12,14	18,5	78,6	150,2	12,10	21,6	79,3	292,3	12,00	30,1	78,5
30#	5,0	12,20	14,0	78,0	12,16	18,0	79,1	148,6	12,11	12,8	79,4	292,4	12,02	29,4	77,7

A.1.5.2 Test B

Input voltage: 90 Vac
Frequency: 47 Hz
Temperature: 25 °C
Relative Humidity: 95 %

The test report example is the same as in clause A.1.5.1.

A.1.5.3 Test C

Input voltage: 90 Vac
Frequency: 47 Hz
Temperature: 40 °C
Relative Humidity: 95 %

The test report example is the same as in clause A.1.5.1.

A.1.5.4 Test D

Input voltage: 264 Vac
Frequency: 63 Hz
Temperature: 0 °C
Relative Humidity: 95 %

The test report example is the same as in clause A.1.5.1.

A.1.5.5 Test E

I Input voltage: 264 Vac
Frequency: 63 Hz
Temperature: 25 °C
Relative Humidity: 95 %

The test report example is the same as in clause A.1.5.1.

A.1.5.6 Test F

I Input voltage: 264 Vac
Frequency: 63 Hz
Temperature: 40 °C
Relative Humidity: 95 %

The test report example is the same as in clause A.1.5.1.

A.2 Switcher Loop Stability Test

A.2.1 Test Purpose

To verify that the control loop works under all AC input, DC load conditions and temperature. Measure and plot Open Loop Gain/Phase characteristics at each of the following test conditions.

A.2.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.2.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 47 Hz ~ 63 Hz.
- Output Load: 25 %, 50 % and 100 % of the rated load.
- Ambient temperature: see table A.1.
- Ambient humidity: 95 % RH.

A.2.4 Test Criteria

When the ring return circuit is closed and the gain is 0 dB, the phase margin should be greater than 45 degrees. When the phase is 0 degrees, the gain margin should be lower than -6 dB. When the two conditions are met the test is considered to have been passed.

A.2.5 Results report example

Table A.3

		0 °C		25 °C		40 °C	
Input voltage/freq.	**Output % Load (A)**	**Phase Margin (degrees) (deg)**	**Gain Margin (dB) (dB)**	**Phase Margin (degrees) (deg)**	**Gain Margin (dB) (dB)**	**Phase Margin (degrees) (deg)**	**Gain Margin (dB) (dB)**
90 Vac / 47 Hz	0,25	102,11	-15,252	102,12	-93,934	102,17	-43,627
	0,5	102,89	-18,552	102,91	-95,564	101,95	-92,869
	1,0	102,44	-12,820	102,17	-21,672	94,253	-92,149
120 Vac / 60 Hz	0,25	102,06	-13,696	94,536	-97,039	102	-40,941
	0,5	103,49	-11,292	102,41	-34,034	102,06	-34,453
	1,0	102,96	-12,911	103	-88,753	102,73	-25,169
230 Vac / 50 Hz	0,25	102,15	-13,669	102,05	-39,697	101,75	-49,524
	0,5	103,05	-8,798	103,35	-32,090	103,19	-36,213
	1,0	103,42	-16,245	102,84	-93,199	102,39	-91,762
264 Vac / 63 Hz	0,25	102,17	-12,603	101,95	-36,273	101,81	-39,402
	0,5	103,04	-8,933	103,35	-71,241	103,28	-33,732
	1,0	103,55	-15,846	102,89	-37,331	102,57	-37,281

Bode Plot Graph Pictures

From every situation in the above report, a bode plot should be made and reported. An example is shown in figure A.1. The total number of plots is 4 (input voltages) X 3 (output loads) X 3 (temperatures) = 36.

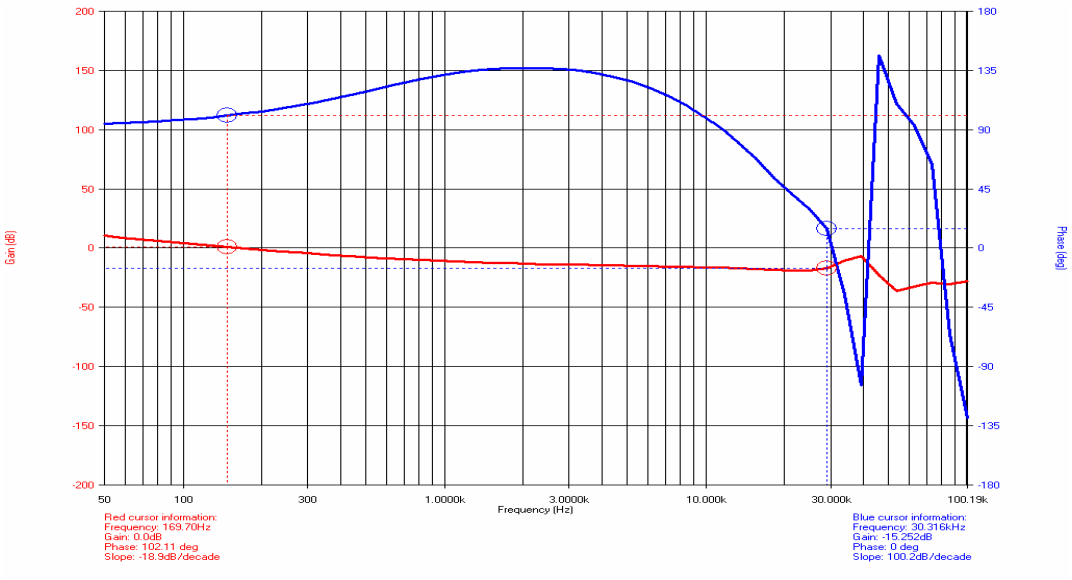

Figure A.1: Example of Bode plot: Input: 90 Vac / 47 Hz; Output: 0,25 A; Ambient Condition: 0 °C

A.3 Internal Thermal Profile

A.3.1 Test Purpose

This test is to verify whether the temperature inside the housing, complies with the requirements and safety standards.

