



SLOVENSKI STANDARD SIST EN 18007-1:2024

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Elektromagnetno utripno varjenje - 1. del: Znanje o varjenju, terminologija in slovar

Electromagnetic pulse welding - Part 1: Welding knowledge, terminology and vocabulary

Schweißen und verwandte Verfahren - Elektromagnetisches Pulsschweißen - Teil 1: Schweißwissen, Terminologie und Begriffe

Soudage par impulsion électromagnétique - Partie 1 : Connaissance, terminologie et vocabulaire du soudage

Ta slovenski standard je istoveten z: **EN 18007-1:2024**

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English Version

Electromagnetic pulse welding - Part 1: Welding knowledge, terminology and vocabulary

Soudage par impulsion électromagnétique - Partie 1 :
Connaissance, terminologie et vocabulaire du soudage

Elektromagnetisches Pulsschweißen - Teil 1:
Schweißwissen, Terminologie und Begriffe

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 18007-1:2024) has been prepared by Technical Committee CEN/TC 121 “Welding and allied processes”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by January 2025, and conflicting national standards shall be withdrawn at the latest by January 2025.

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

The EN 18007 series of standards, under the general title *Electromagnetic pulse welding*, consists of the following parts:

- *Part 1: Welding knowledge, terminology and vocabulary,*
- *Part 2: Design of welded joints,*
- *Part 3: Qualification of welding operators and weld setters,*
- *Part 4: Specification and qualification of welding procedures,*
- *Part 5: Quality and inspection requirements.*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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EN 18007-1:2024 (E)**Introduction**

Electromagnetic pulse welding is an innovative solid-state welding technology that belongs to the group of pressure welding processes and is based on the use of electromagnetic forces to deform, accelerate and weld workpieces. No external heat source is used, the connection is only created by a high-velocity impact.

The increasing use of the electromagnetic pulse welding process has created the need for a standard, to ensure that the welding operations are carried out in the most effective manner and that appropriate controls are performed on all aspects of the implementation.

To be effective, welded products should be free from problems in production and in service. To achieve this goal, it is recommended to provide controls from the design phase through material selection, choice of parameters, the fabrication itself, and inspection. For example, poor design can create serious and costly difficulties in the workshop or in service. Incorrect process parameters and/or material selection can result in welding defects. Welding procedures should be correctly formulated and approved to avoid weld discontinuities. To ensure the manufacture of a quality product, management should understand the causes of potential problems and implement appropriate inspection procedures and subsequent quality measures. Supervision should be implemented to ensure that the specified quality is achieved.

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1 Scope

This document defines terms and definitions related to the electromagnetic pulse welding process. In this document, the term “aluminium” refers to aluminium and its alloys.

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 25901 (all parts), *Welding and allied processes — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the ISO 25901 series 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

electromagnetic pulse welding

creation of a welded joint by impact using a pulsed electromagnetic field

3.2

electromagnetic pulse sheet welding

creation of a welded joint of sheets by impact using a pulsed electromagnetic field

3.3

electromagnetic pulse tube welding

creation of a welded joint of tubes by impact using a pulsed electromagnetic field

3.4

electromagnetic pulse crimping

creation of a crimp connection (mechanical joint) using electromagnetic forming

3.5

flyer sheet

flyer tube

sheet or tube that is accelerated by electromagnetic forces during the process (see Figure 1)

3.6

target sheet

target tube

sheet or tube that is stationary during the process (see Figure 1)

3.7

driver

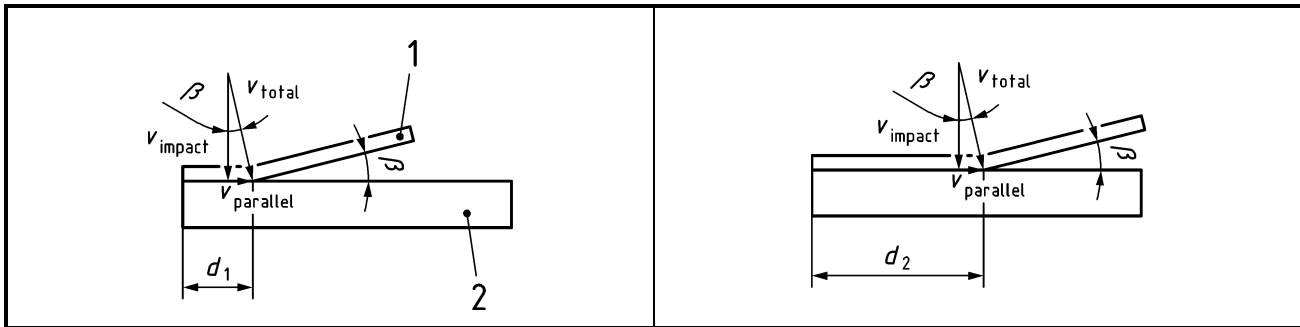
auxiliary workpiece used for efficient acceleration of workpieces with low electrical conductivity

