

WELMEC

European Cooperation in Legal Metrology

Corresponding Tables

Active electrical energy meters

**OIML R 46 2012 –
MID 2014/32/EU Annex V (MI-003)**



WELMEC

European Cooperation in Legal Metrology

WELMEC is cooperation between the legal metrology authorities of the Member States of the European Union and EFTA.

This document is one of a number of Guides published by WELMEC to provide guidance to manufacturers of measuring instruments and to Notified Bodies responsible for conformity assessment of their products.

The Guides are purely advisory and do not themselves impose any restrictions or additional technical requirements beyond those contained in relevant EU Directives.

Alternative approaches may be acceptable, but the guidance provided in this document represents the considered view of WELMEC as to the best practice to be followed.

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Notes:

1. The column “Comments” indicates when necessary the relevant text of OIML R 46 and related explanations concerning the compliance with relevant MID requirement.
2. The column “Conclusion” gives the conclusion on the compliance between MID and OIML R 46 for the relevant requirement.

The indication “Covered” means that:

- the requirement of OIML R 46 is identical to the one of MID; or
- the requirement of OIML R 46 is more severe than the one of MID; or
- All the requirement of OIML R 46 fulfils MID requirements (even when MID allows other alternatives).
- In case the requirement is not fully covered, a short statement explains what is covered.

The indication “Not Covered” means that the MID requirement is either not compatible with the relevant OIML R 46 requirement or not included in OIML R 46.

The indication “Not Relevant” means that the requirement in Annex I of the MID is not relevant for Active electrical energy meters.