A.3.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.3.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 50 Hz.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.
- Ambient humidity: 85 % RH.

A.3.4 Test Criteria

The temperature should meet EN 60950-1 [12].

A.3.5 Results report example

I/P:90 Vac / 50 Hz

Table A.4

Components Site / Description	C2	C4	C6	C7	LF1	Q1	C3	T1	D7
spec max	105	105	105	105	110	150	125	110	150
80 % spec	84	84	84	84	88	120	100	88	120
1#	68,8	70,4	75,7	63,4	85,4	88,4	85,6	81,4	108,8
2#	67,5	69,8	78,6	64,2	84,4	88,8	84,8	82,7	110,1

I/P:264 Vac / 50 Hz

Table A.5

Components Site / Description	C2	C4	C6	C7	LF1	Q1	C3	T1	D7
spec max	105	105	105	105	110	150	125	110	150
80 % spec	84	84	84	84	88	120	100	88	120
1#	64,4	69,8	73,1	58,2	73,7	90,1	81,4	85,3	105,2
2#	63,6	68,8	74,8	57,1	74,8	91,4	81,8	84,8	106,4

A.4 External Thermal Profile

A.4.1 Test Purpose

This test is to verify whether the external temperature of the housing, complies with the requirements and safety standards.

A.4.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.4.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 50 Hz.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.
- Ambient humidity: 85 % RH.

A.4.4 Test Criteria

The temperature is maximum 65 °C in conformance with EN 60950-1 [12].

A.4.5 Results report example

Table A.6

Components NO	Thermal temperature (deg.c)	
	I/P: 90 Vac / 50 Hz O/P:1A	I/P: 264 Vac / 50 Hz O/P:1A
1#	58,6	57,9
2#	58,1	57,8
3#	57,6	56,6
4#	59,0	58,4
5#	57,8	57,5

A.5 Life test

A.5.1 Test Purpose

To verify the reliability of products for the life test condition.

A.5.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.5.3 Test Condition

- Input voltage: 230 Vac.
- Input Frequency: 50 Hz.
- Output Load: a cycle of 5 s 50 % of the rated load and 5 s 100 % of the rated load.
- Ambient temperature: see table A.1.
- Ambient humidity: 90 % ~ 95 % RH.
- Time: 500 hours.

A.5.4 Test Criteria

After this test, the electric performance should meet specification.

A.5.5 Results report example

Table A.7

Serial number		Output Voltage(V)	Ripple(mV)	Efficiency(%)
Before test	1#	12,00	29,3	78,5
	2#	12,01	30,1	76,9
	3#	12,03	29,4	77,6
	4#	12,00	28,9	78,4
	5#	12,02	29,3	77,8
	6#	12,01	30,1	78,5
	7#	12,03	29,6	77,9
	8#	12,00	29,8	78,5
	9#	12,00	30,3	77,9
	10#	12,01	30,4	78,5
	11#	12,03	29,6	76,9
	12#	12,04	29,8	78,4
	13#	12,00	30,3	77,8
	14#	12,02	30,6	78,5
	15#	12,01	29,9	77,9

Serial number		Output Voltage(V)	Ripple(mV)	Efficiency(%)
After test	1#	12,03	29,8	77,8
	2#	12,00	30,3	78,5
	3#	12,00	30,4	77,9
	4#	12,01	29,6	78,5
	5#	12,03	29,8	77,9
	6#	12,04	30,3	78,5
	7#	12,00	30,6	76,9
	8#	12,02	29,9	78,4
	9#	12,01	29,7	77,8
	10#	12,00	30,1	78,5
	11#	12,01	29,6	77,9
	12#	12,00	29,3	76,9
	13#	12,03	30,1	77,6
	14#	12,01	29,6	78,4
	15#	12,02	29,8	77,8

A.6 Dynamic load switching test

A.6.1 Test Purpose

This test is to verify the reliability of the power supply for the dynamic load conditions.

A.6.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.

- Expiry date of the latest calibration.

A.6.3 Test Condition

- Input voltage: 230 Vac.
- Input Frequency: 50 Hz.
- Output Load: block current 5 s 50 % and 5 s 100 % of the rated load.
- Ambient temperature: see table A.1.
- Time: 500 hours.

A.6.4 Test Criteria

After the test, the electrical performance should meet the specifications.

A.6.5 Results report example

The results report example is the same as in clause 9.5.5.

A.7 Output trans response-load slew and step

A.7.1 Test Purpose

This test is to verify the reliability of the power supply for output trans response load conditions.

A.7.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.7.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 47 Hz ~ 63 Hz.
- Output Load: current 20 % - 80 % and 80 % - 20 % of the rated load, with a slew rate of 1,0 A / µs and T1 = T2 = 0,5 ms.
- Ambient temperature: see table A.1.

A.7.4 Test Criteria

With the output current from 20 % to 80 %, and from 80 % to 20 %, the output voltage should change less than 5 %. At 12 Vdc, 5 % is 0,6 Vdc.

