INTERNATIONAL STANDARD

**ISO 21250-2**

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# Rolling bearings — Noise testing of rolling bearing greases —

## Part 2: Test and evaluation method BQ+

*Roulements — Essais de bruit de graisse pour roulement —*
*Partie 2: Méthode d'essai et interprétation BQ+*



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# Foreword

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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).

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This document was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

This document is intended to be used in conjunction with ISO 21250-1.

A list of all parts in the ISO 21250 series can be found on the ISO website.

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.



# Introduction

The rolling bearing life theory emphasizes the use of pure and homogeneous lubricants as essential for a long bearing service life. The lubrication of rolling bearings is described in several national standards. The GfT worksheet 3[12] contains theoretical and practical knowledge of rolling bearing lubrication.

Grease lubrication is the most common type of rolling bearing lubrication. The purity grade of rolling bearing grease is influenced by thickeners, base oils, additives and solid lubricant additives as well as the manufacturing process and is reflected in the running noise. Therefore, noise testing of rolling bearing greases is recommended.

In addition, grease noise testing in accordance with this document allows the grease manufacturers to develop low-noise lubricants with better damping properties. This document can also support the rolling bearing manufacturers and end-users in the selection of low noise grease with better damping properties.

This document covers requirements for the testing assembly and the test machine of method BQ+ to determine and assess the noise characteristics of rolling bearing grease jointly with ISO 21250-1, ISO 21250-3 and ISO 21250-4.

# Rolling bearings — Noise testing of rolling bearing greases —

# Part 2:
# Test and evaluation method BQ+



## 1 Scope

This document specifies the testing and evaluation method of rolling bearing grease noise in accordance with the method BQ+.

## 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 5593, *Rolling bearings — Vocabulary*

ISO 15242-1, *Rolling bearings — Measuring methods for vibration — Part 1: Fundamentals*

ISO 21250-1:2020, *Rolling bearings — Noise testing of rolling bearing greases — Part 1: Basic principles, testing assembly and test machine*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5593, ISO 15242-1, ISO 21250-1 and the following 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/

**3.1**
**sampling rate**
sample rate
<signal processing> frequency with which a continuous signal is sampled and converted into a time-discrete signal

Note 1 to entry: The unit is hertz (Hz) or samples (readings) per second [samples per second (samples/s)].

**3.2**
**peak reset**
manual or automatic zeroizing of the peak detector

## 4 Symbols, abbreviated terms and subscripts

For the application of this document, the symbols, abbreviated terms and subscripts according to ISO 21250-1:2020, Table 1 and Table 2, in addition to the symbols and abbreviated terms contained in Table 1 and the subscripts contained in Table 2, apply.

**Table 1 — Symbols and abbreviated terms**

| Symbol/abbreviated term | Unit | Description |
|---|---|---|
| $f$ | Hz | Frequency |
| FFT | — | Fast Fourier transform |
| *GD* | — | Grease damping |
| H[a] | — | High-band, H-band (1 800 Hz to 10 000 Hz) |
| L[b] | — | Low-band, L-band (50 Hz to 300 Hz) |
| M[a] | — | Medium-band, M-band (300 Hz to 1 800 Hz) |
| $v$ | $\mu m \cdot s^{-1}$ | Vibration velocity |

[a] Can be also used as subscript to indicate the related band.

[b] The L-band is used in noise and vibration analysis in the ISO 15242 series. However, this document does not consider this frequency range for grease noise testing and its analysis.

