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Siemens PLM Software

# LMS Qsources

## Structural and acoustic exciters

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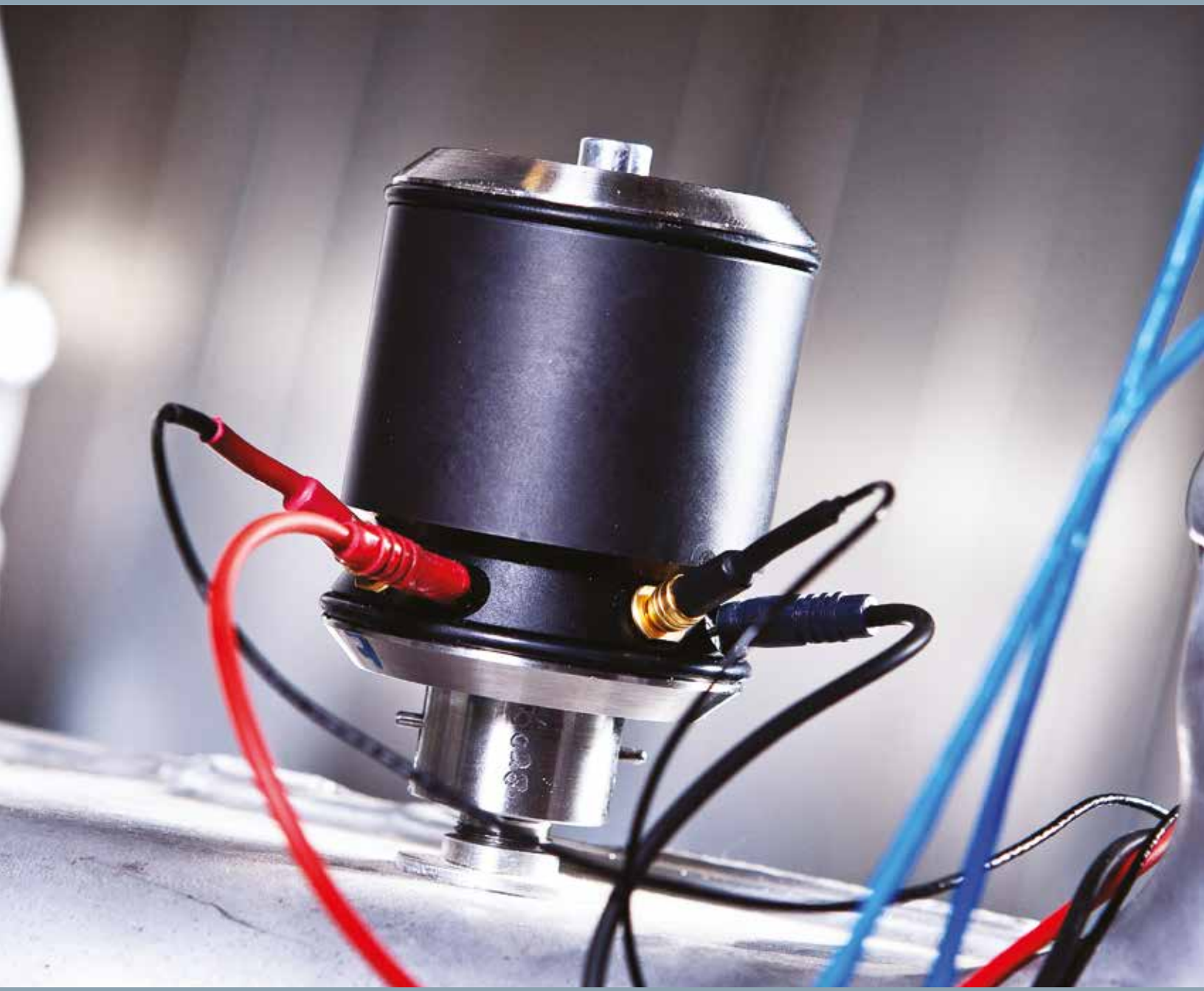


# LMS Qsources

## Advanced excitation technology

To design sound for the desired product sensation and brand identity, a thorough understanding of the different noise contributors is key. Noise, vibration and harshness (NVH) engineers therefore require state-of-the-art and highly accurate measurement equipment that enables new analysis methods. The increasing number of product variants that need to be developed in a shorter period puts time pressure on the people conducting the measurement campaign. Consequently, NVH departments are demanding highly efficient excitation devices that can seamlessly be integrated into the measurement chain.

