BS EN ISO 669:2016

BSI Standards Publication

Resistance welding — Resistance welding equipment — Mechanical and electrical requirements

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National foreword

This British Standard is the UK implementation of EN ISO 669:2016. It supersedes BS 3065:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/29, Resistance welding.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Resistance welding - Resistance welding equipment - Mechanical and electrical requirements (ISO 669:2016)

Soudage par résistance - Matériel de soudage par résistance - Exigences mécaniques et électriques (ISO 669:2016)

Widerstandsschweißen - Widerstandsschweißeinrichtungen - Mechanische und elektrische Anforderungen (ISO 669:2016)

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European foreword

This document (EN ISO 669:2016) has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 "Welding and allied processes" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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The text of ISO 669:2016 has been approved by CEN as EN ISO 669:2016 without any modification.

Contents

Page

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.

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

This third edition cancels and replaces the second edition (ISO 669:2000), which has been technically revised.

Resistance welding — Resistance welding equipment — Mechanical and electrical requirements

1 Scope

This International Standard defines and specifies certain identified electrical and mechanical characteristics of equipment used for

— resistance spot welding,

— projection welding,

— resistance seam welding,

— upset welding[1)], and

— flash welding[2)].

This International Standard specifies the information to be given in equipment specifications and the test methods to be used for measuring those characteristics.

Not all requirements apply to all types of equipment.

The following types of power sources are included:

— single phase with alternating welding current;

— single phase with rectified welding current by rectification of the output of the welding transformer;

— single phase with inverter welding transformer;

— three phase with rectified welding current by rectification of the output of the welding transformer;

— three phase with a current rectification in the input of the welding transformer (sometimes called frequency convertor);

— three phase with inverter welding transformers.

This International Standard does not apply to welding transformers that are separate from the equipment.

NOTE Safety requirements for resistance welding equipment are covered by IEC 62135–1.

2 Normative references

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

ISO 5826:2014, *Resistance welding equipment — Transformers — General specifications applicable to all transformers*

ISO 17657-2, *Resistance welding — Welding current measurement for resistance welding — Part 2: Welding current meter with current sensing coil*

1) Often referred to by the non-preferred term, butt welding.

2) Often referred to by the non-preferred term, flash butt welding.

ISO 17657-5, *Resistance welding — Welding current measurement for resistance welding — Part 5: Verification of welding current measuring system*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

IEC 62135-1, *Resistance welding equipment — Part 1: Safety requirements for design, manufacture and installation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17677-1 and the following apply.

3.1 Mechanical parts of spot, projection, and seam welding equipment

3.1.1
arm
device for transmitting the *electrode force* (3.1.16) which can also conduct the welding current or support a separate conductor

Note 1 to entry: See Figure 1 and Figure 3.

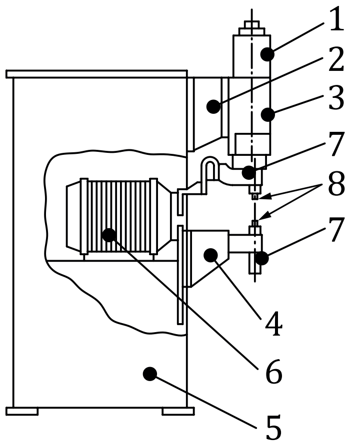
3.1.2
welding head
device comprising the force generation and guiding system carrying an *electrode holder* (3.1.3), *platen* (3.1.5), or *seam welding head* (3.1.6) mounted to the upper arm or directly to the machine body

Note 1 to entry: See Figure 1.

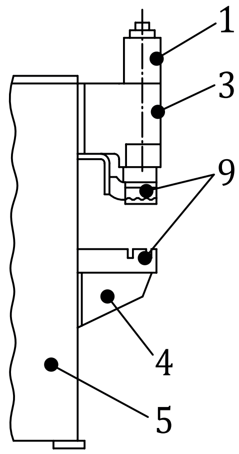
3.1.3
electrode holder
device holding a *spot welding electrode* (3.1.4) or an electrode adaptor

[SOURCE: ISO 8430-1, ISO 8430-2, and ISO 8430-3]

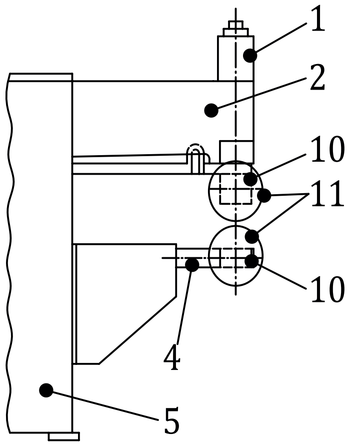
Note 1 to entry: See Figure 1.



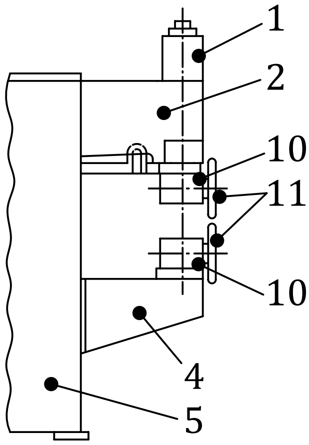
a) Spot welding equipment



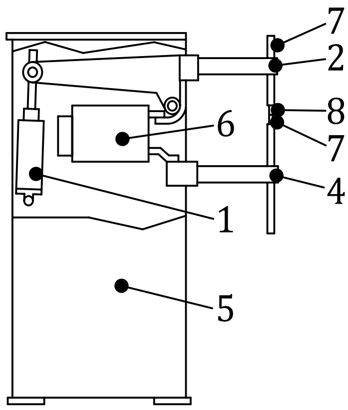
b) Projection welding equipment



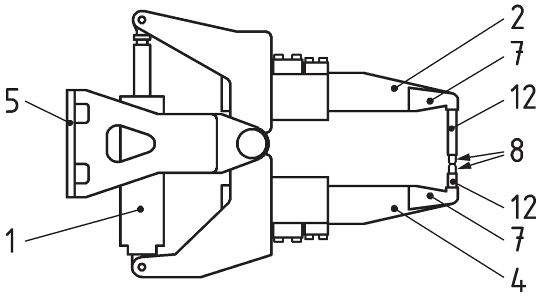
c) Longitudinal seam welding equipment



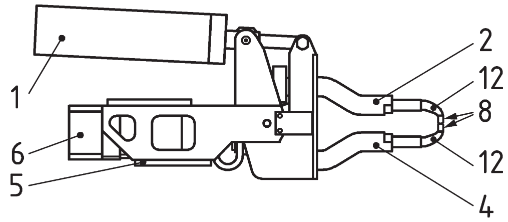
d) Transverse seam welding equipment



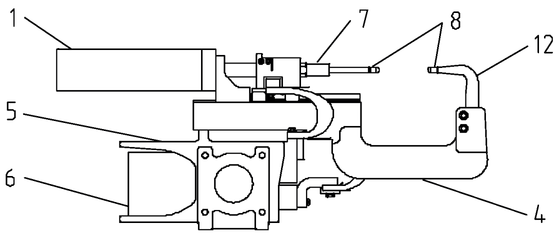
e) Rocker arm welding equipment



f) Welding gun without transformer



g) Manual gun with integrated transformer

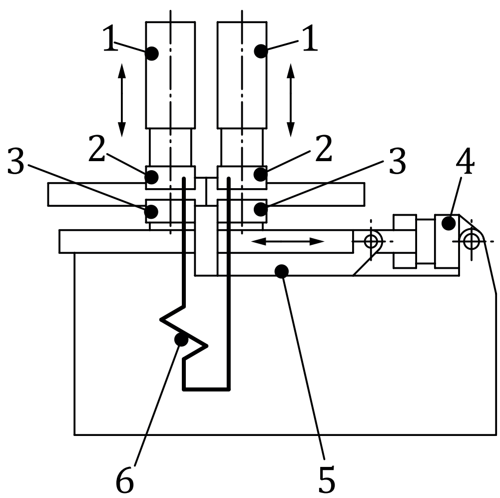


h) Robot mount C-gun

Key

1	force generation system	5	frame	9	platen
2	moveable arm	6	transformer	10	seam welding head
3	welding head	7	electrode holder	11	electrode wheel
4	stationary arm	8	spot welding electrode	12	electrode adapter

Figure 1 — Elements of spot, projection, and seam welding equipment



Key

1 clamping device
2 clamping die
3 current-carrying clamping die

4 slide drive
5 slide
6 welding transformer

Figure 2 — Elements of upset welding equipment

a) Arm length fixed **b) Arm length adjustable**

Figure 3 — Arms (lower arms)

3.1.4
spot welding electrode
electrode designed for spot welding

[SOURCE: ISO 5184 and ISO 5821]

Note 1 to entry: See Figure 1.

