Brüel & Kjær TRANSDUCERS AND CONDITIONING

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WELCOME

Brüel & Kjær supplies integrated solutions for the measurement and analysis of sound and vibration. As a world leader in sound and vibration measurement and analysis, we use our core competencies to help industry and governments solve their sound and vibration challenges, leaving them free to concentrate on their primary tasks: efficiency in commerce and administration.

Our Mission is to help our customers measure and manage the quality of sound and vibration in their products and in the environment.

Our Vision is to be the first-choice long-term business partner, delivering innovative technical solutions that create sustainable value for our customers.

THE WHOLE MEASUREMENT CHAIN

Brüel & Kjær delivers advanced technological solutions and products of renowned quality. These cover the entire sound and vibration measurement chain, from a single transducer to complete turnkey systems.

PRODUCTS

Our market-leading product portfolio covers all of the components and tools required for high quality measurement and analysis of sound and vibration. We are unique in the industry, allowing you to source all of your components from one supplier.

SYSTEMS

Our products are designed to fit together and cooperate intelligently. This simplifies the process of creating systems optimised to solve your specific issues.

SOLUTIONS

In certain instances, we supply both the systems as well as highly-skilled engineers to operate them and supply analysis results – meaning you can focus on your core business without worrying about operating and maintaining equipment.

SERVICES

We offer a full range of services for our products and systems including: installation, training, support, software updates, calibration, planned maintenance, repair and rental.

QUALITY ASSURANCE

All products, systems and solutions are thoroughly tested in harsh environmental conditions. Our status as an ISO 9001-certified company gives you the peace of mind that extremely high standards are always met.

CUSTOMER-DRIVEN

Our most important skill is listening to the challenges customers meet in their work processes, where increasing functional demands, time pressures, regulatory requirements and budget constraints mean that getting it right the first time is becoming ever more critical. Receptive dialogue allows us to fully understand specific customer needs and develop long-term sound and vibration solutions.

Responding to the challenges faced by our customers has lead us to cover a diverse range of applications including: traffic or airport noise, car engine vibration, evaluation of building acoustics, cabin comfort in passenger aeroplanes, production quality control, and wind turbine noise. Over the years, we have developed creative and technically advanced solutions to innumerable customer problems, some of which you can see on our website at: www.bksv.com/casestudies.

LOCAL ACCESS TO A GLOBAL ORGANISATION

Brüel & Kjær is a global company. We operate through our network of sales offices and representatives in 55 countries. These local teams are supported by our global group of engineering specialists, who can advise on and solve all manner of sound and vibration measurement and analysis problems. To augment our service, we regularly hold local courses and road-shows, and participate in sound- and vibration-focused exhibitions and conferences worldwide

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Transducers have been a core part of Brüel & Kjær's business for more than 70 years. The quality of our transducers is world renowned and is the result of our unique experience and knowledge, backed up by meticulous testing and quality control, which ensures that you get the performance and durability you expect.

To Brüel & Kjær, quality is not measured by product performance or durability alone. We also strive to provide excellent support to our customers throughout the relationship, from initial enquiry to after-sales services. We take pride in providing the entire measurement chain – from the tiniest accessory to whole systems and solutions.

Top Quality

In all aspects of sound and vibration there are challenges to be met. For example, making sure that the car that one takes to work each day can withstand the mechanical shocks imposed on it, demands measurements of accuracy and precision. This requires instruments with the performance and quality to match. All our products are thoroughly tested, often in the harshest environmental conditions. Extremely high standards are met in all aspects of product and service provision, as reflected in our status as an ISO 9001 certified company. Legislation also sets exacting standards. This often means documented results that are traceable to known sources, such as a national calibration laboratory. And naturally, the support customers receive must always be the most reliable.

Development and Production of Brüel & Kjær Transducers

Based on input from our customers, their requirements, and our own product development plans, we determine the specification of a new transducer. Initially, analytical tools including a finite element model (FEM) and other simulation tools based on our decades of experience are created. From these models we can begin to optimise the performance of the new design. The models reduce development time so the first units reach customers faster with the specified performance.

Engineers discussing a finite element model (FEM)

Testing and Verification

Models can only take the design so far. Brüel & Kjær also has decades of design and manufacturing experience to draw on in creating transducers of the best value with excellent long-term stability. Following verification of the mathematical model, the next step in the development of a new transducer is to construct several prototypes. In addition to testing and verifying against the FEM, each prototype is also subjected to:

- Environmental testing – heat, humidity, etc.
- EMC (electromagnetic compatibility)
- Base strain
- Measurement accuracy
- Destructive testing

Electrostatic discharge immunity test as part of EMC testing

There are many external inputs that can cause measurement errors in a transducer and affect the accuracy of the measurement. Therefore, it is extremely important to know how sensitive each type of transducer is to these external parameters. The sensitivity to unwanted external sources can only be accurately determined using advanced testing techniques and Brüel & Kjær has developed its own testing equipment for this purpose. Of course, each design will have its own unique response to external environmental factors. We document each design's sensitivity to its environmental and more in our detailed Product Data sheets. Understanding how to make good measurements is where we add value, we have a support engineer available by phone, on the web or in person to answer your question and share best practices. Additionally, we have a wealth of information in our Transducer Handbooks, Application Notes and Technical Reviews, all available at www.bksv.com.

Production – Test, Test and Test Again!

Ongoing testing, verification, and artificial aging ensure that the quality of the manufactured product is always maintained.

Every Brüel & Kjær transducer is thoroughly tested during its production to ensure that its performance is within the specified parameters on the Data Sheet. Extremely high standards are met in our production quality and this is reflected in our status as an ISO 9001 and EN 9100 certified company. Depending on the type, a transducer can be subjected to between five and ten separate test procedures.

If any problems are detected during normal production verification, we have extensive in-house test equipment including:

- EMC
- Climatic testing
- Base bending
- Shock, etc.

This gives our engineers the tools to quickly identify the root cause, fix the underlying problem and resume normal production to make timely delivery with the quality you expect from Brüel & Kjær

Final Calibration

An individual calibration is performed on each microphone and accelerometer during production or in our calibration laboratory. Although a frequency calibration at a limited number of frequencies is easier to perform and simpler to document traceablity back to a national standard, our experience is that a modern calibration technique based on FFT analysis provides the resolution needed to detect certain types of problems. Our unique status as not only a manufacturer of transducers but also the primary Danish standards labs reduces our traceability steps back to a primary standard which reduces the uncertainty in our calibrations.

Implementation of TEDS

A wide range of TEDS (Transducer Electronic Data Sheet) transducers are available from Brüel & Kjær. TEDS is standardised by the Institute of Electrical and Electronics Engineers (IEEE) and is supported by many front-ends and conditioning amplifiers including Brüel & Kjær's PULSE LAN-XI data acquisition, VC-LAN Vibration Controllers, the NEXUS line of conditioning amplifiers, the 16-channel Conditioning Amplifier Type 2694 and many more.

TEDS offers a number of benefits:

- Plug and play facilities
- Type, S/N, sensitivity and more read in directly from the transducer
- Significantly reduced setup time
- Practical elimination of cable routing errors

How Does TEDS Work?

Basically the chip containing the TEDS data and TEDS interface is built into the transducer. TEDS data is updated during the measurement system's boot sequence or whenever "update TEDS" is activated.

TEDS data can be transmitted to the front-end in two different ways:

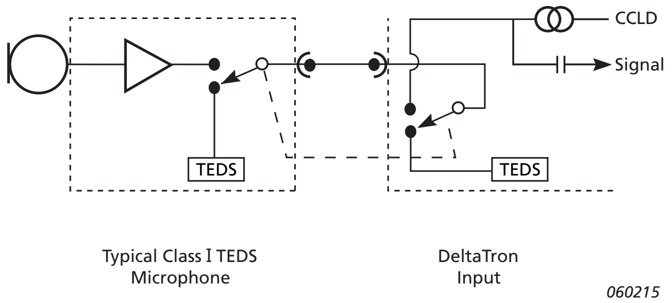
- Class I TEDS: On the same wire as the analogue signal
- Class II TEDS: Via a separate wire

Class I is always used with CCLD transducers since TEDS can be implemented using the traditional coaxial cable.

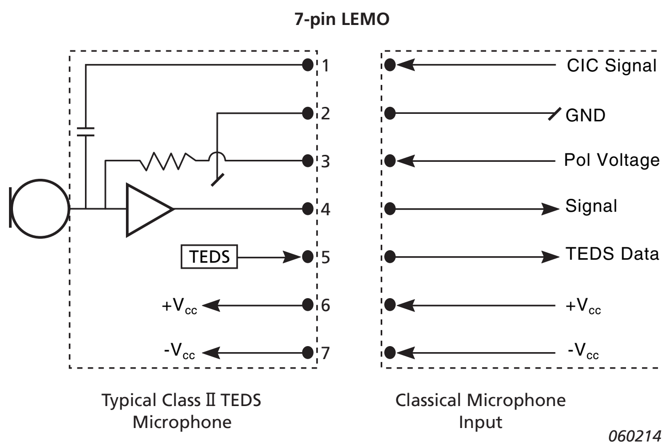
For measuring microphones, either Class I or Class II can be used depending on the preamplifier, where the actual TEDS chip is located. When Class II is used, pin 5 (often denoted as "No connection" in earlier product data) is used to transmit the TEDS data. This is important when using extension cables as some older cables might really not have pin 5 connected, which will break the TEDS chain.

The TEDS microphone and preamplifier bundles are assembled under controlled conditions, which means that special precautions are taken to avoid dust and contamination entering the boundary between microphone cartridge and the preamplifier. This is important in order to maintain low noise even at high temperatures and high relative humidity. It is also important that when TEDS, Class I or II, is used with microphones that the microphone stays with the preamplifier it was programmed with since the preamplifier is where the TEDS information of the specific microphone is actually stored. To avoid this error, many Brüel & Kjær microphones are permanently connected to their preamplifiers

Example of Class I TEDS transducer as used in a CCLD TEDS microphone



Example of Class II TEDS as used in a TEDS microphone



The IEEE 1451.4 Standard

Currently the version programmed and the actual chip used to store the transducer's TEDS information is in transition. Most sound and vibration transducers (Brüel & Kjær as well as other manufacturers) conform to IEEE P1451.4 V.0.9 which is actually a standard proposal and differs slightly from the final standard IEEE 1451 V.1.0.

Re-mapping to IEEE 1451 V.1.0 is available for all Brüel & Kjær transducers at time of order or as part of after-sales service. Relevant Brüel & Kjær hardware (PULSE, NEXUS, etc.) support both the proposed and final version of the standard, and in many applications the user will not notice a difference between the two standards. The major difference between the proposed and final version concerns the memory map. In the proposed version, all data is in a R/W area of the memory, while in V.1.0 some permanent data (manufacturer, etc.) has been moved to a write once area of the memory. This leaves more space in the "user area" of the memory.

Currently, Array Microphone Types 4957, 4958 and 4959 are supplied with TEDS according to the final revision – IEEE 1451.4 V.1.0.

TEDS Templates

The TEDS template defines the memory mapping of the TEDS chip and hence the "understanding" between transducer and front-end.

A number of TEDS templates have been standardised by the IEEE and in addition to this, a number of non-standard vendor specific templates exist. The different TEDS templates are differentiated by different ID numbers.

See TEDS Microphones for a listing of the templates used with Brüel & Kjær microphones and preamplifiers.

Ordering Transducers

To order from Brüel & Kjær, you just need to know an item's order number. For transducers and signal conditioners, these will be a number preceded by the word "Type". For example:

- 1/2-inch Prepolarized Microphone Type 4188
- Miniature Triaxial DeltaTron Accelerometer Type 4520
- Charge to DeltaTron Converter Type 2647

A transducer may have several models that vary from each other (different sensitivity, interface or accessories). This is denoted by a letter after the number, by a dash (-) and three alphanumeric characters, or a combination of a letter and then three alphanumeric characters, for example:

- Charge to DeltaTron Converter Types 2647-A, 2647-B and 2647-C
- Miniature Triaxial DeltaTron Accelerometer Types 4520-001 and 4502-004
- 1/2-inch Free-field Microphone including High-temperature Preamplifier Type 1706 with TEDS Type 4189-H-041

There are some general rules within transducer families relating to the letter:

- For CCLD accelerometers, a "B" in the type number indicates that the transducer contains TEDS
- For microphones:
  – "A" or "H" in the type number indicates a CCLD preamplifier with TEDS
  – "B", "C", or "L" in the type number indicates a 7-pin LEMO preamplifier with TEDS

For accessories, the order number is an alphanumeric code starting with two letters. For example:

- AO-xxxx: Extension Cables
- UA-xxxx: Adaptor and Mounting Clips
- YM-xxxx: Adhesive Mounting Pads
- YJ-xxxx: Glue and Adhesives
- QS-xxxx: Glue and Adhesives

Each transducer has a Product Data sheet (PD) with ordering information – including all required accessories. You can find transducer PDs on www.bksv.com.

Customisation

Despite the large number of transducers available in Brüel & Kjær's standard selection, special measurement situations can occur requiring a transducer that cannot be met by our standard product range. In order to effectively meet our customers' needs, we offer customised products.

We already have a broad portfolio of non-standard products developed for special applications. For further details on what Brüel & Kjær can offer for special applications, please contact your local representative.

A Heritage of Excellence

Brüel & Kjær has more than 70 years of proven commitment to continuous product improvement and groundbreaking new innovations in measurement transducers.

Milestones in Brüel & Kjær Microphone History

First Generation	1956		Type 4131	World's first volume-produced measurement microphones, Types 4131 (free-field) and 4132 (pressure-field), developed, amongst others, by Dr. Per V. Brüel
	1967		Type 4138	World's first 1/8" measuring microphone. Due to on-going product improvements, this type is still available
	1975		Type 4160	Brüel & Kjær is requested to produce a replacement for the Western Electric WE 640 AA Reference Microphone. As a result, Type 4160 and later the ½" Type 4180 were introduced (still the world de facto acoustical standards)
	1980		Type 4155	Brüel & Kjær launches the world's first high-stability, measurement grade, electret microphones
	1984		Type 4179	Using advanced modelling and clever design, this microphone has a noise floor of –2.5 dB(A), still unbeaten after nearly 30 years!
Falcon Range	1987		Type 4182	Brüel & Kjær introduces probe microphone for measurement in extremely confined spaces and up to more than 600ºC
	1993		Type 4188 *	Falcon series is introduced. Featuring stainless steel, press-fitted diaphragms, these microphones result in a step change in microphone technology
	1994		Type 4189	Falcon series at peak performance. Type 4189 is probably the world's most popular ½" free-field microphone
	2000		Type 4297	The world's only one-unit Sound Intensity Calibrator enables calibration without dismantling the probe
Titanium Generation	2003		Type 4948 *	Surface Microphone – a Brüel & Kjær first: an "all titanium" sensor originally developed for aerospace applications
	2004		Type 4949 *	Surface Microphones now also find their way into the automotive industry, where they break new frontiers in wind-tunnel testing
	2005		Type 4952 *	World's first outdoor microphone where all parts exposed to the weather are made from polymer materials
	2006		Type 4955 *	Continuing the "All Titanium" concept, this TEDS microphone has 1.1 V/Pa sensitivity and a typical noise floor of 5.5 dB
	2009		Type 4961	Multi-field Microphone – world's first ¼" measurement microphone that guarantees accurate and error-free measurements in both free and diffuse fields and at any angle
	2012		Type 1706	World's first microphone preamplifier that can handle temperatures up to +125°C/+257°F

Pictures are not to scale

* Utilising one or more Brüel & Kjær patented principles

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Milestones in Brüel & Kjær Accelerometer History

Year	Type	Description
1943	Type 4301	World's first commercial piezoelectric accelerometer made from Rochelle salt crystals and developed by Dr. Per V. Brüel
1957	Type 4310	Brüel & Kjær's first lead zirconate titanate (PZT) accelerometer
1971	Type 8305	Brüel & Kjær's standard reference accelerometer based on an inverted, centre-mounted compression design with quartz crystal piezoelectric element, ensured a high degree of accuracy for calibration
1974	Type 4366	This all-titanium accelerometer was the first based on Brüel & Kjær's patented DELTASHEAR® design. Still in use today, the construction is regarded as one of the all-time, classic accelerometer constructions
1977	Type 4374	The first miniature accelerometer with a PlanarShear design - extending the frequency range of Brüel & Kjær Shear design
1985	Type 4390	World's first accelerometer with constant voltage line-drive (CVLD) built-in preamplifier
1985	Type 8317	Brüel & Kjær's first and highly reliable industrial DELTASHEAR® accelerometer suitable for permanent vibration monitoring in potentially explosive environments
1996	Types 4507 and 4508	World's first dedicated modal shear accelerometer family
1998	Type 4506	The world's first ORTHOSHEAR® triaxial accelerometer - one seismic mass for optimized noise floor and orthogonality
1999	Type 4507-B	Another world first - an accelerometer with integrated TEDS (Transducer Electronic Data Sheet)
2005	Type 4524-B	The first miniature triaxial accelerometer with integrated TEDS
2008	Type 4526	A THETASHEAR®, CCLD accelerometer for applications up to 180°C (356°F) – the highest temperature for an accelerometer with built-in preamplifier in the industry
2012	Type 8347-C	Wide temperature range (–321 to +900° F (–196 to +482°C)) industrial accelerometer with superior temperature transient performance from Shear design
	Type 4527	This universal CCLD triaxial accelerometer never sits still on the shelf, and has the widest temperature and dynamic range
		Brüel & Kjær becomes AS/EN9100 certified within the scope of development, production and service of customer-specific accelerometers

Pictures are not to scale

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Brüel & Kjær supplies integrated solutions for the measurement and analysis of sound and vibration. As a world-leader in sound and vibration measurement and analysis, we use our core competencies to help industry and governments solve their sound and vibration challenges so they can concentrate on their primary task: efficiency in commerce and administration.

The Complete Solution

We are unique in the industry in producing all of the elements for complete sound and vibration test systems. Our goal is to create the most technologically advanced components, built to the highest quality and designed to save time and eliminate errors in the measurement process. We have an unequalled product range, but our real advantage lies within our ability to supply a complete solution.

Not only do the individual components meet the highest performance standards in the industry, they are also designed to interact and communicate with each other to provide unrivalled measurement security and user feedback. This allows us to create solutions that are targeted at optimising your work processes, to provide rapid, reliable results.

As the sound and vibration challenges facing industry are diverse – from traffic or airport noise, vibration in a car engine, evaluation of building acoustics, cabin comfort in a passenger aeroplane to production quality control or wind turbine noise, we have over the years developed creative and technically advanced solutions to innumerable customer problems. Some of the work we have done with customers is published as case studies.

Transducers in the Measurement Chain

Transducers are the vital first link in your measurement chain. As they stand on the front line and provide you with the raw data you need, it is critically important that they are trustworthy.

Brüel & Kjær has always set the standard that others have tried to follow and offers the industry's largest selection of transducers, to help you make the most accurate measurements possible.

In the following pages, you can learn about how Brüel & Kjær's wide range of transducers can be applied in such disparate fields such as Aerospace and Defence, Automotive/Ground Vehicles and Telecom/Audio.

Transducers for Aerospace and Defence Solutions

Ever-shortening design and development timeframes of modern aerospace and space programs demand 'right-first-time' engineering. The aerospace sector is seriously contemplating aviation efficiency and environmental issues, whilst defence industries have the added concerns of ensuring reliability and high performance of military systems, often under extreme conditions.

Recognising that high quality, goal-focused, time- and cost-efficient testing is critical to meeting program milestones, Brüel & Kjær addresses today's engineering needs by providing quality sensor solutions.

Whether turnkey solutions or dual-use application needs, Brüel & Kjær provides the aerospace and defence sectors with transducers that comply with common industry standards such as:

- BS EN ISO 9001:2008
- EN 9100:2009
- AS 9100 Rev. C

Brüel & Kjær's quality management system is applicable to: development, production, sales and service of customer-specific transducers.

Acoustic Test Suite

Whether your interest is exterior or interior noise, our acoustic test suite provides data acquisition and assessment systems to combat your noise problems by optimising noise performance, improving sound quality, and ensuring compliance with environmental legislation.

- Noise source mapping and location
- Wind tunnel and flight testing
- Engine and aircraft certification
- Acoustic material testing
- Cabin comfort and occupational health
- Ramp noise and sonic boom
- Underwater acoustics
- Hull monitoring
- Acoustic stealth and noise signature management

8103, 8104
8105, 8106

4961

4938-A-011

Environmental Test Suite

Reproducing realistic operational conditions in the laboratory is essential for qualifying the real-life integrity of structures to ensure durability. Whether for billion-dollar satellites, launchers, aircraft, instruments or structures, our comprehensive vibration test solutions provide a wealth of environmental test systems.

- Durability and acoustic fatigue testing
- Classical and pyro shock
- Sine, random, sine-on-random, random-on-random testing
- Shock response spectrum
- Kurtosion
- Field data replication

Rotating Test Suite

Vibration analysis of rotating machinery provides valuable information on engine health, reliability and performance. From R&D and production test cell applications to on-ground maintenance, our vibration measurement and analysis systems provide you with powerful machine analysis tools.

- Vibration analysis, monitoring and diagnostics
- Vibration data acquisition and analysis in engine test cells
- On-ground vibration check of aircraft engines
- Order analysis and autotracking
- Balancing and trim balancing
- HUMS transducers

Structural Test Suite

Structural dynamics testing is vital to understand and optimise the inherent dynamic properties of structures, to ensure reliable and safe operation. Our structural test suite offers complete systems for controlled excitation testing, real-life operational testing and test-FEA integration – from the smallest components to the largest assembled structures.

- Operating Deflection Shapes analysis
- Operational Modal Analysis
- Classical Modal Analysis
- Normal mode testing
- Structural dynamics modifications
- Model correlation and updating


Photo courtesy of Agusta Westland


Model of a total aeroplane during modal analysis

Transducers for Automotive/Ground Vehicle Solutions

Passenger vehicles such as cars, trucks, motorcycles, buses and trains continuously need to be more exciting and pleasant, while becoming safer and emitting less noise. This makes Noise, Vibration and Harshness (NVH) testing a key to competitive advantages for vehicle manufacturers.

Brüel & Kjær's expert knowledge of the industry, combined with extensive experience of customer-driven projects, allows us to cover the whole vehicle NVH development process. Our solutions range from vehicle NVH simulators for target setting, to spherical beamforming for 360-degree noise mapping.

We provide a wide range of engineering services to improve products or execute complete development programmes, in cooperation with global partners.

Interior NVH

Time Domain SPC enables engineers to calculate, listen to, and modify individual contributions to the vehicle occupants (both airborne and structure-borne), and assists with design and validation of programme NVH targets.

