

BS 7996:2009



BSI Standards Publication

Torque measuring devices – Calibration and classification using continual torque application – Method

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ISBN 978 0 580 53116 3

ICS 17.100

The following BSI references relate to the work on this standard:

Committee reference ISE/NFE/4

Draft for comment 09/30200283 DC

Publication history

First published September 2009

Amendments issued since publication

Date	Text affected
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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 September 2009. It was prepared by Subcommittee ISE/NFE/4/1, *Uniaxial testing of metals*, under the authority of Technical Committee ISE/NFE/4, *Mechanical testing of metals*. A list of organizations represented on these committees can be obtained on request to their secretary.

Information about this document

This British Standard describes a method of calibration and classification only and should not be used or quoted as a specification.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and competent people.

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 notes in smaller italic type, and does not constitute a normative element.

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 a method for the calibration and classification of torque measuring devices using continuous torque application where the inertial effects are minimal. This includes torque measuring devices used for the calibration of hand torque tools conforming to BS EN ISO 6789, and torque measuring devices conforming to BS 7882.

The information to be given on the certificate of calibration is also specified in this standard.

Annex A provides diagrams of the continuous application of torque, and examples for the calibration of torque measuring devices. Annex B gives an example of determining uncertainty of the calibration results of the torque measuring device. Annex C shows how to calculate mechanical and electronic bandwidth.

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.

BS 7882, *Method for the calibration and classification of torque measuring devices*

BS EN ISO 6789, *Assembly tools for screws and nuts – Hand torque tools – Requirements and test methods*

JCGM 200, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)* (third edition available at: http://www.bipm.org/utls/common/documents/jcgm/JCGM_200_2008.pdf)

3 Terms, definitions, abbreviations and symbols

For the purposes of this British Standard, the terms and definitions given in JCGM 200 and the following apply.

3.1 acceleration period

time interval during which the rate of change of applied torque starts from zero and then attains a constant value

3.2 bandwidth of the reference standard

B_{RS}

response of the reference standard to a step input (expressed in hertz)

NOTE See Annex C.

3.3 bandwidth of the torque measuring device

B_{TMD}

response of the torque measuring device to a step input (expressed in hertz)

NOTE See Annex C.

3.4 calibration torque T

torque, with traceability derived from national standards of mass, length and time, and of specified uncertainty of measurement, which can be applied to the torque measuring device

3.5 constant rate period

time interval between the acceleration and deceleration periods at which the rate of change of applied torque is constant

3.6 continuous application of torque

sequence consisting of three time periods: acceleration period, constant rate period and deceleration period

NOTE Refer to Figure A.1.

3.7 data acquisition system

electronic module that has the ability to transfer, store, amplify and filter signals from a torque measuring device

NOTE Where analogue signals are acquired by the torque measuring device, and these are converted into a digital data stream using an analogue to digital converter, the stream of data may be digitally filtered, re-sampled and stored, or logged ready for analysis.

3.8 data skew

change in applied torque during the period between nominally synchronized readings from the reference standard and the torque measuring device

NOTE This period can be due to the readings being taken at different times or propagation delays. It can be determined, at various stable torque values throughout the torque calibration range, by applying a sharp mechanical stimulus to the system and measuring the difference in response times of the outputs from the reference standard and the torque measuring device.

3.9 deceleration period

time interval during which the rate of change of applied torque decreases from a constant value to zero

3.10 deflection d

algebraic difference between the indicator reading prior to the application of a torque and the indicator reading for each applied torque in a given measurement series

NOTE The deflection may be derived from either digital data output or visual data output.

