



BSI Standards Publication

**Plastics — Joining of thermoplastic
moulded components — Specification of
variables for thermal joining processes**

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Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 42, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2018. It was prepared by Technical Committee WEE/3, *Welding of Thermoplastic Moulded Components*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

This British Standard has been developed to help organizations better understand and implement controls with the following thermal joining processes through the use of thermal joining process specifications:

- ultrasonic welding/staking/spot welding;
- infrared welding;
- hot gas convection welding;
- linear vibration welding;
- orbital vibration welding;
- spin welding;
- laser welding;
- hot plate welding;
- heat staking: hot air;
- heat staking: electrical; and
- heat staking: infrared (IR).

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies the minimum essential variables in order to produce a component of the required consistency and quality for the following thermal joining processes:

- ultrasonic welding/staking/spot welding;
- infrared welding;
- hot gas convection welding;
- linear vibration welding;
- orbital vibration welding;
- spin welding;
- laser welding;
- hot plate welding;
- heat staking: hot air;
- heat staking: electrical; and
- heat staking: infrared (IR).

This British Standard defines the thermal joining process specification (TJPS) for each of the thermal joining processes listed above, to ensure that all the essential variables are properly considered, including the qualified range of each variable, in order to establish and maintain component quality at an acceptable level.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions 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.

[BS EN ISO 472](#), *Plastics — Vocabulary*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in [BS EN ISO 472](#) and the following apply.

3.1 component

joined sub-components

3.2 dimensional report

full measurement report on product before welding including flatness at weld joint

3.3 essential variable

joining condition that influences the quality of the joint and requires qualification

3.4 joining organization

organization responsible for the serial production joining and maintenance of quality

3.5 joining procedure

specified course of action to be followed in making a joint, including the joining process(es), reference to materials, preparation, pre-heating (if necessary), control of process parameters and necessary equipment to be used

3.6 joining process

method of softening or melting to obtain a permanent joint

3.7 joining process qualification record (JPQR)

record comprising all data of mechanical test results for the specified range of each essential variable needed for qualification of a TJPS, used by the joining organization as part of the sign-off documentation

3.8 joint

junction of two sub-components

3.9 part moisture content

amount of moisture content in parent material at the time of welding

3.10 process report

document confirming that the sub-component has been manufactured using the correct moulding process parameters, conditions, material grade, masterbatch reference, masterbatch percentage, and regrind percentage

3.11 sub-component

part to be joined

3.12 thermal joining process specification (TJPS)

document that has been qualified and provides the required variables of the joining procedure to ensure repeatability during production

3.13 visual examination acceptance criteria document

document specifying imperfections on sub-components that affect the functionality of the joint; e.g. weld lines, burn marks, surface contamination

3.14 welding

process of uniting softened surfaces of materials, generally with the aid of heat

3.15 work instruction

simplified TJPS, suitable for joining process owner

4 Technical content of thermal joining processes specification (TJPS)

A TJPS shall provide the minimum information specified in a) to d) required to make a joint of acceptable quality, as part of the component manufacturing quality agreement between the joining organization and the customer.

TJPSs cover a certain range for each essential variable. The range of each essential variable shall be qualified using a JPQR, and the procedure for measuring each variable shall conform to agreed specifications.

NOTE 1 Example templates of TJPSs are given in [Annex A](#) to [Annex K](#). Worked example TJPSs for hot plate welding and heat staking: electrical are given in [Annex L](#) and [Annex M](#), respectively.

NOTE 2 A work instruction can be prepared for each specific, applicable TJPS as part of detailed production planning.

NOTE 3 When completing the TJPS the technical support/manual/documentation of the joining process equipment manufacturer or service supplier should be consulted.

a) Related to the joining organization

- 1) identification of the joining organization;
- 2) TJPS reference number/revision;
- 3) signature of the person responsible for approval, appointed by the joining organization

NOTE The responsibilities, knowledge, skills and competence for the person responsible for approval are set out in PD CEN/TR 16862.

b) Related to the sub-component(s)

- 1) sub-component material:
 - i) material supplier name;
 - ii) designation of the material(s) and reference standard(s), if any, or an alternative identification if a reference standard does not exist;
 - iii) moisture content;
 - iv) regrind percentage;
 - v) masterbatch reference and masterbatch percentage;
- 2) dimensional report;
- 3) process report;
- 4) customer component/part number;
- 5) supplier component/part number;
- 6) visual examination acceptance criteria document number

c) Common to all joining processes

- 1) joint preparation;
- 2) ambient temperature;
- 3) sub-component temperature;
- 4) joining process qualification record (JPQR)

d) Specific to a joining process

- 1) Ultrasonic welding/staking/spot welding (see [Annex A](#)):
 - i) joining process(es): welding, staking or spot welding;
 - ii) machine type (fixed or handheld);
 - iii) frequency;
 - iv) power rating;

- v) maximum tool temperature;
 - vi) tool face amplitude/amplitude profile;
 - vii) down speed;
 - viii) trigger force (if applicable)/(not handheld);
 - ix) pre-trigger/touch (yes/no) (not handheld);
 - x) pre-trigger amplitude (if applicable)/(not handheld);
 - xi) joining force/force profile (not handheld);
 - xii) meltdown/collapse/weld displacement (not handheld);
 - xiii) joining or welding time;
 - xiv) hold/cooling time;
 - xv) weld energy;
- 2) Infrared welding (see [Annex B](#)):
- i) emitter condition;
 - ii) distance of sub-components from IR source;
 - iii) pre-heat/soak temperature (or power);
 - iv) pre-heat/soak time;
 - v) full heat temperature/power;
 - vi) full heat time;
 - vii) removal of heating to sub-component contact time/changeover time;
 - viii) welding force;
 - ix) meltdown/collapse/weld displacement;
 - x) cooling time;
- 3) Hot gas convection welding (see [Annex C](#)):
- i) gas flow rate;
 - ii) gas temperature;
 - iii) gas feed type;
 - iv) distance between sub-components and tool;
 - v) heating time;
 - vi) removal of heating to sub-component contact time/changeover time;
 - vii) welding force;
 - viii) meltdown/collapse/weld displacement;
 - ix) cooling time;
- 4) Linear vibration welding (see [Annex D](#)):
- i) frequency;
 - ii) amplitude/amplitude profile;
 - iii) IR pre-heat time (if applicable);
 - iv) IR pre-heat power (if applicable);

