LegalEVcharge – Practical legal metrology framework for electric vehicle charging stations

NordCharge

Requirements for active electrical energy meters for DC applications

Version 1 issued 2021-09-21

Contents

Foreword

The present document was prepared in the framework of the EURAMET TCEM project LegalEVcharge – Practical legal metrology framework for electric vehicle charging stations – and NordCharge, a group of Nordic countries working on legal metrology regulations for electric vehicle charging stations.

While the Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments (recast) (MID) harmonises the requirements for active electrical energy meters without distinction between AC or DC, at present, no standard gives presumption of conformity with MID for DC active electrical energy meters. The European Commission issued the mandate M/541 requesting the European standardisation organisations on 15 December 2015 to prepare such a standard by 31 December 2017. For practical reasons, it is necessary to define a set of detailed technical specifications satisfying the performance requirements of MID.

This document is intended as a temporary solution providing guidance to the industry until such a standard is available and gives presumption of conformity with MID.

Until EN 50470-3:2006 cedes to give presumption of conformity with MID or VDE-AR-E 2418-3-100:2020-11 is withdrawn, the latter may be used instead of this document.

1. Scope

This document applies to DC active electrical energy meters in the scope of MID and their type tests.

2. Normative references

EN 50470-3	Electricity metering equipment (AC) – Part 3: Particular requirements – Static meters for active energy (class indexes A, B and C)
EN 62052-11	Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment
IEC 62053-41	Electricity metering equipment – Particular requirements – Part 41: Static meters for DC energy (classes 0,5 and 1)
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

3. Terms and definitions

EN 50470-3:2021 clause 3 applies with the following addition.

3.7

display

function making the result of the measurement available in a transparent, trustworthy and non-discriminatory way

Note 1 to entry: Other regulation can require other information to be shown. This display may be combined with other displays, e.g. for the unit price.

Note 2 to entry: Depending on the technical implementation, it can be necessary to show the information to identify the transaction together with the result of the measurement.

3.8

power factor

under periodic conditions, ratio of the absolute value of the active power *P* to the apparent power *S*

$$\lambda = \frac{P}{|S|}$$

NOTE: Under sinusoidal conditions, the power factor is the absolute value of the active factor.

[IEV 131-11-46]

Contrary to EN 62052-11:2021, the terms indoor meter and indoor detached indicating display are not used as synonyms and the term indoor meter is not used to refer to indoor detached indicating displays and vice versa.

Contrary to EN 62052-11:2021, the terms outdoor meter and outdoor detached indicating display are not used as synonyms and the term outdoor meter is not used to refer to outdoor detached indicating displays and vice versa.

4. Standard electrical values

EN 50470-3:2021 clause 4 applies with the following modifications.

In subclause 4.2.1, the only sentence is replaced by “For transformer operated meters intended for operation with LPITs, no preferred values are defined.” and Note 2 is removed. In Table 1, “Transformer operated” is replaced by “Transformer operated, except intended for use with LPITs”.

In subclause 4.3, the note is removed. In Table 3, “Voltage circuit” is replaced by “Voltage circuit for meters with auxiliary power supply”.

5. Construction requirements

EN 50470-3:2021 clause 5 applies.

6. Meter marking and documentation

EN 50470-3:2021 clause 6 applies with following modification.

The unnumbered note is numbered “Note 2”. In Table 7, a footnote “c for transformer operated meters intended for use with LPITs, the marking on the case may consist of a reference to the display or the relevant LPIT standard provided the relevant quantities are shown on the display. If these quantities are referred to the primary, the instrument transformer ratio is not shown.” is added and referenced in column C in the rows “Nominal voltage(s) or voltage range” and “Nominal current and current range”.

7. Accuracy requirements

EN 50470-3:2021 clause 7 applies with the following modifications.

The active factor cos *φ* is replaced by the power factor.

Tests are carried out for unity power factor only. Tests relating to the disturbances “harmonics” and “DC and harmonics in the current circuit” are removed. Specifications of acceptable limits and tests relating to frequency variation are removed.

In subclause 7.6, the formula is replaced as follows and the references to specific units in the definitions of quantity symbols are removed.

$$\frac{\Delta t}{\text{min}} = \frac{240 \times 10^3}{k \times m \times \frac{U_{\text{test}}}{\text{V}} \times \frac{I_{\text{start}}}{\text{A}}}$$

In Table 9, row “differential mode current disturbances (2–150 kHz)”, the acceptable limits of variation are divided by 2.

In Tables 9 and 10, “(cos *φ*)” is removed from the title row.

In subclause 7.13, the sentence “The meter shall not exploit the MPEs or systematically favour any party.” is added at the end.

