

Australian/New Zealand Standard™

**Performance of transformers and
electronic step-down convertors for ELV
lamps**

**Part 1: Test method—Energy
performance**



AS/NZS 4879.1:2008

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Consumers' Federation of Australia
Electrical Compliance Testing Association
Energy Efficiency and Conservation Authority of New Zealand
Institution of Professional Engineers New Zealand
National Appliance and Equipment Energy Efficiency Committee

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Australian/New Zealand Standard™

Performance of transformers and electronic step-down convertors for ELV lamps

Part 1: Test method—Energy performance

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Constituted Subcommittee EL-041-08, Lighting Equipment—Energy performance.

The objective of this Standard is to provide industry, consumers, test laboratories, regulators and users of transformers and electronic step-down convertors used with ELV lamps with a test method to determine their energy efficiency. This Standard further specifies requirements for the energy performance mark.

This Standard was prepared in response to the publication of a plan for the regulation of transformers and electronic step-down convertors for ELV lamps under the National Appliance and Equipment Energy Efficiency Program (NAEEEP) in 2005.

It is proposed that this publication be adopted as an IEC Standard soon after its publication.

This Standard draws upon AS/NZS 4665.1, *Performance of external power supplies*, Part 1: *Test method and energy performance mark*.

This Standard consists of two parts. These are:

AS/NZS

4879 Performance of transformers and electronic step-down convertors for ELV lamps

4879.1 Part 1: Test method—Energy performance (this Standard)

4879.2(Int) Part 2: Minimum Energy Performance Standards (MEPS) requirements

Part 2 of this Standard specifies Minimum Energy Performance Standards (MEPS) requirements and high efficiency levels for transformers and electronic step-down convertors up to certain ratings.

This Standard is structured to allow common requirements in Australia and New Zealand.

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.

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FOREWORD

During development of this test method, considerable effort was spent analysing three separate methods, in order to find the one giving the least uncertainty of measurement. The three methods were:

- (a) *Method 1* The converter was viewed as a stand-alone unit and its output measured by the use of electrical power measurement equipment when driving incandescent halogen lamp(s).
- (b) *Method 2* The converter was viewed as a stand-alone unit and its output measured by a voltmeter to measure its output when driving a near-perfect non-inductive resistor. Output power is then determined by simply measuring output voltage.
- (c) *Method 3* The electronic converter was viewed as an integral part of a luminaire. Its efficacy in lumens/watt was then measured.

Method 1 was chosen, aided by the development of a new high frequency power calibration technique developed by the National Measurement Institute of Australia. This technique allows traceable calibration of digital wattmeters or power analysers to the international unit (Watt).

Method 3 was disregarded as converters are often sold separately, thus—

- (i) a specific manufacturer's lamp would need to be specified as a reference lamp;
- (ii) this lamp would need complex high frequency calibration; and
- (iii) lead lengths in an integrating sphere would affect test repeatability (although the converter could be placed in the sphere with the lamp).

Method 2 was discarded as either—

- (A) specific construction would need to be specified for the non-inductive resistor; or
- (B) the resistor and voltmeter would need complex high frequency calibration.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Interim Standard
Performance of transformers and electronic step-down convertors for
ELV lamps

Part 1: Test method—Energy performance

1 SCOPE AND GENERAL**1.1 SCOPE**

This Standard specifies a test method for determining the energy efficiency of magnetic isolating transformers and electronic step-down convertors primarily used or intended to be used with extra-low voltage (ELV) lamps covered in IEC 60357.

The transformers or convertors covered in this Standard have a mains supply input and a single a.c or d.c ELV output. These are referred to as ELV lighting convertors (ELCs) in this Standard.

The ELCs are generally used for Class III luminaires or SELV lighting systems with an output voltage not exceeding 50 V a.c.

1.2 EXCLUSION

This Standard does not cover safety requirements. These are covered separately in AS/NZS 61347.1, AS/NZS 61347.2.2 or AS/NZS 61558.1 and AS/NZS 61558.2.6.

Appendix A includes information on the energy performance mark.

2 REFERENCED DOCUMENTS

The following documents are referenced in this Standard.

NOTE: See Appendix F for additional reading.

