

Acceptance inspection of Class 2 alternating-current watthour meters

The European Standard EN 60514 : 1995 has the status of a
British Standard

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PEL/13, Insulators for power systems, upon which the following bodies were represented:

- BEAMA Metering Association (BMA)
- Building Automation and Mains Signalling Association (BAMSA) (BEAMA Ltd.)
- Electricity Association
- Electricity Pool of England and Wales
- Energy Systems Trade Associations
- Flag Association
- Institution of Electrical Engineers
- Office of Electricity Regulation (OFFER)
- United Kingdom Automatic Meter Reading Association

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 August 1995

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The following BSI references relate to the work on this standard:
Committee reference PEL/13
Draft announced in *BSI News* March 1995

ISBN 0 580 24545 4

Amendments issued since publication

Amd. No.	Date	Text affected

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National foreword

This British Standard has been prepared by Technical Committee PEL/13 and is the English language version of EN 60514 : 1995 *Acceptance inspection of Class 2 alternating-current watthour meters*, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC 514 : 1975 published by the International Electrotechnical Commission (IEC).

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a side line in the margin. The introduction, which was deleted by CENELEC, is quoted in national annex NA.

Cross-reference

Publication referred to	Corresponding British Standard
IEC 521	BS EN 60521 : 1995 <i>Class 0, 5, 1 and 2 alternating current watthour meters</i>

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Descriptors: Watthour meters, induction type meters, alternating-current meters, class 2, acceptance inspection, 100 % inspection, sampling inspection

English version

Acceptance inspection of Class 2 alternating-current watthour meters

(IEC 514 : 1975, modified)

Contrôle de réception des compteurs à
courant alternatif de la classe 2
(CEI 514 : 1975, modifiée)

Annahmeprüfung von
Wechselstrom-Wirkverbrauchszählern der
Klasse 2
(IEC 514 : 1975, modifiziert)

This European Standard was approved by CENELEC on 1994-12-06. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 514 : 1975, prepared by IEC TC 13, Equipment for electrical energy measurement and load control, together with common modifications prepared by the Technical Committee CENELEC TC 13, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60514 on 1994-12-06.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1995-07-15
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1995-07-15

For products which have complied with HD 309.2 S1 : 1979 before 1995-07-15, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-07-15.

Annexes designated 'normative' are part of the body of the standard. Annexes designated 'informative' are given for information only. In this standard, annex A is normative and annex B is informative.

Common modifications

Delete the introduction and replace 'report' by 'standard' throughout the text.

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ACCEPTANCE INSPECTION OF CLASS 2 ALTERNATING-CURRENT WATTHOUR METERS

1. Scope

The methods and procedures included in this standard apply to newly manufactured direct connected induction type watthour meters of Class 2, covered by IEC Publication* 521, which are produced and delivered in large quantities.

They provide for 100% inspection or sampling inspection for acceptance by the purchaser.

2. General remarks

2.1 Two methods of acceptance inspection are proposed, namely:

- 100% inspection, and
- sampling inspection.

2.2 The 100% inspection consists of testing all the meters of a batch.

2.3 The sampling inspection is based upon the principles of mathematical statistics and as a consequence certain specified risks are undertaken both by the manufacturer and the purchaser. However, sampling inspection generally is more economical than 100% inspection.

In this report sampling inspection has been planned so that, in practice, the quality of the meter batches can be judged with nearly the same accuracy as with 100% inspection.

2.4 Two methods of sampling inspection are described:

- inspection by attributes;
- inspection by variables.

These two methods have been chosen so that the judgement of quality is virtually the same for both methods.

2.5 Inspection by *attributes* gives results indicating conformity or non-conformity.

It *shall* be applied when the characteristic under inspection cannot be measured.

It *shall* also be applied when a characteristic can be measured but the values are not of normal distribution (Laplace-Gauss).

It *may* be applied, when the distribution is approximately normal, in place of inspection by variables.

The advantage of inspection by attributes is its simplicity of application.

* Class 0.5, 1 and 2 alternating-current watthour meters (being printed).

2.6 Inspection by *variables* gives additional information but it is applicable only when the values of a characteristic are measurable and when those values are approximately normally distributed. In these circumstances, inspection by variables is the recommended method.

The advantage of inspection by variables is a smaller sample size than by attributes for the same risk of decision. However, it requires more calculation.

The test results are represented by:

$\bar{x}$ = the sample mean as an estimation of the batch mean;
 s = the standard deviation
 $\bar{w}$ = the average range } as an estimation of the dispersion of the characteristic x in the batch.

Note. – The average range is easier to calculate than the standard deviation. However, when suitable calculating means are available for making a decision and for preparing additional information, the use of the standard deviation enables the efficiency of the method to be increased for the same sample size.

3. Units

The units employed in this report are those used by the IEC.

