



Australian Government
Department of Industry, Science,
Energy and Resources

National
Measurement
Institute

NMI M 13-1

Active-energy electricity meters (a.c.)

Part 1: Metrological and technical
requirements

Based on:

AS 62052.11 (2018)

AS 62053.21 (2018)

AS 62053.22 (2018)

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Amendments

No.	Page	Location	Details of change
1	N/A	General	This document specifies pathway 2, now separated from NMI M 6-1.
2	1	1.1	Updated 'Scope' to clarify this document only applies to alternating current (a.c.).
3	4	3.4	Amended 'Information to be Displayed on Meter Exterior' to refer to the Australian Standard, clarify that the markings shall be visible when the meter is installed, and added alternatives for some markings if there is limited space.
4	5	3.5	Amended Verification Mark to: <ul style="list-style-type: none"> • Correct Verifying Authority to Utility Meter Verifier • Add a note that it may be in the form of a Certificate of Verification.
5	6	4	'Accuracy classes and Maximum Permissible Errors' have been moved from Annex C to this clause.
6	7	5	'Assessment of Requirements in the Australian Standards' have been moved from Annex D to this clause.
7	7	5, Table 4	Clarified assessment of clause 5.12 of AS 62052.11.
8	8	5, Table 8	Added Note 1 to clarify the required test points for ambient temperature, voltage and frequency variations.
9	9	6.1.1	Amended 'Documentation' to remove: <ul style="list-style-type: none"> • Reference to traceability for internal clocks – this is covered by clause 6 • Record-keeping requirements – this is covered by NMI P 106 and (future) software policies.
10	9	6.1.2	Amended 'Meters Submitted for Testing' to make it clearer that sample meters are required by testing facility – not submitted to NMI with application
11	9	6.1.3	Amended 'Laboratory Examination' to make it clearer that sample meters are required by testing facility – not submitted to NMI with application.
12	N/A	N/A	Removed 'Acceptable Indications' as not applicable for this document.

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Preface

It is Australian Government policy to harmonise Australian standards with international metrological requirements to the greatest possible extent. This document presents one pathway for the pattern approval of electricity meters.

This pathway is based on a suite of standards published by Standards Australia which are modified adoptions of International Electrotechnical Commission (IEC) standards.

This pathway was previously specified as pathway 2 in NMI M 6-1, v3.0 (July 2020). There are no significant changes in this document compared to the previous edition, other than the separation of the pathways into separate documents. All amendments are listed in the Amendments table above.

Other pathways may be available. At the time of publication, the following pathways exist:

1. NMI M 6-1 and NMI M 6-2
2. NMI M 13-1 (this document) and NMI M 13-2
3. NMI R 46-1-2 and NMI R 46-3.

1 Scope and Application

1.1 Scope

This document contains requirements for the metrological control of active-energy electricity meters (meters) intended for use for trade, including the metrological and technical requirements for pattern approval and verification. The requirements apply to all watt hour meters operating on alternating current circuits, used for single-rate or multi-rate operation, in single or polyphase installations, having a nominal operating frequency of 50 Hz and a connection voltage not exceeding 600 V.

In-field performance requirements are not addressed in this document.

1.2 Application

This document describes a pathway¹ for approval.

This pathway comprises some requirements based on NMI M 6-1 [1] along with specified requirements from the following suite of standards published by Standards Australia

- AS 62052.11 (2018) [2]
- AS 62053.21 (2018) [3]
- AS 62053.22 (2018) [4]

The requirements based on NMI M 6-1 are specified in:

- Clause 2 Terminology
- Clause 3 Metrological and Technical Requirements
- Clause 6 General

The requirements based on the suite of Australian Standards are provided in:

- Clause 4 Accuracy Classes and Maximum Permissible Errors
- Clause 5 Assessment of Requirements in the Australian Standards

The Australian Standards also refer to safety standard AS 62052.31 (2017) [5], though only some parts of this safety standard are relevant for pattern approval as specified in Annex A.

Note: Full compliance with the safety standard may be required under jurisdictional or contractual requirements.

The National Measurement Institute reserves the right to vary or interpret requirements if it is deemed appropriate to support new or different technologies or applications.

¹ See the Preface for information on other pathways.