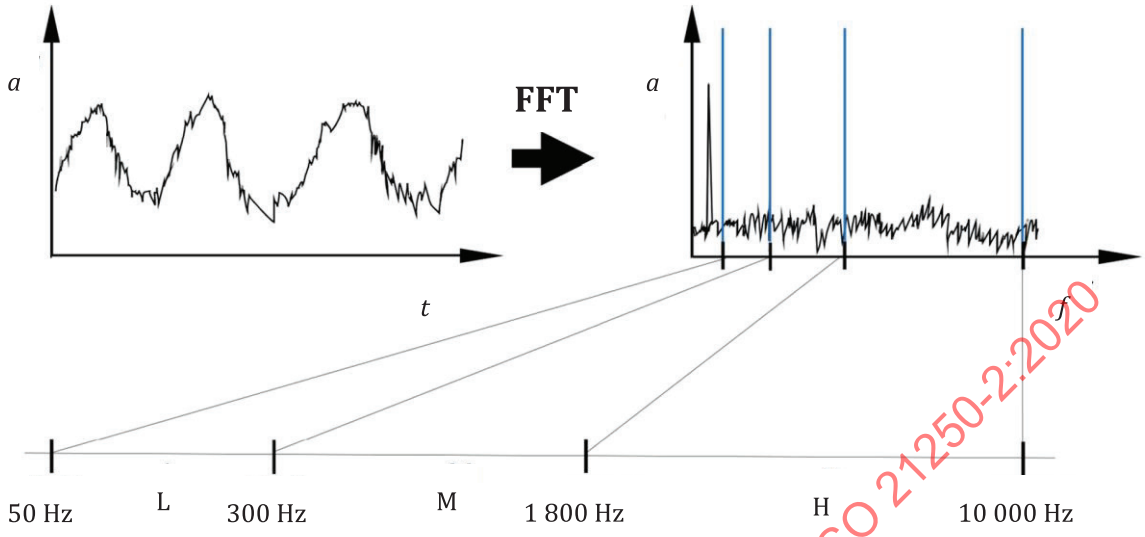
**Table 2 — Subscripts**

| Subscript | Description |
|---|---|
| BQ+ | Method BQ+ according to this document |
| NL | Noise level, average value (of vibration velocity) |
| ref | Reference, ungreased bearing |
| rms | Root mean square |

# 5 Calculation method

## 5.1 Signal processing

The recorded time signal is transformed into a frequency signal via fast Fourier transform (FFT) and is subjected to an analysis of the bands (L-, M- and H-band; effective value/rms-value), as shown in Figure 1.




**Key**

| | |
|---|---|
| *a* | amplitude |
| *f* | frequency |
| *t* | time |
| FFT | fast Fourier transform |
| H | H-band |
| L | L-band |
| M | M-band |

**Figure 1 — Signal transformation**



## 5.2 Calculation of damping

The damping ability is to be calculated according to Formulae (1) and (2).

M-band:

$$GD_{\text{M BQ+}} = \frac{v_{\text{NL, M ref}} - v_{\text{NL, M}}}{v_{\text{NL, M ref}}} \quad (1)$$

H-band:

$$GD_{\text{H BQ+}} = \frac{v_{\text{NL, H ref}} - v_{\text{NL, H}}}{v_{\text{NL, H ref}}} \quad (2)$$

## 5.3 Calculation of peak values

The peak detection algorithm for processing of the input signal is shown in ISO 21250-1:2020, Figure 1 a).

The flow chart for determining the peak values is shown in Figure 2.

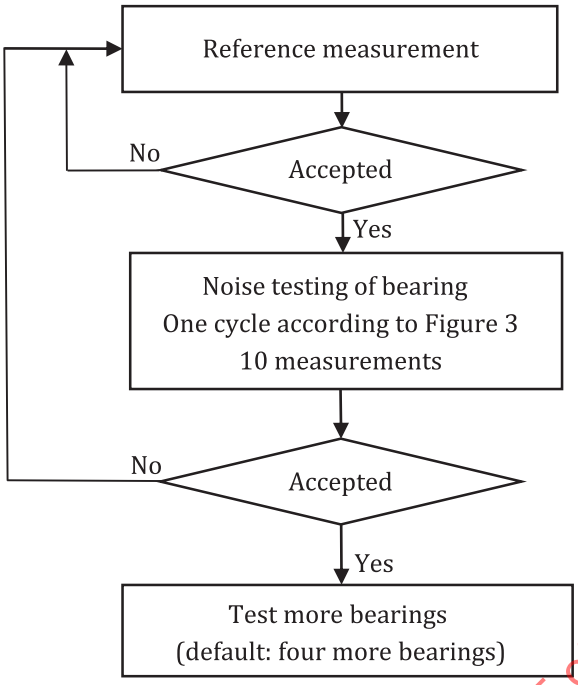



**Figure 2 — Flow chart of grease noise assessing BQ+**

The sampling rate of 25,6 kHz over a measurement period of 3,2 s shall be applied.

