AS/NZS 4665.1:2005

Australian/New Zealand Standard™

Performance of external power supplies

Part 1: Test method and energy performance mark

STANDARDS Australia

STANDARDS NEW ZEALAND Paerewa Aotearoa

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee TE-001, Safety of Electronic Equipment. It was approved on behalf of the Council of Standards Australia on 17 October 2005 and on behalf of the Council of Standards New Zealand on 28 October 2005.
This Standard was published on 10 November 2005.

The following are represented on Committee TE-001:

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This Standard was issued in draft form for comment as DR 04528.

Australian/New Zealand Standard™

Performance of external power supplies

Part 1: Test method and energy performance mark

First published as AS/NZS 4665.1:2005.

Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 6991 8

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TE-001, Safety of Electronic Equipment.

The objective of this Standard is to provide designers, manufacturers, importers, test laboratories, regulators and users of mains input external power supplies having a single extra low voltage output with a test method to assess the energy efficiency of these devices. It also includes information on the energy performance mark.

This Standard was prepared in response to the publication of a plan for the regulation of external power supplies under the National Appliance and Equipment Energy Efficiency Program (NAEEEP) in 2004. This Standard draws upon a test method published in 2003 by the US Environmental Protection Agency (EPA) as part of the ENERGY STAR program, following input from several countries including Australia. The EPA test method is the de-facto standard in the United States and China. This AS/NZS Standard is technically similar to the EPA standard.

It is intended that this Standard should be proposed as the basis for an IEC Standard once it has been published in Australia.

This series consists of 2 parts. These are:

AS/NZS	
4665	Performance of external power supplies
4665.1	Part 1: Test method and energy performance mark (this Standard)
4665.2	Part 2: Minium energy performance standard (MEPS) requirements

Part 1 contains the test method for assessing the efficiency of external power supplies and includes information on the energy performance mark. It applies to power supplies with either d.c. or a.c. output up to 250 W or 250 VA respectively.

Part 2 specifies minimum energy performance standard (MEPS) requirements and 'high efficiency' levels for external power supplies. Regulatory authorities have advised that it is intended to mandate this Part 2 Standard in regulations in Australia and New Zealand no earlier than 1 October 2007.

The terms 'normative' and 'informative' are used to define the application of the appendix to which they apply. A normative appendix is an integral part of a standard, whereas an informative appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to figures, are deemed to be requirements of this Standard. 'Shall' indicates a requirement is mandatory, while 'should' indicates a recommendation and good practice.

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Performance of external power supplies

Part 1 Test method and energy performance mark

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies a test method for calculating the energy efficiency of external power supply units (often known as 'a.c. adaptors', 'plug packs' or 'power-packs') with mains supply input (nominally 115 V a.c. or 230 V a.c.) and a single output at extra low voltage (ELV), either a.c. or d.c., and a maximum output of 250 W or 250 VA.

Internal power supplies and external power supplies with multiple, simultaneous output voltages are excluded from the scope of this Standard.

D.c. or battery powered equipment is excluded from the scope of this Standard.

The purpose of this Standard is to define a standardized test method to measure the efficiency of single voltage external power supplies across a defined range of load conditions.

Appendix A includes information on the energy performance mark.

1.2 REFERENCED DOCUMENTS

The following normative documents contain provisions which, through reference in this document, constitute provisions of this Standard:

AS 2706	Numerical values—Rounding and interpretation of limiting values
AS/NZS 62301	Household electrical appliances—Measurement of standby power
IEC 60050-300	International Electrotechnical Vocabulary—Electrical and electronic measurements and measuring instruments

1.3 DEFINITIONS

For the purpose of this Standard the following definitions apply. Terms defined in IEC 60050-300 also apply.

1.3.1 Active mode

Active mode refers to a condition in which the input of a power supply is connected to line voltage a.c. and the output is connected to a load drawing some power (i.e. any power output level other than no load).

1.3.2 Active mode efficiency

Active mode efficiency is the ratio, expressed as a percentage, of the output power (either d.c. power or active a.c. power) produced by a power supply to the active input power (a.c.) required to produce it. Active mode efficiency can be defined for any power supply in active mode.

1.3.3 Active power

The r.m.s. value of the product of the instantaneous voltage and instantaneous current taken over one period. (Unit: W)

NOTE: Most measuring instruments average active power over a number of periods (a.c. cycles); readings from such instruments are equally valid for this measurement. Average active measurements are generally required over a defined period of time. Active power is sometimes referred to as real power.