A.7.5 Results report example

Table A.8

Item Serial number	Output voltage(V)			
	90 Vac / 47 Hz	115 Vac / 60 Hz	230 Vac / 50 Hz	264 Vac / 63 Hz
1#	0,2655	0,2988	0,2788	0,2911
2#	0,2859	0,3021	0,2924	0,2915
3#	0,2759	0,3125	0,2951	0,3015
4#	0,2958	0,3028	0,2891	0,3142
5#	0,2856	0,2958	0,2798	0,2898

A.8 AC input inrush current test

A.8.1 Test Purpose

This test is to verify the reliability of the power supply for AC input current test conditions.

A.8.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.8.3 Test Condition

- Input voltage: 90 Vac and 264 Vac.
- Input Frequency: 50 Hz.
- Output Load: 100 % of the rated load.
- The inrush current is measured at an ambient temperature of 25 °C, with the test unit temperature stabilized in the power off condition until at ambient temperature.

A.8.4 Test Criteria

The AC inrush current should be less than 50 A.

A.8.5 Results report example

Table A.9

Components Serial number	90 Vac / 50 Hz (A)	264 Vac / 50 Hz (A)
1#	10,3	10,8
2#	16,3	14,2
3#	13,8	15,0
4#	14,2	16,2
5#	15,0	14,9

A.9 Turn on delay test

A.9.1 Test Purpose

This test is to verify the turn on delay of the power supply.

A.9.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.9.3 Test Condition

- Input voltage: 110 Vac.
- Input Frequency: 60 Hz.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.

A.9.4 Test Criteria

The turn-on delay should be less than 2 000 ms.

A.9.5 Results report example

Table A.10

Components Serial number	Turn-on delay time (ms)
1#	1 241
2#	1 551
3#	1 435
4#	1 268
5#	1 554

A.10 Output hold-up time test

A.10.1 Test Purpose

This test is to verify the output hold-up time of the power supply.

A.10.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.10.3 Test Condition

- Input voltage: 110 Vac.
- Input Frequency: 60 Hz.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.

A.10.4 Test Criteria

The output hold-up time should be more than 10 mS.

A.10.5 Results report example

Table A.11

Components Serial number	Hold-up time (ms)
1#	23,2
2#	21,5
3#	24,5
4#	20,7
5#	22,6

A.11 Rise time and overshoot test

A.11.1 Test Purpose

This test is to verify the output rise time and overshoot of the power supply.

A.11.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.11.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 47 Hz ~ 63 Hz.
- Output Load: 0 % ~ 100 % of the rated load.
- Ambient temperature: see table A.1.

A.11.4 Test Criteria

The rise time should be less than 50 ms measured from 10 % to 90 % of the output voltage.

The overshoot at turn on and turn off should not exceed 10 % of the nominal voltage value.

A.11.5 Results report example

Table A.12

Input Voltage		90 Vac / 47 Hz		115 Vac / 60 Hz		230 Vac / 50 Hz		264 Vac / 63 Hz	
Serial number		Rise time(mS)	Overshoot (mV)	Rise time(mS)	Overshoot (mV)	Rise time(mS)	Overshoot (mV)	Rise time(mS)	Overshoot (mV)
1	0 A	3,625	250	2,585	250	2,224	250	2,165	250
	1,0 A	5,205	250	3,554	250	3,185	250	3,564	250
2	0 A	3,524	250	2,524	250	2,281	250	2,224	250
	1,0 A	5,152	250	3,621	250	3,239	250	3,314	250
3	0 A	3,554	250	2,624	250	2,251	250	2,456	250
	1,0 A	5,213	250	3,651	250	3,218	250	3,329	250
4	0 A	3,421	250	2,682	250	2,212	250	2,652	250
	1,0 A	5,128	250	3,652	250	3,258	250	3,332	250
5	0 A	3,458	250	2,584	250	2,124	250	2,124	250
	1,0 A	5,211	250	3,624	250	3,264	250	3,241	250

A.12 Output transient response deviation test

A.12.1 Test Purpose

This test is to verify the output transient response deviation of the power supply.

A.12.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.12.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 47 Hz ~ 63 Hz.
- Output Load: 0 % ~ 100 % of the rated load.
- Ambient temperature: see table A.1.

A.12.4 Test Criteria

The deviation percentage should be less than 5 %. The deviation percentage is $(V_{high} - V_{low)} / V_{normal} \times 100\ \%)$.

A.12.5 Results report example

Table A.13

Input			90 Vac / 47 Hz		115 Vac / 60 Hz		230 Vac / 50 Hz		264 Vac / 63 Hz	
Serial number	Normal Voltage (V)	Load (A)	Output Voltage (V)	deviation percent (%)	Output Voltage (V)	deviation percent (%)	Output Voltage (V)	deviation percent (%)	Output Voltage (V)	deviation percent (%)
1	12,0	0	12,22	1,92	12,22	1,92	12,22	1,92	12,22	1,92
		1,0	11,99		11,99		11,99		11,99	
2		0	12,21	1,75	12,21	1,75	12,21	1,75	12,21	1,75
		1,0	12,00		12,00		12,00		12,00	
3		0	12,24	1,92	12,24	1,92	12,24	1,92	12,24	1,92
		1,0	12,01		12,01		12,01		12,01	
4		0	12,20	1,83	12,20	1,83	12,20	1,83	12,20	1,83
		1,0	11,98		11,98		11,98		11,98	
5		0	12,23	1,67	12,23	1,67	12,23	1,67	12,23	1,67
		1,0	12,03		12,03		12,03		12,03	

A.13 Dynamic load test

A.13.1 Test Purpose

This test is to verify the dynamic load test of the power supply.