## 6 Test method BQ+

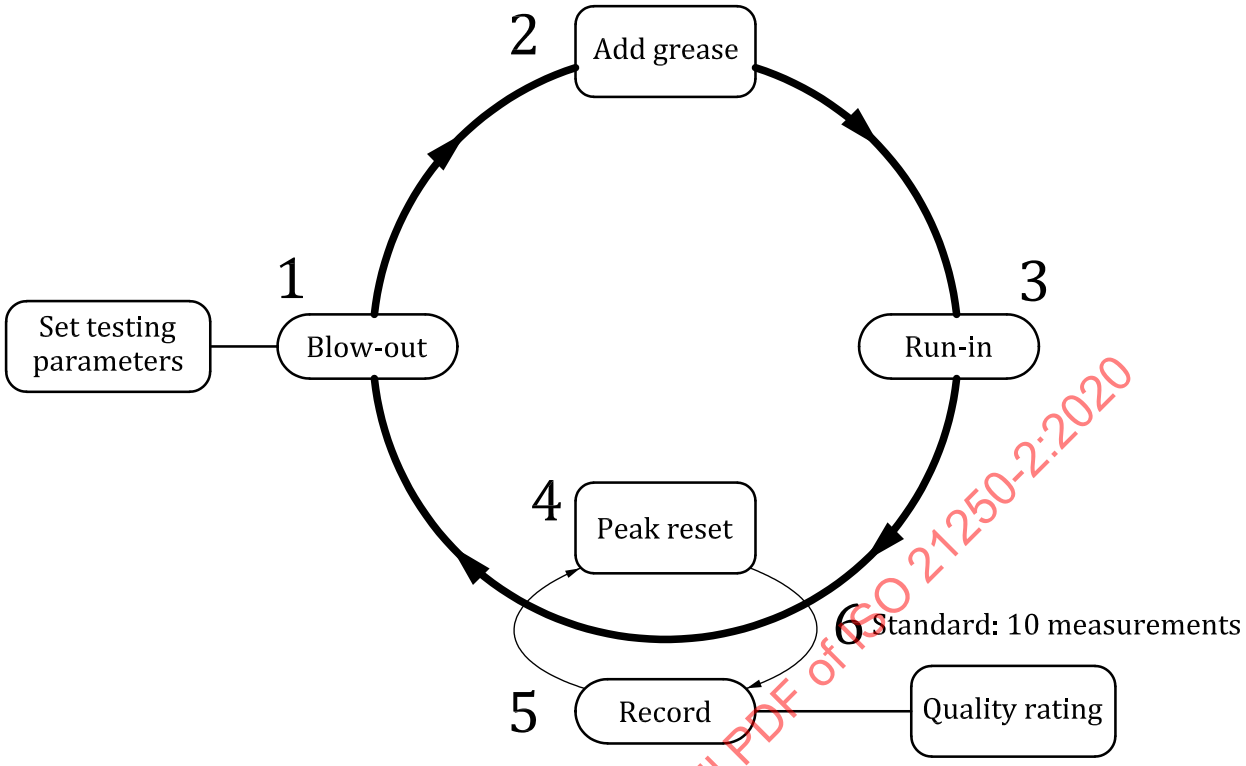
### 6.1 Measuring principle

For the application of this document, the measuring principle, test bearings and amount of grease, test load, spindle speed, signal recording and display of measuring results according to ISO 21250-1:2020, Clause 7, shall apply.

An example of a test machine, the test setup, electronic system and test reports is given in Annex A. A recommendation for inserting the amount of grease is given in Annex B and practical hints for calibration are given in Annex C.

### 6.2 Testing procedure

The testing procedure is illustrated in Figure 3 and is defined in the key to Figure 3.




**Key**

1 blow-out: this is to empty and clean the test bearing and create space for the next grease fill

2 add grease; dosage and pressure reduction: this provides for injecting a certain grease quantity out of the dosing unit to test bearing. Instructions for injecting the amount of grease are included in Annex B

3 running-in: after each dosage, the bearing shall be run-in for a certain time (default: 10 s) to distribute the grease in the bearing

4 peak reset shall be carried out before the next measurement

5 record peak: the highest peak value recorded during the measurement time (default: 3,2 s) shall be registered

6 further measurements shall be carried out, until the specified number of measurements is done (standard: 10 measurements in total)

**Figure 3 — Graphical representation of a cycle**

More cycles shall be completed until the specified number of doses has been carried out (standard: 10 doses in total). Further bearings (standard: five in total) shall be examined. After completing the testing procedure, the recorded peak values shall be evaluated according to the quality rating scale given in Clause 7.