4. Definitions

For definitions concerning meters, reference is made to IEC Publication 521. The majority of the definitions of sampling techniques are generally in accordance with the Glossary (1972) of the European Organization for Quality Control (E.O.Q.C.) and with ISO/R 645 (1967) and ISO/R 1786 (1970)*, Statistical Vocabulary and Symbols.

4.1 Batch

A definite quantity of meters of the same type, of the same voltage and current rating and the same register, delivered by one supplier, manufactured or produced under conditions which are presumed uniform.

4.2 Batch size

The number N of meters in a batch (ISO).

4.3 Sample

Meters taken at random for inspection from a batch.

4.4 Sample size

The number n of meters in the sample (ISO).

4.5 100% inspection

Inspection of every meter in a batch.

4.6 Sampling inspection

The inspection of a limited number of meters, taken at random from the batch, according to a prescribed sampling plan (ISO mod.).

4.7 Sampling plan

A plan according to which one or more samples are taken to obtain information and possibly to reach a decision (ISO).

* It is intended to take the corresponding definitions of IEC Publication 410 (1973), Sampling Plans and Procedures for Inspection by Attributes, into consideration in the future.

4.8 *Characteristic (quality characteristic)*

A property (e.g. dielectric strength, starting, accuracy at one test point) of a meter which contributes to the quality and which helps to differentiate between the meters of a given batch. The differentiation may be either quantitative (by variables) or qualitative (by attributes).

If it is measurable, its value for a given meter i is indicated by x_i (ISO mod.).

4.9 *Defect*

A failure of a meter to meet a standard with respect to a characteristic (ISO mod.).

4.10 *Defective meter*

A meter having one or more defects (ISO mod.).

4.11 *Operating characteristic curve*

A curve showing, for a given sampling plan, the probability of acceptance of a batch as a function of its actual quality for a given characteristic (ISO mod.).

4.12 *Inspection by attributes*

Inspection whereby certain characteristics of the sample meters are evaluated, classified as conforming or not conforming to the requirements, the number of defective meters counted and used as the basis for judgement of the batch (E.O.Q.C.).

4.13 *Acceptance number*

The maximum permitted number of defects in a sample for inspection by attributes.

4.14 *Inspection by variables*

Inspection whereby certain characteristics of the sample meters (e.g. a meter error for a particular current) are measured with respect to a continuous scale (e.g. in per cent), and their mean value, the standard deviation or the average range calculated and used as the basis for judgement of the batch.

4.15 *Sample mean $\bar{x}$*

The arithmetic mean of values x_i for a characteristic (e.g. a meter error for a particular current) in the sample:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

4.16 *Range w_j*

The difference between the maximum and minimum observed values of a given characteristic in a sub-group:*

$$w_j = |x_{\max} - x_{\min}|$$

for sub-group j .

4.17 *Average range $\bar{w}$ ***

The arithmetic mean of the r ranges w_j of the r sub-groups in a sample:

$$\bar{w} = \frac{\sum_{j=1}^r w_j}{r}$$

* For the purpose of this report, the size m of a sub-group j is 5 and there are r sub-groups in a sample.

** This is an estimation of the dispersion of the characteristic x in a batch.

4.18 Standard deviation of the sample

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

This is an estimation of the dispersion of the characteristic x in a batch.

4.19 Acceptance trapezium

A graph, with control limits, on which are plotted two corresponding statistical values (i.e. sample mean $\bar{x}$ and either standard deviation s or average range $\bar{w}$), for each sample.

4.20 Acceptable quality level (AQL)

For a given characteristic, the maximum percentage of defective meters in a batch that, for the purpose of sampling inspection, can be considered satisfactory (E.O.Q.C.).

5. Acceptance conditions for batches

A batch is deemed to comply with the requirements of this standard and shall be accepted if for each inspected characteristic the proportion of defective meters does not exceed the following specified values:

- no meter shall be accepted with a false constant or faulty insulation (for sampling inspection, see Sub-clauses 9.2.1.1 and 9.2.1.4).

Under test conditions in Clause 7:

- not more than 1% of the meters shall complete one revolution of the rotor with a current of $0.001 I_b$;
- not more than 1% of the meters shall fail to complete one revolution of the rotor with a current of $0.006 I_b$;
- not more than 1% of the meters shall have errors exceeding the prescribed limits for each test point (Nos. 4 to 9 in Table II).

In the event of sampling inspection, the above conditions shall be considered satisfied* when for each characteristic of the meters in the batch:

- for inspection by attributes the number of defective meters in the sample is smaller than or equal to the acceptance number;
- for inspection by variables the graphically presented test result is within the acceptance trapezium or the calculated test result does not exceed the specified limits.

