
**Resistance welding — Welding current
measurement for resistance welding —**

Part 2:

**Welding current meter with current
sensing coil**

*Soudage par résistance — Mesurage des courants en soudage par
résistance —*

Partie 2: Ampèremètre avec tore de mesure de courant



Reference number
ISO 17657-2:2005(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17657-2 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding*.

ISO 17657 consists of the following parts, under the general title *Resistance welding — Welding current measurement for resistance welding*:

- *Part 1: Guidelines for measurement*
- *Part 2: Welding current meter with current sensing coil*
- *Part 3: Current sensing coil*
- *Part 4: Calibration system*
- *Part 5: Verification of welding current measuring system*

Introduction

Requests for official interpretations of any aspect of this part of ISO 17657 should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body. A complete listing of these bodies can be found at <http://www.iso.org>.

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Resistance welding — Welding current measurement for resistance welding —

Part 2: Welding current meter with current sensing coil

1 Scope

This part of ISO 17657 specifies a welding current meter with a current sensing coil to measure the weld time and the r.m.s. value of the welding current during a certain interval using single-phase alternating current of frequency of 50 Hz or 60 Hz, or direct current.

This part of ISO 17657 is applicable for a welding current measuring system, with a display or calibrated output port, which may be connected to a welding controller.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 669, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements*

ISO 17657-1:2005, *Resistance welding — Welding current measurement for resistance welding — Part 1: Guidelines for measurement*

ISO 17657-3:2005, *Resistance welding — Welding current measurement for resistance welding — Part 3: Current sensing coil*

ISO 17657-4:2005, *Resistance welding — Welding current measurement for resistance welding — Part 4: Calibration system*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 669 and the following apply.

3.1

minimum measuring time

minimum settable value of the measuring time

See Figure A.1.

3.2

maximum measuring time

maximum settable value of the measuring time, which will depend on the types of component making up the welding current meter

See Figure A.1.

3.3
indicated measuring time

duration of measuring time, from start time to finish time, while the welding current is flowing

NOTE Normally the start and finish times for measuring current flow are automatically set. If the start time is set at zero or at a value greater than zero, and the finish time is set at a smaller value than the weld time, as shown in Figure A.1, then the welding current is calculated for the measuring duration between the start time and the finish time.

3.4
automatic zero level correction

device that allows removal of the effect of zero drift of output when direct welding current measurement is incorporated

3.5
drift

amount of shift in the zero position

3.6
measuring accuracy

scatter limit of indicated or output values permissible, which is indicated against the full scale value

4 Physical environment and operating conditions

Unless otherwise specified, the welding current meter shall be capable of operating under the following conditions without any adverse effect on its accuracy:

- at an ambient air temperature between of +5 °C and +40 °C;
- in relative humidity up to 95 %;
- at altitudes up to 1 000 m above mean sea level;
- where gas, fine dust, oil mist, spatters, etc. are included in the air such as those caused by ordinary arc or spot welding work.

When the operating conditions deviate from those specified above, an agreement shall be made between the manufacturer and the purchaser.

5 Classification of welding current meters with their current sensing coil, and designation of product

5.1 Classes of welding current meter with current sensing coil

Welding current meters with their current sensing coil are classified as in Table 1 depending on the measuring accuracy.

Table 1 — Classification of welding current meters with current sensing coil by measuring accuracy

Classification	Measuring accuracy	Application
Highly accurate class	± 1,0 % of full scale	Laboratory use
Accurate class	± 2,0 % of full scale	Routine use for highly accurate systems
Ordinary class	± 5,0 % of full scale	Routine use for ordinary systems

5.2 Designation of product

The following shall be indicated:

- current type that can be measured i.e. alternating current and/or direct current;
- maximum current measurable;
- specified accuracy as a welding current meter.

EXAMPLE 1 Only single-phase alternating current measurable, ordinary class, and maximum measuring current value of 15 kA.

