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# Deutsche Akkreditierungsstelle GmbH

als Kalibrierlaboratorium im / *as calibration laboratory in the*

# Deutschen Kalibrierdienst

Deutsche Akkreditierungsstelle D-K-15199-01-00

| | |
|---|---|
| Kalibrierschein<br>*Calibration certificate* | Kalibrierzeichen<br>*Calibration mark* |
| | 000789 |
| | D-K-15199-01-00 |
| | 2015-03 |

| | |
|---|---|
| Gegenstand<br>*Object* | **IC-Artefact A/B für Profil, Flankenlinie, Teilung, Rundlauf und $M_{dK}$** |
| Hersteller<br>*Manufacturer* | **FRENCO GmbH<br>Jakob-Baier-Straße 3<br>90518 Altdorf** |
| Typ<br>*Type* | **d = 105.000 mm; ß = 0°, 20° r + l** |
| Fabrikat/Serien-Nr.<br>*Serial number* | **04711 00 01 00** |
| Auftraggeber<br>*Customer* | **Musterkunde** |
| Auftragsnummer<br>*Order No.* | **20154711** |
| Anzahl der Seiten des Kalibrierscheines<br>*Number of pages of the certificate* | **7** |
| Datum der Kalibrierung<br>*Date of calibration* | **16.03.2015** |

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.
*This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).*
*The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.*
*The user is obliged to have the object recalibrated at appropriate intervals.*



| Datum<br>*Date* | Leiter des Kalibrierlaboratoriums<br>*Head of the calibration laboratory* | Bearbeiter<br>*Person in charge* |
|---|---|---|
| 18.03.2015 | Dipl. Ing (FH) J. Kühl | J. Stellwag |

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| D-K-15199-01-00 |
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## 1 profile and helix trace

### 1.1Calibration method profile and helix trace

The gear artefact was calibrated on a gear inspection device whose deviations were determined via a measuring task specific calibration with PTB calibrated artefacts in order to correct the measured values for $F_{\alpha}$; $f_{H\alpha}$ as well as $F_{ß}$ and $f_{Hß}$ (PTB: National Metrology Institute of Germany).

### 1.2 Measurement conditions

The reference axis was determined during the calibration of the gear artefact through the centres of 2 circles. Each of these centres was calculated from a runout measuring whose measuring planes were located on the surface area of 2 cylinders with a diameter of 52.3mm. The distance between the measuring planes for the roundness measurements was 22.5mm (upwards) and 148.5mm (downwards) from the measuring plane.

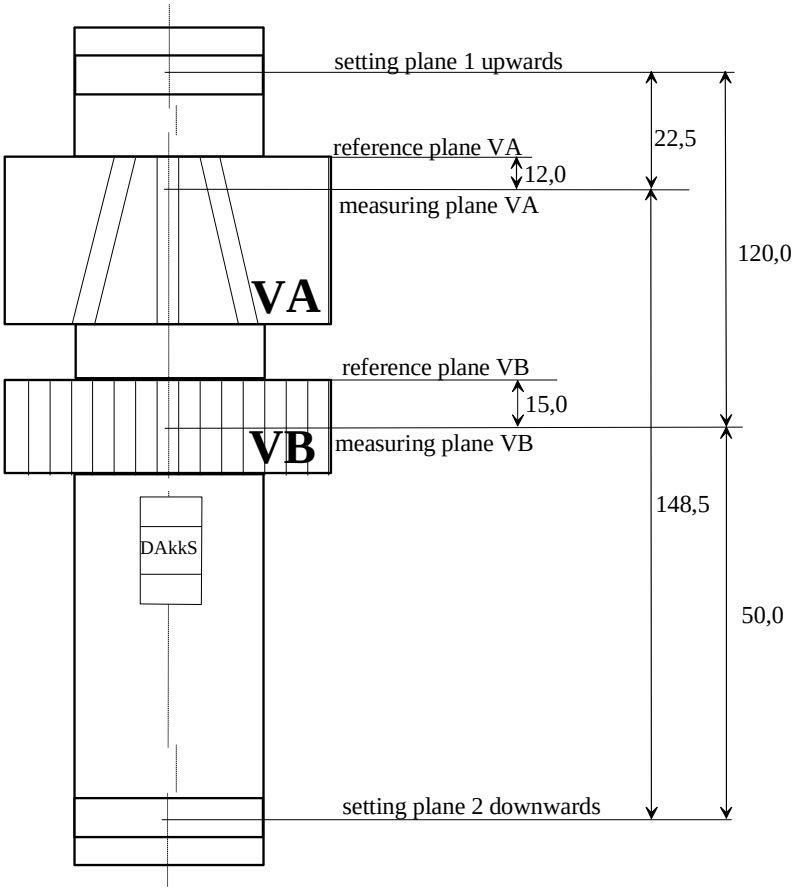


Figure 1: Position of the reference plane and the measuring plan

The reference plane of the artefact is the end face of the gear which is located on the opposite side as the official mark. The regression lines were laid through the graphs in accordance with the method of the smallest error square sum.