## 7 Evaluation of results

### 7.1 Rating scale

The GN (grease noise) scale in accordance with Table 3 can be used to assess the noise behaviour of the lubricating grease.

**Table 3 — Grease noise classes — Rating scale**

| Grease noise class GN scale | Peak values | Description |
|---|---|---|
| GN X (very dirty) | Worse than a grease with noise class GN 1 | Contamination/particles cause damage on the raceways and reduce the bearing life |
| GN 1 (dirty) | ≤ 40 µm · $s^{-1}$ (for > 95 % of all values) | |
| GN 2 (loud) | ≤ 20 µm · $s^{-1}$ (for > 95 % of all values)<br>≤ 40 µm · $s^{-1}$ (for > 98 % of all values) | Impurities/particles can lead to damage on the raceways, which will result in increased bearing noise |
| GN 3 (pure, clean) | ≤ 10 µm · $s^{-1}$ (for > 95 % of all values)<br>≤ 20 µm · $s^{-1}$ (for > 98 % of all values)<br>≤ 40 µm · $s^{-1}$ (for all values) | Impurities/particles cause an audible bearing noise; there is, however, no damage to the raceways. |
| GN 4 (quiet, silent) | ≤ 5 µm · $s^{-1}$ (for > 95 % of all values)<br>≤ 10 µm · $s^{-1}$ (for > 98 % of all values)<br>≤ 20 µm · $s^{-1}$ (for all values) | High purity and only a small number of impurities/particles are present; individual noise peaks can still be measured |

## 7.2 Damping ability

The damping ability of the grease in the M-band $GD_{\mathrm{M\ BQ+}}$ shall be calculated according to Formula (1) and the damping ability of the grease in the H-band $GD_{\mathrm{H\ BQ+}}$ shall be calculated according to Formula (2).

# Annex A
(informative)

# Test machine, test setup, electronic system and test reports: examples

## A.1 Test machine

The test machine shall have the following main components:

— a high-quality spindle with a speed of 1 800 $min^{-1}$ ($^{+1\,\%}_{-2\,\%}$ speed deviation) and a rotation of the inner ring in one direction;

NOTE The lower speed limit is considered to be 1 764 $min^{-1}$ and the upper speed limit 1 818 $min^{-1}$.

— a pneumatic loading device for loading of the bearing;

— electronics with evaluation software;

— a special interface to the fully automated measurements, storage of collected readings and interpretation of results.

The test machine is usually a semi-automatic machine for use in laboratories and can consist of the following units (see Figure A.1):

— personal computer (PC);

— input and output devices;

— storage space for tools;

— calibration device;

— printer;

— electronics;

— pneumatic and test mechanics.

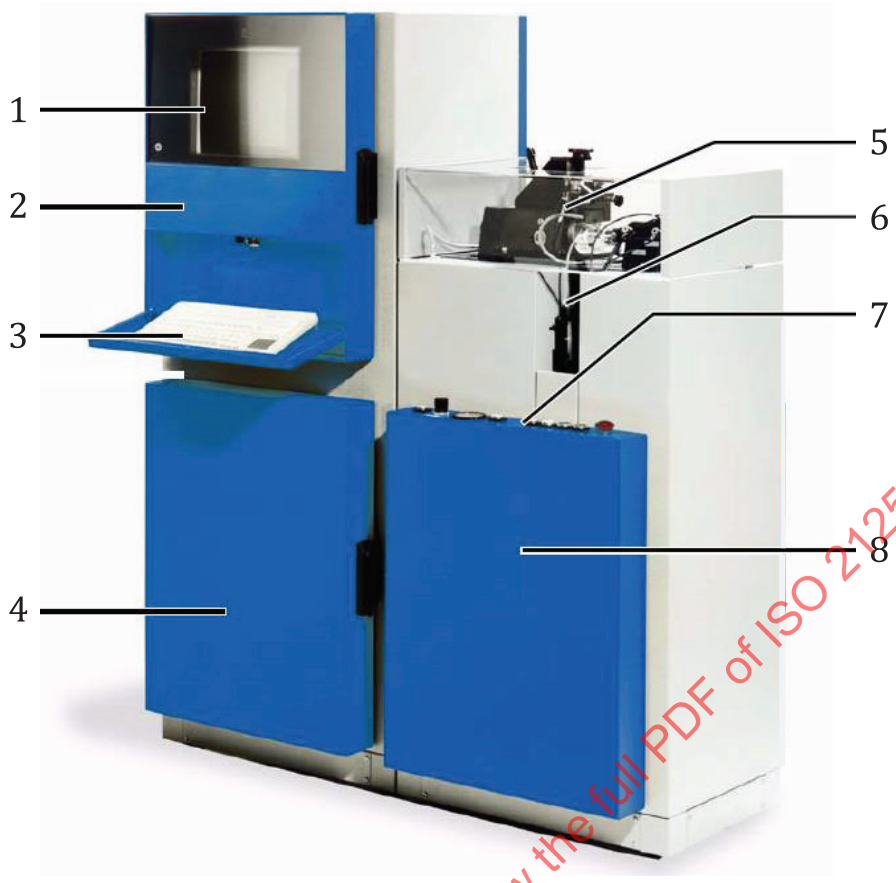
It should contain the following additional components:

