



**International
Standard**

ISO 14373

**Resistance welding — Procedure
for spot welding of uncoated and
coated low-carbon steels**

*Soudage par résistance — Mode opératoire pour le soudage par
points des aciers à bas carbone revêtus et non revêtus*

**Third edition
2024-01**

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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 document 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 14373:2015), which has been technically revised.

The main changes are as follows:

- figures showing failure types and modes for tensile shear and cross tension testing removed;
- new coating types added;
- cross-tension strength (CTS) values added;
- tensile shear strength (TSS) formula removed;
- tolerance for distortions reduced.

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>.

Introduction

Information on appropriate welding equipment is given in [Annex A](#) and information on spot-welding conditions is given in [Annex B](#). This information is provided for guidance only.

Depending on the service conditions of the fabrication, the type of welding equipment, the characteristics of the secondary circuit, the electrode force actuation system, the electrode material and the shape, it is possible that certain modifications will be necessary. In such cases, further information can be obtained from the relevant application standard, where one exists.

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Resistance welding — Procedure for spot welding of uncoated and coated low-carbon steels

1 Scope

This document specifies requirements for resistance spot welding in the fabrication of assemblies of uncoated and metallic-coated or weldable non-metallic-coated low-carbon steel, comprising two or three sheets of metal, where the maximum single-sheet thickness of components to be welded is within the range 0,4 mm to 3,0 mm.

This document is applicable to welding of sheets of the same or unequal thickness, where the thickness ratio is less than or equal to 3:1.

Welding with the following types of equipment is within the scope of this document:

- a) pedestal welding equipment;
- b) portable welding guns;
- c) automatic welding equipment where the components are fed by robots or automatic feeding equipment;
- d) multi-spot-welding machines;
- e) robotic welding machines.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10447, *Resistance welding — Testing of welds — Peel and chisel testing of resistance spot and projection welds*

ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding*

ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding*

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

3 Terms and definitions

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

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

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

3.1

weld pitch

centre-to-centre distance between adjacent spot welds

3.2

edge distance

distance from the edge of the component to the centre of a weld

4 Symbols

Symbol	Term	Unit
d_w	weld diameter (see ISO 17677-1)	mm
d_e	electrode tip diameter	mm
t	sheet thickness	mm

5 Materials

5.1 Form

The steel shall be flat rolled, in coil or cut to length, and shall be free from harmful imperfections.

5.2 Coatings

A partial list of coatings to which this document is applicable is given in [Annex C](#).

6 Surface conditions

Prior to welding, all surfaces of components to be welded shall be free from grease, scale, rust, paint, dirt or excessive pitting. Standard oiling from rolling or stamping operations is not detrimental to welding.

When the steel sheet has been hot formed, it shall be sandblasted (or processed by any equivalent cleaning process) prior to welding to remove the oxides formed during the hot forming operation. Steel sheets coated with aluminium-silicon coatings can be welded directly after hot forming without sandblasting.

Uncoated hot-rolled steel shall be in the pickled condition.

Coated steels can be supplied with a chromate or phosphate passivation treatment. Phosphated uncoated steel may also be used. These materials can be welded, although adjustment can be required to the welding parameters outlined in [Annex B](#). Generally speaking, only thin phosphate pre-treatment of steel is acceptable prior to spot welding.

Certain surface treatments, such as the application of paint primers, weldable organic coatings, rust preventatives and oils can be applied before welding, provided that the coating is uniform in thickness and it has been shown that consistent welds conforming to this document can be obtained. Excessive use of surface pre-treatment reduces the length of electrode life.

7 Edge conditions, form of component and weld pitch

The components to be welded shall be free from any burrs or other defects which could interfere with interface contact in some way or which could necessitate excessive force in fitting the parts together.

The shape of the component should be such that there is satisfactory interfacial contact in the area where the welds are to be made. The edge distance should not be less than $1,25 d_w$ (see [Figure 1](#)), where d_w is the weld diameter as defined in [10.1](#). The use of edge distances less than the recommended values influences weld quality adversely. In such cases, the nominal weld size specified may be less than that given in [10.1](#), therefore due allowance is needed for a lower weld strength (see [10.4](#)).