2 Terminology

The following definitions have been based for the most part on those in references [1] and [6]. Refer to the Australian Standards [2, 3 and 4] for other terms specific to clauses 4 and 5.

2.1 Accuracy Class

The class of measuring instruments or measuring systems that meet stated metrological requirements that are intended to keep measurement errors or instrumental uncertainties within specified limits under specified operating conditions.

2.2 Auxiliary Device

A device or function within the meter that is not part of the basic metrology function. The main auxiliary devices are:

- communication for transmitting measurement data;
- tariff changing controls;
- load control devices; and
- disconnect/reconnect contactors.

2.3 Basic Current (I_b)

The value of the current in accordance with which the relevant performance of a direct-connected meter is fixed.

Note: The term 'current' indicates root mean square (rms) values unless otherwise specified.

2.4 Direct-connected Meter

A meter intended for use without an external measurement transformer, i.e. for direct connection to the circuit being metered.

2.5 Error

The indication of a meter minus the true value of the corresponding input quantity.

2.6 Maximum Current (I_{max})

The highest value of current at which the meter purports to meet the accuracy requirements of this document.

2.7 Maximum Permissible Error

The extreme value of the error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system.

2.8 Measuring Element

The part of the meter which produces an output proportional to the energy measured.

2.9 Meter Constant

The value expressing the relation between the energy registered by the meter and the corresponding value of the test output (for solid state meters) or the number of revolutions of the rotor (for electromechanical meters). For solid state meters, the constant should be in either pulses per kilowatt hour (imp/kWh) or watt hours per pulse (Wh/imp); for electromechanical meters, this value should be in either revolutions per kilowatt hour (rev/kWh) or as watt hours per revolution (Wh/rev).

2.10 Percentage Error

Percentage error is given by the following formula:

$$\text{percentage error} = (\text{energy registered by the meter} - \text{true energy}) \times 100 / \text{true energy}$$

Note: Since the true value cannot be determined, it is approximated by a value with a stated uncertainty that can be traced to national standards.

2.11 Performance

The ability of the meter to accomplish its intended functions.

2.12 Rated Current (I_n)

The value of the current in accordance with which the relevant performance of a transformer-operated meter is fixed.

2.13 Rated Operating Conditions

An operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system performs as designed.

2.14 Reference Frequency (f_{nom})

The value of the frequency in accordance with which the relevant performance of the meter is fixed.

2.15 Reference Voltage (U_{nom})

The value of the voltage in accordance with which the relevant performance of the meter is fixed.

2.16 Register of a Meter

That part of the meter which enables the measured value to be determined.

2.17 Static or Solid State or Electronic Watt Hour Meter

A watt hour meter in which current and voltage act on solid state (electronic) elements to produce an output proportional to the energy to be measured.

2.18 Transformer-operated Meter

A meter intended for use with one or more external measurement transformers.

2.19 Voltage Circuit

The internal connections of the meter, part of the measuring element and, in the case of static meters, part of the power supply, supplied with the voltage of the circuit to which the meter is connected.

2.20 Watt Hour Meter (Active-Energy Meter)

An instrument intended to measure active energy by integrating active power with respect to time.

3 Metrological and Technical Requirements

3.1 Units of Measurement

The following units of measurement and their symbols shall be used.

Active energy	
Unit	Symbol
watt hour	Wh
kilowatt hour	kWh
megawatt hour	MWh
gigawatt hour	GWh

3.2 Calculated Quantities

For all calculated quantities included in the transaction, the indicated quantity shall equal the quantity obtained by using the indicated values included in the calculation together with any rounding applied. If the indicated calculated quantity is rounded, it shall be rounded to ± 0.5 of the minimum measured quantity.

Calculated quantities include energy values stored in meter registers such as time of use, import and export and phase registers.

3.3 Rules for the Determination of Errors

The rules for the determination of errors are as follows:

- the value of reference quantities or measurement standards used for the determination of maximum permissible errors shall have an expanded uncertainty (coverage factor two) no greater than one-third of the maximum permissible error specified for the meter under test (see ISO Guide to the Expression of Uncertainty in Measurement [7]);
- the maximum permissible errors apply to all meters irrespective of their principles of operation;
- the maximum permissible error specifications are applicable to all indications included in the transaction as appropriate.

