

BRITISH STANDARD

Method for calibration and classification of torque measuring devices

ICS 17.100



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ISBN 978 0 580 55351 6

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

Committee reference ISE/NFE/4

Draft for comment 07/30133498 DC

Publication history

First published May 1997

Second edition, January 2008

Amendments issued since publication

Amd. no.	Date	Text affected
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Contents

Foreword *ii*

1	Scope	<i>1</i>
2	Terms, definitions, abbreviations and symbols	<i>1</i>
3	Preparation for calibration	<i>3</i>
4	Calibration procedure	<i>7</i>
5	Calculation of results	<i>8</i>
6	Classification of torque measuring devices	<i>11</i>
7	Calibration certificate	<i>13</i>

Annexes

Annex A (informative)	Orientation diagrams	<i>14</i>
Annex B (informative)	Method example of determining uncertainty of the calibration results of the torque measuring device	<i>16</i>

Bibliography *25*

List of figures

Figure A.1	Example of preloading and calibration sequences for a torque measuring device with round shaft drives, six increasing and decreasing torques, classes 0.05 to 5.0	<i>14</i>
Figure A.2	Example of preloading and calibration sequences for a torque measuring device with round shaft drives, six increasing torques only, classes 0.05 to 5.0	<i>14</i>
Figure A.3	Example of preloading and calibration sequences for a torque measuring device with square drives, six increasing and decreasing torques, classes 0.05 to 5.0	<i>14</i>
Figure A.4	Example of preloading and calibration sequences for a torque measuring device with square drives, six increasing torques only, classes 0.05 to 5.0	<i>15</i>
Figure A.5	Example of preloading and calibration sequences for a torque measuring device, six increasing and decreasing torques, classes 0.2 to 5.0.	<i>15</i>
Figure A.6	Example of preloading and calibration sequences for a torque measuring device, six increasing torques only, classes 0.2 to 5.0	<i>15</i>
Figure B.1	Worked example in torque units: 100 N·m torque measuring device clockwise torque, increasing series only	<i>19</i>
Figure B.2	Uncertainties calculated in accordance with B.3	<i>20</i>
Figure B.3	Worked example in mV/V: 2 kN·m torque measuring device clockwise torque, increasing and decreasing series	<i>22</i>
Figure B.4	Uncertainties calculated in accordance with B.4	<i>24</i>

List of tables

Table 1	Uncertainty of calibration torques	<i>3</i>
Table 2	Criteria for classification of torque measuring devices	<i>12</i>

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 25 and a back cover.

Foreword

This British Standard is published by BSI and came into effect on 31 January 2008. It was prepared by Technical Committee ISE/NFE/4, *Torque measurement and testing*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 7882:2008 supersedes BS 7882:1997, which is withdrawn.

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 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 requirements for the calibration and classification of torque measuring devices, including those used for the calibration of hand torque tools to BS EN ISO 6789.

It describes the method of calibration, calculation of calibration results and the classification of the torque measuring device in a static mode. The information to be given on the certificate of calibration is also listed.

2 Terms, definitions, abbreviations and symbols

For the purposes of this British Standard, the following terms, definitions, abbreviations and symbols apply.

NOTE Where applicable, this British Standard has been prepared using PD 6461-1.

2.1 calibration torque

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

2.2 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.

2.3 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.

2.4 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

2.5 lower limit of calibration

$T_{\min}$

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

2.6 reference standard

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.

2.7 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.

2.8 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.

2.9 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

2.10 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

2.11 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.

2.12 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.

2.13 residual deflection

d_0

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

2.14 resolution

r

smallest discernable measurement interval on the torque measuring device indicator

2.15 torque

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

2.16 torque measuring device

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

NOTE The instrumentation can be an electronic instrument, a mechanical device, i.e. a scale and pointer system, or a Bourdon tube instrument.

3 Preparation for calibration

3.1 Reference standard

3.1.1 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.

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%.

3.1.2 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.

3.2 Condition and identification of a torque measuring device

3.2.1 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.

3.2.2 All parts of the torque measuring device shall be identified in accordance with **3.2.1**, 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).

3.2.3 Where an electrical indicator used with a torque measuring device is replaced with another, the following requirements shall be met to ensure that the calibration is not invalidated.

- a) The original indicator shall have a valid calibration certificate, traceable to national standards, that gives the results of a calibration made in terms of the units to be measured. The indicator shall have been calibrated over a range equal to or greater than the range over which it is used with the torque measuring device.
- b) The replacement indicator shall have a resolution equal to or better than the indicator it is replacing and shall have a valid calibration certificate, traceable to national standards, that gives the results of a calibration made in terms of the units to be measured. The indicator shall have been calibrated over a range equal to or greater than the range over which it is used with the torque measuring device.
- c) The date of calibration on the certificate for the original indicator shall not precede that of the certificate for the replacement indicator by more than 12 months.
- d) The certificates for the two indicators show that the readings of the torque measuring device, as measured by the two indicators, agree with the values given below, over the range of the classification of the torque measuring device:
 - $\pm 0.025\%$ of indicated reading for a class 0.05 device;
 - $\pm 0.050\%$ of indicated reading for a class 0.1 device;
 - $\pm 0.10\%$ of indicated reading for a class 0.2 device;
 - $\pm 0.25\%$ of indicated reading for a class 0.5 device;
 - $\pm 0.50\%$ of indicated reading for a class 1.0 device;
 - $\pm 1.00\%$ of indicated reading for a class 2.0 device;
 - $\pm 2.50\%$ of indicated reading for a class 5.0 device.
- e) If it is necessary to replace cables, the replacement cables shall be of the same specification as the originals to ensure that the calibration remains valid.

3.3 Resolution of the indicator

NOTE An indicator can be a direct reading display or the output of a data acquisition system.

3.3.1 Analogue scale

When the output of the torque measuring device is measured by an indicator with an analogue scale, i.e. a dial gauge or Bourdon tube instrument, the resolution r shall be determined from the ratios between the width of the pointer and the centre-to-centre distance between two adjacent scale graduation marks (scale interval).

NOTE The ratios should be 1/2, 1/5 or 1/10.

A spacing of at least 1.25 mm shall be used for the estimation of a tenth of the division on the scale.

When using an optical recognition system, i.e. video, the video frame rate shall be at least 10 times the display update being recorded.

A vernier scale of dimensions appropriate to the analogue scale may be used to allow direct fractional reading of the instrument scale division.

3.3.2 Digital scale

The resolution shall be considered to be one increment of the last active number of the numerical indicator.

3.3.3 Variation of readings

If the readings fluctuate by more than the value previously calculated for the resolution (with no torque applied to the instrument), the resolution shall be deemed to be equal to half the range of fluctuation.

3.3.4 Units

The resolution r shall be converted to units of torque.

3.4 Lower limit of calibration $T_{\min}$

To ensure that the classification is consistent with the resolution of the torque indicator, a lower limit of calibration shall be determined. The calibration shall not be performed below this lower limit, given by the equation:

$$T_{\min} = a \cdot r$$

where:

r is the resolution determined in accordance with **3.3**

a has the following values:

- 4 000 for a class 0.05 torque measuring device;
- 2 000 for a class 0.1 torque measuring device;
- 1 000 for a class 0.2 torque measuring device;
- 400 for a class 0.5 torque measuring device;
- 200 for a class 1.0 torque measuring device;
- 100 for a class 2.0 torque measuring device;
- 40 for a class 5.0 torque measuring device.