The weld pitch (see [Figure 1](#)) should be greater than $16 t$ and $3 d_w$. Tolerances for the weld pitch should not exceed $\pm 10 \%$, provided that it does not fall below the minimum value. If the weld pitch is too short, the

shunting current through the previous weld will reduce the size of the following weld. An increase of the welding current can partially mitigate the problem.

8 Electrodes

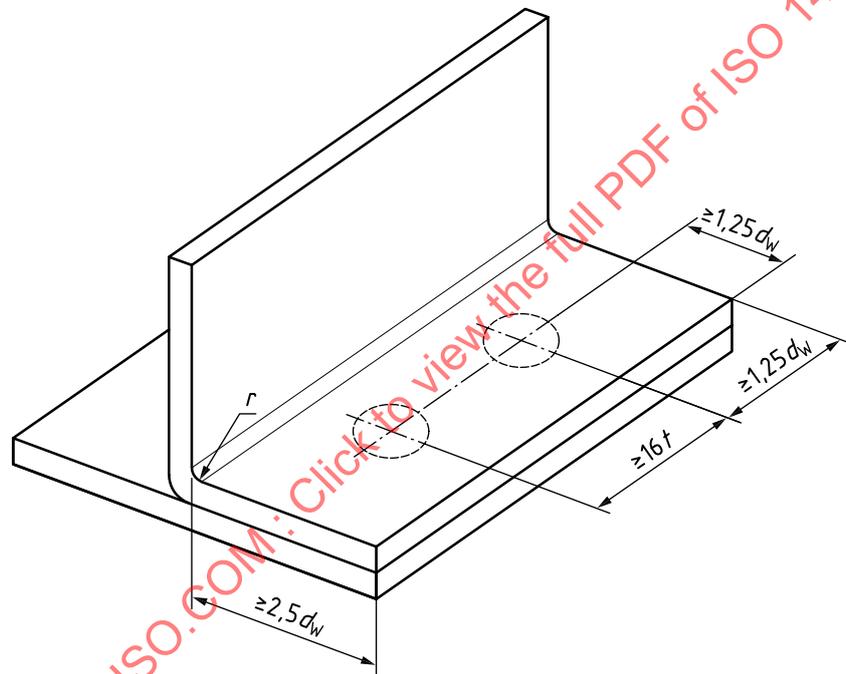
8.1 Materials

The electrode materials shall be a copper alloy and should possess high thermal and electrical conductivity. They should conform to and be used in accordance with ISO 5182.

8.2 Dimensions

The welding electrodes should be of sufficient cross-sectional area and strength to carry the welding current and electrode force without overheating, excessive deformation or excessive deflection.

The electrode dimensions should conform to ISO 1089 for taper fits, ISO 5184 for straight electrodes, ISO 5830 for male electrode caps and ISO 5821 for female electrode caps, as applicable.



Key

d_w weld diameter

t sheet thickness

r corner radius

Corner radius r should be between one and three times the sheet thickness t .

Figure 1 — Recommended edge conditions and weld pitch

When welding two sheets of thickness up to and including 3 mm using truncated cone type electrodes, the electrode tip diameter should be chosen from standard sizes according to [Formula \(1\)](#).

$$d_e = a\sqrt{t} \quad (1)$$

where

d_e is the initial tip diameter, in mm;

t is the thickness of the sheet in contact with the electrode, in mm;

a is a factor usually between 5 and 7.

When using domed electrodes (e.g. Type F0 according to ISO 5821) with small tip radii or electrodes with very small working faces, [Formula \(1\)](#) does not always apply, in which case the electrode dimensions depend on accessibility and flange width. In such cases, the electrode tip dimensions and welding conditions are selected to give a weld diameter as specified in [10.1](#).

When welding two sheets of unequal thickness, the electrode dimensions should be specified with reference to the thinner sheet thickness. In the case of three thicknesses, the thinner sheet of each combination should be used as the reference.