3.4 Information to be Displayed on Meter Exterior

Refer to AS 62052.11:2018 clause 5.12.1 Name-plates noting the following:

- Meters shall be clearly and permanently marked, and the markings shall be visible when the meter is installed.
- Space for an approval mark is required. The approval mark is an NMI pattern approval number which associates the meter with a Certificate of Approval issued by the Chief Metrologist (or delegate).
- The reference frequency must be 50 Hz.
- For transformer-operated, the markings must include the rated current (the rated secondary current of the transformer) and the maximum current.
- Space for a verification mark shall be provided as described in clause 3.5.
- Any special notice or limitation of use relating to the meter shall be either clearly marked on a notice visible to the operator or provided in an operators' manual.

3.5 Verification Mark

Provision shall be made for the application of a verification mark either on a stamping plug or an adhesive label. The following requirements apply:

- the mark shall be easily affixed without affecting the metrological properties of the meter;
- the mark shall be visible without moving or dismantling the meter when in use;
- the part on which the mark is located shall not be removable from the meter without damaging the mark; and

- the size of the space shall be sufficient to contain the marks applied by the Utility Meter Verifier and to ensure that those marks shall be legible. A minimum size of 200 mm² is recommended.

Note: A verification mark may be in the form of a Certificate of Verification. See Clause 6.2 and NITP 14 for more information.

3.6 Sealing

Provision shall be made for sealing those devices and parameters that have a metrologically significant effect and that determine the measurement result. This may include devices and parameters that affect the configuration of the meter as well as those which affect the calibration. If instructions or data, which alter the parameters that determine the measurement result, can be introduced through an auxiliary device interface into the meter, the interface shall also be sealed.

Sealing may be by mechanical or solid state means. Mechanical means include those where access to a solid state means of changing the parameters (for example via a keyboard) is prohibited by a mechanical seal.

The requirements for solid state seals are:

- Access by authorised persons to protected parameters shall be protected by some form of physical key or a password or access code (for example a four-digit code).
- Any access to alter protected parameters shall be automatically recorded (for example by means of a counter which automatically increments when access is initiated).
- The record shall be readily accessible by a simple action (for example by display of the counter when a button identified as being for this purpose is pressed, or during the indication check).
- The record shall be readily identifiable as such and shall not be easily confused with other indications of the meter.
- A reference record in the same form as the incremental record shall be permanently marked on the meter to indicate that the parameters have been accessed since the last verification (for example the reference record could be associated with the verification mark).
- The record shall not repeat in a sequence of less than 99 alterations. It shall also persist reliably for a period of at least two years (unless it is overwritten by a further alteration). The record shall persist through tests for influence factors and disturbances specified in the document.

4 Accuracy Classes and Maximum Permissible Errors

There are four accuracy classes provided in the Australia Standards [2, 3 and 4]: class 0.2 S, 0.5 S, 1 and 2. The four accuracy classes and associated error limits (maximum permissible errors) are summarised in Tables 1 and 2 below.

Table 1. Percentage error limits for single phase and polyphase direct-connected meters with balanced loads

Value of current		Power factor	Percentage error limits for meters of class			
For direct connected meters	For transformer operated meters		0.2 S	0.5 S	1	2
—	$0.01 I_n \leq I < 0.05 I_n$	1	± 0.4	± 1.0	—	—
$0.05 I_b \leq I < 0.1 I_b$	$0.02 I_n \leq I < 0.05 I_n$	1	—	—	± 1.5	± 2.5
$0.1 I_b \leq I \leq I_{max}$	$0.05 I_n \leq I \leq I_{max}$	1	± 0.2	± 0.5	± 1.0	± 2.0
$0.1 I_b \leq I < 0.2 I_b$	$0.02 I_n \leq I < 0.1 I_n$	0.5 inductive	± 0.5	± 1.0	—	—
		0.8 capacitive	± 0.5	± 1.0	—	—
$0.1 I_b \leq I < 0.2 I_b$	$0.05 I_n \leq I < 0.1 I_n$	0.5 inductive	—	—	± 1.5	± 2.5
		0.8 capacitive	—	—	± 1.5	—
$0.2 I_b \leq I \leq I_{max}$	$0.1 I_n \leq I \leq I_{max}$	0.5 inductive	± 0.3	± 0.6	± 1.0	± 2.0
		0.8 capacitive	± 0.3	± 0.6	± 1.0	—