Sound Engineering

The NVH Simulator Suite auralises NVH data with advanced sound-simulation techniques, allowing you to efficiently communicate NVH targets to non-experts even before physical prototypes are available. The On-road Simulator allows evaluation of virtual vehicles, and even benchmarking of competitive vehicles under real driving conditions.

Powertrain Testing

Brüel & Kjær provides tools for efficient powertrain testing:

- Very high-temperature triaxial accelerometers
- Crankshaft angle analysis software
- Systems for measuring sound power versus RPM
- Holography systems for locating noise sources and measuring partial sound power versus RPM and crank angle
- Wide band noise source identification systems customised to fit engine test cells
- NVH simulators to evaluate powertrain components or complete powertrains in full vehicle context

Hybrid-electrical and electrical vehicles:

- Switching noise analysis, transient analysis, high-frequency beamforming, multi-field microphone with very low magnetic sensitivity for measuring in unknown sound fields
- NVH simulator for exterior vehicle noise
- Vibration testing of large batteries

Photo courtesy of Linamar Corporation, Inc.

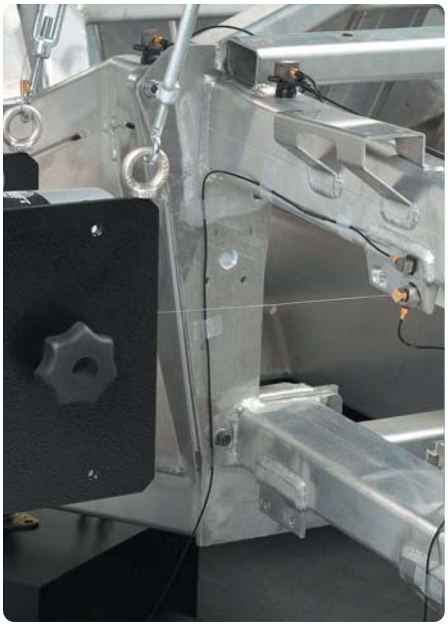
Structural Analysis

The Structural Dynamics Suite helps improve the dynamic behaviour of any structure. It includes Operating Deflection Shapes analysis covering the full set of methods (frequency, order, time), Classical Modal Analysis with a wide range of powerful curve-fitters, and Operational Modal Analysis.

Squeak and Rattle

Our unique equipment range ensures that automotive components and interiors are durable and free from noise, and supports industry-standard QA practices for squeak and rattle vibration testing.

- Low-noise shaker systems
- Sound quality analysis software
- Array-based systems for quick localisation of noise sources



Wind Tunnel Testing

Surface microphones on the exterior of a vehicle measure the pressure fluctuations at different positions, whilst beamformers placed outside the main airflow pinpoint the location of noise sources and quantify the relative noise contributions. When combined with a spherical beamformer inside the vehicle, a detailed noise cause-effect relationship is achieved using minimal testing time.

Exterior Noise

As community regulations put ever tighter restrictions on noise emission, our Vehicle Pass-by solutions offer complete support to ensure compliance with the latest standards. Adding moving-source beamforming enables noise source localisation and troubleshooting during measurements. Our Indoor Simulated Pass-by Noise System enables efficient comparison of design alternatives.

Transducers for Telecom and Audio Solutions

Manufacturers of electroacoustic equipment such as loudspeakers, microphones, telephones, headsets, hearing aids and hydrophones deliver successively high-quality acoustical designs by continuously innovating their products and processes.

Acoustic performance has become increasingly important as users demand high quality audio in every situation, whether reproducing sound or transmitting speech. Measuring and documenting the acoustic performance, therefore, is a key element in the product improvement process, during both its development and manufacture.

Brüel & Kjær has a long tradition of close connections with the fields of telecommunications and audio, pioneering many methods that are now standard practice all over the world.

Today, based on our accumulated knowledge and experience, we offer a variety of electroacoustic test systems, audio analyzers, and transducers for electroacoustic applications.

Electroacoustic Test Systems

Our experience of providing quality acoustic solutions gives us a solid background when developing new systems for emerging technologies and markets. Our range of dedicated electroacoustic test systems is eminently suitable for acoustic design, benchmarking, prequalification and conformance testing of mobile phones, tablets, VoIP phones, headsets, loudspeakers, etc.

The test system supports the entire workflow required by typical test procedures. This covers system calibration and verification, various acoustic measurement suites for evaluating the performance of devices under testing, and reporting. Tools for easy comparison of measurements as well as tools to hear and edit recordings are also available.

Vibration testing of telephone

Telephone test head

Audio Analyzers

With PULSE being one of the most commonly used platforms for conducting acoustic measurement, it forms a solid foundation for our audio analyzers. These offer a variety of analysis methods, covering traditional sine testing (using SSR and TSR), spectrum analysis (using FFT and CPB) for testing using real speech, and perception-based test methods.

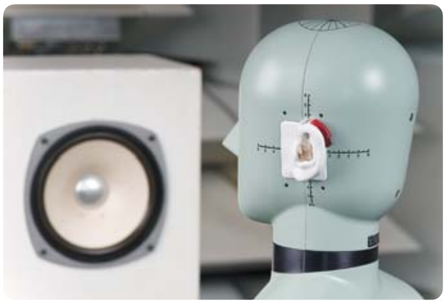
In combination with the dedicated hardware, this supports the audio engineer in achieving the acoustic design goals setup. Besides its measurement and analysis capabilities, PULSE also offers tools to automate test procedures, as well as reporting and data management tools for easy archiving and retrieving of measurement data and related information.

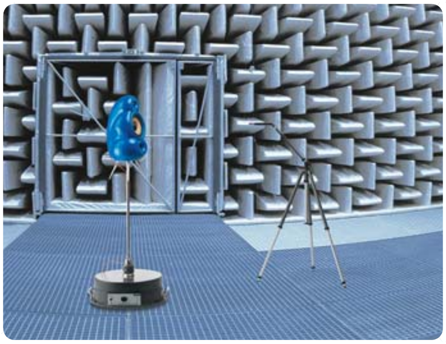
Transducers

To guarantee reliable acoustic measurements, most national standards laboratories use Brüel & Kjær reference microphones. Consequently, most acoustical measurement in the world ultimately refers back to Brüel & Kjær products.

A comprehensive portfolio of transducers supports standardised testing of telephones, hearing aids, headphones, headsets, ear phones, loudspeakers, receivers and many other applications.

Our range of acoustical transducers includes ear simulators, mouth simulators and microphones. All transducers supplied by Brüel & Kjær contain information about their actual sensitivity. When the transducer is connected to the analyzer this information is automatically transferred to the analyzer, ensuring that the proper setting is always used for the specific measurement task.





Brüel & Kjær offers a broad spectrum of solutions that respond to varying needs and applications. This adaptability is evident in the range of transducers designed for specific environments, industries, tasks and conditions, as well as general purpose instruments that provide a wide operational range.

Selecting the best transducer for a given measurement task can be understandably overwhelming. Our interactive transducer selection guide on www.bksv.com can be a big help to quickly narrow your choices. Alternatively, you can use the Microphone Matrix below to help you select the right microphone to fit your needs.

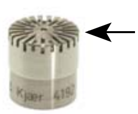
Condenser microphones:
- are either externally polarized or prepolarized
- come in different sizes: 1-inch, 1/2-inch, 1/4-inch, or 1/8-inch
- are optimised for either free-, pressure-, or diffuse-field

For a quick overview, product types are listed according to these classifications. Microphones that do not directly match one of these classes are denoted as “Special Microphones”.

1/8-inch microphones are pressure types. Due to their small size, the free-field and pressure response are approximately the same up to quite high frequencies (for example, the free-field correction is less than 1 dB at 15 kHz).

Mapping Brüel & Kjær measurement microphones in the Microphone Matrix is now a simple task.

The Microphone Matrix

Type of Microphone		Type 1/8-inch	1/4-inch	1/2-inch	1-inch	Polarization
	Free-field		4954	4137 4176 4188 4189 4950		Prepolarized
			4939	4190 4191	4145	Externally polarized
	Pressure-field		4944	4947 4948 4949 4953		Prepolarized
		4138	4938 4941	4192	4144	Externally polarized
	Diffuse-field			4942		Prepolarized
				4943		Externally polarized
	Special		4961 4958	4948 4949		Prepolarized
			4187, 4957 4938-WH-1418 4938-W-001	4180 4193 4955	4160 4179	Externally polarized

For Selection Consider the Following

Which kind of input module – classical or CCLD?
CCLD (including DeltaTron and IEPE) can only work with prepolarized types; classical input works with both prepolarized and externally polarized cartridges. For more information about CCLD and classical input see the preamplifier section. For portable instruments and where high humidity is present, prepolarized microphones are preferred. For more general use in the laboratory or where high temperature is present, the use of external polarised microphones is recommended.

Does the microphone have to fulfil any specific standard?
If this is the case, see Microphone Standards in the appendix.

Frequency range and maximum sound pressure level (SPL) will often determine which microphone size to use.

Generally a smaller microphone has a broader frequency range and a lower sensitivity. For more details, see Maximum Limits and Dynamic Range.

For which sound field should the microphone be optimised*?
For measurements made away from reflecting surfaces, for example, when making outdoor measurements, or in acoustically well-damped indoor environments, a free-field microphone is best. But for measurements made in small closed couplers, or close to hard surfaces, a pressure-field microphone is best. For measurements in enclosed areas where reverberation is likely, microphones optimised for diffuse-field (random-incidence) response are best. In some cases, pressure type microphones can also be found to have sufficiently flat random incidence response. This is because the random

* Optimised means that the microphone has a flat frequency response in the specified frequency range of the particular sound field

incidence response of a pressure-field microphone is much flatter across the frequency range than that of a microphone optimised for flat free-field response. A special case is the measurement of surface pressure where surface microphones would be the obvious choice.

Special application or condition?
For special applications, a special microphone can be selected, for example, laboratory standard microphones, outdoor microphones, array microphones, infra- sound microphones, etc. If the microphone is to be used in extreme temperature conditions, see Effects of Temperature for guidance.

Maximum Limits and Dynamic Range

Inherent Noise: Even if a microphone is placed in a "totally quiet" room there will be some Brownian movement of the microphone back-plate and diaphragm. These movements correspond to very small pressure fluctuations and will cause changes in the cartridge capacity which – if a polarisation voltage is present – cause an output voltage from the microphone. The SPL corresponding to this output voltage is defined as the inherent noise of the microphone cartridge.

3% Distortion Limit: Even though the condenser microphone is highly linear, at a certain pressure there will be some distortion of the output signal. At Brüel & Kjær we specify the 3% distortion limit as a recommended maximum limit for accurate measurements.

10% Distortion Limit: Increasing the sound pressure behind the 3% distortion limit will result in a further increase in distortion. In some cases, a 10% distortion limit is specified. In many practical cases, the 10% distortion limit is determined by the preamplifier.

Maximum SPL: Due to mechanical forces acting on the cartridge there is a maximum pressure level which should never be exceeded or the long-term stability can be influenced and/or mechanical damage can happen. The corresponding sound pressure level is called the maximum SPL.

Dynamic Range of Microphone/Preamplifier Combinations: In a practical application, the lower limit of dynamic range is determined by the combined noise from the cartridge and the preamplifier. The upper SPL limit will often be determined by the output voltage swing from the preamplifier. This is especially important when using CCLD preamplifiers, since here the maximum voltage is limited by the input stage compliance (open-circuit) voltage.

A compliance voltage of, say, 28 V as used in many front-ends will limit the maximum voltage swing to around 14 V_{pp} and this may determine the real maximum limit of a cartridge/ preamplifier combination.

Brüel & Kjær defines the dynamic range as the range from the noise floor in dBA to the SPL resulting in a 3% distortion limit with a given cartridge/preamplifier combination, and nominal compliance voltage where relevant.

The table below shows the maximum SPL as determined by the preamplifier. However, it must be mentioned that in some cases the maximum SPL is limited by the cartridge. This is especially true for classical input using ±40 V supply. On the other hand, a classical input with ±14 V supply will reduce the maximum SPL 9 dB compared with ±40 V supply.

Maximum measurable SPL in dB for different cartridge sensitivities, rounded to nearest integer value

Cartridge Sensitivity mV/Pa	CCLD ±7 V Output Swing	NEXUS ±40 V	PULSE ±14 V
50	134	149	140
31.6	138	153	144
12.5	146	161	152
3	158	173	164
1	168	183	174

The general formula is:

$$Max.\ SPL\ in\ dB = [94 + 20*\log(V_{max}/S_v)]$$

where V_{max} is the maximum (3% distortion) RMS output voltage of the preamplifier and S_v is the (loaded) cartridge sensitivity in V/Pa.

Measuring in Magnetic Fields

When performing sound measurements in magnetic fields like: on a hybrid or electrical car, close to wind turbine generators, close to big MR scanners or other similar equipment, it may be beneficial to use the latest Brüel & Kjær microphones made out of titanium, such as Types 4948, 4949, 4955 and 4961. The titanium is much less susceptible to magnetic fields than metals normally used in microphones.

The magnetic field impact is seen as noise and is increasing the noise floor of the microphone. For example:

- 1/4-inch Array Microphone 4958 has a susceptibility to magnetic fields corresponding to an equivalent SPL of 40 dB for an 80 A/m, 50 Hz field
- 1/2-inch Free-field Microphone Type 4189 has a susceptibility to magnetic fields corresponding to an equivalent SPL of 6 dB SPL for an 80 A/m, 50 Hz field
- Titanium microphone Types 4955 and 4961 have no detectable influence from an 80 A/m, 50 Hz magnetic field

The Effects of Temperature

What happens at high temperatures (above +80°C)?

- Electronic components may exceed their maximum junction temperature. This is very serious and should be avoided.
- Pre-polarized microphones may lose electret voltage. This will result in permanent sensitivity loss, which means, externally polarized microphones should always be used if high temperature tests are performed for longer periods of time
- The diaphragm tension will reduce. This means increased sensitivity and changes in frequency response
- The cable jacket and other isolators may melt. While this is not beautiful, it is not always catastrophic

- In practically all cases, an exponential increase in the inherent electronic noise must be expected. The basic rule of thumb: Many temperature depending factors will double for every 10° temperature increase (Arrhenius' law)

Microphones are specified at 23°C, and have a Temperature Coefficient which specifies how the microphone will behave with changed temperature. This parameter tells something about the microphones stability and quality. See the microphone's product data for information about its Temperature Coefficient.

General purpose microphones like Type 4189 perform well within their specifications in the temperature range from –30 to +150°C.

General purpose preamplifiers have a relatively stable DC bias up to around 80°C. They are specified from –20 to +60°C (–4 to +140°F), but work very well at temperatures of up to +80°C, with some increase in noise.

High-temperature Preamplifier Type 1706 is designed to perform up to 125°C. At high temperatures, it has a more stable DC bias point and no reduction of maximum SPL limit. The electrical noise increases at high temperatures, which affects the lower limit of the dynamic range of the microphone/ preamplifier combination and limits its ability to measure very low sound pressure levels.

In regards to the use of cables in high temperatures, you should note that PUR cables are not recommended. Consider silicone cables, which are rated at 150°C or PFA cables which function from –75 to +250°C, like cable AO-0406.

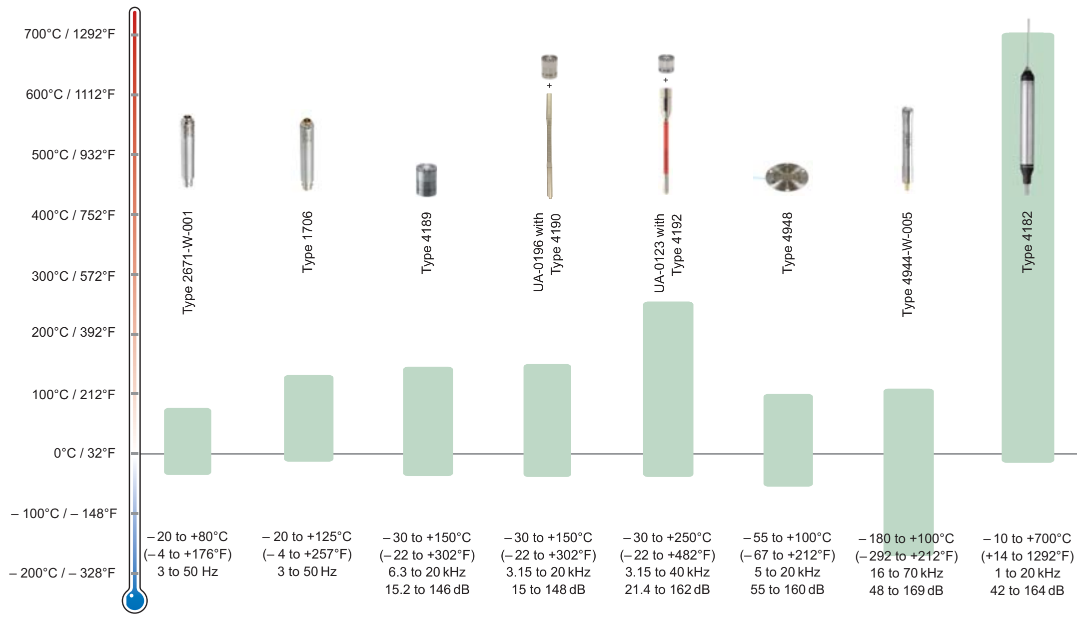
What if it gets real hot (+125°C)?

- You must get the preamplifier away from the hot spot
- Flush Mounting Kits UA-0122 and UA-0123 or Swan Neck UA-0196 are good tools to use
- Sometimes Probe Microphone Type 4182 will do the job

Probe Microphone Type 4182 allows sound pressure measurements to be made in small or awkward places or in harsh environments with high temperatures (up to 700°C). The probe microphone has a smooth frequency response from 1 Hz to 20 kHz, with a very smooth high-frequency roll-off. Measurements can be performed extremely close to the sound source due to its small size. Measurement points can be closely spaced when it is necessary to have high spatial resolution. The static pressure inside the probe microphone can be equalized to that of the measurement site.

Measuring in extremely cold temperatures (–160°C)

Type 4944-W-005 is a special microphone that is designed to handle measurements down to –180°C, which is perfect for use in, for example, cryogenic wind tunnels.



Replacement of Discontinued Brüel & Kjær Microphones

Most present Brüel & Kjær microphones are Falcon Range™ microphones. The Falcon Range offers a number of advantages, for example, the diaphragm mounting method (press fit mounted or laser welded) provides a higher mechanical robustness. Furthermore, the use of a stainless steel diaphragm results in an improved resistance to environmental conditions. The table can be helpful if you need to replace an older Brüel & Kjær microphone type.

Older Microphone Types	Recommended Replacement Microphone Types
4133	4191
4134	4192
4135	4939
4136	4938
4147	4193
4155	4189
4165	4190
4166	4943
4196/4935	4957
4198	4952
4951	4958
4181	4197
UA-1404	4952

Definition of Given Microphone Specifications

Standards

The following abbreviations for standards are used in the tables.

	IEC 61094		IEC 61672*		ANSI
A	IEC 61094–4 WS1F	**I**	IEC 61672 Class 1	**K**	ANSI S1.4 Type 1
B	IEC 61094–4 WS2F	**J**	IEC 61672 Class 2	**L**	ANSI S1.4 Type 2
C	IEC 61094–4 WS3F			**M**	ANSI S1.12 Type M
D	IEC 61094–4 WS1P				
E	IEC 61094–4 WS2P				
F	IEC 61094–4 WS3P				
G	IEC 61094–1 LS1P				
H	IEC 61094–1 LS2P				

* IEC 61672 is the sound level meter standard and is only applicable to the microphone when it is used with a sound level meter

PSI or dB?

Traditionally acoustical engineers work in dB SPL defined 20 × log (p_a/20 mPa) where p_a is the actual (dynamic) pressure in pascals.

Pressure sensors often refer to PSI (Pounds per Square Inch).

It may be good to know that dB SPL can easily be converted to pascal and after that to PSI.

1 Pa = 0.0001450 PSI and hence 1 PSI >> 6.9 kPa

dB SPL	Pressure Pascal	Pressure PSI
94	1	0.000145
154	10^3	0.145
174	10^4	1.45
194	10^5	14.5
200	2×10^5	29

Free-field Microphones

Free-field microphones are particularly suitable for performing measurements away from reflecting surfaces, for example, when making outdoor measurements with a sound level meter, or in an acoustically well-damped indoor environment such as an office with natural acoustic damping.

Type No.		**4939**	**4954**	**4137***	**4176**	**4188**	**4189**
Diameter	inch	1/4	1/4	1/2	1/2	1/2	1/2
Optimised		Free-field	Free-field	Free-field	Free-field	Free-field	Free-field
Standards		C	C	J, L	I, K	I, K	B, I, L
Nominal Open-circuit Sensitivity	mV/Pa	4	3.16	31.6	50	31.6	50
Polarization Voltage**	V	200	0	0	0	0	0
Optimised Frequency Response ±2 dB	Hz	4 to 100000	4 to 80000	8 to 12500	7 to 12500	8 to 12500	6.3 to 20000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	35 to 164 (2670)	35 to 164 (2670)	15.8 to 146 (2669)	14 to 142 (2669)	15.8 to 146 (2669)	15.2 to 146 (2669)
Inherent Noise	dB (A)	28	<35	14.2	13.5	14.2	14.6
Capacitance	pF	6.1	5.1	12	12.5	12	13
Venting		Side	Side	Rear	Rear	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	0.3 to 3	1 to 5	0.5 to 5	1 to 5	2 to 4
Operating Temperature Range	ºC	–40 to 150	–40 to 150	–30 to 125	–30 to 100	–30 to 125	–30 to 150
Temperature Coefficient	dB/ºC	+0.003	+0.009	+0.005	–0.004	+0.005	–0.001
Pressure Coefficient	dB/kPa	–0.007	–0.007	–0.021	–0.02	–0.021	–0.01

* Class 2 microphone for Type 2237 ** 0 V = Prepolarized microphone

Type No.		4190	4191	4950	4145
Diameter	inch	1/2	1/2	1/2	1
Optimised		Free-field	Free-field	Free-field	Free-field
Standards		B, I, L	B, I, L, M	I, K	A, I
Nominal Open-circuit Sensitivity	mV/Pa	50	12.5	50	50
Polarization Voltage*	V	200	200	0	200
Optimised Frequency Response ±2 dB	Hz	3.15 to 20000	3.15 to 40000	4 to 16000	2.6 to 18000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	15 to 148 (2669)	21.4 to 162 (2669)	14 to 142 (2669)	10.2 to 146 (2669)
Inherent Noise	dB (A)	14.5	20	13.5	10
Capacitance	pF	16	18	12.5	66
Venting		Rear	Side	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	1 to 2	1 to 2	0.5 to 5	1 to 2
Operating Temperature Range	ºC	–30 to 150	–30 to 300	–30 to 100	–30 to 100
Temperature Coefficient	dB/ºC	–0.007	–0.002	+0.006	–0.002
Pressure Coefficient	dB/kPa	–0.01	–0.007	–0.02	–0.015

* 0 V = Prepolarized microphone

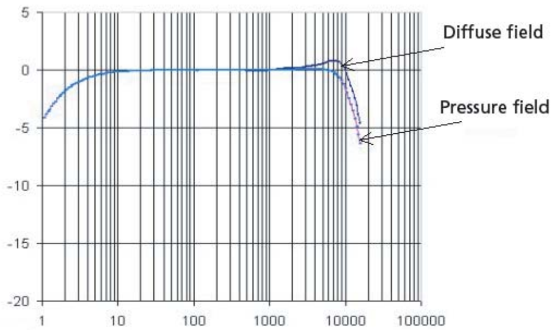
Diffuse-field Microphones

A diffuse-field microphone, also called a random-incidence microphone, is designed to have a flat response when signals arrive simultaneously from all directions. They should, therefore, not only be used for making measurements in reverberation chambers, but also in all situations where the sound field is diffuse, or where several sources contribute to the sound pressure at the measurement position. Examples include indoor measurements where the sound is reflected by walls, ceilings, and objects in the room, or measurements made inside a car.

