



SPEKTRA

Schwingungstechnik und Akustik GmbH Dresden



Products & Services

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Calibration Systems CS18



Calibration Systems CS18 for Sound and Vibration Measurement Engineering

The CS18 Calibration System is a system family with various versions that are optimized for a wide variety of measurements in sound and vibration engineering. Calibration of the magnitude of transfer coefficient is a common feature of all systems. The SRS-35 Measurement and Control System can integrate acceleration signals over time with high precision and so allows transducers sensitive to vibration velocity and displacement to be calibrated as well. Many optional extras are available by means of which the performance of every system can be upgraded still further.

Possible modes of calibration by CS18:

Vibration: Absolute and comparison calibration

Sound: Comparison calibration of sound pressure in a free sound field or a pressure chamber.

Electrical quantities: Comparison calibration of charge and voltage

The **SRS-35 Measurement, Analysis and Control System** by SPEKTRA is the common electronic platform of all CS18 systems. A dedicated software package provides a standardized user interface and is allocated to each system. Depending on the required configuration, their standard signal conditioners directly accept charge sensors, sensors with integrated impedance converters or two measuring microphones.

Explanations to the Calibration Systems

Modern **Calibration Systems** are conforming to ISO 16063 in vibration engineering and to IEC 61094, IEC 61672, IEC 61043, and IEC 60942 in acoustics.

Secondary Calibration is calibration by comparing the test object with a reference standard. The unknown transfer coefficient of the test object is traced back to the known transfer coefficient of the reference standard, in acoustics often by substitution.

Primary Calibration is absolute calibration. In vibration engineering, the excitation acceleration is traced back to the wavelength of Helium-Neon laser light by means of interferometric amplitude measurement.

The **Excitation Signal** in calibration can be vibration acceleration with a sinusoidal or shock-type waveform, depending on the goal of calibration, or sound pressure, configured as a plane wave in a free sound field or alternating pressure in a pressure chamber.

The **Result of Calibration** is the transfer coefficient or its level in dB and a statement of its range of uncertainty.

The **Frequency Range of Calibration** is determined by 0.05 Hz to 20 kHz in vibration engineering or 0.1 Hz to 20 kHz for the calibration in acoustics.

The **Performance** of a calibration system for vibration is mainly dependent on the vibration exciter and reference standard, as they determine the frequency range, maximum test object weight and measurement uncertainty. In acoustics, the inner dimensions of the anechoic chamber determine the lower limiting frequency of free-field calibration.

The **Measurement Uncertainty** of modern systems is specified according to GUM (ISO Guide to the Expression of Uncertainty in Measurement, 1995) with expansion factor $k = 2$. It is stated in the documentation specifically for each system as a function of frequency, weight of object under test (for vibration) and other relevant calibration parameters.

Systems for Comparison Calibration



CS18 VLF System for the comparison calibration of vibration sensors at very low frequencies 0.05 Hz to 160 Hz, e.g. seismic sensors with a weight of up to 23 kilogram and sensors of whole-body vibration



CS18 MF System for the calibration of vibration sensors in frequency range 3 Hz to 10 kHz; standard system for common vibration sensors



CS18 HF System for the comparison calibration of sensors in a working frequency range from 5 Hz to 20 kHz and for resonance search up to 50 kHz

Users: DAkkS calibration labs, quality management divisions in industry, sensor manufacturers

Calibration Systems CS18

Systems for Absolute Calibration



CS18P VLF, horizontal or vertical excitation, for the absolute calibration at very low frequencies in the range from 0.05 Hz to 160 Hz, e.g. seismic, shock and human vibration sensors



CS18P HF, System for the absolute method of vibration calibration in frequency range 5 Hz to 20 kHz

Users: National offices of metrology, DAkkS calibration laboratories, quality management divisions in industry, sensor manufacturers

Systems for Shock Calibration



CS18 LMS, system with pneumatic shock exciter for calibrating sensors at shock acceleration up to 15,000 g_n . Efficient system for calibrating crash sensors.



CS18 MS, system for calibration of sensors with medium shock acceleration up to 40,000 g_n . Efficient system for calibrating shock sensors



CS18 HS/VHS, system for calibration of sensors with (very) high shock acceleration up to 200,000 g_n . Efficient system for calibrating shock sensors

Users: Quality assurance in automotive industries

Systems for Sound Pressure Calibration



CS18 FF¹⁾, System for the free-field calibration of microphones and sound level meters in the frequency range 125 Hz to 20 kHz by the substitution



CS18 SPL, System for the pressure calibration of $\frac{1}{2}$ " and $\frac{1}{4}$ " measuring microphones by the comparison method in the frequency range 31.5 Hz to 5 kHz

Users : DAkkS calibration laboratories, universities, acoustical research centers

¹⁾ The anechoic test chamber complies with ISO 3745 precision class 1. It is supplied as part of every CS18 FF. The dimensions of the chamber are about 2 m x 2 m x 2.5 m.

Examples of Combinations from Calibration Systems with Production Facilities



CS18 VLF in connection with a climatic chamber for use in the sensor development



CS18 MF Calibration System in connection with a Thermo-stream; Calibration under different temperatures in the R&D field.

Hard- and Software Options to increase the range of capacity in the calibration procedure

- **ANA PR** Signal conditioner for making direct connection to piezo-resistive sensors, including software for the determination of electrical quantities
- **CAL-Q-U-ICP®** Module and software for calibrating the magnitude of the transfer coefficient of charge and voltage amplifiers
- **APS 0109** Zero Position Controller
- **Data Base** Database linkage, interface to database of sensors and measuring instruments
- **MS-C** Multi-Sine Calibration
- **PHASE** Phase-calibration of vibration sensors, with the option CAL-Q-U-ICP® also of signal conditioners
- **TEDS** Calibration of sensors using their integrated electronic data sheet (according to IEEE 1541.4)
- **MUB** Drawing up and determination of the individual Measurement uncertainty budget when supplying a CS18 Calibration system
- **CS18 ZK** Accessories bag contains all the means for weighing, mounting, isolating sensors, connecting cables, cable clamps, cable adapters for making connection to an instrument, torque wrench and auxiliary utensils.
- **Mobil** Transportation trolley for CS18 MF and CS18 HF
- **AIR** Supply unit for air bearing shakers
- **CLIMATE** Hygrometer and thermometer for the laboratory
- **SEMINAR** with teaching and training

SPEKTRA does carry out annually **Calibration Seminars** for all users of calibration systems.

All data are subject to change without notice

November 2013

Overview Fields of Application

CS18 Calibration Systems



Acceleration

Primary Calibration		Secondary Calibration	
Calibration System	Frequency Range	Calibration System	Frequency Range
CS18P VLF	0.05 Hz ... 160 Hz	CS18 VLF	0.05 Hz ... 160 Hz
		CS18 MF	3 Hz ... 10,000 Hz
CS18P HF	5 Hz ... 20,000 Hz	CS18 HF	5 Hz ... 20,000 Hz

Shock

Primary Calibration		Secondary Calibration	
Calibration System	Shock Acceleration	Calibration System	Shock Acceleration
		CS18 LS	100 m/s ² ... 2,000 m/s ²
CS18P MS	20 m/s ² ... 50,000 m/s ²	CS18 MS	200 m/s ² ... 40,000 m/s ²
CS18P HS	5,000 m/s ² ... 750,000 m/s ²	CS18 LMS	200 m/s ² ... 150,000 m/s ²
		CS18 HS/VHS	10,000 m/s ² ... 2,000,000 m/s ²

Acoustics (Secondary Calibration)

Pressure Chamber Calibration		Free Field Calibration	
Calibration System	Frequency Range	Calibration System	Frequency Range
CS18 SPL-VLF	0.1 Hz ... 31.5 Hz		
CS18 SPL	31.5 Hz ... 5,000 Hz		
		CS18 FF	125 Hz ... 20,000 Hz

All data are subject to change without notice

November 2013

CS18 VLF

Calibration System Very-Low-Frequency



Application

- Secondary calibration according to **ISO 16063-21** (comparison method) of charge type, ICP®, voltage, capacitive and piezo-resistive sensors for acceleration, velocity and distance, with Sine excitation with high accuracy
- Secondary calibration of **reference standards**
- **Resonant frequency search** from 10 to 200 Hz
- Calibration of **vibration meters**
- Calibration of **vibration calibrators**
- Calibration of **seismic sensors**

Range of Use

- **Certified calibration laboratories**
- Departments for the **supervision of measuring instruments** in research and industries (automotive, aviation, space, military)
- **Quality assurance** in sensor production
- **National metrology laboratories**, with optional extra 'Primus' as a CS18P VLF primary calibration system)

Features

- **Traceable** to Physikalisch Technische Bundes-anstalt (**PTB**) Braunschweig by the SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**)
- **Calibration of sensors** with / without amplifiers, measurement instruments with indication of their own by applying of determinate acceleration signals
- **Calibration of calibrators** by exact measurement of vibration quantities
- **Frequency range 0.2 Hz ... 160 Hz**, optional frequency range 0.1 Hz ... 160 Hz
- **Sensor mass (DUT) up to 900 gram**, at horizontal / vertical excitation, **optional 3 kilogram**
- Air-bearing **long stroke vibration exciter** with electrical zero-positioning-controller (vibration displacement 100 mm)
- **Repeatability** under identical conditions less to 63 Hz < 0.1 %, otherwise less than 0.5 %
- **Upgradeable** to a combined Sine calibration system, e.g. type CS18 VLF / HF, CS18P VLF

CS18 VLF

Calibration System Very-Low-Frequency

Components

- Vibration control system **SRS-35**, SPEKTRA
with electronic zero position controller **APS 0109**
- Software CS18 VLF with operation modes: sensor calibration, measurement, supply, sweep
- Power amplifier **APS 125**
- Air-bearing long-stroke vibration exciter **APS 113-AB** for up to 100 mm vibration displacement
- Electronic zero position control **APS 0109**
- **Vertical Mounting Kit** for vertical excitation
- Horizontal excitation on foundation (foundation not supplied)
- Reference standard accelerometer **BN-07** or **BN-13**
- **Single-ended reference standard** for the calibration of calibrators
- Standard PC

Specification CS18 VLF with air bearing vibration exciter APS 113-AB in the frequency range 0.2 Hz ... 160 Hz for sensor mass up to 900 gram (DUT)

for environmental conditions: temperature 23°C (± 2°C) and relative humidity 30 % ... 75 %

Frequency Range		Sensor Mass DUT horizontal / vertical	Expanded Measurement Uncertainty ²⁾ Amount ³⁾ / Phase ¹⁾	Working Range (peak value)		
from	to			Minimum	Maximum ⁴⁾ (Displacement, Velocity, Acceleration)	Maximum ⁵⁾ (Displacement, Velocity, Acceleration)
0.2 Hz	< 0.4 Hz	900 gram	1.5 % / 1.5°	0.2 Hz .. 1.0 Hz: 0.04 m/s²	0.2 Hz .. 1.25 Hz: 50 mm	0.2 Hz .. 1.25 Hz: 50 mm
0.4 Hz	< 1 Hz		1.0 % / 1.5°		1.25 Hz .. 8.0 Hz: 0.4 m/s	1.25 Hz .. 8.0 Hz: 0.4 m/s
1 Hz	63 Hz		0.5 % / 0.7°	1.0 Hz .. 160 Hz: 0.1 m/s²	8 Hz .. 63 Hz: 10 m/s²	8 Hz .. 63 Hz: 20 m/s²
> 63 Hz	160 Hz		1.0 % / 1.0°		63 Hz .. 160 Hz: 5 m/s²	63 Hz .. 160 Hz: 10 m/s²
Reference-Frequency 8 Hz, 16 Hz			0.5 % / 0.7°			

¹⁾ Only in combination with optional extra PHASE

²⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor) for the best possible DUT (other devices that are not as ideal have to be evaluated with individual additions)

³⁾ Values only valid for electrical sensor signals ≥ (1 mV or 1 pC)

⁴⁾ Maximum acceleration for maximum payload (DUT); higher excitations possible according to datasheet APS 113-AB

⁵⁾ Maximum acceleration without any payload (DUT); higher excitations possible according to datasheet APS 113-AB

Options for calibration systems CS18 VLF:

- EF Extended frequency range from 0.1 Hz
- HL High Masses horizontally up to 5 kg and vertically up to 3 kg
with the additional vibration exciter APS 129; e.g. for calibration of seismometers and geophones
- TABLE granite plate on block of sandstone to mount and use the system properly

CS18 MF

Calibration System Medium-Frequency



Application

- Secondary calibration according to **ISO 16063-21** (comparison method) of charge type, IEPE, voltage, capacitive and piezo-resistive sensors for acceleration, velocity and displacement, with Sine excitation with high accuracy
- Secondary calibration of **reference standards**
- **Resonant frequency search** up to 20 kHz
- Calibration of **vibration meters**
- Calibration of **vibration calibrators**

Range of Use

- **Certified calibration laboratories**
- Departments for the **supervision of measuring instruments** (automotive, aviation, space, military)
- **Quality assurance** in sensor production

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**)
- **Calibration of sensors** with / without amplifiers, measurement instruments with indication of their own by applying of determinate acceleration signals
- **Calibration of calibrators** by exact measurement of vibration quantities
- **Frequency range** 3 Hz ... 10 kHz
- **Sensor mass** up to 500 gram
- **Repeatability** under identical conditions up to 5 kHz < 0.2 %, otherwise less than 0.5 %
- **Upgradeable** to a combined Sine calibration system, e.g. type CS18 VLF / MF
- **Continuous frequency sweep** for consistency check of vibration sensors
- **Including single-ended reference standard** for the calibration of vibration calibrators

CS18 MF

Calibration System Medium-Frequency

Components

- Vibration control system **SRS-35**, SPEKTRA
- Software CS18 MF with operation modes: sensor calibration, measurement, supply, sweep
- Power amplifier **PA 14-180**, SPEKTRA
- Vibration exciter **SE-10**
- Internal reference standard accelerometer **BN-09**
- **Single-ended reference standard** for the calibration of calibrators
- Standard-PC

Specification

CS18 MF with vibration exciter SE-10

in the frequency range 3 Hz ... 10 kHz for sensors with mass to max. 500 gram (DUT)

for environmental conditions: temperature 23°C / 73 °F ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

Frequency Range		Sensor Mass DUT Up to	Expanded Measurement Uncertainty ²⁾ Amount ³⁾ / Phase ¹⁾	Working Range (peak value)		
From	To			Minimum	Maximum ⁴⁾ (Displacement, Velocity, Acceleration)	Maximum ⁵⁾ (Displacement, Velocity, Acceleration)
3 Hz	< 5 Hz	500 gram	2.0 % / 2.0°	1.0 m/s ²	3 Hz .. 12.5 Hz: 5 mm	3 Hz .. 12.5 Hz: 5 mm
5 Hz	< 10 Hz		1.5 % / 1.5°		12.5 Hz .. 48 Hz: 0.4 m/s	12.5 Hz .. 200 Hz: 0.4 m/s
10 Hz	< 20 Hz		1.0 % / 0.7°		48 Hz .. 1 kHz: 120 m/s²	200 Hz .. 10 kHz: 500 m/s²
20 Hz	1,000 Hz		0.7 % / 0.7°		1 kHz .. 5 kHz: 190 m/s²	
> 1,000 Hz	5,000 Hz	250 gram	1.5 % / 1.5°		5 kHz .. 10 kHz: 350 m/s²	
> 5,000 Hz	10,000 Hz	50 gram	2.5 % / 2.0°			
Reference-Frequency 80 Hz, 100 Hz, 160 Hz		500 gram	0.5 % / 0.7°			

¹⁾ Only in combination with optional extra PHASE

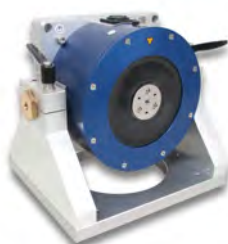
²⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement) with k = 2 (coverage factor)

³⁾ Valid for electrical sensor signals $\geq$ (1 mV or 1 pC)

⁴⁾ Maximum acceleration for maximum payload (DUT)

⁵⁾ Maximum acceleration without any payload

Options for calibration systems: see leaflet CS18-extras



Optional:

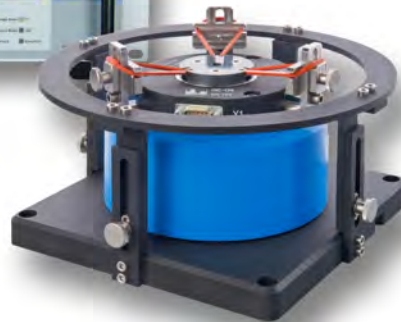
SE-10 with trunnion for angular operation

All data are subject to change without notice

October 2015

CS18 HF

Calibration System High-Frequency



SE-09
HF Vibration Exciter
with included
Reference Standard

Application

- Secondary calibration according to **ISO 16063-21** (comparison method) of charge type, ICP®, voltage, capacitive and piezo-resistive sensors for acceleration, velocity and distance, with Sine excitation with high accuracy
- Secondary calibration of **reference standards**
- **Resonant frequency search** up to 50 kHz
- Calibration of **vibration meters**
- Calibration of **vibration calibrators**

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research and industry (automotive, aviation, space, military)
- **Quality assurance** in sensor manufacturing
- **National metrological laboratories** (with the optional extra 'Primus' as a Primary Calibration System CS18P HF)

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (PTB) Braunschweig by the accredited SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certific.**)
- **Calibration of sensors** with/without amplifiers, measurement instruments with own indication by applying defined acceleration signals
- **Calibration of calibrators** by exact measurement of vibration quantities with an additional accelerometer
- **Frequency range** 5 Hz ... 20 kHz
- **Sensors with mass up to 200 gram**
- **Repeatability** under identical conditions less than 0.1 % up to 5 kHz, otherwise less than 0.5 %
- Air-bearing **high-frequency vibration exciter** with **internal reference standard accelerometer**
- **Max. acceleration** without DUT: 20 g_n
- **Upgradeable** to a combined Sine calibration system, e.g. type CS18 HF / VLF or CS18P HF
- **Including single-ended reference standard** for the calibration of vibration calibrators

CS18 HF

Calibration System High-Frequency

Components

- Vibration control system **SRS-35**, SPEKTRA
- Software CS18 HF with operation modes: sensor calibration, measurement, supply
- Power amplifier **PA 14-500**
- Air-bearing high-frequency vibration exciter **SE-09** with heavy base plate **M**
- Reference standard transducer **BN-09**, integrated in vibration exciter **SE-09**
- **Single-ended reference standard** for the calibration of calibrators
- Standard-PC

Specification

CS18 HF with vibration exciter SE-09

in the frequency range 5 Hz ... 20 kHz for sensor mass up to 200 gram (DUT)¹⁾

for environmental conditions: temperature 23°C (± 2°C) and relative humidity 30 % ... 75 %

Frequency Range		Sensor Mass DUT Up to	Expanded Measurement Uncertainty ²⁾ Amount ³⁾ / Phase ⁴⁾	Working Range (peak value)		
from	to			Minimum	Maximum ⁵⁾ (Displacement, Velocity, Acceleration)	Maximum ⁶⁾ (Displacement, Velocity, Acceleration)
5 Hz	< 10 Hz	200 gram	1,0 % / 1,0°	1,0 m/s ²	5 Hz .. 12 Hz: 4 mm	5 Hz .. 12 Hz: 4 mm
10 Hz	< 20 Hz		0,7 % / 0,7°			
20 Hz	1.000 Hz		0,5 % / 0,7°			
> 1.000 Hz	5.000 Hz	50 gram	0,7 % / 0,7°		12 Hz .. 53 Hz: 0,3 m/s	12 Hz .. 106 Hz: 0,3 m/s
> 5.000 Hz	10.000 Hz		1,5 % / 1,0°			
> 10.000 Hz	15.000 Hz		2,0 % / 2,0°			
> 15.000 Hz	20.000 Hz		3,0 % / 3,0°			
Reference frequency 80 Hz, 100 Hz, 160 Hz		200 gram	0,5 % / 0,7°		53 Hz .. 20 kHz: 100 m/s²	106 Hz .. 20 kHz: 200 m/s²

¹⁾ Specifications for CS18 HF with other vibration exciters on request

²⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor) for the best possible DUT (other devices that are not as ideal have to be evaluated with individual additions)

³⁾ Valid for electrical sensor signals ≥ (1 mV or 1 pC)

⁴⁾ Only in combination with optional extra PHASE

⁵⁾ Maximum acceleration for maximum payload (DUT); higher excitations possible according to datasheet SE-09

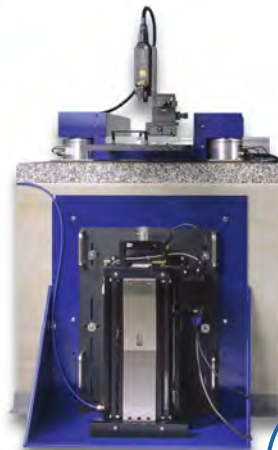
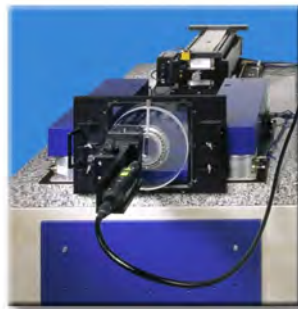
⁶⁾ Maximum acceleration without any payload; higher excitations possible according to datasheet SE-09

For the advanced technical data, please see data sheet for the SE-09

Options for calibration systems: see leaflet CS18-extras

CS18P VLF

Primary Calibration System Very-Low-Frequency



Primary
Calibration of
- Reference Standards
- Laser Vibrometers

Applications

- **Primary calibration** of vibration sensors, calibrators and measurement systems with very high quality and performance according to **ISO 16063-11** (Primary Calibration, method 3)
- **Primary calibration** of laser vibrometers and reference laser vibrometers performance to **ISO 16063-41**
- **Primary calibration of reference standards**
- **Resonant frequency search** from 10 to 200 Hz
- Calibration of **vibration meters**
- Calibration of **vibration calibrators**
- Calibration of **seismic sensors**

Range of Use

- **National metrology laboratories** as highest measurement authorities
- **Authorized calibration laboratories** (such as DAkkS-Labs in Germany)
- Departments for the **supervision of measuring instruments** in research and industries
- **Quality assurance** in sensor production

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**), NIST (MRA) ...
- **Calibration of sensors** with / without amplifiers, of measurement instruments with indication of their own by applying determinate acceleration signals
- **Calibration** of calibrators by exact measurement of definite vibration quantities
- **Air-bearing long stroke exciter** with electronic zero position control unit for full 100 mm peak to peak stroke application
- **Frequency range 0.2 Hz ... 160 Hz**, **Option -EF**: starting from 0.1 Hz
- **Sensor mass up to 900 gram**, **Option -HL**: 5 kg horizontal / 3 kg vertical
- All **digital laser vibrometer** as primary reference standard
- Additionally applicable for **secondary calibrations** according to ISO 16063-21 by using integrated **secondary reference standard**
- **Upgradeable** to calibration systems, e.g. type CS18P VLF / HF

CS18P VLF

Primary Calibration System Very-Low-Frequency



Components

- Precision measuring and control system **SRS-35**, SPEKTRA
- Software CS18P VLF with operation modes: sensor calibration, measurement, supply, sweep
- Electronic zero position controller **APS 0109**
- Power amplifier **APS 125**
- Air bearing long-stroke vibration exciter **APS 113AB** for up to 100 mm vibration displacement
- **Vertical Mounting Kit** for vertical excitation
- Digital laser vibrometer **PLV-01** as **primary reference standard**
- **Prism** for the calibration of laser vibrometers
- Vibration isolation **VI-02** for vibrometer PLV-02

Specifications of CS18P VLF (Primary System) at 23°C (± 2°C) and relative humidity 30 % ... 75 %

Frequency Range		Sensor Mass DUT horizontal / vertical up to	Expanded Measurement Uncertainty ²⁾		Working Range (peak value)		
from	to		Amount ³⁾ / Phase ¹⁾ Sensors and Laser Vibrometers with analog Signal Output	Amount Reference Laser Vibrometer	Minimum	Maximum ⁴⁾ (Displacement, Velocity, Acceleration)	Maximum ⁵⁾ (Displacement, Velocity, Acceleration)
0.2 Hz	< 0.4 Hz	900 gram	0.7 % / 0.7°	0.25 %	0.2 Hz .. 1.0 Hz: 0.04 m/s² 1.0 Hz .. 160 Hz: 0.1 m/s²	0.2 Hz .. 1.25 Hz: 50 mm	0.2 Hz .. 1.25 Hz: 50 mm
0.4 Hz	< 1 Hz		0.5 % / 0.5°			1.25 Hz .. 8.0 Hz: 0.4 m/s	1.25 Hz .. 8.0 Hz: 0,4 m/s
1 Hz	63 Hz		0.3 % / 0.5°			8 Hz .. 63 Hz: 20 m/s²	8 Hz .. 63 Hz: 20 m/s²
> 63 Hz	160 Hz		0.7 % / 0.7°			63 Hz .. 160 Hz: 10 m/s²	63 Hz .. 160 Hz: 10 m/s²
Ref. Frequency 8 Hz, 16 Hz			0.3 % / 0.5°				

Specifications of CS18P VLF (Secondary System)

0.2 Hz	< 0.4 Hz	900 gram	1.5 % / 1.5°	-	0.2 Hz .. 1.0 Hz: 0.04 m/s²	0.2 Hz .. 1.25 Hz: 50 mm	0.2 Hz .. 1.25 Hz: 50 mm
0.4 Hz	< 1 Hz		1.0 % / 1.5°			1.25 Hz .. 8.0 Hz: 0.4 m/s	1.25 Hz .. 8.0 Hz: 0.4 m/s
1 Hz	63 Hz		0.5 % / 0.7°			8 Hz .. 63 Hz: 20 m/s²	8 Hz .. 63 Hz: 20 m/s²
> 63 Hz	160 Hz		1.0 % / 1.0°			63 Hz .. 160 Hz: 10 m/s²	63 Hz .. 160 Hz: 10 m/s²
Ref. Frequency 8 Hz, 16 Hz			0.5 % / 0.7°				

¹⁾ Only in combination with optional extra PHASE

²⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement) with k = 2 (coverage factor)

³⁾ Valid for electrical sensor signals ≥ (1 mV or 1 pC)

⁴⁾ Maximum acceleration for maximum payload (DUT)

⁵⁾ Maximum acceleration without any payload (DUT)

Options for calibration systems

- EF extended frequency range starting from 0,1 Hz
- HL higher payloads up to 5 kg in horizontal and 3 kg in vertical direction