15 kA ac class 5.0

EXAMPLE 2 Single-phase alternating current and direct current measurable, accurate class, and maximum measuring current value of 20 kA.

20 kA ac/dc class 2.0

6 Requirements for welding current meter with current sensing coil

6.1 Welding current meter

The welding current meter shall consist of a data processing unit, and a display of the welding current and weld time. An example of the construction is illustrated in Annex B.

The welding current shall be indicated as at least the true r.m.s. (root-mean-square) value. The weld time should be counted on a cycle basis or the length indicated in milliseconds, calculated as the product of the length of 1 cycle and the number of cycles.

Welding current meters alone (without the current sensing coil) are classified as in Table 2 depending on the measuring accuracy.

Table 2 — Requirements for measuring accuracy of welding current meters

Classification	Measuring accuracy	Application
Highly accurate class	$\pm 0,5$ % of full scale	Laboratory use
Accurate class	$\pm 1,0$ % of full scale	Routine use for highly accurate systems
Ordinary class	$\pm 2,0$ % of full scale	Routine use for ordinary systems

The scatter shall be checked against the rated value of the test welding current meter in accordance with the test procedures specified in ISO 17657-4.

6.2 Current sensing coil

The current sensing coil shall conform to requirements described in ISO 17657-3. The conversion coefficient of the current sensing coil should coincide with requirements of the integrator built into the welding current meter, and the value of the low-inductive output resistor shall meet the requirement specified by the supplier for the current sensing coil itself.

6.3 Welding current meter with its current sensing coil

The error of the welding current meter with its coil should be adjusted together with that of the welding current meter and its current sensing coil. If it is necessary to change the current sensing coil, the welding current measuring system shall be calibrated with a reference welding current measuring system.

The error of welding current measuring system should be calculated with the sum of both error values of the welding current meter and its current sensing coil, or determined by measurements for a welding current meter with its current sensing coil.

The maximum error of welding current measuring systems within the measuring range shall be within the measuring accuracy stipulated in Table 1 corresponding to required class.

6.4 Integrator

The integrator for processing the output signal from the current sensing coil shall be designed to allow the measurement of at least full-wave alternating current and heat-controlled alternating current. The output signal should not be clipped or distorted by the supply voltage to the integrator.

NOTE When the welding current meter is applied for measuring the medium-frequency alternating current or medium-frequency direct current, an agreement may be needed between the manufacturer and the purchaser.

6.5 Data processing unit

The data processing unit consists of at least an analog-digital converter, memories and CPU. The values shall be kept in the memory until the next measurement.

The computing algorithm shall be designed to obtain a true r.m.s. value of the welding current. The start time and finish time used for the calculation shall comply with Annex A to this part of ISO 17657 and to ISO 17657-1:2005.

Annex A to this part of ISO 17657 and to ISO 17657-1:2005 shall also be referred to in order to calculate the welding current value for the weld time and for an indicated measuring time.

6.6 Display unit and output ports

The welding current meter should be built with a display device, either of the pointer type, the digital display type or print-out type, indicating the measured welding current and weld time defined in ISO 17657-1, and show the welding current value for an indicated measuring time. The current flow time should be automatically determined in the case of direct current measurements.

The time unit for input of all time values in alternating current mode shall be controlled at least in one cycle unit of the frequency of power source. In direct current mode, however, a millisecond unit may be used in addition to, or as an alternative to cycles.

The welding current meter may have some output ports for welding current waveform as an analog output signal, and the values of welding current and weld time etc. as digital signals.

6.7 Minimum and maximum duration of welding current

Measuring duration of welding current shall be determined based on the start and finish times of measurement as illustrated in Annex A.

The start and finish times for direct welding current shall comply with the principle of Figure A.1 and of Annex A in ISO 17657-1:2005.

6.8 Maximum measuring current

Measuring accuracy for the maximum measuring current indicated on the nameplate shall comply with those shown in Table 1 provided it is measured according to the method described in 7.1 using full-wave alternating current.