Type No.		4942	4943
Diameter	inch	1/2	1/2
Optimised		Diffuse-field	Diffuse-field
Standards		K	K
Nominal Open-circuit Sensitivity	mV/Pa	50	50
Polarization Voltage*	V	0	200
Optimised Frequency Response ±2 dB	Hz	6.3 to 16000	3.15 to 10000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	15.2 to 146 (2669)	15.9 to 148 (2669)
Inherent Noise	dB (A)	14.6	15.5
Capacitance	pF	13	16
Venting		Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	2 to 4	1 to 2
Operating Temperature Range	ºC	–40 to 150	–40 to 150
Temperature Coefficient	dB/ºC	–0.001	–0.010
Pressure Coefficient	dB/kPa	–0.01	–0.008
Preamplifier Included		No	No

* 0 V = Prepolarized microphone

In many cases, the pressure- and diffuse-field responses will both be within ±2 dB up to a certain frequency. The graph shows that for Type 4943, both responses are within ±2 dB up to 10 kHz



Pressure-field Microphones

A pressure-field microphone is best suited for measurement of the sound pressure in a small closed couplers or close to hard reflective surfaces. A special class of pressure microphones is Brüel & Kjær's surface microphone, which due to its unique geometrical dimensions, can be mounted directly on surfaces such as the skin of an aeroplane or the surface of a car, for easy measurement of the true pressure fluctuations.

Type No.		**4138**	**4938***	**4944**	**4947**	**4192**	**4144**
Diameter	inch	1/8	1/4	1/4	1/2	1/2	1
Optimised		Pressure-field	Pressure-field	Pressure-field	Pressure-field	Pressure-field	Pressure-field
Standards		–	F	F	K	E, K, M	D, L
Nominal Open-circuit Sensitivity	mV/Pa	1	1.6	1	12.5	12.5	50
Polarization Voltage†	V	200	200	0	0	200	200
Optimised Frequency Response ±2 dB	Hz	6.5 to 140000	4 to 70000	4 to 70000	8 to 10000	3.15 to 20000	2.6 to 8000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	52.2 to 168 (2670 + UA-0160)	42 to 172 (2670)	46 to 170 (2670)	21.4 to 160 (2669)	20.7 to 162 (2669)	11 to 146 (2669)
Inherent Noise	dB (A)	43	30	30	17.5	19	9.5
Capacitance	pF	3.5	6.1	5	14	18	55
Venting		Side	Side	Side	Rear	Side	Side
Lower Limiting Frequency (–3 dB)	Hz	0.5 to 5	0.3 to 3	0.3 to 3	1 to 5	1 to 2	1 to 2
Operating Temperature Range	ºC	–30 to 100	–40 to 150	–40 to 150	–30 to 125	–30 to 150	–30 to 100
Temperature Coefficient	dB/ºC	–0.01	+0.003	+0.008	+0.006	–0.002	–0.003
Pressure Coefficient	dB/kPa	–0.01	–0.003	–0.003	–0.006	–0.005	–0.016
Preamplifier Included		No	No	No	No	No	No

* Type 4938-W-001 is optimised for high static pressure
† 0 V = Prepolarized microphone

Type No.		**4948**	**4948-A**	**4948-B**	**4949**	**4949-B**	**4956**
Diaphragm	inch	0.41	0.41	0.41	0.41	0.41	1/2
Optimised		Surface Pressure	Surface Pressure	Surface Pressure	Surface Pressure	Surface Pressure	Pressure
Standards		–	–	–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1.4	1.4	1.4	11.2	11.2	12.5
Polarization Voltage*	V	0	0	0	0	0	0
Optimised Frequency Response ±3 dB	Hz	5 to 20000	5 to 20000	5 to 20000	5 to 20000	5 to 20000	3.5 to 20000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	55 to 160	55 to 160	55 to 160	30 to 140	30 to 140	26.5 to 135 (2671-W-001)
Inherent Noise	dB (A)	55 (typical)	55 (typical)	55 (typical)	30 (typical)	30 (typical)	18.6
Capacitance	pF	N/A	N/A	N/A	N/A	N/A	13
Venting		Front	Front	Front	Front	Front	Front
Lower Limiting Frequency (–3 dB)	Hz	1 to 5	1 to 5	1 to 5	0.5 to 5	0.5 to 5	1 to 2
Operating Temperature Range	ºC	–55 to 100	–55 to 100	–55 to 100	–30 to 100	–30 to 100	–30 to 70
Temperature Coefficient	dB/ºC	0.013	0.013	0.013	0.013	0.013	–0.006
Pressure Coefficient	dB/kPa	–0.007	–0.007	–0.007	–0.007	–0.007	–0.009
Preamplifier Included		CCLD	CCLD	CCLD	CCLD	CCLD	N/A
TEDS UTID		769	769	769	769	769	N/A
CIC		No	Yes	Yes	No	Yes	N/A

* 0 V = Prepolarized microphone

Multi-field Microphone

Multi-field microphones are ideal for any situation in which the nature of the sound field is unpredictable, or the direction of the dominant noise source is difficult to pinpoint or shifts over time.

Brüel & Kjær's Multi-field Microphone Type 4961 is the world's first 1/4-inch condenser microphone with a 20 dB(A) noise floor, 60 mV/Pa sensitivity and a maximum SPL of 130 dB – which is the same basic performance you would expect from a conventional 1/2-inch condenser microphone. It guarantees that your measurements are accurate in free or diffuse sound fields and at any angle of incidence.

Manufacturing and Stability

The microphone and preamplifier's all-titanium construction ensures maximum resistance to corrosion. This means that you will never have to worry about pinholes in the microphone's diaphragm – a common problem with nickel foil diaphragms. And titanium's insensitivity to magnetic fields means that you do not have to worry about interference from electromagnetic sources.

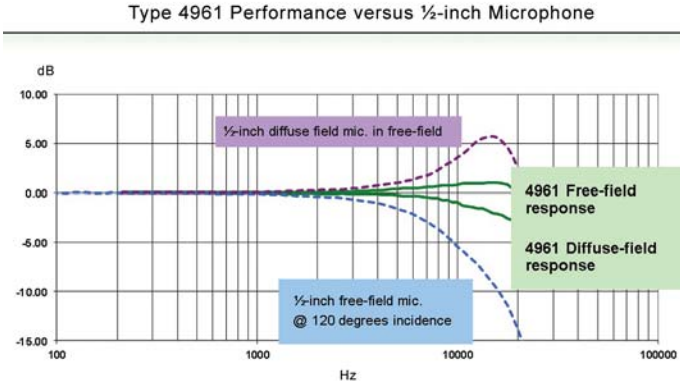
Type No.		4961	4961-B
Diameter	inch	1/4	1/4
Optimised		Multi-field	Multi-field
Standards		–	–
Nominal Open-circuit Sensitivity	mV/Pa	65	65
Polarization Voltage	V	0	0
Optimised Frequency Response ±2 dB	Hz	12 to 20000	12 to 20000
Dynamic Range with Preamplifier	dB(A) to dB	20 to 130	20 to 130
Inherent Noise	dB (A)	20	20
Capacitance	pF	N/A	N/A
Venting		Side	Side
Lower Limiting Frequency (–3 dB)	Hz	3 to 6	3 to 6
Operating Temperature Range	ºC	–20 to +80°C	–20 to +80°C
Temperature Coefficient	dB/ºC	0.01	0.01
Pressure Coefficient	dB/kPa	–0.013	–0.013
Preamplifier Included		CCLD	CCLD
TEDS UTID		769	769
Connector		SMB	10–32 UNF

Small Microphone*, *Big Performance

Because Type 4961 is so small and relatively insensitive to the angle of incidence, its response is uniform (even at high frequencies) in virtually any sound field.

It is very easy to position when setting up measurements – technicians can simply place it where they want to measure and save valuable time.

Well-suited for complex spaces with non-stationary or multiple sources that need to be measured in one go, Type 4961 is ideal for the automotive or aerospace industries, for example, during in-cabin noise measurements. In effect, a single multi-field microphone can cover many measuring scenarios that would otherwise require three different conventional ½-inch microphones.



Array Microphones

Array-based measurement techniques allow you to quickly map the sound intensity from a number of points across a source. Brüel & Kjær provides a wide selection of arrays to cover most measurement situations including acoustic holography and beamforming, as well as the microphones best suited for use in these systems.

- **Type 4957** is an economy type with only basic TEDS and a limited frequency range, but a higher sensitivity
- **Type 4958** is a precision type with "intelligent" TEDS, that is, TEDS that contains polynomial coefficients describing the complex transfer function of the microphone. This information can be used in the array application in order to increase precision
- **Type 4959** is a very short microphone for hand-held and foldable arrays

Note that both Types 4944-A and 4954-A can be used with arrays as well.

Type No.		4957	4958	4959
Diameter	inch	1/4	1/4	1/4
Optimised		Array	Array	Array
Standards		–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	11.2	11.2	11.2
Polarization Voltage*	V	0	0	0
Optimised Frequency Response ±2 dB	Hz	50 to 10000	20 to 20000	50 to 20000
Dynamic Range with Preamplifier	dB(A) to dB	32 to 134	28 to 140	32 to 134
Inherent Noise	dB (A)	<32	<28	<32
Capacitance	pF	N/A	N/A	N/A
Venting		Front	Front	Front
Lower Limiting Frequency (–3 dB)	Hz	<50	<50	<50
Operating Temperature Range	ºC	–10 to 55	–10 to 55	–10 to 55
Temperature Coefficient	dB/ºC	–	–	–
Pressure Coefficient	dB/kPa	–	–	–
Preamplifier Included		CCLD	CCLD	CCLD
TEDS UTID/UDID		I27-0-0-0U	I27-0-0-1U	I27-0-0-1U
Connector	Type	SMB	SMB	Brüel & Kjær array
Length of Array Microphone with Plug (including plug)	–	28.0 (34.2)	28.0 (34.2)	12.0 (18.2)

* 0 V = Prepolarized microphone

Low-noise Microphones

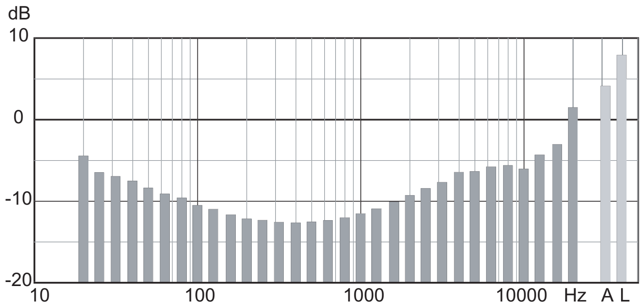
Low-noise microphones are required for qualification of anechoic chambers for sound power measurements and test of components with low sound power ratings.

- **Type 4179** is suitable for monitoring very low background noise levels down to –5.5 dB(A) and must be used with dedicated preamplifier Type 2660 or 2660-W-001. This combination has an unbeatable noise floor of –2.5 dBA
- **Type 4955** is a 1/2-inch TEDS “all titanium” microphone with an excellent noise floor of typically 5.5 dBA
- **Type 4955-A** is a dedicated unit for sound level meters, such as Types 2250 and 2270. It is optimised to work with ±18 V

Type No.		4179	4955
Diameter	inch	1	1/2
Optimised		Low-noise	Low-noise
Standards		–	–
Nominal Open-circuit Sensitivity	mV/Pa	100	1100
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	10 to 10000	10 to 16000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	–2.5 to +102 (2660)	6.5 to 110 (Built-in)
Inherent Noise	dB (A)	–5.5*	<6.5†
Capacitance	pF	40	N/A
Venting		Side	Front
Lower Limiting Frequency (–3 dB)	Hz	5 to 7	5
Operating Temperature Range	ºC	–30 to 100	–20 to 100
Temperature Coefficient	dB/ºC	–0.004	< ±0.01
Pressure Coefficient	dB/kPa	–0.016	–0.013
Preamplifier Included		No	Yes
TEDS UTID			116289
Connector		N/A	LEMO 1B

* Cartridge alone, must be used with Type 2660 preamplifier and WH-3315 + WL-1302
† With integral preamplifier

Every microphone has an inherent noise caused, amongst other things, by Brownian movements. This results in a noise voltage, which cannot be avoided even with the best microphone. Low-noise TEDS Microphone Type 4955 consists of a high sensitivity 1/2-inch cartridge, which has been optimised for the lowest inherent noise and a matching preamplifier. The graphs shows the typical noise spectrum for Type 4955



Outdoor Microphones

Brüel & Kjær's outdoor microphones are intended for permanent or semi-permanent outdoor use. In addition to the obvious weather protection, other features can be found with all Brüel & Kjær outdoor microphones, including calibration facilities, on-site remote verification (CIC), and conformance with standards of special importance such as IEC 61672 with sound level meters such a Type 2250 and Type 2270. This particular standard defines the requirements to the directivity response of the microphone and is often overlooked or misinterpreted.

- **Weatherproof Microphone Unit Type 4184** is for permanent, semi-permanent and portable noise monitoring. It features a probe type microphone for optimal protection and directivity response plus both CIC facility and a built-in acoustic sound source for verification
- **Outdoor Microphone Type 4198** is for semi-permanent noise monitoring. Depending on circumstances, this well-protected microphone can sustain several months of unattended use. Features CIC, a Falcon Range microphone and Outdoor Microphone Kit UA-1404
- **Outdoor Microphone Type 4952** has outer parts constructed of carefully selected polymer materials making it suitable for longer periods of unattended outdoor use (at least one year service intervals). This microphone also features CIC. The use of separate equalization filters enables Type 4952 to fulfil the requirements of IEC 61672 both for 0° and 90° of incidence
- **Outdoor Microphone Kit UA-1404** is for the protection of your existing Type 4188, 4189, or 4190 microphones

All outdoor microphones are supported by a broad range of accessories. Please refer to the Microphone Accessories for an overview.

Type No.		4184	4198	4952
Diameter	inch	Probe	1/2	1/2
Optimized		Outdoor	Outdoor	Outdoor
Standards		I, K	I, K	I, K
Nominal Open-circuit Sensitivity	mV/Pa	12.5	50	31.6
Polarization Voltage*	V	200	0	0
Optimized Frequency Response ±2 dB	Hz	20 to 8000	6.3 to 16000	8 to 12500
Dynamic Range with Preamplifier	dB(A) to dB	25 to 140	15.2 to 146	15.8 to 146
Inherent Noise	dB (A)	25	15.2	<16
Venting		Rear	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	<20	2 to 4	1 to 5
Operating Temperature Range	ºC	–40 to 55	–25 to 60	–30 to 60
Temperature Coefficient	dB/ºC	–0.005	–0.001	0.005
Pressure Coefficient	dB/kPa	–0.006	–0.01	–0.021
Preamplifier Included		Yes	Yes	Yes
Connector		B&K 7-pin	LEMO 1B	LEMO 1B

* 0 V = Prepolarized microphone

Laboratory Standard Microphones

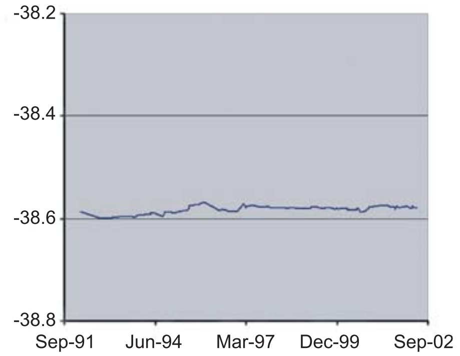
The most used laboratory standard microphones are **Types 4160** (1-inch) and **4180** (1/2-inch). These microphones have a well-defined cavity in front of the diaphragm and are optimised for use in couplers and for maximum long term stability under reference conditions. The proven long term stability is on the order of a few mdB per year.

The most common way of performing primary calibration of laboratory standard microphones is to use the reciprocity calibration principle. Brüel & Kjær offers the world's most used reciprocity calibration apparatus, Type 5998, which is part of Reciprocity Calibration System Type 9699.

Type No.		**4160**	**4180**
Diameter	inch	1	1/2
Optimised		Calibration	Calibration
Standards		G	H
Nominal Open-circuit Sensitivity	mV/Pa	47	12.5
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	2.6 to 8000	4 to 20000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	10 to 146 (2673)	21 to 160 (2673)
Inherent Noise	dB (A)	9.5	18
Capacitance	pF	55	17.5
Venting		Side	Side
Lower Limiting Frequency (–3 dB)	Hz	1 to 2	1 to 3
Operating Temperature Range	ºC	–10 to 50	–30 to 100
Temperature Coefficient	dB/ºC	–0.003	–0.002
Pressure Coefficient	dB/kPa	–0.00016	–0.00007
Preamplifier Included		No	No

Measured stability of Brüel & Kjær Laboratory Reference Microphone Type 4180 over a 10-year period.

Note: 0.2 dB/division



Brüel & Kjær also offers a range of special microphones, including:

- **Low-frequency Microphone Type 4193** is designed to measure infrasound, for example, in ship engine rooms, in helicopters and in wind-buffeted buildings
- **Type 4964** brings the –3 dB limit of Hand-held Analyzer Types 2250 and 2270 down to 0.3 Hz and with UC-0211 down to 0.13 Hz
- **Binaural Microphone Type 4101-A** is designed especially for binaural recording where testing on a human subject is preferred and/or the use of the traditional Head and Torso Simulator (HATS) method is precluded
- **Probe Microphone Type 4182** has a choice of probe tubes, stiff or flexible, making it perfect for measurements in awkward places
- **Impedance Tube Microphone Type 4187** is a 1/4-inch microphone specially designed for use in Impedance Tube Kit Type 4206. The microphone features a non-detachable protection grid that forms an airtight front cavity



Type No.		4193	4193 with UC-0211	4964
Diameter	inch	1/2	1/2	1/2
Optimised		Low-frequency	Low-frequency	Low-frequency
Standards		E, K, M	E, K, M	B, I, L
Nominal Open-circuit Sensitivity	mV/Pa	12.5	2	50
Polarization Voltage	V	200	200	0
Optimised Frequency Response ±2 dB	Hz	0.07 to 20000	0.13 to 20000	0.03 to 20000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	20.7 to 161 (2669)	29 to 148 (2669)	16.5 to 134 (2671-W-001)
Inherent Noise	dB (A)	19	29	14.6
Capacitance	pF	18	118	14
Venting		Side	Side	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.01 to 0.05	<0.1	0.01 to 0.05
Operating Temperature Range	ºC	–30 to 150	–30 to 150	–30 to 150
Temperature Coefficient	dB/ºC	–0.002	–0.002	0.006
Pressure Coefficient	dB/kPa	–0.005	–0.005	0.01
Preamplifier Included		No	No	No




Type No.		4965	4101-A	4182	4187
Diameter	inch	1/5	1/5	Probe	1/4
Optimised		Binaural recording headphones	Binaural recording with TEDS	Probe	Pressure
Standards		–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	20	20	3.16	4
Polarization Voltage*	V	0	0	200	200
Optimised Frequency Response ±2 dB	Hz	20 to 20000	20 to 20000	1 to 20000	1 to 6400
Dynamic Range with Preamplifier	dB(A) to dB	23 to 134	23 to 134	42 to 164	–
Inherent Noise	dB (A)	23	23	42	–
Capacitance	pF	N/A	N/A	N/A	6.4
Venting		Rear	Rear	Selected	Rear
Lower Limiting Frequency (–3 dB)	Hz	<20	<20	<0.7	<1
Operating Temperature Range	ºC	10 to 40	–30 to 70	–10 to 700	–
Temperature Coefficient	dB/ºC	–	–	–0.005	–
Pressure Coefficient	dB/kPa	–	–	–0.007	–
Preamplifier Included		CCLD	CCLD	Yes	No
Connector		10–32 UNF	10–32 UNF	7-pin B&K	

* 0 V = Prepolarized microphone

Transducers for Sound Intensity Analysis

The measurement of sound intensity provides information on the magnitude and the direction of the sound energy in the sound field. The measurement technique is used for a variety of applications such as the determination of sound power, sound absorption and sound transmission. Sound intensity is calculated from the product of the sound pressure and the particle velocity; sound pressure can easily be measured directly but the particle velocity is usually determined by a finite difference approximation. This requires two phase-matched microphones in a face-to-face configuration. Brüel & Kjær provides a number of sound intensity probes that conform to Class 1 in the Sound Intensity Instrumentation Standard, IEC 61043, which describes the characteristics of microphone pairs, intensity probes and calibration techniques for intensity measurements.

Sound Intensity Probes

Two sound intensity probes are available:

- **Type 3654** for use with the sound intensity analysis system based on Hand-held Analyzer Type 2270
- **Type 3599**, suitable for use with sound intensity analyzers based on PULSE

The main difference is that Type 3654 is based on a 10-pin cabling system whereas Type 3599 is based on an 18-pin cabling system and includes a remote control unit. The acoustical specifications are the same as both use Sound Intensity 1/2-inch Microphone Pair Type 4197 and Dual Preamplifier Type 2683.

