

Deutsche Akkreditierungsstelle GmbH

Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV

Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition

Accreditation



The Deutsche Akkreditierungsstelle GmbH attests that the calibration laboratory

SPEKTRA Schwingungstechnik und Akustik GmbH Dresden
Heidelberger Straße 12, 01189 Dresden

is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out calibrations in the following fields:

Mechanical quantities

- Acceleration ^{a)}
- Measuring instruments for vehicle inspection
- Brake deceleration recorder (HU adapter)

Acoustical quantities

Electrical quantities

DC and low frequency quantities

- DC voltage
- AC voltage
- DC current
- Capacitance
- Charge

^{a)} also on-site calibration


The accreditation certificate shall only apply in connection with the notice of accreditation of 06.05.2021 with the accreditation number D-K-15183-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 9 pages.

Registration number of the certificate: **D-K-15183-01-00**

Braunschweig,
06.05.2021

Dr Heike Manke
Head of Division

Translation issued:
06.05.2021



Head of Division

The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.

<https://www.dakks.de/en/content/accredited-bodies-dakks>

This document is a translation. The definitive version is the original German accreditation certificate.

See notes overleaf.

Deutsche Akkreditierungsstelle GmbH

Office Berlin
Spittelmarkt 10
10117 Berlin

Office Frankfurt am Main
Europa-Allee 52
60327 Frankfurt am Main

Office Braunschweig
Bundesallee 100
38116 Braunschweig

The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf.

No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS.

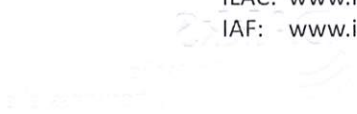
The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.

The up-to-date state of membership can be retrieved from the following websites:

EA: www.european-accreditation.org

ILAC: www.ilac.org

IAF: www.iaf.nu



Deutsche Akkreditierungsstelle GmbH

Annex to the Accreditation Certificate D-K-15183-01-00 according to DIN EN ISO/IEC 17025:2018

Valid from: 06.05.2021

Date of issue: 06.05.2021

Holder of certificate:

**SPEKTRA Schwingungstechnik und Akustik GmbH Dresden
Heidelberger Straße 12, 01189 Dresden**

Calibration in the fields:

Mechanical quantities

- **Acceleration ^{a)}**
Measuring instruments for vehicle inspection
- **Brake deceleration recorder (HU adapter)**

Acoustical quantities

Electrical quantities

DC and low frequency quantities

- **DC voltage**
- **AC voltage**
- **DC current**
- **Capacitance**
- **Charge**

^{a)} also on-site calibration

For the with * marked measurement quantity / calibration item the calibration laboratory is permitted, without being required to inform and obtain prior approval from DAkkS, to use calibration standards or equivalent calibration procedures listed here with different issue dates.

The calibration laboratory maintains a current list of all calibration standards / equivalent calibration procedures within the flexible scope of accreditation.

The management system requirements in DIN EN ISO/IEC 17025 are written in language relevant to operations of calibration laboratories and operate generally in accordance with the principles of DIN EN ISO 9001.

*The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.
<https://www.dakks.de/en/content/accredited-bodies-dakks>*