1.3.4 Ambient temperature

Ambient temperature is the temperature of the ambient air immediately surrounding the EUT.

1.3.5 Apparent power (S)

The total or apparent power (S) is the product of r.m.s. voltage and r.m.s. current. (Unit: VA)

1.3.6 Equipment under test (EUT)

EUT is an acronym for 'equipment under test,' which in this case refers to the external single-output power supply being tested.

1.3.7 Extra low voltage (ELV)

A voltage available at the output of a power supply that does not exceed 50 V a.c. or 60 V d.c. between conductors and between conductors and earth, when the power supply is supplied at rated input voltage.

1.3.8 Nameplate input frequency

Nameplate input frequency is the appropriate a.c. input frequency of the power supply as specified on the power supply by the manufacturer. This is also called rated input frequency. (Unit: Hz)

NOTE: Many power supplies are labelled to operate on more than one input frequency.

1.3.9 Nameplate input voltage

Nameplate input voltage is the appropriate a.c. input voltage of the power supply as specified on the power supply by the manufacturer. This is often expressed as a range, such as 100 V to 240 V. This is also called rated input voltage. (Unit: V)

1.3.10 Nameplate output current

The output current of the power supply as specified on the power supply by the manufacturer. This is also called rated output current. Alternatively, it is the nameplate output power divided by the nameplate output voltage (Unit: A)

1.3.11 Nameplate output power (P_{no})

The output power of the power supply as specified on the power supply by the manufacturer. Alternatively, it is the nameplate output current multiplied by the nameplate output voltage. (Unit: VA for a.c. and W for d.c.)

1.3.12 Nameplate output voltage

Nameplate output voltage is the voltage output of the power supply as specified on the power supply by the manufacturer. This is also called rated output voltage. (Unit: V)

NOTE: Because unregulated and regulated power supplies both exhibit some voltage deviation from nameplate output voltage when supplying different loads, actual output voltage is likely to differ from nameplate voltage at certain current outputs.

1.3.13 No load

No load is the mode when the input of a power supply is connected to an a.c. source consistent with the power supply's nameplate input voltage, and there is no output current.

1.3.14 No load power

No load power is the active power (a.c.) consumed by a power supply operating in the no load condition. (Unit: W)

NOTE: No load efficiency would by definition be 0 when calculated on a percentage basis. See Clause 3.3.

1.3.15 Power factor (true)

The true power factor is the ratio of the active, (or real), power (P) consumed in watts to the apparent power (S), drawn in volt-amperes. (Unit: no unit)

$$pf = P/S$$

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

1.3.16 Single output external power supply

For the purposes of this Standard, a single output external power supply—

(a) has an input from mains supply (usually 110 V, 60 Hz; 230 V, 50 Hz; 240 V, 50 Hz or a range including some or all of these input conditions); and

(b) has one ELV output (either a.c. or d.c.) that is either at a fixed voltage or user selectable through a selector switch; and

(c) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load; and

(d) is contained in a separate physical enclosure from the end-use product (i.e. the housings of the power supply and its associated product are different, not their retail packaging); and

(e) is connected to the end use product via a hard-wired or removable male/female electrical connection, cable, cord or other wiring; and

(f) does not have batteries or battery packs that physically attach directly to the power supply unit (including those that are removable e.g. a battery pack for a portable electric drill); and

(g) does not have a battery chemistry or type selector switch and an indicator light or state of charge meter.

NOTES:

1 Appendix B contains a flowchart to assist in determining if a power supply is covered by this Standard.

2 These units are often used to power/re-charge laptop computers, mobile telephones, portable stereo units and other portable household devices.

3 These units are not built into the equipment being powered and hence are 'external' to the device being powered. Designs covered include units with an integral mains plug, 'in-line' units and units with provision for equipment to sit in a cradle whilst being used.

1.3.17 Total harmonic distortion (*THD*)

THD is the ratio, expressed as a percent, of the r.m.s. value of an a.c. signal after the fundamental component is removed, to the r.m.s. value of the fundamental component.

THD of current is defined as:

$$THD_1 = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2 \cdots + I_{13}^2}}{I_1}$$

where

I_1 = r.m.s. value of the fundamental of the current signal

I_{2-13} = r.m.s. values of the 2nd to 13th harmonics of the current signal respectively

NOTE: A.c. signals have only odd number harmonics.