A.13.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.13.3 Test Condition

- Input voltage: 90 Vac.
- Input Frequency: 47 Hz.
- Output Load: 250 % / 30 ms 100 % / 1 s of the rated load.
- Slew rate: 0,1 A / µs.
- Ambient temperature: see table A.1.

A.13.4 Test Criteria

The output voltage should be more than 9 Vdc.

A.13.5 Results report example

Table A.14

Item Serial number	Output voltage (V)
1	10,6
2	10,8
3	10,2
4	10,6
5	10,5

A.14 Brown out and recovery test

A.14.1 Test Purpose

This test is to verify the brown out and recovery of the power supply.

A.14.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.14.3 Test Condition

- Input voltage: reduce the AC input voltage to 0 Vac in 30 s then immediately increase the AC input voltage to 90 Vac, hold up 10 s, then fall to 0 Vac, and then increase AC input to 90 Vac in 30 s. Repeat this 20 times.
- Input Frequency: 50 Hz.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.

A.14.4 Test Criteria

After the test, the electric performance should meet the specifications. The power supply should have clean ON/OFF and OFF/ON transition. No permanent damage.

A.14.5 Results report example

Table A.15

Components Serial number	Power on		Power off	
	Input voltage	Start-up / Steady Output voltage	Input voltage	Steady / Fall Output Voltage
1#	47,8/56,6	11,48/11,85	55/47,5	11,85/11,26
2#	49,6/55,3	11,51/11,96	53/48,2	11,96/11,21
3#	49,2/55,6	11,42/12,03	54/47,3	12,03/11,35
4#	49,8/54,2	11,46/12,01	52/48,6	12,01/11,25
5#	49,7/55,1	11,40/11,99	53/48,0	11,99/11,23

A.15 Temperature storage test

A.15.1 Test Purpose

This test is to verify if the power supply can endure the storage temperature.

A.15.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.15.3 Test Condition

- Chamber temperature - 40 °C ~ + 70 °C.
- Cycle time: 3 hours.
- Cycles: 2.

A.15.4 Test Criteria

After the test, the electric performance should meet the specifications. No permanent damage.

A.15.5 Results report example

Table A.16

Serial number	Before test voltage (V)	After test voltage (V)	Hi-pot:P-S:3,75 kVA C 10 mA 1 Min	Insulation:500 VDC 1 Min 100 MΩ MIN	
			Input to output	To output plug	To housing
1#	12,01	12,02	OK	OK	OK
2#	12,03	12,01	OK	OK	OK
3#	12,04	12,00	OK	OK	OK
4#	12,00	12,01	OK	OK	OK
5#	12,02	12,00	OK	OK	OK
6#	12,01	12,03	OK	OK	OK
7#	12,00	12,01	OK	OK	OK
8#	12,01	12,02	OK	OK	OK
9#	12,00	12,02	OK	OK	OK
10#	12,03	12,01	OK	OK	OK
11#	12,01	12,03	OK	OK	OK
12#	12,02	12,00	OK	OK	OK
13#	12,02	12,02	OK	OK	OK
14#	12,01	12,01	OK	OK	OK
15#	12,03	12,04	OK	OK	OK
16#	12,00	12,00	OK	OK	OK
17#	12,02	12,00	OK	OK	OK
18#	12,01	12,00	OK	OK	OK
19#	12,03	12,02	OK	OK	OK
20#	12,00	12,01	OK	OK	OK
21#	12,00	12,02	OK	OK	OK
22#	12,01	12,02	OK	OK	OK
23#	12,03	12,01	OK	OK	OK
24#	12,04	12,03	OK	OK	OK
25#	12,00	12,00	OK	OK	OK
26#	12,00	12,02	OK	OK	OK
27#	12,00	12,01	OK	OK	OK
28#	12,02	12,00	OK	OK	OK
29#	12,01	12,00	OK	OK	OK
30#	12,03	12,02	OK	OK	OK

A.16 Humidity storage test

A.16.1 Test Purpose

This test is to verify if the power supply can endure the storage humidity.

A.16.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.

- Expiry date of the latest calibration.

A.16.3 Test Condition

- Chamber temperature + 50 °C.
- Relative humidity: 95 %.
- Test time: 24 hours.

A.16.4 Test Criteria

After the test, the electric performance should meet the specifications. No permanent damage.

A.16.5 Results report example

This example is the same as in clause A.15.5.

A.17 Power cycle test

A.17.1 Test Purpose

This test is to verify the power turn on/off and the stability of the power supply even after a break condition of the power line.

A.17.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.17.3 Test Condition

- Input voltage: 230 Vac.
- Input Frequency: 50 Hz.
- Input voltage: on 5 s, off 5 s repeat 10 000 times.
- Output Load: 100 % of the rated load.
- Ambient temperature: see table A.1.

A.17.4 Test Criteria

After the test, the electric performance should meet the specifications. No permanent damage.

A.17.5 Results report example

This example is the same as in clause A.15.5.

A.18 Shipping test

A.18.1 Test Purpose

This test is to verify the endurance of the power supply for the vibration and non repetitive shock during transportation.

A.18.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.18.3 Test Condition

- Input: not connected.
- Output: not connected.
- Ambient temperature: see table A.1.
- This test should be performed in following order:
    1) drop test;
    2) vibration test.