Benefitting from more than 30 years of experience in noise and vibration technology, LMS™ Engineering services has provided innovative excitation hardware over the last two decades under the brand LMS™ Qsources hardware.

Covering a wide range of advanced excitation hardware, LMS Qsources seamlessly matches hardware with LMS™ software. This unique combination significantly exceeds current market standards with regard to productivity, data accuracy and customer expectations.

The excitation hardware is developed with input from customers, suppliers and LMS Engineering, allowing high product functionality, quality and reliability. In this brochure you will find an overview of our standard products. If you require a customized product, LMS Engineering optimizes or develops new excitation hardware through co-development.

# Miniature shaker

This LMS Qsources miniature (mini-) shaker has been developed to perform highly accurate structural excitation in a minimum space. It provides excitation, but with extremely low mass and stiffness loading of the test object.

The system includes integrated force and acceleration transducers. This allows the engineer to obtain driving point frequency response functions (FRFs) very quickly.

The internal accelerometer measures acceleration of the stinger at the contact side. The force generated by this structural exciter is not huge, but it is sufficient for the excitation of car bodies, engines, transmissions, machinery, etc.

The mini-shaker is especially suitable for those who plan to perform experimental modal analysis, transfer path analysis (TPA), frequency-based substructuring (FBS) and experimental statistical energy analysis.

The excitation device, including the sensors, has been miniaturized to the maximum, providing an excellent solution for all those hard-to-reach excitation locations.

The mini-shaker can introduce dynamic excitation where conventional shakers don't have access and impact hammers are impractical due to the connections from the suspension/exhaust/powertrain to the body or the interior acoustic cavity. In addition, the mini-shaker is a very efficient exciter for modal analysis on engines, gearboxes and similar components.

Another advantage is the ability to perform FRF measurements with only one operator.

It improves the efficiency of testing by eliminating most of the support and alignment work associated with shaker testing, and is self-supporting.

To increase measurement speed, the mini-shaker can be glued to the test object easily and quickly.

The mini-shaker is self-aligning, which means when the device is mounted on the structure, the force is aligned along the axis of excitation, saving additional setup time.

The mini-shaker can be controlled by LMS Test.Lab™ software spectral testing together with the LMS Qsources measurement amplifier. The integrated transducers are integrated circuit piezoelectric-type sensors and are compatible with LMS SCADAS™ hardware input modules.

To enable long reliable use, LMS Engineering offers a specific sensitivity measurement service of the internal transducers, including a detailed performance check.

The average force level is 2 real mean square of Newton ($N_{rms}$) over the frequency range of 50 to 5,000 hertz (Hz).

**Key benefits**

- Unique miniature size for inaccessible locations
- Efficient, self-supporting shaker
- Reduced instrumentation time – no manual alignment required
- Increased accuracy – integrated force and acceleration sensors
- Wide frequency range – 50 to 5,000 Hz

**Key features**

- Unique internal 3D suspension system
- Self-suspending and self-aligning shaker
- Built-in mechanical and electronic protection
- Integrated internal stinger system

**Application**
Transfer path analysis
Frequency-based substructuring
Modal analysis (EMA)
Attachment point mobility measurements
Time waveform replication (TWR)
Statistical energy analysis (SEA)

**Physical specifications**
Dimensions: 28 x 38 millimeters (mm)
Total mass: 100 grams
Mass loading of the test object: 10 grams

**Performance**
Sensor frequency range (±2 decibels (dB)): 50 to 5,000 Hz
Accelerometer frequency range (±2 dB)*: 50 to 5,000 Hz
Force level**: 2 $N_{rms}$
Internal sensors type: integrated circuit piezoelectric (ICP)
Amplifier requirement: 16 root mean square of the voltage (Vrms) or 60 watts (W) to 4 ohm

* Accelerometer signal valid for local mass < 10 kilograms (kg) and local stiffness < 3e8 N/m
** When using continuous broadband random noise

**Supplied accessories**
User manual
Signal and power cables
Electronic protection device
Flight case
Sensitivity sheet internal sensors

**Product requirements**
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar

**Options**
LMS Qsources measurement amplifier (Q-AMP)
LMS Qsources sensitivity measurement (Q-SR-SENS)
Excitation hardware application training

# Integral shaker

The LMS Qsources integral shaker has been designed to excite a very broad range of structures.