SECTION 2 GENERAL CONDITIONS FOR MEASUREMENT

2.1 GENERAL

Measurements shall be made under test conditions and with equipment specified in AS/NZS 62301, except where otherwise specified below.

2.2 ROUNDING

Unless otherwise stated, numbers shall be rounded and recorded to four significant figures in accordance with AS 2706.

2.3 MEASURING EQUIPMENT

Power measurements shall be made with suitably calibrated voltmeters and ammeters (d.c. outputs only), or a power analyser. Measurements of active power of 0.5 W or greater shall be made with an uncertainty of ≤2%. Measurements of active power of less than 0.5 W shall be made with an uncertainty of <0.01 W. The power measurement instrument shall have a resolution of 0.01 W or better for active power. Measurements of voltage and current shall be made with an uncertainty of <2%.

2.4 TEST ROOM

The tests shall be carried out in a room that has an air speed close to the EUT of <0.5 m/s. The ambient temperature shall be maintained at (23 +5)°C throughout the test. There shall be no intentional cooling of the EUT by use of separately powered fans, air conditioners or heat sinks. The EUT shall be tested on a thermally non-conductive surface.

Products intended for outdoor use may be tested at additional temperatures, provided those are in addition to the conditions specified above and are noted in a separate section on the test report.

2.5 TEST VOLTAGE

An a.c. reference source shall be used to provide input voltage to the EUT. The input to the EUT shall be the specified test voltage +1% and the specified test frequency +1%. Where the EUT nameplate input voltage is 115 V or the nameplate input voltage range includes 115 V, the test voltage shall be 115 V at 60 Hz. Where the EUT nameplate input voltage is 230 V or the nameplate input voltage range includes 230 V, the test voltage shall be 230 V at 50 Hz. Where the EUT nameplate input voltages or input voltage range includes both 115 V and 230 V, the EUT shall be tested at both 115 V at 60 Hz and 230 V at 50 Hz. Where the EUT nameplate input voltage is 240 V only, the test voltage shall be 240 V at 50 Hz.

If voltage and/or frequency ranges are not specified by the manufacturer, or if the nameplate values are unclear, the EUT shall not be tested.

2.6 A.C. REFERENCE SOURCE

The input voltage source shall be capable of delivering at least 10 times the nameplate input power of the EUT. Regardless of the a.c. source type, the *THD* of the supply voltage, when supplying the EUT in the specified mode, shall not exceed 2%, up to and including the 13th harmonic. The ratio of peak value to r.m.s. value of the test voltage (i.e. crest factor) shall be between 1.34 and 1.49.

SECTION 3 MEASUREMENT APPROACH

3.1 PREPARING EUT FOR TEST

Power supplies shall be tested in their final, completed configuration (i.e. with the input and output cord(s) and fitting(s) as supplied by the manufacturer).

Any built-in switch in the EUT controlling power flow to the a.c. input shall be in the 'on' position and the existence of such a switch shall be noted in the final test report.

The output measurements shall be taken at the output connector at the point where it joins the product to be powered if this can be disconnected. In the case where the EUT is directly connected (hard wired) to the product to be powered (i.e. no plug), the cord shall be cut immediately adjacent to the product to be powered and measurement probes connected at this point.

NOTES:

1 It is also possible to utilize this procedure to test the efficiency of a bare circuit board power supply prior to its incorporation into a finished housing and the attachment of its output cord. For example, a power supply manufacturer or component manufacturer may wish to assess the efficiency of a design that it intends to provide to an OEM for incorporation into a finished external power supply. However, the efficiency of the bare circuit board power supply may not be used to characterize the efficiency of the final product (once enclosed in a case and fitted with an output cord). Power supplies are to be tested in their final, completed configuration in order to represent their measured efficiency on product labels or specification sheets.

2 Test leads should be such that they introduce negligible effects on measurements.

3.2 LOAD CONDITIONS

External power supplies with a switchable output are normally tested twice; once with the output voltage set to the lowest voltage value and then again with the output voltage set to the highest voltage value.

The EUT shall be tested at the load conditions specified in Table 1.

TABLE 1

LOAD CONDITIONS FOR EUT

Percentage of nameplate output current	
Load condition	**Percentage**
1	100 ±2
2	75 ±2
3	50 ±2
4	25 ±2
5	0

NOTE: The 2% allowance is of nameplate output current, not of the calculated current value. For example, a EUT at Load Condition 3 may be tested in a range from 48% to 52% of rated output current.