Individual Drop

Quantity = 1 box

Drop test

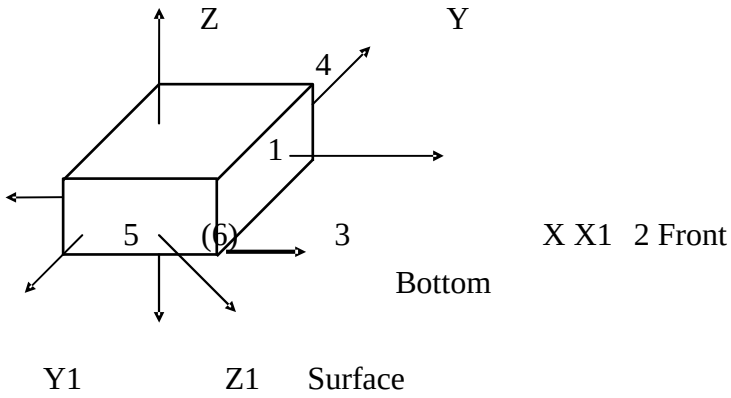

Figure A.2

Vibration test in the carton package:

10 Hz - 55 Hz - 10 Hz, 1,5 G peak to peak, 3 axes, 20 minutes sweep.

A.18.4 Test Criteria

No appearance damage or component damage. After the test, the electric performance should meet the specifications. No permanent damage.

A.18.5 Results report example

Table A.17

Drop Test			
	Test Order	**Drop Height cm**	**Remarks**
1	Bottom Corner (most critical Corner)	90	
2	Top Corner (most critical Corner)	90	
3	Top Edge (most critical Edge)	90	
4	Vertical Edge (most critical Edge)	90	
5	Bottom Edge	90	Select different Edge for each 3 sample
6	Face 3	90	
7	Face 1	90	
8	Face 2	90	
9	Face 4	90	
10	Face 5	90	
11	Face 6	90	
Vibration Test			
	Test Order	**Test time (minutes)**	**Remarks**
12	Face 1 - Face 3	20	With Face 3 facing down
13	Face 2 - Face 4	20	
14	Face 5 - Face 6	20	

A.19 Single drop test

A.19.1 Test Purpose

This test is to verify reliability of the power supply for a drop.

A.19.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.19.3 Test Condition

- Input: not connected.
- Output: not connected.
- Ambient temperature: see table A.1.
- Height: 61 cm.
- Faces: 4.
- Drop surface: 1 cm wood.

A.19.4 Test Criteria

No appearance damage or component damage. After the test, the electric performance should meet the specifications. No permanent damage.

A.19.5 Results report example

This example is the same as in clause A.15.5.

A.20 Non-operational vibration test

A.20.1 Test Purpose

This test is to verify if the power supply can endure the vibration during removing and operating.

A.20.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.

- Date of the latest calibration.
- Expiry date of the latest calibration.

A.20.3 Test Condition

- Input: not connected.
- Output: not connected.
- Ambient temperature: see table A.1.
- Vibration frequency: 10 Hz ~ 55 Hz.
- Test axis: X, Y, Z axis.
- Time: 5 minutes per axis.

A.20.4 Test Criteria

No appearance damage or component damage. After the test, the electric performance should meet the specifications. No permanent damage.

A.20.5 Results report example

This example is the same as in clause A.15.5.

A.21 Short circuit protection test

A.21.1 Test Purpose

This test is to verify if the power supply can endure a short circuit at the output.

A.21.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.21.3 Test Condition

- Input: 230 Vac.
- Frequency: 50 Hz.
- Output: 100 % of the rated load - short circuit.

- Ambient temperature: see table A.1.

A.21.4 Test Criteria

The short circuit protection should meet the specifications.

A.21.5 Results report example

Table A.18

Item Serial number	Protection Time (s)	After test voltage (V)
1#	2	12,03
2#	2	12,01
3#	2	12,00
4#	2	12,02
5#	2	12,01

A.22 Over voltage protection test

A.22.1 Test Purpose

This test is to verify if the power supply can endure over voltage.

A.22.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.22.3 Test Condition

- Input: 90 Vac ~ 264 Vac.
- Frequency: 47 Hz ~ 63 Hz.
- Ambient temperature: see table A.1.

A.22.4 Test Criteria

The over voltage circuit protection voltage should be lower than 16 V.

A.22.5 Results report example

Table A.19

Item Serial number	Output current (A)	Output voltage with over over-voltage is "on" (V)			
		90 Vac / 47 Hz	115 Vac / 60 Hz	230 Vac / 50 Hz	264 Vac / 63 Hz
1#	0	14,2	14,3	14,2	14,1
	1	14,4	14,5	14,5	14,5
2#	0	14,2	14,3	14,3	14,3
	1	14,4	14,4	14,4	14,4
3#	0	14,2	14,3	14,2	14,1
	1	14,4	14,5	14,5	14,5
4#	0	14,2	14,3	14,3	14,3
	1	14,4	14,4	14,4	14,4
5#	0	14,2	14,3	14,3	14,3
	1	14,4	14,4	14,4	14,4

A.23 Over current protection test

A.23.1 Test Purpose

This test is to verify if the power supply can endure over current.

A.23.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.23.3 Test Condition

- Input: 90 Vac ~ 264 Vac.
- Frequency: 47 Hz ~ 63 Hz.
- Ambient temperature: see table A.1.

A.23.4 Test Criteria

The over current circuit protection should limit the current at a value between 2 and 3 A. After removing the short circuit after 15 minutes the power supply should auto recover without damage.

