



SLOVENSKI STANDARD
oSIST prEN ISO 23864:2021
01-september-2021

Neporušitveno preskušanje zvarnih spojev - Ultrazvočno preskušanje - Uporaba tehnike TFM in sorodnih tehnik/postopkov (ISO 23864:2021)

Non-destructive testing of welds - Ultrasonic testing - Use of automated total focusing technique (TFM) and related technologies (ISO 23864:2021)

Zerstörungsfreie Prüfung von Schweißverbindungen - Ultraschallprüfung - Verwendung der automatisierten Totalfokussierungsmethode (TFM) und verwandte Technologien (ISO 23864:2021)

(standards.iteh.ai)

Essais non destructifs des assemblages soudés - Contrôle par ultrasons - Utilisation de la technique d'acquisition automatisée de focalisation en tout point (FTP) et de techniques associées (ISO 23864:2021)

Ta slovenski standard je istoveten z: prEN ISO 23864

ICS:

25.160.40 Varjeni spoji in vari Welded joints and welds

oSIST prEN ISO 23864:2021 en,fr,de

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN ISO 23864:2021](#)

<https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021>

INTERNATIONAL
STANDARD

ISO
23864

First edition
2021-01

**Non-destructive testing of welds —
Ultrasonic testing — Use of automated
total focusing technique (TFM) and
related technologies**

*Essais non destructifs des assemblages soudés — Contrôle par
ultrasons — Utilisation de la technique d'acquisition automatisée de
focalisation en tout point (FTP) et de techniques associées*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN ISO 23864:2021](https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021)

<https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021>



Reference number
ISO 23864:2021(E)

© ISO 2021

iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 23864:2021](https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021)

<https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	v
1 Scope	1
2 Normative references	2
3 Terms and definitions	2
4 Testing levels	2
5 Information required before testing	3
5.1 Items to be defined before procedure development.....	3
5.2 Specific information required by the operator before testing.....	4
5.3 Written test procedure.....	4
6 Requirements for personnel and equipment	5
6.1 Personnel qualifications.....	5
6.2 Test equipment.....	5
6.2.1 General.....	5
6.2.2 Instrument.....	5
6.2.3 Probes.....	6
6.2.4 Scanning mechanisms.....	6
7 Preparation for testing	6
7.1 Volume to be tested.....	6
7.2 Imaging typical weld discontinuities.....	6
7.2.1 Discontinuity orientation.....	6
7.2.2 Discontinuity location.....	7
7.2.3 Suitable imaging paths for specific discontinuity types.....	7
7.3 Verification of test setup.....	10
7.4 Scan increment setting.....	10
7.5 Geometry considerations.....	10
7.6 Preparation of scanning surfaces.....	11
7.7 Temperature.....	11
7.8 Couplant.....	11
8 Testing of parent material	11
9 Range and sensitivity	11
9.1 General.....	11
9.2 Range and sensitivity settings.....	12
9.2.1 General.....	12
9.2.2 Setting range and sensitivity on the test object itself.....	12
9.2.3 Gain corrections.....	12
9.3 Checking of the settings.....	12
10 Reference blocks and test blocks	13
10.1 General.....	13
10.2 Material.....	13
10.3 Dimensions and shape.....	13
10.4 Reference reflectors.....	13
11 Equipment checks	13
12 Procedure verification	14
13 Weld testing	14
14 Data storage	14
15 Interpretation and analysis of TFM images	14
15.1 General.....	14
15.2 Assessing the quality of TFM images.....	15

ISO 23864:2021(E)

15.3	Identification of relevant indications	15
15.4	Classification of relevant indications	15
15.5	Determination of location and length of an indication	15
15.5.1	Location	15
15.5.2	Length	15
15.6	Determination of amplitude or height of an indication	15
15.6.1	General	15
15.6.2	Based on amplitude	16
15.6.3	Based on height	16
15.7	Evaluation against acceptance criteria	16
16	Test report	16
17	Austenitic welds	18
Annex A (informative) Typical reference blocks and reference reflectors		19
Annex B (informative) TFM images of typical discontinuities		24
Bibliography		32

iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 23864:2021](https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021)

<https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021>

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 the IIW, *International Institute of Welding*, Commission V, *NDT and Quality Assurance of Welded Products*, 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).

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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN ISO 23864:2021](#)

<https://standards.iteh.ai/catalog/standards/sist/1209c166-8001-441d-946d-9fe73dbfa020/osist-pren-iso-23864-2021>

Non-destructive testing of welds — Ultrasonic testing — Use of automated total focusing technique (TFM) and related technologies

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document specifies the application of the TFM technique and related technologies for semi- or fully automated ultrasonic testing of fusion-welded joints in metallic materials of minimum thickness 3,2 mm.