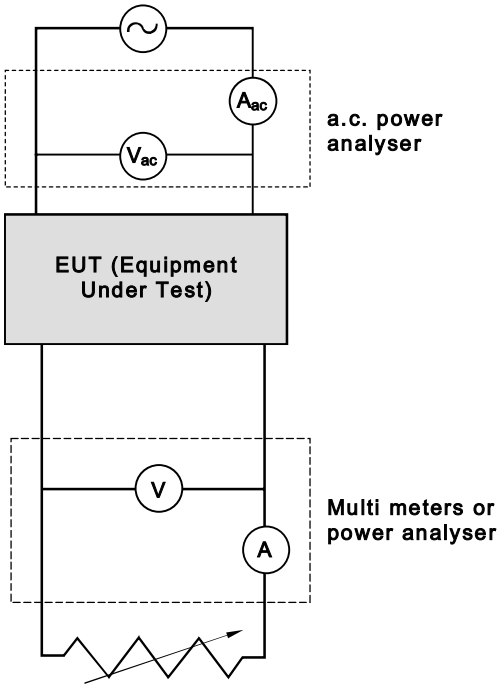
3.3 TEST LOAD

In order to load the power supply to produce all four active mode load conditions (as defined in Table 1), a set of variable resistive or electronic test loads shall be used. The test loads shall have a power factor of 0.95 to 1.

NOTES:

1 While these loads may have different characteristics to the electronic loads the power supply is intended to power, they provide standardized and readily repeatable references for testing and product comparison.

2 Resistive loads need not be measured precisely with an ohmmeter. A variable resistor is simply adjusted to the point where the ammeter confirms that the desired percentage of nameplate output current is flowing. Figure 1 shows a simplified schematic of an external power supply test set-up using variable resistance as a load. For electronic loads, the desired output current should be adjusted in constant current (CC) mode rather than adjusting the required output power in constant power (CP) mode.



NOTE: Separate d.c. voltage and current meters may be used to determine the output power of a d.c. EUT only in those cases where the ripple on the d.c. voltage and current is not more than 5%.

FIGURE 1 GENERIC TEST SET-UP USING A VARIABLE RESISTANCE LOAD

3.4 TESTING SEQUENCE

The tests shall be conducted as follows:

(a) The EUT shall be connected to the test load as shown in Figure 1, and operated at load condition 1, as specified in Table 1, for at least 30 min.

(b) Immediately after this warm-up period, the power consumption of the a.c. input shall be monitored for stability according to AS/NZS 62301. If the a.c. input power is not stable, it shall be reported that the EUT cannot be tested and testing shall cease.

(c) If the a.c. input power is stable, the stability of output power shall be assessed according to AS/NZS 62301:

(i) If the output power is considered stable, the output power shall be measured according to AS/NZS 62301 and the result shall be recorded as the measurement for the relevant load required in Table 2.

(ii) If the output power is considered not stable, then the procedures for determining average power or accumulated energy described in AS/NZS 62301 shall be used, and the result shall be recorded as the measurement for the relevant load required in Table 2.

(d) The load shall then be reduced to the next lowest load condition specified in Table 1 (viz 75%, 50%, 25% and 0% load). Steps (c) and (d) shall be repeated until all load conditions in Table 1 have been tested.

(e) Where additional output voltages or input voltages or frequencies are to be tested, these tests shall be conducted in accordance with steps (a) to (d) above.

If testing of additional, optional load conditions is desired, that testing should be conducted in accordance with this test procedure and shall be carried out after completing the measurements described in Items (a) to (e).

TABLE 2

REQUIRED REPORTED DATA (MEASURED AND CALCULATED)

Reported quantity	Description
output current (A) (a.c. or d.c.) output voltage (V) (a.c. or d.c.) output power (W) (a.c. or d.c.)	Measured at load conditions 1 – 4
a.c. input voltage (V) a.c. input power (W) Total harmonic distortion (*THD*) True power factor	Measured at load conditions 1 – 5
Power consumed by EUT (W)	Calculated at load conditions 1 – 4, Measured at load condition 5
Efficiency	Calculated at load conditions 1 – 4
Average efficiency	Arithmetic average of efficiency at load conditions 1 – 4

3.5 EFFICIENCY CALCULATION

Efficiency at each active load condition (1 to 4) shall be calculated by dividing the EUT's measured active output power at a given load condition by the active a.c. input power measured at that load condition.