- v) IR pre-heat changeover time (if applicable);
 - vi) welding force/force profile;
 - vii) meltdown/collapse/weld displacement;
 - viii) welding time;
 - ix) hold/cooling time;
- 5) Orbital vibration welding (see [Annex E](#)):
- i) frequency;
 - ii) amplitude/amplitude profile;
 - iii) welding force/force profile;
 - iv) meltdown/collapse/weld displacement;
 - v) welding time;
 - vi) hold/cooling time;
- 6) Spin welding (see [Annex F](#)):
- i) machine type (servo-drive/inertia);
 - ii) head mass (inertia machines only);
 - iii) run-up time (inertia machines only);
 - iv) rotational speed;
 - v) down speed;
 - vi) welding force/force profile;
 - vii) welding time;
 - viii) number of rotations (if applicable);
 - ix) meltdown/collapse/weld displacement;
 - x) hold/cooling time;
 - xi) final angular position (if applicable);
- 7) Laser welding (see [Annex G](#)):
- i) wavelength;
 - ii) laser power;
 - iii) peak power (pulse lasers only);
 - iv) pulse energy (pulse lasers only);
 - v) pulse duration and repetition rate (pulse lasers only);
 - vi) beam delivery (contour);
 - vii) focal length of focusing lens;
 - viii) beam energy profile/dimensions;
 - ix) power density;
 - x) laser transmission of lower sub-component;
 - xi) laser transmission of upper sub-component;
 - xii) laser absorber type (if applicable);

- xiii) welding/clamping force;
 - xiv) scan speed (if applicable);
 - xv) number of passes (if applicable);
 - xvi) weld time (if applicable);
 - xvii) meltdown/collapse/weld displacement;
 - xviii) temperature close/loop (if applicable);
 - xix) power mapping/zoning (if applicable);
 - xx) hold/cooling time;
- 8) Hot plate welding (see [Annex H](#)):
- i) plate temperature;
 - ii) hot plate surface coating (if applicable);
 - iii) melting force;
 - iv) heating time;
 - v) meltdown/collapse/displacement;
 - vi) removal of heating to part contact time/changeover time;
 - vii) welding force;
 - viii) weld collapse/displacement;
 - ix) hold/cooling time;
- 9) Heat staking: hot air (see [Annex I](#))
- i) hot air temperature;
 - ii) airflow;
 - iii) distance of stake pin from end of nozzle;
 - iv) heating time;
 - v) changeover time;
 - vi) cold stake tool/platen force;
 - vii) cold stake tool contact time;
 - viii) final cold tool position/dead stop (if applicable);
- 10) Heat staking: electrical (see [Annex J](#))
- i) heated tool temperature/temperature profile;
 - ii) heating time (if no temperature profile);
 - iii) tool/platen force;
 - iv) cooling time (if no temperature profile);
 - v) release temperature (if no temperature profile);
 - vi) final tool position/dead stop (if applicable);
- 11) Heat staking: infrared (see [Annex K](#))
- i) IR power;
 - ii) distance of stake pin from heat source;

- iii) heating time;
- iv) cold stake tool/platen force;
- v) cold stake tool contact time.

Annex A (informative)

Template for TJPS: Ultrasonic welding/staking/spot welding

Figure A.1A — Thermal joining process specification (TJPS): Ultrasonic welding/staking/spot welding

Thermal joining process specification (TJPS): Ultrasonic welding/staking/spot welding			
Joining organization:		TJPS reference number/revision:	
Component name:			
Customer component/part number		Supplier component/part number	
JPQR number:			
Sub-component A:*		Sub-component B:	
Material type/designation:		Material type/designation:	
Material supplier name		Material supplier name	
Material grade		Material grade	
Masterbatch reference		Masterbatch reference	
Masterbatch percentage (%)		Masterbatch percentage (%)	
Regrind (%)		Regrind (%)	
Moisture content range (%)		Moisture content range (%)	
Dimensional report number		Dimensional report number	
Process report number		Process report number	
Visual examination acceptance criteria document number		Visual examination acceptance criteria document number	
*Sub-component A to be the part in initial contact with the sonotrode/horn			
Joining process (welding/staking/spot welding):			
Machine characteristics			
Machine type (fixed/handheld)			
Frequency (kHz)			
Power rating (kW)			
Joining parameters:		Value/tolerance or range	
Ambient temperature (°C)			
Sub-component temperature (°C)			
Tool temperature (°C)			
Tool face amplitude (µm)/amplitude profile			
Down speed (mm/s) (not handheld)			
Trigger force (N) (if applicable)/(not handheld)			
Pre-trigger/touch (yes/no) (not handheld)			
Pre-trigger amplitude (µm) (if applicable)/(not handheld)			
Joining force (N)/force profile (not handheld)			
Meltdown/collapse/weld displacement (mm) (not handheld)			
Joining or welding time (s)			
Hold/cooling time (s)			
Weld energy (J or Ws)			
Compiled by:		Signature:	
		Date:	
Approved name:		Signature:	
		Date:	

Figure A.1B — *Thermal joining process specification: Ultrasonic welding/staking/spot welding – Joint design*