— a special adapter for mounting the test bearing including inlet for the grease, as well as inlet for compressed air to blow out the grease;

— a grease dispensing unit, preferably from a linear actuator, which is driven by a variable-speed electric motor and moves the piston in the syringe with the grease sample.

The testing procedure should be automated to eliminate subjective operator influences and the risk of possible contamination, which negatively influence the result. It is on a controlled dosage of grease and peak measurement in combination with a test bearing that has a very good noise level quality.

The testing procedure should preferably be monitored by software, which stores all vibration peaks and evaluates the result in accordance with Clause 5.




**Key**

1 screen
2 electronic control cabinet
3 keyboard
4 cabinet for tools, printer and calibration device
5 test mechanics
6 grease dosing unit
7 control panel
8 cabinet for electrical, mechanical and pneumatic unit

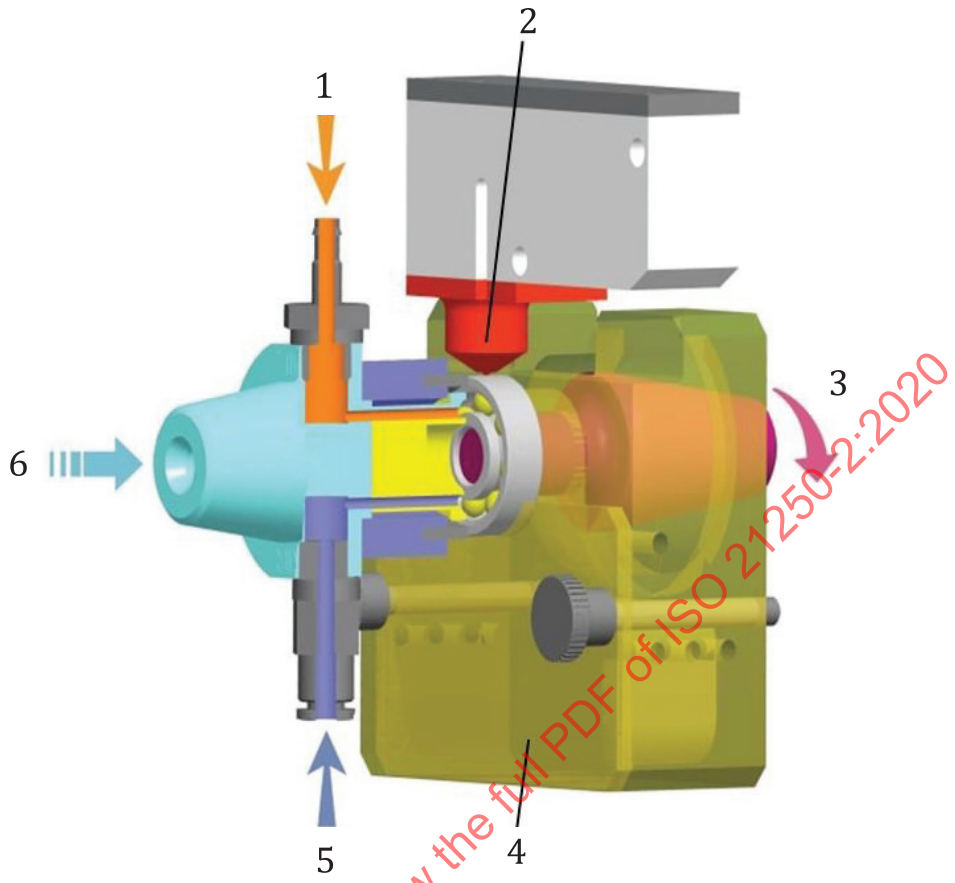
**Figure A.1 — Example of a test machine**



## A.2 Test setup

The test bearing shall be pushed onto a mandrel firmly connected with the spindle. The axial load shall be applied via an adapter onto the outer ring.

