

**External a.c. -  
d.c. and a.c. -  
a.c. power supplies – Determination of no-load power and average  
efficiency of active modes**

Sources d'alimentation externes en  
courant alternatif et en courant continu -  
Détermination de la consommation hors  
charge et du rendement moyen en mode  
actif

Externe AC/DC- und AC/AC-Netzteile -  
Bestimmung von Nulllast und  
durchschnittlicher Effizienz im Betrieb

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## Foreword

This document (EN 50563:2011) has been prepared by the Technical Committee CENELEC TC 108X, Safety of electronic equipment within the fields of audio/video, information technology and communication technology and the Technical Committee CENELEC TC 59X, Performance of household and similar electrical appliances.

The following dates are fixed:

- latest date by which this document (dop) 2012-10-10  
has to be implemented at national  
level by publication of an identical  
national standard or by endorsement
- latest date by which the national (dow) 2014-10-10  
standards conflicting with this  
document have to be withdrawn

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## Introduction

This European Standard was written in response to an EC mandate requesting the creation of a harmonised standard providing a reliable, accurate and reproducible method of measuring the no-load power consumption and determining the average efficiency of active modes for external power supplies, which takes into account the generally recognised state of the art measurement methods.

This standard makes extensive reference to EN 50564 *Electrical and electronic household and office equipment - Measurement of low power consumption*, which was also prepared under an EC mandate to support the ecodesign Directive. Other provisions are based on the test method published by the EPA and the Australian/NZ Standard AS/NZS 4665.1.

The methods defined in this standard are intended to cover no-load power consumption and average efficiency of active modes for a.c. - a.c. and a.c. – d.c. external power supplies.

The aim is to ensure this European Standard is compatible with the objectives of EU legislation for ecodesign. This standard is applicable to a wider range of products than EC Regulation No 278/2009.

## 1 Scope

This European Standard specifies methods of measurement of electrical power consumption, and the reporting of results, for external power supplies. This standard is applicable to external power supplies with a rated input voltage within the range 100 V a.c. to 250 V a.c. having a single output with a rated output power not exceeding 250 W and a rated output voltage not exceeding 230 V a.c. or 325 V d.c. The output voltage may be either at a fixed voltage, or at a voltage which is user selectable, or at a voltage that is automatically selectable by the external power supply so as to be compatible with one or more product-loads.

NOTE 1 This document has been written in particular to support EC Regulation No 278/2009 for the measurement of no-load condition electric power and average efficiency of active modes for external power supplies.

NOTE 2 This standard does not specify safety requirements for products nor safety precautions to be taken by those performing measurements. It does not specify minimum performance requirements, nor does it set maximum limits on power or energy consumption.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50564:2011, *Electrical and electronic household and office equipment – Measurement of low power consumption (IEC 62301:2011, modified)*

IEC 60050-131:2002, *International Electrotechnical Vocabulary – Part 131: Circuit theory*

IEC 60050-300:2001, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*



### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-131:2002 and IEC 60050-300:2001 and the following apply.

Throughout this standard the term “power” is used to refer to “active power” unless otherwise specifically stated

#### 3.1 Equipment related definitions

##### 3.1.1

##### **external power supply**

void

NOTE 1 Refer to relevant legislation.

NOTE 2 EC Regulation 278/2009 defines External Power Supply as follows:

*‘external power supply’ means a device which meets all of the following criteria:*

- a) *it is designed to convert alternating current (AC) power input from the mains power source input into lower voltage direct current (DC) or AC output;*
- b) *it is able to convert to only one DC or AC output voltage at a time;*
- c) *it is intended to be used with a separate device that constitutes the primary load;*
- d) *it is contained in a physical enclosure separate from the device that constitutes the primary load;*
- e) *it is connected to the device that constitutes the primary load via a removable or hard-wired male/-female electrical connection, cable, cord or other wiring;*
- f) *it has nameplate output power not exceeding 250 Watts;*
- g) *it is intended for use with electrical and electronic household and office equipment as referred to in Article 2(1) of Regulation (EC) No 1275/2008.*

##### 3.1.2

##### **rated input frequency**

a.c. input frequency of the external power supply, as specified by the manufacturer

##### 3.1.3

##### **rated input voltage**

a.c. input voltage of the external power supply, as specified by the manufacturer

##### 3.1.4

##### **rated output current**

output current of the external power supply, as specified by the manufacturer

NOTE In EC Regulation 278/2009 the corresponding term is “nameplate output current”.