Abbreviations used: see last page

Page 1 of 9

This document is a translation. The definitive version is the original German annex to the accreditation certificate.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾		Remarks			
Acoustical quantities * Sound pressure level (free field) / Measuring microphone Free-field open-circuit or effective sensitivity level of measuring microphones with / without wind shield	Sensitivity level: -60 dB to +20 dB (referring to 1V / Pa)	IEC 61094-8:2012 Substitution method in an anechoic chamber with ½" or 1" standard microphone at sound pressure level 74 dB to 94 dB	0.30 dB 0.25 dB 0.35 dB 0.40 dB		Measurement of cartridge capacitance			
	125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 10 kHz > 10 kHz to 20 kHz							
	Sensitivity level: -60 dB to +20 dB (referring to 1 V / Pa)							
Sound pressure level (pressure) / Measuring microphone Open-circuit or effective pressure sensitivity level of measuring microphones	250 Hz / 124 dB 1 000 Hz / 94 dB 1 000 Hz / 114 dB	IEC 60942:2004 Calibration with reference standard: Pistophone Calibrator Calibrator	0.15 dB					
	Sensitivity level: -60 dB to +20 dB (referring to 1V / Pa)							
	31.5 Hz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 16 kHz							
	31.5 Hz to 2 kHz	IEC 61094-5:2016 Comparative measurement in an electro-acoustical coupler ½"-micr. 31.5 Hz to 16 kHz 1"-micr. 31.5 Hz to 8 kHz at 64 dB to 124 dB	SPEKTRA SQ-4.2 0.15 dB 0.20 dB 0.40 dB	SPEKTRA SQ-4.1 0.15 dB 0.50 dB -	Calibration at frequency f > 10 kHz (½"-microphone) or f > 5 kHz (1"-microphone) only possible with removable microphone grid			
	Sound pressure level: 74 dB to 130 dB (referring to 20 µV / Pa)	IEC 60942:2004 Substitution measurement with traced-back calibrators	Approved calibrators 0.1 dB	Any other calibrators 0.2 dB	Data apply to reference conditions for approved sound calibrators: (23 °C; 101.3 kPa; 50 % r.h.)			
	250 Hz / 124 dB 1 000 Hz / 94 dB 1 000 Hz / 114 dB							
Frequency: 250 Hz or 1 000 Hz								
	Total harmonic distortion: 0.1 % to 10 %	Measurement with traced-back frequency counter	0.05 Hz					
	Total harmonic distortion: 0.1 % to 10 % in the Range 31.5 Hz to 4 kHz	Ratio of the fundamental frequency to ten harmonic components	0.2 %					
Sound pressure level (pressure), frequency, total harmonic distortion / Calibrators Pistonphones and Sound calibrators	Sound pressure level: 60 dB to 130 dB (referring to 20 µV / Pa)	IEC 60942:2004 Calibration with reference standard (LS1P or LS2P) ½" or 1"	0.2 dB 0.3 dB					
	31.5 Hz to 10 kHz > 10 kHz to 16 kHz							
	Frequency 31.5 Hz to 16 kHz					Measurement with traced-back frequency counter	0.05 Hz	
	Total harmonic distortion: 0.1 % to 10 % in the Range 31.5 Hz to 4 kHz					Ratio of the fundamental frequency to ten harmonic components	0.2 %	

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾		Remarks
			Approved sound level meters	Any other sound level meters	
Sound pressure level (free field) / Sound level meters Sound level meters with separate microphone with / without wind shield	Deviation of indication in frequency range 125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 10 kHz > 10 kHz to 20 kHz	IEC 61672-3:2013 Substitution method in an anechoic chamber with ½" or 1" standard microphone at sound pressure level 74 dB to 94 dB	0.35 dB	0.65 dB	
			0.30 dB	0.40 dB	
Sound level meters with microphone attached to body with / without wind shield	Deviation of indication in frequency range 125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 10 kHz > 10 kHz to 20 kHz		0.40 dB	0.50 dB	
			0.45 dB	0.60 dB	
Sound pressure level Sound level meters (pressure)	Deviation of indication at reference point 250 Hz / 124 dB 1 000 Hz / 94 dB 1 000 Hz / 114 dB	IEC 61672-3:2013 Calibration with reference standard: Pistonphone Calibrator Calibrator	0.15 dB	0.20 dB	Deviation of indication is stated without considering the effect of the device body Calibration at frequency f > 10 kHz (½"-microphone) or f > 5 kHz (1"-microphone) only possible with removable microphone grid
			Approved sound level meters	Any other sound level meters	
0.30 dB	0.40 dB				
Sound level meter Inherent noise	Lowest measuring range A weighting	IEC 61672-3:2013 Measurement at lowest possible ambient sound (down to 20 dB (A))	0.5 dB		
		IEC 61672-3:2013 Measurement with shorted dummy capacitor	0.1 dB		