Average efficiency shall be calculated and reported as the arithmetic mean of the efficiency values calculated at load conditions 1, 2, 3, and 4 in Table 1. This is a simple arithmetic average of active mode efficiency values, and is not intended to represent weighted average efficiency, which would vary according to the duty cycle of the product powered by the EUT.

3.6 POWER CONSUMPTION CALCULATION

Power consumption of the EUT at each load condition 1 – 4 is the difference between the a.c. active input power (W) at that load condition and the active output power (W) at that load condition. The power consumption of load condition 5 (no load) is equal to the a.c. active input power (W) at that load condition.

SECTION 4 ENERGY PERFORMANCE MARK

Where a power supply is marked with an energy performance mark, the mark shall be in accordance with Appendix A.

SECTION 5 TEST REPORT

5.1 GENERAL

When reporting data:

(a) Indicate additional values or ranges where applicable.

(b) Indicate source(s) of information, if it is not marked on the EUT.

(c) Use N/S for 'not stated' and N/A for 'not applicable'.

5.2 MANDATORY INFORMATION

The following information shall be reported for each external power supply tested:

(a) EUT manufacturer or brand.

(b) EUT model number.

(c) EUT country of manufacture.

(d) Whether a built-in switch controlling power to the a.c. input is present on the EUT.

(e) Product powered by the EUT (if known).

(f) The following information from the EUT:

  (i) Nameplate input voltage (V).

  (ii) Nameplate input current (A).

  (iii) Nameplate input frequency (Hz).

  (iv) Nameplate output voltage (V).

  (v) Nameplate output current (A) and/or output power (W, if d.c., or VA, if a.c.).

  (vi) Nameplate output voltage type (a.c. or d.c.) and frequency (Hz), if a.c.

  (vii) Other information marked on the EUT where considered useful or relevant to the energy efficiency tests or identification of the EUT.

(g) Description of the a.c. input including—

  (i) pin configuration and type of plug and/or appliance inlet (e.g. US, Japan, AU/NZ, China, Europe, UK, or other);

  (ii) whether the plug is integral with, or separate from, the EUT; and

  (iii) length of any input cord (if present).

(h) Output plug description (where fitted).

(i) EUT output cord length (to +1 cm).

(j) Any modifications or special connectors used for the test (e.g. adaptor plugs, cutting cords, etc).

(k) Name and address of test lab.

(l) Date of test.

(m) Name of technician(s) performing the test.

(n) Test report number.

(o) Test Standard used for testing.

(p) Maximum and minimum ambient temperatures immediately surrounding the EUT.

(q) Description of test equipment used.

(r) The required reported data (measured and calculated) from Table 2.

(s) Where the EUT includes an energy performance mark (refer to Appendix A), the mark shall be reported.

5.3 OPTIONAL INFORMATION

The following information should be provided, if available:

(a) A photograph of the EUT showing—

  (i) nameplate information; and

  (ii) the size of the entire EUT with a metric rule for scale.

(b) Date of manufacture.

(c) Maximum air speed adjacent to the EUT.

(d) Calibration dates of test equipment used.

5.4 SAMPLE TEST REPORT

A sample test report is shown in Appendix C.

The test data are most usable and readily compared to other results if also presented in graphical form, as shown in the sample test report in Appendix C.

The 'Input and Output Power vs Output Current' chart in Appendix C provides an additional, useful means of conveying a power supply's relative efficiency as it includes a.c. input power and output power at 100%, 75%, 50%, 25%, and 0% of nameplate current output on a single chart. The area between the input and output power curves will be quite small with highly efficient power supplies. Note also that the output power graph will be very close to a straight line in a regulated power supply, but may deviate from a straight line significantly in unregulated units where voltage is not stable across a range of load conditions.

APPENDIX A

ENERGY PERFORMANCE MARK

(Normative)

A1 REQUIREMENT

When a single output external power supply has an energy performance mark, the mark shall be a numeral from the sequence I to X in accordance with Paragraph A2, indicating the energy performance of the power supply in accordance with Table A1.

A power supply shall be marked with the appropriate numeral, specified in Table A1, when it meets both the no-load power and average active mode efficiency requirements associated with that numeral, at all voltage and frequency values marked on its nameplate when tested in accordance with this Standard. If the power supply does not meet the energy performance requirements, it shall be marked with the numeral I.