AS

2706 Numerical values—Rounding and interpretation of limiting values

AS/NZS

61347 Lamp controlgear

61347.1 Part 1: General and safety requirements

61347.2.2 Part 2.2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps (IEC 61347-2-2, Ed 1.2(2006) MOD)

61558 Safty of power transformers, power supply units and similar

61558.1 Part 1: General requirements and tests

61558.2.6 Part 2.6: Particular requirements for safety isolating transformers for general use (IEC 61558-2-26:1997, MOD)

IEC

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

60357 Tungsten halogen lamps (non vehicle)—Performance specifications

ISO

Guide 98 Guide to the expression of uncertainty in measurement (GUM)

3 DEFINITIONS

For the purpose of this Standard, the definitions given in IEC 60050-300 and those below apply.

3.1 Extra-low voltage (ELV)

A voltage not exceeding 50 V a.c. r.m.s. or 120 V ripple-free d.c.

NOTE: 'Ripple-free' is conventionally an r.m.s. ripple voltage not more than 10% of the d.c. component. The maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system.

3.2 Extra-low voltage lighting convertor (ELC)

Either a magnetic transformer or electronic step-down convertor used with ELV lamps, which—

- (a) receives an input from mains supply;
- (b) has single voltage ELV output (either a.c. or d.c.); and
- (c) is sold with, or intended to be used with, ELV lamp(s) that constitute the primary load.

3.3 Equipment under test (EUT)

In this Standard, refers to the ELC (see Clause 3.2).

3.4 Active mode efficiency

The ratio of the output power produced by an ELC to the input power required to produce it expressed as a percentage. Active mode efficiency is able to be defined for any ELC in active mode.

3.5 Power

The r.m.s. value of the product of the instantaneous voltage and instantaneous current taken over a unit time period, measured in watts (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 measurements are generally required over a defined period of time.

3.6 Ambient temperature

The temperature of the ambient air in the periphery of the EUT (see Clause 3.3).

3.7 Nameplate input frequency

The frequency of a.c. supply voltage at the input as declared by the manufacturer, measured in hertz (Hz). Also called rated input frequency.

NOTE: ELCs may be designed and marked to operate on dual frequencies or more.

3.8 Nameplate input voltage

The appropriate a.c. input voltage of the ELC (see Clause 3.2) as declared by the manufacturer, measured in volts (V). This is also expressed as a range, such as 100–240 V. Also called rated input voltage.

3.9 Nameplate output power (P_{no})

The power output of the ELC declared by the manufacturer and measured in watts (W) or kilowatts (kW). Also called rated output power.

3.10 Nameplate output voltage

The voltage output of the ELC as declared by the manufacturer and measured in volts (V). Also called rated output voltage.

3.11 Safety extra-low voltage (SELV)

A voltage not exceeding 50 V a.c. r.m.s. or 120 V ripple free d.c. between conductors, or between any conductor and earth, in a circuit which is isolated from the supply mains by means including a safety isolating transformer or convertor with separate windings.

- 1 The voltage limit is not exceeded either at full load or no-load but it is assumed, for the purpose of this definition, that any transformer or convertor is operated at its rated supply voltage.
- 2 'Ripple-free' is conventionally an r.m.s. ripple voltage not more than 10% of the d.c. component. The maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system

3.12 Class III luminaire

A luminaire in which protection against electric shock relies on electrical supply at safety extra-low voltage (SELV, see Clause 3.11) and in which voltages higher than those of SELV are not generated.

3.13 Stabilized temperature

The temperature of the ELC, that, following repeated measurements after start-up does not show a trend in a particular direction.

3.14 Stabilized output frequency

The frequency of the ELC that, following repeated measurements after start-up, does show a trend in a particular direction.

3.15 Total harmonic distortion (THD)

The ratio, expressed as a per cent, of the r.m.s. value of an a.c. voltage, other than the fundamental, to the r.m.s. value of the fundamental component.

THD of voltage is defined as—

$$\text{THD}_1 = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + V_5^2 + \dots + V_n^2}}{V_1} \quad \dots (1)$$

where

V_n = r.m.s. value of voltage at the n_{th} harmonic

V_1 = the r.m.s. value of the voltage at the fundamental frequency.

NOTES:

- 1 a.c. signals have only odd number harmonics.
- 2 For practical measurement considerations, the n_{th} harmonic is restricted to the 13th harmonic.

3.16 Uncertainty

Defined as U_x , where 'x' denotes parameters such as volts, efficiency and power. (See Appendix B to determine uncertainties.

4 GENERAL CONDITIONS FOR TEST AND MEASUREMENT

4.1 General

Measurements shall be made under test conditions and with equipment described in Clauses 4.3 to 4.8.

4.2 Rounding

Unless otherwise stated, numbers shall be rounded in accordance with AS 2706.