3.1.5
platen
device normally having tee slots and carrying projection welding electrodes or welding tools

[SOURCE: ISO 865]

Note 1 to entry: See Figure 1.

3.1.6
seam welding head
device comprising an *electrode wheel bearing* (3.1.7) and mounted on the upper and lower arm for longitudinal and/or transversal seam welding

Note 1 to entry: See Figure 1.

3.1.7
electrode wheel bearing
device guiding the *electrode wheel* (3.1.8) for force transfer and mostly for current transfer

3.1.8
electrode wheel
electrode as a rotating disc

Note 1 to entry: See Figure 1.

Note 2 to entry: This device can be driven by a motor or moved by the workpiece (idler wheels). The driver can be direct to the electrode shaft or to its circumference (knurl drive) (see Figure 6).

3.1.9
electrode wheel profile
form of the *electrode wheel* (3.1.8) being single- or double-sided bevelled or radiused depending on the welding conditions and access

Note 1 to entry: See Figure 5.

3.1.10
electrode wheel speed
<direct drive seam welding> rotational speed, *n*, of the *electrode wheel* (3.1.8)

Note 1 to entry: See Figure 4.

3.1.11
electrode wheel speed
<knurl drive seam welding> linear tangential speed, *v,* of the *electrode wheel* (3.1.8) at the circumference

Note 1 to entry: See Figure 4.

3.1.12
throat gap
e
<spot and seam welding equipment> usable distance between the *arms* (3.1.1) or the outer current conducting parts of the welding circuit

Note 1 to entry: See Figure 6.

3.1.13
platen distance
e
<projection welding equipment> clamping distance between the *platens* (3.1.5)

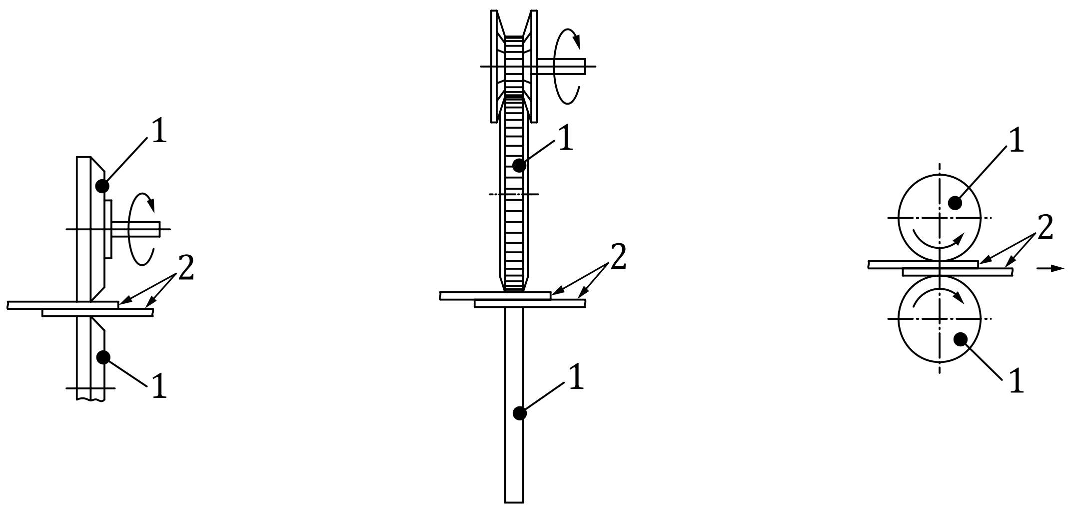
Note 1 to entry: See Figure 6.

Note 2 to entry: See also *die distance* (3.2.11).

3.1.14
throat depth
l
usable distance from the centre of the *platens* (3.1.5) or the axes of the electrodes or, in the case of oblique electrodes, the point of intersection of the electrode axes in the working position or the contact line of *electrode wheels* (3.1.8) and that part of the equipment body located closest to it

Note 1 to entry: See Figure 6.

Note 2 to entry: This definition does not consider any offset of the electrode tips.



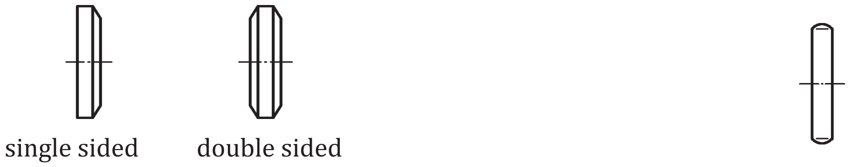
a) Direct drive **b) Knurl drive** **c) Idler wheels**

Key

1 electrode wheel

2 workpieces to be welded

Figure 4 — Drive types of electrode wheels



a) Bevelled **b) Radiused**

Figure 5 — Electrode wheel profiles

a) Spot welding equipment **b) Projection welding equipment**

c) Upset welding equipment (top view) **d) Seam welding equipment**

Key

e throat gap

l throat depth

Figure 6 — Main dimensions

3.1.15
electrode stroke
c
physical displacement of electrodes during process function

Note 1 to entry: When the electrode is attached to the force generation system, the stroke of both the electrode and the driving cylinder is equal.

Note 2 to entry: When the moving electrode is attached to a hinged lever moved by a force generation system, the maximum stroke of the electrode by convention equals the length of the chord of the arc generated by the tip of the moving electrode for the full stroke of the driving cylinder.

Note 3 to entry: The stroke of the electrode may be composed of a “work clearance stroke” without any contact, facilitating the introduction of the workpiece between the electrodes and a smaller “working stroke”.

3.1.16
electrode force
F
force to the workpiece transmitted by the electrodes

3.1.17
maximum electrode force
F_{max}
maximum electrode force which can be generated by the welding equipment without permanent damage to its mechanical parts

3.1.18
minimum electrode force
F_{min}
minimum electrode force which can be used for proper functioning of the welding equipment

3.2 Mechanical parts of upset and flash welding equipment

3.2.1
slide drive
drive generating and transferring the movements and upset forces necessary for welding to a workpiece located in the *clamping device* (3.2.2)

Note 1 to entry: See Figure 2.

Note 2 to entry: For flash welding, the drive may be required to reciprocate the slide for preheating by following the flashing movement and to provide the upset force.

3.2.2
clamping device
device generating the contact force necessary for current flow and providing the *clamping force* (3.2.13) necessary to withstand the upset force if no *supplementary clamping devices* (3.2.3) or *backstops* (3.2.4) are used

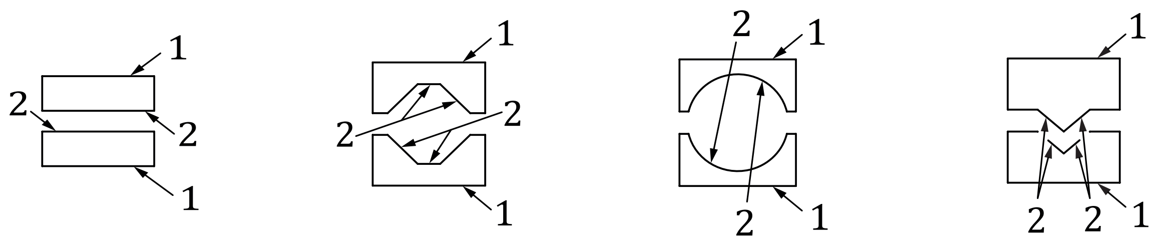
Note 1 to entry: See Figure 2.

3.2.3
supplementary clamping device
non-current carrying device to provide the *clamping force* (3.2.13) necessary to resist the upset force

3.2.4
backstop
device to support the total or a part of the *upsetting force* (3.2.15) to a workpiece in order to prevent a workpiece from sliding during upsetting

3.2.5
clamping die
device designed to transfer all forces to the workpiece in contacting with its clamping face

Note 1 to entry: See Figure 2 and Figure 7.



Key

1 mounting or support face

2 contact and/or clamping face

Figure 7 — Types of clamping dies (illustrated in upsetting direction)

3.2.6
die length
G
usable length of a *clamping die* (3.2.5) in the upsetting direction

Note 1 to entry: See Figure 8.

3.2.7
die width
W
usable width of a *clamping die* (3.2.5) perpendicular to the upsetting and clamping direction

Note 1 to entry: See Figure 8.

3.2.8
die thickness
δ
dimension of the die in the clamping direction

Note 1 to entry: See Figure 8.

3.2.9
die stroke
q
difference between the smallest and largest *opening gap* (3.2.10)

Note 1 to entry: See Figure 8.

3.2.10
opening gap
f
usable distance between flat clamping faces

Note 1 to entry: See Figure 8.

Note 2 to entry: If the workpiece has to be loaded perpendicular to the upsetting direction, the usable gap of profile dies is smaller than flat dies (see Figure 7).