TABLE A1

ENERGY PERFORMANCE REQUIREMENTS FOR EACH NUMERAL

Mark	No-load power consumption requirements		Active mode efficiency requirements	
	Nameplate output power (P_{no}) (W)	No load power (W)	Nameplate output power (P_{no}) (W)	Average active mode efficiency
I	Used if it does not meet any of the following criteria			
II	Reserved for future use			
III	0 to <10	≤0.5	0 to 1	≥0.49 × P_{no}
			>1 to 49	≥0.09 L_n (P_{no}) + 0.49
	10 to ≤250	≤0.75	>49 to 250	≥0.84
IV	0 to <10	≤0.5	0 to 1	≥0.5 × P_{no}
			>1 to 51	≥0.09 L_n (P_{no}) + 0.5
	10 to ≤250	≤0.5	>51 to 250	≥0.85
V	Reserved for future use with Tier 2 Energy Star levels			
VI – X	Reserved for future use			

where

P_{no} = is the nameplate output power of the EUT

L_n = refers to the natural logarithm (base e). The algebraic order of operations requires that the natural logarithm calculation be performed first and then multiplied by 0.09, with the resulting output added to 0.49 or 0.5 as indicated in the table.

A2 DESIGN OF THE ENERGY PERFORMANCE MARK

The characteristics of the mark shall conform to the following description:

Format: Roman numeral: I, II, III, IV, V, VI, VII, VIII, IX or X.

NOTE: Numerals II and V to X are reserved for future use.

Font: Times Roman preferred, but other plain serif fonts are acceptable.

Colour: Text to contrast with the background colour except it may be the same colour where the nameplate information is an integral part of the power supply enclosure e.g. moulded into the enclosure.

Placement: On the power supply, with the exact location to be at the discretion of the manufacturer.

The mark shall be legible and indelible.

An example of the mark is shown in Figure A1.

NOTE: The text 'Efficiency Level' may be omitted.

FIGURE A1 EXAMPLE OF NUMERAL INDICATING EFFICIENCY

APPENDIX B

FLOWCHART FOR DEFINITION OF SINGLE OUTPUT EXTERNAL POWER SUPPLY

(Informative)

The following flowchart can be used to determine if an external power supply is covered by this Standard.