**These pages of the calibration certificate have been translated from the German original. In case of any doubts or disputes, please refer to the German certificate.**

Profile and helix inspections were carried out at gear VA at flank 1R and 2L.

The helix inspections were carried out in the transverse plane on the measuring cylinder $d_M$ = 105.000 mm in the right-hand flank position (unfiltered) with a probe ball diameter of 3.0 mm. The evaluation area of the helix trace $L_ß$ was situated symmetrically to the centre of the facewidth.

During profile inspection the involute areas were touched from root to tip in the measuring planes (see figure 1). Calibration was carried out in the right-hand flank position (unfiltered). The probe ball diameter was 3.0 mm.

**Used gear data and evaluation areas**

| Helix angle ß [°] | Number of teeth | module $m_n$ [mm] | pressure-angle $\alpha$ [°] | Base circle diameter $d_b$ [mm] | Root rolling length $L_f$ [mm] | Tip rolling length $L_a$ [mm] | Profile inspection area $L_\alpha$ [mm] | Helix inspection area $L_ß$ [mm] | Evaluation area for $f_{hß}$ [mm] |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 30 | 3.50000 | 20.0000 | 98.6677 | 8.13 | 27.13 | 19.00 | 70.0 | 60.0 |
| 20 r | 30 | 3.28892 | 18.8817 | 98.6676 | 8.13 | 27.13 | 19.00 | 70.0 | 60.0 |
| 20 l | 31 | 3.18283 | 18.8820 | 98.6677 | 8.13 | 27.13 | 19.00 | 70.0 | 60.0 |

### 1.3 Ambient temperatures

The room temperature in which the inspections were carried out was between 19.8° C and 19.9° C.

### 1.4 Measurement results

The measurement results are shown in the table below. They are mean values taken from several inspections.

**Helix**

| Helix angle ß [°] | Flank number | Helix total deviation $F_ß$ [µm] | Helix angle deviation $f_{Hß}$ [µm] | Helix form deviation $f_{fß}$ [µm] |
| --- | --- | --- | --- | --- |
| 0 | 1R | 1.0 | L 0.1 | 0.9 |
| 0 | 2L | 1.2 | R 0.6 | 0.6 |
| 20° r | 1R | 15.2 | 15.0 | 0.7 |
| 20° r | 2L | 16.5 | 16.3 | 0.9 |
| 20° l | 1R | 1.3 | 0.9 | 0.9 |
| 20° l | 2L | 1.0 | -0.4 | 1.0 |

The total helix deviations $F_ß$ and the helix angle deviations $f_{Hß}$, as shown in the table above, have been corrected with the measuring machine deviation as determined in advance. Only helix form deviations $f_{fß}$ can be taken from the uncorrected individual charts (attachment, sheet 1 to 3).

**Profile**

| Helix angle ß [°] | Flank number | Profile total deviation $F_α$ [µm] | Profile Base circle deviation $f_{Hα}$ [µm] | Profile form deviation $f_{fα}$ [µm] |
| --- | --- | --- | --- | --- |
| 0 | 1R | 1.5 | -1.0 | 1.0 |
| 0 | 2L | 1.6 | -0.9 | 1.2 |
| 20° r | 1R | 1.2 | -0.8 | 0.8 |
| 20° r | 2L | 1.2 | -0.5 | 1.0 |
| 20° l | 1R | 10.0 | -10.3 | 1.0 |
| 20° l | 2L | 10.1 | -10.1 | 1.0 |

The total helix deviations $F_ß$ and the helix angle deviations $f_{Hß}$, as shown in the table above, have been corrected with the measuring machine deviation as determined in advance. Only profile form deviations $f_{fα}$ can be taken from the uncorrected individual charts (attachment, sheet 1 to 3).