3. The text in *italic* is an extract from the relevant clause of the OIML Recommendation.

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
ANNEX I				
1.1	Allowable Errors Under rated operation conditions and in absence of a disturbance, the error of measurement shall not exceed the maximum permissible error (MPE) value as laid down in the appropriate instrument-specific requirements. Unless stated otherwise in the instrument-specific annexes, MPE is expressed as a bilateral value of the deviation from the true measurement value.	3.2 3.3.1	<i>"The meter shall be designed and manufactured such that its error does not exceed the maximum permissible error for the specified class under rated operating conditions."</i>	Covered
1.2	Under rated operating conditions and in presence of a disturbance, the performance requirement shall be as laid down in the appropriate instrument-specific requirements.	3.3.6	Table 5 defines the performance criteria for meters subject to disturbances.	Covered
	Where the instrument is intended to be used in a specified permanent continuous electromagnetic field the permitted performance during the radiated electromagnetic field-amplitude modulated test shall be within MPE.	3.3.5	Table 4 defines the requirements for permanent continuous electromagnetic fields. In 6.3.15.1 specific test details are mentioned.	Covered
1.3	The manufacturer shall specify the climatic, mechanical and electromagnetic environments in which the instrument is intended to be used, power supply and other influence quantities likely to affect its accuracy, taking into account of the requirements laid down in the appropriate instrument-specific annexes.	3.2	In 3.2 the rated operating conditions are stated.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
1.3.1 Climatic environments The manufacturer shall specify the upper temperature limit and the lower temperature limit from any of the values in Table 1 unless otherwise specified in the Annexes MI-001 to MI-010, and indicate whether the instrument is designed for condensing or non-condensing humidity as well as the intended location for the instrument, i.e. open or closed. <u>Temperature limits:</u> Upper temperature limit 30 °C / 40 °C / 55 °C / 70 °C Lower temperature limit 5 °C / -10 °C / -25 °C / -40 °C	3.2	The rated operating conditions are specified in Table 1: <i>“From lower temperature limit to upper temperature limit as specified by manufacturer. The manufacturer shall specify the lower temperature limit from the values: -55 °C, -40 °C, -25 °C, -10 °C, +5 °C.</i> <i>The manufacturer shall specify the upper temperature limit from the values: +30 °C, +40 °C, +55 °C, +70 °C.”</i> Remark: MID does not allow to specify a lower temperature limit of -55°C	Covered
1.3.2 (a) Mechanical environments are classified into classes M1 to M3 as described below M1: This class applies to instruments used in locations with vibration and shocks of low significance, e.g. for instruments fastened to light structures subject to negligible vibrations and shocks transmitted from local blasting or pile-driving activities, slamming doors, etc.	6.4.13.1 6.4.13.2	M1 is applicable.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
M2: This class applies to instruments used in locations with significant or high levels of vibration and shock, e.g. transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.	6.4.13.1 6.4.13.2	OIML R 46 provides the adequate severity levels but the testing of the accuracy during the application of the disturbance is not required	Partially covered
M3: This class applies to instruments used in locations where the level of vibration and shock is high and very high, e.g. for instruments mounted directly on machines, conveyor belts, etc.		OIML provides no adequate severity levels for M3	Not covered
(b) The following influence quantities shall be considered in relation with mechanical environments: - Vibration - Mechanical shock	6.4.13	The meter is examined with vibrations and mechanical shocks.	Covered
1.3.3 (a) Electromagnetic environments are classified into E1, E2 or E3 as described below, unless otherwise laid down in the appropriate instrument-specific annexes. E1: This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.	Table 4 and 5	Severity levels for electromagnetic environment tests of OIML R 46-1 correspond to level E2 of MID and of OIML D 11.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
E2: This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in other industrial buildings.	Table 4 and 5	Severity levels for electromagnetic environment tests of OIML R 46-1 correspond to level E2 of MID and of OIML D 11.	Covered
E3: This class applies to instruments supplied by the battery of a vehicle. Such instruments shall comply with the requirements of E2 and the following additional requirements - voltage reductions caused by energizing the starter-motor circuits of internal combustion engines, - load dump transients occurring in the event of a discharged battery being disconnected while the engine is running.		Level E3 is not applicable for the instruments covered by MID since MI-003 is limited to active electrical energy meters intended for residential, commercial and light industry use.	Not relevant
(b) The following influence quantities shall be considered in relation with electromagnetic environments: - voltage interruptions - short voltage reductions - voltage transients on supply lines and/or signal lines - electrostatic discharges - radio frequency electromagnetic fields - conducted radio frequency - electromagnetic fields on supply lines and/or signal lines - surges on supply lines and/or signal lines	Table 4 and 5	Table 4 and 5 list all these tests as relevant for active electrical energy meters. However, conducted frequencies in the range 2-150 kHz (VLF and LF disturbances on mains) are not covered. Remark: OIML D11 references EN 61000-4-19 standard in order to cover the frequency range. The test has to be applied for current only.	Partially covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