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Frequency weighting	A, B, C, LIN, Z, FLAT weightings 22.4 Hz to 22.4 kHz	IEC 61672-3:2013 Supply of electrical signal through dummy capacitor in voltage range RMS 20 µV to 20 V 26 dB to 146 dB (re 1 µV)	0.1 dB	
Frequency weighting at 1 kHz	A, B, C, LIN, Z, FLAT weightings 1 kHz		0.05 dB	
Level linearity	A, B, C, LIN, Z, FLAT weightings 22.4 Hz to 22.4 kHz		0.1 dB	
Tone burst response	Tone pulse duration: 0.25 ms to 1 000 ms 4 kHz		0.1 dB	
C-weighted peak level	Test signal: 0.5 and 1 cycle 31.5 Hz; 500 Hz; 8 kHz		0.1 dB	
Overload indication	Positive and negative half-sinusoidal signals 4 kHz	IEC 61672-3:2013 Supply of electrical signal through dummy capacitor in voltage range RMS 20 µV to 20 V 26 dB to 146 dB (re 1 µV)	0.1 dB	
Signal conditioner for microphones Polarization voltage	Polarization voltage 200 V	IEC 61672-3:2013 Measurement of voltage difference to reference source	0.2 V	
Force sensitivity (Mechanical impedance)	125 Hz to 800 Hz > 800 Hz to 4 kHz > 4 kHz to 8 kHz	IEC 60318-6:2007 Calibration with impedance head at (23.0 ± 0.5)°C	0.4 dB (0.5 dB) 0.5 dB (0.7 dB) 1.0 dB (1.0 dB)	Calibration at 5.4 N and 2.5 N contact force
Artificial mastoid	250 Hz		1.0 degree	

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Acceleration	For sinusoidal excitation and narrow-band evaluation methods (sine approximation), the amplitudes of vibration acceleration, vibration velocity and vibration displacement are unambiguously linked to one another by the vibration frequency. This is why vibration velocity sensors and vibration displacement sensors can be calibrated using the measured acceleration as stated in the table in ranges of velocity and displacement - converted accordingly for the stated frequency ranges. All measuring ranges refer to peak values (sinus amplitude).			
Acceleration (secondary) sinusoidal * Vibration sensor Digital Vibration meter (DTI) Vibration meter Vibration calibrator Laser vibrometer Calibration System for vibration Sensors	0.01 m/s ² to 20 m/s ²	ISO 16063-21:2003 DKD-R 3-1, Part 3:2018 0.1 Hz to < 0.2 Hz 0.2 Hz to < 0.4 Hz 0.4 Hz to < 1 Hz 1 Hz to 63 Hz > 63 Hz to 160 Hz	1.5 % / 2.0° 1.0 % / 1.0° 0.7 % / 0.7° 0.5 % / 0.7° 1.0 % / 1.0°	Sensor weight up to 0.9 kg Displacement amplitude up to 400 mm Calibration result: - complex sensitivity (amount/phase) - displayed deviation - vibration amplitude
	0.1 m/s ² to 500 m/s ²	2 Hz to < 5 Hz 5 Hz to < 20 Hz 20 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	1.5 % / 1.0° 1.0 % / 1.0° 0.5 % / 0.5° 1.0 % / 1.0° 2.0 % / 1.0°	Sensor weight up to 1.0 kg at 2 Hz to 2 kHz 0.5 kg at 2 kHz to 10 kHz Displacement amplitude up to 10 mm
	1 m/s ² to 250 m/s ²	5 Hz to < 10 Hz 10 Hz to < 20 Hz 20 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 15 kHz > 15 kHz to 20 kHz	1.0 % / 1.0° 0.7 % / 0.7° 0.5 % / 0.5° 0.7 % / 0.7° 1.5 % / 1.0° 2.0 % / 2.0° 2.5 % / 3.0°	Sensor weight up to 0.2 kg Displacement amplitude up to 8 mm
Geophone / Seismometer Measurement chain	0.001 m/s ² to 20 m/s ²	ISO 16063-21:2003 DKD-R 3-1, Part 3:2018 0.2 Hz to < 1 Hz 1 Hz to 10 Hz > 10 Hz to 160 Hz > 160 Hz to 400 Hz	1.5 % / 1.5° 1.0 % / 1.0° 2.0 % / 2.0° 3.0 % / 3.0°	Maximum payload refer under chapter: "Acceleration sinusoidal Geophones / Seismometer" Calibration result: - complex sensitivity (amount /phase)
Acceleration (secondary) shock (sin ² -pulse) * Vibration sensor Vibration meter Digital Vibration meter (DTI) Calibration system for vibration Sensors	0.2 km/s ² to 2 km/s ² 0.2 km/s ² to 2 km/s ² > 2 km/s ² to 20 km/s ² > 20 km/s ² to 100 km/s ²	ISO 16063-22:2005 DKD-R 3-1, Part 2:2018 Shock excitation Pulse width (PWHS): 10 ms to 1 ms 4.0 ms to 1.6 ms 0.4 ms to 0.1 ms 0.2 ms to 0.08 ms	1 % 0.8 % 1.5 % 3.0 %	Excitation with pendulum Sensor weight up to 0.3 kg Excitation with PN-LMS Sensor weight up to 0.05 kg
Acceleration (secondary) shock (sin-pulse) * Vibration sensor Vibration meter Calibration system for vibration Sensors	0.2 km/s ² to 2.5 km/s ² 0.2 km/s ² to 5.5 km/s ² 0.2 km/s ² to 10 km/s ² 10 km/s ² to 40 km/s ²	ISO 16063-22:2005 Shock excitation Pulse width (PWHS): 200 µs to 150 µs < 150 µs to 100 µs < 100 µs to 30 µs 70 µs to 30 µs	1.0 % 1.5 % 2.0 % 4.0 %	Excitation with HOP-MS Sensor weight up to 0.05 kg