8. Climatic conditions

EN 50470-3:2021 clause 8 applies.

9. Effects of external influences

EN 62052-11:2021 clause 9 applies with the following modifications.

The active factor cos *φ* is replaced by the power factor.

The “Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports” is replaced by the test of subclause 9.1.

9.1. Test for immunity to conducted, differential mode current disturbances in the frequency range 2 kHz to 150 kHz

IEC 62053-41:2021 subclause 9.2 applies with the following modification.

c) Mains port:

1) 10 Hz to 2 kHz: for direct connected meters I_{Diff} = 2 A; for transformer operated meters I_{Diff} = 0,02 × I_{max}.

2) 2 kHz to 150 kHz: for direct connected meters I_{Diff} = 3 A; for transformer operated meters I_{Diff} = 0,03 × I_{max}.

10. Requirements concerning the software and protection against corruption

EN 50470-3:2021 clause 10 applies.

11. Type test

EN 62052-11:2020 clause 10 applies. In subclause 10.2 lit. f, “Proof of metrological traceability: For national metrology institutes and designated institutes: self-declaration according to ISO/IEC 17025;” is added before “For accredited test laboratories”.

12. Durability

EN 50470-3:2021 clause 12 applies.

13. Reliability

EN 50470-3:2021 clause 13 applies.

14. Reproducibility

The application of the same measurand in a different location or by a 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 (MID Annex I point 2).

15. 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 (MID Annex I point 3).

A. Requirements related to the installation (informative)

A.1. General

Meters for electric vehicle charging stations (EVCS) must be outdoor meters.

The EVCS must be designed such that the instructions of the meter manufacturer are respected. This includes the operating temperature when the EVCS is installed as intended by the EVCS manufacturer.

Meters for EVCS often have a range of U_n rather than a single value. In this case, tests shall be carried out both for the minimum and the maximum of the range.

Meters shall be installed such that it is not possible to divert the measured quantity in normal conditions of use unless it is readily apparent. This may require the meter to have suitable features such as hardware or software sealing provisions.

Many states require a resolution of 0,01 kWh on the display.

In case of power supply failures in direct sales applications, it is convenient to be able to conclude the transaction. This requires a means to save and display the legally relevant data such as the use of an emergency power supply. Consumer protection regulation in many states do not allow for billing to be based on estimations or fixed prices in case of power failures.

If power supply failures are unlikely, it may be commercially favourable not to bill consumers in case of a power supply failure during the transaction. In this case, means such as an emergency power supply are not necessary if evidence about the presence of a power supply failure is available. Such evidence can consist of time since the last restart of the meter or the timestamp of the last restart systematically included in the legally relevant data.

A.2. Display

MID requires the result of the measurement to be made available to the consumer in a

- transparent – the consumer can compare the measurement result indicated by the measuring instrument with the corresponding value on the bill without having to trust the other party;
- trustworthy – the authenticity of the indicated result is assured;
- non-discriminatory – no party can block the access to the authentic indication of the measurement result by sealing the interface, setting a password or requiring a tool that is not easily available to the other party.

This requirement applies to the meter in its intended practical working conditions.

Often, meters are installed in closed and locked electrical cabinets where access is restricted to skilled persons for safety reasons. In this case, a meter where the display is integrated in the meter housing does not satisfy the requirements when in use (Annex I point 10.2 MID: “Easy reading of the presented result shall be permitted under normal conditions of use.”). The indication of the result shall be shown such that the requirements are met, in this case outside the meter’s housing.

State of the art technology allows for a cost-effective implementation of this requirement. For example, the measurement result can be shown on a display outside the meter for information while the legally relevant data is cryptographically signed and send by mail or e-mail. The data must be transferred to the possession of the consumer and allow them to archive them effectively and without relying on the supplier or any proprietary system after the transfer. The required information for verifying the authenticity of the data, e.g., a public key, can be made available in a human readable, e.g., clear text, and a machine readable format, e.g., a QR code, on the charging station. Many states require these data to be available remotely, e.g., in an independently run database of charging stations, to allow the consumer to verify the data when receiving the bill. The cryptographically signed legally relevant data shall include not only the measurement result, but also information required to identify the transaction (Annex I point 11.2 MID). Such information is namely the identification of the meter as well as time and date the measurement result was taken. The measurement result includes the reading of the energy register, information about the corrections that were applied (see subclause A.3) and warnings about relevant incidents, e.g., power supply failures (see subclause A.1).

If the consumed energy is calculated outside the meter based on the values of the cumulative energy register at the start and at the end of the transaction, the legally relevant data that need to be made available to the consumer are these two values of the cumulative energy register. For convenience of the consumer and in order to bill the consumed energy, the supplier may calculate the difference and make it available to the consumer. This difference has no legal value. Transparency requires this to be made known to the user (Annex I point 10.4 MID). For direct sales applications, the difference shall be made available to the consumer.