### 1.5 Measurement uncertainty

The following table shows the expanded measurement uncertainties of the aforementioned measurement results.

**Helix**

| Helix angle ß [°] | Measurement uncertainty U of $F_{ß}$ [µm] | Measurement uncertainty U of $f_{Hß}$ [µm] | Measurement uncertainty U of $f_{fß}$ [µm] |
| --- | --- | --- | --- |
| 0° | 1.7 | 1.3 | 1.0 |
| 20° r | 1.9 | 1.6 | 1.0 |
| 20° l | 1.9 | 1.6 | 1.0 |

**Profile**

| Helix angle ß [°] | Measurement uncertainty U of $F_{\alpha}$ [µm] | Measurement uncertainty U of $f_{H\alpha}$ [µm] | Measurement uncertainty U of $f_{f\alpha}$ [µm] |
| --- | --- | --- | --- |
| 0° | 2.0 | 1.7 | 1.0 |
| 20° r | 2.0 | 1.7 | 1.0 |
| 20° l | 2.0 | 1.7 | 1.0 |

The expanded measuring uncertainty as shown above is calculated from the standard measuring uncertainty multiplied by the expansion factor k = 2. It was determined according to DAkkS-DKD-3. The value of the measured variable is within a probability of 95% in the assigned value interval.

## 2. Pitch and Runout

### 2.1 Calibration method

Pitch and runout of the gear artefact was calibrated on a gear inspection device by using the rosette-procedure. This is an error separation process which is self-traceable.

### 2.2 Measurement conditions

The reference axis was determined like described under section 1.2.

The pitch inspection were carried out on the measuring cylinder $d_M$ = 106.804 mm with a probe ball diameter of 3.0 mm.

The runout deviations were calculated from the space width of the pitch measuring points considering a ball diameter of 7.0 mm.

### 2.3 Ambient temperatures

The room temperature in which the inspections were carried out was between 19.8° C and 20.0° C.

### 2.4 Measurement results and measurement uncertainty

The following table shows the measurement results and the expanded measurement uncertainties.

**pitch/runout gear VB**

| | Left flank | Right flank | U in µm |
| --- | --- | --- | --- |
| $f_p$ [µm] | 0.5 | 39.4 | 0.6 |
| $F_p$ [µm] | 2.0 | 40.0 | 0.7 |
| $F_r$ [µm] | 43.6 | | 1.0 |

Attachment 4 shows the graphic.

The expanded measuring uncertainty as shown above is calculated from the standard measuring uncertainty multiplied by the expansion factor k = 2. The value of the measured variable is within a probability of 95% in the assigned value interval.

## 3. DOB (Dimension over balls)

### 3.1 Calibration method

The dimension over measuring circles of artefact B was determined with 2 balls on a length measuring device. The measurement was carried out as a differentiation measurement to a DKD-calibrated setting mandrel.

### 3.2 Measurement conditions

The dimension over measuring circle was determined with 2 balls of diameter 7.000 815mm on an Abbe-type length comparator. It was then converted to a ball diameter of 7.000000 mm, to 20°C and interpolated to a measuring force of 0 N. The measuring plane is shown in figure 1.

### 3.3 Measurement results

**DOB**

| Helix angle ß [°] | Gap 1 consisting of flanks no. | Gap 2 consisting of flanks no. | DOB [mm] | Measurement uncertainty U [µm] |
| --- | --- | --- | --- | --- |
| 0° | 1R and 2L | 16R and 17L | 116.6342 | 1.5 |
| 20° r | 1R and 2L | 16R and 17L | 116.8785 | 1.9 |
| 20° l | 1R and 2L | 16R and 17L | 116.7391 | 1.9 |

The expanded measuring uncertainty as shown above is calculated from the standard measuring uncertainty multiplied by the expansion factor k = 2. The value of the measured variable is within a probability of 95% in the assigned value interval.

### 3.4 Ambient temperatures

The artefact temperature while inspections were carried out was between 20.0° C and 20.1°C.

## 4. Standards

All descriptions and evaluations are as per DIN ISO 21771 (2014), VDI/VDE 2607 (2000) and VDI 2613 (2003), the rule of signs as per VDI/VDE 2612 (2000) and the description of the flanks according to VDI 2613 (2003).

## 3 Recognition of DAkkS calibration certificates abroad

The Deutsche Akkreditierungsstelle GmbH is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
Further signatories within and outside Europe are found on the websites of EA (www.european-accreditation.org) and ILAC (www.ilac.org).