Table 2. Percentage error limits for polyphase meters carrying a single-phase load, but with balanced polyphase voltages applied to voltage circuits

Value of current		Power factor	Percentage error limits for meters of class			
For direct connected meters	For transformer operated meters		0.2 S	0.5 S	1	2
$0.1 I_b \leq I \leq I_{max}$	$0.05 I_n \leq I \leq I_{max}$	1	± 0.3	± 0.6	± 2.0	± 3.0
$0.2 I_b \leq I \leq I_{max}$	$0.1 I_n \leq I \leq I_{max}$	0.5 inductive	± 0.4	± 1.0	± 2.0	± 3.0

5 Assessment of Requirements in the Australian Standards

Tables 3 to 9 specify the requirements in the Australia Standards that are assessed for pattern approval. The Australian Standards are:

- AS 62052.11 (2018) [2]
- AS 62053.21 (2018) [3]
- AS 62053.22 (2018) [4]

These standards also make reference to AS 62052.31 (2017) [5] for safety requirements. However, the objective of pattern approval is to assess metrological performance, so NMI does not require full compliance with the Australian Standards. In particular, safety requirements that are not also related to metrology will not be required or assessed for pattern approval.

Table 3 Terms and definitions, and, Standard electrical values

AS 62052.11 [2]	Description	Assessed?
3	Terms and definitions	Yes
4	Standard electrical values	Yes

Table 4 Mechanical requirements and Tests

AS 62052.11 [2]	Description	Assessed?
5.1	General Mechanical Requirements	Not Assessed
5.2.1	Sealing ¹	Not Assessed
5.2.2.1	Spring Hammer Test	Not Assessed
5.2.2.2	Shock Test	Yes
5.2.2.3	Vibration Test	Yes
5.3	Window	Yes
5.4	Terminals - Terminal block(s) - Protective earth terminal	Not Assessed
5.5	Terminal cover(s)	Not Assessed
5.6	Clearance and creepage distances	Not Assessed
5.7	Insulating encased meter of protective class II	Not Assessed
5.8	Resistance to heat and fire	Not Assessed
5.9	Protection against penetration of dust and water	Not Assessed
5.10	Display of measured values	Yes
5.11	Output device	Yes
5.12.1	Marking of meter – Name plates ²	Yes
5.12.2	Marking of meter – Connection diagrams and terminal marking	Not Assessed

Note 1: Refer to clause 3.6 of this document.

Note 2: Safety related markings are not assessed. Also refer to clause 3.4 of this document.

Table 5 Climatic Conditions

AS 62052.11 [2]	Description	Assessed?
6.1	Temperature range	Yes
6.2	Relative Humidity	Not Assessed
6.3.1	Dry Heat Test	Yes
6.3.2	Cold test	Yes
6.3.3	Damp Heat Cyclic	Yes
6.3.4 / Appendix ZA	Protection Against Solar Radiation	Yes

Table 6 Electrical Requirements

AS 62052.11 [2]	Description	Assessed?
7.1.2	Voltage dips and short interruptions	Yes
7.2	Heating	Not Assessed
7.3	Insulation. Reference to [5] clauses 6.7, 6.8 and 6.10	Not Assessed
7.3 / Appendix ZZ	Impulse test for robustness, [5] Appendix ZZ	Yes
7.4	Immunity to earth fault	Yes
7.4	Reference to [5] clause 6.10.3.2	Not Assessed
AS 62053.21 [3] or AS 62053.22	Description	Assessed?
7.1	Power consumption	Yes
7.2	Influence of short-time overcurrents	Yes
7.2	Reference to [5] clauses 6.9.8, 6.10.5 and 6.10.6.	Not Assessed
7.3	Influence of self-heating	Yes
7.4	AC Voltage test	Not Assessed

Table 7 Electrical Requirements – Electromagnetic compatibility (EMC)

AS 62052.11 [2]	Description	Assessed?
7.5.1	General	Yes
7.5.2	Test of immunity to electrostatic discharges (ESD)	Yes
7.5.3	Test of immunity to electromagnetic RF fields	Yes
7.5.4	Fast transient burst test	Yes
7.5.5	Test of immunity to conducted disturbances, induced by RF fields	Yes
7.5.6	Surge immunity test	Yes
7.5.7	Damped oscillatory waves immunity test	Yes
7.5.8	Radio interference suppression	Not Assessed