Where a pad or mandrel is used as the second electrode, its surface shall be maintained to match the profile of the work piece.

During normal production, electrodes tend to alloy, dimple or mushroom, leading to an increase in electrode tip diameter. The diameter of at least one of the electrodes should not normally be allowed to increase above a value which results in a reduction in weld size to less than the acceptable minimum, as specified in [10.1](#). When this diameter has been reached (if not before), the electrode should be replaced or redressed to its initial size and contour.

Installation of an automatic electrode tip dressing system is recommended in high-volume production lines.

Where electrode tips of different diameters are in contact with the work, the permissible increase over the initial diameter should apply to the smaller of the two electrode tips.

A greater increase in electrode tip diameter is permissible only if tests prove that the strength of the weld does not fall below the desired requirements.

In cases where automatic weld current increase is used (i.e. stepper controls), the increase in electrode tip diameter can be greater. The acceptable increase can be determined by empirical means, provided that the weld size does not fall below that specified in [10.1](#).

8.3 Cooling of electrodes

The bore of the cooling water hole and pipe should conform to ISO 5184, ISO 5830 or ISO 5821, whichever is applicable.

It is recommended that the water flow be a minimum of 4 L/min per electrode for welding two uncoated steel sheets of thickness up to and including 3,0 mm. Higher flow rates are recommended when welding coated steels. The internal water-cooling feed tube should be arranged to ensure that the water impinges onto the back working face of the electrode. The distance between the back and the working face of the electrode should be in the range given in the relevant International Standard. If the distance becomes too small after several dressing operations, the electrode can collapse.

9 Weld assessment

9.1 General

Before the following weld assessments, the welding equipment, materials to be welded and joint designs shall be confirmed in accordance with the requirements of ISO 15609-5. The testing to assess the weld quality shall be performed in accordance with the requirements of ISO 15614-12.

9.2 Weldability testing

The weldability of a particular steel can be assessed by determining weldability lobes and the electrode life in accordance with ISO 18278-1 and ISO 18278-2. These tests are also used to assess whether a particular set of welding equipment is suitable for producing specific components.

Guidelines for the welding equipment and welding conditions are given in [Annexes A](#) and [B](#).

9.3 Production testing

The following tests shall be carried out to ensure consistent spot weld quality under production conditions:

- a) a visual examination, in accordance with [Clause 10](#);
- b) either a peel test or a chisel test, in accordance with ISO 10447; alternatively, other equivalent non-destructive tests may be used (e.g. ultrasonic testing).

In addition, other tests, such as tensile shear tests, may be carried out.

9.4 Frequency of testing

When practicable, actual components shall be used for testing. When it is not practicable to use actual components, test pieces of the same material with relevant flange widths shall be used and there shall be sufficient material of the same type or types associated with the test piece in the throat of the machine to approximate the magnetic effect of the work piece under production conditions.

Tests should be carried out on each of the following occasions:

- a) at the beginning of each shift or daily work period;
- b) immediately before and after new or reconditioned electrodes are fitted to the machine;
- c) whenever any of the following occurs: major maintenance, repairs, change in key machine components or machine settings;
- d) immediately following a change of supply sources for materials or components to be welded.

Manufacturing shall not start until a satisfactory test weld has been obtained at the beginning of each of these specified periods. In the event of the test piece failing at the end of the shift or work period, 2 % or 10 pieces (whichever is greater) shall be selected from the production during the period following the previous test on that machine and shall be tested in accordance with [Clause 10](#). In the event of any of the selected components failing, the whole of the production during that period shall be deemed not to have conformed to this document.

For visual examination, no dressing, painting or other operation interfering with the examination of the weld zone shall be carried out on the assemblies until after the welding has been inspected. The surface of the work pieces shall be at least of the same quality as the test pieces in conformity with [10.4.1](#).

10 Weld quality requirements

10.1 Weld diameter

The weld diameter shall be determined according to ISO 17677-1.