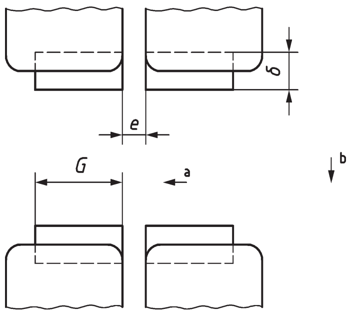
3.2.11
die distance
e
<upset and flash welding equipment> distance between both die pairs in the upsetting direction

Note 1 to entry: See Figure 8.

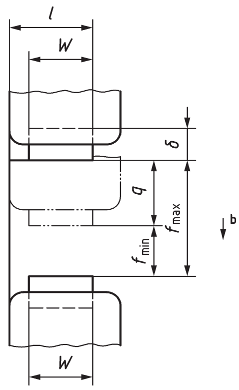
3.2.12
throat depth
l
distance perpendicular to the direction of the *upsetting force* (3.2.15) between the machine body and the outer edge of the *clamping dies* (3.2.5)

Note 1 to entry: See Figure 6 and Figure 8.

Note 2 to entry: See also *throat gap* (3.1.12).



a) View perpendicular to clamping and upsetting direction



b) View in upsetting direction

Key

G	die length
e	die distance
δ	die thickness
W	die width
l	throat depth
q	die stroke
f_{min}	minimum opening gap
f_{max}	maximum opening gap
a	Upsetting direction.
b	Clamping direction.

Figure 8 — Upset and flash welding equipment dimensions

3.2.13
clamping force
F_2
force applied to the workpiece by the *clamping dies* (3.2.5)

3.2.14
maximum clamping force
F_{2max}
maximum force the equipment is capable of providing to prevent any sliding and to maintain good electrical contact with the electrodes

3.2.15
upsetting force
F_1
force acting in the upsetting direction to press the workpieces together

3.2.16
maximum upsetting force
F_{1max}
maximum upsetting force which can be generated by the welding equipment without damage to its mechanical parts

3.2.17
minimum upsetting force
F_{1min}
minimum upsetting force which can be used for proper functioning of the welding equipment

3.3 Static mechanical characteristics

3.3.1
contact fault
fault relating to the *eccentricity* (3.3.2) and deflection

3.3.2
eccentricity
g
distance to which the central points of the electrode working faces or the clamping platens are displaced in relation to each other by the *electrode force* (3.1.16)

Note 1 to entry: See Figure 9 and Figure 10.

Note 2 to entry: The eccentricity of spot and seam welding equipment (see Figure 9) is calculated by the following formula:

$$g = b - a$$

Note 3 to entry: The eccentricity of projection welding equipment (see Figure 10) is measured in accordance with 11.2.2.

3.3.3
angular deflection
α
difference between the angular position, α_1, unloaded of the electrode axes, the clamping platen faces, or the workpiece axes and the angular position, α_2, under load

Note 1 to entry: α_1 may be zero by design.

Note 2 to entry: See Figure 9 to Figure 11.

Note 3 to entry: The angular deflection of spot and seam welding equipment (see Figure 9) is calculated by the following formula:

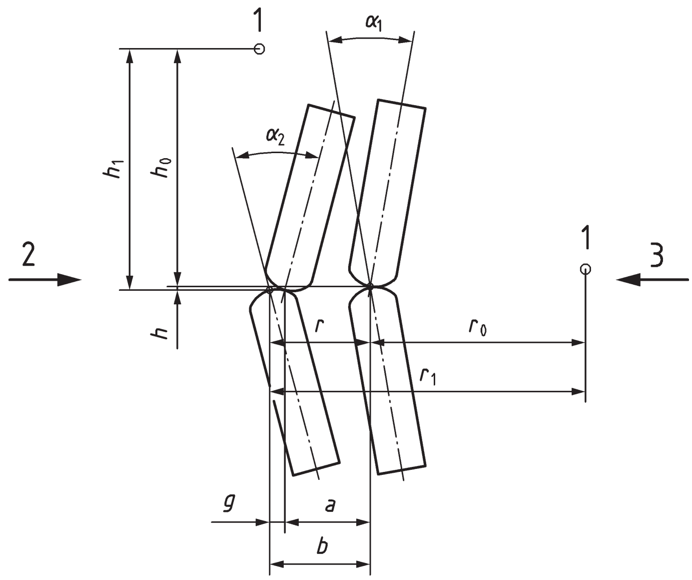
$$\alpha = \alpha_2 - \alpha_1$$

Note 4 to entry: The angular deflection of projection welding equipment (see Figure 10) is calculated by the following formula:

$$\alpha = \arctan\left(\frac{b_1 - b_2}{b_3}\right)$$

Note 5 to entry: The angular deflection of upset welding equipment (see Figure 11) is calculated by the following formula:

$$\alpha = \arctan\left(\frac{b}{k}\right)$$



Key

h_0	axial deflection - unloaded	b	length for determination of the contact fault
h_1	axial deflection - loaded	g	eccentricity (b - a)
h	axial deflection ($h_1 - h_0$)	α_1	angular position - unloaded
r_0	radial deflection - unloaded	α_2	angular position - loaded
r_1	radial deflection - loaded	1	reference measurement point
r	radial deflection ($r_1 - r_0$)	2	electrodes - loaded by F
a	length for determination of the contact fault	3	electrodes - unloaded

Figure 9 — Contact fault of spot and seam welding equipment

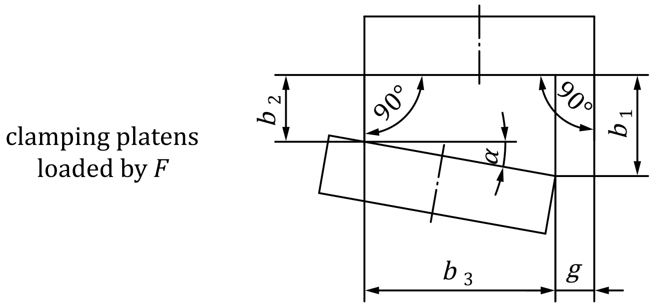


Figure 10 — Contact fault of projection welding equipment

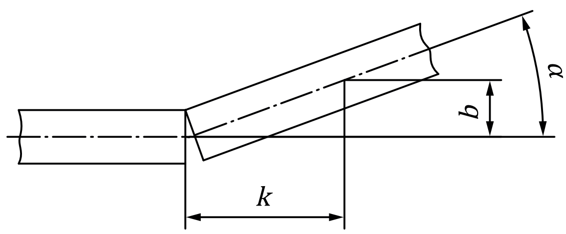


Figure 11 — Contact fault of upset welding equipment

3.3.4
radial deflection

r

displacement, normal to the direction of the *electrode force* (3.1.16), to which the central point of the electrode working face or a *platen* (3.1.5) is displaced by the application of the electrode force

Note 1 to entry: See Figure 9.

Note 2 to entry: The difference between radial deflection values r1 (electrode 1) and r2 (electrode 2) is equal to the value of *eccentricity* (3.3.2).

3.3.5
axial deflection

h

displacement of the central point of the electrode in the direction of the *electrode force* (3.1.16) as a result of the application of the electrode force

Note 1 to entry: See Figure 9.

3.3.6
machine stiffness

K

displacement or extension of the force generation system when the *maximum electrode force*, F_{max}, (3.1.17) is applied

Note 1 to entry: See 11.2.6.

Note 2 to entry: Not to be confused with stiffness as a function of force divided by displacement.

3.3.7
maximum angular displacement between top and bottom platen

δ_3

in projection welding, the maximum angle between the surfaces of the top and bottom *platens* (3.1.5) in two axes parallel and perpendicular to the throat of the machine

Note 1 to entry: See Figure 17 and Figure 18.

3.3.8
perpendicularity in movement of top and bottom platen

δ_4

in projection welding, the variation in perpendicularity between the trajectory of the movable top platen and the bottom platen when used as a reference measured in three dimensions (i.e. to the right and left and at the front and rear of the *platen* (3.1.5))

Note 1 to entry: See Figure 12.

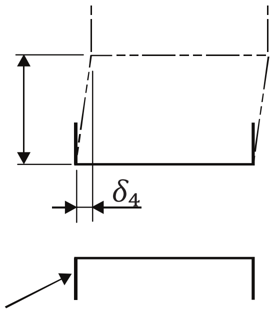


Figure 12 — Perpendicularity in movement of top platen (projection welding)

3.4 Electrical and thermal characteristics

3.4.1
duty
schedule of the operating conditions of equipment (their respective durations and sequences)

3.4.2
continuous duty
duty (3.4.1) corresponding to a permanent on load operation without any interruption, in which case, the *duty factor* (3.4.4) is 100 %

3.4.3
periodic duty
repeated identical cycles of a constant load and a no load time with the sum of one load time and one no load time being the weld cycle time

Note 1 to entry: This International Standard considers the load to be constant, i.e. without any preheating and/or post heating period.

3.4.4
duty factor
X
ratio for a given interval of the on load duration to the total time

Note 1 to entry: This ratio, lying between 0 and 1, can be expressed as a percentage.