Type No.		3654	3599
Standards		IEC 61043, Class 1	IEC 61043, Class 1
Microphones		4197	4197
Dual Preamplifier		2683	2683
Remote Control Unit		–	ZH-0632
Spacer Length		6 to 50 mm	6 to 50 mm
Spacers Included	8.5 mm 12 mm 50 mm	250 Hz to 6300 Hz 250 Hz to 5000 Hz 20 Hz to 1250 Hz	250 Hz to 6300 Hz 250 Hz to 5000 Hz 20 Hz to 1250 Hz

Sound Intensity Microphone Pairs

Type No.		4197	4178
Diameter	inch	1/2	1/4
Free-field Frequency Response ±1 dB	Hz	5 to 12500	6 to 14000
Free-field Frequency Response ±2 dB	Hz	0.3 to 20000	4 to 100000
Phase Response Difference (Absolute Value) 1/3-octave Centre Frequencies		< 0.05°: 20 Hz to 250 Hz < f(Hz)/5000: 250 Hz to 6300 Hz	1000 Hz to 20000 Hz: ±0.1° × f [kHz]
Amplitude Response Difference Normalized at 200 Hz		<0.2 dB: 20 Hz to 1000 Hz <0.4 dB: 20 Hz to 7100 Hz	<0.3 dB: 100 Hz to 10000 Hz <0.5 dB: 100 Hz to 20000 Hz
Accessories Included		8.5 mm Spacer: UC-5349 12 mm Spacer: UC-5269 50 mm Spacer: UC-5270	6 mm Spacer: UC-0196 12 mm Spacer: UC-0195
Polarized Capacity Difference	pF	<1.0	<0.3

Dual Preamplifier

Type Number	2683
Phase Matching	<0.015°at 50 Hz (20 pF capacitance) f(kHz) × 0.06°: 250 Hz to 10000 Hz
Electrical Noise re Microphone Sensitivity: 1/4-inch 6.4 pF Dummy 1/2-inch 19.5 pF Dummy	 39.2 dB SPL(A) 19.4 dB SPL(A)
Attenuation for 1/2-inch Microphones	Ch.A Typ.: 0.6 dB Ch.B Typ.: 0.3 dB
Attenuation for 1/4-inch Microphones	Ch.A Typ.: 1.7 dB Ch.B Typ.: 0.7 dB

Microphones for High-intensity Testing

Most noise measurements are limited to around 140 to 150 dB maximum SPL, but applications such as measurement of gunshots, airbag deployment noise, etc., require measurements of dynamic pressure fluctuations corresponding to a SPL far beyond 160 dB.*

For measurements below 110 dB, the condenser microphone will normally be the preferred transducer, while above 200 dB pressure sensors have to be used. In the intermediate range, you can select between pressure sensors or condenser microphones.

Condenser microphones benefit from a higher degree of standardisation, wider frequency range, lower noise floor, and standardised calibration methods. They are readily available as TEDS microphones for direct connection to industry standard CCLD inputs. Condenser microphones are normally fully specified with respect to frequency response, free-field corrections, influence of accessories, etc.

- **High-static Pressure Microphone Type 4938-W-001** is specially designed for measuring in high static pressure from 1 – 10 Atm. The change in response at different static pressures has been minimised
- **Airbag Microphone Type 4938** + **WB-1418** is designed to fulfil “Microphone and Preamplifier System for measuring acoustic impulses within vehicles – SAE J247 FEB87”, but only when combined with Preamplifier Type 2670 + WB-1419
- **High Sound Pressure Microphone Type 4941** is used for gunshots, fireworks and rocket testing

* Note: Above 160 dB air behaves highly non-linearly



Type No.		**4941**	**4938-W-001**	**4938 + WB-1418**
Diameter	inch	1/4	1/4	1/4
Optimised		High-pressure	High static pressure	Airbag
Standards		–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	0.09	1.6	0.4
Polarization Voltage	V	200	200	200
Optimised Frequency Response ±2 dB	Hz	4 to 20000	4 to 70000	0.5 to 70000
Dynamic Range with Preamplifier (Preamplifier type number)	dB(A) to dB	73.5 to 184 (2670)	42 to 172 (2670)	50 to 177 (2670 + WB-1419)
Inherent Noise	dB (A)	59	30	30
Capacitance	pF	3.3	6.1	6.1
Venting		Side	Side	Side
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	0.3 to 3	0.05 to 0.2
Operating Temperature Range	ºC	–40 to 150	–40 to 150	–40 to 150
Temperature Coefficient	dB/ºC	–	+0.003	+0.003
Pressure Coefficient	dB/kPa	–	–0.003	–0.003
Preamplifier Included		No	No	No

Hydrophones for High-intensity Measurements

Although originally intended for underwater measurements these hermetically sealed devices are also very suitable for high intensity pressure measurements in air. This is because of the low sensitivity of the hydrophone. The usable frequency range is from a few fractions of a Hz to around 20 kHz.

Hydrophones

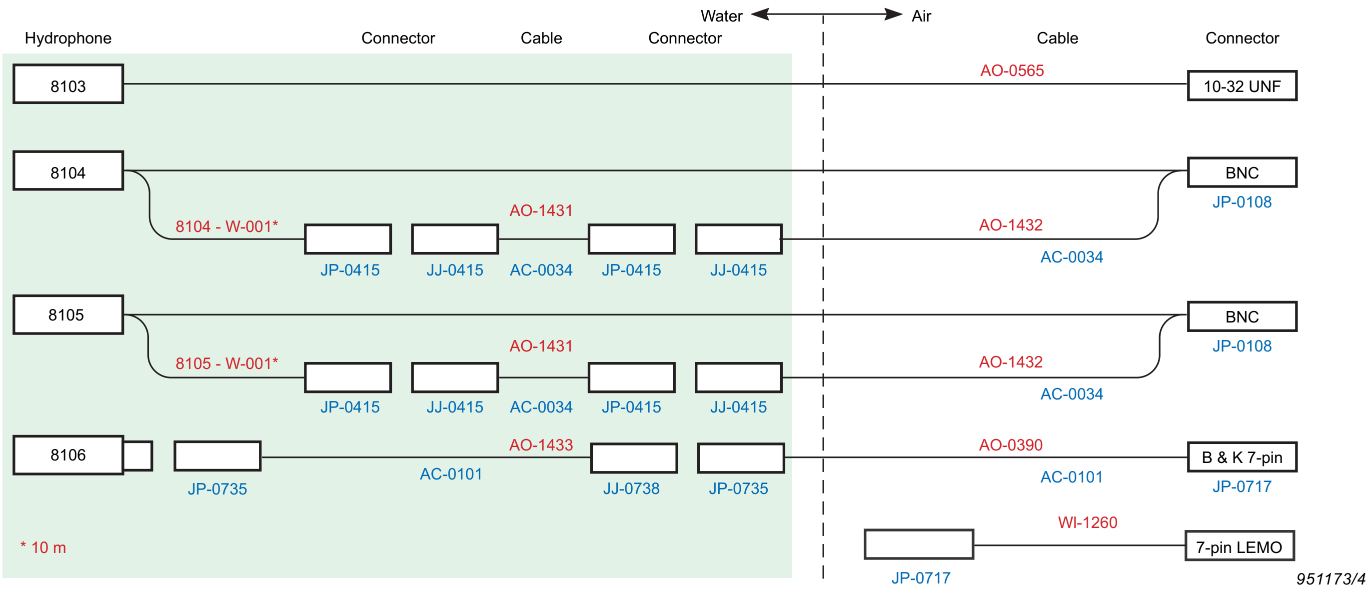
The Brüel & Kjær range of hydrophones is a range of individually calibrated, waterborne-sound transducers that have a flat frequency response and are omnidirectional over a wide frequency range. Their construction is such that they are absolutely waterproof and have good corrosion resistance. There are four types.

- **Type 8103** is suitable for laboratory and industrial use and particularly for the acoustic study of marine animals or for cavitation measurements.
- **Type 8104** is ideal for calibration purposes.
- **Type 8105** is a robust, spherical hydrophone that can be used at an ocean depth of 1000 m. It has excellent directional characteristics, being omnidirectional over 270° in the axial plane and 360° in the radial plane.
- **Type 8106** has a built-in amplifier that gives a signal suitable for transmission over long underwater cables. It can be used down to an ocean depth of 1000 m.

Type No.		**8103**	**8104**	**8105**	**8106**
Sensitivity*		–211 dB re 1 V/µPa ±2 dB	–205 dB re 1 V/µPa ±2 dB		–173 dB re 1 V/µPa ±3 dB
Nominal Voltage Sensitivity		29 µV/Pa	56 µV/Pa		2.24 mV/Pa
Nominal Charge Sensitivity*		0.1 pC/Pa	0.44 pC/Pa	0.41 pC/Pa	N/A
Capacitance* **(including standard cable)**		3700 pF	7800 pF	7250 pF	N/A
Frequency Response* (re 250 Hz)		0.1 Hz to 20000 Hz +1/–1.5 dB 0.1 Hz to 100000 Hz +1.5/–6.0 dB 0.1 Hz to 180000 Hz +3.5/–12.5 dB	0.1 Hz to 10000 Hz ±1.5 dB 0.1 Hz to 80000 Hz ±4.0 dB 0.1 Hz to 120000 Hz +4/–12.0 dB	0.1 Hz to 100000 Hz +1/–6.5 dB 0.1 Hz to 160000 Hz +3.5/–10.0 dB	10 Hz to 10000 Hz +0.5/–3.0 dB 7 Hz to 30000 Hz +0.5/–6.0 dB 3 Hz to 80000 Hz +6/–10.0 dB
Horizontal Directivity (radial xy plane)		±2 dB at 100000 Hz			±2 dB at 20000 Hz
Vertical Directivity (axial xz plane)		±4 dB at 100000 Hz	±2 dB at 50000 Hz	±2 dB over 270° at 80000 Hz ±2.5 dB at 100000 Hz	±3 dB at 20000 Hz
Leakage Resistance* (at 20°C)		>2500 MΩ			
Operating Temperature Range	**Short-term**	–30°C to +120°C			
	Continuous	–30°C to +80°C			–10°C to +60°C
Sensitivity Change with Temperature	**Charge**	0 to +0.03 dB/°C	0 to +0.03 dB/°C	0 to +0.03 dB/°C	–
	Voltage	0 to –0.03 dB/°C	0 to –0.04 dB/°C	0 to –0.03 dB/°C	0 to +0.01 dB/°C
Max. Operating Static Pressure		252 dB = 4×0^6 Pa = 40 atm = 400 m ocean depth		260 dB = 9.8×10^6 Pa = 100 atm = 1000 m ocean depth	
Sensitivity Change with Static Pressure		0 to -3×10^{-7} dB/Pa (0 to –0.03 dB/atm)			0 to 1×10^{-7} dB/Pa 0 to 0.01 dB/atm
Allowable Total Radiation Dose		5×10^7 Rad.			
Dimensions	**Length**	50 mm (1.97″)	120 mm (4.73″)	93 mm (3.66″)	182 mm (7.17″)
	∅ (body)	9.5 mm (0.37″)	21 mm (0.83″)	22 mm (0.87″)	32 mm (1.26″)
Weight, including integral cable		170 g (0.37 lb)	1.6 kg (3.5 lb)		382 g (0.84 lb)
Integral Cable		6 m waterproof low-noise double-shielded PTFE cable with standard miniature coaxial plug	10 m waterblocked low-noise shielded cable to MIL–C–915 with BNC plug		
Raw Cable		AC-0043	AC-0034		AC-0101

* Nominal value, each hydrophone is supplied with its own calibration data
Note: Unless otherwise stated, all values below are valid at 23°C (73°F)

Hydrophone Cables and Connectors



Brüel & Kjær hydrophones are available in standard variants with the following default cable lengths:

- Type 8103 default length is 6 m
- Type 8104 default length is 10 m
- Type 8105 default length is 10 m

For Type 8106, which is supplied without cable, Underwater Cable AO-0390 is available in customer specific lengths up to 200 m.

A condenser microphone must be combined with a preamplifier to provide impedance conversion, some filtering, and the capability to drive relatively long cables without significant signal degradation.

Preamplifiers are designed in accordance with two principles:
- Classical preamplifier design
- CCLD preamplifier design

Each has its own special features.

Classical Preamplifiers

The classical preamplifier has an easy to understand concept. It is basically a unity gain amplifier with extremely high input impedance and very low input capacitance.
- The supply voltage can be either ±15 V DC or a single 80 V DC.
- The output signal has its own separate wire, as do the polarization and CIC voltage.
- Pin 5 is often used for transmission of TEDS data (so called Class II TEDS).
- CIC (Charge Injection Calibration) is possible by injecting a signal (on pin 1 of the LEMO connector).

CCLD Preamplifiers

Despite its origin in the vibration transducer world, the Constant Current Line Drive (CCLD) principle is increasing in popularity in the area of sound and measurement applications.

Different manufacturers market transducers using the CCLD principle under different names. The benefit of CCLD is that the same wire is used for both the signal and the supply current! Using Class I TEDS, even the TEDS data can be transmitted over that same wire (using a level controlled electronic switch).

This enables the use of cost-effective coaxial cables and BNC connectors popularly used in general applications.

A CCLD input can be connected to a microphone, vibration sensor, or any other sensor with CCLD output. Due to the working principle, the signal is superimposed on a DC voltage. This DC bias voltage is typically around 12 V. Bias drift (over temperature or time) will reduce the dynamic range.

Due to the lower DC supply voltage (typically 20 – 28 V DC compliance voltage out of the front-end), there are some restrictions to the upper limit for a CCLD solution. Other limitations with CCLD solutions include: confined use with prepolarized microphones only, and the unavailability of CIC. However in many practical applications, this is happily accepted in order to get the benefits of CCLD, that is, ease of use and inexpensive cables!

The DC bias voltage is often used by the front-end to provide some simple means of cable monitoring. A bias voltage below a certain value is interpreted as short circuit while a DC value above a certain value as open circuit.

Classical Versus CCLD Preamplifier

	Classical	CCLD
Output Voltage	55 V_p	7 V_p
Output Current	2 – 20 mA	3 – 20 mA
Noise	<2 µV	4 µV
Distortion	≤80 dB	≤70 dB
Verification	CIC/IVC	No
IEEE 1451.4	Yes	Yes
Cable Price	Higher	Lower
Connector	LEMO	BNC
Microphone Type	Both	Prepolarized only
Accelerometer Conditioning	No	Yes

Brüel & Kjær Range of Microphone Preamplifiers

We offer a large selection of robust and acoustically optimised preamplifiers that allow operation in a wide range of environmental conditions. The high-output current capability of Brüel & Kjær preamplifiers allows the use of extremely long cables, even with high sound pressure levels present at high frequencies.

Preamplifiers are available in both 1/2-inch and 1/4-inch dimensions for direct fit with the most used microphones cartridge sizes. Adaptors are available for 1-inch and 1/8-inch cartridges.
- The most popular classical 1/2-inch preamplifier is **Type 2669** which is available in several different versions
- **Type 2669-W-001** is modified for use with input modules with LEMO socket and split supply (for example, with PULSE and NEXUS). It must be used with cable WL-1302
- **Type 2670** is a Falcon Range product for precision acoustic measurements with Brüel & Kjær’s wide range of condenser microphones. It is available in different versions, each with their own special features
- CCLD preamplifier **Type 2671** is very compact and operates over a wide range of temperature, humidity and other environmental conditions
- When insert voltage calibration is required, **Type 2673** is the obvious choice
- **Type 2695**, perhaps due to its small size, (half the length of the extremely popular CCLD preamplifier Type 2671), is an often overlooked unit
- **Type 2699** combines a CCLD preamplifier and an A-weighting filter in one unit. This type can be easily distinguished from other preamplifiers due to the two engraved rings

When sold alone, most preamplifers are supplied with TEDS template UTID 1025. When sold as part of a TEDS microphone combination, the template UTID is 769 or 116289.

Type No.		2669-B	2669-L	2669-C	2669-001	2670	2670-W-001	1706
Diameter	inch	1/2	1/2	1/2	1/2	1/4	1/4	1/2
Optimised		Acoustical*	Acoustical	Cylindrical	For Type 4232 only	Phase	Short, 48 mm	CCLD
Connector at Preamplifier		LEMO 0B, 7-pin	LEMO 0B, 7-pin	LEMO 1B, 7-pin	LEMO 1B, 7-pin	Fixed (2 m)	Fixed (0.6 m)	BNC
Connector at Instrument/Cable		B&K, 7-pin	LEMO 1B, 7-pin	None	None	LEMO 1B, 7-pin	0.6 m cable with LEMO 1B, 7-pin	N/A
Calibration Facility		CIC	CIC	CIC	CIC	CIC	CIC	None
Polarization Voltage Support		Yes	Yes	Yes	Yes	Yes	Yes	No
Supply Voltage	V	±14 to ±60 or 28 to 120	±14 to ±60 or 28 to 120	±14 to ±60 or 28 to 120	±14 to ±60 or 28 to 120	±14 to ±60 or 28 to 120	±5 to ±20 or 10 to 40†	28
Max. Output Voltage (Peak)	V	55 (5 below supply)	55 (5 below supply)	55 (5 below supply)	55 (5 below supply)	55 (5 below supply)	15	7
Max. Output Current (Peak)	mA	20	20	20	20	20	17	19
Frequency Range	Hz	3 to 200000 ±0.5 dB (15 pF)	3 to 200000 ±0.5 dB (15 pF)	3 to 200000 ±0.5 dB (15 pF)	3 to 200000 ±0.5 dB (15 pF)	15 to 200000 ±0.5 dB (6.2 pF)	15 to 200000 ±0.5 dB (6.2 pF)	20 to 50000 ±2 dB (12 pF)
Attenuation	dB	<0.35	<0.35	<0.35	<0.35	<0.4	<0.4	<0.35
Noise A-weighted, typical	µV	1.9	1.9	1.9	1.9	4	9	4
Noise 22.4 Hz to 300 kHz, typical	µV	8.2	8.2	8.2	8.2	14	18	15
Input Impedance	GΩ || pF	15 || 0.3	15 || 0.3	15 || 0.3	15 || 0.3	15 || 0.25	15 || 0.25	6 || 0.5
TEDS UTID		1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2248944	No	1025 from serial number 2264319

* Acoustical means a tapered preamplifier house. Other preamplifiers have cylindrical houses
† Note: The warranty does **not** cover Preamplifier Type 2670-W-001 if used at a supply voltage >40 V

Type No.		2670-WB-1419	2671	2671-W-001	2673	2695	2699
Diameter	inch	1/4	1/2	1/2	1/2	1/2	1/2
Optimised		Airbag	CCLD	CCLD	Calibration	Short CCLD	CCLD
Connector at Preamplifier		Fixed (2 m) cable	BNC	BNC	LEMO 0B, 7-pin	10–32 UNF	BNC
Connector at Instrument Cable		LEMO 1B, 7-pin	N/A	None	LEMO 1B, 7-pin	N/A	N/A
Calibration Facility		None	None	None	IVC	10–32 UNF	BNC
Polarization Voltage Support		Yes	No	No	Yes	No	No
Supply Voltage	V	±14 to ±60 or 28 to 120	28	28	±14 to ±60 or 28 to 120	28	28
Max. Output Voltage (Peak)	V	55 (10 below supply)	7	7	55 (10 V below supply)	7	7
Max. Output Current (Peak)	mA	20	19	19	19	19	18
Frequency Range	Hz	1 to 100000 ±1 dB (6.2 pF)	20 to 50000 ±2 dB (12 pF)	3 to 50000 2 dB (12 pF)	3 to 200000 ±0.5 dB (20 pF)	20 to 50000 ±2 dB (15 pF)	A-weighted to IEC 61672 Class 1
Attenuation	dB	11	<0.35	<0.35	<0.05	<0.2	0, ±0.3 dB at 1 kHz
Noise A-weighted, typical	µV	4	4	2	1.8	4	8 Max., LIN
Noise 22.4 Hz to 300 kHz, typical	µV	14	15	4	11	12	N/A
Input Impedance	GΩ || pF	15 || 15	1.5 || 0.4	10 || 0.4	1 || 0.05	1.7 || 0.4	10 +20 – 40% || 0.5
TEDS UTID		1025 from serial number 2264319	1025 from serial number 2264319	1025 from serial number 2221155	No	1025	1025

Type No.		2660	2660-W-001
Diameter	inch	1/2 and 1/1	1/2
Optimised		Low-noise	Low-noise
Connector at Preamplifier		None	None
Connector at Instrument/Cable		B&K, 7-pin	B&K, 7-pin
Calibration Facility		None	None
Polarization Voltage Support		Yes	Yes
Supply Voltage	V	120 and 12	±14 to ±16 V
Max. Output Voltage (Peak)	V	45	4
Max. Output Current (Peak)	mA	1.5	1.5
Frequency Range	Hz	20 to 200000 ±1 dB (0 dB)(47 pF)	20 to 200000 ±1 dB (0 dB)(47 pF)
Attenuation	dB	<0.06	<0.06
Noise A-weighted, typical	µV	0.8	0.8
Noise 22.4 Hz to 300 kHz, typical	µV	5	5
Input Impedance	GΩ || pF	36 || 0.3	36 || 0.3
TEDS UTID		No	No

Replacing Discontinued Brüel & Kjær Preamplifiers

Modern (Falcon Range) preamplifiers have several advantages over the older types, for example, with respect to parameters, settling time, noise immunity, physical size and connectors.

The table below can be helpful if you need a replacement for an older Brüel & Kjær type.