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Acceleration (primary) sinusoidal * Vibration sensor Vibration meter Vibration calibrator Laser-vibrometer Calibration system for vibration Sensors	0.01 m/s ² to 30 m/s ²	ISO 16063-11:1999 DKD-R 3-1, Part 4:2018		Sensor weight up to 0.9 kg Displacement amplitude up to 400 mm Calibration result: - complex sensitivity (amount /phase) - displayed deviation - vibration amplitude
		0.1 Hz to < 0.2 Hz 0.2 Hz to < 0.4 Hz 0.4 Hz to < 1 Hz 1 Hz to 63 Hz > 63 Hz to 160 Hz	1.0 % / 1.5° 0.5 % / 0.7° 0.5 % / 0.5° 0.3 % / 0.5° 0.7 % / 0.7°	
Geophone / Seismometer Measurement chain	0.001 m/s ² to 20 m/s ²	ISO 16063-11:1999 DKD-R 3-1, Part 4:2018		<i>m</i> _{max} : maximum Payload Device under Test Calibration result: - complex sensitivity (amount/phase) - displayed deviation
		0.1 Hz to < 0.2 Hz <i>m</i> _{mMax} vertical: 50 kg <i>m</i> _{max} horizontal: 30 kg	1.5 % / 2.0°	
		0.2 Hz to < 1 Hz <i>m</i> _{max} vertical: 50 kg <i>m</i> _{max} horizontal: 30 kg	1.0 % / 1.0°	
		1 Hz to 10 Hz <i>m</i> _{max} vertical: 50 kg <i>m</i> _{max} horizontal: 30 kg	0.7 % / 1.0°	
		> 10 Hz to 160 Hz <i>m</i> _{max} vertical: 20 kg <i>m</i> _{max} horizontal: 20 kg	1.5 % / 1.5°	
		> 160 Hz to 400 Hz <i>m</i> _{max} vertical: 10 kg	2.0 % / 2.0°	
Vibration sensor is integrated in vibration exciter (internal reference accelerometer)	0.01 m/s ² to 30 m/s ²	ISO 16063-11:1999 DKD-R 3-1, Part 4:2018		For vibration exciters whose technical data correspond to the vibration exciters used in the laboratory Displacement up to 400 mm Calibration result: - complex sensitivity (amount /phase)
		0.1 Hz to < 0.2 Hz 0.2 Hz to < 0.4 Hz 0.4 Hz to < 1 Hz 1 Hz to 63 Hz > 63 Hz to 160 Hz	1.0 % / 1.5° 0.5 % / 0.7° 0.4 % / 0.5° 0.3 % / 0.4° 0.5 % / 0.7°	
Vibration sensor Vibration meter Vibration calibrator Laser vibrometer Calibration System for vibration Sensors	1 m/s ² to 250 m/s ²	ISO 16063-11:1999 DKD-R 3-1, Part 4:2018		Sensor weight up to 0.9 kg Displacement amplitude up to 400mm Calibration result: - complex sensitivity (amount /phase) - displayed deviation - vibration amplitude
		5 Hz to < 20 Hz 20 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 15 kHz > 15 kHz to 20 kHz	0.5 % / 0.5° 0.3 % / 0.5° 0.5 % / 0.5° 1.0 % / 1° 2.0 % / 2° 2.5 % / 3°	