6. Place of inspection

The inspection shall be carried out by mutual agreement:

- on the manufacturer's premises, but on test benches other than those on which the adjustments were made;
- or on the purchaser's test benches;
- or on other agreed test benches.

7. Test conditions

7.1 Reference conditions

Tests shall be carried out under conditions given in Table I.

* The risk of a wrong interpretation of the results can be read off from the operating characteristic curves of Tables IXa, b and c.

TABLE I
Reference conditions

Influence quantity	Reference value	Tolerances on reference value
Ambient temperature ¹⁾	23 °C	± 2 °C
Position ²⁾	Vertical	± 1 °
Voltage ³⁾	Reference voltage	± 1.5 %
Frequency	Reference frequency	± 0.5 %
Voltage and current waveform	Sinusoidal	Distortion factor ≤ 5 %
Magnetic induction of external origin at reference frequency ⁴⁾	Zero	Induction not producing an error variation greater than ± 0.3 %

- ¹⁾ For any ambient temperature outside the range 21°C to 25°C, but within the range 15°C to 30°C, it is permissible to apply a correction for the reference temperature of 23°C, using the mean temperature coefficient of the meter type as declared by the manufacturer.
- ²⁾ The construction and assembly of the meter shall be such that the correct vertical position is ensured (in both the “front-to-back” and “left-to-right” vertical planes) when:
- a) the base of the meter is supported against a vertical wall, and
 - b) a reference edge (such as the lower edge of the terminal block) or a reference line marked on the meter case is horizontal.
- ³⁾ In respect to polyphase meters:
The phase sequence shall be as marked on the diagram of connections.
Each phase or line voltage shall not differ from the mean corresponding voltage by more than 1%.
The current in each phase or line respectively shall not differ from the mean current by more than 2%.
The phase displacements of each of these currents with respect to the corresponding line-to-neutral voltage irrespective of the power factor, shall not differ from one another by more than 3°.
- ⁴⁾ The test consists of:
- a) for a *single-phase* meter, determining the errors at first with the meter normally connected to the mains and then after inverting the connections to the current circuit as well as to the voltage circuits: The half of the difference between the two errors is the value of the variation of error. Because of the unknown phase of the external field, the test has to be made at 0.1 I_b at unity power-factor and 0.2 I_b at 0.5 power-factor;
 - b) for a *three-phase* meter, making three measurements, at 0.1 I_b at unity power-factor, after each of which the connections to the current circuits and to the voltage circuits are changed over 120°, while the phase sequence is not altered. The greatest difference between each of the errors so determined and their average value is the value of the variation of error.

7.2 Uncertainty of measurement

The measuring instruments and other apparatus used for the tests shall be such that the overall uncertainty of measurement does not exceed the following values:

$$\begin{aligned} &\pm 0.4 \% \quad \text{at unity power-factor} \\ &\pm 0.6 \% \quad \text{at 0.5 power-factor.} \end{aligned}$$

7.3 Cover and seal

The meters shall be tested with their covers on and manufacturer's seal unbroken, except when verifying certain mechanical characteristics.

8. Inspection and test procedure

The quality of the batch of meters shall be checked by adopting the inspection and test procedure detailed in this clause.

8.1 Preliminary tests and pre-conditioning

The meters to be tested shall be visually examined in order to verify that none shows signs of damage and that their specified markings are correct.

The meters shall be energized at reference voltage and $0.1 I_b$ at unity power-factor for at least 30 min to verify that the rotors turn and to pre-condition the meters.

For 100% inspections, any replacements which may be required shall be subject to agreement between manufacturer and purchaser.

For sampling inspection, it is permissible to replace one meter in a sample of 30 and two meters in a sample of 40.

All meters which satisfy the foregoing requirements shall be subjected to the tests in the order given below, unless otherwise agreed upon between manufacturer and purchaser, except for test No. 11, which is always the last test.

8.2 Test No. 1: dielectric properties

The test voltage of 2 kV (r.m.s.), which shall be substantially sinusoidal and having a frequency between 45 Hz and 65 Hz, shall be applied for 1 min between all terminals interconnected and the case or a flat metal base on which the meter is placed, when insulated cases are used.

8.3 Test No. 2: running with no-load *

With the meter energized at reference voltage, at unity power-factor and with a current of $0.001 I_b$ and connected as shown in the diagram of connections, the rotor shall not make a complete revolution.

8.4 Test No. 3: starting *

With the meter energized at reference voltage, at unity power-factor and with a current of $0.006 I_b$ and connected as shown in the diagram of connections, the rotor shall start and make more than one revolution.

8.5 Tests Nos. 4 to 9: accuracy

The accuracy tests for single-phase and polyphase meters shall be carried out at the current values and power-factor values given in Table II, without waiting for the thermal equilibrium to be attained.