3.4.5
rated input voltage
U_{1N}
input voltage for which the equipment is constructed

3.4.6
rated no load voltage
U_{20} or U_{2d}

3.4.7
a.c. no load voltage
U_{20}
voltage of one output winding of the transformer when the external circuit is open and the *rated input voltage* (3.4.5) is applied to the input terminals

Note 1 to entry: Several settings of the input winding result in relevant values of the no load voltage.

3.4.8
d.c. no load voltage
U_{2d}
<inverter type equipment> measured maximum output voltage when operating under no load conditions with the *rated input voltage* (3.4.5) applied to the input terminals

Note 1 to entry: See 7.3.

3.4.9
permanent input current
I_{1p} or I_{Lp}
input current corresponding to the *permanent output current* (3.4.10)

Note 1 to entry: The relationship between input and output currents depend on the type of welding equipment.

Note 2 to entry: I_{1p} is used for single phase equipment while I_{Lp} is used for three phase equipment.

3.4.10
permanent output current
I_{2p}
highest output current on all settings of the regulator for continuous operation

[SOURCE: 100 % *duty factor* (3.4.4)]

Note 1 to entry: This parameter is used to characterize the performance of the equipment, but is not an operating condition except for seam welding.

3.4.11
permanent power
S_p
maximum electrical input power for 100 % *duty factor* (3.4.4) without the equipment exceeding the specified temperature rise

Note 1 to entry: This parameter is used to characterize the performance of the equipment, but is not an operating condition except for seam welding.

3.4.12
maximum time per impulse
t_i
time during which the output current may flow without interruption at a given output current or voltage adjustment

Note 1 to entry: This time is limited

— by the saturation of the magnetic circuit for welding equipment with rectification of the input, or

— by the heat rise of the rectifier for welding equipment with rectification of the output.

3.4.13
maximum short circuit current input
I_{1cc} or I_{Lcc}
root mean square (rms) value of the current at *rated input voltage* (3.4.5) at the highest output voltage tapping

Note 1 to entry: The electrodes being short circuited in accordance with Clause 8 and the two values given correspond to the minimum and maximum values of the impedance compatible with this method of short circuit.

Note 2 to entry: I_{Lcc} is used for welding equipment with rectification.

3.4.14
maximum short circuit output current
I_{2cc}
root mean square (rms) value of the current at *rated input voltage* (3.4.5) at the highest output voltage tapping

Note 1 to entry: The electrodes being short circuited in accordance with Clause 8 and the two values given correspond to the minimum and maximum values of the impedance compatible with this method of short circuit.

3.4.15
input power at 50 % duty factor
S_{50}
maximum electrical input power for 50 % *duty factor* (3.4.4) without the equipment exceeding the specified temperature rise calculated by the following formula:

$$S_{50} = S_p \sqrt{2}$$

3.5 Pneumatic and hydraulic characteristics

3.5.1
supply pressure
p_1
pressure of the energizing medium at the supply point of the welding equipment

3.5.2
minimum supply pressure
p_{1min}
minimum pressure at the supply point of the welding equipment to obtain the *maximum electrode force* (3.1.17)

3.5.3
maximum supply pressure
p_{1max}
maximum pressure allowable at the supply point of the welding equipment

3.5.4
rated cooling liquid flow
Q
total quantity of cooling liquid to operate the equipment at *permanent power* (3.4.11) without exceeding the temperature rise limits

3.5.5
cooling liquid pressure drop
Δ_p
pressure drop at the *rated cooling liquid flow* (3.5.4)

4 Symbols and abbreviated terms

The symbols used in this International Standard are listed in Table 1.

Table 1 — Symbols and their designations

Symbol	Designation	Reference
a	length for determination of the contact fault	3.3.1, Figure 9
a_1, a_2	lengths for determination of the angular deflection	11.3
b	length for determination of the contact fault	3.3.1, Figure 9, Figure 10
b_1, b_2, b_3	lengths for determination of the contact fault	3.3.1, 11.2.3, 11.3.3, 11.4.2, Figure 10
c	electrode stroke	3.1.15, 11.1
d	diameter of the tip of electrode or width of the electrode wheels	8.2
d_k	disc diameter	11.2.3
D_1	ball diameter	11.2.1
e	1) throat gap	3.1.12, 3.1.13, 8.4, 11.1, 12.3
	2) platen distance	3.1.13, 12.2
	3) die distance	3.2.11, 8.4, 12.3
e'	distance for calculation of the length of copper bar	8.3
f	opening gap	3.2.10
f_{max}	maximum opening gap	3.2.13
f_{min}	minimum opening gap	3.2.13
F	electrode force	3.1.16, 8.4

Table 1 *(continued)*

Symbol	Designation	Reference
F_{max}	maximum electrode force	3.1.17, 8.2, 8.3, 11.1, 12.3, 13
F_{min}	minimum electrode force	3.1.18, 12.3
F_1	upsetting force	3.2.15
F_{1max}	maximum upsetting force	3.2.16, 8.4, 11.1, 12.3, 13
F_{1min}	minimum upsetting force	3.2.17, 12.3, 13
F_2	clamping force	3.2.13
F_{2max}	maximum clamping force	3.2.14, 8.4, 11.4, 12.3, 13
F_{2min}	minimum clamping force	12.3, 13
F_1', F_2'	opposite forces	11.2.3
g	eccentricity	3.3.2, 11.1, 11.2.2, 11.3.2, 12.3, Figure 9, Figure 10
g_{10}, g_{50}, g_{100}	eccentricity at 10 %, 50 % or 100 % of the maximum force	12.3
G	die length	3.2.6, Figure 8
h	axial deflection	3.3.5, 11.2.5, Figure 9
h_0	axial deflection - unloaded	Figure 9
h_1	axial deflection – loaded	Figure 9
I_{1cc}	maximum short circuit current input	3.4.13, 8, 13
I_{1p}	permanent input current	3.4.9, 9.1, 13
I_{1X}	input current at a given duty factor	3.4.14
I_{2cc}	maximum short circuit output current	3.4.14, 12.3, 13
I_{2p}	permanent output current (100 % duty factor)	3.4.11, 9.1, 9.2, 12.3, 13
I_{Lcc}	maximum short circuit current input	3.4.15, 13
I_{Lp}	permanent input current	3.4.10, 9.1, 9.2, 13
k	distance for determination of angular deflection	3.3.3, 11.3, 11.4, Figure 11
K	machine stiffness	3.3.6, 11.2.6
l	throat depth	3.1.14, 3.1.16, 3.2.13, 11.1, 12.3
L_{sc}	short circuit length of copper bar	8.4, 11.4
L	length of copper bar	8.3
m	mass of the welding equipment	12.3, Annex A
n	(rotational) electrode wheel speed	3.1.10, 12.3
p_1	supply pressure	3.5.1
p_{1min}	minimum supply pressure	3.5.2, 12.3, 13
p_{1max}	maximum supply pressure	3.5.3, 12.3, 13
q	die stroke	3.2.9, Figure 8
Q	rated cooling liquid flow	3.5.4, 10, 12.3, 13
r	radial deflection	3.3.4, 11.2.4, Figure 9
r_0	radial deflection – unloaded	Figure 9
r_1	radial deflection – loaded	Figure 9
S_p	permanent power (100 % duty factor)	3.4.11, 9.1, 9.2, 12.3
S_{50}	input power at 50 % duty factor	3.4.15 ,12.2
t_i	maximum time per impulse	3.4.12
U_{1N}	rated input voltage	3.4.5, 7, 9.2, 12.3, 13
U'_{1N}	input voltage	7

Table 1 *(continued)*

Symbol	Designation	Reference
U_{20}	rated a.c. no-load voltage	3.4.6, 3.4.7, 7, 12.3, 13
U'_{20}	a.c. no-load voltage	7
U_{2d}	rated d.c. no-load voltage from inverter type welding equipment	3.4.8, 3.4.9, 7, 7.1, 12.3, 13
v	(linear tangential) electrode wheel speed	3.1.11, 12.3
W	die width	3.2.7, Figure 8, 8.4
X	duty factor	3.4.4, 3.4.14
α	angular deflection	3.3.3, Figure 10, Figure 11, 11.1, 11.2.3, 11.4.2, 12.3
α_1, α_2	angular positions for determination of the angular deflection	3.3.3, 11.3.3, Figure 9
α_{10}, α_{50}, α_{100}	angular deflection at 10 %, 50 % or 100 % of the maximum force	12.3
Δ_p	pressure drop of the cooling liquid circuit	3.5.5, 12.3, 13
δ	die thickness	3.2.8, Figure 8
δ_3	maximum angular displacement between top and bottom platen	3.3.7, 11.2.7
δ_4	perpendicularity in movement of top and bottom platen	3.3.8, 11.2.8

5 Physical environment and operating conditions

5.1 General

Welding equipment shall be suitable for use in the physical environment and operating conditions specified below. This International Standard is only applicable to resistance welding equipment used indoors.