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of *k* = 2 unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Vibration sensor is integrated in vibration exciter (internal reference accelerometer)	1 m/s ² to 100 m/s ²	ISO 16063-11:1999 DKD-R 3-1, Part 4:2018 5 Hz to < 20 Hz 20 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 15 kHz > 15 kHz to 20 kHz	0.5 % / 0.4° 0.3 % / 0.4° 0.3 % / 0.4° 0.5 % / 0.7° 1.0 % / 1.5° 1.5 % / 2.0°	For vibration exciters whose technical data correspond to the vibration exciters used in the laboratory Calibration result: - complex sensitivity (amount /phase)
Reference Laser vibrometer	0.01 m/s ² to 30 m/s ²	ISO 16063-41:2011 0.1 Hz to < 0.4 Hz 0.4 Hz to < 1.0 Hz 1.0 Hz to 160 Hz	0.25 % / 0.20° 0.15 % / 0.20° 0.15 % / 0.20°	Calibration result: Deviation of indication Displacement amplitude up to 400 mm Calibration result: - complex sensitivity (amount /phase)
	1.0 m/s ² to 250 m/s ²	ISO 16063-41:2011 5 Hz to 1 kHz > 1 kHz to 10 kHz > 10 kHz to 15 kHz > 15 kHz to 20 kHz	0.15 % / 0.2° 0.15 % / 0.5° 0.25 % / 1.0° 0.30 % / 1.5°	Displacement amplitude up to 8 mm Calibration result: - complex sensitivity (amount /phase)
Acceleration (primary) static * Vibration sensor	0.17 m/s ² to < 0.342 m/s ² 0.342 m/s ² to < 0.513 m/s ² 0.513 m/s ² to < 1.703 m/s ² 1.703 m/s ² to < 3.355 m/s ² 3.355 m/s ² to < 6.306 m/s ² 6.306 m/s ² to < 9.219 m/s ² 9.219 m/s ² to 9.811 m/s ²	ISO 16063-16:2014 Calibration from 0 m/s ² until maximum local gravity acceleration by inclination in the earth's gravity field	2.4 % 1.3 % 0.90 % 0.30 % 0.20 % 0.10 % 0.04 %	Calibration result: deviation for measuring instruments and transmission coefficient for sensors (transducer)
Vibration meter	0 m/s ² to 9.811 m/s ²		0.01 m/s ²	
Inclination angle (secondary) Inclination angle sensor	1.0° to < 2° 2° to < 3° 3° to < 10° 10° to < 25° 25° to < 50° 50° to < 75° 75° to 90°	Calibration in the angular range 1° to 90° in relation to the direction of the gravitational vector g_L	2.2 % 1.2 % 0.50 % 0.30 % 0.20 % 0.10 % 0.04 %	Calibration result: - transfer coefficient
Angular rate dynamic (secondary)	8 °/s to 3000 °/s	0.5 Hz to < 1 Hz < 1 Hz to 200 Hz	0.7 % / 0.8° 0.6 % / 0.8°	Calibration result: - complex sensitivity (value/phase) - displayed deviation
Charge amplifier	0.1 pC to 10.000 pC	0.2 Hz to 20 kHz > 20 kHz to 50 kHz	0.25 % / 0.5° 1.0 %	Calibration result: - complex sensitivity (value/phase)
Voltage Measuring amplifier	1 mV to 30 V	0.2 Hz to 20 kHz > 20 kHz to 50 kHz	0.2 % / 0.5° 1.0 %	
Dynamic Force (secondary) shock Impact hammer	10 N to 500 N	Shock excitation (sin ² -pulse) 10 ms to 0.1 ms	5 %	Calibration result: transfer coefficient