Older Preamplifier Types	Recommended Replacement Preamplifier Types
2619	2669
2627	2673
2633	2670
2639	2669
2645	2673

Specification	4138	4144	4145	4160	4176	4178	4179	4180	4188	4189	4190	4191	4192
Main Purpose	High frequency	General purpose Low sound pressure level	General purpose Low sound pressure level	Reference	General purpose	Sound intensity	Very low sound pressure level	Reference	General purpose	General purpose	General purpose	General purpose	General purpose
Diameter	1/8-inch	1-inch	1-inch	1-inch	1/2-inch	1/4-inch	1-inch	1/2-inch	1/2-inch	1/2-inch	1/2-inch	1/2-inch	1/2-inch
Description	Pressure-field	Pressure-field	Free-field	Pressure-field	Free-field	Sound intensity microphone pair	Free-field	Pressure-field	Free-field	Free-field	Free-field	Free-field	Pressure-field
Nominal Open-circuit Sensitivity	1.0 mV/Pa −60 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	47 mV/Pa −27 dB re 1 V/Pa	50 mV/Pa –26 dB re 1 V/Pa	4 mV/Pa –48 dB re 1 V/Pa	100 mV/Pa –20 dB re 1 V/Pa	12.5 mV/Pa –38 dB re 1 V/Pa	31.6 mV/Pa –30 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	12.5 mV/Pa –38 dB re 1 V/Pa	12.5 mV/Pa –38 dB re 1 V/Pa
Polarization Voltage	200 V	200 V	200 V	200 V	0 V	200 V	200 V	200 V	0 V	0 V	200 V	200 V	200 V
Optimised Frequency Response	±2 dB: 6.5 Hz to 140 kHz	±2 dB: 2.6 Hz to 8 kHz	±2 dB: 2.6 Hz to 18 kHz	±2 dB: up to 8 kHz	±2dB: 6.5 Hz to 16 kHz	±2 dB: 4 Hz to 100 kHz	±2 dB: 10 Hz to 10 kHz	±1.5 dB: <20 kHz	±1 dB: 12.5 Hz to 8 kHz ±2 dB: 8 Hz to 12.5 kHz	±1 dB: 10 Hz to 8 kHz ±2 dB: 6.3 Hz to 20 kHz	±1 dB: 5 Hz to 10 kHz ±2 dB: 3.15 Hz to 20 kHz	±1 dB: 5 Hz to 16 kHz ±2 dB: 3.15 Hz to 40 kHz	±1 dB: 5 Hz to 12.5 kHz ±2 dB: 3.15 Hz to 20 kHz
Lower Limiting Frequency (–3 dB)	0.5 to 5 Hz	1 to 2 Hz	1 to 2 Hz	1 to 2 Hz	0.5 to 5 Hz	0.3 to 3 Hz	5 to 7 Hz	1 to 3 Hz	1 to 5 Hz	2 to 4 Hz	1 to 2 Hz	1 to 2 Hz	1 to 2 Hz
Inherent Noise (Typical)	43 dB(A)	9.5 dB(A)	10 dB(A)	9.5 dB(A)	14.6 dB (A)	28 dB(A)	–2.5* dB(A)	18 dB(A)	14.2 dB(A) 14.5 dB(Lin)	14.6 dB(A) 15.3 dB (Lin)	14.5 dB(A) 15.3 dB(Lin)	20.0 dB(A) 21.4 dB(Lin)	19.0 dB(A) 21.3 dB(Lin)
3% Distortion Limit (Max.†)	168 dB	146 dB	146 dB	146 dB	142 dB	164 dB	140 dB*	160 dB	146 dB	146 dB	148 dB	162 dB	162 dB
3% Distortion Limit RMS (V)	5.0 V	20.0 V	20.0 V	18.8 V	12.6 V	12.7 V	2.0 V*	25.0 V	12.6 V	20.0 V	25.1 V	31.5 V	31.5 V
Operating Temperature Range	–30 to +100°C (–22 to +212°F) Can be used up to 150°C (302°F)	–30 to +100°C (–22 to +212°F) Can be used up to 150°C (302°F)	–30 to +100°C (–22 to +212°F) Can be used up to 150°C (302°F)	–10 to +50 ºC (+30 to 122°F)	–30 to +125°C (–22 to +257°F)	–40 to +150°C (–40 to +302°F)	–30 to +100°C (–22 to +212°F) Can be used up to 150°C (302°F)	–10 to +50 ºC (+30 to 122°F)	–30 to +125°C (–22 to +257°F)	–30 to +150°C (–22 to +302°F)	–30 to +150°C (–22 to +302°F) Can be used up to 300°C (572°F)	–30 to +150°C (–22 to +302°F) Can be used up to 300°C (572°F)	–30 to +150°C (–22 to +302°F) Can be used up to 300°C (572°F)
Temperature Coefficient	–0.01 dB/°C	–0.003 dB/°C	–0.002 dB/°C	–0.003 dB/°C	0.005 dB/°C	0.003 dB/°C	–0.004 dB/°C	–0.002 dB/°C	+0.005 dB/°C	–0.006 dB/°C	–0.012 dB/°C	–0.002 dB/°C	–0.002 dB/°C
Pressure Coefficient	–0.01 dB/kPa	–0.016 dB/kPa	–0.015 dB/kPa	–0.00016 dB/kPa	0.02 dB/kPa	−0.007 dB/kPa	–0.016 dB/kPa	–0.00007 dB/kPa	–0.021 dB/kPa	–0.010 dB/kPa	–0.010 dB/kPa	–0.007 dB/kPa	–0.007 dB/kPa
Effect of Vibration, SPL for $1\ m/s^2$ axial acceleration	58 dB	67 dB	67 dB	67 dB	63.5 dB	60 dB	60 dB	65 dB	63.5 dB	62.5 dB	62.5 dB	65.5 dB	65.5 dB
Effect of magnetic field, SPL for 80 A/m, 50 Hz field	40 dB	18 dB	18 dB	18 dB	30 dB	10 dB	12 dB	20 dB	7 dB	6 dB	4 dB	16 dB	16 dB
Estimated Long Term Stability at 20°C		<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 400years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 250years	<1 dB/400 years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years
Estimated Long Term Stability at 150°C (dry air)		>2 hr/dB	>2 hr/dB		>10 hr/dB	>100 hr/dB			>10 hr/dB	>2 hr/dB	>100 hr/dB	>100 hr/dB	>100 hr/dB
Standards‡	–	D, L	A, I	G	I, K		–	H	I, K	B, I, L	B, I, L	B, I, L, M	E, K, M
Recommended Brüel & Kjær Preamplifier (type no.)	2670 + UA-0160	2669 2673 + UA-0786	2669 2673 + UA-0786	2669 2673 + UA-0786	2669, 2671 2699, 1706	2683	2660 WH-3315 + WL-1302	2673	2669, 2671 2699, 1706	2669, 2671 2699, 1706	2669	2669	2669

Specification	4193	4197	4938	4939	4940	4941	4942	4943	4944	4947	4950	4953	4954	4956	4964
Main Purpose	Low frequency	Sound intensity	High sound pressure level High frequency	General purpose High frequency	For use with Sound Level Meter Type 2231	Very high sound pressure level	General purpose	General purpose	High sound pressure level	QA testing	General purpose	General purpose	General purpose	General purpose	Low frequency
Diameter	1/2-inch	1/2-inch	1/4-inch	1/4-inch	1/2-inch	1/4-inch	1/2-inch	1/2-inch	1/4-inch	1/2-inch	1/2-inch	1/2-inch	1/4-inch	1/2-inch	1/2-inch
Description	Infrasound Pressure-field	Free-field pair for sound intensity	Pressure-field	Free-field	Free-field	Pressure-field	Diffuse-field	Diffuse-field	Pressure-field	Pressure-field	Free-field	Pressure-field	Free-field	Pressure-field	Free-field
Nominal Open-circuit Sensitivity	12.5 mV/Pa –38 dB re 1 V/Pa	11.2 mV/Pa −39 dB re 1 V/Pa	1.6 mV/Pa −56 dB re 1 V/Pa	4 mV/Pa –48 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	0.09 mV/Pa –81 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	50 mV/Pa −26 dB re 1 V/Pa	1 mV/Pa –60 dB re 1 V/Pa	12.5 mV/Pa –38 dB re 1 V/Pa	50 mV/Pa –26 dB re 1 V/Pa	50 mV/Pa –26 dB re 1 V/Pa	3.16 mV/Pa –50 dB re 1 V/Pa	12.5 mV/Pa –38 dB re 1 V/Pa	50 mV/Pa –26 dB re 1 V/Pa
Polarization Voltage	200 V	200 V	200 V	200 V	0 V	200 V	0 V	200 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
Optimised Frequency Response	±1 dB: 0.12 Hz to 12.5 kHz ±2 dB: 0.07 Hz to 20 kHz	±1 dB: 5 Hz to 12.5 kHz† ±2 dB: 0.3 Hz to 20 kHz	±2 dB: 4 Hz to 70 kHz	±2 dB: 4 Hz to 100 kHz	±1 dB: 10 Hz to 8 kHz ±2 dB: 6.3 Hz to 20 kHz	±2 dB: 4 Hz to 20 kHz	±1 dB: 10 Hz to 10 kHz† ±2 dB: 6.3 Hz to 16 kHz	±1 dB: 5 Hz to 6.3 kHz† ±2 dB: 3.15 Hz to 10 kHz	±2 dB: 4 Hz to 70 kHz (–3 dB): 3 Hz to 70 kHz	±2 dB: 8 Hz to 10 kHz	±2 dB: 6.5 Hz to 16 kHz	±2 dB: 3 Hz to 10 kHz	±2 dB: 4 Hz to 80 kHz ±3 dB: 3 Hz to 100 kHz	±1 dB: 7 Hz to 12 kHz† ±2 dB: 2 Hz to 20 kHz	±1 dB: 0.04 Hz to 8 kHz† ±2 dB: 0.03 Hz to 20 kHz
Lower Limiting Frequency (–3 dB)	0.01 to 50 mHz	0.14 Hz	0.3 to 3 Hz	0.3 to 3 Hz	2 to 4 Hz	0.3 to 3 Hz	2 to 4 Hz	1 to 2 Hz	0.3 Hz to 3 Hz	1 to 5 Hz	0.5 to 5 Hz	1 to 2.4 Hz	0.3 to 3 Hz	1 to 2 Hz	0.01 to 0.05 Hz
Inherent Noise (Typical)	19.0 dB(A) 21.3 dB(Lin)	20.0 dB(A)	30 dB(A)	28 dB(A)	14.6 dB(A) 15.3 dB(Lin)	59 dB	14.6 dB	15.5 dB	30dB(A)	17.5 dB(A) 18.7 dB(Lin)	14.6 dB(A)	16.2 dB(A)	35 dB(A)	18.6 dB(A) 20.9 dB(Lin)	14.6 dB(A) 15.3 dB(Lin)
3% Distortion Limit (Max.†)	162 dB	162 dB	172 dB	164 dB	146 dB	184 dB	146 dB	148 dB	170 dB	160 dB	142 dB	146 dB	164 dB	160 dB	146 dB
3% Distortion Limit RMS (V)	31.5 V	28.2 V	12.7 V	12.7 V	20.0 V	2.9 V	20.0 V	25.6 V	5.7 V	25.0 V	12.6 V	20.0 V	10.0 V	25.0 V	20.0 V
Operating Temperature Range	–30 to +150°C (–22 to +302°F) Can be used up to 300°C (572°F)	–40 to +150°C (–40 to +302°F) Can be used up to 300°C (572°F)	–40 to +150°C (–40 to +302°F)	–40 to +150°C (–40 to +302°F)	–30 to +150°C (–22 to +302°F)	–40 to +150°C (–40 to +302°F)	–30 to +150°C (–22 to +302°F)	–40 to +150°C (–40 to +302°F)	–40 to +150°C (–40 to +302°F)	–30 to +125°C (–22 to +257°F)	–30 to +125°C (–22 to +257°F)	–30 to +150°C (–22 to +302°F)	–40 to +150°C (–40 to +302°F)	–30 to +70°C (–22 to +158°F)	–30 to +150°C (–22 to +302°F)
Temperature Coefficient	–0.002 dB/°C	–0.002 dB/°C	0.003 dB/°C	0.003 dB/°C	–0.006 dB/°C		–0.006 dB/°C	−0.015 dB/°C	0.008 dB/°C	0.006 dB/°C	0.005 dB/°C	–0.008 dB/°C	0.009 dB/°C	0.013 dB/°C	–0.006 dB/kPa
Pressure Coefficient	–0.005 dB/kPa	–0.007 dB/kPa	−0.003 dB/kPa	−0.007 dB/kPa	–0.010 dB/kPa		–0.010 dB/kPa	–0.008 dB/kPa	–0.003 dB/kPa	–0.006 dB/kPa	0.02 dB/kPa	0.008 dB/kPa	–0.007 dB/kPa	0.0009 dB/kPa	–0.010 dB/kPa
Effect of Vibration, SPL for $1\ m/s^2$ axial acceleration	65.5 dB	65.5 dB	69 dB	60 dB	62.5 dB		62.5 dB	62.5 dB	69 dB	65.5 dB	63.5 dB	62.5 dB	60 dB	65.5 dB	62.5 dB
Effect of magnetic field, SPL for 80 A/m, 50 Hz field	16 dB	6 to 34 dB	10 dB	10 dB	6 dB		6 dB	4 dB	48 dB(A)	16 dB	30 dB	6 dB	10 dB		6 dB
Estimated Long Term Stability at 20°C	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years		<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years	<1 dB/ 1000years
Estimated Long Term Stability at 150°C (dry air)	>100 hr/dB	>100 hr/dB	>100 hr/dB	>100 hr/dB	>2 hr/dB		>2 hr/dB	>100 hr/dB	>2 hr/dB	>2 hr/dB	>10 hr/dB	>2 hr/dB	>2 hr/dB		>2 hr/dB
Standards‡	E, K, M		F	C		–	K	K	F	K	I, K	–	C	E, K, M	B, I, L
Recommended Brüel & Kjær Preamplifier (type no.)	2669	2683	2669 + UA-0035 2670	2669 + UA-0035 2670	2669, 2671 2699, 1706	2669 + UA-0035 2670	2669, 2671 2699, 1706	2669	2669, 2670 2671, 2699 1706 + UA-0035	2669, 2671 2699, 1706	2669, 2671 2699, 1706	2669, 2671 2699, 1706	2669, 2670 2671, 2699 1706 + UA-0035	2669, 2671 2699	2669, 2671 2699, 1706

* See Product Data for details
† To ensure correct operation, the microphone should not be exposed to sound pressure levels exceeding the stated 3% Distortion Limit by more than 10 dB. Above this level, the output becomes heavily distorted (clipping occurs). In addition, an externally polarized microphone will temporarily lose its charge and will need some time to recover. However, even if the 3% Distortion Limit is exceeded, for example, by up to 20 dB, the microphone will not suffer permanent damage provided it is used with a Brüel & Kjær preamplifier.
‡ Standards: A = IEC 61094–4 WS1F, B = IEC 61094–4 WS2F, C = IEC 61094–4 WS3F, D = IEC 61094–4 WS1P, E = IEC 61094–4 WS2P, F = IEC 61094–4 WS3P, G = IEC 61094–1 LS1P, H = IEC 61094–1 LS2P, I = IEC 61672 Class 1, J = IEC 61672 Class 2, K = ANSIS1.4 Type 1, L = ANSIS1.4 Type 2, M = ANSIS1.12 Type M

Note: The effect of humidity is insignificant, and therefore not shown.

The most important parameter for any measurement device is sensitivity. The sensitivity can be defined as the ratio of the output quantity to the input quantity. To determine the sensitivity is to calibrate the measurement device.

A calibration is performed:
- To ensure that your measurements are correct
- To prove that measurement methods and the equipment used are accurate, for example, to prove that a measurement complies with the requirements of national legislation, standard bodies or customers
- To verify the stability of the measurement equipment, including equipment used to perform calibration
- To account for local measurement conditions, for example, variations in ambient pressure and temperature
- To ensure product quality
- To build confidence in measurement results

Calibrators


4231


4226


4228


4229

Type No.		4231	4226	4228	4229
Description		Sound Calibrator	Multifunction Acoustic Calibrator	Pistonphone	Hydrophone Calibrator
Standards		EN/IEC 60942 (2003) Class LS* and Class 1 ANSIS 1.40–1984	EN/IEC 60942 (1998) Class LS and Class 1 ANSIS 1.40–1984	IEC 60942 (1998) Class 1	–
Calibration Pressure	dB SPL	94 and 114	94, 104 and 114	124	From 151 to 166 dB re 1 μPa, depending on hydrophone
Calibration Frequencies	Hz	1000	31.5 Hz to 16 kHz in octave steps plus 12.5 kHz	251.2	251.2
Calibration Accuracy	dB	±0.2	±0.2 at 94 dB	±0.2	±0.7
Transducer		1-inch and 1/2-inch (1/4-inch and 1/8-inch with adaptor)	1/2-inch and 1/4-inch	1-inch, 1/2-inch,1/4-inch and 1/8-inch	Fits Types 8100, 8101, 8103, 8104, 8105 and 8106

* Type 4231 conforms with Class LS tolerances over the full temperature range from –10 to +50°C

Sound Intensity Calibrators

Requirements for laboratory and field use are different. Brüel & Kjær, therefore, offers two instruments for sound intensity calibration:

- **Type 3451-A** for laboratory use
- **Type 4297** for field use

Both calibrators fulfil IEC 61043, 1993 Class 1.

Type No.		3541-A	4297
Main Application		In the laboratory	In the field
Dismantling of Probe		Necessary	Unnecessary (up to 3 kHz)
Calibration of Sound Intensity Level	L_I	Yes	No
Calibration of Sound Pressure Level	L_p	Yes	Yes
Calibration of Particle Velocity Level	L_v	Yes	No
Pressure-Residual Intensity Index	$L_p - L_I$	250 Hz	20 to 3 kHz with spacer 20 to 6.3 kHz without spacer
Spacings Accommodated		Irrelevant as spacer must be removed from probe	Probe must be based on 12 mm spacer
Sound Pressure Source		Separate pistonphone	Integrated
Noise Generator		Sine tone at 250 Hz	Integrated pink noise generator
Microphones Accommodated	inch	1/4 and 1/2	1/2
Number of Mechanical Parts		4	1

Adaptors for Calibration

DP-0776	Adaptor for 1/2-inch microphones Use with Type 4228
DP-0775	Adaptor for 1/4-inch microphones Use with Types 4228 and 4231
DP-0774	Adaptor for 1/8-inch microphones Use with Types 4228 and 4231
DP-0888	Adaptor for checking sound intensity probes with Type 4231, sound pressure level 97 dB ±0.7 dB
DP-0977	Adaptor (for un-flanged surface microphone)
DP-0978	Adaptor for Type 4101-A
DP-0979	Adaptor for flush-mounted surface microphone
DB-4009	1/4-inch Adaptor for UA-0033
DB-4010	1/8-inch Adaptor for UA-0033
UC-0210	1/2-inch Adaptor for Type 4231
DB-4121	1/2-inch Adaptor for Type 4961
DB-4199	Adaptor for Acoustic Calibrator Type 4226 Use with Types 4184 and 4184-A
Electrostatic Actuators	
UA-0023	For 1-inch microphones
UA-0033	For 1/2-inch microphones
UA-1639	For calibration of surface microphones
Actuator Adaptors	
DB-0264	For 1/4-inch microphones Use with UA-0033
DB-0900	For 1/8-inch microphones Use with UA-0033

DP-0776

DP-0775

DP-0977

DP-0774

DP-0979


DP-0978


UA-0023


UA-0033


UA-1639


DB-0264


DB-0900

TEDS Microphones

A TEDS microphone consists of a microphone cartridge and its preamplifier with a memory chip, sealed to form one unit called the TEDS microphone.

TEDS Templates

The TEDS template defines the memory mapping of the TEDS chip and hence the “understanding” between transducer and front-end.

A number of TEDS templates have been standardised by the IEEE and in addition to this a number of non-standard vendor specific templates exist. The different TEDS templates are differentiated by different ID numbers. At the moment Brüel & Kjær uses the following templates for TEDS microphones and preamplifiers.

*IEEE P1451.4 V.0.9 – TEDS Templates**

UTID No.	Name	Remarks
769	Microphone integrated preamplifier	Used for most TEDS microphones
1025	Microphone preamplifier	Used for most TEDS microphone preamplifiers
116289	Microphone integrated preamplifier extended sensitivity	Used in special cases like low-sensitivity microphones or reference frequency not 250 Hz

IEEE 1451.4 V.1.0 – TEDS Templates

UDID No.	Name	Remarks
127-0-0-0U	Microphone with integrated preamplifier, V.1.0	This template is without transfer function Replaces UTID 769 and 116289
127-0-0-1U	Microphone with integrated preamplifier, transfer function, V.1.0	Same as UDID 127-0-0-0U but with transfer function Replaces UTID 34013408

To find out more about TEDS, see Implementation of TEDS.

* Default template for most Brüel & Kjær TEDS microphones

Common Specifications

For detailed specifications, please see the product data for the individual components (microphone or preamplifier). Unless otherwise stated, all specifications are valid under the following conditions:

- CCLD input types: 24 – 28 V compliance voltage
- Classical input types: 80 V DC supply†
- Dynamic range low limit: Noise floor dBA
- Max. SPL dB: The 3% distortion limit in dB SPL RMS rounded to nearest integer. The undistorted peak level will normally be 3 dB higher
- Cartridge sensitivity: Nominal
- TEDS microphone sensitivity: Stated as the nominal cartridge sensitivity except for 1/4-inch and 1/8-inch cartridges where the loaded sensitivity differs considerably from the open circuit sensitivity

† If, for example, the supply voltage to a classical preamplifier is reduced from 80 V to 28 V or ±14 V, the maximum SPL may theoretically be reduced by up to 15.7 dB

Temperature Range

The read/write temperature range of the TEDS chip is guaranteed by the chip manufacturer up to +85°C only (+185°F), but the TEDS chip will survive the full specified temperature range of the TEDS microphone/preamplifier without any damage.

Cable Length

TEDS is guaranteed to work properly with a cable length up to 100 m (328 ft).