CS18P HF

Primary Calibration System High-Frequency



Primary
Calibration of
- Reference Standards
- Laser Vibrometers



Applications

- **Primary calibration** of vibration sensors, calibrators and meters with lowest measurement uncertainty according to **ISO 16063-11** (Primary calibration using method 3)
- **Primary calibration** of laser vibrometers and reference laser vibrometers according to **ISO 16063-41**
- **Primary calibration** of **reference standard transducers**
- **Resonant frequency search** up to 50 kHz

Range of Use

- **National metrological laboratories** as highest metrological authorities
- **Certified calibration laboratories** with outstanding quality demands
- **Departments of measuring instrument verification** in research and industry
- **Quality assurance** in sensor manufacturing

Features

- **Traceable** to Physikalisch Technische Bundes-anstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**), NIST (MRA) ...
- **Calibration** of **sensors** with / without measuring amplifier, **measuring systems** with indication of their own by applying of determinate acceleration signals
- **Calibration** of **calibrators** by measurement with ultra-high precision
- **Frequency range** 5 Hz ... 20 kHz (... 50 kHz)
- **Sensors** with mass up to 200 gram
- **Digital laser vibrometer** as primary reference standard
- Application of an **air-bearing high-frequency vibration exciter** with internal reference standard
- Maximum acceleration 40 g_n
- Additionally applicable for **secondary calibrations** according to ISO 16063-21 by using integrated **secondary reference standard**
- **Upgradeable** to combined calibration system CS18P VLF / HF

CS18P HF

Primary Calibration System High-Frequency



Components

- Precision measuring and control system **SRS-35**, SPEKTRA
- Software CS18 HF with operation modes: sensor calibration, measurement, supply, sweep
- Power amplifier **PA 14-500**
- Air bearing vibration exciter **SE-09** with base plate **M**
- All-digital Polytec laser vibrometer **PLV-01** as **primary reference standard**
- **Prism** for the calibration of laser vibrometers
- Vibration isolator **VI-01** for laser vibrometer PLV-02
- **BN-09** as secondary reference standard, integrated in exciter SE-09
- **Single-ended reference standard** for the calibration of calibrators

Specifications of CS18P HF (Primary Calibration) at 23°C (± 2°C) and relative humidity 30 % ... 75 %

Frequency Range		Sensor Mass DUT horizontal / vertical up to	Expanded Measurement Uncertainty ²⁾		Working Range (peak value)		
from	to		Amount ³⁾ / Phase ¹⁾ Sensors and Laser Vibrometers with analogue Signal Output	Display Deviation Ref. Laser Vibrometer	Minimum	Maximum ⁴⁾ (Displacement, Velocity, Acceleration)	Maximum ⁵⁾ (Displacement, Velocity, Acceleration)
5 Hz	< 20 Hz	200 gram	0.5 % / 0.5°	0.2 %	0.1 m/s ²	5 Hz .. 12 Hz: 4 mm	5 Hz .. 12 Hz: 4 mm
20 Hz	1,000 Hz		0.3 % / 0.5°				
> 1,000 Hz	5,000 Hz		0.5 % / 0.5°				
> 5,000 Hz	10,000 Hz	50 gram	1.0 % / 1.0°	0.3 %		12 Hz .. 53 Hz: 0.3 m/s	12 Hz .. 106 Hz: 0.3 m/s
> 10,000 Hz	15,000 Hz		2.0 % / 2.0°	0.4 %			
> 15,000 Hz	20,000 Hz		2.5 % / 3.0°	0.5 %			
Reference Frequency 80 Hz, 100 Hz, 160 Hz		200 gram	0.3 % / 0.5°	0.2 %	10 m/s ²	53 Hz .. 20 kHz: 100 m/s²	106 Hz .. 20 kHz: 200 m/s²

Specifications of CS18P HF (Secondary Calibration)

5 Hz	< 10 Hz	200 gram	1.0 % / 1.0°	-	1.0 m/s ²	5 Hz .. 12 Hz: 4 mm	5 Hz .. 12 Hz: 4 mm
10 Hz	< 20 Hz		0.7 % / 0.7°				
20 Hz	1,000 Hz		0.5 % / 0.7°				
> 1,000 Hz	5,000 Hz		0.7 % / 0.7°				
> 5,000 Hz	10,000 Hz	50 gram	1.5 % / 1.0°		1.0 m/s ²	12 Hz .. 53 Hz: 0.3 m/s	12 Hz .. 106 Hz: 0.3 m/s
> 10,000 Hz	15,000 Hz		2.0 % / 2.0°				
> 15,000 Hz	20,000 Hz		3.0 % / 3.0°				
Reference Frequency 80 Hz, 100 Hz, 160 Hz		200 gram	0.5 % / 0.7°		10 m/s ²	53 Hz .. 20 kHz: 100 m/s²	106 Hz .. 20 kHz: 200 m/s²

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor) for the best possible DUT (other devices that are not as ideal have to be evaluated with individual additions)

²⁾ Only in combination with optional extra PHASE

³⁾ Valid for electrical sensor signals ≥ (1 mV or 1 pC)

⁴⁾ Maximum acceleration for maximum payload (DUT); higher excitations possible according to datasheet SE-09

⁵⁾ Maximum acceleration without any payload; higher excitations possible according to datasheet SE-09

Options for calibration systems

-TABLE block made of sand stone for proper installation and utilization of the system

CS18 LS

Calibration System Shock Pendulum



Sensor Calibration
Crash Test

Applications

- **Secondary calibration** of shock-sensors as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **accelerometer standards**

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research and industry, particular in **automotive crash test laboratories**
- **Quality assurance** in sensor manufacturing

Features

- **Traceable** to Physikalisch-Technische Bundes-anstalt (**PTB**) Braunschweig by the SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**)
- Application of a **shock pendulum with integrated reference standard**
- Maximum shock amplitude: **200 g_n**
- **Type of excitation:** shock half sine
- Position of DUT: **horizontal**
- Maximum sensor mass: **up to 300 gram**
- **Calibration of sensors** with / without measuring amplifier and **measuring systems** (sensor and signal conditioner)
- **Direct connection of piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software **PR measurement**
- **Upgradeable** to a combined calibration systems, e.g. type CS18 LF / LS

CS18 LS

Calibration System Shock Pendulum



Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock pendulum **SE-210 SP-LS** with set of dampers for adjusting the pulse width
- Reference standard transducer **BN-02**
- Standard PC

Performance specification of CS18 LS with reference standard BN-02

for environmental conditions: temperature 23°C ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

Shock Acceleration		10 g_n ... 200 g_n
Pulse Width		1 ms ... 10 ms
Sensor Mass (DUT)		max. 300 gram
Expanded Uncertainty ¹⁾	10 g_n ... 150 g_n	< 1,0 %
	> 150 g_n ... 200 g_n	< 1.5 %

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Specification of integrated PR module

Module for supplying power to piezo-resistive sensors or for supplying DC power to sensors (e.g. VC types)

Components of the integrated PR module

- Plug-in module to CS18 electronic unit SRS-35
- External connecting box for individual sensor adaptation
- Software for determining the electrical aptitude for calibration of PR sensors (measurement of bridge resistance, offset and offset drift, offset compensation, shunt calibration, insulations test)

Options for the PR module

- Individual external connection boxes
- TEDS for PR sensors

Technical specification PR module

Bridge Power Supply	4-lead or 6-lead configuration selectable, power will be measured and controlled
Voltage Range	-10 V ... 0 V ... +10 V
Current	maximum 100 mA
Bridge Completion	resistors for completing single-arm and two-arm partial bridges can be integrated in a connecting box (dimensioning according to specific sensor)
Shunt Resistors	2 units can be integrated in a connecting box, resistance values can be stored in an EEPROM
Amplifier	0 ... 42 dB
Gain Steps (DC)	factors to be set by software: 1, 2, 4, 8, 16, 32, 64, 128
Offset	offset measurement and offset compensation can be performed

Options for calibration systems: see leaflet CS18-extras

CS18 MS

Calibration System Medium-Shock Secondary



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments (measuring chain) with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**

Range of Use

- **Accredited calibration laboratories**
- **Calibration laboratory departments** of industrial firms particular in automotive, aviation or space travel industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities (with upgrade to primary system)

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration-Laboratory D-K-15183-01-00
- **Broad amplitude range** from **20 g_n ... 4.000 g_n**
- Type of excitation: **sinusoidal shock, adjustable signal shape or burst**
- **Independent control** of amplitude and pulse width (within certain ranges, see table)
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **30 gram**
- Realization of **fully automatic calibrations** according to own test regime (up to 1 shock/s)
- **Calibration** of **sensors** with / without measuring amplifier and **measuring systems** (sensor with signal conditioner)
- **Direct connection** of **piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software option **PR measurement**
- **Upgradeable** to a combined calibration system e.g. CS18 MS / HF

CS18 MS

Calibration System Medium-Shock Secondary



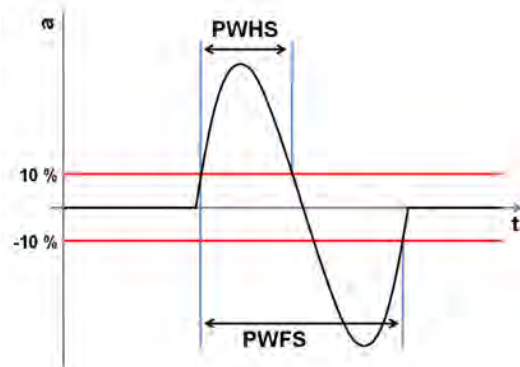
Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-220 HOP-MS**
- Reference standard **BN-02**
- **PA 14-500** power amplifier

Performance Specification ¹⁾

Max. sensor mass (DUT): 30 gram

Min. shock amplitude: 20 g_n



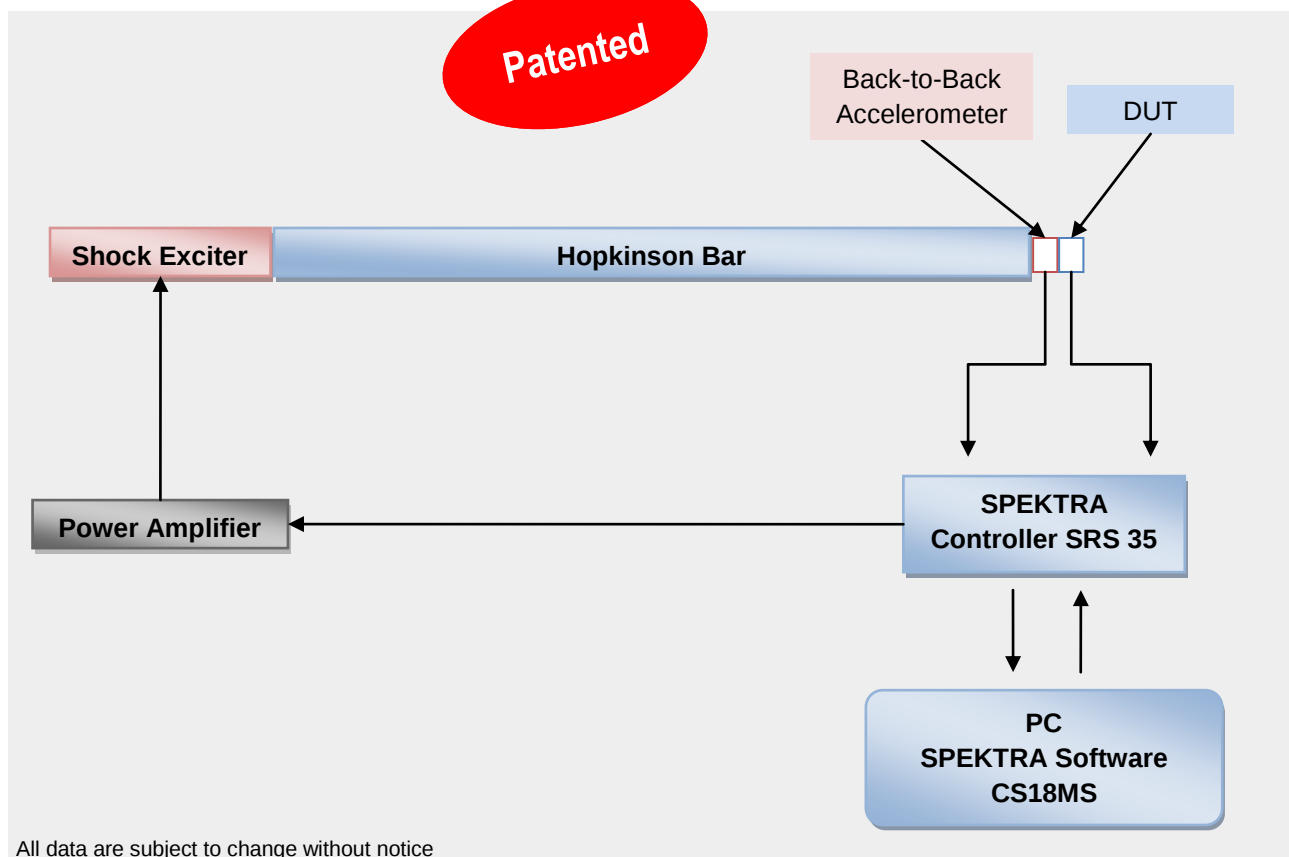
Shock Amplitude	PWHS ²⁾	PWFS ²⁾	Uncertainty ³⁾
20 g_n ... 250 g_n	180 μs	360 μs	< 2.0 %
20 g_n ... 500 g_n	125 μs	250 μs	< 2.0 %
20 g_n ... 1,000 g_n	70 μs	140 μs	< 2.5 %
20 g_n ... 4,000 g_n	40 μs	80 μs	< 3.0 %

¹⁾ All data for environmental conditions: temperature 23°C ($\pm 2^\circ C$) and relative humidity 30 % ... 75 %

²⁾ PWHS = max. Pulse Width Half Sine Wave; max. PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Dimensions Hopkinson Bar	Length	approx. 2.5 m
	Height	approx. 1.3 m
	Width	approx. 0.5 m



All data are subject to change without notice

November 2013

CS18 LMS

Calibration System Low-Medium-Shock



Sensor Calibration
Crash Test

Applications

- **Secondary calibration** of shock-sensors as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **accelerometer standards**
- **Testing** of small parts (e.g. MEMS)

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research and industry, particular in **automotive crash test laboratories**
- **Quality assurance** in sensor manufacturing

Features

- **Traceable** to Physikalisch-Technische Bundesanstalt (**PTB**) Braunschweig by the SPEKTRA Calibration-Laboratory D-K-15183-01-00 (**DAKKS Calibration Certificate**)
- **Pneumatic shock exciter** with integrated reference standard; **Air Bearing** for Anvil
- **Broad amplitude range** from **5 g_n ... 10,000 g_n**
- **Type of excitation:** shock half sine
- **Pulse duration** up to 5 ms
- Sensor (DUT) mass up to **50 gram** (can be higher for testing applications)
- Excitation axis: **vertical**
- **Good repeatability** of shock
- Realization of **all automatic calibrations** according to own test regime (up to 1 shock/s)
- **Calibration** of **sensors** with / without signal conditioner
- **Direct connection** of **piezo-resistive sensors** by means of integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software **PR measurement**
- **Upgradeable** to a combined calibration systems, e.g. type CS18 LF / LMS
- Automated regulation of amplitudes up to **600 g_n** is possible

CS18 LMS

Calibration System Low-Medium-Shock



Components

- Control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-201 PN-LMS** by SPEKTRA with **Control box**
- Reference standard transducer **BN-02**
- Standard PC

Performance specification of CS18 LMS with reference standard BN-02

for environmental conditions: temperature 23°C ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

Shock Acceleration		5 g_n ... 10,000 g_n
Pulse Width		0.1 ms ... 5 ms
Sensor Mass (DUT)		max. 50 gram
Expanded Uncertainty ¹⁾	5 g_n ... 20 g_n	< 2,0 %
	> 20 g_n ... 200 g_n	< 1,5 %
	> 200 g_n ... 4,000 g_n	< 1.8 %
	> 4,000 g_n ... 10,000 g_n	< 3,0 %

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Specification of integrated PR module

Module for supplying power to piezo-resistive sensors or for supplying DC power to sensors (e.g. VC types)

Components of the integrated PR module

- Plug-in module to CS18 electronic unit SRS-35
- External connecting box for individual sensor adaptation
- Software for determining the electrical aptitude for calibration of PR sensors (measurement of bridge resistance, offset and offset drift, offset compensation, shunt calibration, insulations test)

Options for the PR module

- Individual external connection boxes
- TEDS for PR sensors

Technical Data PR module

Bridge Power Supply	4-lead or 6-lead configuration selectable, power will be measured and controlled
Voltage Range	-10 V ... 0 V ... +10 V
Current	maximum 100 mA
Bridge Completion	resistors for completing single-arm and two-arm partial bridges can be integrated in a connecting box (dimensioning according to specific sensor)
Shunt Resistors	2 units can be integrated in a connecting box, resistance values can be stored in an EEPROM
Amplifier	0 ... 42 dB
Gain Steps (DC)	factors to be set by software: 1, 2, 4, 8, 16, 32, 64, 128
Offset	offset measurement and offset compensation can be performed

Options for calibration systems: see leaflet CS18-extras

All data are subject to change without notice

April 2014

CS18 HS

Calibration System High-g-Shock Secondary



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**

Range of Use

- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel or in the military industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration-Laboratory D-K-15183-01-00
- Type of excitation: **sinusoidal shock**
- Shock amplitudes up to **100.000 g_n**
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **30 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 20 shocks/ minute)
- **Calibration** of sensors with / without measuring amplifier and **measuring systems** (sensor with signal conditioner)
- **Direct connection of piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software **PR measurement**
- **Upgradeable** to a combined calibration system e.g. CS18 HS / HF

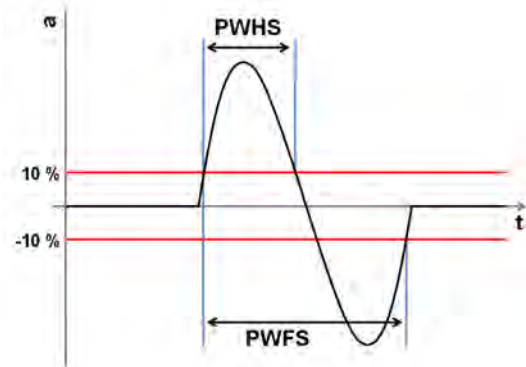
CS18 HS

Calibration System High-g-Shock Secondary



Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-221 HOP-HS**
- Reference standard strain gauge **BN-19**
- High speed **Data Acquisition System**



Performance Specification¹⁾

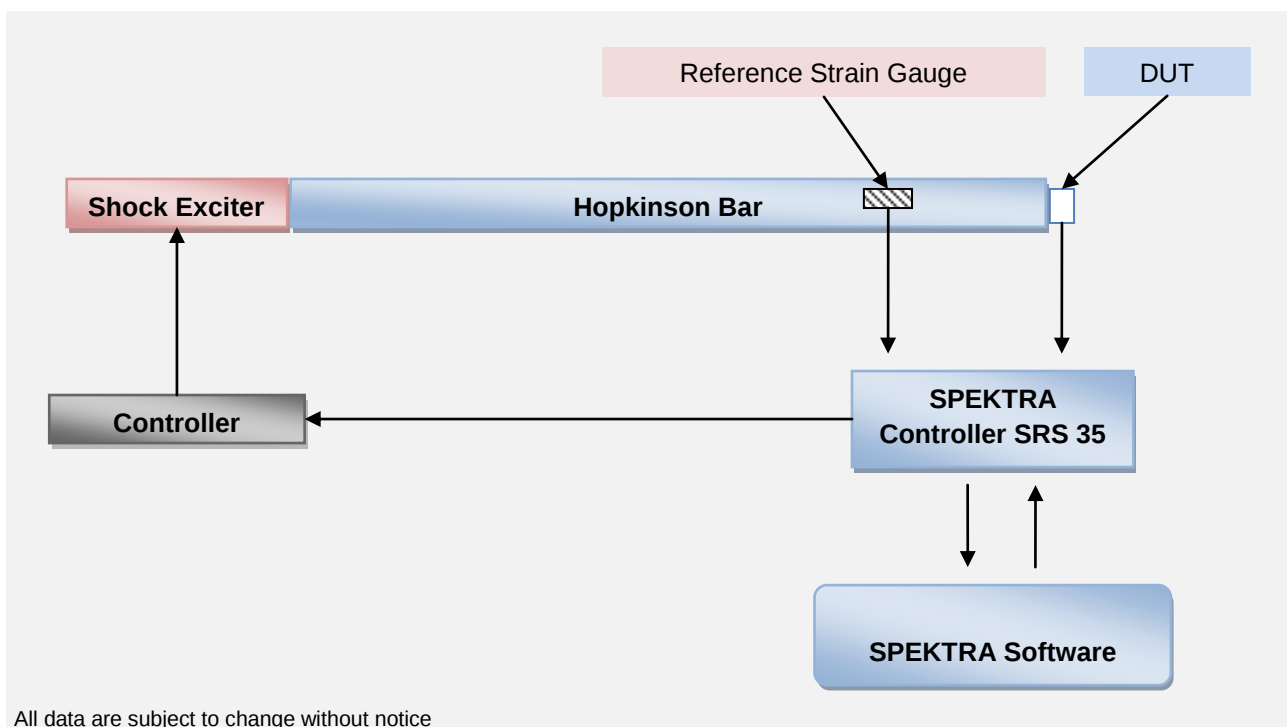
Shock Acceleration		10,000 g_n ... 100,000 g_n
Pulse Width PWFS / PWHS ²⁾		typical 50 μs / 25 μs
Sensor Mass (DUT)		max. 30 gram
Uncertainty ³⁾	10,000 g_n ... 20,000 g_n	< 3 %
	20,000 g_n ... 50,000 g_n	< 4 %
	50,000 g_n ... 100,000 g_n	< 5 %

¹⁾ All data for environmental conditions: temperature 23°C ($\pm$ 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Air Supply		8 bar
Dimensions Hopkinson Bar	Length	approx. 3.5 m
	Height	0.8 m ... 1.2 m
	Width	approx. 1 m



All data are subject to change without notice

November 2013

CS18 VHS

Calibration System Very-High-g-Shock Secondary



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**

Range of Use

- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel or in the military industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration-Laboratory D-K-15183-01-00
- Type of excitation: **sinusoidal shock**
- Shock amplitudes up to **200.000 g_n**
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **15 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 20 shocks/ minute)
- **Calibration** of sensors with / without measuring amplifier and **measuring systems** (sensor with signal conditioner)
- **Direct connection of piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software **PR measurement**
- **Upgradeable** to a combined calibration system e.g. CS18 VHS / HF

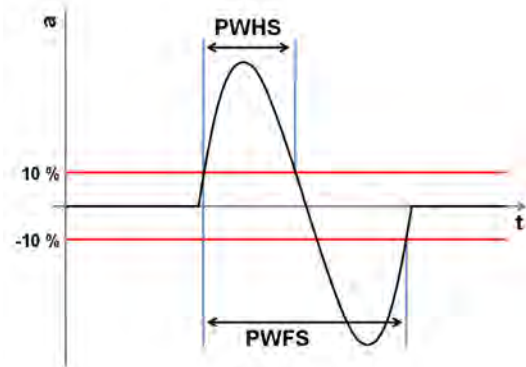
CS18 VHS

Calibration System Very-High-g-Shock Secondary



Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-222 HOP-VHS**
- Reference standard strain gauge **BN-19**
- High speed **Data Acquisition System**



Performance Specification¹⁾

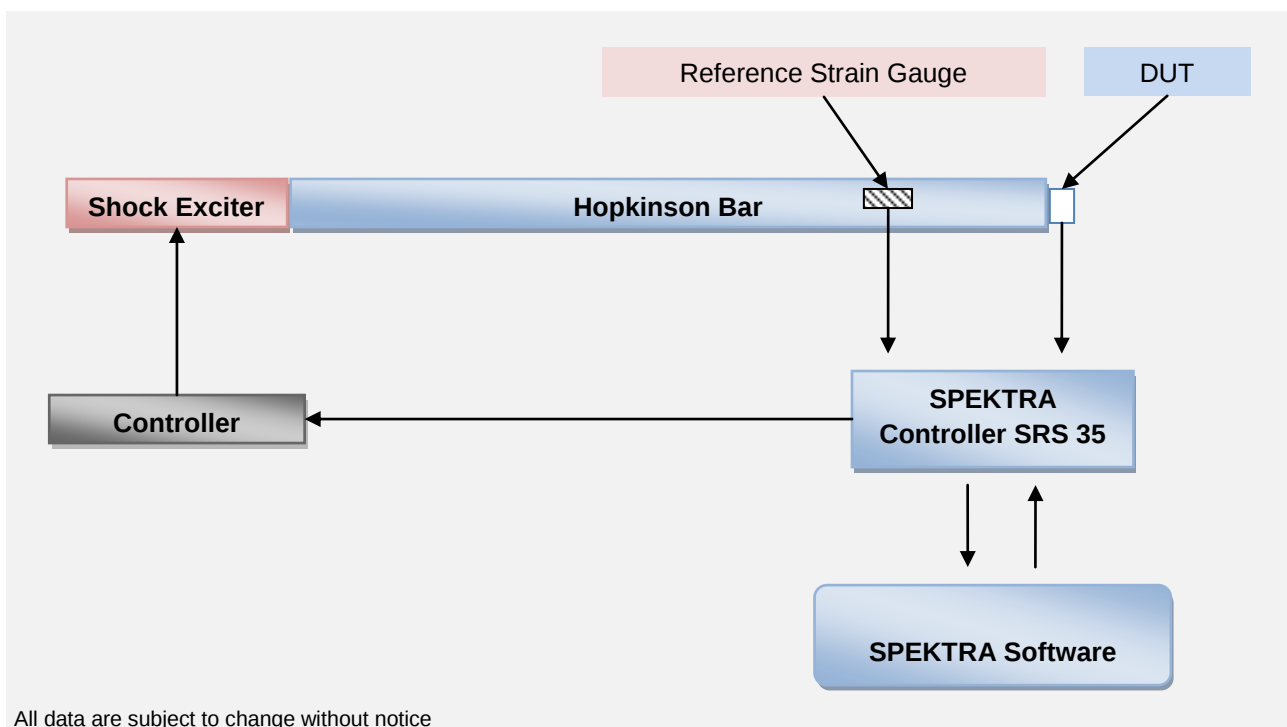
Shock Acceleration		10,000 g_n ... 200,000 g_n
Pulse Width PWFS / PWHS²⁾		typical 40 μs / 20 μs
Sensor Mass (DUT)		max. 15 gram
Uncertainty³⁾	10,000 g_n ... 20,000 g_n	< 3 %
	20,000 g_n ... 50,000 g_n	< 4 %
	50,000 g_n ... 100,000 g_n	< 5 %
	100,000 g_n ... 200,000 g_n	< 8 %