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Annex to the accreditation certificate D-K-15183-01-00

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Brake deceleration recorder (HU adapter) Acceleration (secondary)	0.5 m/s ² to 20 m/s ²	Verkehrsblatt 2018, issue 21, No. 156 ISO 16063-21:2003 * DKD-R 3-1, Part 3:2018 * 0.5 Hz to < 10 Hz 10 Hz to 20 Hz	1.0 % 2.0 %	
Angular rate	8 °/s to 100 °/s	Verkehrsblatt 2018, issue 21, No. 156 0.5 Hz to 10 Hz > 10 Hz to 20 Hz	1.2 % 2.2 %	
Electrical quantities DC voltage Measuring instruments	0.1 V to 25 V	E-DC-03.U_V1	$50 \cdot 10^{-6} \cdot U$	U = measured value
DC voltage Sources	0.1 V to 25 V 200 V	E-DC-01.U_V1	$50 \cdot 10^{-6} \cdot U$ $1.5 \cdot 10^{-3} \cdot U$	U = measured value
DC current Measuring instruments	20 µA to < 12 mA 12 mA to < 120mA 120 mA to 1000 mA	E-DC-02.I_V1	$0.10 \cdot 10^{-3} \cdot I$ $0.10 \cdot 10^{-3} \cdot I$ $0.30 \cdot 10^{-3} \cdot I$	I = measured value
DC current Sources	20 µA to < 12 mA 12 mA to < 120mA 120 mA to 1000 mA	E-DC-04.I_V1	$0.10 \cdot 10^{-3} \cdot I$ $0.10 \cdot 10^{-3} \cdot I$ $0.30 \cdot 10^{-3} \cdot I$	I = measured value
AC voltage Measuring instruments, sources	3.4 mV to 7000 mV	E-AC-02.U_LF_V1, E-AC-02.U_MF_V1 0.1 Hz to < 10 Hz	$1.3 \cdot 10^{-3} \cdot U$	U = measured value
	0.012 V to 12 V	E-AC-03.U_LF_V1, E-AC-03.U_MF_V1 10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$0.60 \cdot 10^{-3} \cdot U$ $0.40 \cdot 10^{-3} \cdot U$ $0.50 \cdot 10^{-3} \cdot U$ $0.80 \cdot 10^{-3} \cdot U$ $1.5 \cdot 10^{-3} \cdot U$	
Charge Measuring instruments	1.37 pC to 7000 pC	E-AC-02.Q_LF_V1, E-AC-02.Q_MF_V1 1.0 Hz to < 10 Hz 10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$1.3 \cdot 10^{-3} \cdot Q$ $0.6 \cdot 10^{-3} \cdot Q$ $0.4 \cdot 10^{-3} \cdot Q$ $0.5 \cdot 10^{-3} \cdot Q$ $0.8 \cdot 10^{-3} \cdot Q$ $1.5 \cdot 10^{-3} \cdot Q$	Q = measured value
Capacitance	100 pF, 1000 pF	E-C-01.C_V1 Substitution measurement with reference capacitor 1000 Hz	$0.3 \cdot 10^{-3} \cdot C$	C = measured value

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

On-site Calibration

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Acceleration (secondary) sinusoidal vibration test system	0.79 m/s ² to 500 m/s ²	2 Hz to 5 Hz > 5 Hz to 2 kHz > 2 kHz to 5 kHz	2.0 % 1.5 % 2.0 %	Calibration result: displayed deviation The environmental conditions and characteristics of the vibration test system must be within specified limits
Acceleration (secondary) shock vibration test system	20 m/s ² to 500 m/s ²	20 ms to 10 ms 10 ms to 2 ms 2 ms to 0.5 ms	2.0 % 1.5 % 2.0 %	

Abbreviations used:

CMC	Calibration and measurement capabilities
DKD-R	Guideline of Deutscher Kalibrierdienstes (DKD), published by Physikalisch-Technische Bundesanstalt
E-...	Self-developed calibration procedure of SPEKTRA Schwingungstechnik und Akustik GmbH Dresden
IEC	International Electrotechnical Commission

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 95 % and have a coverage factor of $k = 2$ unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.