1.3.4 Other influence quantities to be considered, where appropriate, are: - voltage variation - mains frequency variation - power frequency magnetic fields - any other quantity likely to influence in a significant way the accuracy of the instrument.	Table 4 and 5	Table 4 and 5 list all these tests relevant for active electrical energy meters.	Covered
1.4 When carrying out the tests as envisaged in this Directive, the following paragraphs apply:			
1.4.1 <i>Basic rules for testing and the determination of errors</i> Essential requirements specified in 1.1 and 1.2 shall be verified for each relevant influence quantity. Unless otherwise specified in the appropriate instrument-specific annex, these essential requirements apply when each influence quantity is applied and its effect evaluated separately, all other influence quantities being kept relatively constant at their reference value. Metrological tests shall be carried out during or after the application of the influence quantity, whichever condition corresponds to the normal operational status of the instrument when that influence quantity is likely to occur.	chapter 3	Chapter 3 defines the type examination tests and summarizes the associated requirements. The essential requirements are verified for each relevant influence quantity, where all other influence quantities are kept constant at their reference value.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
1.4.2	<i>Ambient humidity</i> - According to the climatic operating environment in which the instrument is intended to be used either the damp heat-steady state (non-condensing) or damp heat cyclic (condensing) test may be appropriate. - The damp heat cyclic test is appropriate where condensation is important or when penetration of vapour will be accelerated by the effect of breathing. In conditions where non-condensing humidity is a factor the damp-heat steady state is appropriate.	6.4.16.3 6.4.16.4	A damp heat, steady-state test is performed in case of non-condensing applications, while a damp heat, cyclic test is performed in case of condensing applications.	Covered
2	Reproducibility The application of the same measurand in a different location or by different user, all other conditions being the same, shall result in the close agreement of successive measurements. The difference between the measurement results shall be small when compared with the MPE.	5 5	Reproducibility is incorporated in the method of testing by performing various measurements from the lowest current to the highest current and then from the highest current to the lowest current. <i>Not covered is the requirement that the difference between the measurement result should be small when compared with the MPE as R 46 doesn't give a concrete test.</i>	Partially covered
3	Repeatability The application of the same measurand under the same conditions of measurement shall result in the close agreement of successive measurements. The difference between the measurement results shall be small when compared with the MPE.	5	For repeatability no specific requirements are stated. According to OIML R 46 "National authorities may prescribe more stringent test regimes than those described in this section." Remark: It is recommended to apply 1/10 of the MPE as a maximum difference.	Not covered Not covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
4	Discrimination and sensitivity A measuring instrument shall be sufficiently sensitive and the discrimination threshold shall be sufficiently low for the intended measurement task.	3.7.2	The test output of the meter is designed such that its accuracy can be examined with one tenth of the base maximum permissible error.	Covered
5	Durability A measuring instrument shall be designed to maintain an adequate stability of its metrological characteristics over a period of time estimated by the manufacturer's instruction when in the environmental conditions for which it is intended.	3.8 6.4.17	The aim of the durability test is to demonstrate the stability of the metrological characteristics of the meter.	Covered
6	Reliability A measuring instrument shall be designed to reduce as far as possible the effect of a defect that would lead to an inaccurate measurement result, unless the presence of such a defect is obvious.	3.8	<i>"The meter shall be designed to reduce as far as possible the effect of a defect that would lead to an inaccurate measurement result."</i>	Covered
7	Suitability			
7.1	A measuring instrument shall have no feature likely to facilitate fraudulent use, whereas possibilities for unintentional misuse shall be minimal.	3.6.1.1	<i>"Electricity meters shall be provided with the means to protect their metrological properties. National authorities shall determine levels of authorised access for software protection (3.6.3), parameter protection (3.6.4) and checking facility event record (3.6.9)."</i>	Covered
7.2	A measuring instrument shall be suitable for its intended use taking account of the practical working conditions and shall not require unreasonable demands of the user in order to obtain a correct measurement result.	3.7	See the requirements for "Suitability for use".	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
7.3	The errors of a utility measuring instrument at flows or currents outside the controlled range shall not be unduly biased.	Table 2 6.4.9	Specific requirements are given for currents between the starting current and below the minimum current. Due to the installation conditions it is not expected that a meter will be exposed to currents above the maximum current in normal conditions. For exposure to short-circuits the meter is examined with short-time overcurrents.	Covered
7.4	Where a measuring instrument is designed for the measurement of values of the measurand that are constant over time, the measuring instrument shall be insensitive to small fluctuations of the value of the measurand, or shall take appropriate action.		An electricity meter is an integrating instrument. Thus, this requirement is not applicable.	Not relevant
7.5	A measuring instrument shall be robust and its materials of construction shall be suitable for the conditions in which it is intended to be used.	6.4.10 6.4.9 6.4.11 6.4.14 6.4.15	The electricity meter has to be such robust that it can withstand impulse voltages of the grid, short-time overcurrents, earth faults, solar radiation and ingress of dust.	Covered
