

Test instruction

Ultrasonic testing

Content	Page
Test instruction	1
1 Scope	3
2 References	3
3 Terms and definitions	3
4 Surface conditions	4
5.1 Test equipment	4
5.2 Probes	4
5.3 Control of test equipment	4
5.4 Couplant	4
5.5 Testing system	4
5.6 Test sensitivity	4
5.7 Monitoring level	4
6 Testing scope and required quality classes	4
6.1 Testing scope	4
6.2 Definition of testing areas	5
6.2.1 Steel bars	5
6.2.2 Shafts	6
6.2.3 Punched/track discs	6
6.2.4 Rings	7
6.2.5 Bevel gears	7

Changes

2025-01-20:

The following changed in comparison to SPB-QS-0002:2022-04-04:

Factory standard replaces SPB

Fastenau

Thorsten

2025.01.21

14:48:03 +01'00'

Responsible division: QS	Editor Förste, Maïke	Approval: N. Weber / C. Eschert	Technical reference: J. Schünemann / P. Schulte	Page: 1 / 9
-----------------------------	-------------------------	------------------------------------	--	----------------

6.3	Quality classes	7
7	Description of indications	8
8	Documentation	9
9	Deviation	9
Annex A	Process description ultrasonic testing (internal use only)	Section 2
	Document workflow	Section 3

1 Scope

This test instruction structures ultrasonic testing of different parts for highly stressed gearbox components in the scope of DIN EN 10228-3 and SEP 1923.

This test instruction applies to employees of REINTJES GmbH, employees of suppliers and employees of testing companies who are commissioned with ultrasonic testing of corresponding parts. The test must be carried out by qualified and certified test personnel in accordance with UT level 2 or, if permissible, UT level 1 in accordance with DIN EN ISO 9712. For tests outside the scope of DIN EN 10228-3, equivalent regulations can be used - after written consent of the quality assurance department of REINTJES. A name list of the auditors with the required certification must be submitted to REINTJES.

Phased array tests are not covered in this test instruction. An examination in this regard is possible after consultation with REINTJES and submission of all relevant documents for examination.

2 References

The following documents, cited in part or in whole, shall apply for the use of this standard. In case of dated references, only the referenced edition applies; in case of undated references, the latest edition of the referenced document (including all amendments) applies. The applicable version of the standards listed below and the rules issued by the classification societies shall apply to all contents not covered by this factory standard.

DIN EN 1330-2	Non-destructive testing - Terminology - Part 2: Terms common to the non-destructive testing methods
DIN EN 10228-3	Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings
DIN EN 10308	Non-destructive testing - Ultrasonic testing of steel bars
DIN EN ISO 2400	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 1
DIN EN ISO 5577	Non-destructive testing - Ultrasonic testing - Vocabulary
DIN EN ISO 7963	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 2
DIN EN ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
DIN EN ISO 16810	Non-destructive testing - Ultrasonic testing - General principles
DIN EN ISO 16811	Non-destructive testing - Ultrasonic testing - Sensitivity and range setting
DIN EN ISO 16827	Non-destructive testing - Ultrasonic testing - Characterization and sizing of discontinuities
DIN EN ISO 22232-1	Non-destructive testing - Characterization and verification of ultrasonic test equipment - Part 1: Instruments
DIN EN ISO 22232-2	Non-destructive testing - Characterization and verification of ultrasonic test equipment - Part 2: Probes
DIN EN ISO 22232-3	Non-destructive testing - Characterization and verification of ultrasonic test equipment - Part 3: Combined equipment
SEP 1923	Ultrasonic testing of steel forgings to stringent standards, in particular for components in turbine and generator systems

3 Terms and definitions

For the application of this document, the terms according to DIN EN 1330-2 and DIN EN ISO 5577 apply.

4 Surface conditions

The coupling surfaces must be in the condition required for proper ultrasonic testing and have the corresponding surface quality in accordance with DIN EN 10228-3.

Forged parts can be tested in a water bath. A water bath test must be specified in the acceptance test certificate.

5 Testing requirements

5.1 Test equipment

The ultrasonic testing devices must fulfil the requirements of DIN EN ISO 22232-1 and have a valid calibration. Regular inspection and maintenance of the devices at least once a year must be demonstrated.

5.2 Probes

Ultrasonic testing is preferably carried out with 4 MHz longitudinal wave vertical probes and, if required, with transverse wave probes, whereby the choice of probes depends on the geometric conditions. For testing the area close to the surface, SE vertical probes should preferably be used. When selecting the probes, it must be ensured that the diameter or length of the probe base is smaller than 1/10 of the test object diameter (see DIN EN ISO 16811).