¹⁾ All data for environmental conditions: temperature 23°C ($\pm$ 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Air Supply		8 bar
Dimensions Hopkinson Bar	Length	approx. 3.5 m
	Height	0.8 m ... 1.2 m
	Width	approx. 1 m



All data are subject to change without notice

November 2013

CS18P MS

Primary Calibration System Medium-Shock



Applications

- **Primary calibration** of shock transducers as well as complete measuring instruments (measuring chain) with very high precision and efficiency, according to **ISO 16063-13**
- **Primary calibration** of **shock accelerometer reference standards**

Typical Users

- **National metrology laboratories** as highest measurement authorities
- **Accredited calibration laboratories**
- **Calibration laboratory departments** of industrial companies particular in automotive, aviation or space travel industry
- **Quality assurance** in sensor manufacturing

Features

- **Traceable** to **Physikalisch Technische Bundesanstalt (PTB)** Braunschweig by the accredited **SPEKTRA Calibration-Laboratory D-K-15183-01-00**
- **Broad amplitude range** from **2 g_n ... 5,000 g_n**
- Type of excitation: **sinusoidal shock, adjustable signal shape or burst**
- **Independent control** of amplitude and pulse width (within certain ranges, see table)
- **Excellent repeatability** of shock
- Sensor mass (DUT) up to **30 gram**
- Realization of **fully automatic calibrations** according to own test regime (up to 1 shock/s)
- **Calibration of sensors** with / without measuring amplifier and **measuring systems**
- **Direct connection of piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with software option **PR measurement**
- Integration of a **reference standard** for secondary calibration according to ISO 16063-22
- **Upgradeable** to a combined calibration system e.g. CS18P MS / HF

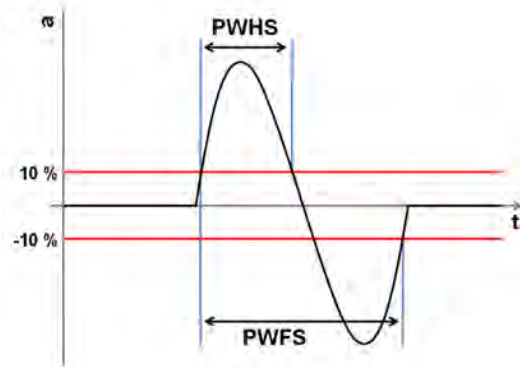
CS18P MS

Primary Calibration System Medium-Shock



Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-220 HOP-MS**
- Reference standard laser vibrometer **PLV-02**
- Reference standard **BN-02** for secondary calibration
- High speed **Data Acquisition System**
- **PA 14-500** power amplifier



Performance Specification Primary¹⁾

Max. sensor mass (DUT): 30 gram

Min. shock amplitude: 2 g_n

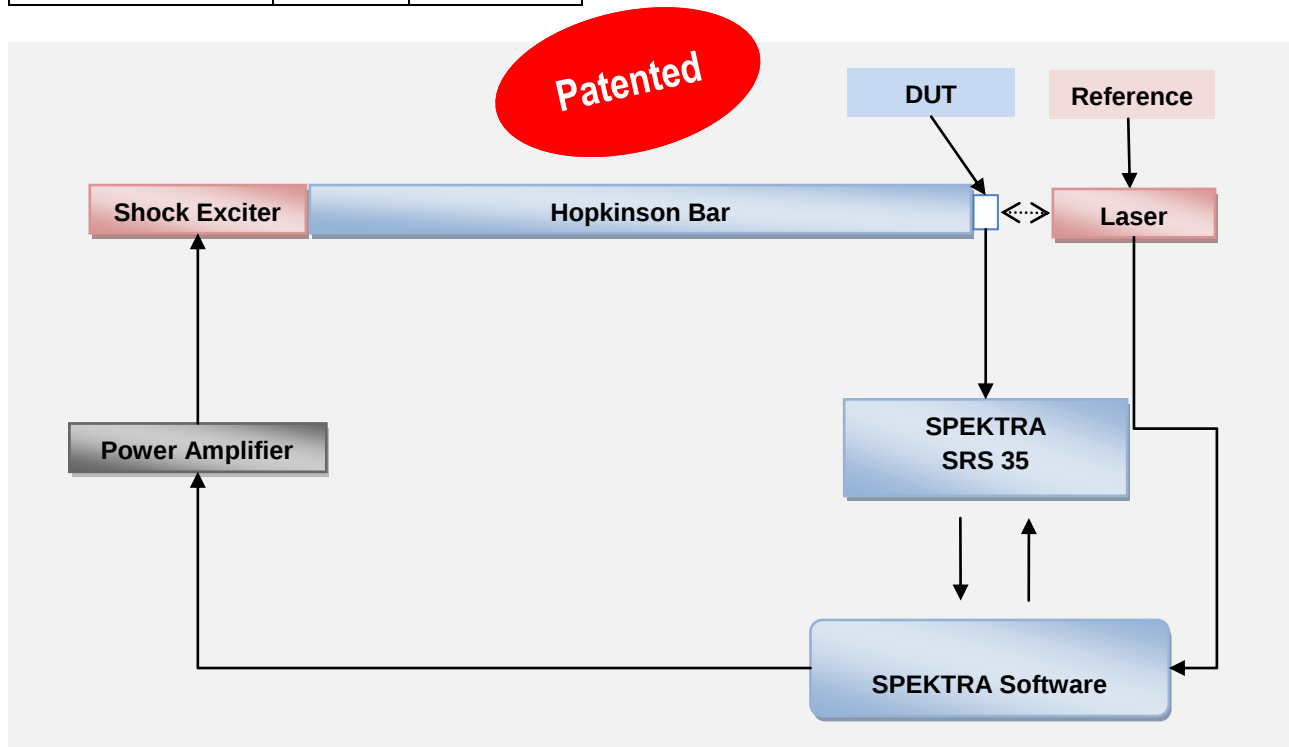
Shock Amplitude	Max. PWHS ²⁾	Max. PWFS ²⁾	Uncertainty ³⁾
2 g_n ... 20 g_n	200 μs	400 μs	< 3 %
20 g_n ... 250 g_n	200 μs	400 μs	< 1,5 %
20 g_n ... 550 g_n	125 μs	250 μs	< 1,5 %
20 g_n ... 1,000 g_n	100 μs	200 μs	< 1,5 %
20 g_n ... 4,000 g_n	60 μs	120 μs	< 2 %
20 g_n ... 5,000 g_n	40 μs	80 μs	< 2,5 %

¹⁾ All data for environmental conditions: temperature 23°C ($\pm$ 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Dimensions Hopkinson Bar	Length	approx. 2,5 m
	Height	approx. 1,3 m
	Width	approx. 0,5 m



All data are subject to change without notice

November 2013

CS18P HS

Primary Calibration System High-g-Shock



Applications

- **Primary calibration** of shock sensor transducers as well as complete measuring instruments (measuring chain) with very high precision and efficiency, according to **ISO 16063-13**
- Primary calibration of **shock accelerometer reference standards**

Range of Use

- **National metrology laboratories** as highest measurement authorities
- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel
- **Quality assurance** in sensor manufacturing

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration-Laboratory D-K-15183-01-00
- **Broad amplitude range to 75.000 g_n**, optionally up to **150.000 g_n** with High Speed Vibrometer
- Type of excitation: **sinusoidal shock**
- **Excellent repeatability** of shock
- Sensor mass (DUT) up to **30 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 20 shocks/min)
- **Calibration of sensors** with / without measuring amplifier and **measuring systems**
- **Direct connection of piezo-resistive sensors** through integrated **PR signal conditioner**
- Determination of **aptitude for calibration** (bridge resistance, offset, drift) of PR sensors in conjunction with Software option **PR measurement**
- Integration of a **reference standard** for secondary calibration according to ISO 16063-22
- **Upgradeable** to a combined calibration system e.g. CS18P HS / HF

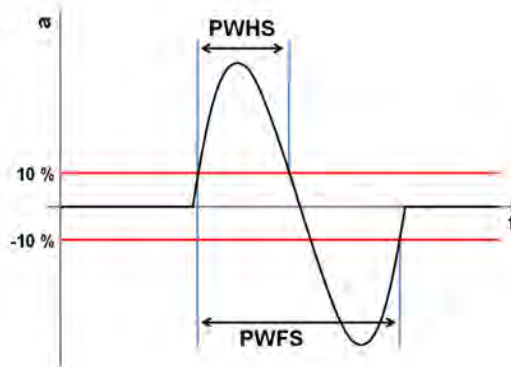
CS18P HS

Primary Calibration System High-g-Shock



Components

- Vibration control system **SRS-35** by SPEKTRA with integrated PR signal conditioner
- Shock exciter **SE-221 HOP-HS**
- Reference standard laser vibrometer **PLV-03**
- Reference standard for secondary calibration
- High speed **Data Acquisition System**



Performance Specification Primary ¹⁾

Shock Acceleration		1,000 g_n ... 75,000 g_n
Pulse Width PWFS / PWHS ²⁾		typical 50 μs / 25 μs
Sensor Mass (DUT)		max. 30 gram
Uncertainty ³⁾	1,000 g_n ... 2,000 g_n	< 2,2 %
	2,000 g_n ... 20,000 g_n	< 2,5 %
	20,000 g_n ... 50,000 g_n	< 2,8 %
	50,000 g_n ... 75,000 g_n	< 3,1 %
	75,000 g_n ... 150,000 g_n	< 5 % ⁴⁾

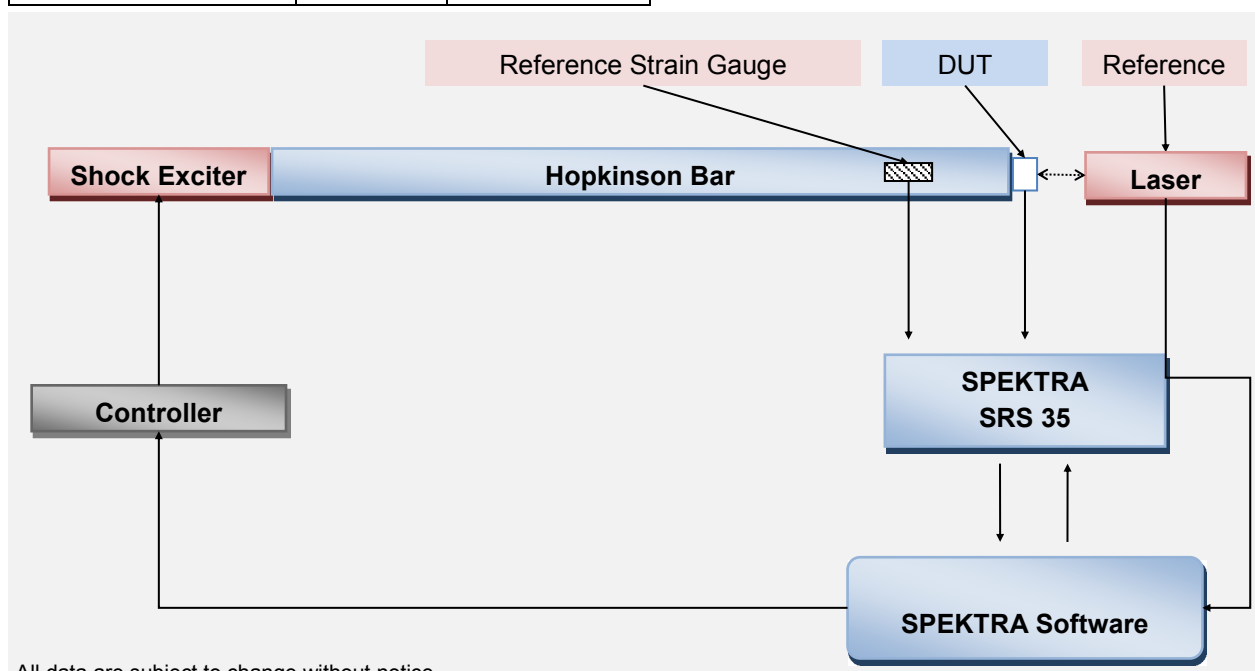
¹⁾ All data for environmental conditions: temperature 23°C ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

⁴⁾ with optional high speed vibrometer

Air Supply		8 bar
Dimensions Hopkinson Bar	Length	approx. 3.5 m
	Height	0.8 m ... 1.2 m
	Width	approx. 1 m



All data are subject to change without notice

June 2015

CS18 SPL-VLF

Calibration System SPL Very Low Frequency



Calibration of
pressure transducers,
measuring
microphones



Application

- Very low frequency calibration of pressure transducers and pressure measuring devices
- Pressure chamber secondary calibration of measuring microphones and microphone measuring chains

Range of use

- Calibration laboratories
- Departments of measuring instrument verification in research and industry, for example in the fields of automotive, aviation and space industry, military research, medical and environmental engineering, ...
- Quality assurance in manufacturing of pressure transducer and measuring microphones.

Features

- True **pressure chamber calibration** with an acoustic calibrator
- **Calibration** of pressure transducers
- **Calibration** of all established measuring microphones (capacitor and electrets microphones, ...)
- **No special mechanical adaptation** necessary
- **Complete exposition** of the test object to the pressure field
- **Supply** of an alternating sound pressure level for the calibration of dynamic pressure measuring chains and devices, in particular of sound level meters
- **Upgradeable** to a combined acoustical calibration system e.g. CS18 SPL / SPL-VLF or an CS18 FF / SPL-VLF

CS18 SPL-VLF

Calibration System SPL Very Low Frequency



Components

- Vibration control system **SRS-35**, SPEKTRA
- **SQ-03** Very-low-frequency pressure generator, SPEKTRA
- **PA14-80** Power amplifier, SPEKTRA
- Reference standards:
 - **BN-A-03** Acoustic calibrator pistonphone type **LS** (124 dB / 250 Hz)
 - **BN-A-04** pressure reference standard
- Standard-PC

Specification of CS18 SPL-VLF

for environmental conditions: temperature 23°C ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

Description	Calibration System CS18 for very low frequency sound pressure level
Size of pressure chamber	20 cm x 20 cm x 65 cm
Signal form	sinusoidal
Frequency range	0.1 Hz ... 31.5 Hz
Pressure range	10 Pa ... 32 Pa 114 dB ... 124 dB
Total harmonic distortion	up to ≤ 0.3 %
Measurement uncertainty ¹⁾	≤ 0.05 dB ≤ 0.5 %

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Calibration procedure:

- Calibration by the method of comparison with a reference standard pressure sensor
- Calibration by the method of comparison among the test objects

CS18 SPL

Calibration System Sound Pressure Level



Application

- Pressure chamber **secondary calibration** of measuring microphones acc. to **IEC 61094-5**
- Pressure chamber **secondary calibration** of sound level meters and sound level measuring chains according to **IEC 61672**
- Calibration of acoustic calibrators and pistonphones according to **IEC 60942**

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research and industry, for example test laboratories in the automotive field or in the aviation and space industry
- **Quality assurance** in manufacturing of microphones, sound level meters and dosimeters

Features

- Reference standards **traceable** to Physikalisch Technische Bundesanstalt Braunschweig (**PTB**) by the accredited SPEKTRA Calibration Laboratory D-K-15183-01-00 (**DAkkS Calibration Certificate**)
- True **pressure chamber calibration** with an acoustic calibrator
- **Calibration** of measuring microphones (capacitor and electret microphones in the sizes 1", 1/2" and 1/4")
- **Supply** of a sound pressure level for the calibration of sound level meters and measuring chains
- **Calibration** of acoustic calibrators
- **Upgradeable** to a combined acoustical calibration system e.g. CS18 SPL / FF, CS18 SPL / SPL-VLF



CS18 SPL

Calibration System Sound Pressure Level

Components (standard)

- Vibration control system **SRS-35**, SPEKTRA with system cables
- Active electro-acoustic coupler **SQ-4.2** for ½" Microphones and ¼" adapter
- Microphone / Calibrator holder fixture
- High-End Power amplifier with system cables
- Working standard microphone / calibrator:
 - GN-A-02** ½" condenser microphone **WS2P**, with ½" standard preamplifier and LS-Adapter
 - BN-A-02** acoustic calibrator class **LS**, (94 dB / 1,000 Hz and 114 dB / 1,000 Hz)
- Measurement uncertainty budget for microphone calibration

Optional reference standards (recommended)

- **BN-A-01** ½" condenser microphone **LS2P**, with ½" VIC (Voltage Insert Calibration) preamplifier
- **BN-A-03** Acoustic calibrator pistonphone type **LS** (124 dB / 250 Hz)

Optional calibration adapter and equipment:

- Calibration adapters for surface microphones
- Active electro-acoustic coupler **SQ-4.1** for 1" Microphones

Specification of CS18 SPL for the environmental conditions in the laboratory:

Temperature: 23°C (± 2°C), Relative humidity: 30 % ... 75 %, **Environmental noise: LZeq < 60 dB**

Type of Sound Field: Pressure Chamber			
Sound Pressure Level		94 dB, adjustable in the range of 64 dB ... 124 dB ²⁾	
Device under test	Frequency range / Sound pressure level	Expanded Uncertainty ¹⁾ Microphone calibration	Expanded Uncertainty ¹⁾ Sound level meter calibration
Calibration Method 1: comparison with Reference Standard Microphone and acoustic coupler			
Measuring Microphones with ½" Diameter, Sound Level Meters and Measuring Chains	31.5 Hz ... 5,000 Hz	0.20 dB	0.25 dB
	> 5,000 Hz ... 10,000 Hz	0.25 dB	0.30 dB
	> 10,000 Hz ... 16,000 Hz	0.45 dB	0.50 dB
Calibration Method 2: absolute calibration with Calibrator / Pistonphone			
Measuring Microphones with ½" Diameter, Sound Level Meters and Measuring Chains	250 Hz / 124 dB	0.20 dB	0.25 dB
	1,000 Hz / 94 dB	0.20 dB	0.25 dB
	1,000 Hz / 114 dB	0.20 dB	0.25 dB
Calibration Method 3: substitution method with the Reference Calibrator / Pistonphone			
Calibrators and Pistonphones	250 Hz / 124 dB	Approved acoustic Calibrators / Pistonphones (class 1 and 2): 0.15 dB	Other acoustic Calibrators and Pistonphones: 0.25 dB
	1,000 Hz / 94 dB		
	1,000 Hz / 114 dB		

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor)

²⁾ 94 dB sound pressure level is the preferred value. The maximum sound pressure level depends on the frequency (see datasheet of coupler)

Option for calibration system:

CLP - Temperature, Hygrometer and Air Pressure sensor with all automatic data transfer to the calibration system. This option is especially recommended if the system is operated with the additional reference standards (pistonphone and calibrator), in order to get the correction factors depending on the environmental conditions.

All data are subject to change without notice

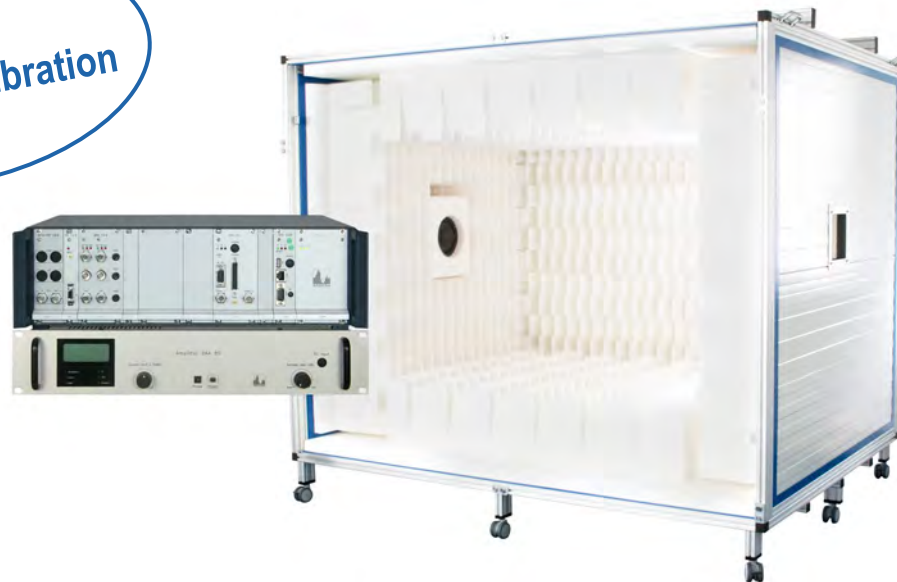
April 2016

CS18 FF

Calibration System Free Field



True
Free Field Calibration



Application

- **Secondary calibration** of measuring microphones, sound level meters and other acoustic sensors according to **IEC 61094-8** and **IEC 61672**
- **Periodic single qualification** according to **IEC 61672-3**
- **Calibration of calibrators** according to **IEC 60942**
- **Acoustical measurements** like:
 - Measurement of directivity characteristic
 - Determination of diffuse-field sensitivity
 - Measurement of acoustic emission of small objects
- **Calibration** of constructively mechanically **non-standard microphones**, e.g. external microphone units, optionally in axial and radial direction of measurement

Range of Use

- **Certified calibration laboratories**
- **Measuring instrument verification** in research and industry, for example civil engineering, aviation and automotive engineering
- **Quality assurance** in manufacturing of microphones and sound level meters

Features

- Reference standards **traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the SPEKTRA Calibration Laboratory D-K-15183-01-00 (DAkkS-calibration certificate)
- True **free-field calibration** in acoustically dead (anechoic) chamber
- **Calibration** of any measuring microphone (condenser, electrets, electro-dynamic etc.) with any construction with / without protection grid
- **Supply** of a defined free-field sound pressure level for the calibration of sound level meters
- **Calibration** of acoustic calibrators
- **Upgradable** to other calibration systems, e.g. CS18 FF / SPL or CS18 FF / SPL-VLF

CS18 FF

Calibration System Free Field



Components:

- Vibration control system **SRS-35** by SPEKTRA
- Power amplifier **PA 14-80** by SPEKTRA
- **Reference standards**
 - ½" condenser microphone cartridge class **LS2P** with ½" VIC (Voltage Insert Calibration) preamplifier
 - Sound acoustic calibrator class **LS**, (94 dB / 1,000 Hz and 114 dB / 1,000 Hz)
- **Working standards**
 - ½" condenser microphone cartridge class **WS2F** with preamplifier
- Microphone fixture, accessories, cables
- Standard-PC
- Dedicated transportable **acoustically dead (anechoic) chamber** by SPEKTRA, completely lined with wedge-shaped absorbers, with loudspeaker, for alternately holding the reference standard and test object, with small window for reading off the indications of compact sound level meters without electrical output channel

Specification of CS18 FF with reference standard microphones listed above

for environmental conditions: temperature 23°C (± 2°C) and relative humidity 30 % ... 75 % and environmental noise of the laboratory: **LZeq < 60 dB**

Anechoic Chamber	Outside Dimensions	2.00 m x 2.00 m x 2.40 m	
	Inside Dimensions	1.25 m x 1.25 m x 1.65 m	
Type of the Sound Field		Free field of plane progressive waves	
Calibration Method		Comparison with reference standard, substitution method	
Recommended Sound Pressure Level for calibration of microphones ²⁾		84.0 dB in the range of 125 Hz - 20 kHz at the calibration point (84 cm distance)	
Frequency Range and Expanded Uncertainty ¹⁾	Measuring Microphones with Different Diameter Measuring Chains with Separate Microphones	125 Hz ... < 250 Hz	0.35 dB
		250 Hz ... 8,000 Hz	0.30 dB
		> 8,000 Hz ... 10,000 Hz	0.40 dB
		> 10,000 Hz ... 20,000 Hz	0.45 dB
Recommended Sound Pressure Level for calibration of sound level meters ²⁾		84,0 dB in the range of 125 Hz - 200 Hz 94,0 dB in the range of 200 Hz - 10 kHz 84,0 dB in the range of 10 kHz - 20 kHz at the calibration point (84 cm distance)	
Frequency Range and Expanded Uncertainty ¹⁾	Sound Level Meters with Microphone Mounted Directly to the Body of the Sound Level Meter	125 Hz ... < 250 Hz	0.50 dB
		250 Hz ... 8,000 Hz	0.40 dB
		> 8,000 Hz ... 10,000 Hz	0.50 dB
		> 10,000 Hz ... 20,000 Hz	0.60 dB

Electrical calibration of sound level meter:

Electrical Tests		Supply of electrical input signal for the electrical tests according to IEC 61672-3, ED1	
Input Signal and Expanded Uncertainty ¹⁾	Sound Level Meters, Measuring Systems	4 kHz tone burst (0.25 ms ... 1 s)	0.20 dB
		C-weighted peak level	0.20 dB
		Level linearity, Frequency weighting, overload indication	0.20 dB

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement) with k = 2 (coverage factor)

²⁾ Recommended sound pressure level for best stability and lowest uncertainty. Higher sound pressure levels are possible (not included in table).