When the physical environment and/or operating conditions are outside those specified below, an agreement may be needed between the supplier and the user (see IEC 60204-1).

NOTE Examples of these conditions are outdoor use, different altitude, different temperature of cooling medium, high humidity, unusually corrosive fumes, steam, excessive oil vapour, abnormal vibration or shock, excessive dust, unusual sea coast, or shipboard conditions.

5.2 Ambient air temperature

Welding equipment shall be capable of operating correctly in an ambient air temperature of between +5 °C and +40 °C.

5.3 Liquid cooling medium

The temperature of the cooling liquid can be up to +30 °C at the inlet of the welding equipment.

Condensation caused by high cooling liquid flow or low cooling liquid temperature in relation to the relative humidity should be prevented.

5.4 Humidity

The welding equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example, 90 % at 20 °C) (see IEC 60204-1).

Harmful effects of occasional condensation shall be avoided by proper design of the welding equipment or, where necessary, by proper additional measures (e.g. built in heaters, air conditioners, drain holes).

5.5 Altitude

Welding equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level. For other altitudes, see ISO 5826:2014, Annex B.

NOTE At altitudes over 1 000m, additional electrical safety considerations may be required (see IEC 60204-1).

5.6 Transportation and storage

Welding equipment shall be designed to withstand or suitable precautions shall be taken to protect against transportation and storage temperatures between −25 °C and +55 °C and for short periods not exceeding 24 h up to +70 °C.

Suitable means shall be provided to prevent damage from humidity, vibration, and shock. Consider frost/freezing protection and draining cooling water before shipping/storage.

6 Test conditions

6.1 General

The electrical and mechanical characteristics are valid for specific resistance welding equipment configuration(s). If the welding circuit is reconfigured or modified, for example, changes to geometries and/or materials, these characteristics may no longer be valid.

For equipment with interchangeable components, the options tested shall be clearly identified and recorded.

6.2 Environmental conditions

The tests shall be carried out on new, dry, and completely assembled welding equipment at an ambient air temperature of between +10 °C and +40 °C.

The ventilation shall be identical with that prevailing under normal service conditions. The measuring devices used shall not interfere with the normal ventilation of the welding equipment or cause abnormal transfer of heat to or from it.

Liquid cooled welding equipment shall be tested with cooling liquid conditions as specified by the manufacturer.

6.3 Measuring instruments

The accuracy of measuring instruments shall be the following:

a) electrical measuring instruments: ±1,0 % of full-scale except for the measurement of insulation resistance and dielectric strength where the accuracy of the instruments is not specified, but shall be taken into account for the measurement;

b) instruments for measuring welding current: ±5,0 % of full-scale;

   Electrical measurements shall be made under full wave, non-transient conditions.

c) temperature measuring instruments: ±2 K.

Unless otherwise specified, the tests required in this International Standard are type tests.

The measurement of welding current shall be carried out using a measuring instrument in accordance with ISO 17657-2 and ISO 17657-5.

7 Rated no load voltage at the output

7.1 General

The following parameters are used to specify rated output voltage characteristics:

— U_{20} – equipment with a.c. current output;

— U_{2d} – equipment with d.c. current output.

The values measured according to 7.2 and 7.3 shall not deviate from the value specified on the rating plate by more than ±2 % for U_{20} and ±5 % for U_{2d}.

Measurement shall be given for all output voltage settings (if applicable).

During the test the input voltage, U_1, shall correspond to U_{1N} ± 5 %.

The input voltage, U_1, shall be recorded and a correction formula, expressed in volts, shall be used to compensate the measurement if the input voltage, U_1, is different from U_{1N}.

$$U_{20} = U_{20}\frac{U_{1N}}{U'_{1N}} \quad (1)$$

Welding equipment may be provided with automatic systems that prevent the transformer from being energized to its maximum output when there is no welding current (e.g. constant current or inverter equipment). In this case, assistance from the manufacturer may be needed to disable these systems or circuits to allow a correct measurement.

7.2 a.c. no load voltage (U_{20})

The RMS value of the a.c. no load voltage shall be measured at the output of the equipment under the following conditions:

— with an open welding circuit;

— with the equipment welding current adjustment set to the maximum value.

7.3 d.c. no load voltage (U_{2d})

The RMS value of the d.c. no load voltage shall be measured at the output of the equipment under the following conditions:

— with a load resistor of R = 10 Ω (±10 %) connected across the output;

— with the equipment welding current adjustment set to the maximum value.

The RMS values of voltage at the output connections, U_{2d}, shall be measured using an integration time of 100 ms.

8 Maximum short circuit current

8.1 General

The maximum short circuit current shall be directly measured with a tolerance of ±5 %.

The short circuit shall be achieved by use of copper tools having a conductivity of at least (45×10^6) Sm^{-1} at 20 °C.

For equipment operating at line frequency if during measurement of the short circuit current, I'_{2cc}, the measured input voltage, U'_{1N}, differs from the rated input voltage, U_{1N}. The following correction formula shall be used to calculate the maximum short circuit output current, I_{2cc}:

$$I_{2cc} = I'_{2cc} \frac{U_{1N}}{U'_{1N}} \qquad (2)$$

Both measured input voltage, U'_{1N}, and short circuit current, I'_{2cc}, shall be measured with the same integration time equal to the welding current impulse duration.

Compliance shall be checked by measurement in accordance with the conditions given in the following:

— 8.2 for spot and seam welding equipment;

— 8.3 for projection welding equipment;

— 8.4 for upset and flash welding equipment.

For equipment with adjustable arms, the following current measurements are made successively:

a) minimum impedance condition, i.e. throat gap and throat depth are minimum;

b) maximum impedance condition, i.e. throat gap and throat depth are maximum.

For equipment with interchangeable arms, the test shall be performed on equipment equipped with the arms specified by the manufacturer. Information on maximum short circuit current shall always be related to the actual arms used in the test and shall be included on the data plate and in product documentation.

8.2 Spot and seam welding equipment

The electrodes or the rotating electrode wheels are brought into contact by applying the maximum electrode force, F_{max}, in accordance with the arm length used. The diameter, d, expressed in millimetres, of the tip of the electrodes or the width of the electrode wheels is related to the electrode force in accordance with Formulae (3) and (4), but it shall be at least 2,5 mm:

spot welding:

$$d = 0{,}16 \sqrt{F_{max}} \pm 5\ \%, \qquad (3)$$

seam welding:

$$d = 0{,}08 \sqrt{F_{max}} \pm 5\ \% \qquad (4)$$

where F_{max} is in daN.

8.3 Projection welding equipment

A copper bar with a cross section sufficient to prevent overheating is placed between the centres of the platens. The maximum electrode force, F_{max}, is applied and maintained.

The length, L, expressed in millimetres, of the copper bar is given by Formula (5):

$$L = 122\ F_{max}\ 10^{-5} + 75 \qquad (5)$$

where F_{max} is the maximum electrode force developed by the machine, in daN.

If the obtainable minimum distance between the platens is greater than the calculated length, the length shall be equal to the minimum distance plus 5 mm.

An additional test shall be made by inserting a copper bar of length, $L + e'$, between the platens where e' is the vertical distance between the lowest and highest position of the lower platen.

8.4 Upset and flash welding equipment

A copper bar with a cross section sufficient to prevent overheating is placed between the dies. The contact surfaces shall be as large as possible. The maximum clamping force ,F_{2max}, is applied.

The short circuit length, L_{sc}, expressed in millimetres, of the copper bar between the opposing faces of the dies (see Figure 13) is given by the following formula, but it shall be at least equal to the minimum die distance plus 5 mm.

$$L_{sc} = 1{,}5 \frac{F}{W} + 2 \tag{6}$$

For machines that operate with preheating, F, expressed in daN, is calculated as follows:

$$F = \frac{F_{1max}}{30} \tag{7}$$

For machines that operate without preheating, F, expressed in daN, is calculated as follows:

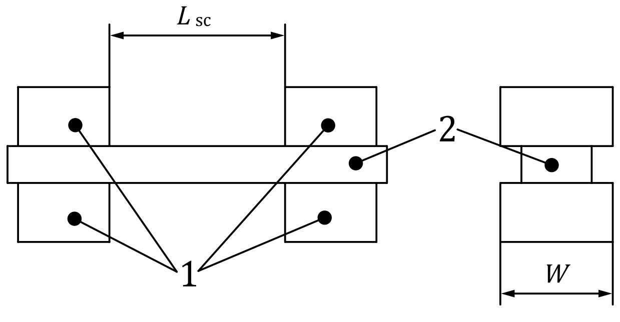
$$F = \frac{F_{1max}}{150} \tag{8}$$

where

W is in millimetres;

F_{1max} is in daN.