TABLE II
Test points and limits of errors

Test No.	Current	Power factor	Number of phases of the meter	For polyphase, whether balanced or unbalanced	Limits of errors in percent
4	$0.05 I_b$	1	Single and polyphase	Balanced	± 3.5
5	I_b	1	Single and polyphase	Balanced	± 2.5
6	I_b	0.5	Single and polyphase	Balanced	± 3.0
7	I_b	1	Polyphase	1 phase loaded	± 3.5
8	I_b	1	Polyphase	1 phase loaded (different phase from test No. 7)	± 3.5
9	I_{max}	1	Single and polyphase	Balanced	± 2.5

* For tests Nos. 2 and 3 for cyclometer type registers, only the most rapidly moving drum shall be engaged.

Contrary to IEC Publication 521 displacement of the zero line is not permitted.

8.6 Test No. 10: verification of meter constant

The rotor shall make a whole number of revolutions, such that the fastest moving drum or pointer of the register may be read with sufficient accuracy to enable the meter constant to be verified with an acceptable degree of confidence.

8.7 Test No. 11: mechanical inspection

This test shall be made on five meters irrespective of the batch size. The five meters under test shall be taken at random for 100% inspection or from the sample for sampling inspection (first sample for double sampling).

The covers shall be removed and the meters inspected for:

- meshing of register;
- soldered and welded seams;
- tightness of screws;
- swarf, filings and metal dust especially in the air-gap(s) of the brake magnet(s);
- any other item which is deemed desirable.

9. Requirements corresponding to different inspection procedures

The inspection method shall be fixed by mutual agreement between the parties and, with the exception of test No. 11, all tests shall be carried out either by:

- 100% inspection, or
- sampling inspection.

Test No. 11 is applicable to both 100% inspection and sampling inspection (see Sub-clause 8.7).

9.1 100% inspection

All meters of a batch shall be tested.

9.1.1 Acceptance number c

A meter batch shall be considered as conforming to the requirements of tests Nos. 2 to 9 when for each test the number of defective meters is not more than c as given in Table III.

TABLE III
Acceptance number c

Batch size N	Values of c
50 to 149	1
150 to 249	2
250 to 349	3
350 to 449	4
450 to 549	5
550 to 649	6
650 to 749	7
750 to 849	8
850 to 949	9
950 to 1 000	10

9.1.2 Procedure to be adopted with regard to defective meters

If the acceptance conditions are satisfied, the defective meters shall be repaired on the premises where the inspection is carried out or replaced by meters fulfilling all the conditions required.

If:

- the acceptance numbers are exceeded;
- meter(s) have failed test No. 11;
- meter(s) have failed tests Nos. 1 and/or 10,

then the results shall be discussed between manufacturer and purchaser and, where required, meter(s) which have failed tests Nos. 1 and/or 10 shall be opened and examined.

9.2 Sampling inspection

When sampling inspection is used, the purchaser's risk of accepting a poor quality or the manufacturer's risk of rejecting a good quality shall be taken into account.

This risk for every one of the characteristics can be read from the operating characteristic curves (see Sub-clause 4.11 and Tables IXa, b and c).

9.2.1 General remarks for sampling inspection

9.2.1.1 Assumptions and selection of the sample

The decision regarding conformity of a batch of N meters to the requirements of this report shall be taken in accordance with the sampling plans in Table V which are based upon the AQL's and manufacturer's risk α as follows:

Depending upon the sample size:

- AQL = 1%, α = 5% to 10% for tests Nos. 2 to 9;
- AQL = 0.2%*, α = 3% to 8% for tests Nos. 1 and 10.

The sampling plans are valid for batches from 50 up to and including 1 000 meters. Quantities larger than 1 000 meters shall be subdivided accordingly into batches of 500 up to 1 000 meters.

The inspection shall be carried out on a sample of size n .

The sample shall be chosen to ensure random selection, either by using the serial numbers of the meters in connection with random numbers (e.g. Table IV) or by any other random selection method which is more favourable from the economic point of view.

Example of using random numbers according to Table IV

The consecutive set of serial numbers of a batch are from 100 to 300.

A list of three-digit numbers is established by choosing the numbers situated at the intersections of three columns e.g. columns Nos. 1, 11 and 21 and of the successive lines starting with line No. 6 (the numbers 1, 11, 21 and 6 may be freely chosen):

Random numbers	Numbers of sample meters
908	First sample meter ¹⁾ Second sample meter ¹⁾
795	
295	
191	
518	
524	Third sample meter ¹⁾
428	
609	
329	
152	
.	
etc.	

¹⁾ The random numbers come within the range of the batch serial numbers.

Duplicated random numbers and those falling outside of the set of serial numbers are disregarded.

* It would be desirable to have an AQL equal to zero, but this is possible only with 100% inspection. An AQL different from zero is permitted only in order to make sampling inspection possible.