Microphone Type No.	Cartridge Diameter (in)	Data CD	Field*	Preamplifier Type No.	Input Type	Adaptor	Sensitivity (dB re 1 V/Pa)	Sensitivity (mV/Pa)	±2 dB Frequency Range (Hz)	Noise floor (dBA)	Max. SPL (dB)
4138-A-015	1/8	No	P	2670	Classical	UA-0160	–65	0.55	6.5 – 140 k	52.2	168
4138-B-006†	1/8	No	P	2670	Classical	UA-0036	–62	0.79	6.5 – 140 k	52.2	168
4138-C-006	1/8	No	P	2670	Classical	UA-0036	–62	0.79	6.5 – 140 k	52.2	168
4138-L-006	1/8	No	P	2670	Classical	UA-0036	–62	0.79	6.5 – 140 k	52.2	168
4188-A-021	1/2	No	F	2671	CCLD		–30	31.6	20 – 12.5 k	19	138
4188-C-001	1/2	No	F	2669-C	Classical		–30	31.6	8 – 12.5 k	15.8	146
4188-L-001	1/2	No	F	2669 - L	Classical		–30	31.6	8 – 12.5 k	15.8	146
4189-A-021	1/2	Yes	F	2671	CCLD		–26	48	20 – 20 k	16.5	134
4189-A-031	1/2	Yes	F	2699	CCLD		–26	48	6.3 – 20 k	18	130
4189-B-001†	1/2	Yes	F	2669-B	Classical		–26	49	6.3 – 20 k	15.2	146
4189-C-001	1/2	Yes	F	2669-C	Classical		–26	49	6.3 – 20 k	15.2	146
4189-H-041	1/2	Yes	F	1706	CCLD		–26	48	6.3 – 20 k	16.5	134

Microphone Type No.	Cartridge Diameter (in)	Data CD	Field*	Preamplifier Type No.	Input Type	Adaptor	Sensitivity (dB re 1 V/Pa)	Sensitivity (mV/Pa)	±2 dB Frequency Range (Hz)	Noise floor (dBA)	Max. SPL (dB)
4189-L-001	1/2	Yes	F	2669-L	Classical		–26	49	6.3 – 20 k	15.2	146
4189-W-003	1/2	Yes	F	2671-W-001	CCLD		–26	48	6.3 – 20 k	16.5	134
4190-B-001†	1/2	Yes	F	2669-B	Classical		–26	48	3.15 – 20 k	15	148
4190-C-001	1/2	Yes	F	2669-C	Classical		–26	48	3.15 – 20 k	15	148
4190-L-001	1/2	Yes	F	2669-L	Classical		–26	48	3.15 – 20 k	15	148
4190-L-002	1/2	Yes	F	2669-L	Classical		–26	48	3.15 – 20 k	15	148
4191-B-001†	1/2	Yes	F	2669-B	Classical		–38	12	3.15 – 40 k	21.4	162
4191-C-001	1/2	Yes	F	2669-C	Classical		–38	12	3.15 – 40 k	21.4	162
4191-L-001	1/2	Yes	F	2669-L	Classical		–38	12	3.15 – 40 k	21.4	162
4192-B-001†	1/2	Yes	P	2669-B	Classical		–38	12	3.15 – 20 k	20.7	162
4192-C-001	1/2	Yes	P	2669-C	Classical		–38	12	3.15 – 20 k	20.7	162
4192-L-001	1/2	Yes	P	2669-L	Classical		–38	12	3.15 – 20 k	20.7	162
4193-B-004†	1/2	Yes	P	2669-B	Classical	UC-0211	–54	2	0.13 – 20 k	29	148
4193-C-004	1/2	Yes	P	2669-C	Classical	UC-0211	–54	2	0.13 – 20 k	29	148
4193-L-004	1/2	Yes	P	2669-L	Classical	UC-0211	–54	2	0.13 – 20 k	29	148
4938-A-011	1/4	Yes	P	2670	Classical		–57	1.4	4 – 70 k	42	172
4938-C-002	1/4	Yes	P	2669-C	Classical	UA-0035	–57	1.4	4 – 70 k	42	172
4938-L-002	1/4	Yes	P	2669-L	Classical	UA-0035	–57	1.4	4 – 70 k	42	172
4939-A-011	1/4	Yes	F	2670	Classical		–49	3.8	4 – 100 k	35	164
4939-C-002	1/4	Yes	F	2669-C	Classical	UA-0035	–49	3.6	4 – 100 k	35	164
4939-L-002	1/4	Yes	F	2669-L	Classical	UA-0035	–49	3.6	4 – 100 k	35	164
4941-A-011	1/4	No	P	2670	Classical		–82	0.08	4 – 20 k	73.5	184
4941-C-002	1/4	No	P	2669-C	Classical	UA-0035	–82	0.08	4 – 20 k	75.8	184
4942-A-021	1/2	Yes	D	2671	CCLD		–26	50	20 – 16 k	18	134
4942-A-031	1/2	Yes	D	2699	CCLD		–26	50	6.3 – 16 k	18	130
4942-B-001†	1/2	Yes	D	2669-B	Classical		–26	50	6.3 – 16 k	15.2	146
4942-C-001	1/2	Yes	D	2669-C	Classical		–26	50	6.3 – 16 k	15.2	146
4942-H-041	1/2	Yes	D	1706	CCLD		–26	50	6.3 – 16 k	18	134
4942-L-001	1/2	Yes	D	2669-L	Classical		–26	50	6.3 – 16 k	15.2	146
4943-B-001†	1/2	Yes	D	2669-B	Classical		–26	50	3.15 – 10 k	15.9	148
4943-C-001	1/2	Yes	D	2669-C	Classical		–26	50	3.15 – 10 k	15.9	148
4943-L-001	1/2	Yes	D	2669-L	Classical		–26	49	3.15 – 10 k	15.9	148
4944-A/B	1/4	Yes	P	Integral	CCLD		–61	0.9	16 – 70 k	48	169
4954-A/B	1/4	Yes	F	Integral	CCLD		–51	2.8	16 – 80 k	40	159
4954-A-011	1/4	Yes	F	2670	Classical		–50.5	3	4 – 80 k	35	164
4955	1/2	Yes	F	Integral	Classical		0.8	1100	10 – 16 k	6.5	110
4955-A	1/2	Yes	F	Integral	Classical		0.8	1100	10 – 16 k	6.5	110
4956-W-001	1/2	Yes	P	2671-W-001	CCLD		–38	12.5	3 – 20 k	26.5	135
4957	1/4	No	F	Integral	CCLD		–39	11.2	50 – 10 k	32	134
4958	1/4	No	F	Integral	CCLD		–39	11.2	10 – 20 k	28	140
4959	1/4	No	P	Integral	CCLD		–39	11.2	50 – 20 k	32	134
4961	1/4	Yes	M	Integral	CCLD	UA-0033	–24.4	60	12 – 20 k	20	130

* P = Pressure, F = Free, D = Diffuse and M = Multi-field
† Delivered with a LEMO to B&K Cable AO-0428. This cable does NOT support TEDS (pin 5 open)

Microphone Verification and Calibration

Charge Injection Calibration (CIC)

This is a Brüel & Kjær patented method for in-situ verification of the integrity of the entire measurement chain, for example, microphone, preamplifier and cabling. Even microphones remote from the input stage/conditioning amplifier can be verified. The basic philosophy behind CIC is that if we have a known condition (for example, a properly calibrated microphone) and establish a reference measurement, then as long as the reference value does not change, nothing has changed and the microphone calibration will still be valid. Additionally CIC verifies the cable and preamplifier. Furthermore, if an error occurs, then the change in the CIC signal will very often clearly indicate which kind of problem causes the error.

The CIC technique is a great improvement over the traditional insert voltage calibration method which virtually ignores the state of the microphone. The CIC technique is very sensitive to any change in the microphone's capacitance, which is a reliable indicator of the microphone's condition.

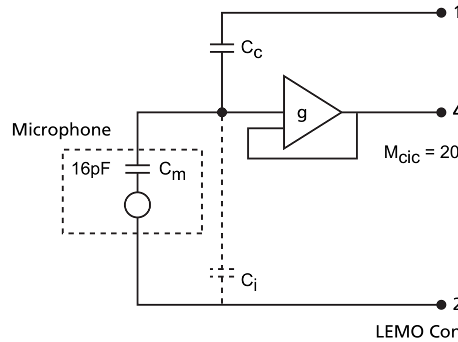
The technique works by introducing a small but accurately defined capacitance C_c (typically 0.2 pF) with a very high leakage resistance (greater than 50000 GΩ) into the circuit of the preamplifier, see figure. C_i and R_i represent the preamplifier's high input impedance and g its gain (= 1).

For a given calibration signal e_i, the output e_o of this arrangement will change considerably, even for small changes in the microphone's capacitance C_m. The CIC technique is about 100 times more sensitive than the insert voltage calibration. In the extreme case where there is a significant leakage between the microphone's diaphragm and its back plate (Cm becomes very large), the output signal will change by tens of decibels compared with only tenths of a decibel using the insert voltage method.

Another important CIC feature is that, unlike the insert voltage technique, it is far less sensitive to external electrical fields.

Insert Voltage Calibration (IVC)

This method was originally developed for calibration of the open-circuit voltage sensitivity of microphones and, for this purpose, it is still the best method. IVC requires a special preamplifier and will not detect microphone changes as easily as the CIC method.



$$M_{cic} = 20 \log \frac{C_c}{C_m + C_i + C_c}$$

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How to Perform CIC

The CIC method can be used to monitor the measurement system at all frequencies covered by the system.

Use low frequencies to observe changes in the preamplifier input resistance or additional leakage.

Use the mid-frequency range, for example, around 1 kHz to check for changes to the microphone capacitance. The CIC output is essentially inversely proportional to the microphone capacitance.

Check the high-frequency attenuation (above 10 kHz) to monitor for changes in the microphone resonance.

When can CIC be Used?

CIC requires use of a preamplifier and a cable that supports CIC plus a front-end input that allows CIC measurement. If the power supply does not support CIC, Brüel & Kjær can supply adaptors to inject the CIC signal:

- WB-0850 for a B&K connector
- UA-1405 for a LEMO connector

CIC is not possible when using preamplifiers with CCLD output.

Brüel & Kjær's PULSE multi-analyzer and the NEXUS range of conditioning amplifiers support CIC for the microphone inputs.

Calibration

The microphone and the entire measurement chain must be calibrated at regular intervals. The calibration provides traceability and proven accuracy to your system. The intention behind CIC is not to replace the calibration, but to enable you to extend the calibration interval.

The best connection between A and B is a cable from Brüel & Kjær. A quality cable is so much more than just an electrical connection between two points. Cables from Brüel & Kjær are carefully selected and designed in order to offer excellent electrical properties such as high screening and low capacitance combined with maximum strength and flexibility for easy handling.

Our most popular cables are highlighted. These offer the best delivery times and prices.

Type No.	Connector A-end	Connector B-end	Raw Cable	Description	
AO-0414	LEMO 1B, Female	LEMO 1B, Male	AC-0289	Most popular extension cable for classical preamplifier and microphone input. Also fits directly in preamplifiers with cylindrical houses. PUR cable –20 to +80°C	
AO-0419	LEMO 0B, Female	LEMO 1B, Male	AC-0219	Preamplifier Cable Silicone Cable –60 to +150°C Suits only Types 2669 and 2673 with tapered house	
AO-0428	LEMO 0B, Female	7-pin B&K, Male	AC-0219	From current classical preamplifier with tapered house to B&K input Silicone cable –60 to +150°C	
AO-0027	7-pin B&K, Female	7-pin B&K, Male	AC-0289	From old Brüel & Kjær preamplifier to B&K input. Single-screened PUR cable –20 to +80°C	
AO-0028	7-pin B&K, Female	7-pin B&K, Male	Double-screened AC-3028	Similar to AO-0027, but with double-screened cable PVC –20 to +80°C	
AO-0488	7-pin B&K, Female	LEMO 1B, Male	AC-0289	Connects older Brüel & Kjær systems to modern input PUR cable –20 to +80°C	
AO-0645	LEMO 1B, Female	LEMO 1B, 10-pin, Male	AC-0289	Connects classical microphone preamplifiers to sound level meter and other inputs (for example, Types 2250, 2270 and 3639) PUR cable –20 to +80°C	

Type No.	Connector A-end	Connector B-end	Raw Cable	Description	
AO-0479	LEMO 1B, Male	BNC, Male	AC-0289	Microphone front-end input cable Only LEMO pin 2 and 4 are con-nected to BNC, LEMO pin 2 is GND PUR cable –20 to +80°C	
AO-0537	7-pin B&K, Female	LEMO 1B, Male	AC-0289	Adaptor cable – use only with Types 2633 and 2639 PUR cable –20 to +80°C	
WL-3185	7-pin B&K, Female	BNC, Male		Adaptor cable, 0.6 m (2 ft)	
AO-0463	10–32 UNF, Male	10–32 UNF, Male	AC-0208	Economy cable PVC –20 to +70°C	
AO-0563	SMB (right angle), Female	SMB (right angle), Female	RG-174	When you need right angle SMB in both ends –10 to +80°C	
AO-0564	SMB (right angle), Female	BNC, Male	RG-174	Where space is limited, right angle SMB and BNC –10 to +80°C	
AO-0587	SMB, Female	BNC, Male	AC-0208	For use with array microphones PVC cable –20 to +70°C	

Type No.	Connector A-end	Connector B-end	Raw Cable	Description	
AO-0687	10–32 UNF, Male	10–32 UNF, Male	AC-0005	Super cable with extensive connector relief PFA cable –40 to +120°C	
AO-0087	BNC, Male	BNC, Male	AC-0006	General purpose coaxial cable with BNC single screened 50 Ω	
AO-0426	BNC, Male	BNC, Male	AC-0299	General purpose coaxial cable with BNC, double-screened 50 Ω	
AO-0531	10–32 UNF, Male	BNC, Male	AC-0208	For surface microphones or 1/4-inch TEDS microphones with 10–32 UNF PVC cable –20 to +70°C	
AO-0699	SMB, Female	10–32 UNF	AC-0005	Low-noise, single-screened coaxial cable PFA cable	
AR-0014	LEMO 1B, Female	LEMO 1B, Male	Shielded flat cable	Signal routing through closed doors and windows 0.2 mm thick	
WL-1287	LEMO 1B, Female	LEMO 1B,10-pin, Male	AC-0289	Connects Type 4182 to sound level meters, for example Types 2250 and 2270, SLM input PUR cable –20 to +80°C	
WL-1302	7-pin B&K, Female	LEMO 1B, Male	AC-0289	Adaptor cable, Type 2660-W-001 to PULSE or NEXUS Maximum ±16 V DC supply PUR cable –20 to +80°C	

Type No.	Connector A-end	Connector B-end	Raw Cable	Description	
EL-4023	4182	LEMO 1B, 10-pin		Cable for Type 4182 to 10-pin LEMO connector	
EL-4025	7-pin B&K, Female	B&K 7-pin, Female	AC-0289	Connection cable for Type 5935-L PUR –20 to +80°C	
WL-1260	7-pin B&K, Female	7-pin B&K, Female	AC-0289	With built-in overvoltage protection for Hydrophone Type 8106 PUR –20 to +80°C	

Raw Cables

This table provides information about the raw cables used for a number of Brüel & Kjær extension cables. Note that the temperature range for a cable with connectors can be limited compared with the specifications for the raw cable.

Raw Cable	∅ mm	Jacket	Colour	Temperature Range, °C	Centre Conductor	Z ohms	pF/m	Description
AC-0005	2	PFA	Black	–75 to +250	Silver-plated steel 0.25 mm	50	105	Special coaxial cable with low triboelectric noise
AC-0079	3.8	PUR	Grey	–50 to +70	7 × 0.10 mm^2		115	Special braided shield microphone cable
AC-0006	4.95	PVC II Low migration	Black	–25 to +85	19 × 0.1 mm	50	101	Single shielded, braided 96% coaxial cable
AC-0208	2	PVC	Grey	–20 to +70	7 × 0.1 Ø	50	95	Single shielded, braided 86% coaxial cable
AC-0219	4	Silicone	Grey	–25 to +180	7 × 0.06 mm^2		90	Special braided shield microphone cable
AC-0289	4.2	PUR	Black	–30 to +70	10 × 0.04 mm^2		95	Special braided shield microphone cable
AC-0299	5.4	PVC II Low migration	Black	–25 to +85	0.88 mm	50	101	Double shielded, braided 96% coaxial cable
AC-3028	9	PVC	Grey	–10 to +70	8 × 0.5 mm^2			Cable hybrid 8 × 0.5 mm^2 + 1 × coaxial cable
AC-0043	3.1	FEP	White	–55 to +200	Silver-plated steel 0.29 mm	50	100	Low-noise double-screen
AC-0034	9.9	Polychloroprene	Black	– 40 to +80	2 × 18 AWG			Single shielded hydrophone MIL-C-915 cable
AC-0101	11.5	Polychloroprene	Black	–35 to +85	4 × 1 mm^2			Single shielded hydrophone cable

More About Cables

Cable Length and Current Limitations

Brüel & Kjær preamplifiers can drive very long cables. The cable length is limited though by the available output current of the preamplifier, especially in situations where high frequency signals must be measured at high levels.

The maximum sound pressure level ($L_{p,peak}$) which can be measured with the combination of available current, cable load, frequency content of signal and microphone sensitivity can be calculated with the following expression:

$$L_{p,\,peak} = 94 + 20\log\left(\frac{i_{peak}}{2\cdot\pi\cdot f_{max}\cdot C_L\cdot 1\,\mathrm{Pa}\cdot S_c}\right)[\mathrm{dB}]$$

where:

i_{peak} = maximum available peak current, either the preamplifiers maximum output current or the supply current minus the preamplifier's current consumption, whichever is the smallest

f_{max} = maximum frequency in the signal

C_L = total capacitative load presented by the connection cable in farad (F). The load is calculated by multiplying the cable length in metres with the cable capacitance in F per metre

S_c = loaded sensitivity of the microphone in V/Pa (Nominal Sensitivity)

The following examples illustrate the use of the above equation.

Example 1:

Using a PULSE module with CCLD Microphone Preamplifier Type 2671, Prepolarized Free-field, ½-inch Microphone Type 4188 and 100 m of 95 pF/m cable:

i_{peak} = 4 mA – 1 mA = 3 mA

C_L = 95 pF/m × 100 m = 9.5 nF

S_c = 31.6 mV/Pa

f_{max} = 10000 Hz

$$L_{p,\,peak} = 94 + 20\log\left(\frac{0.003}{2\cdot\pi\cdot 10000\cdot 9.5\cdot 10^{-9}\cdot 1\,\mathrm{Pa}\cdot 0.0316}\right) = 138\,\mathrm{dB}$$

Example 2:

Using a PULSE module with ½-inch Microphone Preamplifier Type 2669, ½-inch Free-field Microphone Type 4191 and 1000 m of 95 pF/m cable:

i_{peak} = 20 mA – 3 mA = 17 mA

C_L = 95 pF/m × 1000 m = 95 nF

S_c = 12.5 mV/Pa

f_{max} = 20000 Hz

$$L_{p,\,peak} = 94 + 20\log\left(\frac{0.017}{2\cdot\pi\cdot 20000\cdot 95\cdot 10^{-9}\cdot 1\,\mathrm{Pa}\cdot 0.0125}\right) = 135\,\mathrm{dB}$$

Note: The maximum peak sound pressure level for shorter cables may be limited by the available voltage and the preamplifiers maximum slew rate. Further details about the limitations due to voltage, current, and slew rate of the preamplifiers can be found in Brüel & Kjær's Microphone Handbook.

Cable Bending Radius

As a rule of thumb the bending radius should be more than 15 times the cable diameter.

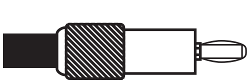
Popular Connectors Used in Acoustic Measurements

Older Brüel & Kjær equipment traditionally used a proprietary B&K coaxial connector JP-0101 and the famous B&K 7-pin microphone plugs for the preamplifier input.

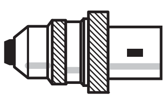
Due to the long lifetime and high stability of Brüel & Kjær instruments, thousands of instruments using these traditional connectors are still on the market, and we still supply extension cables and adaptors that connect these instruments to newer types of transducers.

Eventually, these older connectors were replaced by the LEMO 7-pin connector (for classical microphone input), and the industry standard BNC connector for signal input/output. BNC connectors are also a popular choice for CCLD preamplifiers.

Another popular coaxial connector (originating from the vibration world) is the 10–32 UNF, also called the "Microdot" connector. The 10–32 UNF is especially popular where vibration can be expected. SMB type connectors are often encountered in multi-channel systems, where space around the connector is limited, for example, in array-solutions.



JP-0101



7-pin microphone preamplifier plug (male)

JP-0035

LEMO 7-pin

Adaptors

Adaptors for Mounting Preamplifiers and Extension Rods with Microphones of Different Diameters	
UA-0786	1-inch microphone to 1/2-inch preamplifier, Insert Voltage possibility
DB-0375	1/1-inch microphone to 1/2-inch preamplifier
UA-0035	1/4-inch microphone to 1/2-inch preamplifier (driven shield 0.33 pF) Length = 72.5 mm
WA-0371	1/4-inch microphone to 1/2-inch preamplifier, short version (driven shield 0.08 pF), Length = 32 mm
WA-0406	1/8-inch microphone to 1/2-inch preamplifier
UA-0036	1/8-inch microphone to 1/2-inch preamplifier (driven shield 0.46 pF)
UA-0160	1/8-inch microphone to 1/4-inch preamplifier (driven shield 2.44 pF)
UA-1434	1/2-inch to 1-inch adaptor
UA-0954	Extension for 1/4-inch microphone and angle pieces 90°
JJ-0081	Adaptor BNC, Female to Female
Flexible Adaptors 1/4- to 1/2- inch and Flush Mountings for 1/4- and 1/2-inch Microphones	
UA-0122	Right angle (driven shield 1.25 pF) Length = 60 mm
UA-0123	Straight (driven shield 1.25 pF) Length = 60 mm
Flexible Extension Rod	
UA-0196	1/2-inch to 1/2-inch 210 mm (driven shield 0.22 pF)
Angle Pieces	
EU-4000	1/4-inch to 1/4-inch (driven shield 0.97 pF) 90°
UA-1260	1/2-inch to 1/2-inch (80° approximately)

Corrector

DZ-9566	Random Incidence Corrector gives Types 4176/4188 a flat random response for measurements in diffuse sound fields	

Windscreens

The windscreen is made of specially prepared, open-pored polyurethane foam attenuating wind noise 10 to 12 dB at lower wind velocities, and is suited for hand-held outdoor sound measurements. The windscreen is simply pushed as far as it will go over the microphone (fitted with its normal protection grid) and preamplifier.

UA-1070	Windscreen for Type 4184
UA-1071	Windscreen holder for Type 4184
UA-0207	For 1-inch microphones, spherical, diameter 90 mm, hole 20 mm
UA-0237	For 1/2-inch microphones, spherical, diameter 90 mm, hole 10 mm
UA-0253	6 units of UA-0207
UA-0254	6 units of UA-0237
UA-0459	For 1/2-inch microphones, spherical, diameter 65 mm, hole 10 mm
UA-0469	6 units of UA-0459
UA-1679	Upper part with windscreen for Type 4952
UA-1700	Windscreen for Type 4952
UA-1701	6 units of UA-1700 units
WQ-1099	For 1/4-inch microphones, spherical, diameter 65 mm, hole 5 mm
WQ-1133	For 1/4-inch microphones, ellipse 38 × 55 mm, hole 5 mm
DS-0394	Windscreen for Type 4198/UA-1404
UA-0781	Elliptical Windscreen
UA-0839	6 pack UA-0781
UA-1650	Windscreen auto detect
UA-2133	Windscreen for boundary layer microphone according to IEC/ EN 61400–11
UC-5360	Bird-spikes for UC-0213
WQ-2842	Windscreen for 1/4-inch microphone

Nose Cones

Nose cones are designed to reduce the aerodynamically induced noise present when the microphone is exposed to high wind speeds in a known direction, for example, during sound measurements in wind tunnels, ducts, etc. They replace the normal protection grid of the microphone, and have a streamlined shape with a highly polished surface giving the least possible resistance to air flow and thereby reducing the noise produced by the presence of the microphone itself. The fine wire mesh around the nose cone permits sound pressure transmission to the microphone diaphragm while a truncated cone behind the mesh reduces the air volume in front of the diaphragm.