The weld diameter should approximate to $5\sqrt{t}$ and shall not fall below $3,5\sqrt{t}$, where t is the sheet thickness in mm, unless the application standard permits this.

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When welding two sheets of unequal thickness, the required weld size should be specified with reference to the thinner sheet thickness. In the case of three thicknesses, the thinner sheet of each combination should be used as the reference.

NOTE The use of a smaller weld size than that specified can result in lower weld strength, see [10.3](#).

In cases where a small flange width is specified that fails to satisfy the prescribed relationship between weld size and edge distance (i.e. $1,25 d_w$), a smaller weld diameter should be specified and reference made to the appropriate application standard. In this case, allowance shall be made in the design calculations for the lower strength obtained with smaller welds (see [10.3](#)). The available tolerances in welding conditions and machine operation can be lower at these small weld sizes.

10.2 Failure description of welds

All welds made on test pieces, test specimens and components having a single sheet thickness of up to 1,5 mm usually have plug failures when peel or chisel tested. However, interfacial or mixed failures may be acceptable if allowed in the application standard. Such failures are also favoured by higher sheet thickness, smaller weld sizes in mild steel or in some high-strength steels.

Weld diameter and failure description shall be determined according to ISO 17677-1.

10.3 Weld strength

The spot weld strength is usually measured in two different main loading modes, i.e. cross tension (ISO 14272) and tensile shear (ISO 14273).

The spot weld strength depends on weld size, sheet thickness and steel characteristics (strength but also chemistry and other microstructural parameters). Typical minimum values for single-spot homogeneous two-sheet specimens of mild steel are given in [Table 1](#) for tensile shear and in [Table 2](#) for cross tension. The values are given for sample dimensions specified in ISO 14272 and ISO 14273.

Table 1 — Typical minimum tensile shear strength (TSS) values for mild steel (tensile strength = 300 MPa)

Sheet thickness mm	Nominal $3,5\sqrt{t}$		Nominal $4\sqrt{t}$		Nominal $5\sqrt{t}$		Nominal $6\sqrt{t}$	
	Weld diameter mm	TSS kN	Weld diameter mm	TSS kN	Weld diameter mm	TSS kN	Weld diameter mm	TSS kN
0,6	2,7	1,3	3,1	1,6	3,9	2,0	4,6	2,3
0,8	3,1	2,3	3,6	3,0	4,5	3,6	5,4	4,2
1,0	3,5	3,2	4,0	3,7	5,0	4,3	6,0	5,1
1,2	3,8	4,1	4,4	4,6	5,5	5,4	6,6	6,2
1,6	4,4	5,5	5,1	6,0	6,3	7,4	7,6	8,3
2,0	5,0	7,2	5,7	8,4	7,1	10,8	8,5	13,5
2,5	5,5	10,6	6,3	11,8	7,9	14,5	9,5	17,3
3,0	6,0	12,0	6,9	14,0	8,6	17,8	10,4	22,0

NOTE These values can be used for design calculations. Higher values can generally be obtained in practice.

Table 2 — Typical minimum cross-tension strength (CTS) values for mild steel (tensile strength = 300 MPa)

Sheet thickness mm	Nominal $3,5\sqrt{t}$		Nominal $4\sqrt{t}$		Nominal $5\sqrt{t}$		Nominal $6\sqrt{t}$	
	Weld diameter mm	CTS kN	Weld diameter mm	CTS kN	Weld diameter mm	CTS kN	Weld diameter mm	CTS kN
0,6	2,7	1,1	3,1	1,3	3,9	1,6	4,6	1,9
0,8	3,1	1,7	3,6	2	4,5	2,5	5,4	3
1	3,5	2,5	4	2,8	5	3,5	6	4,2
1,2	3,8	3,2	4,4	3,7	5,5	4,6	6,6	5,5
1,6	4,4	4,9	5,1	5,7	6,3	7,1	7,6	8,5
2	5	7	5,7	8	7,1	9,9	8,5	11,9
2,5	5,5	9,6	6,3	11	7,9	13,8	9,5	16,6
3	6	12,6	6,9	14,5	8,6	18,1	10,4	21,8

NOTE These values can be used for design calculations. Higher values can generally be obtained in practice.