List of References



Calibration Systems CS18, Vibration and Shock Exciters

National Laboratories and Governmental Organizations

BAST – Bundesanstalt für Straßenwesen (Germany)
Beijing Orient Institute of Metrology & Test (China)
CEM – Centro Español de Metrologia (Spain)
CENAM – Centro Nacional de Metrologia (Mexico)
CESTA – Centre d'études scientifiques et techniques d'Aquitaine (France)
CMI – Czech Metrology Institute (Czech Republic)
Eidgenössisches Institut für Metrologie METAS (Switzerland)
FTZ – Forschungs- und Technologiezentrum Deutsche Bahn AG (Germany)
Guangxi Metrology (China)
GUM – GŁÓWNY URZĄD MIAR (Poland)
IM2 – Instituto de Innovación en Minería y Metalurgia (Chile)
KEBS – Kenya Bureau of Standards (Kenya)
KRISS - Korea Research Institute of Standards and Science (South Korea)
National Institute of Metrology (Thailand)
National Institute of Metrology (China)
NPL National Physical Laboratory (INDIA)
PTB Physikalisch Technische Bundesanstalt (Germany)
SIMT Shanghai Institute of Measurement and Testing Technology (China)
STQC – Standardisation Testing and Quality Certification (India)
TSU Technicky Skusobny Ustav Piestany (Slovakia)
TTAI TÜV Rheinland TNO Automotive International B.V. (Netherlands)
TUEV SUED CZ Praha (Czech Republic)

List of References



Automotive Industry Customers

Ashok Leyland (India)
AUDI AG (Germany)
BMW AG (Germany)
Changan Automobile Company Ltd. (China)
Conti TEMIC microelectronic GmbH (Germany)
Daimler AG (Mercedes-Benz) (Germany)
DENTON COE (Germany)
Ford Werke AG (Germany)
Humanetics (USA)
Jinheng Automotive Safety Technology Holdings (China)
Magna Steyr Fahrzeugtechnik AG & Co KG (Austria)
MAN Nutzfahrzeuge AG (Germany)
NTSEL - National Traffic Safety and Environment Laboratory (Japan)
PMG (Canada)
Shanghai Volkswagen (China)
Skoda Auto (Czech Republic)
Takata Petri AG (Germany)
TIANJIN – Auto (China)
TRW Automotive (Germany)
Valeo Klimasysteme GmbH (Germany)

Universities

Leibnitz University Kühlungsborn (Germany)
Peoples Friendship University (Russia)
Sichuan University (China)
Technical University Madrid (Spain)
University Brno (Czech Republic)
University Rostov on Don (Russia)

List of References



Aerospace and Defense

ADD Agency for Defense Development (South Korea)
Airbus Toulouse (France)
CASSIDIAN (Germany)
DSTO Defense Science and Technology Organization (Australia)
EADS Astrium (France)
Eurocopter Deutschland GmbH (Germany)
European Aeronautic Defense and Space Company (multiple countries in Europe)
IABG - Test Organization for the military air- and aerospace industry (Germany)
MTU Aero Engines GmbH (Germany)
NavAir - Naval Air Systems Command (USA)
Rolls Royce Aero Engines (Germany)
Sandia National Laboratories (USA)
Wehrtechnische Dienststelle für Kraftfahrzeuge und Panzer (Germany)

Sensor producer Customer

AIS GmbH (Germany)
ASC GmbH (Germany)
Beijing Electrical Institute (China)
DMT GmbH (Germany)
Jiangyin Electric (China)
Kistler (multiple countries in Europe and Asia)
MSI – ENTRAN (France)
MSI Measurement Specialties Inc. (China)
MSI Measurement Specialties Inc. (USA)
SHS Schmitt-Hofmann Systems GmbH (Germany)
Siemens AG Bad Neustadt (Germany)
X-FAB Semiconductor Foundries AG (Germany)

List of References



Other Industrial Customers

Adams Technologies Private LTD. (India)
CEV - TEK Ltd. Sti. (Turkey)
Deutsche Bahn AG (Germany)
esz AG calibration & metrology Eichenau (Germany)
Hanwha Corporation Gumi Plant (South Korea)
ITD Kinding (Germany)
Kalibrier-Dienst-Saliger (Germany)
POONGSAN FNS CORPORATION (South Korea)
Robert Bosch GmbH (Germany, Czech Republic)
Sarov Labs (Russia)
Siemens AG (Germany)
Testo industrial services GmbH Kirchzarten (Germany)
Trescal GmbH (Germany)
Trescal (France)

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January 2014

CS18 Optional Extras

Overview



In its standard configuration, every CS18 calibration system is optimized for a specific practical application. Its performance, however, can be extended by means of optional extras.

On customer's demand, dedicated options can be compiled and offered with the system.

Software-Options	
TEDS	Calibration of sensors with integrated electronic data sheet (IEEE P1451.4) Reading and writing of calibration data in TEDS-modules of ICP [®] -sensors. In combination with the option PR this can also be used for piezo-resistive sensors.
Data Base	Data Base Connection Basic package of CS18 Software for connection to a sensor or measuring instruments data base of customers, plus individual adaptation charged on T&M basis
CSDB	Data Base Interface to a Microsoft[®] SQL Server Safe and comfortable storage / retrieval of sensor and calibration data (including test configurations) by means of a SQL-Server
PHASE	Phase-calibration, Determination of angle of phase difference Phase-calibration of sensors; in conjunction with optional extra CAL-Q-U-ICP [®] also applicable to charge and voltage amplifiers
CAL-Q-U-ICP[®]	Calibration of gain magnitude of signal conditioners (incl. CAO reference capacitors) Calibration of gain magnitude of charge, voltage and ICP [®] amplifiers; can also be used in conjunction with optional extra PHASE to determine the phase shift of charge and voltage amplifiers
MS-C	Multi-sine calibration of sensors Reduced calibration time by simultaneous excitation of several frequencies
Hardware-Options	
CS18 ZK-STD	Accessories Case for CS18 Acceleration Calibration Systems Contains, amongst others, numerous mounting adapters, a torque wrench, electrical adapters ... When equipping a new calibration laboratory this case should always be included as basic equipment.
CS18 ZK-HOP	Accessories Case for CS18(P) HS Contains, amongst others, replacement projectiles for the SE-221 HOP-HS, sensor cables, hearing protection ... When installing a CS18(P) HS, this case should always be included as basic equipment.
PR	Integrated signal conditioner allowing direct connection of piezo-resistive sensors Programmable sensor power supply to PR sensors and VC types; includes software for the measurement of electrical parameters of PR sensors (bridge resistors, zero drift etc.)
Sensor Supply	Integrated signal conditioner for sensor supply of VC types
Mobil	Transportation trolley or case for on-site calibration Available for CS18 Secondary Calibration Systems except for the VLF
PRIMUS	Hardware and software addendum to primary calibration according to ISO 16063-11 For upgrading a secondary system - type CS18 HF or CS18 VLF
TRANS	Option to determine the transversal transfer coefficient as a function of operating angle for CS18 VLF systems, measurement of transfer coefficient as a function of angle and frequency, a valuable tool to determine the cross sensitivity of sensors
Other Options	
AMC	Annual Maintenance Contract This contract includes the annual recalibration of a CS18 system, the recalibration of a reference standard accelerometer, software updates for all supplied working modes and extended support.
MUB	Determination and compilation of an individual measurement uncertainty budget in the framework of supplying a CS18 calibration system The MUB will be determined at the customer's site for the respective mode of operation and type of equipment by tests and investigations at the final place of operation

All data are subject to change without notice

January 2014

CS18 Optional Extra

CAL-Q-U-ICP®



Application

- Calibration of charge, voltage and ICP® amplifiers;
in conjunction with the optional extra PHASE also applicable to PHASE calibration of signal conditioners

Range of Use

- Certified calibration laboratories
- Departments of measuring instrument verification in research and industry
- Quality assurance in sensor manufacturing

Feature

- Frequency range 0.2 Hz ... 50 kHz

**Electrical
Calibration of
Signal Conditioners**

Performance Parameter

Charge Amplifier:

Frequency Range		Expanded Measurement Uncertainty ¹⁾ of the Transfer Coefficient Amplitude / Phase ²⁾	Measuring Range (Peak Value)
From	To		
0.2 Hz	< 1 Hz	0.5 % / 0.75°	1 pC ... 10 nC
1 Hz	5,000 Hz	0.4 % / 0.5°	
> 5,000 Hz	10,000 Hz	0.4 % / 1.0°	
> 10,000 Hz	20,000 Hz	0.6 % / 2.0°	
> 20,000 Hz	50,000 Hz	1.0 %	

Voltage and ICP® Amplifier:

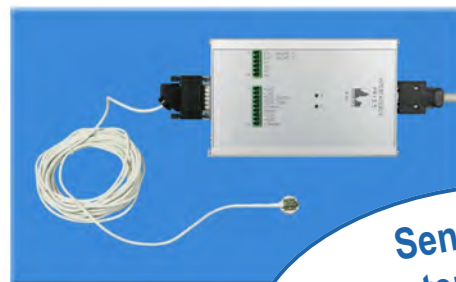
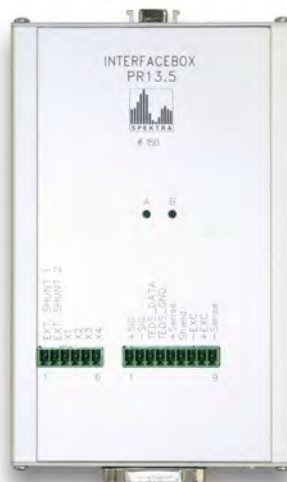
Frequency Range		Expanded Measurement Uncertainty ¹⁾ of the Transfer Coefficient Amplitude / Phase ²⁾	Measuring Range (Peak Value)
From	To		
0.2 Hz	< 1 Hz	0.4 % / 0.75°	10 mV ... 10 V
1 Hz	20,000 Hz	0.3 % / 0.5°	
> 20,000 Hz	50,000 Hz	1.0 %	

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor)

²⁾ Only valid in combination with the optional extra PHASE

CS18 Optional Extra

PR Measurement (PR-M®)



Sensor
Characterization of
Piezo-Resistive
Sensors

Applications

- **PR signal conditioner** power supply of piezo-resistive (bridge), variable capacitance and similar sensors used with the CS18 calibration system

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research, development and industry, particularly in **automotive crash test laboratories**
- **Quality assurance** in sensor manufacturing

Features

- **Calibration** of piezo-resistive sensors
- Determination of **aptitude for calibration** (bridge resistance, offset, offset drift) of PR sensors in conjunction with software **PR measurement**
- Measurement of **input and output resistance**
- **Static calibration** in the local earth gravity field ($\pm 1 g_n$)

CS18 Optional Extra

PR Measurement (PR-M®)



Components

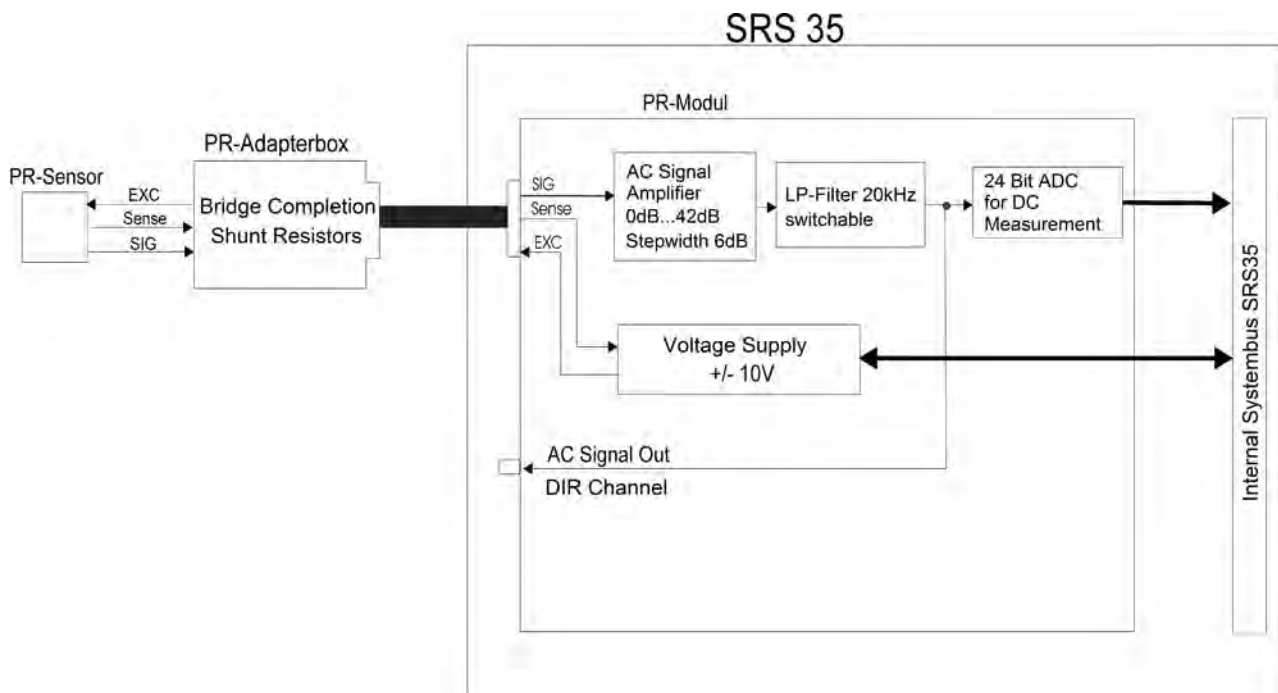
- Plug-in module to CS18 vibration control system **SRS-35**
- External connecting box for individual sensor adaptation
- Software for determining the electrical aptitude for calibration of PR sensors (measurement of bridge resistance, offset and offset drift, offset compensation, shunt calibration, isolation test)

Technical Specification PR Module

Bridge Power Supply	4-wire or 6-wire technique
Voltage Range	-10 V _{DC} ... 0 V _{DC} ... +10 V _{DC} , adjustable
Current	max. 100 mA
Bridge Completion	resistors for completing a quarter or half bridge can be integrated in a
Shunt Resistors	2 units can be integrated in a connecting box,
Amplifier	0 ... 42 dB
Gain Steps (DC)	factors to be set by software: 1, 2, 4, 8, 16, 32, 64, 128
Offset	offset measurement and offset compensation can be performed

Options for the PR Module

- Individual external connection boxes
- TEDS for PR sensors
- Sensor identification module



All data are subject to change without notice

January 2014

CS18 Optional Extra

Sensor SUPPLY internal



Voltage supply for
special sensors

Applications

- Provides proper connection of several kinds of sensors to a voltage input of a measurement device (here: CS18 VCU). Sensor is plugged in at input. Signal output is connected to CS18 VCU input. Provides DC supply voltage(s) for sensor and performs signal preconditioning

Range of Use

- Certified Calibration laboratories
- Departments of **measuring instrument verification** in research, development and industry, particularly in **automotive crash test laboratories**
- **Quality assurance** in the sensor manufacturing

Features

- Supply of typical **supply voltage** for sensors
- **short-circuit-proof** power supply
- **Pre-conditioning** of the sensor output signal
- Impedance converter
- Optional DC reject high pass 0.01 Hz
- Custom made design for several types of sensor

CS18 Optional Extra

Sensor SUPPLY internal



Components

- Plug-in module for CS18 vibration control system **SRS-35**, SPEKTRA
- Sensor In socket, Signal Out socket, Indicator LEDs

Sensor supply		
Voltage Range	Unipolar:	+15 V _{DC} , +/- 2% (Type D,P,K) or custom made + 5 V _{DC} ...+ 15 V _{DC} Bipolar: +15 V _{DC} , -15 V _{DC} , +/- 2% (Type E) or custom made +/- 5 V _{DC} ... +/- 15 V _{DC}
Current	max. 100 mA (polyfuse-protected)	
Options and Parameters		
Balanced differential input (Type D, E, K)	Gain (0 - 5 kHz):	1 +/- 0.02%
	Gain (0 - 10 kHz):	1 +/- 0.05%
	Gain (0 - 20 kHz):	1 +/- 0.2%
	Gain (0 - 50 kHz):	1 +/- 1% (U _{imax} =1 V)
	Signal Delay:	0.4 μs (typical) (<=20 kHz; 20 ... 50 kHz, 1V)
	Voltage range:	+/-10 V _{peak}
Grounded input (Type P)	Gain (0 - 10 kHz):	1 +/- 0.02%
	Gain (0 - 50 kHz):	1 +/- 0.1%
	Signal Delay:	0.2 μs (typical)
	Voltage range:	+/-10 V _{peak}
Common	Input impedance	10 MOhm
Sample sensors	Type P (+15 V _{DC}):	PCB 3701_ (grounded input)
	Type D (+15 V _{DC}):	Dytran 7500A_ (differential input)
	Type K (+15 V _{DC}):	Kistler 83_ (differential input)
	Type E (+15 V _{DC}):	Endevco 7290A (differential input)

Optional extras for the sensor supply

- 1 to 4 channels
- Individual customer-specific connectors and connector pin assignments
- Customized sensor supply voltage(s)

Also available as VCU plug in module „Sensor SUPPLY external“

See also PR-Module for bridged piezo resistive sensors

CS18 Optional Extra

Sensor SUPPLY external



Description

While ICP (IEPE) and charge type sensors can be directly connected to the input of the CS 18 vibration control unit (VCU), other types of sensors like capacitive or bridge type sensors need their own power supply and signal preconditioning. The external power supply adapts those sensors to the CS18 and other measurement devices. It provides a power supply of one or two voltages, performs an impedance conversion, changes a differential to an unipolar signal and optionally removes a DC (e.g. caused by gravitation) from the signal.

The sensor is plugged into the input and the ready made signal comes out at the output. As there are many different kinds of sensors, which need different conditions and options, SPEKTRA offers custom made versions of sensor supply for most common sensors. Because also the pin assignment of the sensor plug may be different, several wiring adaptors can be provided on request.

Applications

- Provides proper connection of several kinds of sensors to a voltage input of a measurement device (here: CS18 VCU). Sensor is plugged in at input. Signal output is connected to CS18 VCU input. Provides DC supply voltage(s) for sensor and performs signal preconditioning

Range of Use

- Certified Calibration laboratories
- Departments of **measuring instrument verification** in research, development and industry, particularly in **automotive crash test laboratories**
- **Quality assurance** in the sensor manufacturing

Features

- Supply of typical **supply voltage** for sensors
- **short-circuit-proof** power supply
- **Pre-conditioning** of the sensor output signal
- Impedance converter
- Optional DC reject high pass 0.01 Hz
- Custom made design for several types of sensor

CS18 Optional Extra

Sensor SUPPLY external



Components

- Sensor supply box in a small metal case.
- Sensor In socket, Signal Out socket, Indicator LEDs
- Wide range mains power supply

Sensor supply		
Voltage Range	Unipolar:	+17 V _{DC} , +/- 2% (Type D,P,K) or custom made + 5 V _{DC} ...+ 17 V _{DC} Bipolar: +17 V _{DC} , -13 V _{DC} , +/- 2% (Type E) or custom made +/- 5 V _{DC} ... +/- 15 V _{DC}
Current	max. 100 mA (polyfuse-protected)	
Options and Parameters		
Balanced differential input (Type D, E, K)	Gain (0 - 5 kHz):	1 +/- 0.02%
	Gain (0 - 10 kHz):	1 +/- 0.05%
	Gain (0 - 20 kHz):	1 +/- 0.2%
	Gain (0 - 50 kHz):	1 +/- 1% (U _{imax} =1 V)
	Signal Delay:	0.4 μs (typical) (<=20 kHz; 20 ... 50 kHz, 1V)
	Voltage range:	+/-10 V _{peak}
Grounded input (Type P)	Gain (0 - 10 kHz):	1 +/- 0.02%
	Gain (0 - 50 kHz):	1 +/- 0.1%
	Signal Delay:	0.2 μs (typical)
	Voltage range:	+/-10 V _{peak}
Common	Input impedance	10 MOhm
Sample sensors	Type P (+17 V _{DC}):	PCB 3701_ (grounded input)
	Type D (+17 V _{DC}):	Dytran 7500A_ (differential input)
	Type K (+17 V _{DC}):	Kistler 83_ (differential input)
	Type E (+17 V _{DC}):	Endevco 7290A (differential input)

Optional extras for the sensor supply

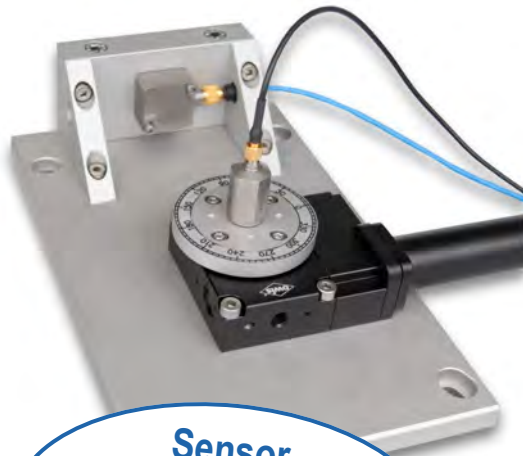
- Individual customer-specific connectors and connector pin assignments
- Customized sensor supply voltage(s)
- High pass 0.01 Hz

Also available as VCU plug in module „Sensor SUPPLY internal“

See also PR-Module for bridged piezo resistive sensors

CS18 Optional Extra

TRANS for CS18 VLF (primary and secondary)



**Sensor
Characterization
Transverse Sensitivity**

APS 500



APS 129



Application

Type CS18 TRANS is the practical implementation of a system for determining the transversal transfer coefficient as a function of operating angle according to ISO 16063-31.

In this system, the angular actuator is remote-controlled by a step motor. Thus the measurement of $S_T(\varphi, f)$ as a function of angle and frequency can be carried out all-automatically.

The system is offered under the trade name CS18 TRANS as an optional extra to a type CS18 VLF Calibration system. It is intended for operation in conjunction with an APS 129 or APS 500 air bearing long-stroke vibration exciter in the frequency range between 2 Hz and 50 Hz.

Features

Excitation in transversal direction is accomplished by means of an air bearing slide table. As a result, both frequency and vibration amplitude (acceleration or displacement) can be set at will or varied continuously within certain limits.

- Due to its step motor, rotation can be controlled precisely in steps, but also continuously.
- Extremely low interferences, e.g. transverse vibrations due to the minor mass of construction

CS18 Optional Extra

TRANS for CS18 VLF (primary and secondary)



Components

- Precision board to mount the angular actuator
- Angular actuator with sensor-mounting board
- Position control for the angular actuator
- Operation mode „Measurement of transverse sensitivity“ for CS18 Software
- Reference standard ATS-7 for installation and periodic verification of angular actuator

Specifications

Measuring device for determining the transverse sensitivity according to ISO 16063-31

Given that the transverse sensitivity of exciter is < 0.1 % in direction of main sensitivity of DUT, the following measurement uncertainties apply:

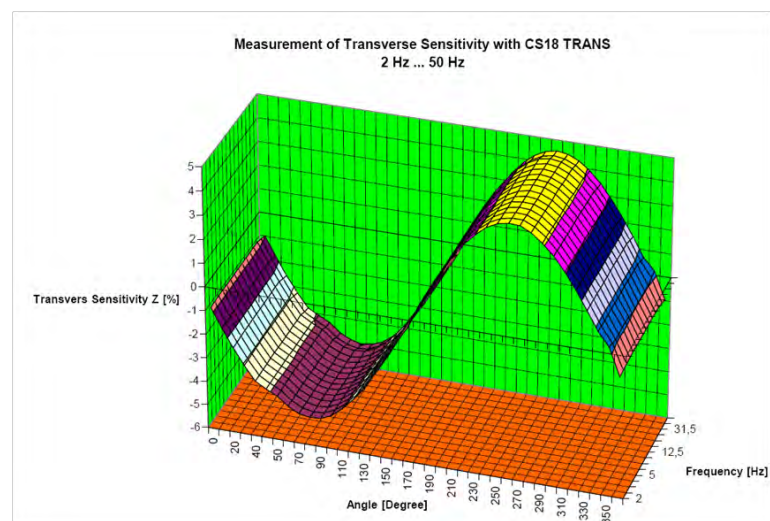
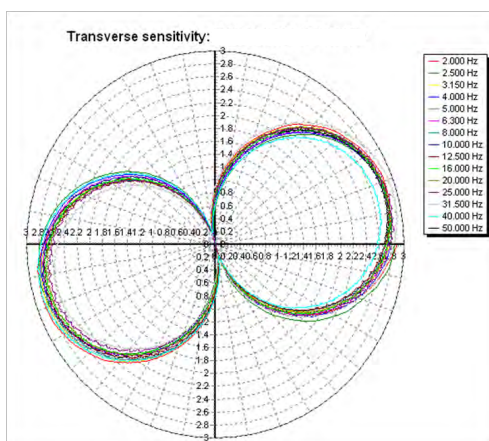
Frequency Range		Weight of DUT ³⁾	Expanded Measurement Uncertainty ¹⁾ Relative Transverse Sensitivity ²⁾	PEAK-Acceleration in m/s ²	
from	to	up to		min.	max.
2 Hz	25 Hz	200 gram	0.3 %	1	2 - 10
> 25 Hz	50 Hz	50 gram	0.5 %		10

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement) with k = 2 (coverage factor)

²⁾ Reference value for interval width of given relative Measurement Uncertainty (e.g. 0.3%) is not the measurement value, as usual (in this case the relative transverse sensitivity), but the dynamic sensitivity of the DUT in direction of main sensitivity at same frequency.

³⁾ Higher weight of DUT possible on demand

The following figures show different illustrations of the relative transverse sensitivity.



All data are subject to change without notice

March 2014

CS18 ZK-STD

Accessories Case for Calibration Systems



* Areas that contain optional accessories (in addition to the standard version) are marked red

Application

For the effective calibration of accelerometers in the laboratory, it is necessary to have an assortment of standard accessories. This assortment is supplied with the accessories case CS18 ZK.

This case contains all important accessories that you may need for the calibration of accelerometers of most of the well-known manufacturers (like Endevco, Brüel & Kjaer, Metra, Kistler, PCB or Dytran). This applies as well for sine calibration systems as for all shock calibration systems except for the CS18 HS for which we offer a separate accessories case.

The accessories case CS18 ZK-STD includes amongst other things:

- Different relevant thread adapters needed for attaching a device under test to a back-to-back sensor or calibration exciter as well as the relevant wrenches for doing so
Moreover the bag contains the means and aids for attaching a device to the reference sensor etc. other than by screwing and means for fastening the sensor cable as well as equipment to avoid damages.
- Sensor cables, cable adaptors and cable mounting clips
- Screw tap and sliding caliper
- Necessary devices needed for a thorough calibration

CS18 ZK-STD

Accessories Case for Calibration Systems



Components of the SPEKTRA Calibration-Accessories Case:

Pos.	Quantity	Name
1	1	Accessories case
Accessories for the mechanical mounting of sensors		
2	19	Diverse mounting bolts, threads, Allen wrench (metric / imperial)
3	1	Special adapter for assembling PR sensors such as Endevco 7264C
4	1	Torque wrench up to max. 4 Nm
5	7	Special nuts for Torque wrench sizes: 9/32", 1/2", 3/4", 1-3/16", 16 mm, 17 mm , 22 mm
6	3	Duple wrenches acc. DIN 3110; sizes: 16/17", 18/19", 30/32"
7	2	Combination wrenches acc. DIN 3113; sizes: 3/4", 1-3/16"
Accessories for the electrical connection of sensors		
8	9	Diverse BNC-Adapter, Couplings, T-connectors, BNC-plug ↔ banana plug and jack
9	2	Adapter: Microdot ↔ BNC, Microdot ↔ TNC
10	1	Sensor cable; Microdot ↔ Microdot (1.5 m)
11	1	Sensor cable; Microdot ↔ BNC (1.5 m)
12	1	Sensor cable; Microdot ↔ TNC (1.5 m)
Additional additives		
13	1	Adapter plate with adapters and test threads, metric and imperial
14	2	Screwdriver
15	1	Screw tap acc. DIN 371, 10-32 UNF
16	1	Sliding caliper
17	1	Cutting knife
18	6	Additives: super glue, wax, acetone, duct tape, Vaseline
19	various	Useful small parts for mounting cables and sensors

Pos.	Quantity	Name
Version 1 - Optional Accessories		
20	1	SAM-066
21	2	Threaded rod 10-32 x 120
22	4	Screw nut 10-32
23	1	Spanner 3/8"
Version 2 - Optional Accessories		
22	1	SAE-102
23	2	Adapter, Screws 0-80
Version 3 - Optional Accessories		
24	1	Temperature– and Moisture meter

All data are subject to change without notice

February 2016

CS18 ZK-HOP

Accessories Case for HOP-HS



Application

For the effective calibration of accelerometers in the laboratory, it is necessary to have an assortment of standard accessories. This assortment will be supplied with the accessories case CS18 ZK-HOP.