NOTE Unless stated otherwise, in this document “TFM” and “TFM technique” refer to the TFM technique as defined in ISO 23243, and to all related technologies, see for example ISO 23865 and ISO 23243.

This document is applicable to components with welds fabricated using metals which have isotropic (constant properties in all directions) and homogeneous conditions. This includes welds in low carbon alloy steels and common aerospace grade aluminium and titanium alloys, provided they are homogeneous and isotropic.

This document applies to full penetration welded joints of simple geometry in plates, pipes and vessels.

This document specifies four testing levels (A, B, C, D), each corresponding to a different probability of detection of imperfections. Guidance on the selection of testing levels is provided. Coarse-grained metals and austenitic welds can be tested when the provisions of this document have been taken into account.

This document gives provisions on the specific capabilities and limitations of the TFM technique for the detection, locating, sizing and characterization of discontinuities in fusion-welded joints. The TFM technique can be used as a stand-alone approach or in combination with other non-destructive testing (NDT) methods for manufacturing, in-service and post-repair tests.

This document includes assessment of indications for acceptance purposes based on either amplitude (equivalent reflector size) and length or height and length.

This document does not include acceptance levels for discontinuities.

The following two typical testing techniques for welded joints are referred to in this document:

- a) side scanning, where the probe(s) is (are) positioned adjacent to the weld cap, typically using wedges. Side scanning can be performed from one side or both sides of the weld;
- b) top scanning where the probe is positioned on top of weld cap with a flexible, conformable delay line or using immersion technique, or using contact technique after removing the weld cap.

Semi-automated testing encompasses a controlled movement of one or more probes along a fixture (guidance strip, ruler, etc.), whereby the probe position is measured with a position sensor. The scan is performed manually.

In addition, fully automated testing includes mechanized propulsion.

ISO 23864:2021(E)

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 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 17635, *Non-destructive testing of welds — General rules for metallic materials*

ISO 18563-1, *Non-destructive testing — Characterization and verification of ultrasonic phased array equipment — Part 1: Instruments*

ISO 18563-2, *Non-destructive testing — Characterization and verification of ultrasonic phased array equipment — Part 2: Probes*

ISO 23865:2021, *Non-destructive testing — Ultrasonic testing — General use of full matrix capture/ total focusing method technique*

ISO 23243, *Non-destructive testing — Ultrasonic testing with arrays - Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577, ISO 17635, ISO 23865 and ISO 23243 apply.

ISO and IEC maintain terminological databases 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/>

4 Testing levels

Quality requirements for welded joints are mainly associated with the material, the welding process and the service conditions. To accommodate all these requirements, this document specifies four testing levels (A, B, C, and D).

From testing level A to testing level C, an increasing probability of detection is achieved by an increasing testing coverage, i.e. covering the test volume in multiple ways, e.g. number of imaging paths, number of array positions.

Testing level D may be agreed for special applications using a written procedure which shall take into account the general requirements of this document. This includes tests of metals other than ferritic steel, tests on partial penetration welds, tests at object temperatures outside the range of 7.7. For level D, a verification on test blocks is mandatory.

Testing levels related to quality levels shall be in accordance with ISO 5817 or technically equivalent standards. The appropriate testing level can be specified by standards for testing of welds (e.g. ISO 17635), by product standards or by other documents. When ISO 17635 is specified, the recommended testing levels are as given in [Table 1](#).

Table 1 — Recommended testing levels

Testing level	Quality level in accordance with ISO 5817
A	C, D
B	B
C	by agreement
D	special application

[Table 2](#) shows the minimum requirements. As described in [7.3](#), the setup shall be verified with reference blocks and/or test blocks in all cases.

Top scanning can be performed with TFM if the weld cap has been removed and the test surface is flat, otherwise adaptive focusing is required to take the geometry of the weld cap into account.

Side scanning with two probes simultaneously at both sides of the weld allows for imaging paths from one probe to the other probe (see ISO 23865).

Table 2 — Details of testing levels, minimum requirements

Testing technique	Testing levels			
	A ^a	B ^a	C ^b	D ^b
Top scanning at fixed probe position to the weld (line scan)	Direct imaging path	Direct imaging path and imaging path using reflection at the opposite surface	Direct imaging path and imaging path(s) which ensure(s) reflected signals from planar discontinuities on the weld bevel	Suitable imaging paths and positions (sides) by agreement
Side scanning at fixed probe position to the weld (line scan)	Direct imaging path, two sides	Direct imaging path and imaging path using reflection at the opposite surface, two sides or two probe positions	Direct imaging path and (multiple) imaging path(s) using reflection at the opposite surface, two sides or two probe positions	Suitable imaging paths and positions (sides) by agreement
Side scanning with raster scanning	Direct imaging path, one side	Direct imaging path and imaging path using reflection at the opposite surface, one side	Direct imaging path and (multiple) imaging path(s) using reflection at the opposite surface, one side, images from different probe positions to the weld are merged	Suitable imaging paths and positions (sides) by agreement
^a For testing levels A and B: imaging using reflection at the opposite surface can be done by extending the ROI (only for TT-TT or LL-LL) or by using corresponding imaging paths. ^b For testing levels C and D: The choice of the imaging paths shall depend on weld bevel design and be motivated in the scan plan based on Table 3 .				