In joints between sheets of unequal thickness, the minimum spot weld strength requirement should be determined by the thickness of the thinner sheet.

Table 1 and Table 2 are based on a proportionality of spot weld strength with sheet thickness and weld diameter. Although this general assumption is valid in many situations, it tends to become wrong in cases such as small weld diameters, high sheet thicknesses and more generally when the failure mode is not a full plug failure.

When considering other steel grades, higher cross tension and tensile shear strength can usually be obtained compared with the values for mild steels given in Tables 1 and 2.

For many higher-strength steel grades, tensile shear strength increases with higher parent material strength. However, CTS is not related to parent material strength but rather to metallurgical phenomena occurring in the weld. The situation can be even more complex when different steel grades are welded with each other (heterogeneous welding).

10.4 Visual examination

10.4.1 Surface condition

The weld surface should be free of any surface cracks or surface porosity.

Surface expulsion, sometimes referred to as weld splash (whiskers), should not be accepted.

The surface shall not be melted since it is the sign of an excess penetration of the weld nugget.

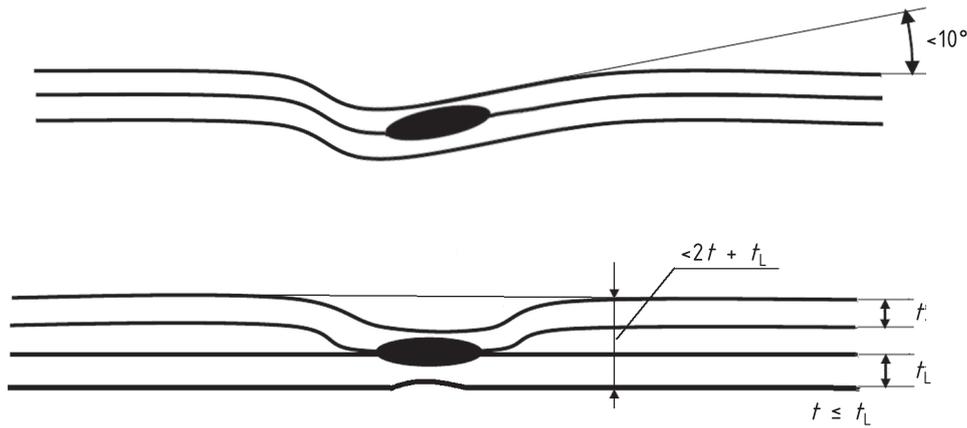
When spot welding two sheets of equal thickness, electrode indentation in each sheet shall be less than 20 % of a single sheet thickness. Depending on the product requirements, lower indentation values may be specified.

When welding two sheets of unequal thickness, indentation in the thinner sheet should not exceed 20 %. A larger indentation is permissible on the reverse side of a non-marking weld.

10.4.2 Distortion

A weld is considered imperfect if:

- a) the parent metal is distorted to the extent that the face of the weld is more than 10° out of the plane of the metal; or
- b) the sheet separation is larger than thinner sheet thickness (see Figure 2)

**Key**

- t thinner sheet thickness
 t_L thicker sheet thickness

Figure 2 — Maximum permissible distortion of sheet

11 Multi-weld arrays

In the majority of applications, spot welds exist as a line of welds or take the form of a weld array. Unless otherwise specified, all the spot welds in a given pattern shall be within $\pm 10\%$ of the specified weld pitch. The maximum weld pitch shall not exceed the specified value by more than 20% in the case of welds made using manually held welding guns. In the case of using multi-spot-welding machines and robotic welding, the distance between adjacent welds shall not exceed the average pitch by more than 10% and 20%, respectively, provided that the weld pitch does not fall below the minimum specified in [Clause 7](#).