Typical test objects include: complete road vehicles, vehicle bodies, powertrain/driveline, suspension systems, aircraft and railway bodies and systems, as well as machinery up to 10 meters (m) by length or 15,000 kg by weight. The size allows the user to make accurate measurements in very narrow spaces.

Special attention is paid to the operating efficiency. The installation is very easy with small removable rings. This shaker can be glued to the test object with no need for extra support. The special mounting bases protect the shaker from excessive glue.

Due to the unique suspension, the force is aligned along the internal stinger axis. This improves the efficiency of testing significantly by eliminating most of the support and alignment work associated with conventional shaker testing.

The shaker installation is the only time the operator needs to be in or under heavy vehicle bodies. The measurement can be performed remotely by only one operator located in a safe place as opposed to adding hammer measurements.

Transfer path analysis on vehicles requires a dedicated set of transfer functions from energy sources to target locations, such as ear pressure or seat rail vibration. If reciprocal measurements are not suitable, this shaker is small enough to excite typical engine or subframe mounting locations in three directions. By contrast, using hammer excitations provides inaccurate results and is often impossible to perform. The frequency range allows the user to capture transfer functions over the complete frequency range from 20 to 2,000 Hz.

In addition, its self-supporting and self-alignment features makes it a great exciter for modal analysis on components like engines and complete powertrains – for example, the average RMS force level is 6 N over the frequency range of 20 to 2,000 Hz.

**Key benefits**

- Optimized for use at difficult-to-reach locations
- Extremely low mass- and stiffness-loading
- Reduced measurement time due to easy and fast preparation
- Suitable for very wide range of noise and vibration analysis

**Key features**

- Extremely small and powerful shaker for TPA and modal applications
- Wide frequency range: 20 to 2,000 Hz
- Self-suspending and self-aligning with unique 3D internal stinger system
- Internal force and acceleration measurement sensors
- Built-in protection electronics

**Application**
Transfer path analysis
Frequency-based substructuring
Modal analysis
Attachment point mobility measurements

**Physical specifications**
Dimensions: 42 x 72 mm
Total mass: 0.35 kg
Mass loading of the test structure: 16 grams

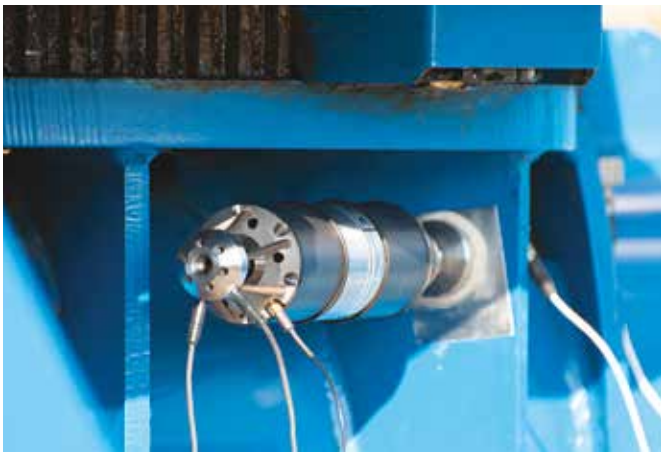
**Performance**
Frequency range for random testing: 20 to 2,000 Hz
Frequency range for sine testing: 40 to 2,000 Hz
Force level: 6 $N_{rms}$
Internal sensors type: ICP

**Supplied accessories**
User manual
Signal and power cables
Electronic protection device
Flight case
Sensitivity sheet reference sensors

**Product requirements**
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar

**Options**
LMS Qsources measurement amplifier
LMS Qsources sensitivity measurement
Excitation hardware application training

# Thumper shaker



The LMS Qsources thumper shaker is a compact, very low frequency shaker intended for the 5 to 200 Hz frequency range. The thumper shaker typically replaces instrumented sledgehammer applications and is able to excite where hammer excitation is not possible because of space constraints. The lack of any external support enables fast instrumentation, and there's no need to align the shaker, the force sensor and the test object. The shaker is mounted to a test structure by glued-on rings. They can be glued onto any test object in any orientation.