3.11 loading direction

direction of applied torque, either clockwise or anti-clockwise about the axis of rotation, when viewed from the end of the torque measuring device to which the calibration torque is applied

3.12 lower limit of calibration $T_{\min}$

lower value of torque at which a torque measuring device of a given class can be calibrated

3.13 maximum calibration torque $T_{\max}$

upper calibration torque value applied to the torque measuring device

3.14 rate of applied torque R_T

change of torque with time

3.15 recording rate R_r

rate at which the visual or digital output is recorded for subsequent analysis

*NOTE 1 The data may be manually recorded or recorded by an optical recognition system, i.e. video, for subsequent analysis.**NOTE 2 The recording rate is sometimes known as the refresh rate.***3.16 reference standard**

RS

equipment used to generate or to measure the reference torque applied to the torque measuring device that is being calibrated

*NOTE Torques may be generated by a power source monitored by the reference standard.***3.17 relative error of indication** E_i

mean deflection for a given value of increasing torque minus the corresponding value of applied torque

*NOTE 1 For the purposes of this standard, relative error of indication is expressed as a percentage of applied torque.**NOTE 2 Relative error of indication is only used where the deflection is in units of torque.***3.18 relative error of interpolation** E_{it}

difference between the value of the mean deflection for a given value of increasing torque and the corresponding calculated value of deflection for the given torque, obtained from a mathematically fitted curve

*NOTE For the purposes of this standard, relative error of interpolation is expressed as a percentage of the computed deflection for the given increasing torque.***3.19 relative repeatability** R_1

closeness of the agreement between the results of two successive measurements from the same applied torque, carried out under the same conditions of measurement

3.20 relative reproducibility R_2

closeness of agreement between the results of successive measurements from the same applied torque, carried out under changed conditions of measurement

3.21 relative residual deflection R_0

maximum residual deflection obtained from all the series of torques

NOTE For the purposes of this standard, relative residual deflection is expressed as a percentage of the mean deflection for the maximum torque applied.

3.22 relative reversibility R_3

difference between the deflection obtained from the last given torque series applied in an increasing mode and the deflection obtained from the same given torque applied in a decreasing mode

NOTE For the purposes of this standard, relative reversibility is expressed as a percentage of the deflection of the last series for the given torque, applied in an increasing mode.

3.23 residual deflection d_0

algebraic difference between the indicator readings before and after the application of a single series of torques

3.24 resolution r

smallest discernible measurement interval on the torque measuring device indicator

3.25 sampling rate

rate at which the analogue to digital converter samples a waveform

NOTE The analogue waveform may be sampled at a much higher rate than the rate at which data is available.

3.26 torque

product of tangential force and length applied about a known centre of rotation

3.27 torque measuring device**TMD**

system comprising electrical, electronic, mechanical, hydraulic or optical torque device, with associated instrumentation, including the automated logging of data when part of the device

4 Preparation for calibration

4.1 Reference standard

4.1.1 Uncertainty of calibration torques

Values for the maximum permissible uncertainty of the calibration torques applied for the determination of different classifications of the torque measuring device shall not exceed the values given in Table 1. Where a reference standard is used to determine a calibration torque, it shall conform to Table 1.

The uncertainty of the calibration torque shall take into account factors such as bandwidth of the system and its own calibration traceability.

Table 1 Uncertainty of calibration torques

Class of torque measuring device to be calibrated	Maximum permissible uncertainty of calibration torque applied ^{A)}
0.05	±0.01
0.1	±0.02
0.2	±0.04
0.5	±0.10
1.0	±0.20
2.0	±0.40
5.0	±1.00

^{A)} Using a coverage factor of $k = 2$ to give a confidence level of approximately 95%.

4.1.2 Traceability of measurements

All definitive measurements, such as mass, length, time and temperature, shall be traceable to national standards; evidence of this shall be provided by a certificate of calibration.

4.1.3 Bandwidth

The bandwidth of the reference standard shall be determined.

Two bandwidth contributions shall be taken into consideration:

- a) mechanical: this is controlled by the natural frequency of the sensing element, i.e. transducer (see C.1);
- b) electronic: this is a function of the instrumentation used (see C.2).

The bandwidth of the reference standard shall be taken as the lower of these two values.

4.2 Condition and identification of a torque measuring device

4.2.1 Calibration shall not be commenced unless the torque measuring device is considered to be in good working order and is identified with a serial number. The maximum working torque shall first have been established.

NOTE Good working order includes the drive components being of a sufficiently good fit to exert a minimum bias on the system.

4.2.2 All parts of the torque measuring device shall be identified in accordance with 4.2.1, including the following, where applicable:

- a) signal cables;
- b) switch boxes;
- c) interfaces;
- d) data acquisition systems;
- e) computers; and
- f) software (where information is available).