4.3 Test room

The tests shall be carried out in a room that has an air speed within 100 mm of the EUT of ≤ 0.5 m/s. The ambient temperature shall be $23 \pm 5^\circ\text{C}$ and maintained at $\pm 1^\circ\text{C}$ throughout the test. There shall be no forced cooling of the EUT. The EUT shall be tested on a thermally non-conductive surface.

NOTE: Products intended for outdoor use may be tested at additional temperatures, provided those are in addition to the conditions specified above.

4.4 Test voltage

An a.c. reference source shall be used to provide input voltage to the EUT.

During the tests, the supply voltage and the frequency shall be maintained constant within $\pm 0.5\%$ during the warm-up period. However, during the actual measurement, the voltage shall be adjusted to within $\pm 0.2\%$ of the specified testing value.

Regardless of the nameplate input voltage and frequency of the EUT, the test shall be performed at 230 V and 50 Hz.

4.5 a.c. reference source

The input voltage source shall be capable of delivering at least three times the nameplate input power of the EUT.

Regardless of the a.c. source type, the THD of the supply voltage, when supplying a resistive load of the same power as the EUT in the specified mode, shall not exceed 2%.

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.

The total harmonic content is determined by summation of the individual frequency r.m.s. voltages using the fundamental as 100%. This shall be measured using an incandescent lamp load of approximately the same power as the EUT.

4.6 Test lamps

Before testing, test lamps shall be selected from lamps manufactured using normal production, to match the output voltage of the EUT. The power consumed by each lamp shall be within $\pm 4\%$ of its rated wattage, when measured using a d.c. supply.

4.7 Thermocouple and temperature indicator

The resolution of the temperature indicator shall be at least 0.1°C , when used with the appropriate thermocouple.

4.8 Measuring instrument

For magnetic transformers, calibrated and traceable a.c. wattmeters, power analysers or digital power meters shall be used.

For electronic step-down convertors, all output power measurements shall be made with a calibrated and traceable wideband power analyser or digital power meter.

Additional tests will be required using an oscilloscope with at least 20 MHz bandwidth or a spectrum analyser/receiver. This will be required for determination of convertor output fundamental frequency and harmonics. The power analyser or digital power meter shall have specified accuracies to within 200 kHz. The overall uncertainty of measurement shall be less than 4% for convertors with output fundamentals at or below 50 kHz and 5% for those above 50 kHz. The uncertainty shall be included in the test report.

Appendix B determines uncertainties and states that equipment for calibration and traceability of measurement is required at frequencies up to 200 kHz and is not restricted up to 50 Hz.

NOTE: Appendix C provides worked examples for determination of uncertainty.

5 COMPATIBILITY WITH ELECTRONIC DIMMER SWITCHES

There are no requirements at this stage.

NOTE: This Clause is under consideration.

6 TESTS

6.1 Preparing EUT for test

If any built-in dimmer is used in the EUT, this shall be set to full power and the presence of such a dimmer shall be noted in the final test report.

- (a) The measurements shall be performed at the output terminals of the EUT. In the case where the EUT is directly connected (hard-wired) to a lamp or has hard-wired flying leads, the connection or leads shall be cut adjacent to the EUT and the test load and measurement probes connected at these points.

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

6.2 Load conditions

The EUT shall be tested for full-load using a number or combination of the standard ELV tungsten halogen lamps of the same rated voltage and of power as specified in Table 1.

The EUT shall be tested for no-load with the output open circuit.

If the EUT is rated between 50–70 W (inclusive) an additional partial load condition test shall be conducted with one 35 W lamp.

TABLE 1
LOAD CONDITIONS FOR EUT

ELC rated load (VA)	Number of lamps			Total load (W)	% rated load
	20 W	35 W	50 W		
20	1			20	100
25	1			20	80
35		1		35	100
50			1	50	100
60	3			60	100
65	3			60	92
70	1		1	70	100
75	2	1		75	100
80	4			80	100
100			2	100	100
105		3		105	100
150			3	150	100
160	3		2	160	100
180	4		2	180	100
200			4	200	100
210	3		3	210	100
250			5	250	100
300			6	300	100
320	1		6	320	100
400			8	400	100
500			10	500	100
550			11	550	100
650			13	650	100
750			15	750	100
800			16	800	100
900			18	900	100
1000			20	1000	100
1200			24	1200	100

NOTE: For EUTs of other than 12 V output, where the above lamps are not commercially available or do not match with the ratings in the table, other lamps can be used to achieve as close as possible to 100% of rated load but not less than 80% of rated load.