7.6	A measuring instrument shall be designed so as to allow the control of the measuring tasks after the instrument has been placed on the market and put into use. If necessary, special equipment or software for this control shall be part of the instrument. The test procedure shall be described in the operation manual.	3.7.2 4.1	<i>"The meter shall be equipped with a test output for efficient testing, such as a rotor with a mark or a test pulse output."</i> The test procedure is described in the manual, delivered during the type evaluation.	Covered
	When a measuring instrument has associated software which provides other functions besides the measuring function, the software that is critical for the metrological characteristics shall be identifiable and shall not be inadmissibly influenced by the associated software.	3.6	The software requirements, as well as the software identification and the protection of metrological properties, is described in chapter 3.6.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
8	Protection against corruption			
8.1	The metrological characteristics of a measuring instrument shall not be influenced in any inadmissible way by the connection to it of another device, by any feature of the connected device itself or by any remote device that communicates with the measuring instrument.	3.6.5 3.6.3.1	<i>"Metrologically critical parts of an electricity meter – whether software or hardware parts – shall not be inadmissibly influenced by other parts of the meter."</i> <i>"An electricity meter shall be constructed in such a way that possibilities for unintentional, accidental, or intentional misuse are minimal."</i>	Covered
8.2	A hardware component that is critical for metrological characteristics shall be designed so that it can be secured. Security measures foreseen shall provide for evidence of an intervention.	3.6.1.1	<i>"Electricity meters shall be provided with the means to protect their metrological properties. National authorities shall determine levels of authorised access for software protection (3.6.3), parameter protection (3.6.4) and checking facility event record (3.6.9)."</i>	Covered
8.3	Software that is critical for metrological characteristics shall be identified as such and shall be secured. Software identification shall be easily provided by the measuring instrument. Evidence of an intervention shall be available for a reasonable period of time.	3.6.2 3.6.4	<i>"Legally relevant software of an electricity meter shall be clearly identified with the software version or another token. The identification may consist of more than one part but at least one part shall be dedicated to the legal purpose."</i> <i>The identification shall be inextricably linked to the software itself and shall be presented on command or displayed during operation. "</i> <i>"The traceability means and records are part of the legally relevant software and should be protected as such. The software employed for displaying the audit trail belongs to the fixed legally relevant software."</i>	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
8.4 Measurement data, software that is critical for measurement characteristics and metrologically important parameters stored or transmitted shall be adequately protected against accidental or intentional corruption.	3.6.3.1 3.6.4.1	<i>“An electricity meter shall be constructed in such a way that possibilities for unintentional, accidental, or intentional misuse are minimal.”</i> <i>“Parameters that fix the legally relevant characteristics of the electricity meter shall be secured against unauthorized modification. If necessary for the purpose of verification, the current parameter settings shall be able to be displayed.”</i>	Covered
8.5 For utility measuring instruments the display of the total quantity supplied or the displays from which the total quantity supplied can be derived, whole or partial reference to which is the basis for payment, shall not be able to be reset during use.	3.6.4.1 3.6.4.2 3.6.4.3	<i>“Parameters that fix the legally relevant characteristics of the electricity meter shall be secured against unauthorized modification. If necessary for the purpose of verification, the current parameter settings shall be able to be displayed.</i> <i>Device-specific parameters may be adjustable or selectable only in a special operational mode of the electricity meter. They may be classified as those that should be secured (unalterable) and those that may be accessed (settable parameters) by an authorized person, e.g. the instrument owner, repairer.”</i> <i>“Zeroing the register that stores the total energy metered shall be considered as a modification of a device specific parameter. Therefore all relevant requirements applicable to device specific parameter are applicable to the zeroing operation.”</i> Resetting of registers shall be handled like settable parameter. MID forbids resetting, R 46 declares resetting optionally acceptable. <i>“When modifying a device-specific parameter, the meter shall stop registering energy.”</i>	Partially covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
9	Information to be borne by and to accompany the instrument			
9.1	A measuring instrument shall bear the following inscriptions: - manufacturer's mark or name - information in respect of its accuracy, plus, when applicable - information in respect of the conditions of use - measuring capacity - measuring range - identity marking - number of EC-type examination certificate or the EC design examination certificate - information whether or not additional devices providing metrological results comply with the provisions of this Directive on legal metrological control.	3.5	All the listed inscriptions are included.	Covered
9.2	An instrument of dimensions too small or of too sensitive a composition to allow it to bear the relevant information shall have its packaging, if any, and the accompanying documents required by the provisions of this Directive suitably marked.		The size of an electricity meter is such that the information can be marked on the meter.	Not relevant