The probes must fulfil the requirements of DIN EN ISO 22232-2.

5.3 Control of test equipment

Calibration block 1 according to DIN EN ISO 2400 and calibration block 2 according to DIN EN ISO 7963 must be used for device adjustment, monitoring of the device function and the probes.

5.4 Couplant

The couplant must wet the surface of the test piece well and ensure perfect coupling. It must also not cause any corrosive damage if measurements are taken on the machined component. The same couplant must be used for calibration and testing. The respective batch number must be documented in the ultrasonic test report and the best-before date on the respective container must be checked before use.

5.5 Testing system

The testing system must be checked regularly in accordance with DIN EN ISO 22232-3 and the performance of the tests must be documented.

5.6 Test sensitivity

The test sensitivity must be sufficient to ensure detecting the smallest discontinuities, which are defined according to the required reporting or evaluation levels for the respective quality class.

5.7 Monitoring level

All indications that reach or exceed 50 % of the respective reporting level (cf. chapter 6.3) (alternatively 6 dB amplification surcharge) must be evaluated.

6 Testing scope and required quality classes

6.1 Testing scope

A grid test in accordance with DIN EN 10228-3 Table 3 must be carried out on the lateral surface and, depending on the geometry of the component, on the end faces. 100 % testing for components for high-speed applications (peripheral speeds > 50 m/s) has to be carried out according to SEP 1923.

Table 1 names the respective product groups for REINTJES and categorises them acc. to DIN EN 10228-3. The column "Testing" corresponds to table 3 of DIN EN 10228-3 and is described in more detail in the respective chapters.

Table 1 Testing scope by product group

Chapter	Product group	Manufacturing	Testing		
6.2.1	steel bars	forging or others for complex moulds		Diameter	Test lanes
			Type 1a	D ≤ 200	2 at 90°
				200 < D ≤ 500	3 at 60°
				500 < D ≤ 1000	4 at 45°
				D > 1000	6 at 30°
Type 1b	Scanning in a cross grid on two mutually perpendicular test surfaces				
Type 1c	acc. to order				
6.2.2	shafts	forging	as type 1a for steel bars		
6.2.3	punched/truck discs	compressing	3b and 3c: Scanning in a cross grid over 360° on the outer lateral surface and one end face		
6.2.4	rings	ring rolling			
6.2.5	bevel gears	compressing			

6.2 Definition of testing areas

Used abbreviations:

D = diameter

d_a = bore diameter

d_{fi} = inner base circle diameter

d_i = inner diameter

d_N = nominal dimension, bar diameter

d_w = shank diameter

EP = refraction position

m_n = medium normal module

t = thickness

6.2.1 Steel bars

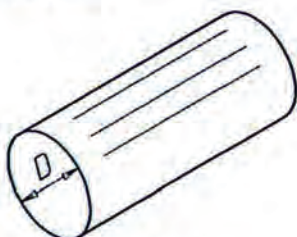


Figure 1 Steel bar type 1a

peripheral speeds < 50 m/s:

Zone 1 = $D \geq 0.3 \times d_N$

Zone 2 = $D < 0.3 \times d_N$

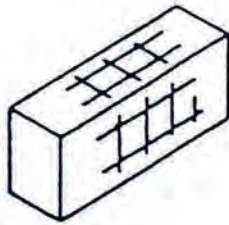
Zone 3 = $0 < D \leq d_N$

peripheral speeds > 50 m/s:

Zone 1 = $D \geq 0.2 \times d_N$

Zone 2 = $D < 0.2 \times d_N$

For steel bars for rotors with peripheral speeds > 50 m/s and drop forgings made of 42CrMo4, zone 1 applies to the power transmission area and zone 2 to the core cross-section. Zone 3 applies to unmachined steel bars over the entire diameter.