The thumper shaker's lean design makes it possible to excite in narrow spaces around machinery. The force level makes it possible to apply it to large structures such as ships, windmills and chemical industry installations for modal or other analyses. An automotive application is available for the measurement of quasi-static deformation of vehicle bodies.

### Supplied accessories
Flight case
Sensitivity sheet reference sensor

### Physical specifications*
Dimensioning: 200 x 45 mm
Weight, excluding cable: 1 kg
Effective frequency range: 5 to 200 Hz
Frequency range force sensor (±2 dB): 5 to 1,100 Hz
Maximum force level**: 25 $N_{rms}$
Maximum peak-to-peak displacement: 40 mm
Output signal conditioning requirement: ICP
Mass loading axial/radial: 150/800 g

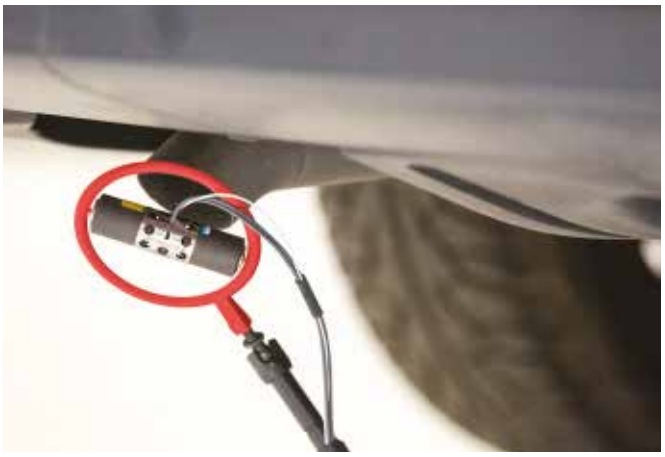
* Performances and dimensions of the device, as stated above, are only an approximation
** When used with broadband continuous random noise between 5 and 30 Hz

### Product requirements
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar

### Key benefits
- High force in lean design
- Fast installation
- Integrated axial force sensor
- Very low frequency excitation
- Excitation in any mounting orientation

### Key features
- RMS force level up to 30 Nrms
- Self-supporting and self-aligning
- A 40 mm peak-to-peak displacement
- Full electric isolation from the test-structure
- Very low electromagnetic straw field
- Suitable for random, large amplitude chirp and sine signals

# Miniature volume source



The LMS Qsources miniature volume source has been developed to acquire acoustic FRFs at low and mid frequencies without disturbing the acoustic sound field by its presence. The source incorporates electrodynamic actuators and an internal sound source strength sensor. It outputs a real-time volume displacement signal, practically independent from the acoustic environment.

Its miniature size allows accurate acoustic transfer function measurements around intake and exhaust nozzles for airborne source quantification techniques. The FRFs are acquired without the influence of a large low-/mid-frequency source. Its size allows it to excite structures from the inside.

In addition to airborne source quantification (ASQ), the source can be used for scaled modal analysis using the internal volume displacement sensor as a reference.

### Application
Airborne source quantification
Transfer path analysis
Vibro-acoustic modal analysis

### Physical specifications
Dimensions: 71 x 22 mm
Mass: 0.20 kg

### Performance
Frequency response sensor (±2 dB): 50 to 1,000 Hz
Internal sensor type: Voltage
Source input impedance: 8 ohm nominal
Power amplifier requirement: 50 W and 20 Vrms

### Supplied accessories
User manual
Flight case
Sensitivity sheet reference sensor

### Product requirements
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar

### Options
LMS Qsources measurement amplifier
LMS Qsources sensitivity measurement
Excitation hardware application training

### Key benefits
- Fast reciprocal FRF acquisition
- Miniature design
- Accurate internal volume displacement sensor
- Wide frequency range

### Key features
- Calibrated sound source for low- and mid-frequency FRF measurements
- Monopole characteristic
- Frequency range: 50 to 1,000 Hz
- Real-time accurate volume displacement signal
- Built-in protection electronics

# Low-/mid-frequency volume source

Since 1996 almost every original equipment manufacturer (OEM) and many automotive suppliers in the world use these sources for improving the acoustic performance of their products on a complete system level.

Volume acceleration sound sources are sophisticated acoustic excitation devices. The source is capable of producing very high noise levels, more than sufficient for the excitation of complete vehicles. The integrated volume acceleration sensor gives real-time feedback on the emitted source strength and can be used as a reference for FRF measurements without any postprocessing.