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
measurement used.				
9.7	The units of measurement used and their symbols shall be in accordance with the provisions of Community legislation on units of measurement and their symbols.	3.1	The units of measurement are defined. Although R46 allows several units only kWh and MWh fulfil the MID requirements.	Covered
9.8	All marks and inscriptions required under any requirement shall be clear, non-erasable, unambiguous and non-transferable.	3.5	<i>"The markings shall be indelible, distinct and legible from outside the meter. The markings of meters intended for outdoor locations shall withstand solar radiation."</i>	Covered
10	Indication of result			
10.1	Indication of the result shall be by means of a display or a hard copy.	3.7.1	<i>"The meter shall have one (or more) indicating device(s) which is (are) capable of presenting or displaying the numerical value of each legal unit of measure for which the meter is approved. The indicating device shall be easy to read and the characters of measurement results shall as minimum be 4 mm high. Any decimal fractions shall be clearly indicated; for mechanical registers, any decimal fraction drum shall be marked differently."</i> A display is mandatory.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
10.2 The indication of any result shall be clear and unambiguous and accompanied by such marks and inscriptions necessary to inform the user of the significance of the result. Easy reading of the present result shall be permitted under normal conditions of use. Additional indications may be shown provided they cannot be confused with the metrologically controlled indications.	3.7.1	<i>"The meter shall have one (or more) indicating device(s) which is (are) capable of presenting or displaying the numerical value of each legal unit of measure for which the meter is approved. The indicating device shall be easy to read and the characters of measurement results shall as minimum be 4 mm high. Any decimal fractions shall be clearly indicated; for mechanical registers, any decimal fraction drum shall be marked differently."</i> R 46 does not have requirements concerning - additional indications or - marks and inscription necessary to inform the user which values are legally relevant ("significance") and which not.	Partially Covered,
10.3 In the case of hard copy the print or record shall also be easily legible and non-erasable.		Not applicable	Not relevant
10.4 A measuring instrument for direct sales trading transactions shall be designed to present the measurement result to both parties in the transaction when installed as intended. When critical in case of direct sales, any ticket provided to the consumer by an ancillary device not complying with the appropriate requirements of this Directive shall bear an appropriate restrictive information.		R46 does not mention direct sales trading.	Not covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
10.5	Whether or not a measuring instrument intended for utility measurement purposes can be remotely read it shall in any case be fitted with a metrologically controlled display accessible without tools to the customer. The reading of this display is the measurement result that serves as the basis for the price to pay.	3.7.1	The meters are fitted with a metrological controlled display. OIML R 46 requires only a “indicating device”. This can lead to the situation that a meter has only a remote display and the consumer has to take care for the indicating device, which is not allowed under MID. Chapter 3.6.7 of OIML R 46 may be the basis for a “remote display” which does not fulfill the requirement of MID	Partially covered
11	Further processing of data to conclude the trading transaction			
11.1	A measuring instrument other than a utility measuring instrument shall record by a durable means the measurement result accompanied by information to identify the particular transaction, when: - the measurement is non-repeatable - the measuring instrument is normally intended for use in the absence of one of the trading parties.		Active electrical energy meters addressed by MID are utility meters.	Not relevant
11.2	Additionally, a durable proof of the measurement result and the information to identify the transaction shall be available on request at the time the measurement is concluded.		See comment in 11.1.	Not relevant
12	Conformity evaluation A measuring instrument shall be designed so as to allow ready evaluation of its conformity with the appropriate requirements of this Directive.	3.7.2	The meter is equipped with a test output for efficient testing.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
ANNEX V (MI-003)				
1	Accuracy The manufacturer shall specify the class index of the meter. The class indices are defined as: Class A, B and C.	3.3.1	Classes A, B and C are covered. Class D is not defined by MID.	Partially Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion																																												