##### 3.1.5

##### **rated output power**

output power of the external power supply, as specified by the manufacturer

NOTE In EC Regulation 278/2009 the corresponding term is “nameplate output power” (Po).

##### 3.1.6

##### **rated output voltage**

output voltage of the external power supply, as specified by the manufacturer

NOTE In EC Regulation 278/2009 the corresponding term is “nameplate output voltage”.

#### 3.2 Measurement related definitions

##### 3.2.1

##### **active mode**

void

NOTE 1 Refer to relevant legislation.

NOTE 2 EC Regulation 278/2009 defines active mode as follows:



*'active mode' means a condition in which the input of an external power supply is connected to the mains power source and the output is connected to a load.*

### 3.2.2

#### **active mode efficiency**

void

NOTE 1 Refer to relevant legislation.

NOTE 2 EC Regulation 278/2009 defines Active mode efficiency as follows:

*'active mode efficiency' means the ratio of the power produced by an external power supply in active mode to the input power required to produce it.*

NOTE 3 The active mode efficiency is likely to depend upon the output power.

### 3.2.3

#### **active power ( $P$ )**

under periodic conditions, mean value, taken over one period  $T$ , of the instantaneous power  $P$ :

$$P = \frac{1}{T} \int_0^T p dt$$

NOTE 1 Under sinusoidal conditions, the active power is the real part of the complex power.

NOTE 2 The SI unit for active power is the watt.

[IEC 60050, definition 131-11-42]

### 3.2.4

#### **apparent power ( $S$ )**

product of the r.m.s. voltage  $U$  between the terminals of a two-terminal element or two-terminal circuit and the r.m.s electric current  $I$  in the element or circuit:

$$S = UI$$

NOTE 1 Under sinusoidal conditions, the apparent power is the modulus of the complex power.

NOTE 2 The SI unit for apparent power is the voltampere.

[IEC 60050, definition 131-11-41]

### 3.2.5

#### **average efficiency of active modes**

average of the active mode efficiencies at 25 %, 50 %, 75 % and 100 % of the rated output current

NOTE In EC Regulation 278/2009 the corresponding term is "average active efficiency".

### 3.3

#### **no-load condition**

void

NOTE 1 Refer to relevant legislation.

NOTE 2 EC Regulation 278/2009 defines No load condition as follows:

*'no-load condition' means the condition in which the input of an external power supply is connected to the mains power source, but the output is not connected to any primary load.*

### 3.4

#### **power factor**

ratio of the active power to the apparent power

NOTE The definition of power factor includes the effect of both distortion and displacement of the current waveform relative to the voltage waveform.

### 3.5

#### **total harmonic distortion (THD)**

ratio of the r.m.s. value of the harmonic content of an alternating quantity to the r.m.s. value of the fundamental component of the quantity

[IEC 60050, definition 551-17-06]

### 3.6

#### **product-load**

product or load that is compatible with the rated output voltage and current of the external power supply

## 4 Information and instructions for use

### 4.1 Information to be provided on or with the external power supply

The information below shall either be marked on each external power supply or contained in documentation provided with each external power supply:

- rated output voltage, in V,
- symbol indicating whether the output voltage is a.c. or d.c.,
- rated output current, in A for currents  $\geq 1$  A and in mA for currents  $< 1$  A,
- rated output power, in W as an alternative marking of the rated output current.

Both the rated output power and the rated output current shall be provided if the rated output current multiplied by the rated output voltage differs from the rated output power by more than  $\pm 5\%$ .

Where the rated output voltage is user-selectable, each selectable output voltage shall be identified and delineated by a solidus.

EXAMPLE      6 / 9 / 12 V

The rated output voltage shall be associated with the symbol for the nature of the supply, which

- for a d.c. output voltage, shall be symbol 5031 of IEC 60417,
- for an a.c. output voltage, shall be symbol 5032 of IEC 60417.

EXAMPLE      Equipment having a 12 V d.c. output would be marked.

The rated output current shall be given for each output voltage. The order of marking the output current shall correspond to the output voltage.

