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Resistance welding — Vocabulary —

Part 1:

Spot, projection and seam welding

**Soudage par résistance —
Vocabulaire —**

Partie 1:

**Soudage par points, par bossages et à
la molette**

Widerstandsschweißen — Begriffe —

Teil 1:

**Punkt-, Buckel- und
Rollennahtschweißen**



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 17677-1:2019), of which it constitutes a minor revision. The main changes compared to the previous edition are as follows:

- the terms and definitions of ISO 14329 have been implemented;
- editorial changes have been made.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

Resistance welding — Vocabulary —

Part 1: Spot, projection and seam welding

1 Scope

This document establishes a vocabulary of terms and definitions for resistance spot welding, projection welding and seam welding.

NOTE In addition to terms used in English and French, two of the three official ISO languages, this document gives the equivalent terms in German; these are published under the responsibility of the member body for Germany (DIN). However, only the terms and definitions given in the official languages can be considered as ISO terms and definitions.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 Welding and testing procedures

3.1.1

chisel test

test in which a chisel is driven between the sheets near to adjacent welds until either fracture occurs or until the metal near the weld yields or bends

3.1.2

cross tension test

tensile test of a resistance welded specimen to determine the mechanical properties and failure mode of the weld

3.1.3

cross-wire welding

projection welding ([3.1.11](#)) of crossed wires or rods

3.1.4

direct welding

resistance welding secondary circuit variant in which welding current and *electrode force* ([3.3.5](#)) are applied to the workpieces by directly opposed *electrodes* ([3.2.1](#)) and only one weld is made by one welding operation

Note 1 to entry: See [Figure 12](#) for typical arrangements.

3.1.5

indirect welding

resistance welding secondary circuit variant in which the welding current flows through the workpieces in locations away from, as well as at, the welds

Note 1 to entry: See [Figure 13](#) for typical arrangements.

3.1.6

multiple impulse welding

welding with more than one impulse

Note 1 to entry: See [Figures 4](#) to [7](#) for related time and *electrode force* ([3.3.5](#)) diagrams.

3.1.7

multiple spot welding

spot welding in which two or more welds are made simultaneously in one welding operation

Note 1 to entry: Examples are *parallel spot welding* ([3.1.8](#)) and *series spot welding* ([3.1.14](#)).

3.1.8

parallel spot welding

resistance welding secondary circuit variant in which the secondary current is divided in parallel electrical paths to make two or more welds simultaneously

Note 1 to entry: See [Figure 11 a](#)).

3.1.9

peel test

destructive test in which a resistance-welded lap joint is tested by applying a peel force which results in stresses mainly in the thickness direction of the weld

3.1.10

pillow test

destructive test in which internal pressure is applied in order to test for leaks and the strength of a seam weld

3.1.11

projection welding

resistance welding in which the resulting welds are localized at predetermined points by projections, embossments or intersections, concentrating force and current by their geometry

Note 1 to entry: The projections are raised on, or formed from, one or more of the *faying surfaces* ([3.3.16](#)) and collapse during welding.

3.1.12

resistance spot welding

resistance welding process producing a weld at the *faying surfaces* ([3.3.16](#)) between overlapping parts by the heat obtained from resistance to the flow of welding current through the workpieces from the *electrodes* ([3.2.1](#)) serving to concentrate the welding current and pressure at the weld area

3.1.13

seam welding

resistance welding in which force is applied continuously and current is applied continuously or intermittently to produce a linear weld, the workpieces being between two *electrode wheels* ([3.2.5](#)) or an electrode wheel and an electrode bar

3.1.14**series spot welding**

resistance welding secondary circuit variant in which the secondary current is conducted through the workpieces and *electrodes* (3.2.1) in a series electrical path to simultaneously form multiple resistance spot, seam or projection welds

Note 1 to entry: See [Figures 1](#) and [11 b](#)).

3.1.15**roll spot welding**

resistance welding process variant that produces intermittent spot welds using one or more rotating circular electrodes

Note 1 to entry: The rotation of the *electrodes* (3.2.1) may or may not be stopped during the making of a weld.