A.23.5 Results report example

Table A.20

Item Serial number	Temperature (°C)	Limit current (A)			
		90 Vac / 47 Hz	115 Vac / 60 Hz	230 Vac / 50 Hz	264 Vac / 63 Hz
1#	0	2,13	2,36	2,61	2,89
	50	2,14	2,38	2,65	2,92
2#	0	2,14	2,35	2,56	2,94
	50	2,12	2,34	2,58	2,91
3#	0	2,13	2,37	2,63	2,93
	50	2,14	2,38	2,65	2,92
4#	0	2,14	2,35	2,56	2,94
	50	2,14	2,35	2,56	2,94
5#	0	2,12	2,34	2,58	2,91
	50	2,13	2,37	2,63	2,93

Item Serial number	Temperature (°C)	Auto recover after 15 minutes shortcircuit / output voltage (Vdc)			
		90 Vac / 47 Hz	115 Vac / 60 Hz	230 Vac / 50 Hz	264 Vac / 63 Hz
1#	0	yes / 12,13	yes / 12,36	yes / 12,61	yes / 12,89
	50	yes / 12,14	yes / 12,38	yes / 12,65	yes / 12,92
2#	0	yes / 12,14	yes / 12,35	yes / 12,56	yes / 12,94
	50	yes / 12,12	yes / 12,34	yes / 12,58	yes / 12,91
3#	0	yes / 12,13	yes / 12,37	yes / 12,63	yes / 12,93
	50	yes / 12,14	yes / 12,38	yes / 12,65	yes / 12,92
4#	0	yes / 12,14	yes / 12,35	yes / 12,56	yes / 12,94
	50	yes / 12,14	yes / 12,35	yes / 12,56	yes / 12,94
5#	0	yes / 12,12	yes / 12,34	yes / 12,58	yes / 12,91
	50	yes / 12,13	yes / 12,37	yes / 12,63	yes / 12,93

A.24 Construction, Appearance and Weight

A.24.1 Test purpose

This test is to verify if the Construction, Appearance and Weight of the power supply is in compliance with the design and the safety requirements.

A.24.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.24.3 Test Condition

- Inspect the power supply with unaided naked eyes.
- Inspection distance 30 cm away from the naked eyes.

- Ambient temperature: see table A.1.

A.24.4 Test Criteria

The construction, appearance and weight should meet specification.

A.24.5 Results report example

Table A.21

Item	Housing(mm)			DC cord		
Serial number	length	width	height	length	Appearance	Weight (g)
1#	71,90	33,55	69,06	1839	OK	128,9
2#	71,92	33,52	69,03	1839	OK	128,3
3#	71,91	33,53	69,03	1842	OK	128,8
4#	71,91	33,54	69,05	1840	OK	129,1
5#	71,90	33,53	69,07	1842	OK	128,7

A.25 Surface Tolerance To Cleaner

A.25.1 Test Purpose

This test is to assure that the housing, mains cord and DC cable are not damaged when the unit is cleaned with household cleaners.

A.25.2 Test Criteria

Not damaged.

A.25.3 Results report example

Table A.22

Serial number	Result
1	Ok
2	Ok
3	Ok
4	Ok
5	Ok

A.26 Hi-Pot test

A.26.1 Test Purpose

To verify the possibility of electric leakage when the input is connected to high voltage.

A.26.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.26.3 Test Condition

- Test voltage: 3,75 kVac.
- Leak current: 10 mA.
- Test time: 1 minute.
- Ambient temperature: see table A.1.

A.26.4 Test Criteria

The power supply should meet the specifications.

A.26.5 Results report example

Table A.23

Item Serial number	Input to output 3,75 kVac 10 mA 1 Minute	Surface structure
1	PASS	OK
2	PASS	OK
3	PASS	OK
4	PASS	OK
5	PASS	OK

A.27 Dielectric withstand test

A.27.1 Test Purpose

To verify the insulation of the power supply.

A.27.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.

- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.27.3 Test Condition

- Test voltage: 500 Vdc.
- Test time: 1 minute.
- Ambient temperature: see table A.1.

A.27.4 Test Criteria

The power supply should meet the at least 100 MΩ dielectric withstand.

A.27.5 Results report example

Table A.24

Item Serial number	Input to output 500 Vdc 1 Minute	Surface structure
1	PASS	OK
2	PASS	OK
3	PASS	OK
4	PASS	OK
5	PASS	OK

A.28 Leakage current test

A.28.1 Test Purpose

To verify the leakage current of the power supply.

A.28.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.28.3 Test Condition

- Input: 230 Vac.
- Frequency: 50 Hz.
- Output load: 100 % of the rated load.
- Ambient temperature: see table A.1.

A.28.4 Test Criteria

The leakage current should be less than 250 µA.

A.28.5 Results report example

Table A.25

Item Serial number	G-L (µA)	PH-L (µA)
1#	11,6	7,3
2#	11,5	7,3
3#	11,6	7,3
4#	11,6	7,3
5#	11,6	7,3
6#	11,5	7,3
7#	11,6	7,3
8#	11,6	7,3
9#	11,6	7,3
10#	11,5	7,3

A.29 DC cord set and plug test

A.29.1 Test Purpose

To verify the reliability of the cords and plugs.

A.29.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.29.3 Test Condition 1

- DC Cord bending cycles: 2 000 times.
- DC Cord velocity: 40 times / min.
- DC Cord Weight load: 200 g.
- Bending angle: 120 degrees.
- Ambient temperature: see table A.1.

A.29.4 Test Condition 2

- Physical inspection DC plug.
- Physical inspection AC plug.