EXAMPLE      An external power supply having a rated output power of 20 W and rated output voltages of 6 / 9 / 12 V would have rated output current of 3.3 / 2.2 / 1.7 A.

### 4.2 Instructions for use

Each external power supply shall be provided with instructions for use that describe the products that the external power supply is compatible with, or the characteristics of the product-load that the external power supply is compatible with. This requirement does not apply if the external power supply is packaged or otherwise supplied together with a dedicated product-load.

If the external power supply automatically adjusts its output to be compatible with certain supply-loads, this fact and the means of detection shall be stated.

EXAMPLE 1      An external power supply may have different connectors, each specific to a particular product-load, such that when a user fits a specific connector the output voltage adjusts automatically.

EXAMPLE 2      An external power supply may signal the product-load via a data path before applying a specific output voltage and/or current.

## 5 General conditions for measurement

### 5.1 General

Unless otherwise specified, measurements shall be made under test conditions and with equipment specified in EN 50564.

Tests specified in this standard are made on an external power supply that is representative of the external power supply the user would receive.

### 5.2 Test room

The requirements of EN 50564:2011, 4.2 apply.



During tests the external power supply shall not be intentionally cooled by external means.

NOTE Placing the external power supply on a metal surface during tests is an example of cooling by external means.

### 5.3 Power supply

The requirements of EN 50564:2011, 4.3 apply.

### 5.4 Power measuring instruments

The requirements of EN 50564:2011, 4.4 apply to the measurement of input power and output power.

NOTE As there is a requirement to report the THD of the input current, it is recommended that a power meter having this capability is selected.

## 6 Measurements

### 6.1 General

Power consumption and efficiency of the external power supply is measured under four conditions of successively decreasing loads (100 %, 75 %, 50 % and 25 % rated output current). In addition, power consumption is measured at 0 % rated output current.

Where the external power supply has two output conductors, these are connected to the load as described in 6.2. Where the external power supply has more than two conductors then the organisation taking responsibility for the product shall, where necessary, be contacted to determine the most appropriate test configuration.

NOTE 1 A cable or plug can have multiple conductors.

NOTE 2 In order to minimise measurement errors test leads should be kept as short as possible and test leads for voltage and current should each form a twisted pair.

Tests are made measuring the input power and output power simultaneously.

### 6.2 Preparation of the external power supply

The sequence of tests shall be performed on the same sample of external power supply.

The following steps shall be followed and documented in the test report as applicable:

- any switch controlling power to the input of the external power supply shall be in the 'on' position;
- the connection between the mains and the external power supply input shall be as supplied by the organisation taking responsibility for the product. Where more than one connection means are provided, testing shall only be carried out in one configuration...

NOTE The connection means referred to above includes, for example, a mains plug, power cord or supply cable.

- output measurements shall be made at the product-load side of the longest output cable provided by the organization taking responsibility for the product, if one or more are provided. Where no cable is provided, output measurements shall be made at the output terminals of the external power supply;

NOTE If the output cable terminates in a proprietary connector, the cable is cut immediately adjacent to that connector and measurements made at that point. Where the external power supply has a fixed connection with the product to be powered, measurements are made at that point; where necessary the cable is cut immediately adjacent to the product-load.

- in order to determine the length of the output cable it is first aligned so as to extend in a straight line away from the enclosure of the external power supply. The length between the point at which the cable exits the enclosure of the external power supply to the furthest contact point for connection of the product-load shall be measured; the accuracy shall be better than or equal to 10 % of the measured cable length.

### 6.3 Load conditions

Determine, by reviewing the instructions for use, if the external power supply automatically adjusts its output to be compatible with certain supply-loads. Where the output is automatically adjusted, the organisation taking responsibility for the product shall, where necessary, be contacted to determine how to set up conditions 1 to 4 of Table 1.



The external power supply shall be tested at the load conditions specified in Table 1.

**Table 1 - Load conditions for the external power supply**

Percentage of rated output current	
Load condition	Percentage
1	100 ± 2
2	75 ± 2
3	50 ± 2
4	25 ± 2
5	0
NOTE The 2 % relates to maximum deviation from the target percentage value. For example, an external power supply at load condition 3 may be tested in a range from 48 % to 52 % of the rated output current.	