3.1.16**shunt weld**

first weld on a series of spot welds, which acts as a shunt

3.1.17**tensile shear test**

test in which a lap-welded specimen is subjected to a tensile force with the aim of determining the mechanical properties of the specimen

3.1.18**stitch welding**

spot welding in which successive welds overlap

3.2 Hardware and tools**3.2.1****electrode****resistance welding electrode**

component of the electrical circuit that supplies electrical power and applies *electrode force* (3.3.5) to the workpiece

EXAMPLE Rotating wheel, rotating roll, bar, cylinder, plate, clamp, chuck, variations thereof.

3.2.1.1**angled electrode****bent electrode**

electrode for spot or *stitch welding* (3.1.18) whose *electrode working face* (3.2.6) is not normal to the mounting axis

3.2.1.2**contact electrode**

resistance welding electrode (3.2.1) designed to conduct secondary current through a workpiece without making a weld

3.2.1.3**offset electrode****eccentric electrode**

electrode for spot or *stitch welding* (3.1.18) whose *electrode working face* (3.2.6) is not concentric with the axis of the *electrode adaptor* (3.2.2)

3.2.2**electrode adaptor****shank**

device used to attach an *electrode* (3.2.1) to an *electrode holder* (3.2.4)

3.2.3

electrode cap

replaceable *electrode* ([3.2.1](#)) tip used in *resistance spot welding* ([3.1.12](#))

3.2.4

electrode holder

device holding a welding *electrode* ([3.2.1](#))

3.2.5

electrode wheel

seam welding wheel

rotating *resistance welding electrode* ([3.2.1](#)) of ring or disc shape

3.2.6

electrode working face

<resistance spot welding and projection welding> end of a *resistance welding electrode* ([3.2.1](#)) in contact with the workpiece

3.2.7

welding head

device comprising the force generation and guiding system, carrying an *electrode holder* ([3.2.4](#)), platen or *electrode wheel* ([3.2.5](#))

3.3 Welding process and parameters

3.3.1

chill time

quench time

period of time between the end of the weld current and the start of post-heat current during which no current flows and the weld is cooled by the *electrodes* ([3.2.1](#))

Note 1 to entry: See [Figure 5](#).

3.3.2

cool time

pause time

time interval between successive heat times in *multiple impulse welding* ([3.1.6](#)) or *seam welding* ([3.1.13](#))

Note 1 to entry: See [Figures 4](#) and [7](#).

3.3.3

current delay time

time interval between reaching set force and initiation of current flow

Note 1 to entry: See [Figure 3](#).

3.3.4

current-off time

period of time between the cessation of current in one *welding cycle* ([3.3.43](#)) and the beginning of current in the next one

3.3.5

electrode force

force applied by the electrodes to the workpieces

Note 1 to entry: See *welding force* ([3.3.44](#)).

3.3.6

welding electrode force

electrode force applied during *weld time* ([3.3.40](#))

3.3.7**forging electrode force
forge force**

electrode force applied in the forge force time

3.3.8**dynamic electrode force**

electrode force applied during the actual *welding cycle* ([3.3.43](#))

3.3.9**static electrode force**

electrode force with no current flowing and no movement in the welding machine

3.3.10**theoretical electrode force**

force, neglecting friction and inertia, available at the electrodes of a resistance welding machine by virtue of the initial force and the theoretical mechanical properties of the system

3.3.11**electrode force programme**

predetermined sequence of changes of force during welding

3.3.12**electrode force and current programme**

predetermined sequence of changes of force and current during the *welding cycle* ([3.3.43](#))

3.3.13**electrode movement during welding**

physical displacement of *electrodes* ([3.2.1](#)) due to thermal expansion, shrinkage and indentation during welding

3.3.14**electrode skidding**

lateral movement of the *electrodes* ([3.2.1](#)) relative to the surface of the workpieces during the welding process

3.3.15**electrode stroke**

physical movement of *electrodes* ([3.2.1](#)) in the electrode axis during the *welding cycle* ([3.3.43](#))

3.3.16**faying surface**

mating surface of a workpiece in contact with another workpiece to which it is to be joined

3.3.17**force application time**

total time of the application of force by the *electrodes* ([3.2.1](#)) to the workpiece in a *welding cycle* ([3.3.43](#))

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.18**force fall time**

time between the start of force decrease to zero force

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.19**force maintenance time**

time in the *welding cycle* ([3.3.43](#)) during which a force is maintained at a predetermined level, excluding the *force rise time* ([3.3.20](#)) and *force fall time* ([3.3.18](#))

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.20

force rise time

time between the start of a force increase and the application of the predetermined force

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.21

electrode force time

force time

time during which the force is built up and applied

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.22

forge time

<welding force programme> time of increased force applied during or after the passage of the welding current

Note 1 to entry: See [Figure 6](#).