6.9 Minimum measuring current

Measuring accuracy for 30 % (± 5 %) current of the maximum measuring current indicated on the nameplate shall comply with those shown in Table 1 provided it is measured according to the method described in 7.2 using full-wave current.

6.10 Phase-controlled current

A measuring accuracy for a phase-controlled alternating current with a firing angle of 60° ($\pm 10^\circ$) shall comply with those shown in Table 1 according to the method described in 7.3 for a welding current value of each full scale of the welding current meter.

NOTE This requirement may be amended if there is an agreement between the manufacturer and the purchaser.

6.11 Minimum time for current measurement

A measuring accuracy of the welding current meter shall comply with those shown in Table 1 provided the welding current is measured in the minimum measuring time indicated on the nameplate according to the method described in 7.4.

6.12 Fluctuation of supply voltage

If the fluctuation in supply voltage to the welding current meter is up to ± 10 %, or battery voltage is within a permissible value, measuring accuracy of the welding current values shall comply with those shown in Table 1 when measurements are made using the method described in 7.5. Furthermore, a device shall be used to indicate any voltage drop in the power supply below the permissible value of the welding current meter and it should be capable of indicating when to use a battery.

6.13 Mechanical strength of current sensing coil

If the current sensing coil is subjected to a mechanical test as described in ISO 17657-3, then after the test, the measuring accuracy shall comply with those stipulated in Table 1.

6.14 Setting position error of current sensing coil

Measuring accuracy shall be checked with the test procedure described in 7.4 of ISO 17657-3:2005, and the deviation shall be recorded. The maximum measuring accuracy value shall comply with those shown in Table 1.

6.15 Influence of ambient temperature

If the welding current meter is subjected to a temperature test as described in 7.6, then the measuring accuracy for the maximum measuring current of the welding current meter indicated on the nameplate shall comply with those shown in Table 1. The tests shall be performed using the method described in 7.1 in not less than 95 % full-wave current.

6.16 Test

6.16.1 Type test

The following type tests shall be carried out according to procedures specified in Clause 7, results of which shall comply with requirements specified in Clauses 5 and 6:

- a) construction;
- b) minimum and maximum duration of welding current;
- c) maximum measuring current test;
- d) minimum measuring current test;
- e) phase-controlled current test;
- f) minimum measuring time test;
- g) fluctuation test of supply voltage;
- h) mechanical tests of current sensing coil;
- i) positioning test of current sensing coil;
- j) thermal test.

6.16.2 Acceptance test

Acceptance of a particular welding current meter with its coil shall be based on the above tests with the order of priority as listed in 6.16.1. However, some or all of items a), b), c) and e) can be omitted by agreement between the contracting parties.