External power supplies with a switchable output shall be tested twice; once with the output voltage set to the lowest voltage setting and then again with the output voltage set to the highest voltage setting. This also applies to external power supplies that automatically adjust their output to be compatible with certain product-loads.

#### 6.4 Test load

The load conditions specified in Table 1 shall be achieved by using a resistive load. The resistive load may be a variable resistor, an electronic test load, or a combination thereof, having a power factor of 0,95 to 1.

NOTE While the test loads may have different characteristics to the product-loads, they provide standardized and readily repeatable references for testing and product comparison.

#### 6.5 Test set-up

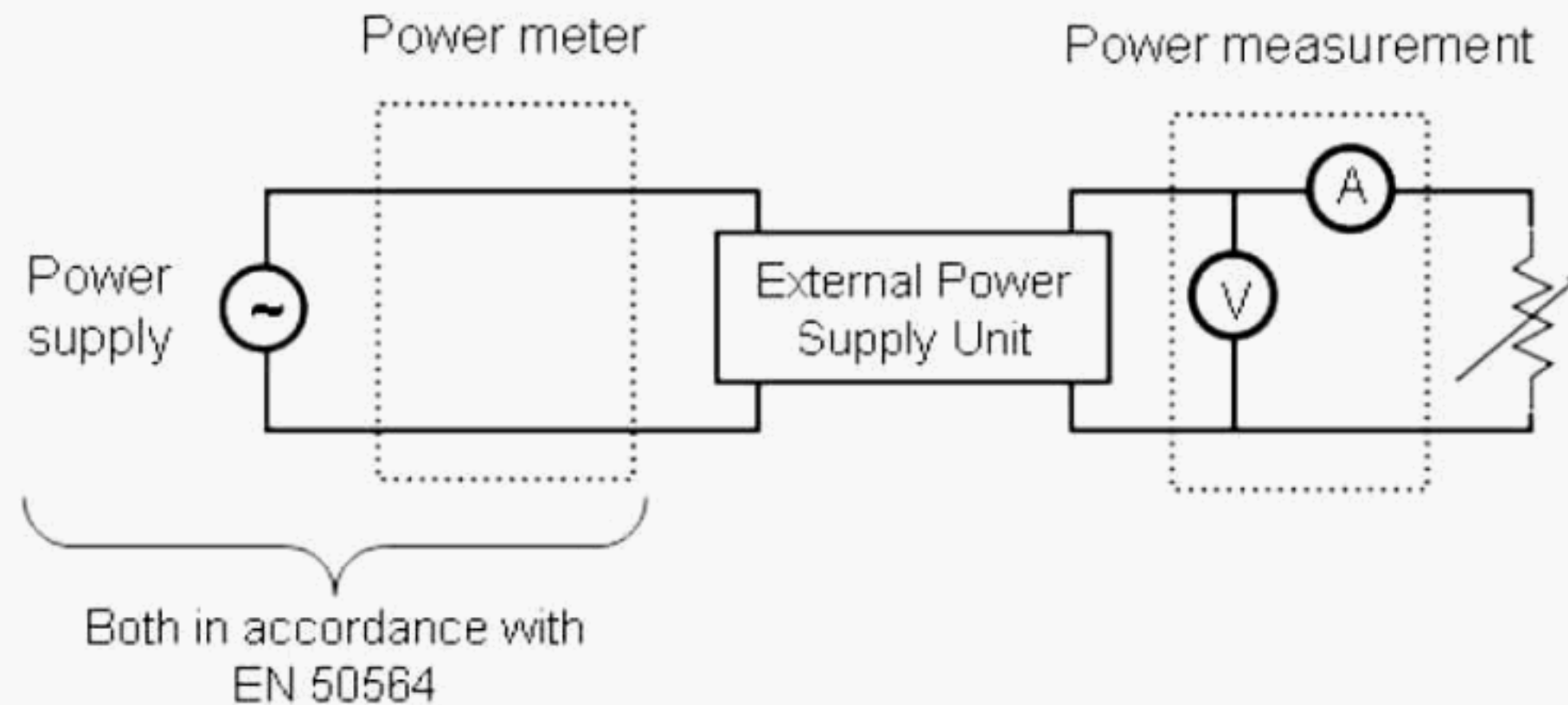
Output power measurements of an external power supply having an a.c. output shall be made with a power meter.