This bag is containing all important accessories which you may need for the calibration of Shock accelerometers.

The accessories case CS18°ZK-HOP amongst other things contains:

- Replacement projectiles for the HOP-HS
- Tools to replace the projectiles
- Tools to attach and remove shock sensors
- Sensor cables, extending cables, cable adaptors, cable connectors, and cable mounting clips
- Hearing Protections
- Necessary devices for a correct calibration work

CS18 ZK-HOP

Accessories Case for HOP-HS



Components of the SPEKTRA Calibration-Accessories Case:

Pos.	Quantity	Name
1	1	Accessories case
Accessories for Maintenance		
2	10	Projectiles
3	1	L-Key Hex 5 mm
4	1	Wrench DIN 3113, 13 mm
Accessories for the electrical connection of sensors		
5	5	Diverse BNC-Adapter, Couplings, T-connectors
6	2	Adapter: Microdot ↔ BNC, Microdot – TNC
7	2	Adapter: TNC-Male ↔ BNC-Female, TNC-Female – BNC-Male
8	1	Sensor cable; Microdot ↔ Microdot (1.5 m)
9	1	Sensor cable; Microdot ↔ BNC (1.5 m)
10	1	Sensor cable; Microdot ↔ TNC (1.5 m)
Additional additives		
11	1	Cutting Knife
12	3	Glue, Mounting Wax, Acetone, Labels
13	Div.	Useful parts for mounting sensors and cables
14	Set	Earplugs
15	1	Earmuff

Calibrator CV-01

Handheld Shaker



Application

- Quick, simple and mobile in-field inspection/ calibration of vibration transducers
- Easy in-field inspection of sensor wirings of machines
- Quick and easy error search on vibration measurement chains of machines

Application Fields

- Calibration laboratories
- All industrial branches
- Engineering offices
- Educational institutions

Features

- Including international recognized DAkkS-calibration certificate
- 16 mm diameter of the coupling area for an optimal linkage of the DUT
- Sensor mounting with 1/4" - 28 thread
- Suitable for DUT masses up to 150gram
- Tare weight of 950gram allows a very reliable calibration because of the high reaction mass
- Very easy to use
- Automated switch-off after 60s and manual adjustable continuous operation
- Rugged calibrator housing for highest reliability
- Practical, ruggedized transportation case
- Included accessory:
 - Mounting Stud 1/4-28 to 1/4-28
 - Mounting Stud 1/4-28 to 10-32
 - Adhesive Mounting Base 1/4-28 to Hex 3/4"
 - 8 batteries
- Comprehensive accessory optional available (check accessory list)

Calibrator CV-01

Handheld Shaker



Page 2 of 3

Description

The handheld shaker CV-01 is a high quality measurement device from SPEKTRA. Its technical details like the large coupling area and the rough housing are featuring this calibrator as well as its extensive accessory. The well balanced reaction mass leads to a good mass ratio to the weight of the DUT whereby up to 150 g heavy transducers can be reliably tested. Nevertheless the calibrator is still quite handy. That allows a very wide range of applications.

The voltage supply is ensured by 4 AA batteries. The calibrator as well as its complete accessory is delivered in a practical and ruggedized transportation case. In addition each calibrator is calibrated by SPEKTRA before its delivery and gets an internationally recognized DAkkS calibration certificate.

Technical Data:

Frequency	159,15 Hz $\pm 0,02\%$	1000 rad/s $\pm 0,02\%$
Acceleration	10 m/s ² $\pm 2\%$	1,02 g $\pm 2\%$
Velocity	10 mm/s $\pm 2\%$	0,39 in/s $\pm 2\%$
Displacement	10 μ m $\pm 2\%$	0,39 mil $\pm 2\%$
Temperature range	-10 °C...+55 °C	15 °F...130 °F
Max. Payload	150 g	5,3 oz
Max. Torque for mounting of transducers	0,5 Nm	4,4 lbf in
Diameter of the coupling area	16 mm	0,63 in
Length of the calibrator	180 mm	7,1 in
Diameter of the calibrator	58 mm	2,3 in
Weight of the calibrator	950 g	33,5 oz
Dimensions of transport case	240 mm x 280 mm x 105 mm (LxWxH)	9,5 in x 11 in x 4,1 in (LxWxH)
Transverse amplitude	<5% of main axis amplitude	
Distortion	<3%	
Signal duration	60 s (Automatic switch-off), continuous operation (manual selectable)	
Warm-up time	5 s	
Mounting thread	1/4"-28 UNF	
Power supply	4x Mignon (AA) - Batteries	

Calibrator CV-01

Handheld Shaker



Page 3 of 3

Optional Accessory:

Order Code	Description
V081070002	Adhesive Mounting Base Hex 3/4"
V081070003	Adhesive Mounting Base Hex 1-3/16"
V081070004	Mounting Stud 1/4-28 to 10-32
V081070005	Mounting Stud 1/4-28 to 1/4-28
V081070006	Mounting Stud 1/4-28 to M5
V081070008	Mounting Stud 1/4-28 to M6
V081070031	Mounting Stud 1/4-28 to M8
V081070044	Mounting Stud 1/4-28 to 5-40
V081070046	Mounting Stud 1/4-28 to M3
V081070020	Mounting Adapter 1/4-28 to M2,5 (F) - Hex 3/4"
V081070021	Mounting Adapter 1/4-28 to M3 (F) - Hex 3/4"
V081070022	Mounting Adapter 1/4-28 to M4 (F) - Hex 3/4"
V081070023	Mounting Adapter 1/4-28 to 2-56 (F) - Hex 3/4"
V081070024	Mounting Adapter 1/4-28 to 5-40 (F) - Hex 3/4"
V081070025	Mounting Adapter 1/4-28 to 10-32 (F) - Hex 3/4"
V081070026	Mounting Adapter 1/4-28 to M5 (F) - Hex 3/4"
V081070028	Mounting Adapter 1/4-28 to M6(F) - Hex 3/4"
V081070032	Bushing 1/4-28 to M2,5
V081070033	Bushing 1/4-28 to M3
V081070034	Bushing 1/4-28 to M4
V081070036	Bushing 1/4-28 to 2-56
V081070037	Bushing 1/4-28 to 5-40
V081070038	Bushing 1/4-28 to 6-32
V081070039	Bushing 1/4-28 to 10-32
V081079004	Mounting Adapter 1/4-28 to M2,5 (M) - Hex 3/4"
V081079005	Mounting Adapter 1/4-28 to M3 (M) - Hex 3/4"
V081079006	Mounting Adapter 1/4-28 to M4 (M) - Hex 3/4"
V081079007	Mounting Adapter 1/4-28 to 2-56 (M) - Hex 3/4"
V081079008	Mounting Adapter 1/4-28 to 5-40 (M) - Hex 3/4"
V50300001	Sensor Cable Microdot - Microdot 1,5m; also available in 3m and 5m
V50300007	Sensor Cable Microdot - BNC 1,5m; also available in 3m and 5m
V50300017	Sensor Cable Microdot - TNC 1,5m; also available in 3m and 5m

Cable adapters and customized mounting adapters on request.

All data are subject to change without notice

December 2016

SQ-4.2

Electro-Acoustic Coupler



Application

- Pressure chamber **secondary calibration** of microphones according to **IEC 61094-5**
- Pressure chamber **secondary calibration** of sound level meters and sound level measuring chains according to **IEC 61672**

Range of Use

- **Certified calibration laboratories**
- Departments of **measuring instrument verification** in research and industry, for example test laboratories in the automotive field or in the aviation and space industry
- **Quality assurance** in manufacturing of microphones, sound level meters and dosimeters

Advantages

- Wide **frequency range** **31.5 Hz ... 16 kHz**
- Low **distortion**, even at low frequencies
- High sound pressure level up to 124 dB
- Symmetric very small pressure chamber

Features

- True **pressure chamber calibration** with an acoustic coupler
- **Calibration** of measuring microphones (capacitor and electrets microphones in the sizes 1/2" and with adapter 1/4")
- **Supply** of a sound pressure level for the calibration of sound level meters and measuring chains
- **Frequency range**
SQ-4.2, 1/2": 31.5 Hz ... 16 kHz
- **Sound pressure level**
64 dB ... 124 dB
- Including Microphone fixture unit
- Including High-End Power Amplifier
- **On request:** solution for 1" microphones available

SQ-4.2

Electro-Acoustic Coupler



System components

- SQ 4.2 active electro-acoustic coupler
- Microphone holder fixture
- High-End Power amplifier
- System cable

Optional reference standards (recommended):

- 1/2" condenser microphone cartridge type **LS2P** or **WS2P** with amplifier
- LS-Adapter (open grid for WS2P Microphone)

Optional calibration adapter:

- Calibration adapter for surface microphones
- Calibration adapter for ear simulators

Soundfield:	Pressure chamber	
Frequency range:	31.5 Hz ... 16 kHz	
Maximum electrical power of the sound source:	0.5 W	
Distortion factor at 94 dB (31,5 Hz ... 1 kHz):	< 3% (THD)	
Stability at 94 dB:	< 0.2 dB	
Diameter of Microphones	1/2" and with adapter 1/4"	
Maximum sound pressure level:	31.5 Hz ... < 63 Hz	104 dB
	63 Hz ... < 250 Hz	114 dB
	250 Hz ... 1.6 kHz	124 dB
	> 1.6 kHz ... 6.3 kHz	104 dB
	> 6.3 kHz ... 16 kHz	74 dB

Typical measurement uncertainty of a microphone calibration with LS2P:

- For environmental conditions: temperature 23°C (± 2°C) and relative humidity 30 % ... 75 %
- Measurement uncertainties determined with SPEKTRA calibration system CS18 SPL

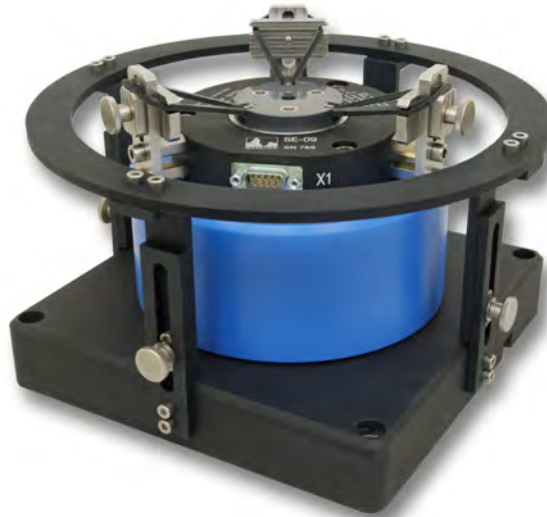
Calibration Method		Comparison calibration	
Sound pressure level		94 dB ²⁾ up to 6.3 kHz	
Typical expanded Uncertainty Frequency Range ¹⁾	Measuring Microphones with Diameter 1/2" Sound Level Meters and Sound Level Measuring Chains	31.5 Hz ... 5 kHz	0.20 dB
		> 5 Hz ... 10 kHz	0.25 dB
		> 10 kHz ... 16 kHz	0.50 dB

¹⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with k = 2 (coverage factor)

²⁾ 94 dB sound pressure level is preferred. Stated values of expanded uncertainty apply to this level.

SE-09

Calibration Vibration Exciter for High Frequencies



Application

- **Primary calibration** of vibration sensors according to **ISO 16063-11**
- **Secondary calibration** of vibration sensors, calibrators and meters with very high quality and performance according to **ISO 16063-21** (comparison calibration)
- Calibration of **reference standard transducers**
- **Resonance frequency search up to 50 kHz**
- Testing of **micro-mechanic sensors** (MEMS)

Range of use

- **Accredited calibration laboratories** with outstanding quality demands
- Departments of measuring instrument verification in **research and industry**
- **Quality assurance** in sensor manufacturing
- **National Metrological Institutes** as highest metrological authorities (in combination with CS18P)

Description

The SE-09 is a high-tech product, which is the result of extensive theoretical and practical examinations. It is designed specially for the usage in calibration laboratories and in national institutes. A significant result of this examinations is the appearance of the first axial head resonance above 52 kHz. In combination with the used internal reference standard accelerometer a true usable frequency range of 50 kHz appears.

Features

- **Air bearing** with ceramic armature
- **Very high first axial head resonance frequency** (> 52 kHz)
- **Very high acceleration amplitudes** (up to 40 g_n)
- **Insignificant Transverse motions** according to ISO 16063-21
- Usable frequency range up to **50 kHz**
- Usable displacement 8 mm (pk-pk)
- Maximum mass of DUT **350 gram**
- Extreme wear resistant **ceramic armature** with defined small electrical conductivity (**ESD characteristics**)
- **Internal high frequency reference accelerometer** (ICP[®]-type, sensitivity about 10 mV / g_n)

SE-09

Calibration Vibration Exciter for High Frequencies



The drive of the shaker is electro dynamic. All components of the drive are designed for high performance. With acceptable temperature rise of the shaker, high acceleration amplitudes can be created.

Low transverse motions on a defined small mechanical base noise can be reached because of specially designed air bearings. Because of the application of top performance materials (armature made from technical ceramic, drive with high-performance magnets) and the optimized form of construction the shaker has a very high power density. The result is a lightweight shaker with small dimensions.

In combination with a reference laser vibrometer – instead of the internal reference accelerometer – the shaker can be used for class 1 primary vibration calibration systems like the CS18P HF

Components

- Internal reference accelerometer, HF- quartz shear ICP® accelerometer
- Basis mass
- Cable holder

Technical Data

Vibration Exciter		
Force Rating ^{1) 2)}	100 N	
Frequency Range	5 Hz ... 50.000 Hz	
Resonance Frequency	> 52 kHz	
Max. Stroke (peak-peak) ^{1) 2)}	8 mm	
Max. Velocity	0.5 m/s	
Max. Acceleration ^{1) 2)}	40 g _n	
Max. Payload	350 gram	
Transverse Motion	typical 5 Hz...10 kHz, < 5 %; 10 kHz...50 kHz < 10 %	
Max. Current Input	9 A rms	
Air Pressure Required	1 bar ... 4 bar; typ. 2 bar	
Total Weight	ca. 7 kg	
Working Temperature Range	23°C (± 2 K)	73.4°F (± 2 K)
Storage Temperature Range	-25°C bis +55°C	-13°F ... +131°F
Data of the Internal Reference Accelerometer ^{1) 3)}		
Sensitivity (± 10 %)	1 mV / m/s ² (10 mV / g _n)	
Frequency Range	3 Hz ... 50 kHz	
Amplitude Linearity	< 0,25%	
Resonance Frequency	ca. 70 kHz	
Excitation Voltage	18 V _{DC} ... 30 V _{DC}	
Constant Current Excitation	2 mA ... 20 mA	
Output Bias Voltage	8 V _{DC} ... 12 V _{DC}	
Discharge Time Constant	0.5 sec ... 2.0 sec	
Settling Time (Within 10% of Bias)	< 5 sec	
Connectors		
Sensor	Cable 2 m with BNC plug 10-32 fixed connected	
Shaker	Cable 3 m with Speakon [®] plug	

¹⁾ Interval mode of operation

²⁾ Recommended operation range; mechanical stop at 10 mm

³⁾ All specifications are at room temperature unless otherwise specified.

Recommended Power Amplifier: **PA 14-500**

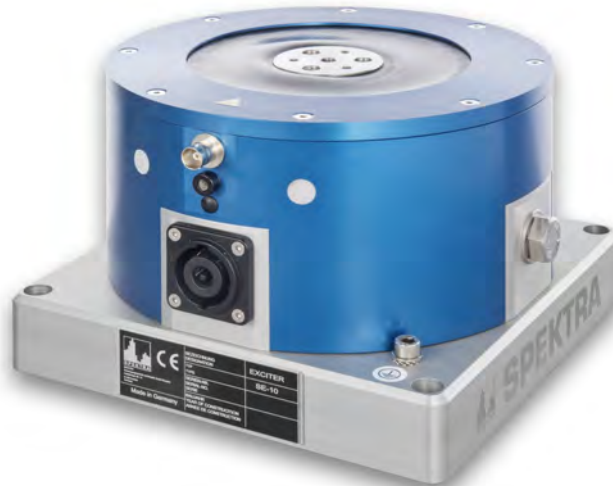
Recommended optional extra: Remote shut-down

All data are subject to change without notice

January 2015

SE-10

Vibration Exciter



Application

- **Vibration testing** in research and development
- **Modal analysis** / Excitation of structures
- **Calibration** of vibration sensors, motion transducers and calibrators
- **Quality Assurance** in sensor manufacturing
- **Educational** demonstrations

Features

- **Light-weight aluminum armature with rugged stainless steel table surface**
- **Efficient electro-dynamic drive**
- **Guidance system with low transverse motions** (according to ISO 16063-21)
- **Force Rating 100 N**
- Usable **Frequency Range** DC up to **10 kHz**
- **High first axial Resonance Frequency** (> 12 kHz)
- **High acceleration amplitudes** (up to 60 g_n)
- Effective **displacement 10 mm** (0.39 in pk-pk)

SE-10

Vibration Exciter



Page 2 of 3

Description

The vibration exciter SE-10 with a flexural guidance system is a high-tech product that is a reliable tool for vibration testing in research and development as well as for daily use in calibration laboratories.

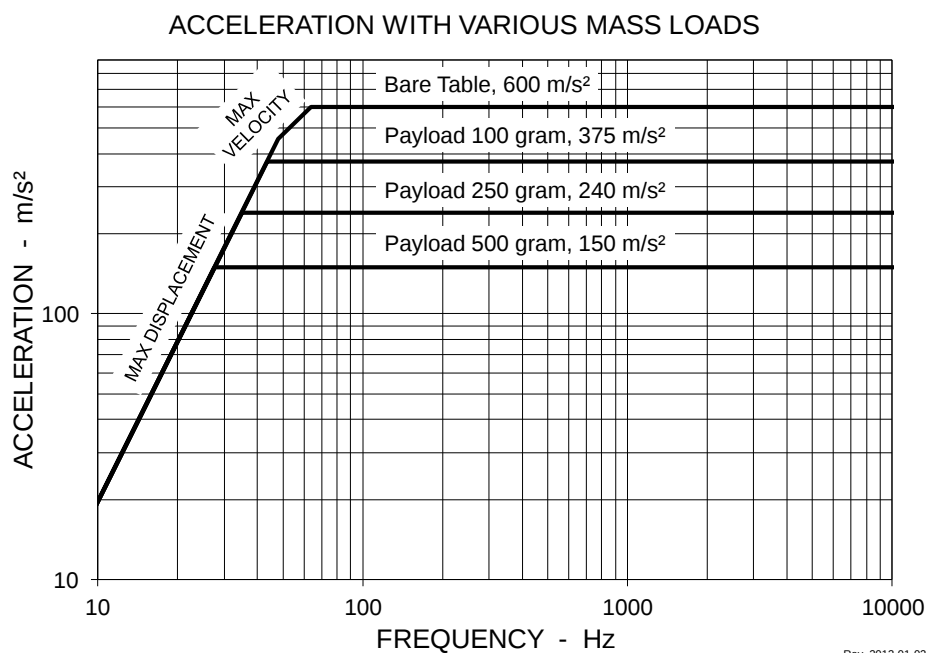
A force rating of 100 N and the high acceleration amplitudes of up to 60 g_n allow for a wide range of applications in vibration tests.

The rugged design, light armature and well-aligned guidance system (with low transverse motions, high radial and low axial stiffness) make the SE-10 a very good choice for the excitation of structures in modal testing.

Users of the SE-10 in calibration laboratories appreciate the faster calibration cycle times with low measurement uncertainties in the frequency range of 3 Hz to 10 kHz - made possible by the optional internal reference standard accelerometer.

Performance

The possible performance charts for vibration measurements with different payloads are exemplified in the following diagram.



Option: Trunnion

for angular operation



SE-10

Vibration Exciter



Page 3 of 3

Technical Data

Vibration Exciter	
Force Rating ¹⁾	100 N (22 lbf)
Frequency Range	DC (3 Hz) ⁴⁾ ... 10 kHz
Axial Resonance Frequency	> 12 kHz
Max. Stroke ²⁾	10 mm (0.39 in)
Max. Velocity	1,5 m/s (59 in/s)
Max. Acceleration ¹⁾	600 m/s ² (60 g _n)
Moving Element Weight	165 gram (0.36 lb)
Max. Payload	500 gram (1.10 lb)
Transverse Motion	typical 3 Hz...7 kHz, < 10 %; 7 kHz...10 kHz, < 25 %
Max. Current Input ¹⁾	13 A rms
Total Weight	9,5 kg (21 lb)
Working Temperature Range	5°C ... +40°C (41°F... 104°F)
Storage Temperature Range	-25°C ... +55°C (13°F... 131°F)
Connectors	
Vibration Exciter	8-pin Speakon®
Sensor ⁴⁾	BNC

Options and Accessories

Internal Reference Standard BN-09 ³⁾	
Sensitivity (± 10 %)	1 mV / m/s ² (10 mV / g _n)
Frequency Range	3 Hz ... 50 kHz
Resonance Frequency	approx. 70 kHz
Excitation Voltage	18 V _{DC} ... 30 V _{DC}
Constant Current Excitation	2 mA ... 20 mA
Output Bias Voltage	8 V _{DC} ... 12 V _{DC}
Discharge Time Constant	0,5 s ... 2,0 s
Settling Time (Within 10 % of Bias)	< 5 s
Amplifier PA 14-180	
Handles	
Trunnion	
	0° - 90°

¹⁾ Interval mode of operation

²⁾ Recommended operation range; mechanical stops at 12 mm (0.47 in)

³⁾ All specification are at room temperature unless otherwise specified

⁴⁾ With the optional internal reference standard accelerometer

SE-11

Vibration Exciter for High Frequencies



Application

- Cross sensitivity testing of small components or sensor with true monoaxial excitation

Range of use

- Development and Test of MEMS Sensors
- Quality assurance in sensor manufacturing

Features

- Ceramic armature with coupling surfaces on the side
- Very high first axial head resonance frequency (> 52 kHz)
- high acceleration amplitude (up to 400 m/s²)
- Very low cross motion typical < 10 % ³⁾
- Usable frequency range from 2 kHz to 50 kHz
- Extreme wear resistant ceramic armature
- Internal high frequency reference accelerometer (ICP[®]-type, sensitivity about 10 mV / g_n)

Description

The SE-11 is a high-tech product, specially designed for cross sensitivity testing of small components or sensors. The DUT can be fixed on the side of the armature. Due to the special design of the armature the DUT can be excited with nearly no cross motion ³⁾ in the frequency range between 2 kHz and 50 kHz.

The drive of the shaker is electro dynamic. All components of the drive are designed for high performance. With acceptable temperature rise of the shaker, high acceleration amplitudes can be created.

Because of the application of top performance materials (armature made from technical ceramic, drive with high-performance magnets) and the optimized form of construction the shaker has a very high power density. The result is a lightweight shaker with small dimensions.

SE-11

Vibration Exciter for High Frequencies



Technical Data

Components

- Internal reference accelerometer
- Basis mass

Vibration Exciter		
Force Rating ^{1) 2)}	100 N peak	
Frequency Range	1 kHz ... 50 kHz	
Resonance Frequency	> 52 kHz	
Max. Stroke ^{1) 2)}	20 µm	
Max. Acceleration ^{1) 2)}	400 m/s² peak	
Max. Payload	10 gram	
Transverse Motion ³⁾	typical less than 10 % between 2 kHz...50 kHz	
Max. Current Input	9 A rms	
Total Weight	9 kg	
Working Temperature Range	23°C (± 2 °C)	73.4°F (± 4 °F)
Storage Temperature Range	-25°C ... +55°C	-13°F ... +131°F
Data of the Internal Reference Accelerometer ²⁾		
Sensitivity (± 10 %)	1 mV / m/s² (10 mV / g _n)	
Frequency Range	2 Hz ... 50 kHz	
Amplitude Linearity	< 0,25%	
Resonance Frequency	ca. 70 kHz	
Excitation Voltage	18 V _{DC} ... 30 V _{DC}	
Constant Current Excitation	2 mA ... 20 mA	
Output Bias Voltage	8 V _{DC} ... 12 V _{DC}	
Discharge Time Constant	0.5 sec ... 2.0 sec	
Settling Time (Within 10% of Bias)	< 5 sec	
Connectors		
Sensor	Cable 3 m with BNC plug 10-32 fixed connected	
Shaker	Cable 3 m with Speakon® plug	

¹⁾ Interval mode of operation

²⁾ All specifications are at room temperature unless otherwise specified

³⁾ Bending vibration at 43 kHz, higher transverse motion

Recommended Power Amplifier: **PA 14-500**

SE-13

Calibration Vibration Exciter for Low Frequencies



Patent pending

The **SE-13** Air Bearing shaker is an electrodynamic force generator specifically designed to be used for calibration and evaluation of accelerometers and other motion transducers in vertical direction. It provides excellent properties for low frequency excitation of such devices. The model consists of a large air bearing load mounting table that allows high payloads up to 50 kg (110 lb) e.g. for the calibration of geophones and heavy seismic sensors.