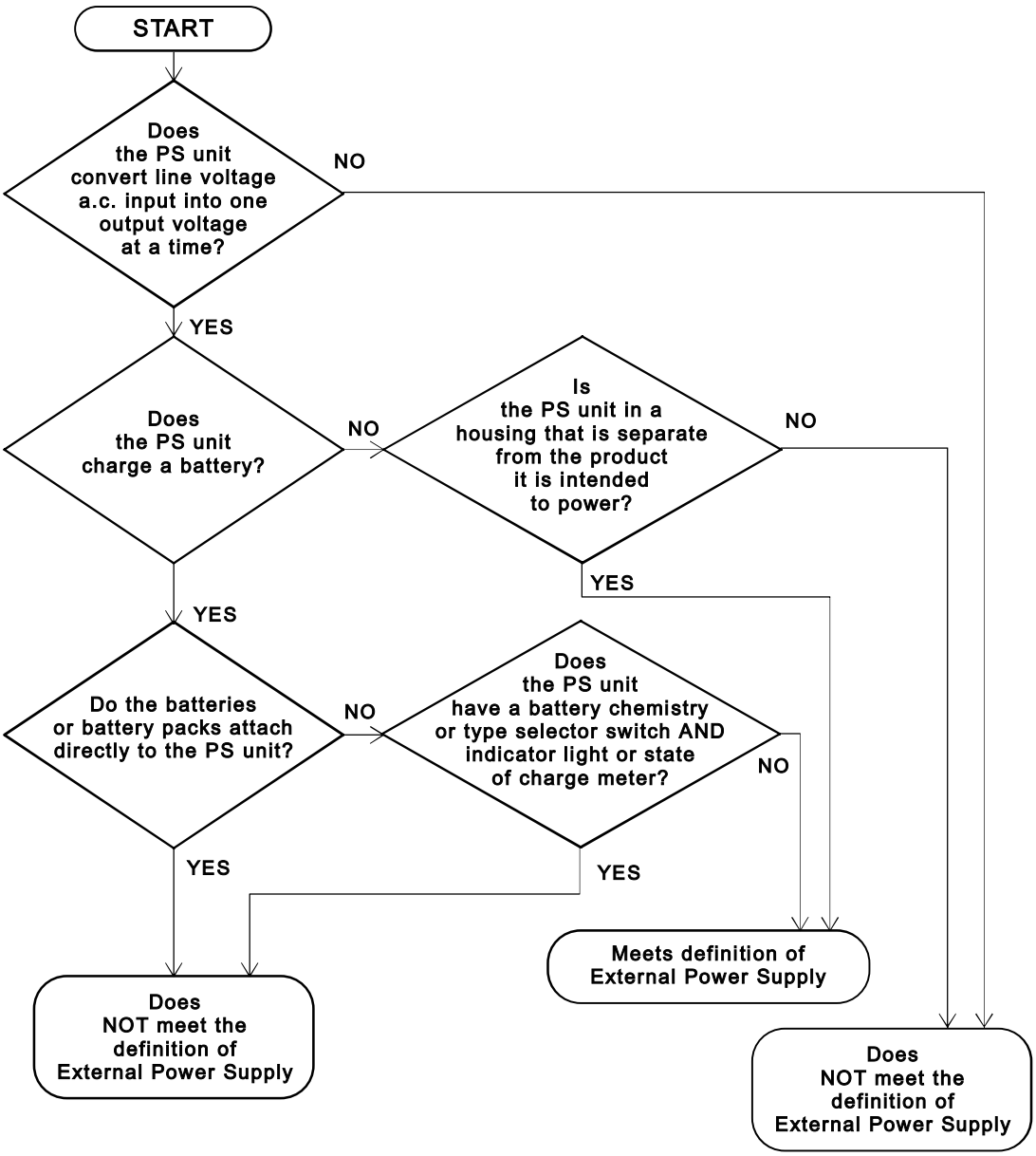


FIGURE B1 FLOWCHART FOR DEFINITION OF SINGLE OUTPUT EXTERNAL POWER SUPPLY

APPENDIX C

SAMPLE TEST REPORT

(Informative)

SINGLE VOLTAGE EXTERNAL POWER SUPPLY TEST REPORT

Test report number	000123
Manufacturer name	Brand X
Model	ABC
Country	China
Input power switch	Not present
Product powered (if known)	Not known

Photograph of Power Supply

Name plate specifications	Input	Output
Voltage (V)	100-240	5.0
Current (A)	0.5	1.0
Power (W)	N/S	N/S
Frequency (Hz)	50/60	DC

LAB INFORMATION

Test laboratory name	XYZ Test Centre
Test laboratory address	1 South St Sydney, NSW 2000
Country	Australia
Test technician(s)	Joe Bloggs
Date measured	14 July 2005
Test Standard used	AS/NZS 4665.1:2005

Test instruments

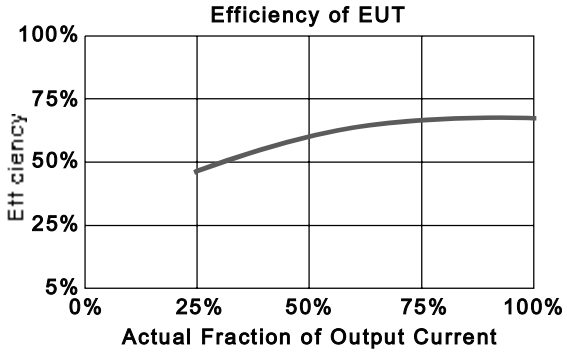
Make/Model	Measurement	Calibration date
Yokagawa YT200	No Load	22 April 2005
Voltec PM300	Active Output	21 April 2005

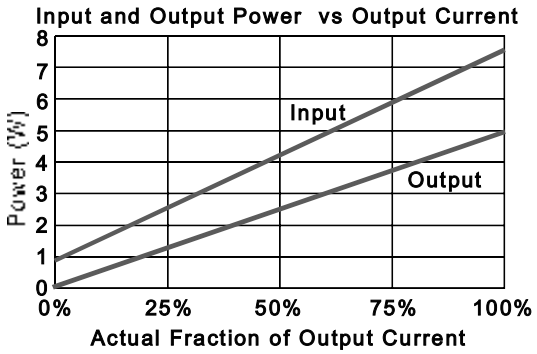
Connections or modifications to the input and/or output cord

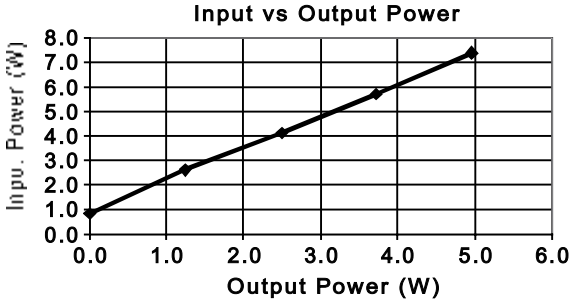
A.c. input plug type	Standard US
D.c. output cord length (cm)	175
D.c. output plug type	Single pin type
Modification to connectors for testing	None