2	Rated operating conditions The manufacturer shall specify the rated operating conditions of the meter; in particular: The values of f_n, U_n, I_n, I_{st}, I_{min}, I_{tr} and I_{max} that apply to the meter. For the current values specified, the meter shall satisfy the conditions given in Table 1; <i>Table 1</i> <table><tr><td></td><td>Class A</td><td>Class B</td><td>Class C</td></tr><tr><td colspan="4">For direct-connected meters</td></tr><tr><td>I_{st}</td><td>$\leq 0,05 \cdot I_{tr}$</td><td>$\leq 0,04 \cdot I_{tr}$</td><td>$\leq 0,04 \cdot I_{tr}$</td></tr><tr><td>I_{min}</td><td>$\leq 0,5 \cdot I_{tr}$</td><td>$\leq 0,5 \cdot I_{tr}$</td><td>$\leq 0,3 \cdot I_{tr}$</td></tr><tr><td>I_{max}</td><td>$\geq 50 \cdot I_{tr}$</td><td>$\geq 50 \cdot I_{tr}$</td><td>$\geq 50 \cdot I_{tr}$</td></tr><tr><td colspan="4">For transformer-operated meters</td></tr><tr><td>I_{st}</td><td>$\leq 0,06 \cdot I_{tr}$</td><td>$\leq 0,04 \cdot I_{tr}$</td><td>$\leq 0,02 \cdot I_{tr}$</td></tr><tr><td>I_{min}</td><td>$\leq 0,4 \cdot I_{tr}$</td><td>$\leq 0,2 \cdot I_{tr}^{(1)}$</td><td>$\leq 0,2 \cdot I_{tr}$</td></tr><tr><td>$I_n$</td><td>$= 20 \cdot I_{tr}$</td><td>$= 20 \cdot I_{tr}$</td><td>$= 20 \cdot I_{tr}$</td></tr><tr><td>$I_{max}$</td><td>$\geq 1,2 \cdot I_n$</td><td>$\geq 1,2 \cdot I_n$</td><td>$\geq 1,2 \cdot I_n$</td></tr><tr><td colspan="4">⁽¹⁾ For Class B electromechanical meters $I_{min} \leq 0,4 \cdot I_{tr}$ shall apply.</td></tr></table>		Class A	Class B	Class C	For direct-connected meters				I_{st}	$\leq 0,05 \cdot I_{tr}$	$\leq 0,04 \cdot I_{tr}$	$\leq 0,04 \cdot I_{tr}$	I_{min}	$\leq 0,5 \cdot I_{tr}$	$\leq 0,5 \cdot I_{tr}$	$\leq 0,3 \cdot I_{tr}$	I_{max}	$\geq 50 \cdot I_{tr}$	$\geq 50 \cdot I_{tr}$	$\geq 50 \cdot I_{tr}$	For transformer-operated meters				I_{st}	$\leq 0,06 \cdot I_{tr}$	$\leq 0,04 \cdot I_{tr}$	$\leq 0,02 \cdot I_{tr}$	I_{min}	$\leq 0,4 \cdot I_{tr}$	$\leq 0,2 \cdot I_{tr}^{(1)}$	$\leq 0,2 \cdot I_{tr}$	I_n	$= 20 \cdot I_{tr}$	$= 20 \cdot I_{tr}$	$= 20 \cdot I_{tr}$	I_{max}	$\geq 1,2 \cdot I_n$	$\geq 1,2 \cdot I_n$	$\geq 1,2 \cdot I_n$	⁽¹⁾ For Class B electromechanical meters $I_{min} \leq 0,4 \cdot I_{tr}$ shall apply.				Table 1 – (3.2)	R 46 is somewhat stricter for some items.	Covered
	Class A	Class B	Class C																																													
For direct-connected meters																																																
I_{st}	$\leq 0,05 \cdot I_{tr}$	$\leq 0,04 \cdot I_{tr}$	$\leq 0,04 \cdot I_{tr}$																																													
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The voltage, frequency and power factor ranges within which the meter shall satisfy the MPE requirements are specified in Table 2. These ranges shall recognise the typical characteristics of electricity supplied by public distribution systems. The voltage and frequency ranges shall be at least: $0,9 \cdot U_n \leq U \leq 1,1 \cdot U_n$ $0,98 \cdot f_n \leq f \leq 1,02 \cdot f_n$ power factor range at least from $\cos\phi = 0,5$ inductive to $\cos\phi = 0,8$ capacitive.	Table 1 – (3.2)	The voltage range is $U_{nom} \pm 10\%$ and the frequency range is $f_{nom} \pm 2\%$. The power factor range is from 0,5 inductive to 0,8 capacitive, except for class C where the operating range is from 0,5 inductive to 0,5 capacitive.	Covered
3 MPEs The effects of the various measurands and influence quantities (a, b, c, . . .) are evaluated separately, all other measurands and influence quantities being kept relatively constant at their reference values. The error of measurement, that shall not exceed the MPE stated in Table 2, is calculated as: $\text{Error of measurement} = \sqrt{a^2 + b^2 + c^2} \dots$ When the meter is operating under varying-load current, the percentage errors shall not exceed the limits given in Table 2.	Annex B.2.1	This method of combined errors is stated in Annex B, which is an informative Annex only.	Not covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)													OIML R 46 (2012)	Comments	Conclusion																																																																	
Table 2 percent at rated operating conditions and defined load current levels and operating temperature <table><tr><td></td><td colspan="3">Operating temperatures + 5 °C ... + 30 °C</td><td colspan="3">Operating temperatures - 10 °C ... + 5 °C or + 30 °C ... + 40 °C</td><td colspan="3">Operating temperatures - 25 °C ... - 10 °C or + 40 °C ... + 55 °C</td><td colspan="3">Operating temperatures - 40 °C ... - 25 °C or + 55 °C ... + 70 °C</td></tr><tr><td>Meter class</td><td>A</td><td>B</td><td>C</td><td>A</td><td>B</td><td>C</td><td>A</td><td>B</td><td>C</td><td>A</td><td>B</td><td>C</td></tr></table> ase meter; polyphase meter if operating with balanced loads <table><tr><td>I_{tr}</td><td>3,5</td><td>2</td><td>1</td><td>5</td><td>2,5</td><td>1,3</td><td>7</td><td>3,5</td><td>1,7</td><td>9</td><td>4</td><td>2</td></tr><tr><td>I_{max}</td><td>3,5</td><td>2</td><td>0,7</td><td>4,5</td><td>2,5</td><td>1</td><td>7</td><td>3,5</td><td>1,3</td><td>9</td><td>4</td><td>1,5</td></tr></table> : meter if operating with single phase load <table><tr><td>I_{tr} see below</td><td>4</td><td>2,5</td><td>1</td><td>5</td><td>3</td><td>1,3</td><td>7</td><td>4</td><td>1,7</td><td>9</td><td>4,5</td><td>2</td></tr></table> mechanical polyphase meters the current range for single-phase load is limited to 5I_{tr} ≤ I ≤ I_{max} When a meter operates in different temperature ranges the relevant MPE values shall apply.														Operating temperatures + 5 °C ... + 30 °C			Operating temperatures - 10 °C ... + 5 °C or + 30 °C ... + 40 °C			Operating temperatures - 25 °C ... - 10 °C or + 40 °C ... + 55 °C			Operating temperatures - 40 °C ... - 25 °C or + 55 °C ... + 70 °C			Meter class	A	B	C	A	B	C	A	B	C	A	B	C	I _{tr}	3,5	2	1	5	2,5	1,3	7	3,5	1,7	9	4	2	I _{max}	3,5	2	0,7	4,5	2,5	1	7	3,5	1,3	9	4	1,5	I _{tr} see below	4	2,5	1	5	3	1,3	7	4	1,7	9	4,5	2		OIML R-46 has only requirements for individual influence quantities, the requirements laid down in table 2 of MID are missing.	Not covered
	Operating temperatures + 5 °C ... + 30 °C			Operating temperatures - 10 °C ... + 5 °C or + 30 °C ... + 40 °C			Operating temperatures - 25 °C ... - 10 °C or + 40 °C ... + 55 °C			Operating temperatures - 40 °C ... - 25 °C or + 55 °C ... + 70 °C																																																																						
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I _{tr} see below	4	2,5	1	5	3	1,3	7	4	1,7	9	4,5	2																																																																				
4	Permissible effect of disturbances																																																																															