For machines that can operate with and without preheating, the lowest value of L_{sc} is used.



Key

1 die

2 copper bar

Figure 13 — Short circuit bar for upset welding equipment

9 Thermal rating

9.1 General

The thermal rating of the equipment is determined by the thermal features of all equipment parts including the welding transformer, welding circuit conductors, and the electric power control circuits.

The thermal rating for the equipment input is expressed by the permanent input current (I_{1p} or I_{Lp}) and permanent power (S_p).

The thermal rating for the equipment output is expressed by the permanent output current (I_{2p}).

These parameters are determined by performing an equipment thermal test as specified in accordance with 9.2.

If the transformer has been tested in accordance with ISO 5826, the equipment test can be performed without measuring the transformer temperature rise. In this case, the declared thermal rating parameters are lower between the transformer parameters and equipment test parameters results.

9.2 Thermal test

Thermal testing shall be performed in accordance with IEC 62135-1.

During the test, equipment is operated in an output condition equivalent to the permanent output current (I_{2p}).

NOTE Typical resistance welding equipment is operated at a reduced duty factor with high output current. Some welding equipment (i.e. seam welders) are designed to operate at the permanent output current, therefore, are tested at this condition. IEC 62135–1 specifies the test conditions.

The permanent input current (I_{1p} or I_{Lp}) is measured during the test.

The permanent power (S_p) is calculated on the input by Formulae (9) and (10):

$$S_p = I_{1p}\, U_{1N} \tag{9}$$

for single phase equipment, or

$$S_p = I_{Lp}\, U_{1N}\, \sqrt{3} \tag{10}$$

for three phase balanced equipment.

10 Cooling liquid circuit (liquid cooled welding equipment)

For water cooled welding equipment, the cooling liquid circuits shall enable a sufficient flow in order to ensure efficient cooling.

The cooling liquid circuit

a) shall be leak-tight at a pressure of 2,5 × the specified maximum operating pressure up to a maximum of 8 bar for 10 min, and

b) shall not have a cooling liquid pressure drop at the rated cooling liquid flow (Q) higher than that stated on the rating plate (Δ_p) (see Clause 12).

11 Static mechanical characteristics

11.1 General

The following static mechanical characteristics are recommended to be given in agreement between the manufacturer and the purchaser:

a) for spot, projection, and seam welding equipment:

 1) eccentricity, g, in millimetres;

 2) angular deflection, α, in milliradians;

b) for upset welding equipment:

 1) angular deflection, α, in milliradians.

Compliance shall be checked by measurement with

— 10 %,

— 50 %, and

— 100 %

of the maximum electrode force, F_{max}, (see 3.1.17) or upsetting force, F_{1max}, (see 3.2.17) at the maximum adjustment of the

— electrode stroke, c (see 3.1.15),

— throat depth, l (see 3.1.14), and

— throat gap, e (see 3.1.12).

The measurements are carried out in accordance with

— 11.2 for spot and projection welding equipment,

— 11.3 for seam welding equipment, and

— 11.4 for upset welding equipment.

Additionally, for moveable guns, eccentricity is also evaluated with the arms oriented vertically and horizontally.

NOTE The results are given as absolute values. If the deflection reverses when the force is increased, this is indicated by plus or minus as appropriate.

11.2 Spot and projection welding equipment

11.2.1 General

The measurement of eccentricity requires elimination of the friction between electrode faces with an apparatus such as described here.

Two hardened discs, as shown in Figure 14 and Figure 15, are placed with their plugs (instead of spot welding electrodes) or with their flanges at the centre of the platens in such a way that their opposite faces are parallel and the eccentricity does not exceed 0,05 mm. A steel ball is placed between the two hardened discs and centred using an appropriate flexible device.

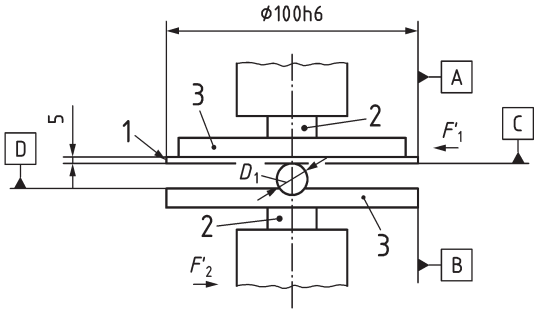
CAUTION — Appropriate precautions shall be taken to prevent the expulsion of the steel ball when under pressure.

NOTE 1 The hardened discs are machined to a tolerance of h6.

NOTE 2 The diameter of the ball, D_1, and the material used for the hardened discs are chosen so that no impression appears on the contact faces at the maximum force.

The contact faces, in particular, should be of hardened steel.

Dimensions in millimetres



Key

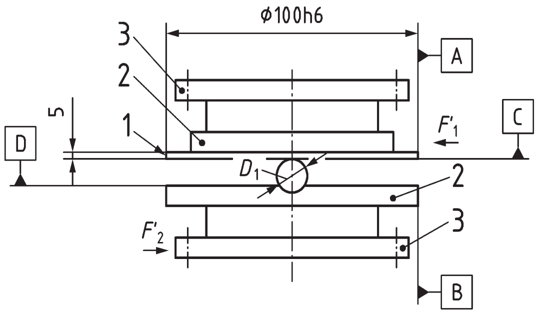
1 hardened disc

2 plug

3 support (steel ball recessed to prevent expulsion)

Figure 14 — Measurement accessory for spot welding equipment

Dimensions in millimetres



Key

1 hardened disc

2 support

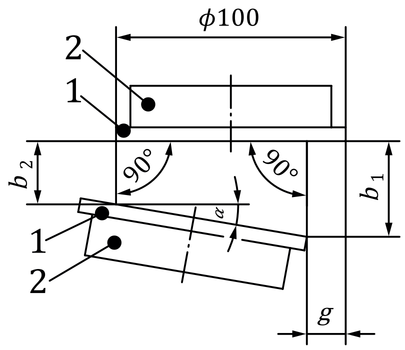
3 mounting flange

Figure 15 — Measurement accessory for projection welding equipment

11.2.2 Eccentricity

The eccentricity (g) is directly measured with a gauge calibrated to 0,01 mm (see Figure 16).

Dimensions in millimetres



Key

1 hardened disc

2 support

Figure 16 — Measurement of eccentricity and deflection

11.2.3 Angular deflection

The angular deflection (α), expressed in milliradians, is calculated using Formula (11):

$$\alpha = \arctan\left(\frac{b_1 - b_2}{100 - g}\right) \times 1\,000 \tag{11}$$

The distances, b_1 and b_2, between the hardened discs are measured using thickness gauges with an accuracy unit of 0,01 mm.

For rocker arm welding equipment, the electrodes should be parallel at the beginning of the test.

NOTE 1 The methods of fixing shown in Figure 14 and Figure 15 are for information only. Plugs can be fitted with adaptors to suit the welding equipment.

NOTE 2 If it is not possible to use discs with a diameter of 100 mm because of the dimensions of the welding equipment, smaller diameters, d_k, can be used by agreement with the user. In this case, the angular deflection, α, is given by Formula (12):

$$\alpha = \arctan\left(\frac{b_1 - b_2}{d_k - g}\right) \times 1\,000 \tag{12}$$

NOTE 3 In order to estimate the behaviour of the welding equipment when using offset electrodes, the discs may be subjected to the simultaneous application of

a) the maximum electrode force, and

b) two opposite forces, F_1' and F_2', equal to 10 % of the appropriate electrode force in a plane parallel to reference faces C and D (see Figure 14 and Figure 15) in the less favourable direction for the welding equipment.

This measurement is repeated with the forces, F_1' and F_2', reversed.

11.2.4 Radial deflection

Radial deflection, r, is calculated as the difference of the values of r_0 and r_1 measured before and after the application of the electrode force between a fixed point on the welding equipment and the central point of the electrode working face.

11.2.5 Axial deflection

Axial deflection, h, is calculated as the difference of the values of h_0 and h_1 measured before and after the application of the electrode force between a fixed point on the welding equipment and the central point of the electrode working face.

11.2.6 Machine stiffness

The machine stiffness, K, is determined by taking the difference in the stroke of the force generation system when the electrodes are brought into contact without electrode force and the maximum weld force, F_{max}.

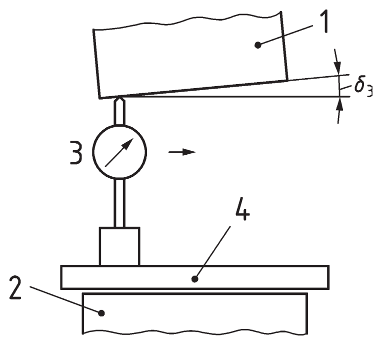
11.2.7 Parallelism of top and bottom platen

The top platen position is set as recommended by the manufacturer. A straightedge is placed on the bottom platen. The base of the dial gauge is placed on the straightedge with its measurement probe in contact with the top platen in accordance with Figure 17.