Zone 1 = $t \leq 160$ (entire thickness)
Zone 2 = $160 < t \leq 180$ (outside (2/3 t resp. 2/3 D))
Zone 3 = $160 < t \leq 180$ (core (1/3 t resp. 1/3 D))

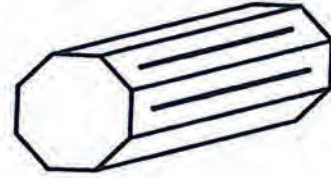
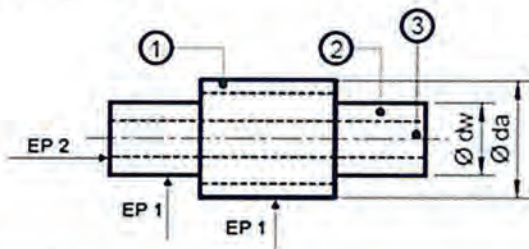


Figure 2 Steel bar type 1b

Figure 3 Steel bar type 1c

For $t > 180$, the scope of testing and quality class are specified in the order or must be agreed separately between REINTJES and the contractor.

6.2.2 Shafts



peripheral speeds < 50 m/s:

Zone 1 = $0.8 \times d_a$ to d_a

Zone 2 = $\geq 0.3 \times d_w$

Zone 3 = $< 0.3 \times d_w$

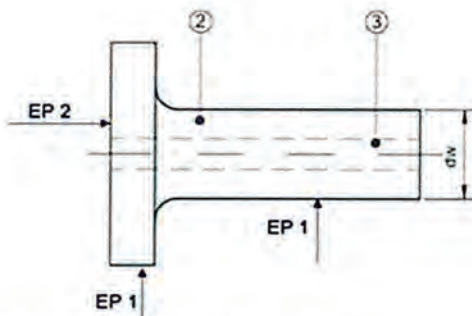
peripheral speeds > 50 m/s:

Zone 1 = $0.8 \times d_a$ to d_a

Zone 2 = $\geq 0.2 \times d_w$

Zone 3 = $< 0.2 \times d_w$

Figure 4 Pinion shaft

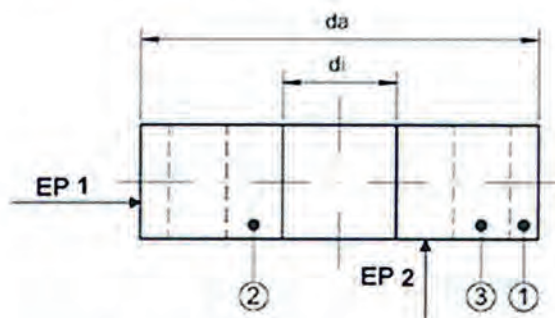


Zone 2 = $0.3 \times d_w$ to d_w

Zone 3 = $< 0.3 \times d_w$

Figure 5 Flanged/moulded shaft

6.2.3 Punched/track discs



pre-turned parts

Zone 1 = $0.8 \times d_a$ to d_a

Zone 2 = d_i to $2 \times d_i$

Zone 3 = $2 \times d_i$ to $0.8 \times d_a$

Figure 6 Punched/track discs

Contour-pre-turned discs must be checked before contour turning.

For unmachined components, quality class 3 applies to the entire diameter d_i to d_a .

6.2.4 Rings

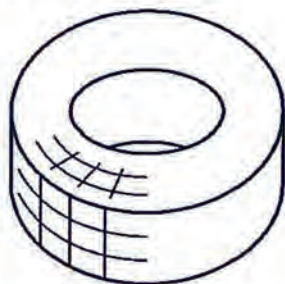
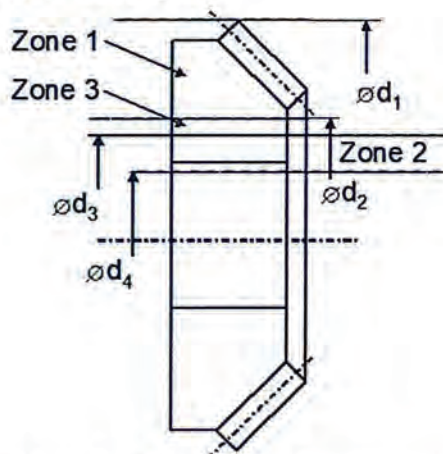


Figure 7 Ring

For rolled, pre-turned rings, quality class 4 applies to the entire diameter d_i to d_a .

For unmachined rings, quality class 3 applies to the entire diameter d_i to d_a .

6.2.5 Bevel gears



$$\text{Zone 1} = d_1 - d_2$$

$$\text{Zone 2} = d_3 - d_4$$

$$\text{Zone 3} = d_2 - d_3$$

$\varnothing d_1$ and $\varnothing d_4$ correspond to the pre-turning dimensions; $\varnothing d_3 = 1.5 \times \varnothing d_4$; $\varnothing d_2 = d_n - 3 \times m_n$

If areas overlap, quality class 4 must be used for these areas.