3.3.23

head approach time

time of movement of the *electrode* ([3.2.1](#)) from the rest position to contact with the workpiece

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.24

head return time

time of electrode return from contact with the workpiece to the rest position

3.3.25

heat-affected zone

HAZ

portion of non-melted parent metal whose microstructure has been affected by the heat of welding

Note 1 to entry: See [Figure 2](#). <https://standards.iso.org/iso/17677-1:2021>

[SOURCE: ISO/TR 25901-1:2016, 2.1.2.2, modified — “by the heat of welding” has been added to the definition and Note 1 to entry has been added.]

3.3.26

heat time

duration of any one impulse in *multiple impulse welding* ([3.1.6](#)) or resistance *seam welding* ([3.1.13](#))

Note 1 to entry: See [Figures 4](#) to [7](#).

3.3.27

hold time

duration of *electrode force* ([3.3.5](#)) after cessation of current flow

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.28

off-time

force set off-time

time after hold time until next start of working cycle

Note 1 to entry: See *actual force off-time* ([3.3.29](#)).

3.3.29**actual force off-time
actual off-time**

measured period of time between two successive *welding cycles* (3.3.43) when no *electrode force* (3.3.5) is being applied to the workpiece

Note 1 to entry: See *off-time* (3.3.28).

Note 2 to entry: See [Figures 3](#) to [7](#).

3.3.30**opposing forces**

forces tending to separate the electrodes, such as from a mismatch of workpieces, spring back, sealants, etc.

Note 1 to entry: See *welding force* (3.3.44).

3.3.31**post-heat time
temper time**

time following the *chill time* (3.3.1) during which a current is passed through the weld for heat treatment or improvement of weld microstructure

Note 1 to entry: See [Figures 5](#) and [6](#).

3.3.32**preheat time**

duration of preheating current flow applied before the welding current

Note 1 to entry: See [Figures 5](#) and [6](#).

3.3.33**expulsion
splash
spatter
flash**

metal particles expelled between the *faying surfaces* (3.3.16) of the components or between the components and electrodes during *resistance spot welding* (3.1.12), *projection welding* (3.1.11) or *seam welding* (3.1.13)

3.3.34**squeeze time**

set time between the initiation of the *welding cycle* (3.3.43) and first application of current

Note 1 to entry: See *actual squeeze time* (3.3.35).

Note 2 to entry: See [Figures 3](#) to [7](#).

3.3.35**actual squeeze time**

actual time between the initiation of the *welding cycle* (3.3.43) and first application of current

Note 1 to entry: See *squeeze time* (3.3.34).

Note 2 to entry: The time and *electrode force* (3.3.5) diagrams of [Figures 3](#) to [8](#) show squeeze time.

3.3.36**time base**

time expressed in cycles of the power supply frequency or in milliseconds

3.3.37

upslope

controlled continuous increase of the current from a predetermined value or zero during a set time period

Note 1 to entry: See *down slope* ([3.3.38](#)).

3.3.38

down slope

controlled continuous decrease of the current until a predetermined value or zero is reached during a set time period

Note 1 to entry: See *upslope* ([3.3.37](#)).