The LMS Qsources low-/mid-frequency source is designed to be used in the 10 to 1,000 Hz frequency band, which is an important frequency band in vehicle development. This source is typically used for transfer path analysis of structure-borne or airborne noise, cabin vibro-acoustic modal analysis and frequency-based substructuring.

Because most applications are for seat positions, the device is optimized for quick positioning on a seat with the acoustic center at ear location, which is compliant with International Organization for Standardization (ISO) 5128.

For linear systems, the reciprocity principle applies. As a vehicle can be seen as a linear system in practice, the input and output can be switched, allowing the introduction of acoustic energy at the ear location and measurement of acceleration at many force input points such as the connection of the suspension/exhaust/engine to the body.

This results in a shorter FRF acquisition time as it is not necessary to excite the system at every force input location with a hammer.

The unique properties of this low-/mid-frequency source include compact, human body diffraction simulation, omnidirectional, time-stable sensitivity and high noise levels. These features make this device extremely accurate and efficient for the analysis of transport vehicles like cars, vans, trucks, buses, trains and aircraft.

To complete the service, a yearly sensitivity determination of the internal reference sensor is available via your local office. A one- or multiple-day training provides the engineer with the necessary knowledge about these sources.

**Key benefits**

- Fast reciprocal FRF acquisition
- Accurate internal volume acceleration sensor
- High sound pressure level
- Human torso diffraction effect

**Key features**

- Volume acceleration sound source for low- and mid-frequency FRF measurements
- Frequency range: 10 to 1,000 Hz
- Real-time accurate volume acceleration signal
- Built-in protection electronics

**Application**
Airborne source quantification
Transfer path analysis
(Vibro)-acoustic modal analysis
Acoustic waveform replication
Statistical energy analysis

**Physical specifications**
Dimensions (torso): 245 x 380 x 790 mm
Dimensions (minimum): 245 x 380 x 485 mm
Mass: 9 kg

**Performance**
Frequency response sensor (±2dB): 10 to 1,000 Hz
Internal sensor type: ICP
Source input impedance: 14 ohm nominal
Power amplifier requirement: 31 Vrms

**Supplied accessories**
User manual
Flight case
Sensitivity sheet reference sensor

**Product requirements**
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar

**Options**
LMS Qsources measurement amplifier
LMS Qsources sensitivity measurement
Excitation hardware application training

# Mid-/high-frequency volume source

The LMS Qsources mid-/high-frequency source is a general use monopole volume acceleration source with an internal reference sensor. It is used by many research and development (R&D) centers in various industry segments.

Automotive OEMs use these acoustic monopole sources for dedicated investigations like transfer path analysis, airborne source quantification and other NVH-related measurements and analyses.

These sources are also in use by full vehicle NVH departments for validation of the high frequency sound package of a prototype. When following up the status of the sound package during a new vehicle development, engineers appreciate the accuracy and the speed with which the reciprocal transfer functions can be measured.

Component suppliers in the industry use these sources to investigate vibro-acoustic behavior of components like engines, transmissions, air conditioning units or other auxillaries. The sound source level in combination with the frequency range makes this source a versatile measurement device designed to meet the needs of NVH R&D departments.

To support pass-by noise engineering, a high frequency source has been optimized which allows to measure acoustic FRFs from 150 to10,000 Hz. That same source (Q-MHF-WIDE) also offers significantly higher noise levels at frequencies over 5 kilohertz (kHz), making it suitable for vibro-acoustic FRF measurements from interior to body interfaces and acoustic FRF measurements to other vehicle cavities.

The negligible diffraction makes it an accurate omni-directional sound source. The reference sensor is integrated at the aperture of the nozzle and measures the volume acceleration accurately. The sensor is practically independent from the acoustic environment where the source is used.

Sophisticated electronics are integrated into the source to protect the acoustic driver against excessive power, making the source a reliable and durable device.

To complete the service, a yearly sensitivity determination of the internal reference sensor is available via your local office. A one- or multiple-day training class provides the engineer with the necessary knowledge.

To deal with the challenges associated with issues such as pass-by noise and electrical drivelines requiring a wider frequency band and higher noise levels, the LMS Qsources high noise level version (Q-MHF-WIDE) is offered.