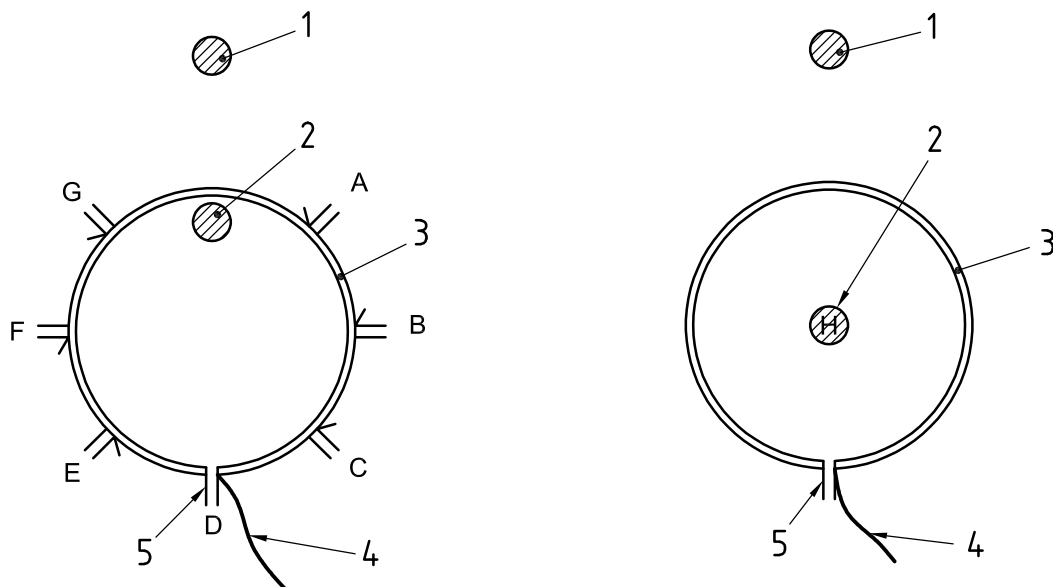
7 Test procedures

7.1 Maximum measuring current

The measuring accuracy of the welding current meter with its coil, for the maximum measuring current should be checked with a reference welding current measuring system in supplying 90 % to 100 % current of the maximum indicated value of the meter. When using the welding current meter for single-phase alternating current, the welding current meter with its coil shall be checked at 95 % or greater of full-wave current. A welding current meter applicable to direct current shall be checked in the maximum measuring time. The fixing part of the current sensing coil shall be set at position B, D or F shown in Figure 1 a) and the secondary conductor shall be located at the centre of the current sensing coil as shown in Figure 1 b).

7.2 Minimum measuring current

The measuring accuracy of the welding current meter with its coil, for the minimum measuring current should be checked with a reference welding current measuring system in supplying 30 % (± 5 %) of the maximum indicated value of the meter. When using the welding current meter for single phase alternating current, the welding current meter with its coil shall be checked at 95 % or greater of full-wave current. A welding current meter applicable to direct current should be checked at the maximum measuring time. The fixing part of the current sensing coil shall be set at position B, D or F shown in Figure 1 a) and the secondary conductor shall be located at the centre of the current sensing coil as shown in Figure 1 b).



a) Positions A to G (secondary conductor contacts to the coil)

b) Position H (secondary conductor located at the centre of coil)

Key

- | | | | |
|---|------------------------------|-------------|------------------------|
| 1 | secondary conductor (return) | A to G | fixing positions |
| 2 | secondary conductor | Figure 1 a) | shows position D used. |
| 3 | current sensing coil | | |
| 4 | lead cable | | |
| 5 | fixing | | |

Figure 1 — Examples of the arrangement of a current sensing coil and their position numbers

7.3 Phase-controlled current

The measuring accuracy of the welding current meter with its coil, in the maximum indicated value of the meter, shall be checked with a reference welding current measuring system in supplying a phase-controlled current with a firing angle of $60^\circ (\pm 10^\circ)$. The specification is only applicable to alternating current. The fixing part of the current sensing coil shall be set at position B, D or F shown in Figure 1 a) and the secondary conductor shall be located at the centre of the current sensing coil as shown in Figure 1 b).

7.4 Minimum time for current measurement

The measuring accuracy of the welding current meter with its coil at the minimum measuring time indicated on the nameplate shall be checked with a reference welding current measuring system in supplying 90 % (± 5 %) of the maximum scale reading of the current meter, and at the minimum measuring time.

7.5 Fluctuation of supply voltage

For welding current meters with their coils, suitable for measurement of single-phase alternating current only, full-wave conduction shall be used:

- alternating current power supply: the measuring accuracy shall be checked for input power supply fluctuations of -10% and $+10\%$, by using a reference welding current measuring system;
- battery supply: the measuring accuracy shall be checked for changing the battery power supply at the permissible limit value of battery voltage.

7.6 Thermal test

Tests described in 7.1 shall be carried out after maintaining the welding current meter and its current sensing coil in a temperature-controlled oven for one hour, until the peripheral temperature reaches test temperature. The thermal test shall be carried out at both +5 °C and +40 °C. The test shall be completed within three minutes of removal from the oven.