3.3.39

weld contact area

area in the *faying surface* ([3.3.16](#)) through which welding current passes from one component to another during resistance welding

3.3.40

weld time

duration of continuous flow of welding current

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.41

welding current programme

predetermined sequence of changes of current

3.3.42

welding cycle time

time required to complete a *welding cycle* ([3.3.43](#)), excluding the time for positioning the *electrodes* ([3.2.1](#))

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.43

welding cycle

<resistance welding> sequence of operations carried out by the machine to make a weld and return the *electrodes* ([3.2.1](#)) to their initial position

3.3.44

welding force

force acting on the *faying surfaces* ([3.3.16](#)), resulting from the *electrode force* ([3.3.5](#)) and any *opposing forces* ([3.3.30](#)), e.g. spring back of the workpieces, and the geometry of the parts

3.3.45

welding force programme

predetermined sequence of changes of force

3.3.46

work clearance stroke

physical displacement of *electrodes* ([3.2.1](#)), which allows them to move from one welding position to the next

Note 1 to entry: See [Figure 8](#).

3.3.47

working cycle time

duration of a succession of operations carried out by a machine or gun for the making of a weld, including the return to the initial position

Note 1 to entry: See [Figures 3](#) to [7](#).

3.3.48**working stroke**

minimum movement of the *electrodes* (3.2.1) during the *welding cycle* (3.3.43)

Note 1 to entry: See [Figure 8](#).

3.3.49**maximum stroke****high lift stroke****retract stroke**

maximum *electrode* (3.2.1) stroke

3.4 Measurements and values**3.4.1****corona bond area**

area surrounding the *nugget* (3.4.11) at the *faying surfaces* (3.3.16) in which only solid phase bonding has occurred

3.4.2**corona bond diameter**

d_c

mean diameter of the *corona bond area* (3.4.1)

Note 1 to entry: See [Figures 2](#) and [9](#).

3.4.3**current pass area**

area through which current passes from an *electrode* (3.2.1) to the workpiece, smaller than the *electrode working face* (3.2.6) and which varies during the welding operation

3.4.4**duty cycle**

X_c

percentage of time during a specified period when a power source or its accessories can be operated at rated output without overheating

Note 1 to entry: $X_c = \frac{\sum(t_{on})}{t_{sp}} \times 100\%$

where t_{on} is the heat time, and t_{sp} is the specific period.

3.4.5**electrode indentation**

spot or seam weld depression formed on the surface of workpieces by *electrodes* (3.2.1)

3.4.6**electrode indentation depth**

e_w, e_l

maximum depth of the *electrode indentation* (3.4.5) measured in the direction of the *electrode force* (3.3.5)

Note 1 to entry: See [Figure 2](#).

3.4.7**electrode indentation diameter**

d_{ew}, d_{el}

diameter of the *electrode indentation* (3.4.5)

Note 1 to entry: See [Figure 2](#).

Note 2 to entry: If possible the mean value should be used.

3.4.8

electrode life

number of acceptable spot welds or length of weld seam that can be made with an electrode without any redressing or replacement of the electrode

3.4.9

electrode service life

electrode production life

number of acceptable spot welds or length of weld seam that can be made with an *electrode* (3.2.1) before the electrode is no longer useable

3.4.10

electrode misalignment

unintentional offset between the axes of the *electrodes* (3.2.1)

3.4.11

nugget

zone in spot, projection or seam weld where the metal has been melted

Note 1 to entry: See [Figure 2](#).

3.4.12

nugget penetration

p_l, p_u

maximum penetration of the *nugget* (3.4.11) into the upper or lower workpiece, measured perpendicular to the *faying surface(s)* (3.3.16) of the workpieces

Note 1 to entry: See [Figure 2](#).

3.4.13

nugget thickness

p

<spot, projection or seam weld> maximum thickness of the *nugget* (3.4.11) in two or more sheets measured perpendicular to the *faying surface(s)* (3.3.16) of the workpieces

Note 1 to entry: For two sheets, $p = p_l + p_u$; see [Figure 2](#).

3.4.14

nugget overlap

o

<seam weld> length of common area between two adjacent overlapping seam weld *nuggets* (3.4.11)

Note 1 to entry: See [Figure 14](#).

Note 2 to entry: The area contains the portion of the preceding weld nugget remolten by the succeeding weld.

3.4.15

seam weld width

width of the weld metal in the plane of the *faying surfaces* (3.3.16) in a direction normal to the longitudinal axis of the linear seam weld

3.4.16

seam weld nugget length

d_l

length of individual weld *nugget* (3.4.11) in the *seam welding* (3.1.13) direction