Output power measurements of an external power supply having a d.c. output with a peak-to-peak ripple voltage that is less than 5 % of the r.m.s. voltage at full load may be made either with a suitable power meter or with a separate voltmeter and ammeter. If the peak-to-peak voltage ripple is greater than or equal to 5 % of the r.m.s. voltage at full load then power measurements shall be made with a d.c. coupled power meter.

The load is adjusted to the point where the measured current is the desired percentage of rated output current. If it is not possible to adjust the output current (i.e. the external power supply is a constant current type) then the output power is varied according to the percentages given in Table 1.

Where a variable resistor is used as the load, Figure 1 shows the measurement set-up. Where an electronic load is used, the constant current mode is used.





#### Key

- 'A' indicates the current measuring part of the power meter
- 'V' indicates the voltage measuring part of the power meter

**Figure 1 - Test set-up**

### 6.6 Measurement uncertainty

The measurement uncertainty related to determination of input power due to the measuring instrument ( $U_e$ ) is given in EN 50564:2011, 4.4.1 and Annex D.

Measurement of output power shall be made such that the calculated or measured power due to the measuring instrument has an uncertainty at the 95 % confidence level of

- $\leq 2 \%$  for powers of 0,5 W or greater,
- $\leq 10 \text{ mW}$  for powers of less than 0,5 W.

NOTE The values for uncertainty related to output power are taken from Annex 1 of EC Regulation 278/2009.

### 6.7 Testing sequence:

The tests shall be conducted as follows:

- a) using the set-up in Figure 1 apply load condition 1 as specified in Table 1;
- b) the output of the EPS shall be maintained at load condition 1 for at least 30 min, this is the warm-up period. After this warm-up period the ac input power is monitored for a period of 5 min to assess stability. If the input power level does not change by more than 5 % during these 5 min the measurement is considered to be stable and the measurements are recorded at the end of the 5 minute period. If ac input power is not stable over a 5 minute period, stability shall be determined in accordance with EN 50564:2011, 5.3. If load condition 1 cannot be maintained for either the warm-up period or the stability period then compliance with this standard cannot be determined;
- c) immediately subsequent to b) load conditions 2 through 5 are measured in sequence each with a 5 minute period for determining stability: it is not necessary to repeat the warm-up period unless the EPS is not stable within each of the 5 minute periods. If ac input power is not stable over a 5 minute period, stability shall be determined in accordance with EN 50564:2011, 5.3. Where it is not possible to immediately follow the preceding test condition a warm-up period of at least 30 min shall be introduced using the relevant load condition.

NOTE The configuration of the power meter may need to change during the above sequence of tests, see EN 50564:2011, B.4

If the external power supply has a user-selectable output voltage, the above sequence is conducted first with the highest output voltage setting and then the sequence is repeated with the lowest voltage setting.



**Table 2 – Required reported data (measured and calculated)**

Reported quantity	Description
r.m.s. output current (mA or A) (a.c. or d.c.)	Measured at load conditions 1 – 4
r.m.s. output voltage (V) (a.c. or d.c.)	
output power (W)	
r.m.s. input voltage (V)	Measured at load conditions 1 – 5
input power (W)	
Total harmonic distortion of the input current (%ITHD)	
Power factor	
Power dissipation by the external power supply (W)	Calculated at load conditions 1 – 4 (see 6.8) Measured at load conditions 5
Efficiency	Calculated at load conditions 1 – 4 (see 6.8)
Average efficiency	Arithmetic average of efficiencies determined for load conditions 1 – 4

### 6.8 Efficiency calculation

The active mode efficiency at load conditions 1 to 4 of Table 1 shall be calculated by dividing the measured output power at a given load condition by the input power measured at that load condition. The average efficiency of active modes shall be calculated by summing the active mode efficiencies and dividing by 4.

### 6.9 Calculation of power dissipation by the external power supply

The power dissipation of the external power supply shall be calculated for load condition 1 of Table 1 by subtracting the measured output power from the measured input power. This is repeated for load conditions 2 to 4 of Table 1.

NOTE The power dissipation of the external power supply for load condition 5 is equal to the input power at that load condition.

## 7 Test report

NOTE A suggested format for this report is given in Annex A, which may require modification if testing at more than one output voltage is required.