A.3. Cable

In EVCS, the active electrical energy to be measured is the energy transferred across the property boundary between supplier and consumer. Especially when the cable is part of the EVCS, the losses between a convenient point to measure the energy and the property boundary can be significant. In any case, uncorrected losses are always to the disadvantage of the consumer, which is a violation of clause 7. The cable loss is generally assumed not to systematically favour any party if they do not exceed one-sixth of the MPE at reference conditions. If the cable losses exceed this threshold, a correction is required. One possible technical solution is a four-wire measurement at the property boundary. Another solution is a mathematical correction with knowledge of the properties of the cable. In this case, the properties of the cable, e.g., a type designation, need to be marked on the

cable and on the meter in the same or similar way as the transformer ratio in case of a transformer operated meter. Depending on the technical solution and the national requirements on the maintenance of the stability, a verification in legal metrology may be required after changing a cable, especially when the four-wire measurement technique is not used.

B. Considerations for verification in legal metrology (informative)

All AC active electrical energy meters used to have separated current and voltage circuit that can be linked in the installation in a very simple way. When both circuits are separated, many meters can be tested simultaneously with all voltage circuits in parallel and all current circuits in series, e.g., in the framework of a verification in legal metrology.

Since isolation current transformers for meter test equipment became available with suitable specifications, simple AC active electrical energy meters are designed with a permanent connection between current and voltage circuits.

However, no isolation current transformers exist for DC. Therefore, only meters with separated current and voltage circuits can be tested efficiently.

While most states do not require a separation of the voltage and current measuring circuits, the cost of verification, which is usually charged to the applicant, depends upon the circuit configuration. This is due to the fact that meters whose measuring circuits are linked must be verified individually, while meters with separate measuring circuits can be batch verified.

In most states, the majority of measurements of a verification in legal metrology are based on the pulse output. However, at least one test checks the relation between the pulse output and the registers. Therefore, registers must be read during the verification and an efficient way of reading the registers efficiently is advisable. A standardised solution is strongly encouraged.

ZZA. Relationship between this Standard and the essential requirements of Directive 2014/32/EU aimed to be covered

Table ZZA.1 – Correspondence between this Standard and Directive 2014/32/EU (MID)

Essential requirements of Directive 2014/32/EU	Clause(s)/subclause(s) of this Standard	Remarks/notes
Annex I Directive 2014/32/EU		
1.1	(see below)	(MID refers to Annex V MID)
1.2	(see below)	(MID refers to Annex V MID)
1.3.1	6.2 8.1	
1.3.2	5.1 5.2	
1.3.3	7.10	
1.3.4	7.10	
1.4.1	7 9	
1.4.2	7.10 8.3	
2	14	
3	15	
4	A.1	
5	12	
6	13	
7.1	5.5 A.1	
7.2	A	
7.3	7.9	
7.4	N/A	
7.5	5	
7.6	5.6 5.8 10.2 10.3 A.2 B	
8.1	7.10 10.7 10.8	
8.2	10.4 10.5 10.6	
8.3	10.3	
8.4	10.4 10.5 10.6	
8.5	5.6.1	
9.1	6	
9.2	6	
9.3	6	
9.4	–	(option of MID not used)

9.5	5	
9.6	N/A	
9.7	5.6.1	
9.8	6.2	
10.1	5	
10.2	5	
10.3	5 A.2	
10.4	A.2	
10.5	5 A.2	
11.1	A.2	
11.2	A.2	
12	5.6 5.8 10.2 10.3 A.2 B	
Annex V (MI-003) Directive 2014/32/EU		
1	6.1	
2	4	
3	7.9 7.13	
4.1	7 9	
4.2	7.10	
4.3.1	7.10	
4.3.2	7.10	
5.1	7.10	
5.2	5.6.1	
5.3	5.7	
5.4	7.6	
5.5	7.7	
6	5.6.1	
7	–	

When a clause in this standard refers to a clause in another standard, the references to subclauses refer to the subclauses of the other standard. If this standard modifies the subclause of the other standard, the references refer to the modified subclauses.

Example Clause 10 of this Standard reads “EN 50470-3:2021 clause 10 applies”. The reference to subclause 10.2 refers to subclause 10.2 of EN 50470-3:2021.

Example Clause 7 of this standard refers to EN 50470-3:2021 clause 7 and amends EN 50470-3:2021 subclause 7.13. The reference to subclause 7.13 refers to the amended subclause 7.13 of EN 50470-3:2021, i.e. including the sentence “The meter shall not exploit the MPEs or systematically favour any party.”