6.3 Quality classes

Table 2 Quality classes, reporting and acceptance levels acc. to DIN EN 10228-3, table 5

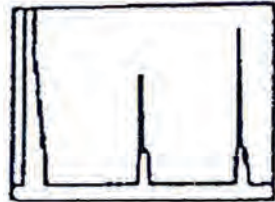
Zone	Quality class	Reporting level	Acceptance level*
Zone 1 (gearing) and Zone 2 (power transmission)	4	> KSR 2 mm	$\leq$ KSR 3 mm
Zone 3 (core zone / remaining volume)	3	> KSR 3 mm	$\leq$ KSR 5 mm

* For discontinuities with expansion and accumulations of discontinuities, for quality class 3 $\leq$ KSR 3 mm and for quality class 4 $\leq$ KSR 2 mm applies in accordance with DIN EN 10228-3.

For steel bars intended for high-speed applications and to be tested in accordance with SEP 1923, for zone 1 quality class 1a applies and for zone 2 quality class 2a for EE+VE without expanse and 2b for EEL+VE with expanse (see Figure 8).

For open die forged shafts and punched discs intended for high-speed applications and to be tested in accordance with SEP 1923, for zone 1 and zone 2 quality class 1a applies and for zone 3 quality class 2a for EE+VE without expanse and 2b for EEL+VE with expanse.

Table 3 Echo shapes for ultrasonic testing - Extract of SEP 1923, table 2

Symbol	Echo shape	A-scan
EE	Single indication (without expanse)	
and	and	
EEL	Single indication with expanse	
VE	Multiple single indications	

Tafel 3. Güteklassen (Erläuterung der Abkürzungen siehe Tafel 2)

Table 3. Quality classes (explanation of abbreviations see Table 2)

Güteklasse Quality class	Echoform/Echohöhe Echo shape/echo height				Rückwand- echoabfall Backwall echo attenuation	ermittelte Reflektorlänge Ascertained reflector lengths
	EE + VE ohne Ausdehnung without expanse		EEL + VE mit Ausdehnung with expanse GA, GN, RZ			EE, VE
	Registriergrenze Recording level	Entscheidungsggr. Acceptance level	Registriergrenze Recording level	Entscheidungsggr. Acceptance level	Entscheidungsgrenze Acceptance level	
	mm KSR mm DSR	mm KSR mm DSR	mm KSR mm DSR	mm KSR mm DSR	dB	mm
1a	1	2	alle Anzeigen ¹⁾ All indications ¹⁾	alle Anzeigen ¹⁾ All indications ¹⁾	4	10
1b	2	2	alle Anzeigen ¹⁾ All indications ¹⁾	alle Anzeigen ¹⁾ All indications ¹⁾	4	10
2a	1	3	alle Anzeigen ¹⁾ All indications ¹⁾	1 1	4	10
2b	3	3	1	1	4	10

Figure 8 Quality classes - Extract of SEP 1923, Table 3

Ultrasonic testing in a water bath or via a water gap between the test probe and the component surface must be specified in the component-related acceptance test certificate.

7 Description of indications

All indications of reflectors that reach or exceed the reporting level must be described with their echo height, echo shape, echo dynamics and their spatial distribution. Furthermore, any backwall echo attenuations and signal-to-noise ratios < 6 dB must be recorded (DIN EN ISO 16827)

The evaluation of indications is based on the echo amplitude of the reflector acc. to the AVG method, whereby the replacement reflector size is to be specified as the diameter of the equivalent disc shaped reflector (KSR) in mm.

8 Documentation

The tests performed, the test results and the assessments must be fully documented by a UT level 2 inspector. Indications requiring registration must be recorded with reproducible dimensions. A component coordinate system must be defined for this purpose. The zero point and the counting direction of this system must be permanently marked on the component.

9 Deviation

In certain areas, isolated inadmissible indications can be tolerated. Tolerance can be applied for via function mailbox tolerierungsantrag@reintjes-gears.de with REINTJES.

Surface defects in the area of the machining allowance are permissible.

A quality notification is created for notifications requiring registration. Registration limits are defined in chapter 6.3. Parts that have displays that require registration or are unauthorised are blocked and cannot be used. If a special release of the blocked components makes sense, the Research & Development department must be consulted first. Only this department is authorised to approve parts for use outside the permissible limits.

REINTJES quality assurance department must be informed of all other deviations from these test instructions. After further internal consultation, this department may decide on the use of the components.