

Australian/New Zealand Standard™

**Information technology equipment—
Energy performance of internal power
supplies**

**Part 1: Methods of measurement of
energy performance**



AS/NZS 5814.1:2012

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Information technology equipment— Energy performance of internal power supplies

Part 1: Methods of measurement of energy performance

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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 computers with a test method to assess the energy efficiency of this equipment.

This Standard was prepared in response to the publication of a plan for the regulation of computers under the Equipment Energy Efficiency Program (E3) in 2004. This Standard draws upon the test method referenced in the ENERGY STAR[®] Program Requirements for Computers: Version 5.0 and Version 5.2 (ENERGY STAR[®] V5.0 and V5.2 Computer Specification) published by the United States' Environmental Protection Agency (EPA) in 2010. The EPA test method is the de facto standard in the United States. This AS/NZS Standard is technically similar to the test method specified in the *Generalized Internal Power Supply Efficiency Test Protocol Rev 6.5*.

The term 'informative' is used to define the application of the appendix to which it applies. An informative appendix is only for information and guidance.

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Australian/New Zealand Standard**Information technology equipment—Energy performance of internal power supplies****Part 1: Methods of measurement of energy performance**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This document specifies a test procedure for calculating the energy efficiency of internal a.c.–d.c. and d.c.–d.c. power supplies. Internal power supplies are located in the same housing as the product that they power. An example of this type of power supply is a desktop computer power supply that has multiple output voltages: +12 V, +5 V, +3.3 V, and –12 V (see Appendix B).

The test method in this document applies specifically to power supplies that meet the following criteria:

- (a) Power supplies that have detailed input and output ratings on their nameplate or in available literature from their manufacturer, specifying the maximum loads that can safely be placed on each individual d.c. output voltage bus and, where necessary, groupings of those voltage busses.
- (b) Power supplies that have connectors that allow the d.c. output voltage busses to be connected and disconnected from the powered product non-destructively.
- (c) Power supplies that can be detached from the housing of the product they power without causing harm to other circuits and components of the product.

This Standard also specifies the following:

- (i) Internal power supply types.
- (ii) Terminology used in the test method.
- (iii) Information required for test reports.

1.2 EXCLUSIONS

The following are not covered by this Standard:

- (a) External power supplies within the scope of the AS/NZS 4665 series.
- (b) A.C.–A.C. voltage transformers.
- (c) Power supplies physically integrated within the main circuit board of the device they are powering.
- (d) Power supplies that have a combination of a.c. and d.c. output voltage busses.

This Standard does not specify electrical safety requirements.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

2706 Numerical values—Rounding and interpretation of limiting values

AS/NZS

4665 Performance of external power supplies

4665.1 Part 1: Test method and energy performance mark

4665.2 Part 2: Minimum energy performance standards (MEPS) requirements

62301 Household electrical appliances—Measurement of standby power (IEC 62301, Ed.1.0 (2005) MOD)

IEC

60050-300 International Electrotechnical Vocabulary—Electrical and electronic measurements and measuring instruments

IEEE

1515-2000 Recommended practice for electronic power subsystems: Parameter definitions, test conditions, and test methods

Intel Corporation

Power Supply Design Guidelines (www.formfactors.org)

1.4 DEFINITIONS

For the purpose of this Standard the definitions contained in IEC 60050-300 and the following apply.

1.4.1 A.C.–D.C. power supply

Devices designed to convert a.c. voltage into d.c. voltage for the purpose of powering electrical equipment.

1.4.2 A.C. signal

A time-varying signal whose polarity varies with a period of time, T , and whose average value is zero. (Ref. IEEE Std 1515-2000)

1.4.3 Ambient temperature

The temperature of the ambient air immediately surrounding the equipment under test (EUT).

1.4.4 Apparent power (S)

The product of r.m.s. voltage and current (VA).

1.4.5 Crest factor

The ratio of peak current to r.m.s. current (or peak voltage to r.m.s. voltage). For a pure sinusoidal wave-shape the crest factor is 1.414, while for a pure constant d.c. load the crest factor is 1.0.

