BRITISH STANDARD

BS EN ISO 22827-2:2005

Acceptance tests for Nd:YAG laser beam welding machines — Machines with optical fibre delivery —

Part 2: Moving mechanism

The European Standard EN ISO 22827-2:2005 has the status of a British Standard

ICS 25.160.30

British Standards

National foreword

This British Standard is the official English language version of EN ISO 22827-2:2005. It is identical with ISO 22827-2:2005.

The UK participation in its preparation was entrusted to Technical Committee WEE/-/1, Briefing committee for welding, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN ISO title page, the EN ISO foreword page, the ISO title page, pages ii to v, a blank page, pages 1 to 9 and a back cover.

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English Version

Acceptance tests for Nd:YAG laser beam welding machines - Machines with optical fibre delivery - Part 2: Moving mechanism (ISO 22827-2:2005)

Essais de réception pour les machines de soudage par faisceau laser Nd:YAG - Machines avec transport de faisceau par fibre optique - Partie 2: Mécanisme de positionnement (ISO 22827-2:2005)

Abnahmeprüfungen für Nd:YAG-Laserstrahlschweißmaschinen - Maschinen mit Versorgung durch Lichtleitfaser - Teil 2: Mechanische Bewegungseinrichtung (ISO 22827-2:2005)

This European Standard was approved by CEN on 26 September 2005.

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Foreword

This document (EN ISO 22827-2:2005) has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 "Welding", 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of an identical text or by endorsement, at the latest by April 2006, and conflicting national standards shall be withdrawn at the latest by April 2006.

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Endorsement notice

The text of ISO 22827-2:2005 has been approved by CEN as EN ISO 22827-2:2005 without any modifications.

INTERNATIONAL STANDARD

ISO 22827-2

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Acceptance tests for Nd:YAG laser beam welding machines — Machines with optical fibre delivery —

Part 2:
Moving mechanism

Essais de réception pour les machines de soudage par faisceau laser Nd:YAG — Machines avec transport de faisceau par fibre optique —

Partie 2: Mécanisme de positionnement

Reference number
ISO 22827-2:2005(E)

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 22827-2 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

ISO 22827 consists of the following parts, under the general title *Acceptance tests for Nd:YAG laser beam welding machines — Machines with optical fibre delivery*:

— *Part 1: Laser assembly*

— *Part 2: Moving mechanism*

Introduction

Requests for official interpretations of any aspect of this part of ISO 22827 should be sent to the Secretariat of ISO/TC 44/SC 10 via the member body in the user's country, a complete listing of which can be found at www.iso.org.

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Acceptance tests for Nd:YAG laser beam welding machines — Machines with optical fibre delivery —

Part 2: Moving mechanism

1 Scope

This part of ISO 22827 covers acceptance testing of equipment for 2D manipulation and also, to some extent, movements along the Z-axis.

NOTE Welding robots and similar 3D equipment for manipulation are covered by other standards, notably ISO 9283.

This part of ISO 22827 specifies two methods for the testing of the accuracy of the moving mechanism. The first method (type 1 test) provides a test method capable of classification of the moving mechanism rigorously according to the required accuracy. The second method (type 2 test) provides a simpler method for testing the moving mechanism by marking. The selection of the test method is optional. However, for large-size laser beam welding machines, such as a laser beam welding machine using 2D moving optics or an X-Y table, the type 2 test is applicable.

This part of ISO 22827 is not applicable for welding cells with manual positioning of the welding head and/or the component, and for fixed-position welding without the moving mechanism.

The requirements can also be applied as a part of verification testing as part of maintenance, as appropriate.

If modifications are made to a laser beam machine (rebuilding, repairs, modifications to the operating conditions, etc.) that have an effect on the acceptance testing, a repeat test may be necessary to cover the machine parameters affected by such modifications.

NOTE The beam generating system, the optical delivery system and the devices for shielding and assist gasses are covered in ISO 22827-1.

This part of ISO 22827 can be applied to a part of the acceptance conditions for the delivery of the laser beam welding machine.