The displacement between the top and bottom platens as shown on the dial gauge is measured at positions A, B, C and D, 15 mm from the edges of the top platen, in accordance with Figure 18. The distance between positions A and B and C and D are also recorded.

δ_3 is the maximum angle of the calculated values for the two axes A to B and C to D.

NOTE For welding machines where the bottom platen slope can be adjusted, measurement can only be performed on the non-adjustable axis.



Key

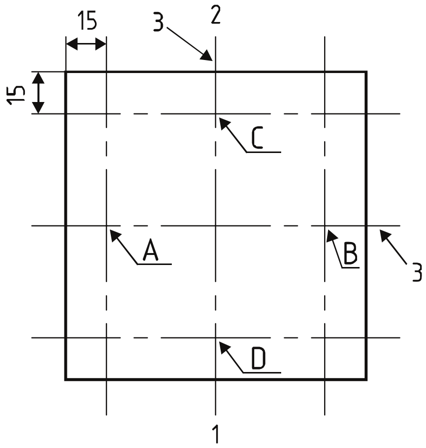
1 top platen (reference position)

2 bottom platen (reference position)

3 dial gauge

4 straightedge

Figure 17 — Measurement method for parallelism of top and bottom platen



Key

1 front edge

2 rear edge

3 centre line

Figure 18 — Platen accuracy at measurement point

11.2.8 Perpendicularity in platen movement, δ_4

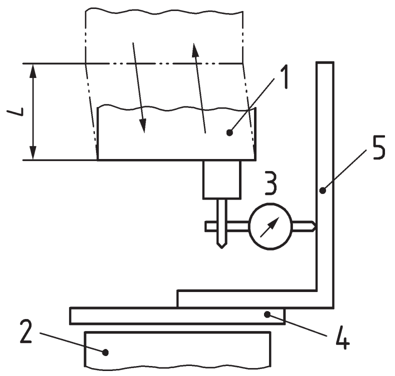
A straightedge is placed on the bottom platen in accordance with Figure 19. A square is placed on the straightedge.

The base of the dial gauge is fixed on the upper platen with its measurement probe at 90° to the direction of travel of the platen and in contact with the vertical edge of the square in accordance with Figure 19.

The top platen is moved over its total stroke, *L*. The displacement of the dial gauge over the total stroke is recorded with the square placed both parallel and perpendicular to the throat of the machine. δ_4 is the maximum value of the two measurements.

For machines where the bottom platen can be moved, measurements are repeated with the bottom platen in the highest and lowest positions.

NOTE For welding machines where the bottom platen slope can be adjusted, measurement can only be performed on the non-adjustable axis.



Key

1 top platen (reference position)
2 bottom platen (reference position)
3 dial gauge
4 straightedge
5 square

Figure 19 — Measurement of perpendicularity in movement of top and bottom platen, δ_4

11.3 Seam welding equipment

11.3.1 General

The welding equipment is fitted with electrode wheels that are normally delivered with it. The measurement device consists of a holder with two knife edges that are applied to the lower electrode wheel (see Figure 20).

Using a gauge calibrated to 0,01 mm, the dimensions, a_1 and b_1, with no load, and a_2 and b_2 with load are measured. The distance between a_1, a_2 and b_1, b_2 is k (see Figure 20).

11.3.2 Eccentricity

Eccentricity, g, expressed in millimetres, is calculated using Formula (13):

$$g = a_1 - a_2 \quad (13)$$

11.3.3 Angular deflection

Angular deflection, α, expressed in milliradians, is calculated using Formula (14):

$$\alpha = \alpha_1 - \alpha_2 \qquad (14)$$

where

$\alpha_1 = \arctan\left(\dfrac{b_1 - a_1}{k}\right) \times 1\,000$ (in milliradians);

$\alpha_2 = \arctan\left(\dfrac{b_2 - a_2}{k}\right) \times 1\,000$ (in milliradians).

a) Unloaded

b) Loaded by *F*

Figure 20 — Measurement arrangement in electrode wheels

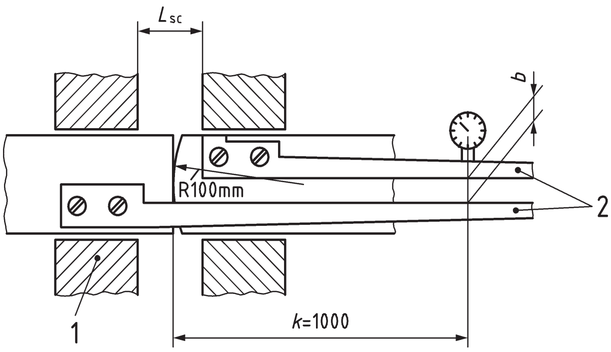
11.4 Upset welding equipment

11.4.1 General

Two bars of steel having a sectional area equal to the maximum area that can be welded and each fitted with a graduated scale approximately 1 000 mm in length are fixed in the dies and placed in contact in such a way that the distance between the dies, L_{sc}, is as given in 8.4.

These bars are kept in position by application of the maximum clamping force, F_{2max}. The contact face of one of the bars shall be curved and of radius R100 mm (see Figure 21).

Dimensions in millimetres



Key

1 clamping die

2 graduated straight-edge

Figure 21 — Measurement arrangement for upset welding equipment

Using a gauge calibrated to 0,01 mm, the dimensions, b_1, with no load and b_2, with load, are measured in the distance, k, from the plane of the contact (see Figure 21).

11.4.2 Angular deflection

Angular deflection, α, expressed in milliradians, is calculated by Formula (15):

$$\alpha = \arctan\left(\frac{b_2 - b_1}{k}\right) \times 1\,000 \qquad (15)$$

12 Rating plate

12.1 General

A clearly and indelibly marked rating plate shall be fixed securely to or printed on all welding equipment.

Compliance is checked by visual inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After the test, the marking shall be easily legible and it shall not be easy to remove the rating plate which shall show no curling.

NOTE The purpose of the rating plate is to inform the user of the electrical and mechanical characteristics of the equipment in order to enable correct selection, installation, and use.

12.2 Description

The rating plate shall be divided into sections containing at least the following information:

a) **Identification**

Box 1	Name and address of the manufacturer and optionally, a trademark and the country of origin, if required.
Box 2	Type (identification) as given by the manufacturer.
Box 3	Traceability of design and manufacturing data (e.g. serial number) and year of production.
Box 4	Reference to this International Standard and year of publication, i.e. ISO 669:2016 (confirming the data presented has been determined using the methods presented in this International Standard).

b) **Mains supply**

Box 5	U_{1N} = ... V	rated input voltage
Box 6	... ~ ... Hz	number of phases, e.g. one or three, symbol for alternating current (~), and the rated frequency, e.g. 50 Hz or 60 Hz
Box 7	S_p = ... kVA	permanent power (duty factor 100 %)

c) **Welding output**

Items with an asterisk are optional on the nameplate, but shall nevertheless be included in the documentation.

Box 8*	Welding current symbol, for example:	
	⎓	direct current (d.c.), or
	~	alternating current (a.c.) and additionally, the rated frequency in Hz (e.g.: ~ 50 Hz).
Box 9	U_{20} = ... V - ... V - ... V	a.c. no-load voltage values, or
	U_{20} = ... V to ... V in ... steps	range of a.c. no-load voltage values and number of adjustable steps.
	U_{2d} = ... V - ... V - ... V	d.c. no-load voltage values, or
	U_{2d} = ... V to ... V in ... steps	range of d.c. no-load voltage values and number of adjustable steps.
Box 10	I_{2cc} = ... A	maximum short circuit output current corresponding to the minimum impedance (*l* and *e* minimum),
		or for equipment with interchangeable arms, maximum short circuit current and specification of the arms (i.e. arm lengths, arms reference number, or arms drawing).
Box 11*	I_{2cc} = ... A	maximum short circuit output current corresponding to the maximum impedance (*l* and *e* maximum)
Box 12	I_{2p} = ... A	permanent output current

d) **Other characteristics**

Items with an asterisk are optional on the nameplate, but shall nevertheless be included in the documentation.

Box 13*	e = ... mm to ... mm	range of the throat gap, platen distance, or die distance
Box 14*	l = ... mm to ... mm	range of the throat depth
Box 15	F_{max} = ... daN	maximum electrode force corresponding to the minimum throat depth and optionally, the maximum throat depth
Box 16*	F_{min} = ... daN	minimum electrode force
Box 17	F_{1max} = ... daN	maximum upsetting force
Box 18*	F_{1min} = ... daN	minimum upsetting force
Box 19	F_{2max} = ... daN	maximum clamping force
Box 20	F_{2min} = ... daN	minimum clamping force

NOTE Box 17 to box 20 are only applicable for upset welding equipment.