**Key benefits**

- Fast reciprocal FRF acquisition
- Accurate internal volume acceleration sensor
- High sound pressure level
- Lightweight compact design

**Key features**

- Volume acceleration sound source for mid- and high-frequency FRF measurements
- Omnidirectional and negligible diffraction
- Real-time accurate volume acceleration signal
- Built-in protection electronics
- Frequency range: 200 to 10,000 Hz
- Special wide frequency high noise level source optimized for high frequency excitation and pass-by noise engineering

**Application**
Airborne source quantification
Transfer path analysis
(Vibro)-acoustic modal analysis
Statistical energy analysis
Vehicle/body airborne isolation
Body panel and trim transmissibility

**Physical specifications**
Diameter nozzle: 30 mm
Tube length: 4 m
Mass: 6 kg

**Performance**
Frequency response sensor (±2 dB): 200 to 10,000 Hz
Internal sensor type: Voltage

**Supplied accessories**
User manual
Flight case
Sensitivity sheet reference sensor

**Product requirements**
LMS Qsources measurement amplifier
LMS Test.Lab spectral acquisition or similar.

**Options**
LMS Qsources measurement amplifier
LMS Qsources ICP type reference sensor (Q-MHF-ICP)
LMS Qsources high noise level version
LMS Qsources sensitivity measurement
Excitation hardware application training

# Low frequency monopole source

The LMS Qsources low frequency monopole source is an omnidirectional noise generator combined with an internal sound source strength measurement. The reference sensor is independent from the acoustic environment where the source is used.

It can excite the passenger and trunk cavity easily to measure FRFs without changing the cavity dynamics to perform accurate acoustic modal analysis. This source therefore allows you multiple source excitation for accuracy and efficiency. This high output source allows you to measure the typical vibro-acoustic body noise transfer functions directly and reciprocally on a complete vehicle.

The Q-MED also measures the FRF sets for pass-by noise engineering. Acoustic FRFs from target microphone to dominant sound sources in and around the vehicle.

### Application
Vibro-acoustic cross vehicle FRF testing
Acoustic modal analysis passenger cavity
Pass-by noise engineering
Airborne source quantification
Transfer path analysis

### Physical specifications
Diameter: Ø71 mm
Length: 200 mm
Mass: 1.9 kg
Mounting thread: M6
Sensor connector: 10 to 32 male microdot
Amplifier connection: banana

### Performance
Frequency response sensor (±2dB): 20 to 1,200Hz
Sensor type: Voltage alternating current ($V_{AC}$)

### Supplied accessories
Manual
Flight case
Sensor sensitivity sheet

### Product requirements
LMS Qsources amplifier
LMS Test.Lab spectral acquisition or similar

### Options
Measurement amplifier [Q-AMP230V]
Sensitivity measurement
Support solutions
Training

### Key benefits
- 1kHz monopole source
- Low frequency source
- Compact design

### Key features
- Dual-driver technology
- Omnidirectional and negligible diffraction
- Real-time volume displacement signal
- Integrated driver protection electronics
- Frequency range vehicle  FRF: 30 to 1,000 Hz
- Frequency range acoustic modal analysis: 5 to 1,000 Hz

# Measurement amplifier

### Application
Compatible with LMS Qsources exciters
Mid-/high-frequency volume source (Q-MHF)
Low-/mid-frequency volume source (Q-LMF)
Miniature volume source (Q-IND)
Integral shaker (Q-ISH)
Miniature shaker (Q-MSH)
Thumper shaker (Q-TMP)
Custom LMS Qsources solutions

### Physical specifications
Dimensions: (L-W-H) 280 x 165 x182 mm
Mass: 2.15 kg

### Performance
Maximum input signal voltage: 10 Vpeak
Maximum output voltage: 31 Vrms
Maximum output current: 6.5 Arms
Amplification (relative to input signal): 32 to 28 dB
Amplification accuracy: 0.5 dB
Frequency range (+1 dB/-3 dB): 10 to 40,000 Hz
Minimum/maximum output load impedance: 3/100 ohm
Self-noise level: < 20 dB(A)
Signal to noise ratio: > 110 dB

### Supplied accessories
User manual
Power cable
Flight case

### Key benefits
- Built-in protection electronics securing connected exciters
- Connectors are on the front allowing fast test setup
- One amplifier for all LMS Qsources hardware
- Low self-noise level

### Key features
- High-power output
- Negligible self-noise level
- Robust lightweight housing

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