Calibration

The international vocabulary of metrology gives a precise definition for calibration.

- Calibration:
  Operation that, under specific conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.
Calibration

As the basis for reliable test results.

- Definition of „Calibration“
- Exemplary description of a calibration of a material testing machine
  - Interpretation of a DAkkS calibration certificate
  - Representation of the measurement uncertainty
  - Classification
- Conclusion and discussion
Calibration as the basis for reliable test results

testXpo 2016

Measurement uncertainty is increasing along the traceability chain.

- Calibration means the determination and documentation of the deviation between the display of a measuring device ... and the correct value of the measured value ...
Calibration as the basis for reliable test results.

- Definition of „Calibration“
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Form of the calibration certificate

Interpretation of the DAkkS calibration certificate with conformity statement.

- Sign of the accreditation body and calibration mark
- Description of the calibration object including:
  - Type
  - Manufacturer
  - MSN and year of construction
  - Location of the machine
- Date of calibration, signature of the executing calibration engineer and signature of head of calibration lab.
Form of the calibration certificate

The calibration of the load cell is performed according DIN EN ISO 7500-1 : 2016.

- Calibration of the load cell according DIN EN ISO 7500-1 : 2016
  - Description of the force measuring system including load cell and measuring chain.
  - Check of the statues of the material testing machine.
  - Calibration of the force indication by using working standards traceable to national standards.
    - for each sensor
    - for each indication interval
  - Zwick calibrations include additionally to the necessary scope of the calibration according DIN EN ISO 7500-1 steps of 0,2/0,4/0,7/1/2/4/7/10 %
Interpretation of the DAkkS calibration certificate with conformity statement.

- Reference of the standard DIN EN ISO 7500-1
- Used working standards with traceability
- Description of the stated measurement uncertainty $U$
- Environmental condition during calibration
- General inspection of the material testing machine
- Legend
Form of the calibration certificate

Interpretation of the DAkkS calibration certificate with conformity statement.

- Description of the calibration object
- Mounting of the calibration object during calibration
- Measuring chain of the calibration object
- Description of the calibration method and detailed results of the calibration
  - Relative display deviation, repeatability and reversible range
  - Display resolution
  - Measurement uncertainty
Measurement uncertainty

A classification under consideration of the expanded measurement uncertainty.

- Measurement uncertainty as a statistical Value out of:
  - Working standard
  - Measurement uncertainty out of the recalibration of the working standard
  - Long-term drift (Ageing)
  - Environmental condition during calibration (ΔT between calibration and recalibration of standard)
- Calibration object
  - Resolution of the calibration object
  - Repeatability of the calibration

- The expanded measurement uncertainty U is indicated. The values determined are with a probability of 95% in the assigned value interval.
Form of the calibration certificate

Interpretation of the DAkkS calibration certificate with conformity statement.

- Classification of the calibration object according to the above-described standard
  - For each indication range
  - For each test direction
  - Individual measurement ranges can be classified differently

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### Table: Calibration Results

<table>
<thead>
<tr>
<th>F in N</th>
<th>F in N</th>
<th>α in %</th>
<th>β in %</th>
<th>γ in %</th>
<th>δ in %</th>
<th>ε in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.0</td>
<td>40.04</td>
<td>-0.09</td>
<td>0.19</td>
<td>-0.06</td>
<td>0.25</td>
<td>0.22</td>
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<td>-0.02</td>
<td>0.12</td>
<td>-0.04</td>
<td>0.13</td>
<td>0.15</td>
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<td>0.10</td>
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<td>-0.11</td>
<td>0.11</td>
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<td>0.08</td>
<td>0.05</td>
<td>0.13</td>
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<tr>
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<td>0.07</td>
<td>0.04</td>
<td>0.03</td>
<td>0.12</td>
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<td>0.05</td>
<td>0.01</td>
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<td>0.04</td>
<td>0.01</td>
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<tr>
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<td>0.30</td>
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<td>0.02</td>
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</tbody>
</table>

### Conformity Statement

1.6.2 Conformitätssatz / Conformity statement

The force measuring device was calibrated according to the listed standard(s). The expanded measurement uncertainty is considered for the classification according to DIN EN ISO 7500-1. The Material Testing Machine can be used as follows:

<table>
<thead>
<tr>
<th>Anzeigebereich in the indication range</th>
<th>Prüfung</th>
<th>Klasse</th>
</tr>
</thead>
<tbody>
<tr>
<td>von from</td>
<td>bis to</td>
<td>test direction</td>
</tr>
<tr>
<td>20 kN</td>
<td>40 N</td>
<td>20000 N</td>
</tr>
<tr>
<td>40 N</td>
<td>20000 N</td>
<td>Druck / Compression</td>
</tr>
</tbody>
</table>

Relative Nullpunktabweichung / Relative zero deviation $\pm 0.00$%
Interpretation of the DAkkS calibration certificate with conformity statement.

- Classification of the calibration object according to the above-described standard
  - For each indication range
  - For each test direction
  - Individual measurement ranges can be classified differently

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Form of the calibration certificate

Classification of the calibration object according to the above-described standard
- For each indication range
- For each test direction
- Individual measurement ranges can be classified differently
More and more Auditors don’t accept manufacturers calibration certificates (Even if they are issued by an accredited laboratory)

ISO / TS 16949 demands (indirect) DAkkS calibration certificates for testing devices.

Benefits of a DAkkS-calibration

- A calibration certificate for the whole machine according DIN EN ISO 7500-1 res. DIN EN ISO 7500-2 and DIN EN ISO 9513 which is national and international accepted.
- A classification under consideration of the expanded measurement uncertainty.
Calibration

As the basis for reliable test results.

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- Conclusion and discussion
Conclusion

By interpreting the calibration certificate it is possible to estimate the measurement uncertainty that the test machine introduces into the material testing.

- A calibration certificate shows the display deviation of the material testing machine.
  - In addition, a repeatability is indicated when the force is calibrated.
  - Conformity statements of Zwick calibration certificates takes the extended measurement uncertainty into account.
  - The range of the true value can be calculated out of a measured value by the classification and measurement uncertainty out of the calibration certificate.
- A DAkkS calibration certificate provides a reliable statement about the measurement uncertainty (accuracy) of the material testing machine.
- The user determines which of his material testing machines is calibrated when and how.