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Guide DKD-L 10-1

Determination of individual measurement uncertainty components according to DIN EN ISO 6789-2:2017

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Deutscher Kalibrierdienst (DKD) – German Calibration Service

Since its foundation in 1977, the German Calibration Service has brought together calibration laboratories of industrial enterprises, research institutes, technical authorities, inspection and testing institutes. On 3rd May 2011, the German Calibration Service was reestablished as a *technical body* of PTB and accredited laboratories.
This body is known as *Deutscher Kalibrierdienst* (DKD for short) and is under the direction of PTB. The guidelines and guides developed by DKD represent the state of the art in the respective areas of technical expertise and can be used by the *Deutsche Akkreditierungsstelle GmbH* (the German accreditation body – DAkkS) for the accreditation of calibration laboratories.
The accredited calibration laboratories are now accredited and supervised by DAkkS as legal successor to the DKD. They carry out calibrations of measuring instruments and measuring standards for the measurands and measuring ranges defined during accreditation. The calibration certificates issued by these laboratories prove the traceability to national standards as required by the family of standards DIN EN ISO 9000 and DIN EN ISO/IEC 17025.

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Foreword

DKD guides are recommendations on technical issues arising from the practical work in accredited calibration laboratories. The guides describe procedures which may serve as a model for the accredited calibration laboratories for defining internal processes and regulations. DKD guides may become an essential component of quality management manuals of calibration laboratories. The implementation of the guidelines will help to incorporate the state of the art in the respective field into laboratory practice. Thus, a standardization of procedures as well as an increased efficiency in the work of calibration laboratories shall be achieved.

DKD guides should not impede the further development of calibration procedures and processes. Deviations from guidelines as well as new procedures are permitted if there are technical reasons to support this action

The present guide was prepared by the Technical Committee *Torque* and approved by the Board of the DKD.

Table of contents

1 Objectives

The standard DIN EN ISO 6789-2:2017 *Assembly tools for screws and nuts - Hand torque tools - Part 2: Requirements for calibration and determination of measurement uncertainty (ISO 6789-2:2017), German version EN ISO 6789-2:2017* describes a calibration procedure for torque tools, including the determination of the measurement uncertainty. DKD-L 10-1 has been prepared to specify the application of the DIN standard. In particular, the determination of the measurement uncertainty by means of statistical methods is described in more detail. This DKD guide focuses on the practical application of the standard and may only be used if the corresponding calibration certificate does not serve to disseminate the unit.

2 Scope of application

Hand torque tools that are not used as transfer standards.

3 Recommended procedure to determine the individual measurement uncertainty components when using DIN EN ISO 6789-2:2017

3.1 Uncertainty components

1. b_r
   a. The uncertainty of detent settings can be estimated at one-fifth (resulting from the play of the detent position) of the scale-dividing value (scale interval) of the detent.
   b. For permanently set torque tools without scale, b_r can be estimated to be zero.
2. b_{rep}
   a. The effect is both user- and type-specific. For reasonably selected groups of torque tools, it is possible for the laboratory to estimate the parameter. The grouping may be carried out, for instance, based on the nominal value, the measuring principle (e.g. indicating, clicking), the resolution, etc. For each group, the parameter according to DIN EN ISO 6789-2:2017 is measured by using 10 torque tools; an estimated value which can be justified from this database will then be determined.
3. b_{od}
   a. The effect depends on the inserting tool (tool-specific). The insert tool provided by the customer is to be used, subject to its conformity with the manufacturer's specifications (reference dimension). Special insert tools must be considered separately.
   b. The laboratory can estimate the parameter for reasonably selected groups of inserting tools. For instance, the grouping can be based on the gearing (e.g. coarse, fine, degree of wear). For each group, the parameter according to DIN EN ISO 6789-2:2017 is measured using 10 specimens of insert tools; an estimated value is determined which can be justified from this database.
4. b_{int}
   a. The influence of the adapters should be determined when establishing the traceability of the calibration equipment, either by using the adapters during the traceability measurements or by carrying out specific, appropriate tests.
   b. If possible, the use of the adapter should be limited to a specific position and this position should be marked in order to minimize the variation of the parameter. If the adapter is marked permanently in one mounting position, b_{int} can be assumed to be zero if it is considered in the measurement uncertainty of the calibration device.

c. If the parameter cannot be determined as part of the calibration equipment, the estimation of the influence in accordance with EN ISO 6789-2:2017 has to be carried out by means of 10 independent measurements. The value of the parameter thus obtained is a characteristic of the respective adapter and does not have to be determined again for each combination of torque tools.