2 Normative references

The following referenced documents are indispensable for the application 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 230-2, *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning numerically controlled axes*

ISO 15616-2:2003, *Acceptance tests for CO_2-laser beam machines for high quality welding and cutting — Part 2: Measurement of static and dynamic accuracy*

ISO/TS 17477:2003, *Acceptance tests for CO_2-laser beam machines for welding and cutting using 2D moving optics type*

3 Terms and definitions

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

3.1
positioning accuracy
precision and repeatability of positioning of the part in motion (work piece, optics, etc.) along a translation or rotation axis

NOTE The following characteristics can be distinguished in accordance with ISO 230-2:

- mean reversal value of an axis: arithmetic mean of the reversal values at all target positions along or around the axis;
- unidirectional and bidirectional repeatability of positioning of an axis: maximum value of the repeatability of positioning at any position along or around the axis and under the conditions specified in ISO 230-2;
- bidirectional accuracy of positioning of an axis: maximum difference between the extreme values of the positional deviations regardless of the position and the direction of motion [ISO 15616-2:2003].

3.2
trajectory accuracy
trajectory deviation between the required path and the realised or marked path.

4 Environmental conditions

Laser beam welding machines shall be installed in welding cells, also including equipment for manipulation of the welding head and/or the component to be welded.

5 Test of accuracy of the moving mechanism

5.1 Type 1 test

5.1.1 Classification of the moving mechanism

The moving mechanism for the laser beam welding system is classified as follows:

A: Very high accuracy welding

B: High accuracy welding

C: Ordinary welding

D: Low accuracy welding

The designation of the classes is arbitrary to some degree. Selection of the required class has to be done during production planning and the class specified in the welding-procedure specification.

Detailed testing of the moving table or rotating fixtures shall be carried out either without a load or with a load (maximum load). When the moving system is provided with a beam-moving axis, this shall be tested.

The positioning accuracy shall be measured in accordance with 5.1.2.

The dynamic trajectory accuracy shall be measured in accordance with 5.1.3.

5.1.2 Inspection of positioning accuracy

The range of repeatability and positioning accuracy of the Nd:YAG laser beam welding machines shall be in accordance with Table 1, according to the classification of the moving mechanism.

Testing shall be carried out at the maximum travelling speed specified in the manufacturer's specification for welding operations. The measured value of accuracy shall be within the range shown in Table 1. At least three measurements shall be taken and averaged.

When the table length is in 1 m or longer, the positioning accuracy shall be measured at every 1 m in span of the movement. Inspection shall be carried out for the X-and Y-coordinates.

Table 1 — Range of repeatability and positioning accuracy

Item	Acceptance criteria for class			
	A	B	C	D
Positioning repeatability				
— unidirectional	± 0,01 mm	± 0,01 mm	± 0,02 mm	± 0,2 mm
— bidirectional	± 0,02 mm	± 0,04 mm	± 0,06 mm	± 0,4 mm
Positioning accuracy	± 0,05 mm/m	± 0,1 mm/m	± 0,2 mm/m	± 0,4 mm/m

The positioning accuracy shall be measured only after verifying that the travelling speed range is within the requirement shown in Table 2.

The positioning accuracy and position repeatability shall be measured based on ISO 230-2 or ISO/TS 17477. However, a simplified test method can be used if specified in the specification.

The inspection shall include that of the working axis or rotating fixtures of the moving table under no load condition. Positioning accuracy of the optical axis of the moving beam shall be tested if the moving beam is used.

The travelling speed accuracy shall be tested at maximum and minimum travelling speeds, as specified in the specification for welding operations. The measured values shall be within the range specified in Table 2. The manufacturer's specification may include a preferred travelling speed for welding operations. The measured value of the preferred travelling speed shall be within the range specified in Table 2.

Table 2 — Range of travelling speed accuracy

Item	Acceptance criteria for class			
	A	B	C	D
Maximum travel speed	± 2 %	± 2 %	± 4 %	± 10 %
Minimum travel speed	± 5 %	± 5 %	± 10 %	± 10 %
Preferred speed accuracy	± 1 %	± 1 %	± 2 %	± 5 %

The passing points for speed measurements shall be marked in the equal-velocity running range within the maximum table size, and the time for passing the distance between the passing points shall be measured.

5.1.3 Inspection of trajectory accuracy

The trajectory accuracy has to be measured in accordance with ISO 15616-2:2003, Clause 5, or measured as the deviation from intersection in accordance with ISO/TS 17477:2003, 5.2.

The limits for the measured values are given in Table 3.

Table 3 — Grouping of trajectory accuracy

Type of trajectory	Acceptance criteria for class			
	A	B	C	D
Rectangle: Maximum value measured at four points Omitted error f_a (mm) and Overshoot error f_o (mm)	0,1	0,2	0,5	1,0
Circle: Roundness error t (mm)	0,05	0,1	0,25	0,5
45° bevel: Reversal error r (mm)	0,05	0,1	0,25	0,5

5.1.4 Test procedure

For the speed measurement of the moving table and rotating parts, use a measuring equipment (digital integrating meter, dial gauge, laser measuring machine, etc.) securely installed on a fixed point outside the machine. Both the static and dynamic accuracy of the moving beam axis shall be measured.