EN 18007-1:2024 (E)**3.8****impact velocity**

normal component (according to target sheet/tube surface) of the velocity of the flyer sheet/tube velocity when it impacts with the target workpiece (see Figure 1)

3.9**collision point velocity**

mean velocity parallel to the target workpiece at which the weld is created (see Figure 1)

**Key**

- 1 flyer
- 2 target

Mean collision point velocity $v_{collision,mean} = \frac{d_2 - d_1}{\Delta t}$.

Figure 1 — Definition of characteristic velocities

3.10**impact angle**

angle between flyer's and target's impact surface during the complete duration of the impact event (see Figure 1)

3.11**jetting critical angle**

angle at which a jet is created at the collision front

3.12**stand-off distance****gap**

initial gap between the joining partners

Note 1 to entry: It is the distance by which the metals to be welded are separated from each other prior to the welding process (see Figure 2).

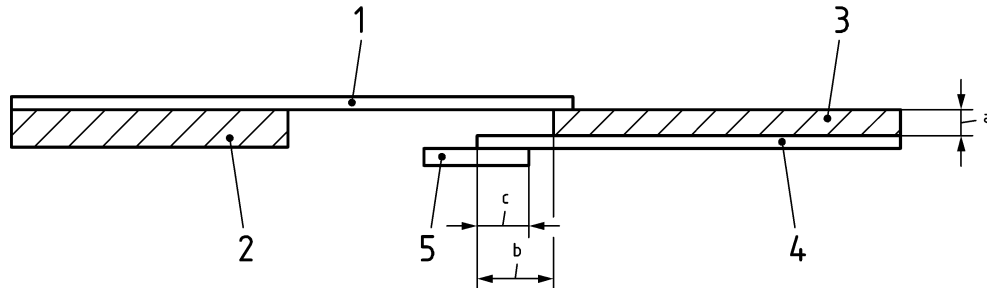
3.13**free length**

length between the flyer tube/sheet and the internal workpiece

Note 1 to entry: It is the part of the flyer (tube or sheet) that can freely move under the effect of the magnetic forces (not obstructed by the support or a part of the target workpiece) (see Figure 2).

3.14**overlap of flyer and tool coil****work length [4]****length of work zone**

distance that the flyer workpiece overlaps with the coil or field shaper (see Figure 2)

**Key**

- 1 Cu 1 mm
- 2 spacer 2
- 3 spacer 1
- 4 Al 1 mm
- 5 flat coil
- a stand-off
- b overlap
- c free-length

Figure 2 — Schematic representation of the geometrical parameters of the electromagnetic pulse welding process (sheet applications)

3.15**discharge energy**

energy discharged into the coil as a result of the discharge of the capacitors, characterized as follows:

$$E = \frac{1}{2} CV^2$$

where

E is the discharge energy (J)

C is the capacitance (F)

V is the charging voltage (V)