A.29.5 Test Criteria

The AC plug should meet EN 50075 [13] and the DC plug should meet:

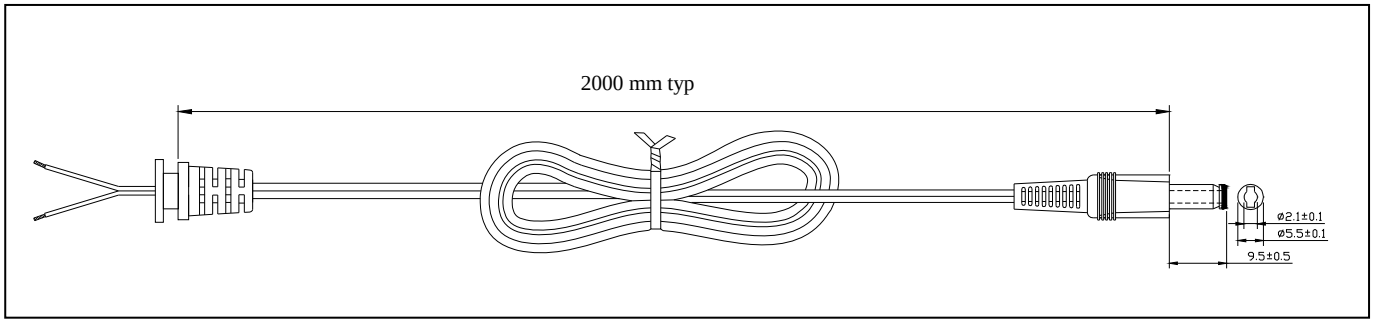

Figure A.3

Results report example:

Table A.26

ITEM Serial number	Test cycles	Percentage of Copper cord broken	Determinant
1#	2 000	0 %	OK
2#	2 000	0 %	OK
3#	2 000	0 %	OK
4#	2 000	0 %	OK
5#	2 000	0 %	OK

A.30 Energy efficiency test

A.30.1 Test Purpose

To verify that the power supply meets the energy specifications.

A.30.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.30.3 Test Condition

- Input voltage: 115 Vac and 230 Vac.
- Input Frequency: 50 Hz.
- Output Load: 0 % ~ 100 % of the rated load.
- Ambient temperature: see table A.1.

A.30.4 Test Criteria

The average efficiency at 25 %, 50 %, 75 % and 100 % of the rated load, equal or better than 77,85 %.

No load power use, less than 0,3 W.

A.30.5 Results report example

Per power supply tested, the next example applies.

Table A.27

Serial number	**1#**					
Input 115 V / 50 Hz	**Active Power Values**					**Average**
Output Current(mA)	0	250	500	750	1000	---
Output Voltage(V)	12,15	12,09	12,04	11,99	11,94	---
Output Power (W)	0	2,4	6,0	9,0	12,0	---
AC Input Power (W)	0,13	3,8	7,4	11,0	14,9	---
Efficiency	---	63,16	81,08	81,82	80,54	76,65
Input 230 V / 50 Hz	**Active Power Values**					**Average**
Output Current(mA)	0	250	500	750	1000	---
Output Voltage(V)	12,15	12,09	12,04	11,99	11,94	---
Output Power (W)	0	2,4	6,0	9,0	12,0	---
AC Input Power (W)	0,26	3,9	7,6	11,3	14,9	---
Efficiency	---	61,54	78,95	79,65	80,54	75,17

A.31 Capacitive load test

A.31.1 Test Purpose

To verify that the power supply will not go into over current protection with the capacitive load.

A.31.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.31.3 Test Condition

- Input voltage: 90 Vac ~ 264 Vac.
- Input Frequency: 50 Hz ~ 60 Hz.
- Output Load: electrolytic capacitor of 2 200 μF.
- Ambient temperature: see table A.1.

A.31.4 Test Criteria

The power supply should not use the over current protection.

A.31.5 Results report example

Table A.28

Serial number	90 Vac / 47 Hz	115 Vac / 60 Hz	230 Vac / 50 Hz	264 Vac / 63 Hz
1#	OK	OK	OK	OK
2#	OK	OK	OK	OK
3#	OK	OK	OK	OK
4#	OK	OK	OK	OK
5#	OK	OK	OK	OK

A.32 Maximum open circuit voltage test

A.32.1 Test Purpose

To verify that the power supply does not exceed the maximum open circuit voltage specification.

A.32.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.32.3 Test Condition

- Input voltage: 90 Vac / 264 Vac.
- Input Frequency: 50 Hz ~ 60 Hz.
- Output Load: 100 % of the rated power.
- Ambient temperature: see table A.1.

A.32.4 Test Criteria

The open circuit voltage should be less than 16 V, when the protection goes to "on".

A.32.5 Results report example

Table A.29

Serial number	90 Vac / 50 Hz (Vdc)	264 Vac / 50 Hz (Vdc)
1#	14,84	14,79
2#	15,69	15,77
3#	14,65	14,75
4#	15,58	15,62
5#	14,82	14,78

A.33 Electrostatic discharge test

A.33.1 Test Purpose

To verify that the power supply meets the electrostatic discharge specifications.

A.33.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.

- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.33.3 Test Condition

In conformance with EN 61000-4-2 [5].

A.33.4 Test Criteria

In conformance with EN 61000-4-2 [5].

A.34 Surge immunity test

A.34.1 Test Purpose

To verify that the power supply meets the surge immunity specifications.

A.34.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.34.3 Test Condition

In conformance with EN 61000-4-5 [7].

A.34.4 Test Criteria

In conformance with EN 61000-4-5 [7].

A.35 Conduction test

A.35.1 Test Purpose

To verify that the power supply meets the conduction specifications.

A.35.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.35.3 Test Condition

In conformance with CISPR 22 [3], class B_QP.

A.35.4 Test Criteria

In conformance with CISPR 22 [3].

A.36 Radiation test

A.36.1 Test Purpose

To verify that the power supply meets the radiation specifications.