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
4.1 General As electrical energy meters are directly connected to the mains supply and as mains current is also one of the measurands, a special electromagnetic environment is used for electricity meters. The meter shall comply with the electromagnetic environment E2 and the additional requirements in 4.2 and 4.3. The electromagnetic environment and permissible effects reflect the situation that there are disturbances of long duration which shall not affect the accuracy beyond the critical change values and transient disturbances, which may cause a temporary degradation or loss of function or performance but from which the meter shall recover and shall not affect the accuracy beyond the critical change values. When there is a foreseeable high risk due to lightning or where overhead supply networks are predominant, the metrological characteristics of the meter shall be protected.	3.3.6	E2 EMC levels of MID and OIML R-46 are in line.	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion																																			
4.2	Effect of disturbances of long duration Table 3 Critical change values for disturbances of long duration <table border="1"> <tr> <th rowspan="2">Disturbance</th> <th colspan="3">Critical change values in percent for meters of class</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> <tr> <td>Reversed phase sequence</td> <td>1,5</td> <td>1,5</td> <td>0,3</td> </tr> <tr> <td>Voltage unbalance (only applicable to polyphase meters)</td> <td>4</td> <td>2</td> <td>1</td> </tr> <tr> <td>Harmonic contents in the current circuits (1)</td> <td>1</td> <td>0,8</td> <td>0,5</td> </tr> <tr> <td>DC and harmonics in the current circuit (1)</td> <td>6</td> <td>3</td> <td>1,5</td> </tr> <tr> <td>Fast transient bursts</td> <td>6</td> <td>4</td> <td>2</td> </tr> <tr> <td>Magnetic fields; HF (radiated RF) electromagnetic field; Conducted disturbances introduced by radio-frequency fields; and Oscillatory waves immunity</td> <td>3</td> <td>2</td> <td>1</td> </tr> <tr> <td colspan="4">(1) In the case of electromechanical electricity meters, no critical change values are defined for harmonic contents in the current circuits and for DC and harmonics in the current circuit.</td> </tr> </table>	Disturbance	Critical change values in percent for meters of class			A	B	C	Reversed phase sequence	1,5	1,5	0,3	Voltage unbalance (only applicable to polyphase meters)	4	2	1	Harmonic contents in the current circuits (1)	1	0,8	0,5	DC and harmonics in the current circuit (1)	6	3	1,5	Fast transient bursts	6	4	2	Magnetic fields; HF (radiated RF) electromagnetic field; Conducted disturbances introduced by radio-frequency fields; and Oscillatory waves immunity	3	2	1	(1) In the case of electromechanical electricity meters, no critical change values are defined for harmonic contents in the current circuits and for DC and harmonics in the current circuit.				Table 4 (3.3.5) and table 5 (3.3.6) 6.3.12 6.3.9 6.3.11 6.3.16 6.4.4 6.4.2, 6.3.15, 6.4.8	The requirements of the different disturbances are covered. Remark: Reversed phase sequence (OIML is stricter for class C = 0,1)	Covered
Disturbance	Critical change values in percent for meters of class																																						
	A	B	C																																				
Reversed phase sequence	1,5	1,5	0,3																																				
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(1) In the case of electromechanical electricity meters, no critical change values are defined for harmonic contents in the current circuits and for DC and harmonics in the current circuit.																																							
4.3	Permissible effect of transient electromagnetic phenomena																																						