1.4.6 D.C.–D.C. power supply

Devices designed to convert d.c. power into d.c. power for the purpose of powering electrical equipment.

1.4.7 D.C. signal

A signal of which the polarity and amplitude do not vary with time. (Ref. IEEE Std 1515-2000)

1.4.8 Efficiency (η)

The ratio, expressed as a percentage, of the total real output power (produced by a conversion process) to the real power input required to produce it, using the following equation:

$$\eta = \frac{\sum_i P_{o,i}}{P_{in}} \times 100 \quad \dots 1-1$$

where $P_{o,i}$ is the output power of the i^{th} output. Unless otherwise specified, the input power (P_{in}) includes all housekeeping and auxiliary circuits required for the converter to operate, including any integrated cooling fans for multiple-output power supplies, and excluding them for single output power supplies.

1.4.9 Enclosed-frame modular internal power supply

A power supply encased in a modular enclosure. An example is shown in Appendix B, Figure B1. The enclosure is installed inside the product it powers and has readily accessible inputs and outputs.

1.4.10 Equipment under test (EUT)

The internal power supply being tested.

1.4.11 Model name

A marketing name that includes reference to the computer model family number, a short description of the product or branding references.

1.4.12 Multiple-output power supply

A power supply designed to provide most of its rated power on more than one main d.c. output voltage. There may be other low power d.c. output voltage(s) for standby power.

1.4.13 Open-frame modular internal power supply

A power supply whose components are grouped on a single printed circuit board but are not enclosed in a case, as shown in Appendix B, Figure B2. Such power supplies are installed inside the product they power, have readily accessible inputs and outputs, and can be separated from the appliance without causing damage to other components and circuits.

1.4.14 Output voltage bus

Any of the d.c. outputs of the power supply, to which loads can be connected and current and power supplied. These busses may supply power at different voltage levels depending on the design of the power supply and the product being powered.

1.4.15 Product family

A high-level description referring to a group of internal power supplies typically sharing one form factor that often contains a range of output configurations.

1.4.16 Rated a.c. input voltage

The supply voltage declared by the manufacturer in the specification of the power supply. For a single-phase power supply, this refers to the line-to-neutral voltage, and for a three-phase power supply, this refers to the line-to-line voltage.

1.4.17 Rated a.c. input voltage range

The supply voltage range (minimum/maximum) as declared by the manufacturer in the specification of the power supply.

1.4.18 Rated d.c. input voltage

The nominal d.c. supply voltage declared by the manufacturer in the specification of the power supply that is typically provided on the power supply nameplate.

1.4.19 Rated d.c. output current

The d.c. output current for each output d.c. bus of the power supply as declared by the manufacturer in the specification or nameplate of the power supply.

1.4.20 Rated d.c. output current range

The d.c. output current range (minimum/maximum) for each output voltage bus of the power supply as declared by the manufacturer in the specification of the power supply.

1.4.21 Rated d.c. output power

The maximum d.c. output power as specified by the manufacturer. This may apply to the total power for all voltage busses, some subset thereof, or a single voltage bus.

1.4.22 Rated d.c. output voltage

The d.c. output voltage for each output voltage bus of the power supply as declared by the manufacturer in the specification of the power supply.

1.4.23 Rated input frequency

The supply a.c. input frequency of the power supply as declared by the manufacturer in the specification of the power supply.

1.4.24 Rated input frequency range

The supply a.c. input frequency range (minimum/maximum) of the power supply as declared by the manufacturer in the specification of the power supply.

1.4.25 Rated input current

The input current of the power supply as declared by the manufacturer in the specification of the power supply.

1.4.26 Rated input current range

The input current range (minimum/maximum) for a power supply as declared by the manufacturer in the specification of the power supply.

1.4.27 r.m.s. (root mean square, also R.M.S)

The square root of the average of the square of the value of the function taken throughout the period. For instance, the rms voltage value for a sine wave may be computed as:

$$V_{\text{RMS}} = \sqrt{\frac{1}{T} \int_0^T V^2(t) dt} \quad \dots 1.2$$

where

T = period of the waveform

$V(t)$ = instantaneous voltage at time t

V_{RMS} = r.m.s. voltage value.