In order to exclude the influences of welding, measurements shall be taken directly against the work piece or the positioning equipment or the moving-type condensing (focusing) optics.

A hard rubber friction wheel, etc. can be used to transmit linear or rotating movement to a movement-measuring instrument.

5.2 Type 2 test

5.2.1 Parameters to be tested

The type 2 test shall include verification of the following parameters:

a) trajectory accuracy;

b) straightness of the motion in X-axis direction;

c) straightness of the motion in Y-axis direction;

d) squareness between X-and Y-axes;

e) positioning accuracy of the motion in X-axis direction;

f) positioning accuracy of the motion in Y-axis direction;

g) moving speed accuracy.

5.2.2 Test devices

The testing shall be carried out with measuring instruments, such as standard scale, tape measure, dial gauge and/or steel wire. The instruments shall be sufficiently accurate and calibrated, validated or verified as appropriate.

5.2.3 Test procedures

5.2.3.1 Trajectory accuracy

5.2.3.1.1 Pattern

The pattern shown in Figure 1 shall be marked out by either

- drawing on a piece of paper or a test piece by fitting a vertically movable ball-point pen on the tip of the optical head, or
- permanent marking on a stainless-steel sheet by the laser beam.

The pattern shall be marked at 1 000 mm/min using the numerical controls of the system. Deviations from the intersections, meandering of trajectories, and deviations of arc trajectories shall be checked as described below. The acceptance criteria for the type 2 test are given in 5.2.4 and Table 4.

For laser machines with an effective machining range of less than 800 mm × 800 mm, the largest square covering the effective machining range shall be used.

For laser machine with a single-side drive, the test shall be carried out on the driving side.

The pattern shown in Figure 1 shall be made as follows:

- one side of the circumferential square shall be parallel to the X-axis;
- the lines shall be drawn continuously;
- the circle shall be drawn continuously;
- the circle that inscribes the circumferential square shall be marked by overwriting in the clockwise and counterclockwise directions.

5.2.3.1.2 Deviation of intersection

Measure the deviation from intersection at the points in Figure 1 (A to H and J to R) where three or more straight lines intersect.

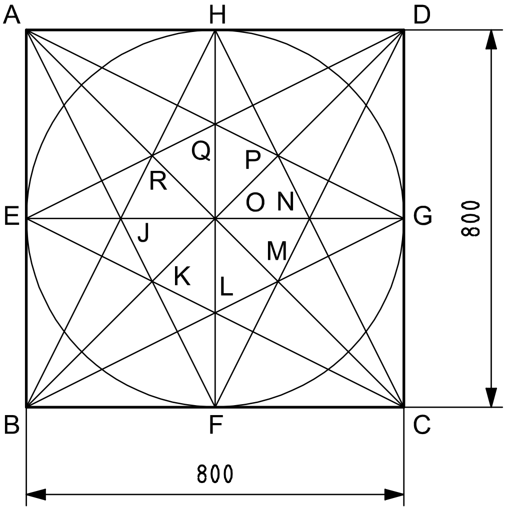
5.2.3.1.3 Meandering of trajectory

Concerning the meandering of trajectory, measure the maximum amplitudes of the straight lines shown in Figure 1.

5.2.3.1.4 Deviation of arc trajectory

Concerning the deviation of arc trajectory, measure the maximum value of the deviations of the circle that inscribes about the square A B C D, and that is overwritten in the clockwise and counterclockwise directions.

Dimensions in millimetres



Sequence of trajectory: A → B → C → D → A → C → H → B → D → F → A → G → E → C → G → B → E → D → H → F → E → H → G → F → G → H →E → F

Figure 1 — Marking figure inspected (sequence of trajectory)

5.2.3.2 Straightness of the motion in X-axis direction

Mark a straight line on the paper placed on a flat plate, such as a steel plate, fitting a ballpoint pen onto the machining head, and moving the laser machine in the X-axis direction.

Stretch a steel wire between both ends of this straight line, and measure the maximum deviation of the straight line from the steel wire, using an optical measuring instrument, at every 1 000 mm in the X-axis direction.

It is recommended that this test be performed in the whole range of the effective machining length of the laser machine.