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)	OIML R 46 (2012)	Comments	Conclusion
4.3.1 The effect of an electromagnetic disturbance on an electrical energy meter shall be such that during and immediately after a disturbance — any output intended for testing the accuracy of the meter does not produce pulses or signals corresponding to an energy of more than the critical change value and in reasonable time after the disturbance the meter shall — recover to operate within the MPE limits, and — have all measurement functions safeguarded, and — allow recovery of all measurement data present prior to the disturbance, and — not indicate a change in the registered energy of more than the critical change value. The critical change value in kWh is $m \cdot U_n I_{max} 10^{-6}$ (m being the number of measuring elements of the meter, U_n in Volts and I_{max} in Amps).	3.3.6. 6.4.1	In 3.3.6 the definition of the critical change values is stated. In 6.4.1 the general instructions for disturbance tests are stated	Covered

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion															
4.3.2	For overcurrent the critical change value is 1,5 %.	6.4.9 3.3.6.2	Remark: OIML R 46 is stricter in some parts Short time overcurrent <table><tr><td>A</td><td>B</td><td>C</td></tr><tr><td colspan="3">Transformer-operated: 20 I_{max}</td></tr><tr><td>1,0</td><td>0,5</td><td>0,05</td></tr><tr><td colspan="3">Direct connected 30 I_{max}</td></tr><tr><td>1,5</td><td>1,5</td><td>0,05</td></tr></table>	A	B	C	Transformer-operated: 20 I _{max}			1,0	0,5	0,05	Direct connected 30 I _{max}			1,5	1,5	0,05	Covered
A	B	C																	
Transformer-operated: 20 I _{max}																			
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5	Suitability																		
5.1	Below the rated operating voltage the positive error of the meter shall not exceed 10 %.	6.3.8 Table 4	In table 4 more stringent limits are stated for severe voltage variations.	Covered															
5.2	The display of the total energy shall have a sufficient number of digits to ensure that when the meter is operated for 4 000 hours at full load (I = I _{max} , U =U _n and PF = 1) the indication does not return to its initial value and shall not be able to be reset during use.	3.7.1	<i>“The register shall be capable of storing and displaying an amount of energy that corresponds to the meter running at P = U_{nom}·I_{max}·n for at least 4000 h, where n is the number of phases. This capability for storage and display applies to all registers relevant for billing including positive and negative flow registers for bi-directional meters and tariff registers for multi-tariff meters.”</i>	Covered															
5.3	In the event of loss of electricity in the circuit, the amounts of electrical energy measured shall remain available for reading during a period of at least 4 months.	3.7.1	<i>“In the case of electronic registers, the minimum retention time for results is one year for a disconnected meter.”</i>	Covered															

Directive 2014/32/EU Essential requirements of Annex I and Annex V (MI-003)		OIML R 46 (2012)	Comments	Conclusion
5.4	Running with no load When the voltage is applied with no current flowing in the current circuit (current circuit shall be open circuit), the meter shall not register energy at any voltage between $0,8 \cdot U_n$ and $1,1 U_n$.	6.2.4	<i>"For this test, there shall be no current in the current circuit. The test shall be performed at U_{nom}."</i> The test has to be performed at $0,8 U_{nom}$ and at $1,1 U_{nom}$.	Not covered
5.5	Starting The meter shall start and continue to register at U_n , $PF = 1$ (polyphase meter with balanced loads) and a current which is equal to I_{st} .	6.2.3	<i>"The meter shall be subjected to a current equal to the starting current I_{st}."</i>	Covered
6	Units The electrical energy measured shall be displayed in kilowatt-hours or in megawatt-hours.	3.1	<i>"The units of measurement for active electrical energy shall be one of the following units: Wh, kWh, MWh, GWh."</i> Although R46 allows several units only kWh and MWh fulfil the MID requirements.	Partially Covered