
**Welding — Friction welding of
metallic materials**

Soudage — Soudage par friction des matériaux métalliques

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Foreword

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*.

Any feedback, question or request for official interpretation related to any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

This second edition cancels and replaces the first edition (ISO 15620:2000), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Clause 2 has been updated;
- in Clause 3, terms not used in the text have been deleted;
- in [Annex B](#) of 4 processes based on friction have been added;
- the recommended test to perform on test weld has been clarified (addition of [Table 4](#)).

Introduction

Friction welding is a method for making welds in the solid phase in which one component is moved relative to and in pressure contact with the mating component to produce heat at the faying surfaces, the weld being completed by the application of a force during or after the cessation of relative motion. There are several forms of supplying energy and various forms of relative movements.

The generation of friction heating results in a comparatively low joining temperature at the interface. This is largely the reason why friction welding is suitable for materials and material combinations which are otherwise difficult to weld. The weld region is generally narrow and normally has a refined microstructure.

While the friction welding process deals primarily with components of circular cross-section it does not preclude the joining of other component shapes.

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Welding — Friction welding of metallic materials

1 Scope

This document specifies requirements for the friction welding of components manufactured from metals.

It specifies requirements particular to rotational friction welding related to welding knowledge, quality requirements, welding procedure specification, welding procedure approval and welding personnel.

This document is appropriate where a contract, an application standard or a regulatory requirement requires the demonstration of the manufacturer's capability to produce welded constructions of a specified quality. It has been prepared in a comprehensive manner to be used as a reference in contracts. The requirements given can be adopted in full or some can be deleted, if not relevant to the construction concerned.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1

axial force

force in axial direction between components to be welded

3.2

burn-off length

loss of length during the friction phase

3.3

burn-off rate

rate of shortening of the *components* (3.4) during the friction welding process

3.4

component

single item before welding

3.5

component induced braking

reduction in *rotational speed* (3.18) resulting from friction between the interfaces

3.6

external braking

braking located externally reducing the *rotational speed* (3.18)

3.7

faying surface

surface of one *component* (3.4) that is to be in contact with a surface of another *component* (3.4) to form a joint

3.8

forge force

force applied normal to the *faying surfaces* (3.7) at the time when relative movement between the *components* (3.4) is ceasing or has ceased

3.9

forge burn-off length

amount by which the overall length of the *components* (3.4) is reduced during the application of the *forge force* (3.8)

3.10

forge phase

interval time in the friction welding cycle between the start and finish of application of the *forge force* (3.8)

3.11

forge pressure

pressure (force per unit area) on the *faying surfaces* (3.7) resulting from the axial *forge force* (3.8)

3.12

forge time

time for which the *forge force* (3.8) is applied to the *components* (3.4)

3.13

friction force

force applied perpendicularly to the *faying surfaces* (3.7) during the time that there is relative movement between the *components* (3.4)

3.14

friction phase

interval time in the friction welding cycle in which the heat necessary for making a weld is generated by relative motion and the *friction force(s)* (3.13) between the *components* (3.4), i.e. from contact of *components* (3.4) to the start of deceleration

3.15

friction pressure

pressure (force per unit area) on the *faying surfaces* (3.7) resulting from the axial friction force

3.16

friction time

time during which relative movement between the *components* (3.4) takes place at *rotational speed* (3.18) and under application of the *friction force(s)* (3.13)

3.17

interface

contact area developed between the *faying surfaces* (3.7) after completion of the welding operation

3.18

rotational speed

number of revolutions per minute of rotating *component* (3.4)

3.19

stick-out

distance a *component* (3.4) sticks out from the fixture, or chuck in the direction of the mating *component* (3.4)

3.20**deceleration phase**

interval in the friction welding cycle in which the relative motion of the *components* (3.4) is decelerated to zero

3.21**deceleration time**

time required by the moving *component* (3.4) to decelerate from friction speed to zero speed

3.22**total length loss (upset)**

loss of length that occurs as a result of friction welding, i.e. the sum of the *burn-off length* (3.2) and the *forge burn-off length* (3.9)