Table 8 Accuracy Requirements

AS 62053.21 [3] or AS 62053.22	Description	Assessed?
8.1	Limits of error due to variation of the current	Yes
8.2	Limits of error due to influence quantities ¹	Yes
8.3	Test of starting and no-load condition	Yes
8.4	Meter constant	Yes

Note 1: For the influence quantities where a current range is specified (ambient temperature, voltage and frequency variations) the test points shall include the maximum current, basic (or nominal) current and the lowest current in the range for each specified power factor.

Table 9 Appendices

AS 62052.11 [2]	Description	Assessed?
Appendix ZA	Method for the Determination of the Resistance of Certain Components to Ultraviolet Light ¹	Yes
Appendix ZB	Disconnect After Reconnect Capability	Not assessed
Appendix ZC	Time Keeping Performance	Yes

Note 1: This test is also referenced in clause 6.3.4 Protection Against Solar Radiation.

6 General

6.1 Pattern Approval

6.1.1 Documentation

Submission of a meter for pattern approval shall be in accordance with the latest version of *NMI P 106 Procedures for the Approval and Certification of Patterns of Measuring Instruments* [9]. A submission shall be accompanied by sufficient technical information including drawings, specifications, photographs and descriptions to ensure complete understanding of the construction and method of operation of the meter.

Details of the measurement data contained in the memory and calculation methods shall also be provided.

For meters with solid state components the documentation shall include a list of solid state sub-assemblies with their essential characteristics, and a description of the solid state devices with drawings, diagrams and general software information explaining their construction and operation.

The software and/or firmware versions for which pattern approval is being sought shall be specified. The applicant shall advise NMI of future modifications to software and/or firmware with the potential to affect the metrology of the meter.

6.1.2 Meters Submitted for Testing

Testing facilities shall carry out examination on one or more sample meters submitted for laboratory tests.

6.1.3 Laboratory Examination

Testing facilities shall examine the sample meters in conjunction with the submitted documentation to assess whether the pattern complies with the applicable specifications.

6.1.4 Laboratory Tests

6.1.4.1 General

Laboratory tests shall be performed in accordance with any limitations of use marked on the meter or included in any documentation accompanying the meter.

6.1.4.2 Tests for Interface

If the meter is provided with an interface through which auxiliary devices or other meters can be connected, the tests shall be carried out with a sample device connected and tests applicable to the interface applied.

6.2 Verification

Verification shall be performed in accordance with *NITP 14 National Instrument Test Procedures for Utility Meters*. Meters shall comply with any requirements listed in the certificate of approval.

Bibliography

- [1] NMI M 6-1, v4.0 (June 2022), Active-Energy Electricity Meters (a.c.)
- [2] AS 62052.11 (2018), Electricity metering equipment (AC) — General requirements, tests and test conditions, Part 11: Metering equipment (IEC 62052-11:2016 (ED.1.1) MOD)
- [3] AS 62053.21 (2018), Electricity metering equipment (AC) — Particular requirements, Part 21: Static meters for active energy (classes 1 and 2) (IEC 62053-21:2016 (ED.1.1) MOD)
- [4] AS 62053.22 (2018), Electricity metering equipment (AC) — Particular Requirements, Part 22: Static meters for active energy (classes 0.2 S and 0.5 S) (IEC 62053-22:2016 (ED.1.1) MOD) OIML D 11: General Requirements for Electronic Measuring Instruments. OIML, Paris, 2004
- [5] AS 62052.31 (2017), Electricity metering equipment (AC) — General requirements, tests and test conditions, Part 31: Product safety requirements and tests (IEC 62052-31:2015 (ED.1.0) MOD)
- [6] OIML V 2-200: International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM). OIML, Paris, 2007
- [7] ISO/IEC Guide 98-3:2008: Guide to the Expression of Uncertainty in Measurement (GUM). ISO, Geneva, 2008
- [8] IEC 62053-52 (2005) Electricity Metering Equipment (AC) – Particular Requirements – Part 52: Symbols
- [9] NMI P 106 Procedures for the Approval and Certification of Patterns of Measuring Instruments