The adapter can contain an intake for the grease as well as an inlet for compressed air to blow out the grease. An example is shown in Figure A.2.




**Key**

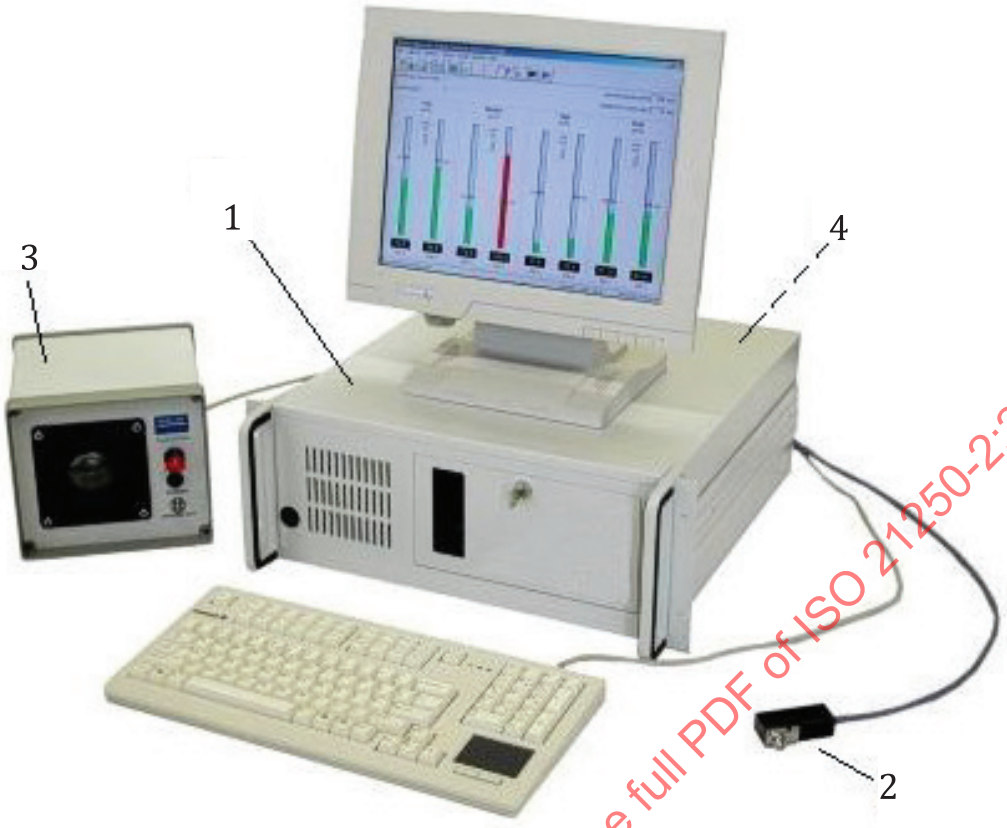
1 grease
2 sensor
3 spindle
4 grease container
5 compressed air
6 axial load

**Figure A.2 — Example of the test mechanism**



## A.3 Electronic system

The measuring electronic system can consist of the components described in Figure A.3.




**Key**

1 industrial PC with adequate performance; data acquisition card: AD-converter, signal processor, antialiasing-filter
2 (two) sensor connections
3 loudspeaker
4 inputs and outputs for machine control (rear side)

**Figure A.3 — Example of measuring electronics**

## A.4 Test reports

The output of the results can be visualized by

— lists, as shown in Figure A.4 a),

— graphs, as shown in Figure A.4 b) or

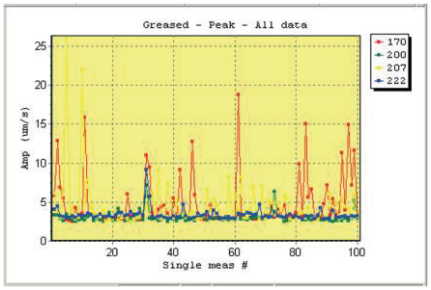
— bar charts, as shown in Figures A.4 c) and d).