(Ref.: IEEE Std 1515-2000)

1.4.28 Single model

A set of one or more technically equivalent models that have identical performance specifications but may be sold under different brand names or model numbers or both. Each model is included on a single test report and has the same energy performance.

1.4.29 Single-output power supply

A power supply designed to provide a single output voltage on one output load bus.

1.4.30 Standby mode

The mode during which all d.c. power is delivered through the standby voltage rail of the power supply (refer to Clause 1.4.31).

1.4.31 Standby voltage rail (V_{sb})

The output voltage bus that is present whenever a.c. power is applied to the a.c. inputs of the supply. (Ref. *Intel Power Supply Design Guidelines* Rev. 0.5)

1.4.32 Steady state

The operating condition of a system wherein the observed variable has reached an equilibrium condition in response to an input or other stimulus in accordance with the definition of the system transfer function. In the case of a power supply, this may involve the system output being at some constant voltage or current value. (Ref. IEEE Std 1515-2000).

1.4.33 Test voltage source

The device supplying power (voltage and current) to the equipment under test (EUT).

1.4.34 Total harmonic distortion (THD)

The ratio, expressed as a percentage, 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 voltage is defined as:

$$THD_1 = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2 + \dots + I_n^2}}{I_1} \quad \dots 1.3$$

where

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

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

A.C. signals have only odd number harmonics.

1.4.35 True power factor

The ratio of the active, or real, power (P) consumed in watts to the apparent power (S) drawn in volt-amperes, with

$$PF = \frac{P}{S} \quad \dots 1.4$$

and

$$S = \sqrt{P^2 + Q^2} \quad \dots 1.5$$

where

PF = power factor

P = active power in watts

Q = reactive power in volt amperes

S = total power in volt amperes.

This definition of power factor includes the effect of both displacement and distortion in the input current (and/or voltage) waveform. (Ref. IEEE Std 1515-2000)

1.4.36 Voltage unbalance

The maximum difference between r.m.s. phase to neutral or phase-to-phase voltage amplitudes at the EUT input terminals. For example, for a wye-connected, three-phase system:

$$V_{\text{UNB}} = (\max[V_{\text{AN}}, V_{\text{BN}}, V_{\text{CN}}] - \min[V_{\text{AN}}, V_{\text{BN}}, V_{\text{CN}}]) \quad \dots 1.6$$

where

$V_{\text{AN}}, V_{\text{BN}}, V_{\text{CN}}$ are the phase voltage magnitudes, and

V_{UNB} is the maximum phase voltage unbalance.

Percent voltage unbalance is calculated by multiplying the maximum voltage unbalance by 100 and dividing the result by the average of the three phase voltages.

$$V_{\text{UNB}\%} = \frac{V_{\text{UNB}}}{\left(\frac{V_{\text{AN}} + V_{\text{BN}} + V_{\text{CN}}}{3} \right)} \times 100 \quad \dots 1.7$$

(Ref.: IEEE Std 1515-2000)

SECTION 2 GENERAL CONDITIONS FOR MEASUREMENT

2.1 GENERAL

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

Input voltage, frequency, output bus loading, and in some cases, the duty cycle of the fan inside the power supply are among the variables that can impact the efficiency of an internal power supply. Clauses 2.4.1, 2.5 and 2.6 specify a minimum set of requirements to control these variables while measuring internal power supply efficiency. Beyond these minimum requirements, the manufacturer and user of the power supply may determine additional requirements, such as harmonic distortion or unbalance specification as needed.

2.2 POWER FACTOR (PF) MEASUREMENT ACCURACY

Accuracy of PF measurements at light loading is dependent upon test setup and noise content of the a.c. source. Interaction between the a.c. source and the power factor correction (PFC) circuit can cause an error in PF measurement when using power analyser instrumentation. This error is significant and can cause as much as 30% error in PF measurements at light loading conditions below 50% of power supply rating. Testing laboratories shall ensure that the a.c. source does not interfere with power factor measurements at light loads. The method that shall be used in this protocol is described below.