Test setup

Maximum and minimum ambient temperatures	(°C)	20.5 (max)	20.3 (min)
Maximum air speed (m/s)	0.1		

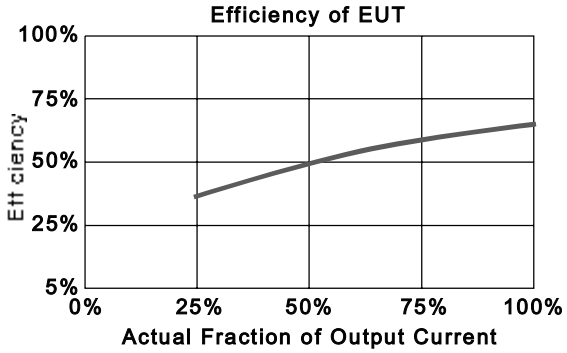


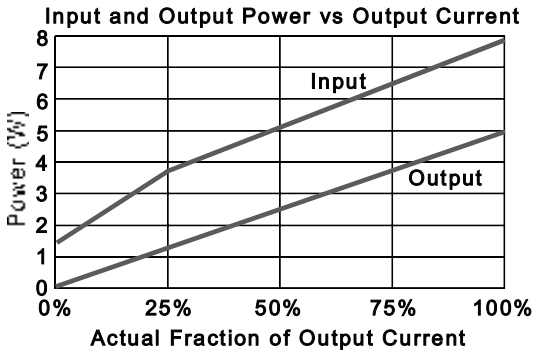


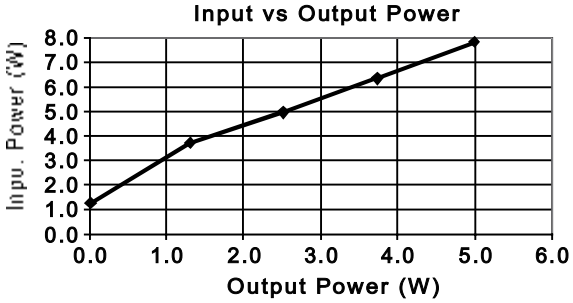


	No load	Active power values				
Percent of nameplate current	**0%**	**25%**	**50%**	**75%**	**100%**	**Average**
d.c. output current (A)	0	0.248	0.498	0.747	1.001	
d.c. output voltage (V)	5.07	5.024	5.003	4.981	4.959	
d.c. output power (W)	0	1.244	2.492	3.721	4.966	
a.c. input current (A)	0.019	0.048	0.070	0.092	0.115	
a.c. input voltage (V)	114.9	114.9	114.9	114.9	114.9	
a.c. input power (W)	0.839	2.621	4.136	5.708	7.390	
Total harmonic distortion (*THD*) of input current	88.75%	86.91%	84.99%	83.29%	81.64%	
True power factor (W/VA)	0.394	0.477	0.513	0.539	0.561	0.497
Power consumed by EUT (W)	0.839	1.377	1.644	1.987	2.425	
Efficiency		47.46%	60.25%	65.19%	67.19%	60.02%

FIGURE C1 MEASURED AND CALCULATED DATA AT 115 V 60 Hz







	No load	Active power values				
Percent of nameplate current	**0%**	**25%**	**50%**	**75%**	**100%**	**Average**
d.c. output current (A)	0	0.248	0.498	0.749	1.000	
d.c. output voltage (V)	5.06	5.021	4.999	4.978	4.957	
d.c. output power (W)	0	1.244	2.487	3.729	4.957	
a.c. input current (A)	0.018	0.041	0.052	0.064	0.076	
a.c. input voltage (V)	229.9	229.9	229.9	229.9	229.9	
a.c. input power (W)	1.360	3.703	4.983	6.395	7.927	
Total harmonic distortion (*THD*)	86.49%	89.84%	89.48%	88.94%	88.30%	
True power factor (W/VA)	0.324	0.396	0.417	0.435	0.451	0.405
Power consumed by EUT (W)	1.360	2.459	2.459	2.666	2.970	
Efficiency		33.60%	49.92%	58.31%	62.53%	51.09%

FIGURE C2 MEASURED AND CALCULATED DATA AT 230 V 50 Hz

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ISBN 0 7337 6991 8

Printed in Australia