3.16**discharge current**

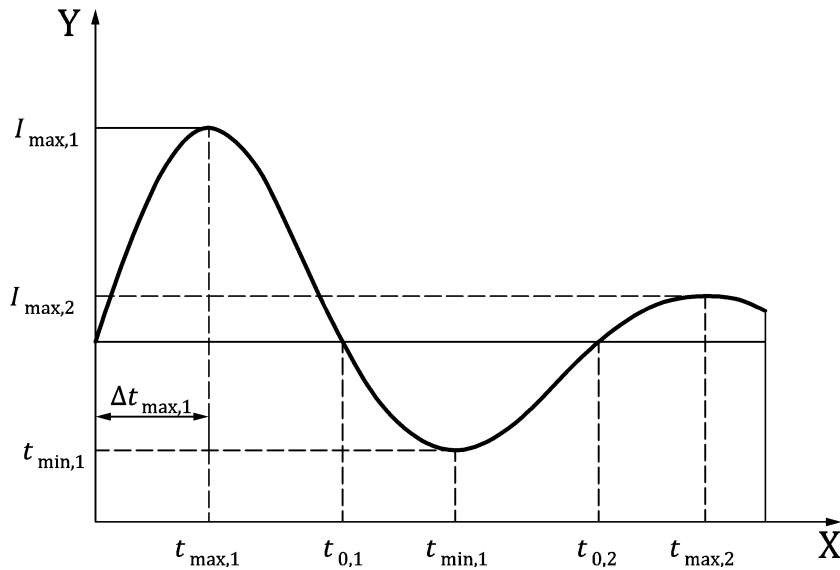
current discharged into the coil as a result of the discharge of the capacitors

3.17**discharge current frequency**

significant frequency of the current induced in the coil from t_0 until $t_{\max,1}$; where the duration $t_{\max,1}$ corresponds to the quarter of the period (noted T/4)

Note 1 to entry: Figure 3 illustrates this concept and presents the current discharge frequency equation.

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**Key**

X time

Y current

$$\text{Significant frequency } f_{\text{significant}} = \frac{1}{4 \times \Delta t_{\text{max},l}}$$

Figure 3 — Pulsed current parameters**3.18****pulse repetition rate**

number of pulses per unit of time

3.19**current rise time**time taken by the electromagnetic pulse to change from a specified low value to a specified maximum value ($\Delta t_{\text{max},l}$ in Figure 3)**3.20****skin effect**

tendency of alternating current to distribute itself inside a conductor in such a way that the current density is highest near the surface of the conductor

3.21**skin depth**depth at which eddy currents penetrate a material, defined as the depth at which their intensity decreases to $1/e$ (about 37 %) of their maximum intensity**3.22****bitter coil**

coil formed by stacking alternating conductors and insulating discs, each foreseen with a radial cut

3.23**single turn coil****one turn coil**

coil consisting of one turn

3.24**helix coil**

coil with the turns arranged in a helical shape

3.25**flat coil**

coil with the turns arranged in a single plane, either single or multi-turn

3.26**Rogowski coil**

toroidal coil without a ferromagnetic core to measure the discharge current in an electrical circuit

3.27**pitch of the coil**

number of turns per unit of length, parallel to the flyer direction

3.28**high pulsed power generator**

device that charges capacitors, stores electrical energy, and discharges it in the forming or welding coil in a very short time interval

Note 1 to entry: It is the machine supplying the discharge energy needed for the electromagnetic pulse welding process.

3.29**field shaper****field concentrator**

component that concentrates the magnetic field onto the welding zone

Note 1 to entry: It essentially increases the amplitude of the magnetic field, onto a smaller region (axially).

4 Welding knowledge**4.1 Process principles**

The electromagnetic pulse technology (also known as electromagnetic pulse forming, crimping and welding) is an automatic production technique that uses electromagnetic forces to deform and join similar or dissimilar materials. Electromagnetic pulse forming is a high-speed deformation process that uses a pulsed electromagnetic field for contactless forming of metals. The energy stored in a capacitor bank is discharged rapidly through a tool coil. The alternating electromagnetic field produced by the coil generates eddy currents in the adjacent workpiece made of a metallic material with good electrical conductivity. The varying currents cause a varying magnetic field that generates the eddy currents. These currents, in turn, produce their own magnetic field. The forces generated by the two magnetic fields oppose each other. Consequently, a repelling force (Lorentz force) between coil and workpiece is created.

The forces generated can for example be used to plastically deform a flyer tube or sheet with high velocity onto an internal or external workpiece (target sheet/tube), to form, cut or perforate a sheet using a special-shaped die. Under precisely controlled conditions and process parameters, a solid-state weld can be realized (electromagnetic pulse welding) after plastic deformation of materials. The configuration for joining tubular products is shown in Figure 5. Depending on the arrangement of the tool coil and workpiece, tubular profiles can be expanded or compressed, or sheet metals can be formed (see Figure 4). A principle sketch of the welding process is shown in Figure 6.

Due to the solid-state nature, this process can be used for joints of similar and dissimilar materials (with very different melting temperatures).