UA-0387: 1/1-inch
UA-0386: 1/2-inch
UA-0385: 1/4-inch
UA-0355: 1/8-inch

Outdoor Protection

UA-1404	Outdoor Microphone Kit for Preamplifier Types 2669, 2671, 2673 and Sound Level Meters 2236, 2237,
DB-3611	Extension for UA-1404: Makes it possible to mount the preamplifier from Sound Level Meter Type 2231 inside
UA-0308	Dehumidifier used with back-vented 1/2-inch microphones with nickel diaphragms
UA-0393	Rain cover with built in actuator
UA-1679	Upper Part with Integral Windscreen for Type 4952
UC-5360	Windscreen Holder with bird spike for Type 4198/UA-1404
	Rain cover for Type 4952

Preamplifier Holders

UA-1317	Preamplifier Holder to be used with 1/2-inch preamplifiers together with a camera tripod. The holder can be swivelled and locked at any angle between +90° and –90° from the vertical
UA-1588	Preamplifier Holder to be used with 1/4-inch preamplifiers together with a camera tripod
UA-0588	Microphone Holder for tripod for Types 2671, 2669-C SLM preamplifiers
UA-1284	Microphone Stand for Type 2669-B/L
UA-2129	Microphone Holder for Types 4961, 4944-A, 4954-A, 4957 and 4958

Tripods

UA-0587	Heavy Duty Tripod for Type 3923 Rotating Boom, max. height 1.46 m
UA-0801	Lightweight Tripod with tilt head, max. height 1332 mm
UA-0803	Tripod for photocells and microphones, max. height 1250 mm
UA-0989	Tripod with pan and tilt head for Type 8329
UA-1251	Lightweight Tripod for Type 2236, compact, max. height 1.22 m
UA-1577	Tripod including CAM head
UA-1707	Tripod Adaptor for Type 4952

Miscellaneous

ZG-0350	LEMO to 7-pin B&K adaptor for connecting cables with LEMO 1B male connector to instruments with B&K 7-pin connectors
UA-1405	CIC Adaptor, LEMO to B&K is an adaptor similar to ZG-0350 with a BNC to mini-jack cable of 1.5 m to inject CIC to the preamplifier
WB-0850	Insert Voltage or CIC Junction Unit 10–32 UNF socket for signal input. Use, for example, cable AO-0038 for signal input
ZG-0328	BNC to B&K 7-pin, provides CCLD supply from microphone 7-pin supply*
WB-1421	BNC to LEMO, provides CCLD supply from microphone LEMO supply*
WB-1452	Microdot to LEMO provides CCLD supply from microphone LEMO supply*
JJ-0032	Adaptor 10–32 UNF (Female) to 10–32 UNF (Female)
UA-0186	25 × JJ-0032
JP-0144	BNC (Female) to B&K Coaxial Banana (Male)
JP-0145	10–32 UNF (Female) to BNC (Male)
UA-0920	Transmitter Adaptor for calibrating Probe Microphone Type 4182
JP-0144	B&K coaxial to BNC adaptor
JP-0028	B&K coaxial to 10–32 UNF
JP-0169	Grounding terminal to 10–32 UNF connector
JP-0145	BNC to 10–32 UNF adaptor


ZG-0350


UA-1405


WB-0850


ZG-0328


WB-1421


WB-1452


JJ-0032


UA-0920


JP-0144

* These units require minimum 28 V DC supply from the front-end. They cannot be used with PULSE multi-analyzer

Brüel & Kjær's electroacoustic solutions can help you improve your development and manufacturing efficiency in:

- Telephony
- Entertainment systems
- Hearing aids
- Headsets
- Public address systems

Brüel & Kjær's versatile test systems offer a broad range of analysis methods and are designed to ensure reliable and comparable results supporting standardised test, calibration, and documentation procedures. Our wide range of standardised couplers ensures a well-controlled acoustic interface.

The following tables give a quick overview of all Brüel & Kjær transducers optimized for electroacoustic testing.

Type No.	4152	4153	4157	4185	4195	4195-Q 4195-Q-HL0 4195-Q-A	4946
Description	Ear simulator	Ear simulator	Ear simulator	Ear simulator for telephonometry	Wideband ear simulator	Wideband ear simulator for production line testing of telephones	2 cc click-on coupler
Coupler Acoustic Equivalent Volume	2 cc / 6 cc	4.2 cc	1.26 cc	4.2 cc	1.26 cc	1.26 cc	2 cc
Microphone Included	No	No	Built-in	Type 4192	Built-in	Built-in	no
Prepolarized Microphone		Yes, optional				Yes	Yes
Accommodates Microphone Size	1/2″ and 1″	1/2″	1/2″ built-in	1/2″	1/2″ built-in	1/2″ and 1/4″ built-in	1/4″, 1/2″ and 1″
Preamplifier Included	No	No	Type 2669	Type 2669	Type 2669	Type 2695	No
Relevant Standard	IEC 60318–5 ANSI S3.7	IEC 60318–1	IEC 60318–4 ANSI S3.35 ITU-T Rec. P.57	IEC 60318–1 ITU-T Rec. P.57	IEC 60318–4 ITU-T Rec. P.57 ITU-T Rec. P.57	IEC 60318–4 ITU-T Rec. P.57 ANSI S3.35	IEC 60318–5 ANSI S3.7
TEDS Enabled Preamplifier	N/A	N/A				Yes	N/A
Test Application	Earphones (supra aural)	Earphones (circum and supra aural)	Insert ear-phones Hearing aids	Earphones (circum and supra aural)	Earphones Telephones	Earphones Telephones	Insert ear-phones Hearing aids
Pinna Type	Simplified	Simplified	N/A	Simplified	Simplified	Simplified	N/A
Calibration Adaptor			DB-2012 DB-2015		DP-0939	DP-0939	
Typical Sensitivity			12.6 mV/Pa	12.5 mV/Pa	15 mV/Pa	15 mV/Pa	

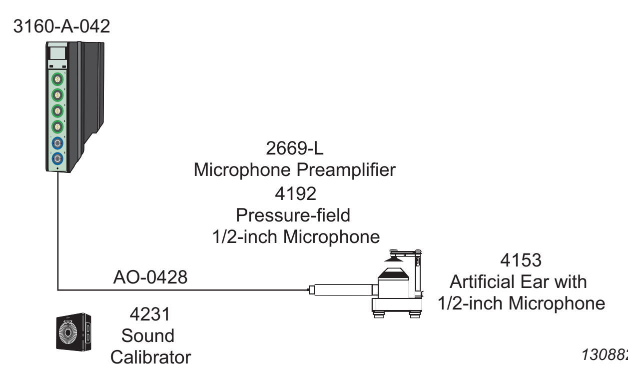
Type No.	4128-C	4128-D	4227	4602-B	4930	4232	9640	2716-C
Description	Head and torso simulator	Head and torso simulator	Mouth simulator	Telephone test head	Artificial mastoid	Anechoic test box	Turntable system	Power amplifier
Coupler Acoustic Equivalent Volume	1.26 cc	1.26 cc						
Microphone Included	Built-in	Built-in	N/A	N/A	N/A	N/A	N/A	N/A
Prepolarized Microphone	Yes, optional	Yes, optional						
Accommodates Microphone Size	1/2″ built-in	1/2″ built-in	N/A	N/A	N/A	1/2″ and 1″	N/A	N/A
Preamplifier Included	Type 2669	Type 2669	N/A	N/A	N/A	no	N/A	N/A
Relevant Standard	ITU-T Rec. P.51, P.57, P.58 & P.64 IEEE 269 & 661 ANSI S3.36	ITU-T Rec. P.51, P.57 & P.58 IEEE 269 & 661 ANSI S3.36	ITU-T Rec. P.59	ITU-T Rec. P.64	IEC 60373 ANSI S3.13 & S.3.26 BS 4009			
TEDS Enabled Preamplifier	No	No	N/A	N/A	N/A	N/A	N/A	N/A
Test Application	All types of ear-phones and telephones	All types of ear-phones and telephones	Telephone transmitters, microphones, etc.	Telephone handsets	Bone vibrators	Hearing aids microphones and receivers	Loudspeakers	
Pinna Type	Anatomically shaped	Anatomically shaped	N/A	Adapts to all simplified pinna simulators	N/A	N/A	N/A	N/A
Calibration Adaptor	UA-1546 DP-0776	UA-1546 DP-0776						
Typical Sensitivity	12.6 mV/Pa	12.6 mV/Pa						

Typical System Configurations

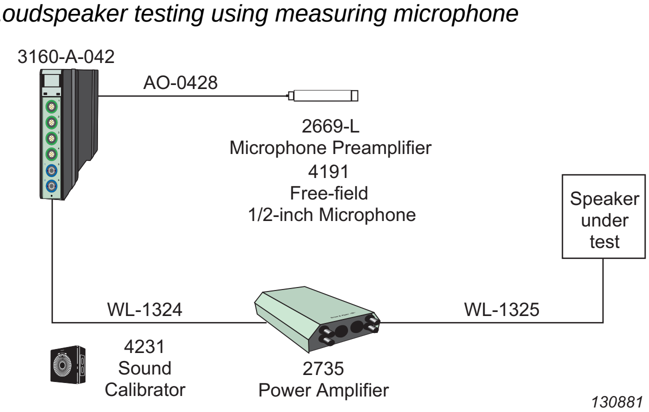
The figures below show different system configurations used for typical electroacoustic applications.

Many typical electroacoustic measurements are available as PULSE™ multi-analyzer projects and form an integral part of the PULSE Audio Analyzer. If more specialised measurement tasks are required, this can be accomplished within PULSE. For highly specialised measurement tasks, Visual Basic® for Applications can be applied. For more information on the use of PULSE in electroacoustic applications, see the product data for PULSE Electroacoustics BP 2085.

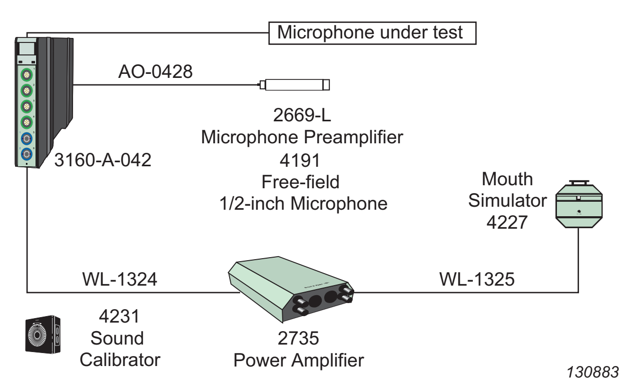
Receiver testing using ear simulator



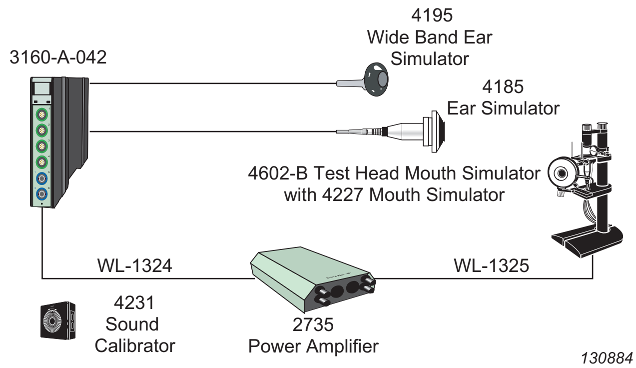
Loudspeaker testing using measuring microphone



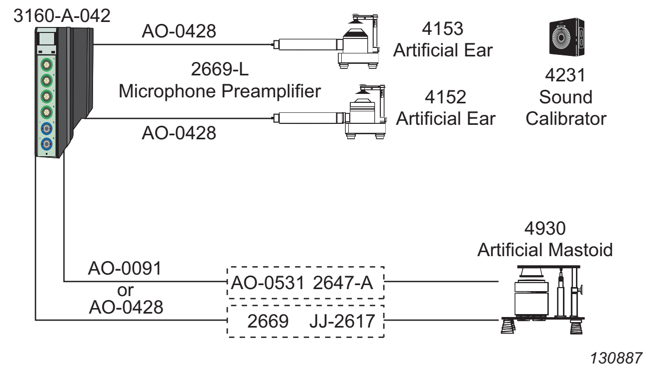
Microphone testing using mouth simulator



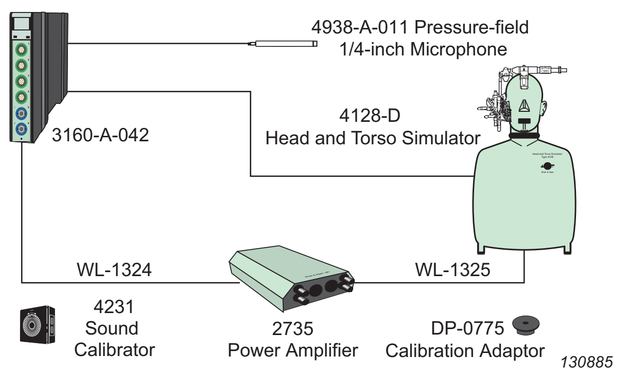
Telephone testing using test head



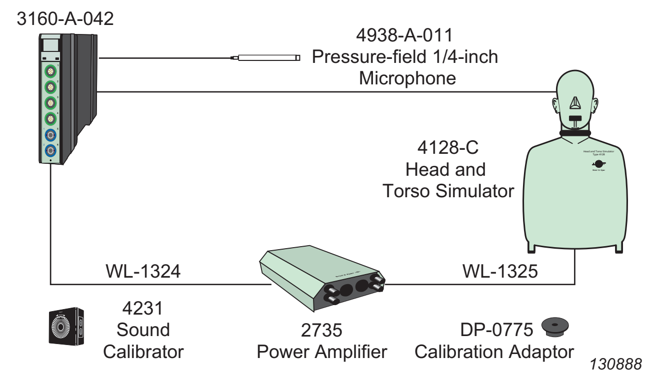
Audiometer testing using ear simulator and artificial mastoid



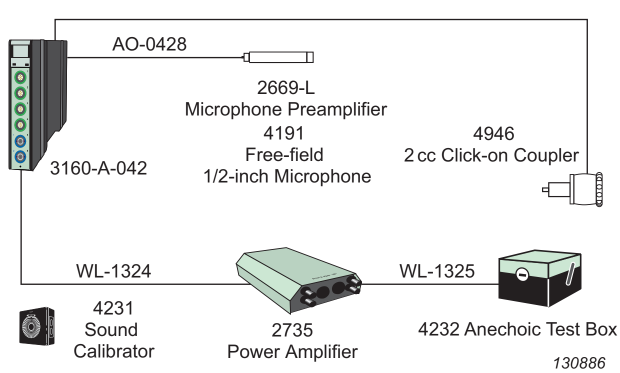
Telephone testing using head and torso simulator (HATS)



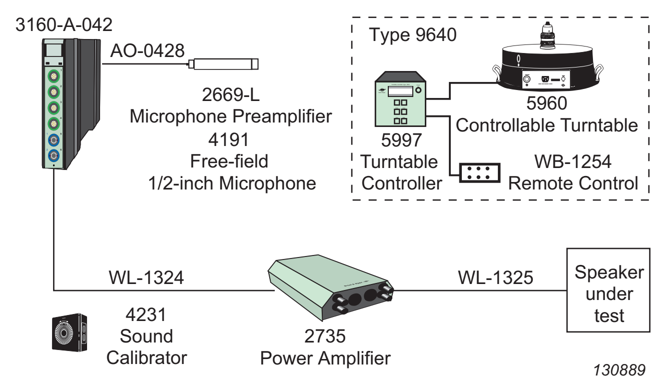
Headphone and headset testing using HATS



Hearing aid testing using ear simulator and anechoic test box



Example directivity measurement setup using turntable system



Artificial Ears and Mastoids

Type No.		4152	4153
Max. Force Applied to Top of Acoustic Coupler	N (kg)	10 (1)	N/A
Coupler Acoustic Equivalent Volume		2 cc and 6 cc	4.2 cc
Microphone Included (type number)		No	No
Prepolarized Microphone (type number)		No	No*
Accommodates Microphone Size		1/2″ and 1″	1/2″
Preamplifier Included		No	No
Relevant Standard		IEC 60318–5 ANSI S3.7 (1995)	IEC 60318–1
Pinna Type		Simplified	Simplified
Coupler Volumes	V_1	2 or 6 cm^3 = 1%	2.5 cm^3 = 1%
	V_2	1.8 cm^3 = 1%	1.8 cm^3 = 1%
	V_3	7.5 cm^3 = 1%	7.5 cm^3 = 1%
Height	mm (in)	104 (4.1)	
Max. Diameter	mm (in)	123 (4.85)	
Accessories Included		• 2 cm^3 Coupler DB-0138 • 6 cm^3 Coupler DB-0913 • Coupler Adaptor Ring DB-0111 • Guard Ring Adaptor DB-1021 • Adaptor for SLM DB-0962	• 1/2″ Adaptor Ring DB-0742 • Adaptor Plate for Headphones DB-0843 • Transmitter Adaptor AQ-0015 • Earcap YJ-0305
Test Applications		For measurements on hearing aids, earphones and headphones	For measurements on earphones, headphones and receivers
Other Applications		For verification of audiometers using earphones	

* Type 4153-W-001 available with Prepolarized Pressure-field ½″ Microphone Type 4947

Type No.		**4157**
Coupler Acoustic Equivalent Volume		1.26 cc
Typical Sensitivity	mV/Pa	12.6
Resonant Frequency	kHz	13.5 ±1.5
Microphone Included		Built-in
Prepolarized Microphone		–
Accommodates Microphone Size		1/2″ built-in
Preamplifier Included (type number)		Type 2669
Relevant Standard		IEC 60318–4 (2010) ANSI S3.35 (2004) ITU-T Rec. P.57, Type 2
Height	mm (in)	23 (.91)
Diameter	mm (in)	23.77 (.94)
Included Accessories		• 1/2″ Microphone Type 4192 • Preamplifier Type 2669 • External Ear Simulator DB-2012 • Ear Mould Simulators DB-2015 and DP-0370 • Tube Stud DP-0368 • Ear Mould Holders DS-0540 and DS-0541 • 1/4″ Microphone Adaptor DP-0276 • Retaining Collar DP-0286 • Dust Protector DS-0535 • Adaptor for ITE Hearing Aids DP-0530
Test Applications		For measurements on hearing aids

Type No.		**4946**
Coupler Acoustic Equivalent Volume		2 cc
Supported Microphones and Preamplfiers		• 1/2″ Pressure-field Microphone Type 4192 (externally polarized) • 1″ Pressure-field Microphone Type 4144 (externally polarized) • 1/2″ Microphone Type 4947 (prepolarized) • 1/2″ Preamplifier Type 2639 • 1/2″ Preamplifier Type 2669 • 1/2″ CCLD Preamplifier Type 2695 • 1/2″ CCLD Preamplifier Type 2671
Microphone Included		No
Accommodates Microphone Size		1/4″, 1/2″ and 1″
Preamplifier Included		No
Relevant Standard		IEC 60318–5 (2006)* ANSI S3.7 (1995)*
Height (with ear mould, coupler and adaptor)	mm (in)	27.6 (1.09)
Max. Diameter	mm (in)	28 (1.10)
Included Accessories		• 2 cc Coupler Basis UA-1615 • 1/2″ Microphone Adaptor UA-1616 • 1/2″ Preamplifier Adaptor for 1″ Microphone UA-2041 • Ear Plug Simulator with Tube Stud for BTE DB-3869 • Ear Mould Simulator for Insert Ear-phones DB-3887 • Ear Mould Simulator for ITES DB-3866 • Tube Stud for ITES DB-3868
Test Application		For measurement on hearing aids with a rugged design for repetitive use in production environment

* Using 1″ Pressure-field Microphone Type 4144

		4930
Frequency Range	Hz	50 to 10 k
Charge Sensitivity to Acceleration*		2 pC per ms^{-2} at 1.0 kHz
Voltage Sensitivity to Acceleration*		–63 dB ref. 1 Volt per ms^{-2} (0.7 mV per ms^{-2}) at 1.0 kHz
Charge Sensitivity to Force	pC/N	300
Voltage Sensitivity to Force*	mV	100
Capacitance*	nF	3
Adjustable Static Force	N	2 to 8
Calibration Surface Area	mm^2	1260
Inertial Mass	kg (lb)	3.5 (7.7)
Max. Height	mm (in)	165 (6.5)
Width	mm (in)	205 (8.1)
Depth	mm (in)	134 (5.3)
Weight	kg (lb)	3.4 (9.5)
Relevant Standard		IEC 60373 (1990) ANSI S3.13 & S.3.26 (1987) BS 4009
Included Accessories		• Spring Balance UA-0247 • Level Indicator UA-0262 • Slide Rule QH-0006, with case
Test Application		For measurements on bone-conducting hearing aids by simulating the mechanical impedance of human mastoid

* Individually calibrated

Note: To calibrate Type 4930, you will need Impedance Head Type 8000, Mini Shaker Type 4810, Shaker Arm UA-0274 and Spring Arrangement UA-0263. When ordered at the same time, these components comprise Artificial Mastoid with Calibrator Type 3505. Type 3505 can also be used to take the same measurements on human mastoids and foreheads and to determine bone conduction threshold values.

Ear and Mouth Simulators for Telephone Testing



Type No.		4185	4195	4195-Q, 4195-Q-HL0 4195-Q-A
Coupler Acoustic Equivalent Volume		4.2 cc	1.26 cc	1.26 cc
Typical Sensitivity	mV/Pa	12.5	15	15
Frequency Range	Hz	100 to 4 k	100 to 8 k	
Microphone Included		Type 4192	Built-in	Built-in
Prepolarized Microphone		–	–	Yes
Accommodates Microphone Size		1/2″	1/2″ built-in	1/2″ and 1/4″ built-in
Preamplifier Included		Type 2669	Type 2669	Type 2695
Relevant Standard		IEC 60318–1 ITU-T Rec. P.57, Type 1	IEC 60318–4 (2010) ITU-T Rec. P.57 ITU-T Rec. P.57, Type 3.2	IEC 60318–4 ITU-T Rec. P.57 ANSI S3.35
Height	mm (in)	103 (4.06)*	126 (5)	90 (3.54)
Max. Diameter	mm (in)	60 (2.6)*	60 (2.4)	39 (1.54)
TEDS Enabled Preamplifier		–	–	Yes
Pinna Type		Simplified	Simplified	Simplified
Included Accessories		• 1/2″ Condenser Microphone Type 4134 • 1/2″ Microphone Preamplifier Type 2669 • Acoustic Coupler UA-1110† • Ring for Acoustic Coupler DB-1160 • Adaptor Sleeve for Acoustic Coupler DB-1164 • Black Collar for Acoustic Coupler YJ-0430 • 5 × Soft Seal YJ-0431 • Microphone Cable AO-0419 • Accelerometer Cable AO-0122 • BNC Input Adaptor JP-0145 • LEMO to B&K Adaptor ZG-0350	• Low-leak Pinna Simulator UA-1304 • High-leak Pinna Simulator UA-1448 • 1/2″ Microphone Preamplifier Type 2669 • IEC 60318–4-compliant Coupler UA-1305 • Soft Seal YJ-0892 • LEMO to B&K Adaptor ZG-0350 • Microphone Cable AO-0419 • Calibration Adaptor DP-0939	**With Types 4195-Q and 4195-Q-HL0:** • Pinna Simulator DB-3800 (Type 4195-Q only) • High-leak Pinna Simulator DB-3800-W-001 (Type 4195-Q-HL0 only) • 1/2″ Microphone Preamplifier Type 2695 • IEC 60318–4-compliant Coupler with Prepolarized Microphone UA-1567 • Adaptor Ring for Calibration UC-5366 **With Type 4195-Q-A:** • Coupler with Microphone Type 4959
Test Application		For measurements on handset telephones including handsets with high impedance earpieces where sealed conditions are required	For wideband measurements on handset telephones where realistic acoustical loads are needed	For wideband production line measurements (QC) on handset telephones

* Coupler and preamplifier
† With built-in miniature sound source

Type 4195-Q series is developed especially for the quality control of telephonic handsets on the production line. With perfect handset seals that ensure high on-line repeatability, it is an innovative concept that allows full measurement compatibility between production and R&D. All interfaces can be customised for specific telephone designs. Type 4195-Q has a similar performance to Type 4195 + low-leak adaptor while Type 4195-Q-HL0 is similar to Type 4195 + high-leak adaptor. Type 4195-Q-A is ideal for high-volume project sales.