Test lamps shall be connected in parallel using appropriate gauge wire in order to introduce negligible additional effects.

6.3 Load test procedure

6.3.1 Full load test

The test shall be conducted as stated below keeping in view the procedure to reduce uncertainty as stated in Table 2.

- (a) The EUT shall be connected to the test load as shown in Figure 1. The supply voltage shall be adjusted to the test voltage and the EUT operated at the load condition in accordance with Clause 6.2 until its temperature and output frequency has been shown to stabilize. The temperature shall be determined at the rated maximum temperature T_c point as defined in Clause 3.15 of AS/NZS 61347.1 or upon the outside of the transformer core.

- (b) One of the following measurement techniques shall be used to record power values.

- (i) Single measurement instrument, two channel.

Input and output power shall be measured simultaneously using a measurement instrument with two channels. The two readings should be triggered together (hold function) and recorded. See Figure 1(a).

- (ii) Two measurement instruments.

Input and output power shall be measured simultaneously.

The parameters, as stated in Table 2, shall be recorded.

See Figure 1(b) for electronic convertor or Figure 1(c) for magnetic convertor.

- (c) For electronic convertors, the following procedures shall be applied:

- (i) Test equipment is to be specially calibrated at a national standards body* and a graph plotted of correction factors.
- (ii) Test equipment shall be set up according to Figure 1(a) or Figure 1(b).
- (iii) The convertor's output fundamental frequency shall be measured.
- (iv) Using knowledge of the test equipment frequency response, decide if special steps shall be taken to reduce uncertainties.

NOTE: Also consider construction of an artefact in order to allow repeated measurements of this kind that will reduce the stability uncertainty term for the test equipment.