Applications

- Primary Calibration (according to ISO 16063-11) of low frequency accelerometers
- Secondary Calibration (according to ISO 16063-21) of low frequency accelerometers
- Seismic simulation of components
- Calibration of reference sensors

Typical DUT

- Heavy seismic sensors (seismometers, geophones)
- Sensors for measurement of vibration immission (DIN 45669)

Features

- 500 N force ¹⁾
- Frequency range: DC ... 400 Hz
- Unique frictionless support system carries up to 50 kg (110 lb) test load
- Efficient electrodynamic drive for sine, random or transient signals
- Air bearing guidance provides excellent waveform purity
- Very low cross motion according to ISO 16063-21
- Large mounting surface: Ø 350 mm

SE-13

Calibration Vibration Exciter for Low Frequencies



Technical Data

Vibration Exciter	
Force Rating ^{1) 2)}	500 N
Frequency Range	DC (0.2 Hz) ³⁾ ... 400 Hz
Max. Stroke ³⁾	25 mm
Max. Velocity ¹⁾	300 mm/s
Max. Acceleration ^{1) 2)}	60 m/s ² peak
Max. Current Input ²⁾	9 A rms
Operation	vertical
Moving Element Weight	8 kg
Max. Payload	50 kg (110 lb)
Table Size	Ø 350 mm
Air Pressure Required	4.0 ... 5.0 bar
Air Flow Required	800 l/h (0.48 cfm)
Air Quality	ISO 8573.1 Class 3
Total Weight	70 kg
Working Temperature	23°C (± 2 K)
Storage Temperature	-25°C ... +55°C
Connectors	
Vibration Exciter: drive	8-pin Speakon [®] plug
Vibration Exciter: compressed air	Air pipe Ø 6 mm
Attachment of Device under Test (DUT)	Thread holes M6 on 100 mm centers

¹⁾ Peak sine

²⁾ Interval mode of operation

³⁾ Recommended operation range peak-peak; mechanical stop at 32 mm (1.3 in)

⁴⁾ With the optional internal reference standard accelerometer

Accessories

Recommended power amplifier	APS 125
Standard mechanical adapter (incl. magnetic field shield)	V081100001
Customized mechanical adapter	On request

SE-13

Calibration Vibration Exciter for Low Frequencies



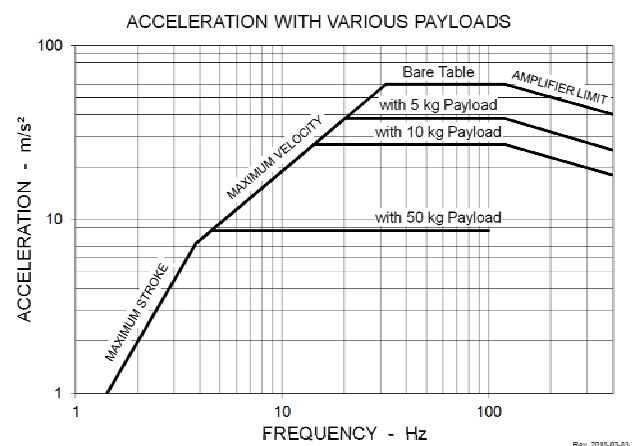
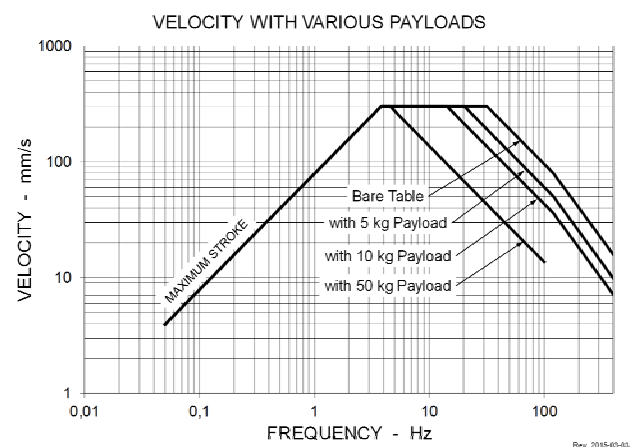
Performance

Test loads of up to 50 kg (110 lb) can be driven to velocity levels typical of those found in seismic specifications. Performance envelopes of the SE-13 shaker are given in the graphs below. These envelopes represent the maximum velocity and acceleration for various test loads that can be achieved on the table.



Application example: Calibration of a typical seismic sensor using the SE-13:

Seismowave CP ZM-500: 11 kg, 0.1...100 Hz



All data are subject to change without notice

April 2016

SE-14

Vibration Exciter



Typical Applications

- **Vibration testing** in research and development
- **Calibration** of acceleration and velocity sensors (e.g. sensors for machine diagnostics)
- **Modal testing** / Excitation of structures
- **Quality assurance** in sensor manufacturing
- **Educational** demonstrations

Features

- Wide frequency range **0 Hz ... 8 kHz**
- High acceleration amplitudes up to **500 m/s²**
- Steel-aluminum-ceramics compound **armature**
- Rugged steel table surface
- **High first axial resonance at 9 kHz**
- **Low temperature increase** of exciter table
- **Stray magnetic field** at table surface < 1 mT
- Max. payload (vertical / horizontal): 2 kg / 1 kg
- **Displacement 20 mm** (Peak - Peak)
- **Internal reference standard** (optional)
- **Current and voltage monitor** output
- **Amplifier state outputs** for integration in testing systems

Description

The SE-14 is a high-tech product that is a reliable tool for vibration testing in research and development as well as for daily use in calibration laboratories. It was especially designed to test and calibrate heavier acceleration and velocity sensors (e.g. sensors for machine diagnostics) over a wide frequency range. Its flexural guidance system perfectly supports sensors with an asymmetric housing or with heavy and stiff cables, without a loss in signal quality. High acceleration amplitudes of up to 500 m/s^2 and a payload capacity of up to 2 kilograms allow for a wide range of applications in vibration tests as well.

Regarding calibration, the SE-14 comes up with two features which will set a new standard for the calibration quality:

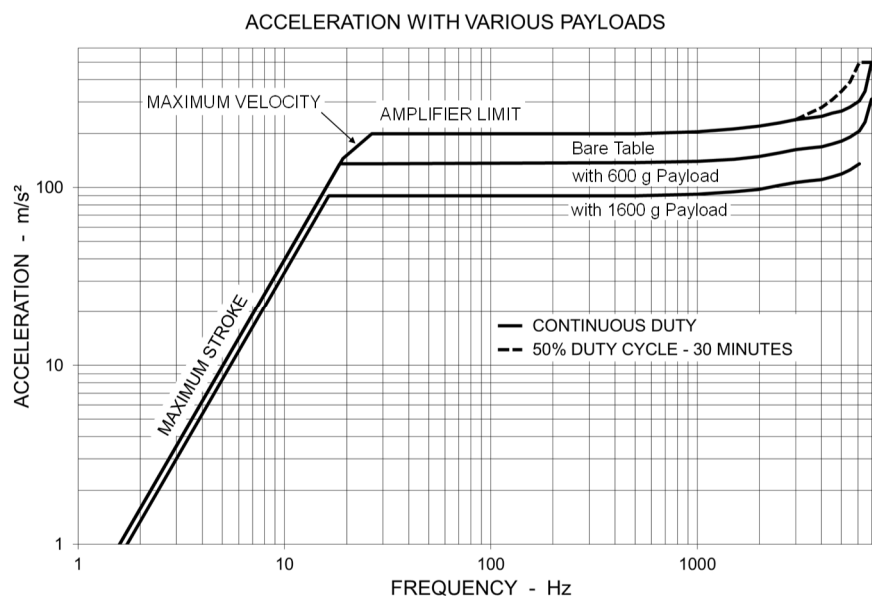
- The vibration exciter armature is made from a compound of ceramics, aluminum and steel, minimizing the heat transfer from the driving coil to the exciter's table surface. During a calibration run or vibration test even at higher levels, there will be no significant temperature rise on the table surface.
- The vibration exciter housing consists of a magnetic shielding, which keeps the stray magnetic field from the permanent magnet system inside of the housing. As a result, the stray magnetic field on top of the table is less than 1 mT. Especially velocity sensors, using an electrodynamic principle, will not be affected from the stray magnetic field during the calibration.

Users of the SE-14 in calibration laboratories also appreciate the faster calibration cycle times with low measurement uncertainties in the frequency range of 3 Hz to 8 kHz - made possible by the optional internal reference standard accelerometer.

Useful safety functions (e.g. temperature/current and over travel control) are already integrated and are visualized on the amplifier's multi function display.

Performance

The possible performance charts for vibration measurements with different payloads are exemplified in the following diagram. Those performance charts are based on operation of the SE-14 with its recommended power amplifier APS 145.



SE-14

Vibration Exciter



Page 3 to 4

Technical Data

Vibration Exciter ¹⁾	
Force Rating ²⁾	80 N (0 Hz to 0.1 Hz) 265 N (above 0.1 Hz)
Frequency Range	0 Hz ... 8 kHz
Axial Resonance Frequency	Bare table: 9 kHz With 300 g payload: > 8 kHz
Max. Stroke ³⁾	20 mm
Max. Velocity	1.2 m/s
Max. Acceleration ²⁾	500 m/s ²
Moving Element Weight	1,3 kg
Max. Payload (vertical / horizontal)	2 kg / 1 kg (more load possible on request)
Transverse Motion (typical)	< 4 kHz: < 10 % 4 kHz ... 8 kHz: < 20 %
Rated Current ²⁾	13 A rms
Stray Magnetic Field	< 1.2 mT on vibration exciter table
Table Size	Ø 65 mm (customization on request)
Dimensions (H x W x L) ⁴⁾	270 x 320 x 320 mm
Weight	45 kg
Carrying Handles (removable)	2
Working Temperature Range	5°C ... 40°C
Storage Temperature Range	-25°C ... 55°C
Recommended Power Amplifier APS 145	
Max. Voltage Output	45 V RMS, 0 Hz ... 15 kHz
Monitor Output	Voltage monitor: 0.1 V/V Current monitor: 0.1 V/A
Power Requirements	Single phase 100 V / 120 V / 230 V RMS, ± 10 %, 50 Hz ... 60 Hz (factory presetting) approx. 1,500 VA at full load
Dimension (H x W x L)	132 (3 U) x 483 x 451 mm prepared for rack mounting
Weight	22 kg
System Cable 0082-6E	
Length	6 m
Connector	8-pin Speakon®

All specification are at room temperature unless otherwise specified

¹⁾ All specification are based on operation of the vibration exciter with its recommended power amplifier

²⁾ Continuous duty

³⁾ Recommended operation range peak-peak; mechanical stops at 22 mm

⁴⁾ without carrying handles

SE-14

Vibration Exciter



Page 4 of 4

Options and Accessories

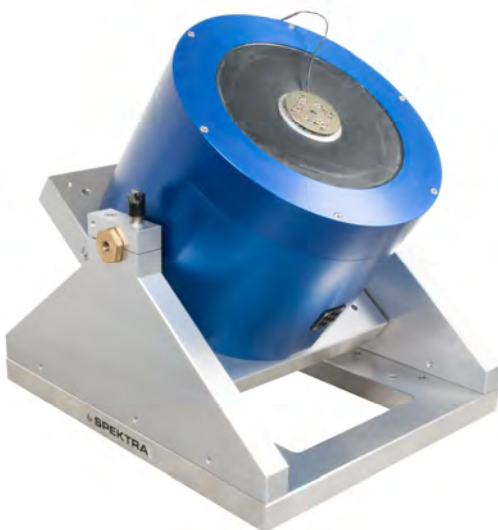
Internal Reference Standard BN-09 (optional)	
Sensitivity ($\pm 10\%$)	1 mV / m/s ² (10 mV / g_n)
Frequency Range (with SE-14)	3 Hz ... 50 kHz
Resonance Frequency	approx. 70 kHz
Excitation Voltage	18 V _{DC} ... 30 V _{DC}
Constant Current Excitation	2 mA ... 20 mA
Output Bias Voltage	8 V _{DC} ... 12 V _{DC}
Discharge Time Constant	0.5 s ... 2.0 s
Settling Time (Within 10 % of Bias)	< 5 s
Connector	BNC Jack on vibration exciter housing
Accessories	
Trunnion Base	08504-0001

All specification are at room temperature unless otherwise specified

Trunnion Base

When choosing the best shaker location for tests, the Trunnion Base allows the shaker to be set up in a wide tilt angle range.

Additional adjustable stops at 0° and 90° allow for a quick and easy change between vertical and horizontal operation with good repeatability. Especially for calibration laboratories this can be a useful feature.



All data are subject to change without notice

November 2016

SE-16

Vibration Exciter for High Frequencies



Application

- High-frequency vibration excitation of small components and sensors in the longitudinal and transverse direction

Range of use

- Quality assurance in sensor manufacturing
- Development and testing of MEMS sensors

Features

- Rugged ceramic armature (15 mm x 15 mm) with coupling surfaces for attaching the test device
- Very high first axial resonance frequency (> 115 kHz)
- High acceleration amplitude (up to 400 m/s²)
- Low transverse motion (typically < 10 %)
- Wide frequency range: 5 kHz to 100 kHz

Description

The SE-16 vibration exciter has been specially developed for high frequency vibration excitation of small components and sensors both in the longitudinal and transverse direction. It can thus be used, for example, for developing and testing MEMS sensors and for quality assurance in sensor manufacturing.

The test device can be attached by glueing on the side or on the top of the coupling surfaces. Thanks to the special design of the rugged ceramic armature and its special bearing, the test device can be excited almost free of any transverse motion in a frequency range of between 5 kHz and 100 kHz.

The drive of the vibration exciter is electro-dynamic, with the required electric energy provided by the power amplifier. All components of the drive are explicitly designed for high performance. With acceptable temperature rise of the vibration exciter, high acceleration amplitudes can be created.

Through the required frequency and power range, the 7224 AE Techron power amplifier can deliver a voltage signal with extremely low distortion factor.

SE-16

High-Frequency Vibration Exciter



Technical data

SE-16 vibration exciter	
Force rating ¹⁾	12 N
Frequency range ²⁾	5 kHz ... 100 kHz
Resonance frequency	> 115 kHz
Max. stroke ³⁾	0.8 µm
Max. acceleration ¹⁾	400 m/s ²
Max. payload	1 g
Transverse motion (typical) ³⁾	< 10% in the range of 5 kHz ... 100 kHz
Rated current	8 A RMS
Max. voltage	10 V RMS
Dimensions (H x W x L)	82 mm x 130 mm x 130 mm
Weight	2.9 kg
7224 AE Techron power amplifier	
Power output	1100 W RMS at 4 Ohm
Output voltage ⁴⁾	49 V
Output current ^{4) 5)}	12 A
Frequency range	0 Hz to 300 kHz
Input impedance	20 kOhm
Power supply	230 V, 10 A, 50/60 Hz
Input signal	±10 V
Control mode	Voltage
Current monitor	0.2 V/A
Dimensions (H x W x L)	89 mm (2 units) x 578 mm x 483 mm
Weight	18.6 kg
System cable	
Length	3 m
Connector of vibration exciter	9-pole Sub-D connector
Connector of power amplifier	Free cable ends

All specification are at room temperature unless otherwise specified

¹⁾ Sine peak value

²⁾ Frequency range may be extended on request

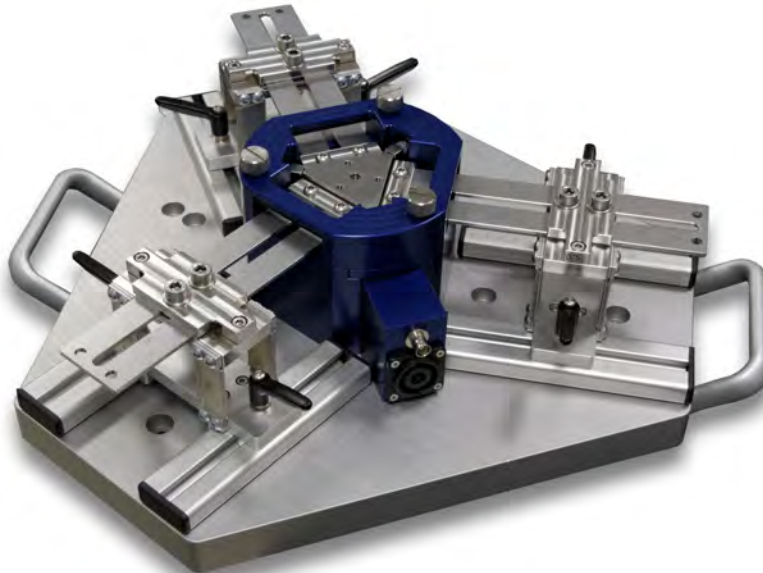
³⁾ Peak-peak

⁴⁾ When in use with SE-16

⁵⁾ Up to 8 A RMS permitted

SE-101 RES-HA

Calibration Vibration Exciter for High Acceleration



Application

- **Secondary calibration** of **amplitude linearity** of vibration sensors up to high-g-levels
- **Fatigue testing**

Range of Use

- **Certified calibration laboratories** with outstanding quality demands
- Departments of **measuring instrument verification** in **research and industry**
- **Quality assurance** in sensor manufacturing
- **Testing of fatigue behavior of devices** at high acceleration levels

Features

- **Very high acceleration amplitudes** (up to 400 g_n)
- **Low Transverse motions** < 5 %
- Usable frequency range **65 Hz ... 500 Hz**
- Maximum mass of DUT **300 gram**
- **Internal reference accelerometer** (ICP®-type, sensitivity about 10 mV / g_n)
- **Customized solutions** and modifications on request

Description

The SE-101 is a high-tech product, which is the result of intensive theoretical and practical examinations. It is designed especially for checking and calibration of amplitude linearity of sensors at certain frequencies up to high acceleration levels.

Thus the significant feature of this exciter is the high acceleration limit of up to 400 g_n using a sinusoidal excitation signal.

The drive of the exciter is electro dynamic. High acceleration amplitudes with very low temperature rise of the shaker and low transverse motions can be reached due to the special resonator design. The easily adjustable spring system allows quick changes of the resonance frequency.

SE-101 RES-HA

Calibration Vibration Exciter for High Acceleration



Components

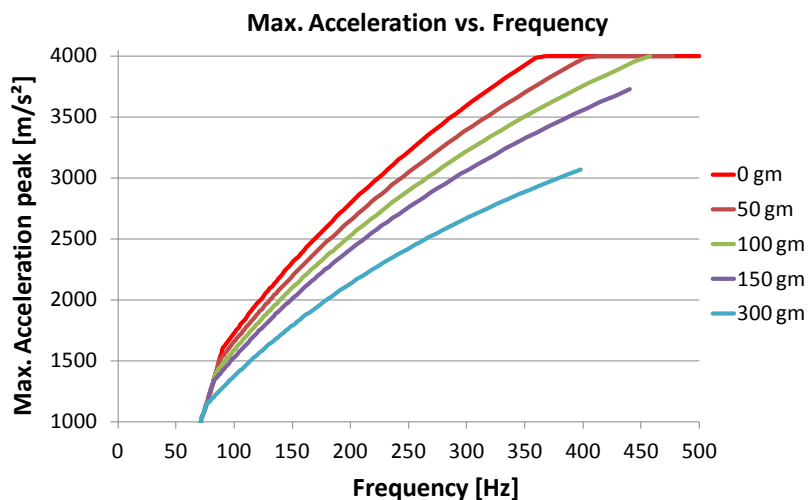
- Vibration exciter
- Internal reference accelerometer, ICP[®] accelerometer
- Base Plate
- Adjustable spring system

Technical Data

Vibration Exciter		
Frequency Range	65 Hz ... 500 Hz (bare table)	
Max. Stroke	10 mm	
Max. Acceleration	400 g_n	
Max. Payload	300 gram (higher payloads on request)	
Transverse Motion	typ. < 5 %	
Max. Current Input	9 A RMS	
Total Weight	21 kg	
Working Temperature Range	23°C (± 2 K)	73,4°F (± 2 K)
Storage Temperature Range	-25°C ... +55°C	-13°F ... +131°F
Data of the Internal Reference Accelerometer		
Sensitivity (± 10 %)	1 mV / m/s ² (10 mV / g_n)	
Frequency Range	2 Hz ... 50 kHz	
Excitation Voltage	18 V _{DC} ... 30 V _{DC}	
Constant Current Excitation	2 mA ... 20 mA	
Output Bias Voltage	8 V _{DC} ... 12 V _{DC}	
Discharge Time Constant	0.5 sec ... 2.0 sec	
Settling Time (within 10 % of bias)	< 5 sec	
Connectors		
Sensor (Internal Reference)	BNC-connector	
Shaker	Speakon®-SV (8-pin)	

Recommended Power Amplifier: **PA 14-180**

Recommended optional extra: Remote shut-down



All data are subject to change without notice

September 2014

SE-201 PN-LMS

Shock Exciter Low-Medium-Shock



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments (measuring chain) with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**
- **Shock testing** of small assemblies / parts

Range of Use

- **Certified calibration laboratories**
- **Calibration laboratory departments** of industrial firms particular in automotive, aviation or space travel industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- **Broad amplitude range** from **5 g_n ... 10,000 g_n**
- Type of excitation: **halfsine shock**
- **Pulse duration** up to 5 ms
- **Good repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **80 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 1 shock/s)
- **Upgradeable** to a CS18 shock calibration system
- **Low transverse motion** of DUT
- Automated regulation of amplitudes up to **6000 g_n** is possible

SE-201 PN-LMS

Shock Exciter Low-Medium-Shock



The SE-201 PN-LMS is a pneumatically driven shock exciter which provides a wide amplitude range. It uses the hammer-anvil principle to generate the shocks. A projectile that is accelerated by pressurized air is used as hammer. While the air pressure is kept constantly, the kinetic energy of the projectile can be controlled by a motor driven mechanical stop that allows a precise adjustment of the projectiles starting position and thus of the distance over which it is accelerated. Thus the SE-201 PN-LMS allows a good and all electric control of the shock amplitude. All mechanical parts are build from wear resistant materials allowing best stability of the shock exciter and providing a good repeatability of shocks.

The SE-201 PN-LMS can be used for calibration purposes (secondary calibration according to ISO 16063-22) as well as for shock testing of small assemblies or parts.

It is optimized for low transverse motion of the DUT. For low shocks ($5 g_n$ to $250 g_n$) an air bearing is used to guide the anvil.

Components

- Pneumatically driven **pulse generator**
- Reference standard **BN-02**
- **Control box** with 5V TTL and serial (RS232) I/O-interface

Performance Specification ¹⁾

Max. sensor mass (DUT):	80 gram
Min. shock amplitude:	$5 g_n$
Max. shock amplitude:	$10,000 g_n$
Pulse Duration (typically):	0.1 ms ... 5 ms
Required Air Pressure:	6 bar (73 PSI)
Required Air Quality:	ISO 8573-1:2010, Class 3

¹⁾ All data for environmental conditions: temperature 23°C ($\pm 2^\circ\text{C}$) and relative humidity 30 % ... 75 %

HOP - MS

Calibration Exciter Medium-g-Shock



Adjustable
Signal Shape, Amplitude,
Pulse Width

Patented

Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**
- **Shock Testing** of small assemblies / parts

Range of Use

- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel or in the military industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- **Traceable** to Physikalisch Technische Bundesanstalt (**PTB**) Braunschweig by the accredited SPEKTRA Calibration-Laboratory D-K-15183-01-00
- **Broad amplitude range** from **20 g_n ... 4.000 g_n**
- Type of excitation: **sinusoidal shock, adjustable signal shape or burst**
- **Independent control** of amplitude and pulse width (within certain ranges, see table)
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **30 gram**
- Realization of **fully automatic calibrations** according to own test regime (up to 1 shock/s)

HOP - MS

Shock Exciter Medium-g-Shock

The SPEKTRA HOP-MS shock exciter is determined for testing and calibrating acceleration sensors as well as for environmental testing of small assemblies and parts. It is specified to provide sine multi period shock excitations. The HOP-MS works according to the Hopkinson-bar principle. It makes use of the propagation and reflection characteristics of a mechanical wave in a slender bar. The Hopkinson-bar is excited by a piezoelectric actuator.

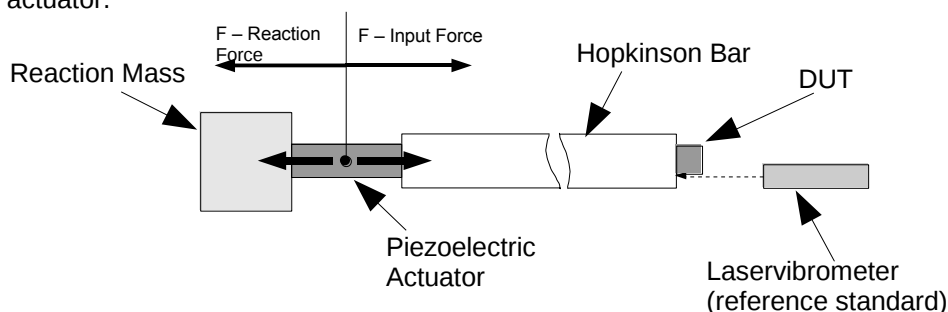
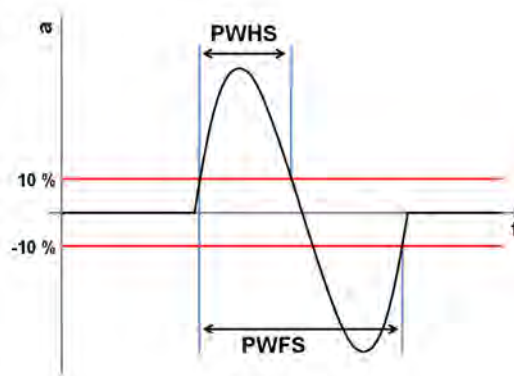


Figure 1 Schematic of the HOP-MS

In Figure 1 a schematic of the HOP-MS is shown. The main parts are: the Hopkinson Bar, Piezoelectric actuator, reaction mass, DUT and the reference standard (in this example a Laser vibrometer). If one applies a driving voltage to the actuator, the Piezo stack changes its length. Due to the reaction mass and Newton's 2nd law a reaction force will be created. The same force will act as input force on the Hopkinson Bar. Since the driving voltage can be controlled nearly arbitrary also the reaction force and thus the acceleration at the end of the bar is determined.