5.2.3.3 Straightness of the motion in Y-axis direction

Mark a straight line on the paper placed on a flat plate, such as a steel plate, fitting a ballpoint pen onto the machining head, and moving the laser machine in the Y-axis direction.

Stretch a steel wire between both ends of this straight line, and measure the maximum deviation of the straight line from the steel wire, using an optical measuring instrument, at every 1 000 mm in the Y-axis direction.

It is recommended that this test be performed in the whole range of the effective machining length of the laser machine.

5.2.3.4 Squareness between X-axis and Y-axis

Mark a square parallel to the X-axis and having a side of 2 000 mm (for a laser beam welding machine having an effective processing area of less than 2 000 mm × 2 000 mm, the largest square covering the effective processing area), measure the lengths of the two diagonals with a tape measure, and determine the difference of the length between them.

5.2.3.5 Positioning accuracy of the motion in X-axis direction

Make a unidirectional movement of 1 000 mm from an arbitrary point in the X-direction by a numerical command (NC). Measure the deviations and determine the difference between the actual value and the programmed value using a standard scale.

5.2.3.6 Positioning accuracy of the motion in Y-axis direction

Make a unidirectional movement of 1 000 mm from an arbitrary point in the Y-direction by an NC command. Measure the deviations and determine the difference between the actual value and the programmed value using a standard scale.

5.2.3.7 Moving speed accuracy

Measure the deviation between the programmed speed and the actual moving speed, with regard to 1/4, 1/2, and 1/1 of the maximum speed for the welding operations in the X-axis and Y-axis directions, respectively. The time interval shall be measured from the moment the head passes the first target position to the moment the head passes the second target position. The head shall have a specified speed when the first target position is reached, and the speed shall be kept constant until the last target position has been reached. Alternatively, the self-diagnosis function of the NC machine can be used.

5.2.4 Acceptance criteria for type 2 test

The acceptance criteria for each of the tests described in 5.2.3 are given in Table 4.

Table 4 — Acceptance criteria for type 2 test

Item	Acceptance criteria
Trajectory accuracy — Deviation of intersection point — Meandering of trajectory — Deviation of arc trajectory	 $\leqslant$ 0,5 mm $\leqslant$ 0,2 mm $\leqslant$ 0,5 mm
Straightness of the motion in X-axis direction	$\leqslant$ 0,4 mm
Straightness of the motion in Y-axis direction	$\leqslant$ 0,4 mm
Squareness of X-axis and Y-axis directions	Difference of the length between diagonals $\leqslant$ 0,5 mm
Positioning accuracy of the motion in X-axis direction	Difference with programmed value ± 0,2 mm max.
Positioning accuracy of the motion in Y-axis direction	Difference with programmed value ± 0,2 mm max.
Moving speed accuracy	Error against programmed speed ± 5 % max.

6 Test report

All tests shall be properly recorded, and the documents filed as appropriate.

An example of the form to be used for reporting results is given in Annex A.

Annex A
(informative)

Example of a test report form

Table A.1 — Example of a test report form

Model name of laser beam welding machine:	**Manufacturing number:**	
	Date of test	**Place of testing:**
Name of tester:		

Items	Request classification	Inspection items	Inspection results
Moving mechanism		Moving stage is loaded ?	Yes or No
		Weight of load (if loaded)	kg
Type 1 test	A B C D	Positioning repeatability:	
		— unidirectional	mm
	necessary	— bidirectional	mm
	or	Positioning accuracy	mm/m
	not necessary	(at travel speed: mm/s)	
		Travel speed accuracy:	
		— Maximum travel speed	%
		— Minimum travel speed	%
		— Set speed accuracy	%
		Trajectory accuracy	
		— Rectangle f_a	mm
		f_o	mm
		— Circle t	mm
		— 45° bevel r	mm
Type 2 test	Implementation	Trajectory accuracy:	
	necessary	— Deviation of intersection	mm
	or	— Meandering of trajectory	mm
	not necessary	— Deviation of arc trajectory	mm
		Straightness:	
		— X-axis direction	mm
		— Y-axis direction	mm
		Squareness of X- and Y- axes direction	
		— Difference of the length between diagonals	mm
		Positioning accuracy of the motion in X-axis direction:	
		— Difference with programmed value	± mm
		Positioning accuracy of the motion in Y-axis direction:	
		— Difference with programmed value	± mm
		Moving speed accuracy:	
		— Error against programmed speed	± %

Bibliography

[1] ISO 9283:1998, *Manipulating industrial robots — Performance criteria and related test methods*

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