In certain circumstances, individual spot welds in a multi-weld array may be classified by the designer as follows:

- Critical welds: all structural and load-bearing welds fall within this classification and shall conform to all the requirements of this document.
- Non-critical welds: non-structural and non-load-bearing welds fall within this classification. Tack welds also fall within this category. Quality requirements of such welds can be agreed between supplier and customer, but deviations from this document are permissible only with regard to location or surface appearance.

Non-critical welds shall be separated by at least three welds conforming to the requirements summarized in [Clause 10](#). All end welds in any array should be located at a distance greater than or equal to $1,25 d_w$ from the flange edges (see [Figure 1](#)). Welds on each side of an interruption of a weld pattern, or at the junction of one panel or flange with any other panel or flange, shall be classified as end welds. End welds shall also be considered where there is a change in flange direction greater than 30° . All end welds shall meet the requirements of this document.

Permissible tolerances in the location of individual welds from the specified location on the appropriate engineering design drawing shall not exceed 10%. For both multi-spot-welding and robotic welding, the angle of approach of the electrode when the welding current is initiated should not exceed 10° to the vertical. It should be emphasized that inclined electrodes result in elliptical weld nuggets and the electrode life decreases as the angle of approach increases.

Annex A
(informative)

Recommendations for spot-welding equipment

The welding equipment should be specified according to ISO 669 and be equipped with an automatic control that performs at least the following cycle of operations in the sequence specified:

- a) it brings the electrodes into contact with the component and applies the welding force (the force between the electrodes) to the work piece;
- b) it causes the welding current to flow after the preset welding force has been attained;
- c) it maintains the flow of welding current for a preset time, the welding force being maintained throughout;
- d) it interrupts or stops the welding current at the end of the preset time;
- e) it maintains the welding force for a preset time, the hold time, after the current ceases to flow;
- f) it releases the force at the end of the hold time and returns the welding equipment to a condition where it is ready to recommence the cycle of operations.

The welding force, welding current, weld time and, where needed, squeeze time and hold time should be variable over a range sufficient to ensure that optimum welding conditions can be obtained.

Effective tooling should be specified and any locating and clamping devices should not interfere with the welding or cause shunting of current through the fixtures themselves.

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Annex B
(informative)

Typical spot-welding conditions

Tables B.1 to B.3 give guidance on spot-welding conditions for the uncoated and coated steels in the most commonly-used thicknesses covered by this document. These will potentially require modification, depending on the mechanical properties and electrical characteristics of the welding equipment (see ISO 669).

These welding conditions are applicable for truncated cone electrodes of ISO 5182 Class A2/2 material and will potentially require modification for other electrode geometries and materials.

In order to rationalize the electrode references, welders may restrain the electrode tip diameters to a few sizes, i.e. 6 mm and 8 mm. This requires an adaptation of the welding forces and currents proposed in these tables.

Sufficient squeeze time should be chosen to enable the electrode force to build up to its preset value.

For lightweight welding guns with limited force capability, the electrode force values are reduced by up to 30 % for sheet thicknesses greater than 1,6 mm. The welding current or weld time, or both, should be adjusted accordingly.

When welding two sheets of unequal thickness, welding conditions should be based on the thinner sheet.

In the case of high-strength steels, higher electrode force can be necessary. Welding currents may be reduced, depending on the type of high-strength steel being welded. Pulse welding schedules can be necessary at the higher carbon equivalent levels and at sheet thicknesses greater than 2,0 mm.

Table B.1 — Guidelines for spot welding of uncoated low-carbon steel sheets of thickness 0,4 mm to 3,0 mm