### 7.1 Product details

All of the following information shall be recorded in the test report:

- details of the organisation taking responsibility for the product (e.g. the manufacturer);
- brand, model number, version or serial number;
- product description, as appropriate;
- rated input voltages and rated input frequency. Rated output voltage, nature of supply (a.c. or d.c.), rated output current and/or rated output power as appropriate (see 4.1).

### 7.2 Test parameters

All of the following information shall be reported:

- ambient temperature;
- test voltage and frequency;
- total harmonic distortion of the voltage waveform of the electricity supply system (%VTHD);
- information to describe the test set-up used at each load condition;
- method used for determining stability of input power (see EN 50564).

If any of the above values change during the test the minimum and maximum values shall be recorded.

### **7.3 Test and laboratory details**

All of the following information shall be recorded in the test report:

- test report number/reference;
- date of test;
- laboratory name and address;
- test officer(s);
- test equipment used;
- calibration due date.

### **7.4 Test data**

All of the following information shall be recorded in the test report:

- measured and calculated data as described in Table 2;
- identification of the measurement method used (see EN 50564:2011, 5.3.2 or 5.3.3);
- the presence of any built-in switch controlling the power flow to the input of the external power supply;
- the means by which the output voltage of the product was selected (if user selectable);
- output cable length;
- calculated uncertainty of the result due to the measuring instrument ( $U_e$ ) (see EN 50564:2011, Annex D) and whether the result complies with EN 50564:2011, 4.4.1.



## ANNEX A

(informative)

### Test report template

External power supply (EPS) under test							
Brand name, as marked on EPS							
Organisation taking responsibility for the EPS		Name		Address			
Model identification							
Version or serial number							
Description				For use with product (where applicable)			
Rated input	Voltage (V)			Current (A)		Frequency (Hz)	
Rated output	Voltage (V)		a.c. or d.c.?	Current (A)		Power (W)	
Test laboratory details							
Name of laboratory							
Address							
Test report number				Test date			
Prepared by				Approved by			
Test conditions							
Ambient temperature (°C)							
Information describing the test set-up used at each load condition							
Test equipment	Manufacturer of test instrument	Model designation	Serial number	Calibration due date			
Voltage source							
Instrument used for measuring input power							
Instrument(s) used for measuring output power							
Test configuration							
Nominal test supply voltage (V)							
Nominal total harmonic distortion of supply voltage waveform (%)							
Test frequency (Hz)							
Did the EPS have a built-in ON/OFF switch on the input?							
Was the output voltage selectable?				Setting used when performing tests			
Output cable length (to the nearest cm)							
Measurement method from EN 50564:2011, 5.3.2 or 5.3.3 used							



Results						
	Load condition					
Percentage of rated output current	0 %	25 %	50 %	75 %	100 %	Average
Output current (A, r.m.s.)						
Output voltage (V, r.m.s.)						
Active output power (W)						
Input voltage (V r.m.s.)						
Input power (W)						
Input current total harmonic distortion (%ITHD)						
True power factor						
Power consumed (W)						
Active mode efficiency						
Average efficiency of active modes						
Calculated measurement uncertainty						

Conclusion			
No-Load condition power consumption (W)			
No-Load limit applied (W)		Regulatory reference	
No-Load verdict (PASS/FAIL)			
Calculated average efficiency of active modes (%)			
Average efficiency of active modes limit applied (%)		Regulatory reference	
Average efficiency of active modes verdict (PASS/FAIL)			

## Bibliography

NOTE This bibliography lists standards and other reports relevant to the measurement of energy and performance of external power supplies.

*Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies - August 11, 2004", by Chris Calwell et. Al*

AS/NZS 4665.1: 2005, *Performance of external power supplies Part 1: Test method and energy performance mark*

ENERGY STAR®, *Program Requirements for Single Voltage Ac-Dc and Ac-Ac Power Supplies*

*Code of Conduct on Energy Efficiency of External Power Supplies*

*Guide to the Expression of Uncertainty in Measurement (GUM) [ISO/IEC/BIPM/IFCC/IUPAC/IUPAP/OIML:1995]*

COOK, RR. *Assessment of uncertainties of measurement for calibration and testing laboratories*. National Association of Testing Authorities (NATA), Australia, 1999

Chris Calwell et. al *Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies - August 11, 2004"*

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