A.36.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.36.3 Test Condition

In conformance with CISPR 22 [3], class B.

A.36.4 Test Criteria

In conformance with CISPR 22 [3], class B, 3 m.

A.37 Harmonic test

A.37.1 Test Purpose

To verify that the power supply meets the harmonic specifications.

A.37.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.37.3 Test Condition

In conformance with EN 61000-3-2 [4].

A.37.4 Test Criteria

In conformance with EN 61000-3-2 [4].

A.38 Electrical fast transient test

A.38.1 Test Purpose

To verify that the power supply meets the electrical fast transient specifications.

A.38.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.38.3 Test Condition

In conformance with EN 61000-4-4 [6].

A.38.4 Test Criteria

In conformance with EN 61000-4-4 [6].

A.39 Voltage dips and interruption test

A.39.1 Test Purpose

To verify that the power supply meets the voltage dips and short voltage interruptions specifications.

A.39.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.39.3 Test Condition

In conformance with EN 61000-4-11 [8].

A.39.4 Test Criteria

In conformance with EN 61000-4-4 [6].

A.40 Surge immunity test

A.40.1 Test Purpose

To verify that the power supply meets the surge immunity specifications.

A.40.2 Test Equipment

All measurement equipment should be listed in the results report:

- Purpose of the measurement equipment.
- Manufacturer.
- Type.
- Serial number.
- Date of the latest calibration.
- Expiry date of the latest calibration.

A.40.3 Test Condition

In conformance with EN 61000-4-12 [9].

A.40.4 Test Criteria

In conformance with EN 61000-4-12 [9].

Annex B (informative): Test record

The power supply should be tested for compliance against the requirements given in the present document.

Table B.1 presents a template for test records with the numbers in table B.1 reflect the accuracy required as an example only.

Table B.1: Test record example

Input volt /freq	90Vac/50Hz		115Vac/50Hz		230Vac/50Hz		264Vac/50Hz		115Vac/50Hz	240Vac/50Hz	100Vac/50Hz	230Vac/50Hz	230Vac/50Hz	230Vac/50Hz	230Vac/50Hz	230Vac/50Hz
Output current	No load	Full load	No load	Full load	No load	Full load	No load	Full load		No load		25% load	50% load	75% load	100% load	
									max 120mV	max 0.3W	min 72.4%					min 74.74%
	Output voltages								Ripple& Noise	input power	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	average25-100
serial number unit	Volt	Volt	Volt	Volt	Volt	Volt	Volt	Volt	mVp-p	W	%	%	%	%	%	%
1	12.15	11.93	12.15	11.93	12.15	11.93	12.15	11.93	35.2	0.23	79.8	79.8	79.8	79.8	79.8	79.8
2	12.21	12.00	12.21	12.00	12.21	12.00	12.21	12.00	34.4	0.25	79.5	79.5	79.5	79.5	79.5	79.5
3	12.23	12.01	12.23	12.01	12.23	12.01	12.23	12.01	33.6	0.24	79.4	79.4	79.4	79.4	79.4	79.4
4	12.19	11.97	12.19	11.97	12.19	11.97	12.19	11.97	32.8	0.24	79.4	79.4	79.4	79.4	79.4	79.4
5	12.18	11.96	12.18	11.96	12.18	11.96	12.18	11.96	35.2	0.23	79.5	79.5	79.5	79.5	79.5	79.5
6	12.19	11.97	12.19	11.97	12.19	11.97	12.19	11.97	36.8	0.23	79.9	79.9	79.9	79.9	79.9	79.9
7	12.11	11.89	12.11	11.89	12.11	11.89	12.11	11.89	35.2	0.23	80.0	80.1	80.2	80.3	80.4	80.5
8	12.16	11.95	12.16	11.95	12.16	11.95	12.16	11.95	34.4	0.24	79.5	79.6	79.7	79.8	79.9	79.10
9	12.13	11.91	12.13	11.91	12.13	11.91	12.13	11.91	28.8	0.23	80.0	80.1	80.2	80.3	80.4	80.5
10	12.15	11.93	12.15	11.93	12.15	11.93	12.15	11.93	30.4	0.23	79.9	79.10	79.11	79.12	79.13	79.14

Input volt	90Vac		264Vac		90Vac	115Vac	230Vac	264Vac		230Vac	Test equipment				
Input freq	50 Hz		50 Hz		50 Hz	50 Hz	50 Hz	50 Hz		50 Hz					last calibration
Output current					0 - 100% load					70 - 80 %		manufacterer	type	serial number	date
test	SCP	OCP	SCP	OCP	noise	noise	noise	noise	Hi-Pot	Burn-in	AC power source				
	Pass:√ / Fail: X										Electronic load				
serial number unit	√ / X	√ / X	√ / X	√ / X	√ / X	√ / X	√ / X	√ / X	√ / X	√ / X	Multimeter				
1	√	√	√	√	√	√	√	√	√	√	Osciloscope				
2	√	√	√	√	√	√	√	√	√	√	power meter				
3	√	√	√	√	√	√	√	√	√	√	Dielectric analyzer				
4	√	√	√	√	√	√	√	√	√	√	……				
5	√	√	√	√	√	√	√	√	√	√	…….				
6	√	√	√	√	√	√	√	√	√	√					
7	√	√	√	√	√	√	√	√	√	√					
8	√	√	√	√	√	√	√	√	√	√					
9	√	√	√	√	√	√	√	√	√	√					
10	√	√	√	√	√	√	√	√	√	√					

SCP = short circuit protection
OCP = over current protection

History

Document history		
V1.1.1	July 2010	Publication