Single sheet thickness		Electrode tip diameter	Welding parameters					
			Low-force, long-time conditions			High-force, short-time conditions		
mm	mm	mm	Electrode force kN	Weld time cycles ^a	Welding current kA	Electrode force kN	Weld time cycles ^a	Welding current kA
> 0,4	≤ 0,6	4	0,9 to 1,1	5 to 7	4 to 6	1,3 to 1,8	4 to 5	5 to 8
> 0,6	≤ 0,8	4	1,2 to 1,3	7 to 10	5 to 7	1,7 to 2,0	6 to 8	6 to 9
> 0,8	≤ 1,0	5	1,4 to 1,5	9 to 12	6 to 8	1,9 to 2,6	7 to 10	7 to 10
> 1,0	≤ 1,2	5	1,6 to 1,8	11 to 15	7 to 9	2,5 to 3,2	8 to 12	8 to 12
> 1,2	≤ 1,6	6	1,9 to 2,1	14 to 18	8 to 11	3,0 to 4,0	9 to 13	10 to 13
> 1,6	≤ 2,0	7	2,6 to 2,9	18 to 22	9 to 13	3,9 to 5,2	10 to 14	12 to 15
> 2,0	≤ 2,5	8	3,4 to 3,7	22 to 28	10 to 15	5,0 to 6,2	12 to 16	14 to 18
> 2,5	≤ 3,0	9	4,4 to 4,7	28 to 35	12 to 17	6,0 to 7,5	15 to 20	17 to 20

^a 1 cycle = 20 ms.

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Table B.2 — Guidelines for spot-welding conditions for zinc-coated steels of thickness 0,4 mm to 3,0 mm

Single sheet thickness		Electrode tip diameter	Welding parameters					
			Hot-dip zinc ^a			Electrolytically deposited zinc ^b		
			Electrode force	Weld time	Welding current	Electrode force	Weld time	Welding current
mm	mm	mm	kN	cycles ^c	kA	kN	cycles ^c	kA
> 0,4	≤ 0,6	4	1,5 to 2,0	6 to 8	7 to 9	1,5 to 2,0	6 to 8	6 to 8
> 0,6	≤ 0,8	4	1,9 to 2,0	8 to 10	8 to 10	1,9 to 2,2	8 to 10	7 to 9
> 0,8	≤ 1,0	5	2,2 to 2,9	9 to 12	9 to 11	2,2 to 2,9	9 to 12	8 to 10
> 1,0	≤ 1,2	5	2,8 to 3,6	10 to 13	10 to 13	2,8 to 3,6	10 to 13	9 to 13
> 1,2	≤ 1,6	6	3,4 to 4,5	11 to 15	14 to 16	3,4 to 4,5	11 to 15	12 to 15
> 1,6	≤ 2,0	7	4,4 to 5,5	12 to 16	18 to 21	4,4 to 5,5	12 to 16	14 to 17
> 2,0	≤ 2,5	8	5,4 to 6,8	14 to 18	22 to 26	5,4 to 6,8	14 to 18	17 to 22
> 2,5	≤ 3,0	9	6,6 to 8,0	17 to 21	26 to 30	6,6 to 8,0	17 to 21	19 to 24

^a Applicable for coating thicknesses G275 (\equiv 20 μ m single side).

^b Applicable for coating thicknesses 7 μ m single side.

^c 1 cycle = 20 ms.

Table B.3 — Guidelines for spot welding of double-sided iron-zinc-alloy- and zinc-nickel-alloy-coated steels of sheet thickness 0,4 mm to 3,0 mm

Single sheet thickness		Electrode tip diameter	Welding parameters		
			Electrode force	Weld time	Welding current
mm	mm	mm	kN	cycles ^a	kA
> 0,4	≤ 0,6	4	1,4 to 1,9	4 to 6	6,0 to 8,5
> 0,6	≤ 0,8	4	1,8 to 2,1	6 to 8	7,0 to 9,5
> 0,8	≤ 1,0	5	2,1 to 2,8	7 to 10	8,0 to 10,5
> 1,0	≤ 1,2	5	2,7 to 3,4	8 to 12	9,0 to 12
> 1,2	≤ 1,6	6	3,2 to 4,3	9 to 13	11,0 to 14
> 1,6	≤ 2,0	7	4,2 to 5,3	10 to 14	13,0 to 16,5
> 2,0	≤ 2,5	8	5,2 to 6,5	12 to 16	16,0 to 21,0
> 2,5	≤ 3,0	9	6,4 to 7,8	15 to 20	18,0 to 23

^a 1 cycle = 20 ms.