8 Marking

The welding current meter shall be marked with following indications:

- a) name of the current meter;
- b) type(s) of welding current;
- c) maximum measuring current (kA);
- d) minimum time for current measurement (ms or number of cycles);
- e) maximum time for current measurement (ms or number of cycles);
- f) threshold level for measuring direct welding current in effective value to determine the weld time (%), (applicable only for direct current measuring system);
- g) rated value of supply voltage for welding current meter (power source line voltage or battery voltage);
- h) power supply frequency for welding machine (Hz);
- i) date of manufacture;
- j) manufacturer's name or its abbreviation;
- k) accuracy class for welding current meter with its coil;
- l) type of coil;
- m) coil sensitivity;
- n) coil class.

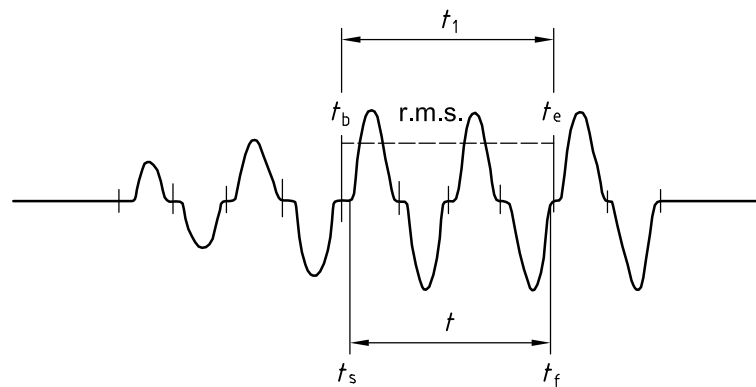
Annex A (normative)

Definition of indicated measuring time and its indicated current value

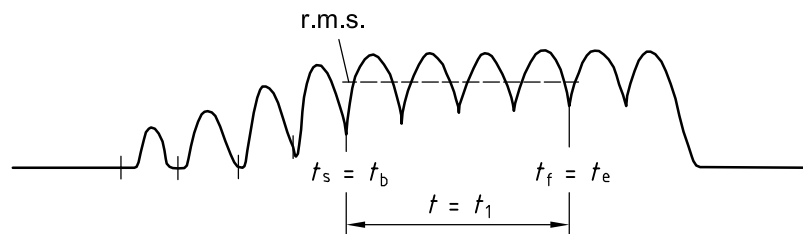
A.1 Indicated measuring time

The calculation shall be performed in a whole-number multiple of each cycle duration of 50 Hz or 60 Hz depending on the frequency of power supply when measuring alternating current, and which shall be applied even in measuring the heat-controlled current. The calculation time for direct current should equate to a whole-number multiple of either one half cycle or one cycle depending on the frequency of power source even for direct current.

Examples of definitions of indicated measuring time are shown in Figure A.1.



a) Single-phase alternating current



b) Direct current

where

- t_b measuring start time
- t_e measuring finish time
- t_f integration finish time
- t_s integration start time
- t_1 measuring time
- t integration time

Figure A.1 — Examples of the indicated measuring time

A.2 Welding current value for the indicated measuring time

The current value is displayed with an effective value accumulated from the start time t_s until finish time t_f of the measuring duration. The computation is achieved using equation (A.1).

$$i_{r.m.s.} = \sqrt{\frac{\int_{t_s}^{t_f} i^2 dt}{t_e - t_b}} \tag{A.1}$$

Where, the time t and t_1 defined as follows:

$$t = t_f - t_s \tag{A.2}$$

$$t_1 = t_e - t_b \tag{A.3}$$

The integration for the square of current value in alternating current is achieved only from t_s to t_f and it is normalized by the time length ($t_e - t_b$) counted in the half cycle (1/100 s or 1/120 s) unit to obtain the effective value. While in direct current measurement, the integrating time, t , is the same as the time, t_1 , for the normalization.