3.23**total weld time**

time elapsed between *component* (3.4) contact and end of forging phase

3.24**welding cycle**

succession of operations carried out by the machine to make a weldment and return to the initial position, excluding *component* (3.4) - handling operations

3.25**weldment**

two or more components joined by welding

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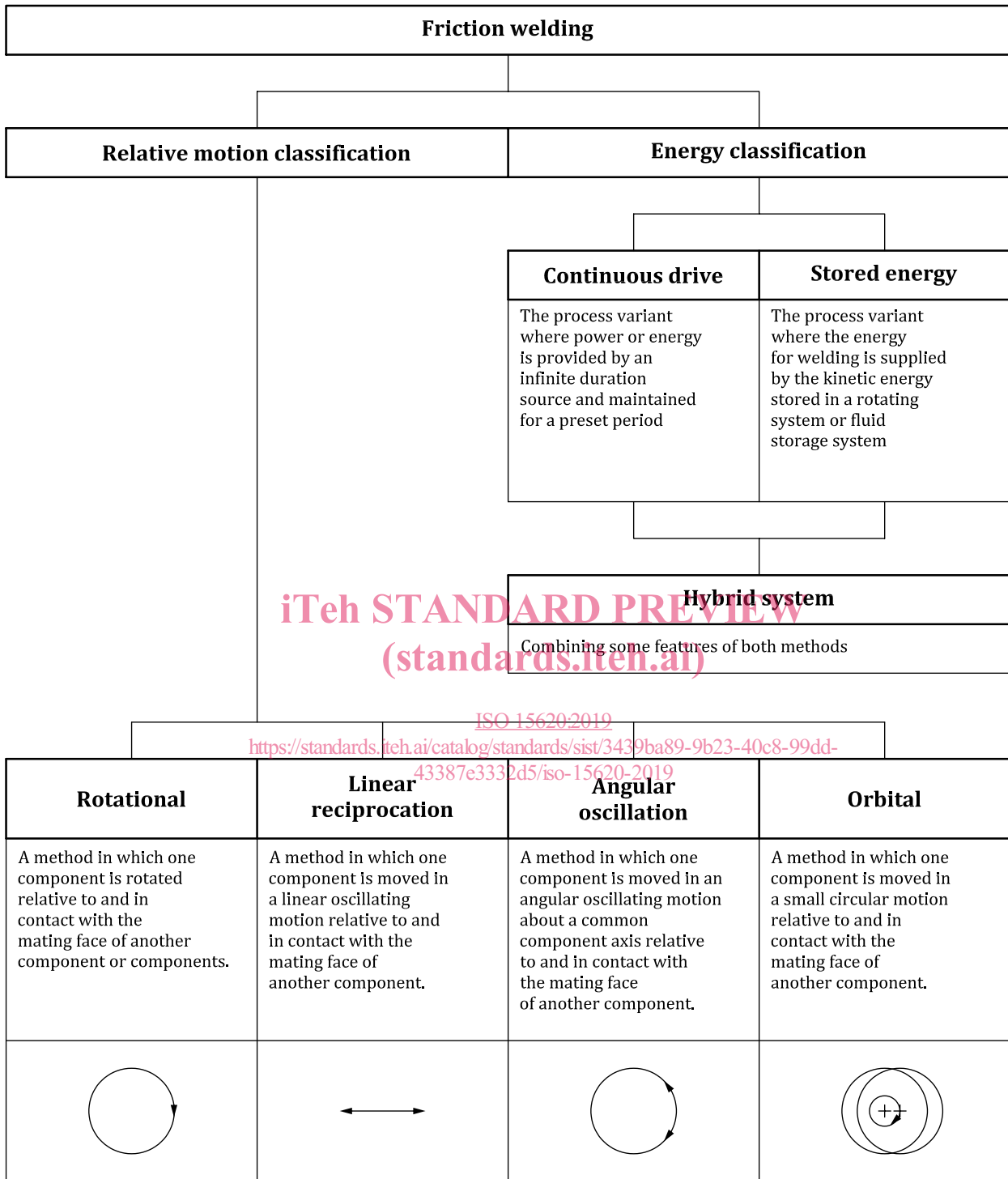
4 Welding knowledge**4.1 Process**