Box 21	p_{1max} = ... bar	maximum supply pressure of the energizing medium that the equipment can support
Box 22	p_{1min} = ... bar	minimum supply pressure of the energizing medium to obtain the maximum electrode force
Box 23	Q = ... l/min	rated cooling liquid flow
Box 24*	Δ_p = ... bar	rated cooling liquid pressure drop
Box 25	m = ... kg	mass of the welding equipment
Box 26*	v = ... m/min to ... m/min n = ... min^{-1} to ... min^{-1}	range of electrode wheel speed

NOTE Box 26 is only applicable to seam welding equipment.

Box 27*	α_{10} = ... mrad	angular deflection at 10 % of F_{max} or F_{1max}
	α_{50} = ... mrad	angular deflection at 50 % of F_{max} or F_{1max}

NOTE These values are given only by agreement between the manufacturer and purchaser.

	α_{100} = ... mrad	angular deflection at 100 % of F_{max} or F_{1max}
Box 28*	g_{10} = ... mm	eccentricity at 10 % of F_{max} or F_{1max}
	g_{50} = ... mm	eccentricity at 50 % of F_{max} or F_{1max}
	g_{100} = ... mm	eccentricity at 100 % of F_{max} or F_{1max}

NOTE 1 These values are given only by agreement between the manufacturer and purchaser.

NOTE 2 The eccentricity, g, is not applicable for upset welding equipment.

The arrangement and sequence of the data shall comply with the principle shown in Figure 22 (for examples, see Annex A).

The dimensions of the rating plate are not specified and may be chosen freely.

NOTE 1 Additional information (e.g. angular deflection, eccentricity, g, maximum time per impulse, t_i) could be given.

NOTE 2 Other useful information could be given in technical literature supplied by the manufacturer, e.g. S_{50}.

<table>
<tr><td colspan="6">a) Identification</td></tr>
<tr><td colspan="6">1)</td></tr>
<tr><td colspan="6">2)</td></tr>
<tr><td colspan="3">3)</td><td colspan="3">4)</td></tr>
<tr><td colspan="6">b) Mains supply</td></tr>
<tr><td colspan="3">5)</td><td colspan="3">6)</td></tr>
<tr><td colspan="3">7)</td><td colspan="3"></td></tr>
<tr><td colspan="6">c) Welding Output</td></tr>
<tr><td colspan="2">8)</td><td colspan="4">9)</td></tr>
<tr><td colspan="2">10)</td><td colspan="2">11)</td><td colspan="2">12)</td></tr>
<tr><td colspan="6">d) Other characteristics</td></tr>
<tr><td colspan="3">13)</td><td colspan="3">14)</td></tr>
<tr><td colspan="3">15)</td><td colspan="3">16)</td></tr>
<tr><td colspan="3">17) if applicable</td><td colspan="3">18) if applicable</td></tr>
<tr><td colspan="3">19) if applicable</td><td colspan="3">20) if applicable</td></tr>
<tr><td colspan="3">21)</td><td colspan="3">22)</td></tr>
<tr><td colspan="3">23)</td><td colspan="3">24)</td></tr>
<tr><td colspan="3">25)</td><td colspan="3">26) if applicable</td></tr>
<tr><td colspan="3">27) if agreed</td><td colspan="3">28) if applicable and agreed</td></tr>
</table>

Figure 22 — Principle of the rating plate

12.3 Tolerances

The actual values obtained from resistance welding equipment shall meet the rated values within the tolerances given in the corresponding subclauses.

Compliance shall be checked by measurement and comparison.

13 Instruction manual

All welding equipment shall be delivered with an instruction manual. In addition to other required information, the instruction manual shall include at least the following information related to this International Standard:

a) rated input voltage, U_{1N}, frequency, and number of phases;

b) rated no load voltage, U_{20} or U_{2d};

c) permanent power, S_{p};

d) permanent input current, I_{1p} or I_{Lp};

e) maximum short circuit current input, I_{1cc} or I_{Lcc};

f) maximum short circuit output current, I_{2cc}, corresponding to the minimum impedance (l and e minimum);

g) maximum short circuit output current, I_{2cc}, corresponding to the maximum impedance (l and e maximum);

h) permanent output current, I_{2p};

i) minimum supply pressure, p_{1min} (if applicable);

j) maximum supply pressure, p_{1max} (if applicable);

k) rated cooling liquid flow, Q;

l) cooling liquid pressure drop, Δ_p.

m) maximum electrode force corresponding to the minimum and maximum throat depth, F_{max} (if applicable).

The following data are only applicable to upset and flash welding equipment:

a) maximum upsetting force, F_{1max};

b) minimum upsetting force, F_{1min};

c) maximum clamping force, F_{2max};

d) minimum clamping force, F_{2min}.

All values shall be identified by the symbols defined in this International Standard.

Additional information related to the parameters defined by this International Standard may also be given.

Compliance shall be checked by reading the instruction manual.

Annex A
(informative)

Examples of rating plates

a) Identification

1) Manufacturer, country, trademark		
2) Resistance seam welding equipment		
3) Serial number	Year of production	4) ISO 669:20XX

b) Mains supply

5) U_{1N} = 400 V	6) 1 ~50 Hz
7) S_p = 176 kVA	

c) Welding Output

8) ~	9) U_{20} = 4 V to 8 V in 4 steps	
10) I_{2cc} = 45 kA	11) I_{2cc} = 30 kA	12) I_{2p} = 22 kA

d) Other characteristics

13) e = 215 mm to 350 mm	14) l = 550 mm
15) F_{max} = 1 200 daN	16) F_{min} = 200 daN
21) p_{1max} = 8 bar	22) p_{1min} = 6 bar
23) Q = 16 l/min	24) Δ_p = 2 bar
25) m = 1 350 kg	26) v = 0,8 m/min to 8,0 m/min
27) α_{10} = mrad α_{50} = 0,05 mrad α_{100} = 0,24 mrad	28) g_{10} = mm g_{50} = 0,015 mm g_{100} = 0,02 mm

Figure A.1 — Seam welding equipment

a) Identification

1) Manufacturer, country, trademark		
2) Resistance seam welding equipment		
3) Serial number	Year of production	4) ISO 669:20XX

b) Mains supply

5) U_{1N} = 400 V	6) 1 ~50 Hz
7) S_p = 56 kVA	

c) Welding Output

8) ~	9) U_{20} = 3,5 V to 8 V in 4 steps	
10) I_{2cc} = 21 kA	11) I_{2cc} = 15 kA	12) I_{2p} = 7,8 kA

d) Other characteristics

13) e = 115 mm to 415 mm	14) l = 1 050 mm
15) F_{max} = 600 daN	16) F_{min} = 100 daN
21) p_{1max} = 10 bar	22) p_{1min} = 6 bar
23) Q = 12 l/min	24) Δ_p = 2 bar
25) m = 560 kg	

Figure A.2 — Spot welding equipment (if indication of angular deflection, α, and eccentricity, g, has not been agreed)

a) Identification

1) Manufacturer, country, trademark			
2) Resistance seam welding equipment			
3) Serial number	Year of production	4) ISO 669:20XX	

b) Mains supply

5) U_{1N} = 400 V	6) 3 ~50 Hz
7) S_p = 212 kVA	

c) Welding Output

8) ⎓	9) U_{20} = 11 V	
10) I_{2cc} = 165 kA	11) I_{2cc} = 130 kA	12) I_{2p} = 22,5 kA

d) Other characteristics

13) e = 200 mm to 500 mm	14) l = 350 mm
15) F_{max} = 3 000 daN	16) F_{min} = 230 daN
21) p_{1max} = 8 bar	22) p_{1min} = 6 bar
23) Q = 38 l/min	24) Δ_p = 4 bar
25) m = 2 230 kg	

Figure A.3 — Projection welding equipment (if indication of angular deflection, α, and eccentricity, g, has not been agreed)

a) Identification

1) Manufacturer, country, trademark			
2) Resistance seam welding equipment			
3) Serial number	Year of production	4) ISO 669:20XX	

b) Mains supply

5) U_{1N} = 400 V	6) 3 ~50 Hz
7) S_p = 410 kVA	

c) Welding Output

8) ⎓	9) U_{20} = 11 V	
10) I_{2cc} = 220 kA	11) I_{2cc} = 200 kA	12) I_{2p} = 53.4 kA

d) Other characteristics

13) e = 135 mm to 180 mm	14) l = 450 mm
15) F_{max} = 1 000 daN	16) F_{min} = 300 daN
17) F_{1max} = 1 000 daN	18) F_{1min} = 500 daN
19) F_{2max} = 2 000 daN	20) F_{2min} = 1 000 daN
21) p_{1max} = 140 bar	22) p_{1min} = 130 bar
23) Q = 150 l/min	24) Δ_p = 6 bar
25) m = 26 000 kg	

Figure A.4 — Upset welding equipment

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389 Chiswick High Road London W4 4AL UK