5 Information required before testing

5.1 Items to be defined before procedure development

Information on the following items is required:

- purpose and extent of testing;
- type(s) of parent material (i.e. cast, forged, rolled); grain size and anisotropy;

ISO 23864:2021(E)

NOTE 1 Several properties of the parent material, in particular deviations in grain elongation due to rolling, have influence on the images generated by TFM. This influence also exists in other ultrasonic testing techniques but is experienced differently. ISO 23865:2021, Clause 15, gives guidance.

NOTE 2 Variation in wall thickness has an influence on the image generated, in particular when using imaging paths containing one or more reflections. ISO 23865:2021, Clause 15, gives guidance.

- c) testing level;
- d) acceptance criteria, including method for evaluation of indications and method for establishing reference level;
- e) specification of calibration blocks, reference blocks, test blocks used;
- f) stage (e.g. manufacturing or in-service) at which the testing is to be carried out;
- g) object and weld geometry details and information on the size of the heat-affected zone. If the size of the heat affected zone is not known, practical values according to the welding process used may be considered;
- h) requirements for access, surface conditions and temperature. Material temperature has a significant influence on the images generated by TFM. Where the test object has a temperature outside the range specified in 7.7, ISO 23865:2021, Clause 15, gives guidance;
- i) personnel qualifications;
- j) reporting requirements.

iTeh STANDARD PREVIEW

5.2 Specific information required by the operator before testing

Before any testing of a welded joint can begin, the operator shall have access to all the information as specified in 5.1, together with the following additional information:

- a) the written test procedure (see 5.3);
- b) joint preparation and dimensions;
- c) relevant information on the welding process;
- d) time of testing relative to any post-weld heat treatment.

5.3 Written test procedure

For all testing using the TFM technique, a written test procedure is required. The procedure shall include the following information as a minimum:

- a) the purpose and extent of testing, including details of the region of interest (ROI) and grid;
- b) the testing technique, including acquisition scheme and imaging algorithm (processing parameters);
- c) the testing level;
- d) the personnel qualification/training requirements;
- e) the equipment to be used (including but not limited to frequency, sampling rate, pitch, element size, wedge dimensions and velocity);
- f) the reference and/or test blocks;
- g) examples of calibration and reference scans;
- h) the sensitivity settings;

- i) required access and surface conditions;
- j) requirements for testing of parent material;
- k) evaluation of indications, including sizing methodology;
- l) acceptance level and/or recording level;
- m) reporting requirements;
- n) any environmental and safety issues;
- o) scan plan showing the following, to provide a standardized and repeatable methodology for testing:
 - object and weld geometry;
 - probe positioning and movement, relative to the weld;
 - the imaging path(s) used, and how these correspond to the location and orientation of expected discontinuities;
 - the coverage of the test object and the ROI.

6 Requirements for personnel and equipment

6.1 Personnel qualifications

Personnel performing testing in accordance with this document shall be qualified to an appropriate level in accordance with ISO 9712 or equivalent in the relevant product sector or industrial sector.

In addition to general knowledge of ultrasonic weld testing, the operators shall be familiar with, and have practical experience in, the use of the TFM technique or related technology. Specific training and examination of personnel should be performed on representative test pieces. These training and examination results should be documented. If this is not the case, specific training and examination should be performed with the finalized ultrasonic test procedures and selected ultrasonic test equipment on representative samples containing natural or artificial reflectors similar to those expected. These training and examination results should be documented.

6.2 Test equipment

6.2.1 General

In selecting the system components (hardware and software), ISO/TS 16829 gives useful information.

6.2.2 Instrument

The ultrasonic instrument used for the TFM testing shall be in accordance with ISO 18563-1, if applicable.

The instrument shall be able to acquire a full or partial matrix and either process it by itself or transmit it to a computer for post-processing. It is recommended that a sampling rate of the A-scan be used of at least five times the nominal probe frequency. It is recommended that the bandwidth of the ultrasonic instrument is sufficient to receive signals of at least two times the centre frequency of the probe, and that high- and low-pass filters are set to appropriate values, e.g. high-pass set not higher than half the centre frequency and low-pass set to at least twice the centre frequency. The specific values selected for these parameters, if applicable, shall be explicitly specified within the written procedure.

The minimum spatial resolution of data points within the image (i.e. grid spacing, nodes) should be chosen such that the amplitude of a reference reflector is stable within a specified tolerance on small