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4.1.1 General

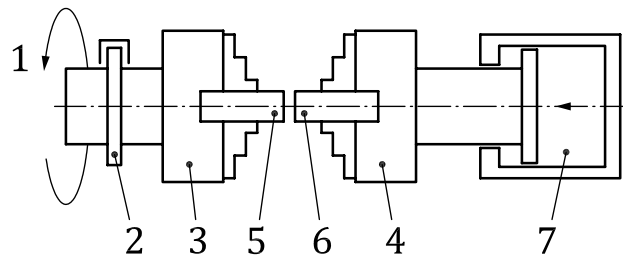
The classification of friction welding processes is listed in [Table 1](#).

Table 1 — Classification of friction welding processes



4.1.2 Direct drive rotational friction welding

The energy input is provided by direct drive at predetermined rotational speed or speeds (see [Figure 1](#) and [Figure 2](#)).

**Key**

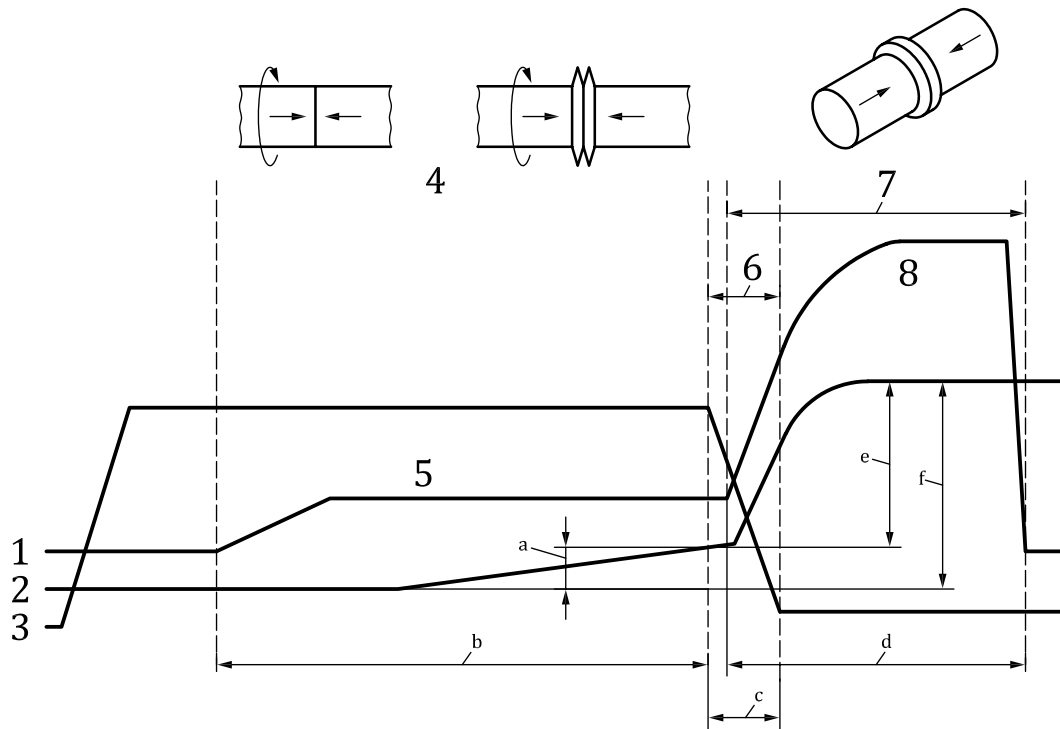
- 1 drive motor
- 2 brake
- 3 rotating clamp
- 4 stationary clamp
- 5 rotating workpiece
- 6 stationary workpiece
- 7 forge cylinder

Figure 1 — Diagram showing direct drive rotational friction welding

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Key

- 1 axial force
- 2 axial displacement
- 3 rotational speed
- 4 friction phase
- 5 friction force
- 6 deceleration phase
- 7 forge phase
- 8 forge force