The definitions of t and t_1 are shown in Table A.1.

Table A.1 — Times used for integration

Type of current	t	t_1
ac	Defined in Figure A.1 a) $t = t_f - t_s$	[Cycle number defined in Figure A.1 a)] × (the length of 1 cycle time) ^a $t_1 = t_e - t_b$
dc	Defined in Figure A.1 b) $t = t_f - t_s$	Same value as the left definition $t_1 = t_f - t_s$

^a The length of 1 cycle time with alternating current = 1/50 s for 50 Hz or = 1/60 s for 60 Hz.

When calculating the welding current value in alternating current measurement, t_s is set to zero and t_b , t_f and t_e are set by the following values:

- t_b is set by the current start time shown in ISO 17657-1:2005, Annex A;
- t_f is set by the current finish time shown in ISO 17657-1:2005, Annex A;
- t_e is set by the time calculated by multiplying the number of cycles by the length of 1 cycle (see ISO 17657-1:2005, Annex A).

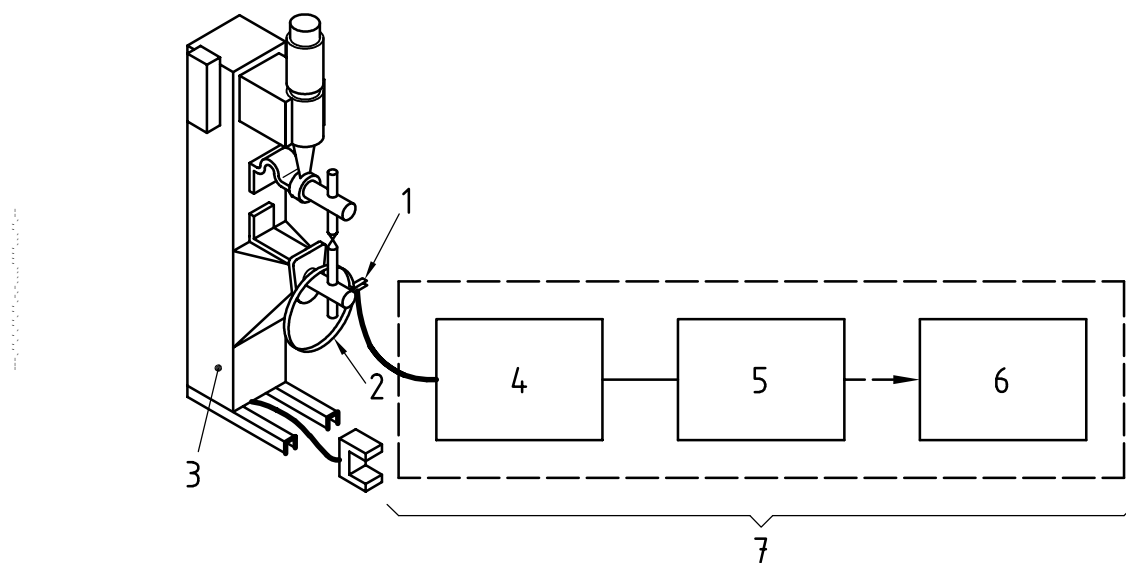
When calculating the welding current value in direct current measurement, t_s and t_b are set by the current start time and t_f and t_e are set by the current finish time shown in ISO 17657-1:2005, Figure A.1.

Annex B (informative)

Set-up of a current sensing coil and construction of welding current meters

The current sensing coil of flexible type shall be set up as shown in Figure B.1 in order to guarantee measuring accuracy.

In a portable type of welding current meter, all the above units, except the current sensing coil, are mounted in one small box.



Key

- 1 fixing
- 2 current sensing coil
- 3 resistance welding machine
- 4 integrator
- 5 data processing unit
- 6 display unit, recorder etc.
- 7 welding current meter

Figure B.1 — Typical set-up of the welding current meter with its coil

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