Components

- Shock exciter **SE-220 HOP-MS**
- Reference standard **BN-02**
- **PA 14-500** power amplifier



Performance Specification¹⁾

Shock Amplitude	PWHS ²⁾	PWFS ²⁾
20 g _n ... 250 g _n	180 µs	360 µs
20 g _n ... 500 g _n	125 µs	250 µs
20 g _n ... 1,000 g _n	70 µs	140 µs
20 g _n ... 4,000 g _n	40 µs	80 µs

¹⁾ All data for environmental conditions: temperature 23°C (± 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

Dimensions Hopkinson Bar	Length	approx. 2.5 m
	Height	approx. 1.3 m
	Width	approx. 0.5 m

All data are subject to change without notice

November 2013

HOP - HS

Calibration Exciter High-g-Shock



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**
- **Shock Testing** of small assemblies / parts

Range of Use

- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel or in the military industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- Type of excitation: **sinusoidal shock**
- Shock amplitudes up to **100.000 g_n**
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **30 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 20 shocks/minute)

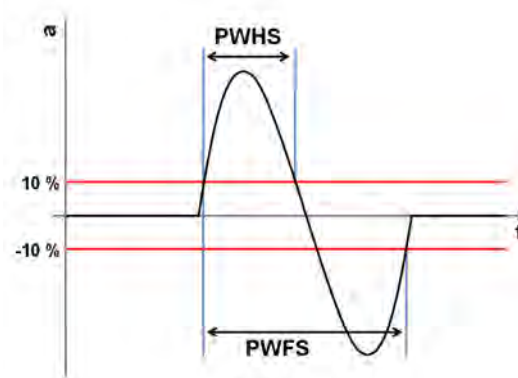
HOP - HS

Shock Exciter High-g-Shock

The SPEKTRA HOP-HS High-g shock exciter is determined for testing and calibrating acceleration sensors. It is specified to provide sinusoidal one period shock excitations. The HOP-HS works according to the Hopkinson-bar principle. It makes use of the propagation and reflection characteristics of a mechanical wave in a slender bar. The HOP-HS consists of a shock exciter barrel and a Hopkinson-bar made of Titanium. Both are mounted on an aluminum beam. Within the barrel a projectile is accelerated pneumatically, hitting the end of the bar in an adjustable distance thus exciting the strain pulse within the bar. A pneumatic control allows to retract the projectile after each shot by applying a negative pressure. While the air pressure is kept constantly, the kinetic energy of the projectile can be controlled by a motor driven mechanical stop that allows a precise adjustment of the projectiles starting position and thus of the distance over which it is accelerated. Thus the HOP-HS allows a good and all electric control of the shock amplitude. All mechanical parts are build from wear resistant materials allowing best stability of the shock exciter and providing a good repeatability of shocks.

Components

- Pneumatically driven **pulse generator**
- Reference standard strain gauge **BN-19**
- **Control box** with 5V TTL and serial (RS232) I/O-interface



Performance Specification¹⁾

Shock Acceleration	10,000 g_n ... 100,000 g_n
Pulse Width PWFS / PWHS ²⁾	typical 50 μs / 25 μs
Sensor Mass (DUT)	max. 30 gram

¹⁾ All data for environmental conditions: temperature 23°C ($\pm$ 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

Air Supply		4 bar
Dimensions Hopkinson Bar	Length	approx. 3.5 m
	Height	0.8 m ... 1.2 m
	Width	approx. 1 m

HOP - VHS

Calibration Exciter Very-High-g-Shock



Applications

- **Secondary calibration** of shock transducers as well as complete measuring instruments in form of a measuring chain, with very high precision and efficiency, according to **ISO 16063-22** (calibration by the comparison method)
- Secondary calibration of **shock accelerometer reference standards**
- **Shock Testing** of small assemblies / parts

Range of Use

- **Accredited calibration laboratories**
- Departments of **measuring instrument verification** in research and development particular in the aviation and space travel or in the military industry
- **Quality assurance** in sensor manufacturing
- **National metrology laboratories** as highest measurement authorities

Features

- Type of excitation: **sinusoidal shock**
- Shock amplitudes up to **200.000 g_n**
- **Excellent repeatability** of shock
- Position of DUT: **horizontal**
- Sensor mass (DUT) up to **15 gram**
- Realization of **all automatic calibrations** according to own test regime (up to 20 shocks/minute)

HOP - VHS

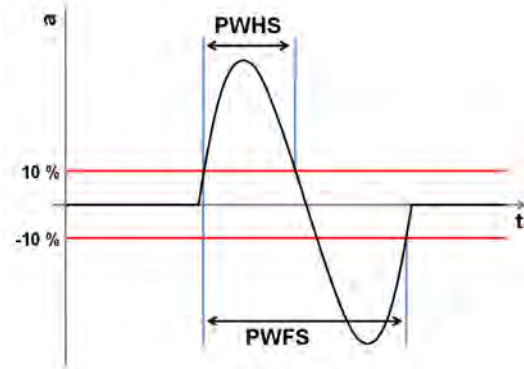
Shock Exciter Very-High-g-Shock



The SPEKTRA HOP-VHS High-g shock exciter is determined for testing and calibrating acceleration sensors. It is specified to provide sinusoidal one period shock excitations. The HOP-VHS works according to the Hopkinson-bar principle. It makes use of the propagation and reflection characteristics of a mechanical wave in a slender bar. The HOP-VHS consists of a shock exciter barrel and a Hopkinson-bar made of Titanium. Both are mounted on an aluminum beam. Within the barrel a projectile is accelerated pneumatically, hitting the end of the bar in an adjustable distance thus exciting the strain pulse within the bar. A pneumatic control allows to retract the projectile after each shot by applying a negative pressure. While the air pressure is kept constantly, the kinetic energy of the projectile can be controlled by a motor driven mechanical stop that allows a precise adjustment of the projectiles starting position and thus of the distance over which it is accelerated. Thus the HOP-VHS allows a good and all electric control of the shock amplitude. All mechanical parts are build from wear resistant materials allowing best stability of the shock exciter and providing a good repeatability of shocks.

Components

- Pneumatically driven **pulse generator**
- Reference standard strain gauge **BN-19**
- **Control box** with 5V TTL and serial (RS232) I/O-interface



Performance Specification¹⁾

Shock Acceleration	10,000 g_n ... 200,000 g_n
Pulse Width PWFS / PWHS ²⁾	typical 40 μs / 20 μs
Sensor Mass (DUT)	max. 15 gram

¹⁾ All data for environmental conditions: temperature 23°C ($\pm$ 2°C) and relative humidity 30 % ... 75 %

²⁾ PWHS = Pulse Width Half Sine Wave; PWFS = Pulse Width Full Sine Wave

³⁾ Determined according to GUM (ISO Guide to the expression of uncertainty in measurement, 1995) with $k = 2$ (coverage factor)

Air Supply		4 bar
Dimensions Hopkinson Bar	Length	approx. 3.5 m
	Height	0.8 m ... 1.2 m
	Width	approx. 1 m

FDG-15

Flux Density Generator



Application

- 3-axial magnetic excitation of devices under test

Range of use

- Testing of components in research and development
- Possible combination with a climatic chamber

Features

- Magnetic flux generator for any spatial direction
- Accuracy of magnetic field vector with respect to sensor axis at least $\pm 1^\circ$
- Earth magnetic field cancellation $\leq 1 \mu\text{T}$
- Homogeneity of flux $\leq 1 \%$

Description

The flux density generator type FDG-15 is a reliable tool for generating a static flux density of up to 3 mT in any direction inside the coil system. The homogeneous magnetic field has a maximum deviation of only 1 percent in the specified dimension.

The flux density generator consists of 3 orthogonal Helmholtz coils. Each Helmholtz coil is connected to a DC Power Supply which generates a constant positive current.

If it is necessary to compensate also the smallest magnetic fields like the earth magnetic field, it is possible to generate flux densities of less than $1 \mu\text{T}$.

Due to the design of the exciter, it can be placed within a climatic chamber and tested regarding both parameters – magnetic excitation and variable climatic conditions.

FDG-15

Flux Density Generator



Technical data

Magnetic Unit	
Frequency range	0 Hz
Maximum Flux Density	3 mT
Step width	1 μ T
Homogeneous Field Dimension Deviation	cube edge size 20 mm $\pm 1 \%$
Direction of Flux Density	Any
Dimensions (H x W x L)	367 mm x 368 mm x 380 mm
Environmental Without Temperature control of coils Maximum Temperature of coils	-40 °C ... 125 °C 150 °C
Total Weight	18 kg
Laboratory Power Supplies (KA3005P)	
Power Supply	110/230 V AC (50/60 Hz)
Output voltage	0 ... 30 V DC
Output current	0 ... 5 A DC
Resolution	10 mV / 1 mA
Environmental	IP20, 0...40 °C, ≤ 80 rH, ≤ 2000 m above sea level
PC Interface	RS232/USB
Fuse	T3 A / 250 V

All specification are at room temperature unless otherwise specified

PA14-500

Power Amplifier



Applications

- Power amplifier for modal testing shaker
- Power amplifier for environmental testing systems

Range of Use

- Research and development departments in industry
- Environment testing laboratories
- Universities and research institutes

Features

- Voltage or current amplifier mode
- Frequency range DC ... 150 kHz
- Current and voltage monitor output
- Gain control
- Current limit control
- Multifunction display
- Switch for phase inversion (0° or 180°)
- Control inputs for remote emergency shut down
- Control mute input
- Amplifier state outputs for integration in testing systems
- Overload protection
- Forced air cooling for continuous operation
- High reliability operation

PA14-500

Power Amplifier

Description

The Power Amplifier Type PA14-500 has been designed to drive any vibration or modal exciter requiring a 500 VA power amplifier.

The rated AC output is 500 VA into a 4 Ohm exciter or resistive load. Harmonic content of the output is very small as heavy negative feedback is used.

The instrument can tolerate temperature and supply line variations while maintaining excellent stability.

The PA14-500 can be used as a voltage generator with low output impedance and a flat voltage frequency response, or as a current generator with high output impedance and a flat current frequency response.

The RMS output-current limit is adjustable.

Specifications

General	
Power Output, Max.	500 VA into a 4 Ohm exciter or resistive load, at 25°C, at 1 kHz and nominal mains voltage.
Voltage Output, Max.	45 V RMS, DC ... 15 kHz
Current Output, Max.	5 A DC 5 A RMS, 0.1 Hz ... 5 Hz 9 A RMS, 10 Hz ... 20 Hz 11 A RMS, 20 Hz ... 15 kHz
Frequency Range	20 Hz ... 15 kHz full power DC ... 150 kHz small signal voltage (-20 dB)
Input Impedance	> 10 kOhm
Input Voltage, Max.	10 V RMS
Monitor Output	Voltage monitor: 0.1 V/V $\pm$ 3 %, 0.1 Hz ... 15 kHz Current monitor: 0.1 V/A $\pm$ 3 %, 0.1 Hz ... 15 kHz
Power Requirements	Single phase 100 V / 120 V / 230 V RMS, $\pm$ 10 %, 50 Hz ... 60 Hz. Approx. 1,000 VA at full load Power insert connector with fuse cartridge and voltage selector at rear
Dimensions	Height: 2 U equivalent of 88 mm (3.5 in.) Width: 482.6 mm (19 in.) with flanges for standard 19" rack mounting Depth: 450 mm (17.7 in.)
Weight	21 kg (46 lb.)
Voltage Mode	
Frequency Response	DC Input: DC ... 15 kHz $\pm$ 0.5 dB DC ... 150 kHz $\pm$ 3.0 dB small signal voltage (-20 dB) AC Input: 5 Hz ... 15 kHz $\pm$ 0.5 dB 2 Hz ... 150 kHz $\pm$ 3.0 dB small signal voltage (-20 dB) (2 separate BNC sockets at back panel)
Total Harmonic Distortion + Noise	< 0.1 % (40 Hz ... 5 kHz) < 0.2 % (5 kHz ... 15 kHz)
Gain	18 V/V ($\pm$ 2 dB) at 1 kHz
Current Mode	
Frequency Response	DC and AC Input: 5 Hz ... 15 kHz $\pm$ 0.5 dB 2 Hz ... 60 kHz $\pm$ 3.0 dB small signal voltage (-20 dB)
Total Harmonic Distortion + Noise	< 0.2 % (40 Hz ... 2 kHz) < 0.8 % (2 kHz ... 15 kHz)
Gain	12 A/V ($\pm$ 2 dB) at 1 kHz

APS Long Stroke Shaker ELECTRO-SEIS®

with Air Bearing Load Mounting Table

Overview 1/2



APS 129



APS 500

Applications

- Seismic simulation for components
- Calibration and test for seismic instruments
- Sensor characterization

Range of Use

- Departments for the supervision of measuring instruments in research, industry, automotive, aviation, space, military
- Test and calibration laboratories

Features

- Long stroke shaker for sine wave, swept sine wave, random or impulse force waveforms
- Mounting table for high payloads
- Low noise vibration by means of air bearing guidance and support

Specifications

	APS 129	APS 129-HF Increased Force	APS 500
Force (Sine Peak)	133 N (30 lbf)	186 N (42 lbf)	95 N (21 lbf)
Stroke (Peak - Peak)	158 mm (6.25 inch)		152 mm (6.0 inch)
Frequency Range	DC ... 200 Hz		
Operation	horizontal or vertical		
Armature Weight	8.5 kg (18.7 lb)		1.5 kg (3.3 lb)
Max. Payload	Horizontal	23.0 kg (50.7 lb)	3.0 kg (6.6 lb)
	Vertical	11.0 kg (24.3 lb)	1.3 kg (2.9 lb)
Impedance	4.4 or 1.1 Ω	1.4 Ω	1.2 Ω
Air Pressure Required	4 bar ... 5 bar (60 psig ... 70 psig)		
Air Flow Required	650 l/h (0.4 cfm)		
Total Shaker Weight	79.0 kg (174.2 lb)		64.0 kg (141.1 lb)
Overall Dimension L x W x H	889 x 219 x 216 mm (35 x 8.6 x 8.5 inch)		813 x 219 x 210 mm (32 x 8.6 x 8.3 inch)
Load Table Size L x W	254 x 254 mm (10 x 10 inch)		79.5 x 79.5 mm (3.1 x 3.1 inch)

Accessories (optional)

	APS 129	APS 129-HF	APS 500
Power Amplifier	APS 125		
System Cables for Connection Shaker to Amplifier	APS 0082-6E		
Zero Position Controller for Vibration Exciters	APS 0109		
Vertical Mounting Kit / Vertical Operation Kit	APS 1291		APS 5002

Additional accessories available

APS Long Stroke Shaker ELECTRO-SEIS®

with Air Bearing Load Mounting Table

Overview 2/2



APS 113-AB



APS 113 AB-LA

Applications

- Seismic simulation for components
- Calibration and test for seismic instruments
- Sensor characterization

Range of Use

- Departments for the supervision of measuring instruments in research, industry, automotive, aviation, space, military
- Test and calibration laboratories

Features

- Long stroke shaker for sine wave, swept sine wave, random or impulse force waveforms
- Low noise vibration by means of air bearing guidance and support

Specifications

	APS 113-AB	APS 113-AB-HF Increased Force	APS 113-AB-LA Lightweight Armature
Force (Sine Peak)	133 N (30 lbf)	186 N (42 lbf)	95 N (21 lbf)
Stroke (Peak - Peak)	158 mm (6.25 inch)		
Frequency Range	DC ... 200 Hz		DC ... 400 Hz
Operation	horizontal or vertical		
Armature Weight	2.7 kg (5.8 lb)		0.95 kg (2.1 lb)
Max. Overhung Load at Armature Attachment Point	1.5 kg (3.3 lb)		1.0 kg (2.2 lb)
Impedance	4.4 or 1.1 Ω	1.4 Ω	1.2 Ω
Air Pressure Required	4 bar ... 5 bar (60 psig ... 70 psig)		
Air Flow Required	500 l/h (0.3 cfm)		
Air Quality	ISO 8573.1 Class 3		
Total Shaker Weight	36.0 kg (80 lb)		34.0 kg (75 lb)
Overall Dimension L x W x H	526 x 213 x 168 mm (20.7 x 8.4 x 6.6 inch)		

Accessories (optional)

	APS 113-AB	APS 113-AB-HF	APS 113-AB-LA
Power Amplifier	APS 125		
System Cables for Connection Shaker to Amplifier	APS 0082-6E		
Zero Position Controller for Vibration Exciters	APS 0109		
Vertical Mounting Kit / Vertical Operation Kit	APS 0162		

Additional accessories available

All data are subject to change without notice

January 2014

APS Long Stroke Shaker ELECTRO-SEIS®

with Linear Ball Bearings

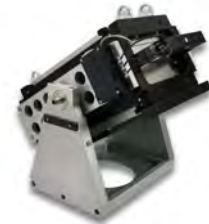
Overview 1/2



APS 113 horizontal



APS 400 vertikal
with APS 0412 Reaction Mass



APS 420 horizontal
with APS 4222 Trunnion Base

Applications

- Modal analysis of dynamic loaded structures
- Seismic simulation for components
- Calibration and test for seismic instruments
- Geoservice, Geoscience, Geophysics, Geoseismic

Range of Use

- Departments for the supervision of measuring instruments in research, industry, automotive, aviation, space, military and civil engineering
- Test and calibration laboratories

Features

- Long stroke shaker for sine wave, swept sine wave, random or impulse force waveforms
- Optimized to deliver power to resonant load with minimum shaker weight and drive power
- Rugged linear guidance system

Specifications

	APS 113 / APS 113-HF	APS 400	APS 420
Force (Sine Peak)	133 N / 186 N (30/42 lbf)	445 N (100 lbf)	900 N (200 lbf)
Velocity (Sine Peak)	1,000 mm/s (39 inch/s)		
Stroke (Peak - Peak)	158 mm (6.25 inch)		150 mm (5.9 inch)
Frequency Range	DC ... 200 Hz		
Operation	horizontal or vertical		
Armature Weight	2.3 kg (5.1 lb)	2.8 kg (6.2 lb)	3.6 kg (8.0 lb)
Max. Overhung Load at Armature Attachment Point	9.0 kg (20 lb)		
DC Coil Resistance	4.4 or 1.1 Ω / 1.4 Ω	1.6 Ω	1.1 Ω
Total Shaker Weight	36.0 kg (80 lb)	73.0 kg (161 lb)	140.0 kg (310 lb)
Dimension L x W x H	526 x 213 x 168 mm (20.7 x 8.4 x 6.6 inch)	526 x 314 x 178 mm (20.7 x 12.4 x 7.0 inch)	591 x 360 x 280 mm (23.3 x 14.2 x 11.0 inch)

APS Long Stroke Shaker ELECTRO-SEIS®

with Linear Ball Bearings

Overview 2/2

Accessories (optional)

	APS 113	APS 400	APS 420
Power Amplifier	APS 125	APS 145	
System Cables for Connecting Shaker to Amplifier	APS 0082-6E	APS 0082-6E	
Auxiliary Table Kit – Horizontal	APS 0052	APS 0452	
Auxiliary Table Kit – Vertical	APS 0077	APS 0477	
Auxiliary Table Kit – Horizontal and Vertical	APS 0078	APS 0478	
Reaction Mass Assembly	APS 0112	APS 0412	APS 4212
Lifting Handles (Set of 4)	APS 0414	APS 0414	APS 4221
Carrying Handles and Tie-down Bars	APS 0108	APS 0421	
Trunnion Base	APS 4222		
Over Travel Switch	APS 8543		
Modal Stinger Kit	APS 8610		
Steel Cable Kit	APS 8611	APS 8612	

Additional accessories available

All data are subject to change without notice

March 2014

DPE-02

Dynamic Pressure Exciter



Advantages

- Realization of all automatic calibrations according to own test regime (up to 1 shock/s)
- User-friendly and efficient
- Upgradeable to a shock acceleration calibration device

Features

- Pressure amplitudes from **22 MPa to 420 Mpa** with pulse duration less than 2 ms
- Create test descriptions in which a calibration run is performed fully automated using the SPEKTRA CS18 Software

Application

- Generates pressure shock impulses with low pulse duration (<2 ms)

Range of use

- **Dynamic calibration** of pressure sensors
- **Dynamic tests** of pressure sensors

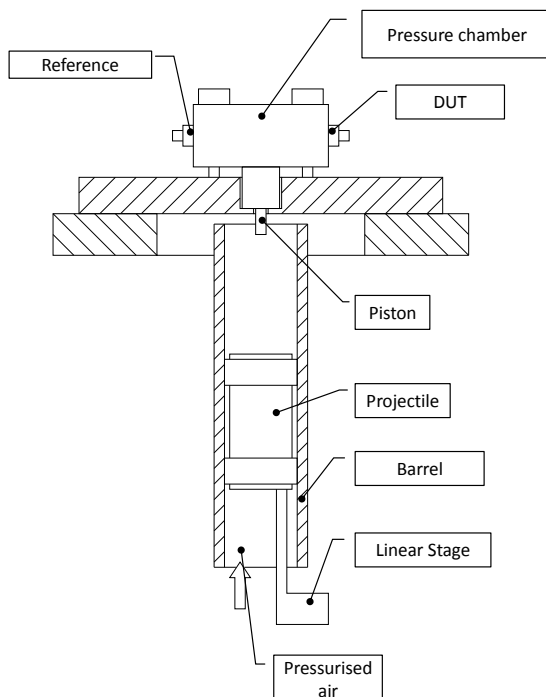
DPE-02

Dynamic Pressure Exciter

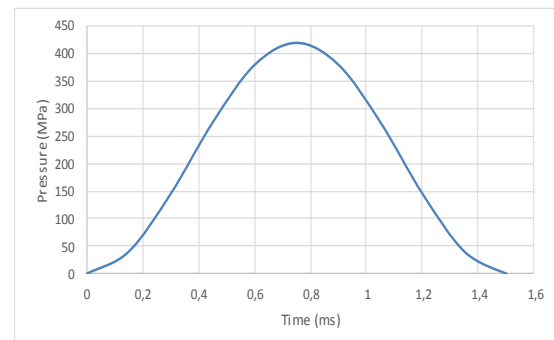


Features	SPEKTRA Shock pressure device
amplitude	22 ... 420 MPa
pulse duration	<2 ms (depends on projectile mass)
operation	pneumatic, fully automated
Impulse form	half sine
pressure transmission	hydraulic (Oil)
upgradeable	shock acceleration

Schematic



Pulse form



Subject to change without notice

May 2015

Pressure Box PSB-01

For pressure control of SE-09



Application

- Control of inlet air pressure for air bearing vibration exciter SE-09
- Reduction of air consumption by air bearings

Range of use

- For calibration with SPEKTRA SE-09 vibration exciter and SPEKTRA CS18 calibration system
- Helpful where air consumption should be minimized, e.g. compressed air from containers

Features

- Voltage supply AC as well as DC possible
- Automatic stop of calibration procedure when air pressure lower than configured minimum pressure
- Thus protection of air bearings of vibration exciter is ensured
- Automatic stop and connection of compressed air during calibration procedure minimizes air consumption

Description

The Pressure Box PSB-01 was developed to control the air flow of air bearing SPEKTRA vibration exciters. It is intended to stop or allow the air flow of a compressed air source and to check the pressure of this source if it is higher or lower than the configured pressure of the pressure switch. If the pressure is not in the correct range the operation of the amplifier will be stopped.

This way the risk of damages to the air bearings by incorrect operation can be eliminated.

In connection with a SPEKTRA CS18 calibration system the compressed air source will be automatically switched on. After finishing the calibration it is switched off. Thereby air consumption is minimized.

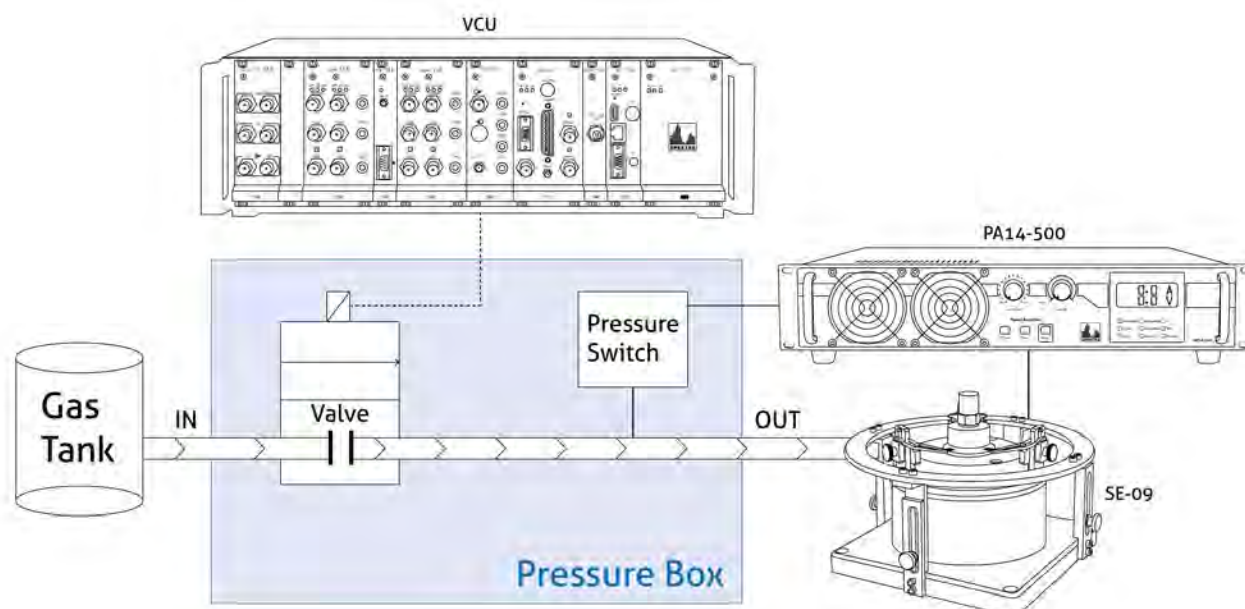
Pressure Box

For pressure control of SE-09

Technical Data

General Specification	
Input Voltage AC	100 V ... 240 V RMS, 50 Hz ... 60 Hz
Input Voltage DC	88 ... 375 V
Air Quality according to ISO 8573-1	Class 3 or better
Air Pressure	1 ... 10 bar (according to pressure threshold)
Pressure threshold SE-09	1.5 bar
Dimensions	200 mm x 300 mm x 120 mm
Connections for compressed air	Quick connector 6 mm
Environment	
Operational Temperature	10 °C ... 30 °C
Storage Temperature	-40 °C ... 60 °C
Do not operate while condensation is present!	

Functional principle



Shock Box

Control unit for SPEKTRA shock exciters



Application

- control of the positioning system for the projectile and manual shock releasing on SPEKTRA shock exciters
- shock calibration with CS18-Systems
- shock calibration with SPEKTRA shock exciters and other measurement systems

Application Fields

- HOP-HS/VHS
- PN-LMS
- CS18 VHS
- CS18 HS
- CS18 LMS

Features

- convenient control for operation of SPEKTRA shock exciters
- menu with two adjustable languages (English/german)
- allows controlling of SPEKTRA shock exciters via Ethernet
- integration into other measurement systems is possible
- simple Reconstructing/Serviceing of SPEKTRA shock exciters (e.g. exchanging the projectile)

Shock Box

Control unit for SPEKTRA shock exciters



The **Shock Box** is a control unit for SPEKTRA shock exciters HOP-HS/VHS and PN-LMS. It allows a manual control of the positioning system for the projectile and of releasing shocks. It also enables the control of the shock exciters from a PC via Ethernet. In order to do this there is an instruction list for full functionality.

With these features the Shock Box creates an interface for controlling the aforementioned shock exciters. She is suitable with CS18 and other measurement systems.