| | | | | |
|---|---|---|---|---|
| 9: 4 | 22.8 | 9.4 | 10.7 | 3.14 |
| 9: 5 | 22.4 | 9.2 | 10.8 | 3.18 |
| 9: 6 | 22.8 | 9.2 | 11.0 | 2.90 |
| 9: 7 | 23.1 | 9.5 | 11.0 | 3.36 |
| 9: 8 | 23.1 | 9.2 | 10.8 | 4.30 |
| 9: 9 | 23.5 | 9.2 | 10.7 | 2.87 |
| 9:10 | 23.6 | 8.9 | 10.5 | 2.83 |
| 10: 1 | 23.8 | 9.8 | 10.8 | 2.96 |
| 10: 2 | 23.8 | 9.8 | 10.9 | 4.00 |
| 10: 3 | 23.8 | 9.5 | 10.8 | 2.99 |
| 10: 4 | 23.5 | 9.6 | 11.0 | 3.06 |
| 10: 5 | 23.1 | 9.8 | 10.7 | 3.13 |
| 10: 6 | 23.0 | 9.8 | 10.8 | 3.26 |
| 10: 7 | 23.2 | 9.3 | 10.6 | 3.07 |
| 10: 8 | 22.3 | 9.5 | 10.8 | 3.28 |
| 10: 9 | 21.7 | 9.8 | 10.6 | 3.09 |
| 10:10 | 22.1 | 10.1 | 10.7 | 3.22 |
| Avg | 23.3 | 9.7 | 11.0 | 3.37 |
| SDEV | 0.6 | 0.3 | 0.3 | 0.73 |
| Min | 21.7 | 8.9 | 10.3 | 2.83 |
| Max | 24.8 | 10.6 | 12.2 | 9.19 |

| BQ1 | BQ2 | BQ3 | BQ4 | BQX | % |
|---|---|---|---|---|---|
| 98.0 | 2.0 | 0.0 | 0.0 | 0.0 | |
| 98.0 | 100.0 | 100.0 | 100.0 | | |

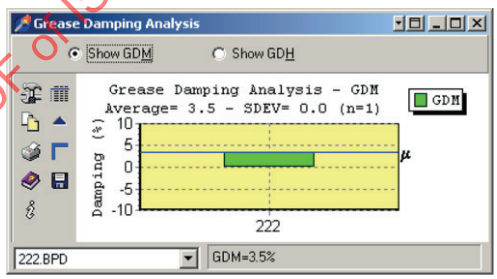
Grease class: GN4

a) List of results




b) Graphical representation of peaks


c) Bar chart, assessment by grease noise classes




d) Bar chart, damping ability of the grease showing the $GD_{\mathrm{M\ BQ+}}$ value

**Figure A.4 — Examples for representation of the testing results**

# Annex B
(informative)

# Recommendation for inserting the amount of grease

## B.1 General

The grease sample should be fed with a syringe and a hose of the dosing unit. The design and execution of the syringe and hose (material hardness) have a significant impact on the performance of the speed-proportional dosing unit and that of the dispensing unit quantity, especially for viscous greases.

## B.2 Syringe

Disposable syringes should be used with a volume of 10 ml and with silicone rubber ring. An example is shown in Figure B.1. The syringe should only be used once.


**Figure B.1 — Recommended syringe**

## B.3 Hose

Hoses made of polyethylene (PE) with 4 mm diameter and 1 mm wall thickness should be used. Both ends of the hose should be shortened to 2 cm to ensure that possible contamination in the hose can be foreclosed. The hose interface shall be free of burrs and adhering (plastic) chips.

## B.4 Specimen collection — Syringe filling

The syringe and hose can simply be connected; see Figure B.2.

**Figure B.2 — Syringe and hose in the assembled state**

It is advisable to fill the syringe by vacuum suction. Air bubbles are not permitted in the syringe under any circumstance (see Figure B.3), as this would affect the dosage and the noise signal.


**Figure B.3 — Invalid sample with bubbles**

The top layer of the grease in the grease container shall be skimmed off (see Figure B.4) to ensure that no impurities affect the noise test. Figures B.5 and B.6 show how the syringe filling should be done. Figure B.7 shows an alternative method of filling the syringe with the help of a (clean) spatula.

**Figure B.4 — Skimming off the top layer of grease**

**Figure B.5 — Filling the syringe with the help of vacuum, here generated by a larger syringe**