Place a line impedance stabilization network (LISN) in series with the output of the a.c. source. The LISN should have 50 μ H inductance in both the line and neutral wires. In addition a parallel capacitor should be installed after the LISN and placed as close as possible to the power analyser input terminals. The capacitor should be 1.0 μ F and rated for a minimum of 250 V a.c. working voltage. The capacitor forms a high frequency circuit with the EUT. The cable length from capacitor body to the power analyser and the cable length from power analyser to EUT should be less than 1 metre. The intent is to minimize the lead inductance between the capacitor and the EUT. The diagram below (Figure 1) shows the recommended test setup with LISN and the parallel capacitor.

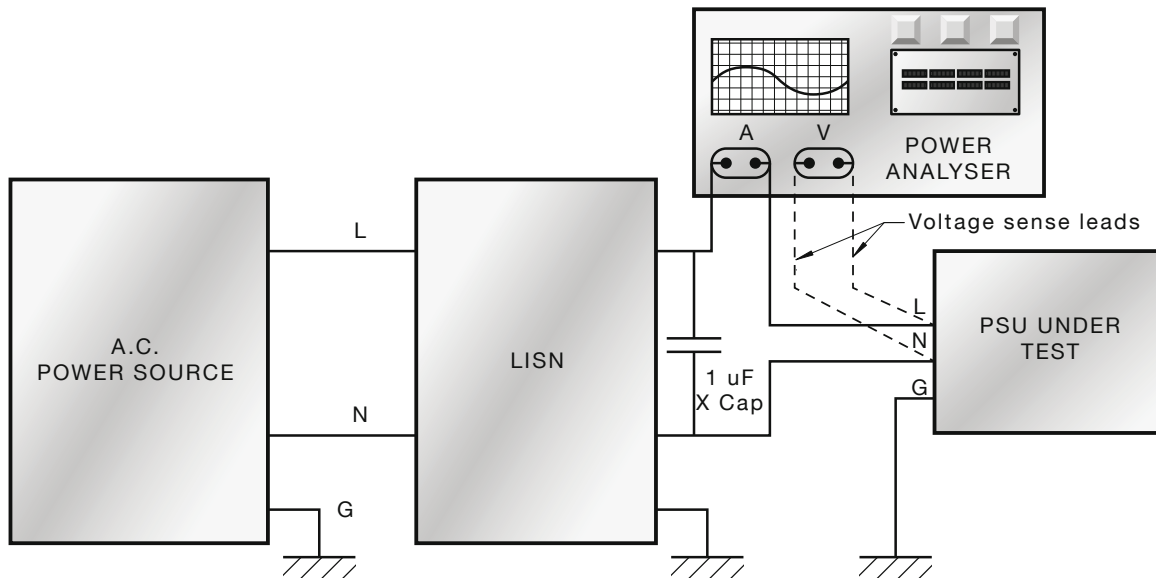


FIGURE 1 REVISED TEST SETUP TO IMPROVE ACCURACY OF POWER FACTOR MEASUREMENT AT LIGHT LOAD CONDITIONS

2.3 POWER MEASUREMENTS

2.3.1 General

Power measurements shall be made with a calibrated voltmeter and ammeter or power analyser as specified under AS/NZS 62301.

Generally a digital power analyser with a fundamental power accuracy of 0.5% or better will comfortably meet the instrument specification and measurement uncertainty required. Suitable instrument calibration should include traceability to appropriate national or international standards.

The measuring instrument should also have a frequency response of at least 3 kHz and be able to measure harmonic components up to at least 2.5 kHz. It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal mathematical calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument should be capable of integrating energy over any user selectable time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 s or less.

2.3.2 Uncertainty, resolution and rounding

Measurements of power of 0.5 W or greater shall be made with an uncertainty of $\leq 2\%$ at the 95% confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of ≤ 0.01 W at the 95% confidence level. The power measurement instrument shall have a resolution of—

- (a) 0.01 W or better for power measurements of 10 W or less;
- (b) 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- (c) 1 W or better for power measurements of greater than 100 W.

All power figures should be in watts and rounded to the second decimal place in accordance with AS 2706. For loads greater than or equal to 10 W, three significant figures shall be reported in accordance with AS 2706.