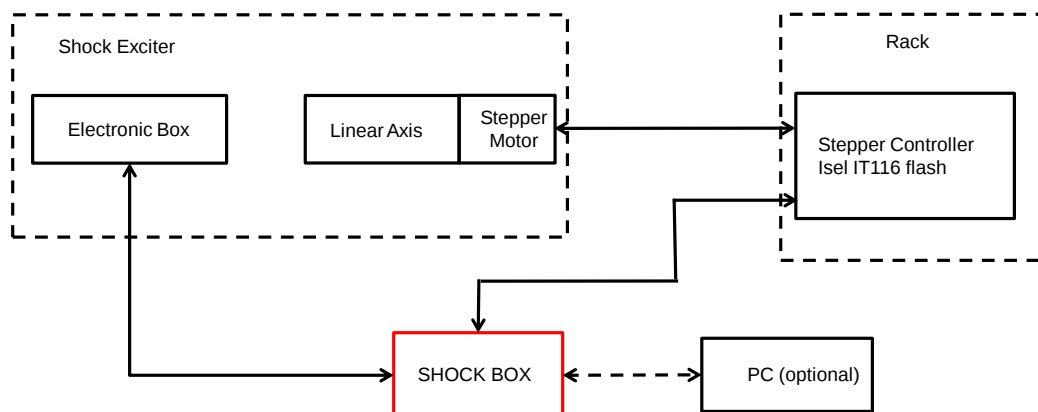
ATTENTION:

The Shock Box is unsuitable for recording the measurement data of a shock.

Technical Data:

Physical Quantity	Value
Supply Voltage	6V
Current Consumption	max. 500 mA
Tolerance of Setting Firing Range	0,1 mm
Tolerance of Setting Pressure	0,01 bar
Transmission Parameters RS232	19200Bd, 8 databit, 1 stopbit, no parity
Housing Metrics LxWxH [mm]	223x104x44
Digital Outputs	3 (5V, max. 20mA)
Analogue Output	0...10 V, 12 Bit
Analogue Input	0...10 V, 12 Bit

Structure of the Shock Exciter System with Shock Box:



VCS 201

Vibration Control System



Fields of Application

The VCS 201 Vibration Control System is a digital measuring and control system to be used in vibration engineering. Thus it is employed as standard control module in vibration test systems by SPEKTRA. It is used to set up and control the test equipment and visualize the test criteria for the simulation of environments of objects under test according to DIN EN 60068-2, military or manufacturer's standards.

The VCS 201 is suitable as control module for any kind of equipment mentioned above. I.e. the VCS 201 can also be used without any trouble for updating existing systems.

A special application of the VCS 201 Vibration Control System is used as SRS-35 in the CS18 Calibration System by SPEKTRA for the calibration of accelerometers.

Applications

Typical applications of the VCS 201 Vibration Control System in combination with a vibration exciter are systems for:

- the simulation of environments in the lab,
- vibration exposure testing in the production of susceptible modules (e.g. CD drives)
- balancing systems for vibration sensors (e.g. airbag sensors)

Features

Selectable modes:

- Sine - fixed frequencies (table)
- Swept sine
- Noise (optional extra)
- Shock (optional extra)

The frequency range of the control action is identical for all modes:

- 5 Hz ... 5 kHz (optional extras: other ranges, up to 0.4 Hz up to 50 kHz)

Other features (subset)

- Remote control option by DCOM or DLL
- Observation channels (notch)
- Laservibrometer as velocity sensor
- Sensor curve correction

Option: Plug-in module I/O13 for generating +24 V switching signals.

This plug-in module is needed when the VCS 201 is part of an automatic test stand and control signals have to be supplied or processed.

Example of Applications



Vibration testing of sensors up to 400 g_n using the VCS 201 on a vibration exciter SE-R101

Design and Configuration

The Vibration Control System VCS 201 is a Vibration Control Unit VCU13 (front-end hardware in 19" modular design) in conjunction with the PC software VCS 201 for WINDOWS.

In its basic version, the VCS 201 includes the following plug-in units: (1 TE = 5.08 mm)

- Dual-channel measuring amplifier ANA13.5 (10 TE)
- Signal generator CPU13.5 (10 TE)
- Signal processor/controller (SHARC) DSP13 (4 TE)
- Power supply unit PS13.5 (14 TE).

Depending on the application, the plug-in units are housed either in a laboratory case or in a 19" module frame to be used as a plug-in for rack mount.

In its basic version, channel 1 of the measuring amplifier carries the reference signal used for control and channel 2 is used as a supplementary measuring channel. Each channel has three inputs which can be selected electronically and to which the following sources can be directly connected:

- Charge transducers, CHAx
- Transducers with integrated amplifiers, ICPx
- Voltage signal, DIR

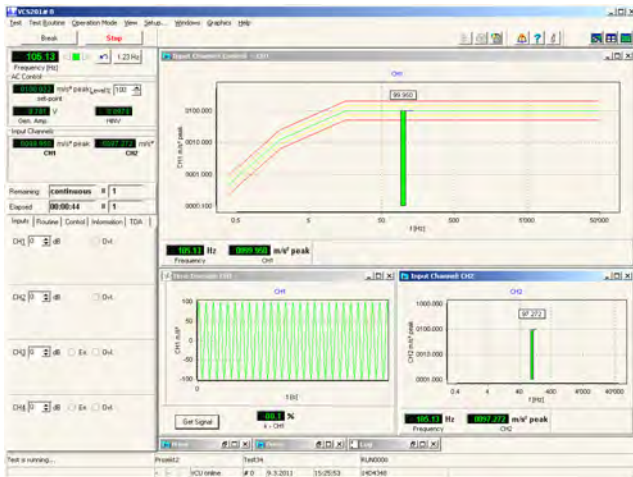
There is a RS-232, USB or ethernet interface for communication with the control PC.

The VCS 201 can be upgraded by adding two more measuring channels (1 plug-in unit ANA13.5).

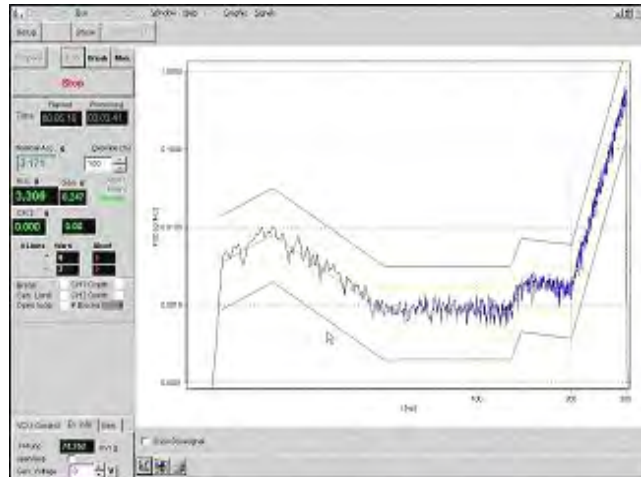
The VCS 201 software is optionally also available for all CS18 calibration systems.

VCS 201

Vibration Control System



Sine sweep 0.4 Hz ... 50 kHz with interfaces a, v, d



Noise in a frequency range with stress profile

Specification

- Signal generation:** 5 Hz ... 5 kHz (option:
0.4 Hz ... 50 kHz with 0.01 Hz
resolution, to be set in discrete steps
- Swept-sine
excitation:** Linear or logarithmic frequency
sweep
- Noise excitation:** controlled noise up to 2,000 lines
2 Hz ... 5 (32) kHz
- Shock excitation:** half sine, trapezoid, saw tooth
0.25 ms ... 40 ms
- Signal inputs:**
 - DIR input for AC signals, e.g.
from a measuring amplifier
 - CHA input for directly
connecting charge sensors
 - ICP[®] input for directly connecting
ICP[®] sensors, incl. 4 mA supply
- Gain:** to be programmed for each channel
in 6 dB steps between
 - 12 dB and 78 dB for combined
inputs DIR / ICP[®]
- Interfaces:** RS 232 / USB / Ethernet
- AD conversion:** 16 Bit resolution: 128 / 64 / 32 /
16 / 8 kHz sampling frequency
- AC signal output:** 10 V (0 V_{RMS} ... 7,071 V_{RMS}) to
external power amplifier
- COLA output:** Constant level output
- AC output:** OUT X analog input for checking
the waveform for each channel
- Power supply:** 230 V / 50 Hz // 115 V / 60 Hz
- Dimensions**
(W x H x D): Width depending on configuration
19 " x 3 U x 320 mm



*Vibration Control System VCS 201
with power amplifier PA14-500*

VCS 400

Vibration Control System – powerful, modular, flexible



Applications

- Vibration tests
- Modal excitation
- Quality assurance
- Environmental tests

Fields of use

- Subsystem for automatic tests in production lines
- Mobile use in field
- Laboratory applications
- Updating of existing vibration test systems
- Customized solutions
- Tailored controller configurations for APS-shakers

Features

- Scalable, flexible vibration control system with variable number of measurement/control channels
- Hardware base:
National Instruments PXI
reasonable price, worldwide available
- Compact hardware, suitable for industrial applications
- Controller for vibration test modes:
sine, random, shock
- Control of acceleration, velocity, displacement, voltage, also with laser vibrometers
- Stand-alone usage without PC possible
- Remote controllable by Ethernet interface, DLL
- Measurement database
- Rich display and export options

VCS 400

Vibration Control System – powerful, modular, flexible



Operation modes

- Sine
- Random
- Shock optional

Application

- Providing well controlled vibration with one exciter in low frequency range
- Orientation measurement for environmental tests
- Easy and medium complex test scenarios

Technical data

Sine	0.1 Hz ... 5 kHz (Extensions on request)
Random	1 Hz ... 5 kHz, 5,000 Lines

Output Channels

- 2 output channels 16 bit, 10 V
- 1 control channel for 1 shaker
- 1 Monitoring channel (COLA, Freq. Monitor...)

Input Channels

- 2 input channels 16 bit (0.2, 1, 5, 10 V) DC
- IEPE/ICP optional
- One of the two input channels is usually connected with a reference sensor at exciter thru a supply box

Configuration

- NI PXI Real time system in flexible composition
- Connection to PC via Ethernet
- Powerful PC User Interface (National Instruments LabVIEW), extensible by customer if necessary
- Digital I/O for status, start, stop
- optional signal conditioning for charge sensors, PR sensors, capacitive sensors

Remote control

- simple flexible remote control by DLL, Ethernet, VI or COM/DCOM

Options

- flexible data analysis
- Complex test schedules by easy scripts inside user interface program

Standards

- DIN EN 60068-2 Part 6, 27, 29, 64, 80

VCS 401

Vibration Control System – powerful, modular, flexible



Applications

- Vibration tests
- Modal excitation
- Quality assurance
- Environmental tests
- Micro-structural investigation

Fields of use

- Subsystem for automatic tests in production lines
- Mobile use in field
- Laboratory applications
- Updating of existing vibration test systems
- Customized solutions
- Tailored controller configurations for SPEKTRA HF-shaker SE-09 and APS-shakers
- Laser measurement station for micro-mechanic components

Features

- Scalable, flexible vibration control system with variable number of measurement/control channels
- Hardware base:
National Instruments PXI
reasonable price, worldwide available
- Compact hardware, suitable for industrial applications
- Controller for vibration test modes:
sine, random, shock, time signal replication
- Control of acceleration, velocity, displacement, voltage, also with laser vibrometers
- Stand-alone usage without PC possible
- Remote controllable by Ethernet interface, DLL
- Measurement database
- Rich display and export options
- Real time data acquisition, transmission, recording
- Complex test schedules by easy scripts inside user interface program

VCS 401

Vibration Control System – powerful, modular, flexible



Operation modes

- Sine
- Random
- Shock
- Sine over Random
- Resonance (search & dwell)
- Time signal replication
- others on request

Technical data

Sine	0.01 Hz ... 50 (95) kHz (Extensions on request)
Random	1 Hz ... 50 (95) kHz, 5,000 (10,000) Lines
Shock	Halfsine, Trapezoid, Sawtooth, Custom; 0.25 ms ... 40 ms

Multi channel operation

- 1 to 8 control channels for up to 8 shakers
- Synchronous excitation, with adjustable phase shift if required
- Individual excitation of some or all channels
- 1 channel control with up to 34 inputs, average, min., max.
- Monitoring channels

Configuration

- NI PXI Real time system in flexible composition
- Connection to PC via Ethernet
- Powerful PC User Interface (National Instruments LabVIEW), extensible by customer if necessary
- 2 to 34 Analogue Inputs 24 Bit, 10 V, with or without IEPE, switchable
- 2 to 8 Analogue Outputs 24 Bit, 10 V
- optional data acquisition channels e.g. 16 * 16 Bit
- optional Digital I/O for status, start, stop
- optional signal conditioning for charge sensors, PR sensors, capacitive sensors

Remote control

- simple flexible remote control by DLL, Ethernet, VI or COM/DCOM

Data acquisition

- Real time data acquisition, transmission, recording
- flexible data analysis

Special solutions

- Low cost standard system, 1 output / 2 input channel(s), 0.1 Hz ... 5 kHz
- 4 Channel Controller for 4 long stroke shakers APS 400 with seismic masses for modal analysis
- HF-Controller with HF Shaker SE-09, 1 Hz ... 95 kHz
- Customized solutions, production test systems, digital acc. Sensor data acquisition, 3D excitation

Standards

- DIN EN 60068-2 Part 6, 27, 29, 64, 80

All data are subject to change without notice

September 2014

List of References *



Measurement and Test Systems, Vibration Control Systems, Engineering Solutions

Universities

Bauhaus-University, Weimar (Germany)

People's Friendship University, Moscow (Russia)

Technical University of Hamburg - Harburg (Germany)

University of Hong Kong (China)

University of Manchester (United Kingdom)

University of Vienna (Austria)

Other Industrial Customers

Amsted Rail (Australia)

Conti TEMIC microelectronic GmbH, Kirchheim / Frankfurt (Germany)

Pacific Seismic (USA)

Panasonic (Japan)

Philips Automotive, Wetzlar (Germany)

Robert Bosch, various sites (Hungary, Spain, Germany, USA/Mexico)

Siemens AG, Leipzig (Germany)

Wacker Chemie, Munich (Germany)

Westinghouse Electric (Sweden)

Vibration Systems configured as stand-alone Test Stands for sensors and modules in development and production **or for use as sub-systems in automatic test stations** for continuous quality monitoring **as well as for modal analysis** of buildings.

* extract from the VCS customer data base

All data are subject to change without notice

January 2014

Calibration Laboratory D-K-15183-01-00 entitled to issue DAkKS and ISO certificates

The DAkKS calibration laboratory with SPEKTRA is accredited for measurand acceleration and acoustical quantities in conformity with international standard DIN EN ISO/IEC 17025. With calibration systems for primary- and secondary calibration the laboratory is able to carry out calibrations with best possible measuring uncertainty.

**Feature of the accredited DAkKS calibration laboratory:
Vibration calibration with a measuring uncertainty
from 0.15 % at primary and from 0.5 % at secondary level.**

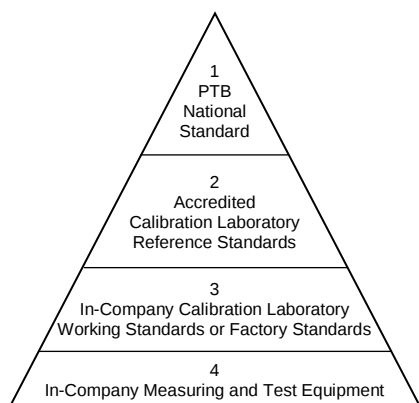
Devices to calibrate are sensors, measuring equipment and calibrators from the fields vibration and acoustics i.e.:

- Vibration sensors (also optical) and measuring microphones
- Vibration meters, laser vibrometers and sound level meters
- Vibration and acoustic calibrators
- Signal conditioners for charge and voltage

As result of the calibration DAkKS or factory calibration certificates will be issued. Calibration certificates of accredited laboratories will be accepted internationally within the framework of ISO 9000 and the MRA (Mutual Recognition Arrangement).



Accreditation certificate of SPEKTRA
DAkKS calibration lab D-K-15183-01-00



Hierarchy of metrological infrastructure
in industrial measurement



View of a calibration stand in the
SPEKTRA DAkKS laboratory

Calibration of

- Geophones from 0.2 Hz (also very low frequ. from 0.1 Hz)
- Human vibration meters
- Crash sensors with shock excitation
- Dynamic force sensors
- Impact hammers

Sound pressure calibration of

- Microphones and
- Sound level meters

Performance spectrum sound pressure calibration – pressure chamber and free field

Physical Quantity	Object of Calibration	Measuring Conditions		Calibration Result
		Frequency	Sound Pressure Level	
Sound Pressure Level (Pressure Chamber)	¼", ½", 1"- Measuring microphones, Pistonphones, Acoustic calibrators	250 Hz 1,000 Hz 31.5 Hz ... 2 kHz	124 dB 94 dB / 114 dB 84 dB ... 114 dB	Pressure non load or factory transfer value of measuring microphones; Display differences of sound level meters; Sound pressure level, frequency and distortion factor of acoustical calibrators and pistonphones
Sound Pressure Level (Free Field)	All types of measuring microphones, Sound level meters, Sound level measuring chains	125 Hz ... 20 kHz	74 dB ... 94 dB	Free-field non load or factory transfer value of measuring microphones; Display differences of sound level meters

DAkkS Calibration Laboratory

DAkkS Calibration

Traceable to the Physikalisch-Technische Bundesanstalt (PTB) and to NIST via MRA

Object of Calibration	Calibration Method	Physical Quantity	Measurement Range	Calibration Result
Vibration sensors charge, ICP®, voltage, capacitive and piezo-resistive types for quantities acceleration, velocity or displacement	Secondary calibration with Sine excitation acc. to ISO 16063-21	Vibration - Acceleration - Velocity - Displacement	0,1 Hz ... 20 kHz 0,01 m/s² ... 500 m/s² horizontal or vertical	- Transfer coefficient (modulus) - Angle of phase shift
Vibrationmeter for machines, or impact on human bodies, vibration calibrators, belt tension measuring device, optical vibrationmeter	Secondary calibration with Sine excitation acc. to ISO 16063-21 Human vibration calibration acc. to ISO 8041	Vibration - Acceleration - Velocity - Displacement	0,1 Hz ... 20 kHz 0,01 m/s² ... 500 m/s² horizontal or vertical	- Transfer coefficient (modulus) - Angle of phase shift - Deviation of displayed value
Reference sensors (primary calibration using laser vibrometers)	Primary calibration with Sine excitation acc. to ISO 16063-11	Vibration - Acceleration - Velocity - Displacement	0,1 Hz ... 20 kHz 0,01 m/s² ... 10 m/s² horizontal or vertical	- Transfer coefficient (modulus) - Angle of phase shift
Geophones, seismometers with / without vibration sensor	Secondary calibration with Sine excitation acc. to ISO 16063-21	Vibration - Acceleration - Velocity - Displacement	0,2 Hz ... 80 Hz 0,01 m/s² ... 30 m/s² horizontal up to 5 kg vertical up to 3 kg	- Transfer coefficient (modulus) - Angle of phase shift - Deviation of displayed value
Signal conditioner, measurement amplifier for charge, ICP®, voltage, capacitive or piezo-resistive types of sensors	Secondary calibration with Sine excitation	- Charge - Voltage	0,2 Hz ... 50 kHz 0,1 pC ... 10,000 pC 1 mV ... 30 V	- Transfer coefficient (modulus) - Angle of phase shift - Deviation of displayed value
Shock accelerometers charge, ICP®, voltage, capacitive or piezo-resistive types	Secondary calibration with shock excitation acc. to ISO 16063-22	Shock acceleration	0,2 km/s² ... 2 km/s² 1 ms ... 10 ms	Transfer coefficient (modulus)
High-g-shock accelerometers charge, ICP®, capacitive or piezo-resistive types	Primary or secondary calibration with shock excitation	Shock - Acceleration - Velocity	0,2 km/s² ... 100 km/s² 4 ms ... 30 µs	Transfer coefficient (modulus)
Impact hammer	Secondary calibration with shock excitation	Force	10 N ... 500 N	Transfer coefficient (modulus)
Laser vibrometer with velocity, displacement or acceleration output as well as Reference laser vibrometer	Primary calibration with Sine excitation acc. to ISO 16063-41	Vibration - Acceleration - Velocity - Displacement	0,1 Hz ... 20 kHz 0,01 m/s² ... 250 m/s²	- Transfer coefficient (modulus) - Angle of phase shift - Deviation of displayed value

Factory Calibrations

Object of Calibration	Calibration Method	Physical Quantity	Measurement Range	Calibration Result
Static accelerometers	Calibration in the earth gravity field	Static acceleration	Calibration at 9.81113 m/s²	Transfer coefficient (modulus)
Inclinometer	Calibration by tilting in the earth gravity field	Static acceleration	0 ° ... 360 ° 0.01° angular resolution	Transfer coefficient (modulus)
Temperature Calibration	Secondary calibration at various temperatures	Acceleration	-40 ° ... 120 °	Transfer coefficient (modulus)

All data are subject to change without notice

January 2013

SPEKTRA offers comprehensive Environmental Testing services



Vibration testing system with climate chamber

SPEKTRA - Your valued partner for quality assurance in research, development and production.

Farsighted companies include environmental evaluation in the early phases of product development as part of a total cost optimization process.

Automotive suppliers as well as manufacturers of electronic components, sensors, and test and measurement equipment utilize our expertise in a wide range of services offered.

We react flexibly to your time constraints. Different tests are performed in parallel. Additional testing requirements such as function monitoring during the test can also be realized.



Vibration testing of small modules under Thermostream®

Mechanical Tests, e.g. according to IEC 60068 or factory standards

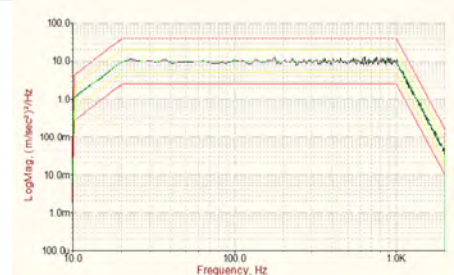
- **Vibration Testing**
 - Sinusoidal
 - Resonance Search
 - Sweep
 - Random
 - Sine on Random

Maximum Displacement:
100 mm (peak-peak)

Maximum Acceleration:
650 m/s²

Maximum Velocity:
3,0 m/s

Maximum Force vector:
11000 N



Broad band Random

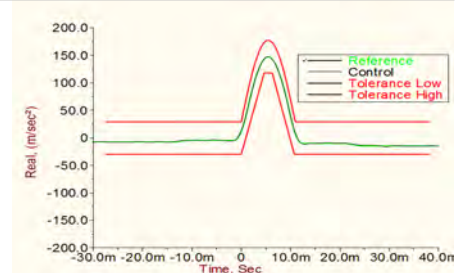
- **Shock Testing**
 - half-sine shock
 - saw-tooth shock
 - trapezoid shock
- **Continuous Shock Tests**

Maximum Displacement:
100 mm (peak-peak)

Maximum Acceleration:
1300 m/s²

Maximum Velocity:
4,5 m/s

Maximum Force vector:
27500 N



Single Shock

Climatic Tests, e.g. according to DIN EN 60068 or factory standards

- Cold
- Dry heat
- Damp heat, constant
- Damp heat, cyclic

The **payload bay volume** of our climatic chamber is 0.6 m³ (600 liter), the dimensions are **800 x 800 x 950 mm**.

Temperature range for constant and cyclic tests: **-70°C ... +180°C**

Change of temperature:
10 K/min

Range of relative humidity:
10 % ... 95 %

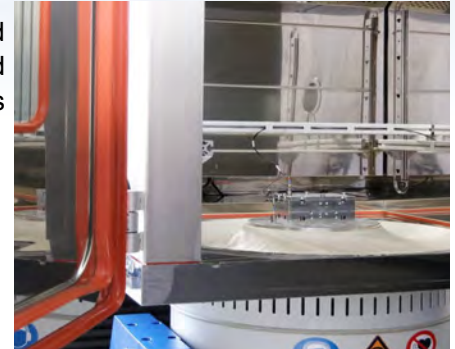


Change of temperature / storage

Combined mechanical / climatic tests

Combined tests with **vibration** and **temperature** are often required by product or factory standards. Those combined tests are realized with our climatic chamber that has a connection to our shaker in its base element.

For projects where there are no specific product or factory standards, we **counsel** our customers on how to specify tests, test severity and how to carry out the examination.



Combined test Vibration / Temperature

Monitoring / Recording of digital and analog signals

With our monitoring software "Observer", both digital and analog output signals can be monitored at sampling rates up to 2 MHz.

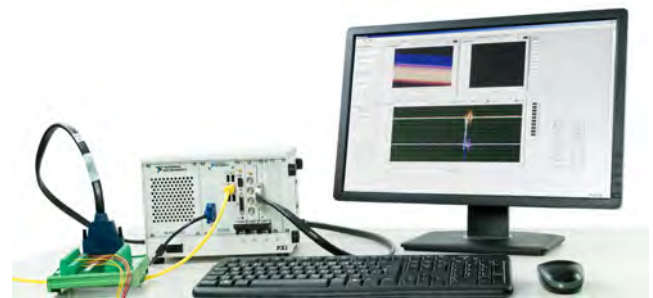
The software was written specifically for this monitoring and can be adapted - if necessary - to meet special requirements of our customers.

With an A/D-converter, voltages up to 10 V can be digitized (higher voltages are provided with voltage divider). By means of suitable converters, additional measured quantities such as current consumption can be monitored.

For the monitoring of devices under test, up to 16 channels are available that can detect very small deviations (in the μs - range), made possible because of the high sampling rate.

Our software displays the relevant test data and stores it as required. Special setups allow recording of specific intervals in a ring buffer.

For the monitored channels, limits can be defined that activate the ring buffer. When the measured values are below or above those limits the data from the ring buffer is automatically stored.



Computerized monitoring of output signals

Example of Use:

The sliding contacts of a device under test should be examined for contact bouncing during a shock test. For this purpose, the output signal (behind the sliding contacts) was decoupled, digitized and recorded with a sampling rate of 20 kHz in the ring buffer with a capacity of one second. This finely graduated sampling rate allowed detection of the shortest interruptions of the output voltage in the microsecond range.

In another example, the output voltages of test devices were monitored during various shock tests. Again, the output signal was decoupled with a voltage divider, digitized by an A/D converter, and recorded with a sampling rate of 50 microseconds in the ring buffer. When the conditions for the predetermined tolerance range (adjustable limit areas that can be programmed with the software) were satisfied, the recorded data of the ring buffer was automatically stored.