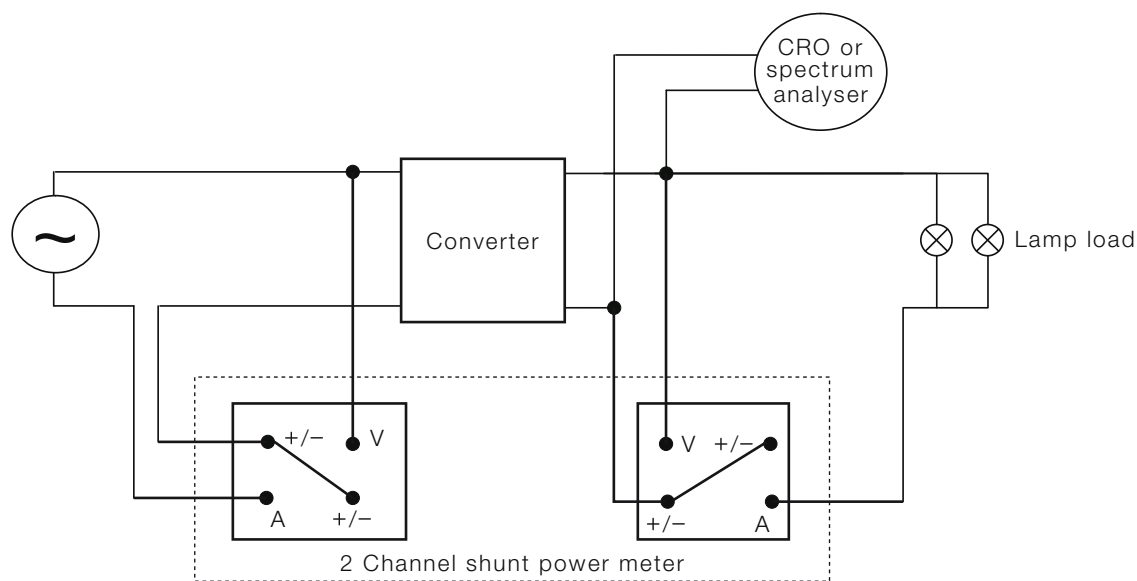
TABLE 2

PROCEDURE TO ACHIEVE NECESSARY UNCERTAINTY

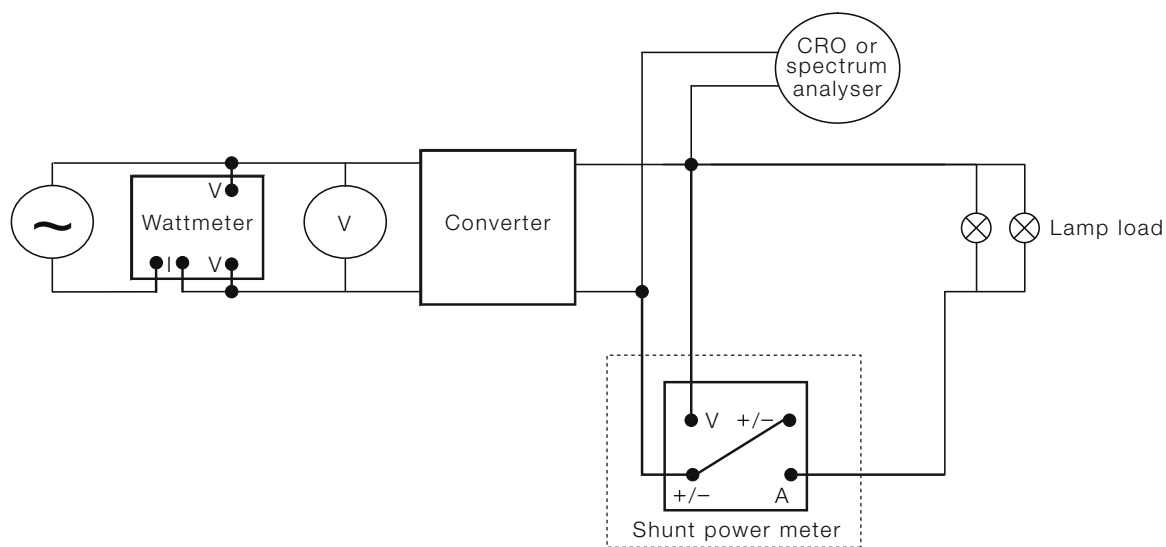
Efficiency calculation	If no need to reduce uncertainty	If need to reduce uncertainty
Take measurement	Use measured value	Measure the convertor output with a spectrum analyser or test receiver
Apply corrections*	Use worst case K_n values (see Appendix B)	Split output power into component parts
Calculate efficiency	Calculate uncertainty	Calculate uncertainty

* Subtract voltmeter losses from supply watts reading. Add voltmeter losses to load watts reading.

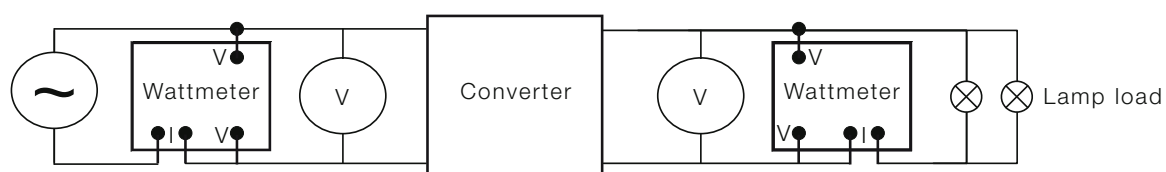
* In Australia, the national Standards body is *National Measurement Institute (NMI)*. In New Zealand, the national Standards body is *Industrial Research Ltd Measurement Standards Laboratory*.



(a) Single measurement



(b) Two measurements for ELC



(c) Two measurements for magnetic convertor

FIGURE 1 SCHEMATICS FOR MEASUREMENT

6.3.2 No-load test

The test of Clause 6.3.1 is repeated with the output of the ELC open circuit. All leads are removed from the output.

6.3.3 Special load test

For ELCs rated 50 W to 70 W, the test of Clause 6.3.1 is repeated with a load of one 35 W lamp and the values of the test reported, in particular the output voltage.

6.3.4 Data report

A data report as stated in Table 3 shall be included in any test report.

NOTE: The information to be supplied in a test report is given in Appendix D; a sample test report is supplied in Appendix E.

TABLE 3
DATA REPORT

Reported quantity	
a.c. input voltage (V_i) test voltage	
Total harmonic distortion (THD)	
a.c. input power (W_i)	
Output voltage (V_o) (a.c. or d.c.)	
Output power (W_o) (a.c. or d.c.)	
Output frequency (electronic convertor)	
If this varies, the frequency at which the test was made.	
Efficiency (%)	
Uncertainty	

6.4 Efficiency determination

Efficiency of the EUT shall be determined at the load condition as defined in Clause 3.4.

It is calculated as—

$$\frac{W_o}{W_i} \times 100 \quad \dots (2)$$

where

W_o = the output power

W_i = the a.c. input power

6.5 Power consumption determination

Power consumption of the EUT shall be determined as the difference between the a.c. input power (W_i) and the output power (W_o).

7 ENERGY PERFORMANCE MARK

Where an ELC is marked with an energy performance mark, the mark shall be as specified in Appendix A.