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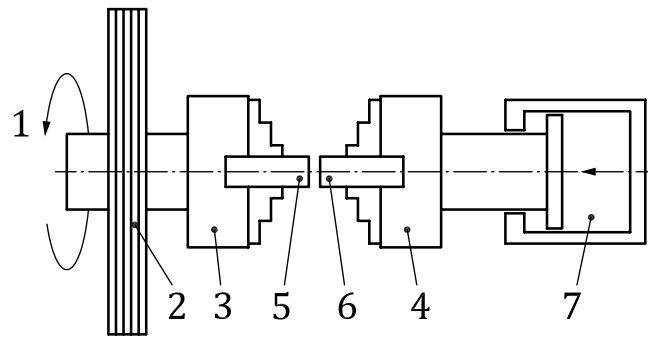
Figure 2 — Diagram showing typical relationships of characteristics for friction welding at constant rotational speed (friction welding, process No. 42 in accordance with ISO 4063)

The spindle is either decelerated at a predetermined rate or stopped by external braking or component induced braking. The main welding parameters are listed below and their relationship is given in [Annex A](#):

- rotational speed(s);
- predetermined friction force(s);
- friction time or burn-off;
- predetermined forge force(s);
- forge time;
- deceleration time and forge delay.

4.1.3 Stored energy (inertia) friction welding

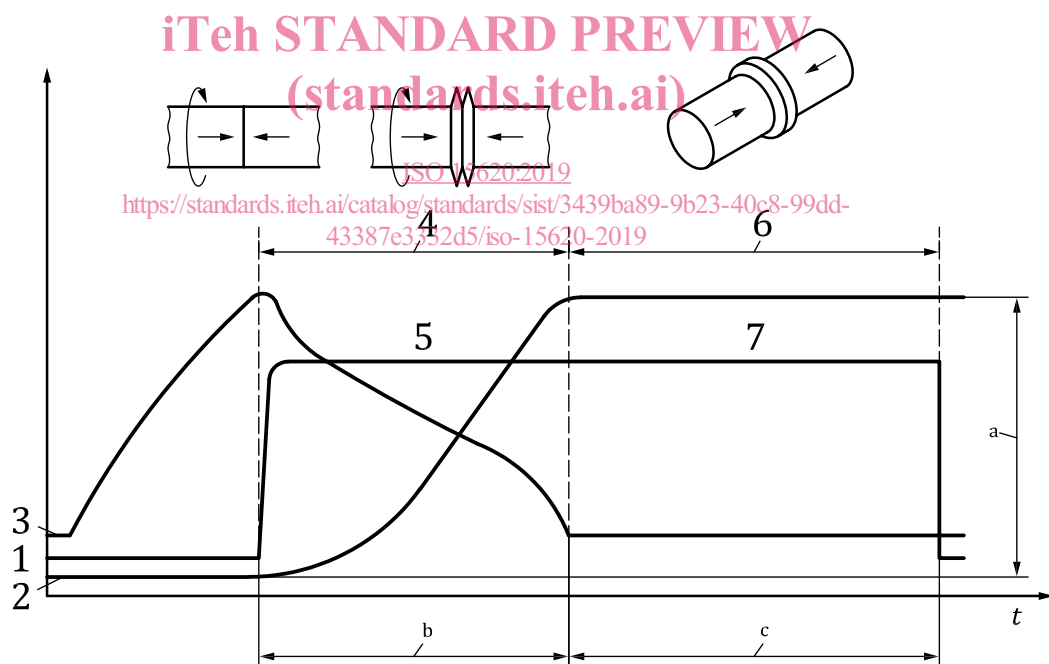
Energy stored in an inertia mass is used up in the friction welding process by component induced braking (see [Figure 3](#) and [Figure 4](#)).



Key

- 1 drive motor
- 2 inertia mass, variable
- 3 rotating clamp
- 4 stationary clamp
- 5 rotating workpiece
- 6 stationary workpiece
- 7 forge cylinder

Figure 3 — Diagram showing inertia friction welding



Key

- | | |
|----------------------|------------------------------|
| 1 axial force | 6 forge phase |
| 2 axial displacement | 7 forge force |
| 3 rotational speed | a Total length loss (upset). |
| 4 friction phase | b Friction time. |
| 5 friction force | c Forge time. |

Figure 4 — Diagram showing typical relationships of characteristics for inertia friction welding (friction welding, process No. 42 in accordance with ISO 4063)