5. b_{l}
   a. Given that the parameter is inherently stable over time (due to constructional details), an individually determined value can be used again when recalibrating the same type of calibration item.
6. b_{re}
   a. Diverging from DIN EN ISO 6789-2:2017, the repeatability of triggering torque tools (click-type torque tools) can also be calculated using spans and a rectangular distribution. Such a calculation usually provides larger estimated values than a calculation in accordance with the standard.
7. W‘
   a. Contrary to the provisions laid down in DIN EN ISO 6789-2:2017, the display deviations of the object to be calibrated and the calibration device can also be included in a common absolute value function when calculating W in order to be able to take into account the knowledge of the respective signs of the contributions.
   b. Instead of using the maximum value of b_{ep} in the measuring range when calculating W, it is also possible to apply a separate value of b_{ep} for each calibration step.

3.2 General information

There are different methods to determine an estimated value from statistical considerations. Such methods are, for example, mean value, mean value plus standard deviation of the mean value and 3-sigma interval. The calibration laboratory is responsible for selecting the appropriate method. This also applies to the statistical evaluation according to DIN EN ISO 6789-2:2017.
In case of a statistical estimation, the risk of an insufficient estimate must be appropriately taken into account. It must be ensured that the data basis used is always up to date. The application of this guide must be clearly stated in the calibration certificate (example: "Procedure: DIN EN ISO 6789-2:2017 in conjunction with DKD-L 10-1").

3.3 Further recommendations

8. If the initial value of the measuring range of a torque tool (manufactured according to DIN EN ISO 6789:2003) is not clearly defined according to DIN EN ISO 6789-2:2017 or if it is zero, calibration may be performed starting at 20 %. In this case, the deviating measuring range must be clearly marked on the tool and a note is to be included in the calibration certificate.

9. Different from DIN EN ISO 6789-2:2017, the calibration may be controlled not only by the signal of the calibration item but also by the signal of the calibration device. This is to be indicated in the calibration certificate.

10. The measurements for determining the parameters must be such that the run-in behaviour of the click-type torque tools does not have any influence. If the parameter measurements are carried out shortly one after another, it may suffice to carry out the

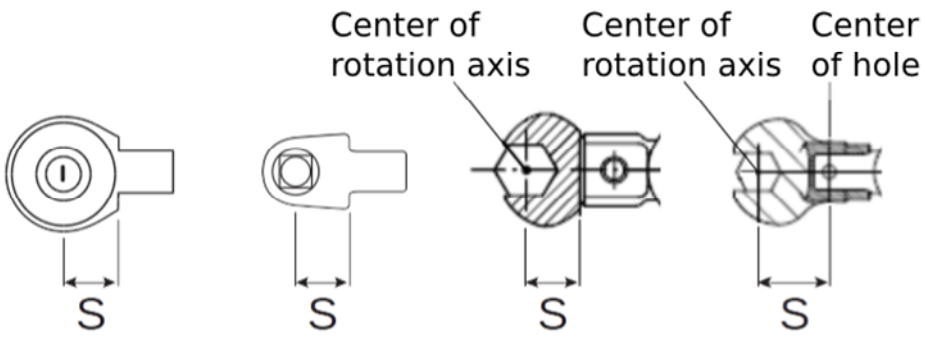
preloading only at the beginning of the parameter determination.

11. When judging the suitability of the calibration equipment for a specific calibration in accordance with section 4.3 of EN ISO 6789-2:2017, only the ratio is used to specify the object to be calibrated. In the final result, adherence to a basic distance factor is no longer given.

12. Specification of the individual parameters in the calibration certificate is not mandatory. The obligation for documentation remains unaffected.

13. The definition of the term "reference dimension" must be clearly defined (see illustration below), or the effective length from the centre of the square to the point of force application of the torque wrench must be indicated.

    The reference dimension (or centre distance) is the length between the rotation axis and the stop edge (stop angle) or centre hole of the insert tool



14. Run-in behaviour, especially with click-type wrenches.
    Explanation: The run-in behaviour should be included in the determination of a_s. This means that neither preloads in the corresponding calibration stage are to be carried out, nor is it permissible to disregard any measurements. In turn, when determining the characteristic values, the tool should be prepared by adequate preloading to prevent any further run-in behaviour. If the measurements for the various characteristic values are carried out in one go, the need for preloads may become superfluous.

    The standard does not demand a specific sequence as to the determination of the characteristic values or the calibration. Both methods are possible. It is recommended to carry out the calibration before determining the characteristic values.

15. Multiple use of measurement series
    Carrying out the full measuring programme offers the possibility of usefully employing certain measuring series for several characteristic values.

16. It is recommended to reduce the number of samples for determining the characteristic values to 5. Thus, the number of samples for calibration is harmonized. This reduction has no significant influence on the resulting uncertainty.

17. Interpolation is required for standardisation at reference points. Provided a linear behaviour, the use of the rule of three is recommended for interpolation. Alternative methods are permissible.

18. From a technical point of view, the calculation of the uncertainty component of the resolution is to be related to the operating point. Nevertheless, the calculation is performed according to DIN EN ISO 6789-2:2017.

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