Type No.		4227
Continuous Output Level (measured 25 mm from lip ring)	dB SPL	200 Hz to 2 kHz: Min. 110 100 Hz to 12 kHz: Min. 100
Distortion (harmonic components up to 8 kHz at 94 dB SPL, 25 mm from lip ring)		200 Hz to 250 Hz: <2% >250 Hz: <1%
Loudspeaker Max. Average Power*	W	10 at 20°C (68°F)
Loudspeaker Max. Pulsed Power	W	50 for 2 seconds
Loudspeaker Impedance	Ω	4
Relevant Standard		ITU-T P.51, IEEE 269 and IEEE 661
Diameter	mm (in)	104 (4.1)
Height	mm (in)	104 (4.1) to top of lip ring
Included Accessories		• Calibration Jig UA-0901 • 2 × Lip Ring SO-0005 • 1/4″ Plastic Microphone Dummy DA-0150
Test Application		For measurements on handset telephones with a realistic simulation of the human voice field
Other Applications		Accurate reference source for near-field testing of handsets and microphones

* With built-in overload protection circuit

Head and Torso Simulators and Telephone Test Heads

Type No.			4128-C	4128-D
Coupler Acoustic Equivalent Volume			1.26 cc	
Relevant Standard			ITU-T Rec. P.51, P.57 & P.58 IEEE 269 & 661 ANSI S3.36	ITU-T Rec. P.51, P.57, P.58 & P.64 IEEE 269 & 661 ANSI S3.36
Listener Frequency Response			Conforms to ITU-T Rec. P.58 for measurements on telecommunications devices and to IEC 60318–7 and ANSI S3.36–1985 for measurements on air conducting hearing aids	
Ear Simulator			Right Ear Simulator Type 4158-C included IEC 60318–4/ITU-T Rec. P.57 Type 3.3-based calibrated ear simulator complying with ITU-T Rec. P.57, IEC 60318–4 and ANSI S3.25 standards	
Mouth Simulator			Built-in	
Typical Sensitivity	**Ear Simulator**	mV/Pa	12.6 (–38 dB re 1 V/Pa) at 250 Hz	
	Mouth Simulator	dB SPL	80 (2 V/500 mm) at 1 kHz	
Mouth Simulator Distortion (harmonic components up to 12 kHz) at 94 dB SPL			200 Hz to 250 Hz: <2% >250 Hz: <1%	
Pinna Simulators			Anatomically shaped and calibrated Dimensions similar to those specified in ITU-T Rec. P.58, IEC 60318–7 and ANSI S3.36	
Sound Pressure Distribution of Mouth Simulator			Conforms to ITU-T Rec. P.58	
Mouth Opening		mm (in)	W × H: 30 × 11 (1.18 × 0.43)	
Equivalent Lip Plane Position, CL			6 mm in front of the sound radiation opening	
Mouth Reference Point, MRP			25 mm in front of mouth CL	
Continuous Output Level at MRP		dB SPL	200 Hz to 2 kHz: Min. 110 100 Hz to 12 kHz: Min. 100	
Max. Average Input Power of Mouth Simulator		W	10 max. continuous average power at 20°C (68°F)	
Max. Pulsed Input Power of Mouth Simulator		W	50 for 2 seconds	
Loudspeaker Impedance		Ω	4	
Handset Thickness*		mm (in)	–	Min: ≥0 (0) Max: 44 (1.73)†
Handset Width*		mm (in)	–	Min: 26 (1.02) Max: 66 (2.6)

* Using the included Handset Positioner Type 4606. Type 4606 can be ordered as optional with Type 4128-C
† Max: 90mm with UA-1587 fork for wide handsets

Types 4128-C and D table continued:

Type No.			4128-C	4128-D
Microphone Included			Built-in	
Prepolarized Microphone			Yes, optional	
Accommodates Microphone Size			1/2″ (built-in)	
Preamplifier Included			Type 2669	
TEDS Enabled Preamplifier			No	
Height	**Head and Torso**	mm (in)	695 (27.4)	
	Torso Only		460 (18)	
Head Angles			Vertical or tilted 17° forwards	
Weight	**HATS**	kg (lb)	9 (19.8)	
	Handset Positioner		–	1.4 (3.09) incl. cradle, excl. handset
	Alignment Jig		–	2.4 (5.29) excl. cradle
Included Accessories			• Right Pinna – soft (Shore-OO 35) DZ-9769 • Left Pinna – soft (Shore-OO 35) DZ-9770 • Ear Mould Simulator – short DB-2902 • Ear Mould Simulator – long UC-0199 • Adaptor for Calibration UA-1546 • Ear Mounting Tool QA-0167 • Preamplifier Mounting Tool QA-0223 • Support Feet UA-1043 • Ref. Microphone Holder UA-2127 • Adaptor for Tripod UC-5290	• Handset Positioner Type 4606 • Right Pinna – soft (Shore-OO 35) DZ-9769 • Left Pinna – soft (Shore-OO 35) DZ-9770 • Ear Mould Simulator – short DB-2902 • Ear Mould Simulator – long UC-0199 • Adaptor for Calibration UA-1546 • Ear Mounting Tool QA-0167 • Preamplifier Mounting Tool QA-0223 • Support Feet UA-1043 • Ref. Microphone Holder UA-2127 • Adaptor for Tripod UC-5290
Test Application			For objective in-situ measurements on headsets, hearing aids, earphones and telephones with realistic simulation of the human voice field as well as the human pinna	For objective in-situ measurements on telephone handsets with realistic simulations of a human holding a handset telephone and of the human voice field as well as the human pinna

With the continual expansion of the world's cellular telephone network, conversations can take place almost anywhere – in quiet offices or in a noisy outdoor environment. Therefore, the acoustic perception of handsets is becoming increasingly important as users demand high voice quality in all situations.

Whether you are working with mobile phones or corded handset/headset telephones, high voice quality using advanced acoustic and electronic signal processing combined with superior design is essential.

When it comes to the actual testing of telephones two standardized test configurations are defined. One is based on Test Head equipped with a stand-alone mouth simulator and ear simulator positioned on the test head. The other is based on HATS (Head and Torso Simulator) with an integrated mouth simulator and one or two integrated ear simulators.

Type No.		4602-B
Speaking Positions		LRGP position (ITU-T Rec. P.76) HATS position (ITU-T P.58) REF position (OREM A) AEN position (ITU-T Rec. P.76)
Max. Handset Width	mm (in)	65 (2.56)
Max. Handset Length (from the centre of the earcap to the top of the handset)	mm (in)	47 (1.85) without the stop screw 59 (2.32) without the rear alignment rods
Relevant Standard		ITU-T Rec. P.64
Pinna Type		Adapts to all simplified pinna simulators
Ear Simulators		Accommodates Ear Simulators Types 4185 and 4195
Height	mm (in)	430 – 468 (16.9 – 18.4)
Width	mm (in)	170 (6.7)
Depth	mm (in)	260 (10.2)
Weight	kg (lb)	5.4 (11.9) 7.4 (16.3) with Mouth Simulator
Included Accessories		• Main column with upper and lower main plates and holder arm • 2 × Handset Alignment Rods UA-1210 • 8 × Handset Alignment UA-1400 (two sets) • Rods with Offset Adjustment • 40 mm Coupler Hole Ring DB-3339 • 50 mm Coupler Hole Ring DB-3340 • Positioning Jig: LRGP, HATS, AEN and REF • Mounting Bushing for Mouth Simulator DS-0884 • Handset Gauge UA-1206 • Handset Gauge for Non-symmetrical Handsets UA-1401
Test Application		For measurements on hearing aids and microphones

Type No.			4232*
Dynamic Range			From below 35 dB to above 110 dB SPL (re 20 μPa)
Uniformity of Sound Field			The measuring area is equivalent to the area occupied by the blue foam. The free-field sound level within the measuring area is equal to the regulated SPL within: ±1 dB from 20 Hz to 10 kHz
Insulation against Airborne Noise		Hz	>40 dB: 20 to 1500 45 to 55 dB: >1500
Sensitivity (for 1 W input)		dB SPL	110 at the test point The test point is defined as the centre of the measuring area
Distortion† (125 Hz to 8 kHz)	**100 dB SPL**		<0.5% 2nd harmonic <0.3% 3rd harmonic
	70 dB SPL		<0.1% 2nd harmonic <0.06% 3rd harmonic
Frequency Range (without electrical equalization)		Hz	100 to 8 k (±2 dB) 35 to 10 k (±3 dB) 6 dB/octave attenuation slope below 35 Hz 24 dB/octave attenuation slope above 10 kHz
Excitation Levels	**Upper Limit**	dB SPL	Maximum 110
	Lower Limit		Determined by ambient noise level and noise rejection
Free-field Properties of Sound Field			Approximates free-field conditions above 500 Hz. Sound radiation is in the horizontal plane
Loudspeaker Maximum Continuous Input Power		W	4.5
Loudspeaker Maximum Peak Input Power		W	40
Loudspeaker Nominal Impedance:		Ω	8 (maximum 25 Ω)
Telecoil Resistance		Ω	1
Telecoil Inductance		μH	9
Accomodates Microphone Size			1/2″ and 1″
Preamplifier Included			No
Height:		mm (in)	260 (10.2)
Width:		mm (in)	365 (14.4)
Depth:		mm (in)	400 (15.7)
Weight:		kg (lb)	22 (48.5)
Dimensions of Measurement Chamber:		mm (in)	60 × 165 × 200 (2.4 × 6.4 × 7.8)
Included Accessories			• 2 × Clip for holding IEC 711 or 2 cm^3 Coupler UA-1375 • Clip for holding reference microphone UA-1376 • Protection Bracket for external microphone preamplifier UA-1370
Test Application			For measurements on hearing aids and microphones

* All values are typical at 25°C (77°F), unless measurement uncertainty or tolerance field is specified. All uncertainty values are specified at 2 σ (that is, expanded uncertainty using a coverage factor of 2)
† Of the built-in sound source (high quality loudspeaker)

Type No.		9640
Turntable Load	kg (lb)	**Turntable plate lined up perfectly in horizontal plane:** Max 100 (220) on centre 30 (66) on periphery **Turntable hung upside down:** Same loads apply
Thread of Mounting Holes on Turntable		UNF 10–32 and M5
Turntable Resolution		1°
Turntable Speed of Rotation	s per revolution	**Cont. Mode:** 22.7 to 720 **Turn_abs and Turn_rel Modes:** 10 (max.)
Controller Commands		**Set 0 Deg:** Sets the reference angle **Acc.:** Sets the acceleration **Max_360 On/Off:** Turns max. 360° on or off ('On' prevents cable wrapping)
IEEE Interface*		Provides remote control of all front-panel functions Conforms with IEEE 488.1 and compatible with IEC 625–1
Turntable Cable Length	m (ft)	15 (48.5)
Turntable Plate Diameter	mm (in)	354 (13.9)
Turntable Weight	kg (lb)	12 (26)
Included Accessories		• Controllable Turntable Type 5960 • Turntable Controller Type 5997 • Remote Control WB-1254 • Turntable Cable AO-0422
Test Application		For accurate positioning during directivity measurements

* For remote control

Type No.		2735
Voltage Gain @ 1 kHz	dB	0 (±0.2 dB) or 20 (±0.2 dB) User selectable
Maximum Input Voltage	V_{pp}	**0 dB gain:** 20 **20 dB gain:** 3.8
Maximum Output Power	W	2 × 45 @ 4 Ω, 5 Hz – 25 kHz
Continuous Output Power @ 4 Ω 5 Hz – 25 kHz	W	@ **20°C:** 2 × 35 @ **50°C:** 2 × 10
Load	Ω, nF	≥3, ≤470
Frequency Response from 20 Hz – 20 kHz (typical)	dB	±0.5 @ 1 W, 4 Ω
THD + Noise @ 1 kHz, 1 W, 4 Ω (typical)	%	1
Common Mode Rejection (typical)	dB	80, up to 10 kHz
Input Impedance	kΩ	>20
Output Impedance (typical)	mΩ	**0 dB gain:** 75 **20 dB gain:** 25
Dynamic Range Max. Output (rms)/Noise (typical)	dB	110
Channel Separation	dB	–80 up to 10 kHz
Input Connectors		2 × BNC, isolated from chassis
Output Connectors		2 × Neutrik® 4-pin Speakon® sockets
Noise at Output "A"	μV	40
Typical Acoustical Noise (fan)	dB(A)	28 @ 1 m
Dimensions	cm (in)	24.3 × 13 × 6 (9.5 × 5.1 × 2.4)
Weight	kg (lb)	0.65 (1.43)
Test Application		For driving sound sources

Brüel & Kjær offers a broad spectrum of solutions that respond to varying needs and applications. This adaptability is evident in the range of transducers designed for specific environments, industries, tasks and conditions, as well as general purpose instruments that provide a wide operational range.

Selecting the best transducer for a given measurement task can be understandably overwhelming. Our interactive transducer selection guide on www.bksv.com can be a big help to quickly narrow your choices. Alternatively, see below for in-depth guides and tools so that you can select the right accelerometer to fit your needs.

Start by selecting the right accelerometer technology, then you can select the right accelerometer type. From there, you can focus on the measurement parameters (frequency range, dynamic range, etc).

Technologies

Accelerometers use a spring-mass system to generate a force proportional to the vibration. Brüel & Kjær offers three types of accelerometers:

- Piezoelectric charge accelerometers
- Piezoelectric CCLD/DeltaTron/IEPE accelerometers
- Piezoresistive accelerometers

Piezoelectric Charge Accelerometers

The force is applied to a piezoelectric (PE) element that produces a charge on its terminals proportional to the acceleration.

PE charge accelerometers are self-generating and, therefore, do not require any external power sources. They are capable of operation at high temperatures, but are constrained by high output impedance requiring low-noise cables and charge amplifiers to condition the signal.

Piezoelectric CCLD Accelerometers

CCLD accelerometers are PE charge accelerometers with integral preamplifiers that have output signals in the form of low impedance voltage output.

Most Brüel & Kjær PE CCCLD accelerometers are hermetically sealed to protect against environmental contamination, have low susceptibility to radio frequency electromagnetic radiation and low impedance output due to the built-in amplifier. This allows the use of inexpensive coaxial cables.

Piezoresistive Accelerometers

Piezoresistive accelerometers are based on MEMS technology. The change of electrical resistance in proportion to applied mechanical stress on the springs retaining the seismic mass generates the output. The accelerometer includes integral mechanical stops and offers outstanding ruggedness, while still maintaining an excellent signal-to-noise ratio after the built-in bridge amplifier.

This type of accelerometer, with a frequency response extending down to DC or constant acceleration, is ideal for measuring motion, low-frequency vibration and long duration low-level shock.

Compare Types

The following table compares the performance of each technology, specification by specification.

	Piezoelectric (PE) Charge	PE CCLD	Piezoresistive (PR)
Weight (relative)	Very low	Very Low	Low
Miniature Design Capability	Yes	Yes	No
Useful Frequency Range Capability	Very high	Very high	Low
Sensitivity to Vibration	High	High	Low
Suitability for High Temperature	Yes	No	No
DC Response	No	No	Yes
TEDS	No	Yes	No
Sensitivity to Environment	Low	Very low	Low
Flat Phase Response at HF	Yes	Yes	No
Suitability for Shock Measurements	Medium	Medium	Low
Long Pulse (crash testing)	No	No	Yes
High g Survivability, ruggedness	Medium	Medium	Medium
Self-generating	Yes	No	No
Long Cables (low impedance output)	No	Yes	Yes
Cryogenic Temperature	Yes	No	No
Synonym	Charge	DeltaTron®, IEPE	Bridge

Measurement Parameters

Generally speaking, the most important parameters to consider are frequency range and dynamic range.

Lower-limiting Frequency Range

This is normally the frequency where the response is 10% lower than the response at 159.2 Hz. For PE charge accelerometers, it is determined by the preamplifier used. For piezoelectric CCLD and piezoresistive types, the lower limiting frequency can be specified precisely because the preamplifier is built-in.

Upper-limiting Frequency Range

This is the frequency where the response has changed 10% compared to the response at 159.2 Hz. It is normally 1/3 of the mounted resonance frequency for undamped mass-spring systems like those in the PE transducers. Preamplifiers and damping of piezoresistive transducers can give many different responses.

With Brüel & Kjær's PULSE data acquisition systems, it is possible to use REq-X to extend the usable frequency range, mainly the upper-limiting frequency range.

Residual Noise Level

This is determined by noise generated by the sensing element and the preamplifier. In most cases, this is largely determined by the electronic noise. For low-level vibration, low residual noise levels are more important than high sensitivity because the high noise floor of the sensor will mask the low-level vibration.

Maximum Range/ Full Scale

This is determined by the maximum voltage swing possible if a preamplifier is included and the physical maximum stress level that can be sustained by the transducer structure without large distortion or destruction. In the graph below, we use Piezoelectric Charge Accelerometer Type 4393 as an example to explain this.

Note: Noise RMS level in 1 Hz bandwidth

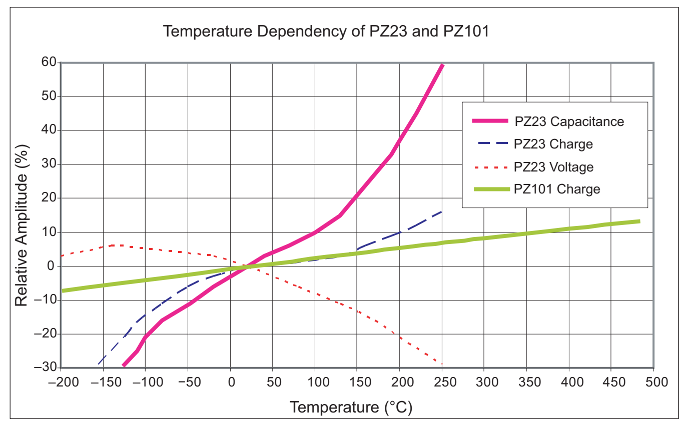
It is always important to select an accelerometer that has a broader measuring range than required.

The Effects of Temperature

What happens at high temperatures?

Piezoelectric accelerometers are capable of vibration measurements over a wide temperature range. However, due to the properties of piezoelectric materials, variations of both voltage and charge sensitivities, as well as impedance, will occur when the accelerometer is operated at temperatures other than the reference.

As an example, the below figure shows the variation in capacitance, charge sensitivity and voltage sensitivity of piezoelectric material PZ23, which is the material used in many Brüel & Kjær accelerometers.

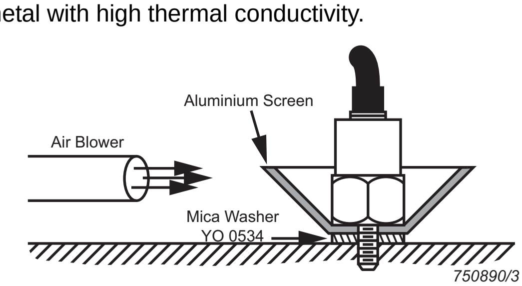


When using a piezoelectric accelerometer at high temperatures, its actual sensitivity, taking into account the change in sensitivity due to the increased operating temperature, can be determined using the "Temperature Coefficient of Sensitivity", which is available on every calibration chart.

The time required for the sensitivity to return to the one stated on the calibration chart is not easy to determine, but it will partly depend on the temperature to which the accelerometer was taken. In general, a period of 24 hours is required for an accelerometer to return to the calibrated sensitivity when it is immediately returned to room temperature from a temperature close to its maximum operating temperature.

Each accelerometer has a specified maximum operating temperature above which the piezoelectric element will begin to depolarize and cause a permanent change in sensitivity. This is 250°C for charge accelerometers with PZ23 piezoelectric material.

It is possible to thermally isolate the base of a general purpose accelerometer from the vibrating surface using a screen made of a metal with high thermal conductivity.

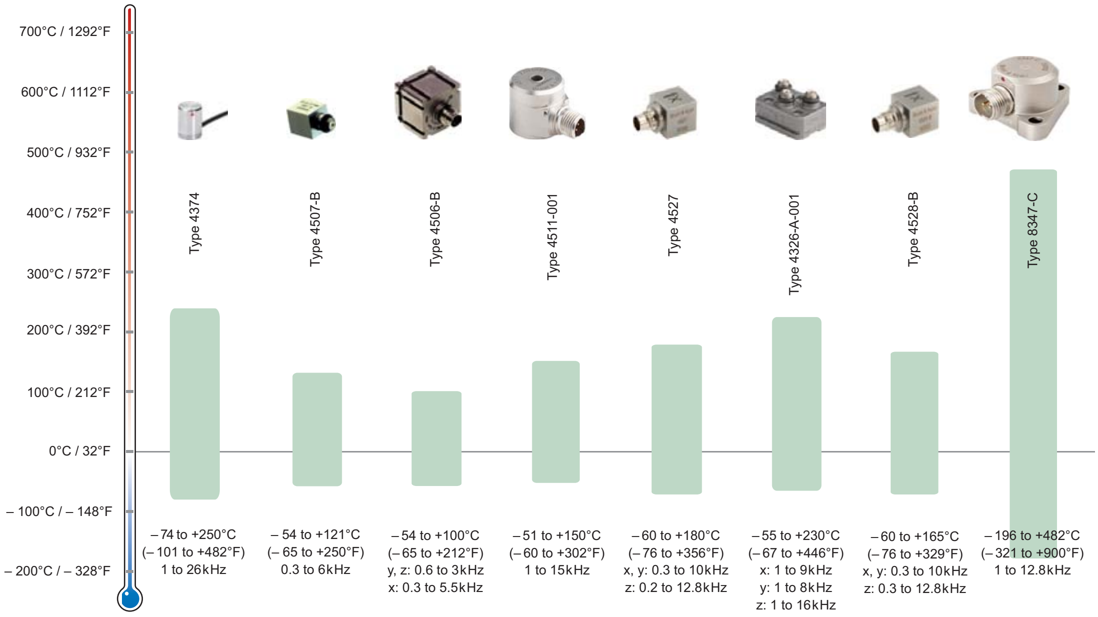


Such a screen enables measurements with charge accelerometers to be made on surfaces with a temperature up to 350°C. If, at the same time, a stream of cooling air is directed at the accelerometer, it is possible to measure on surfaces up to 450°C. However, remember that the stiffness at the mounting point of the accelerometer may be altered by such a fixture, which in turn will lower the resonance frequency of the accelerometer.

For high temperature measurements, Industrial Accelerometer Type 8347-C can be used up to 482°C on its own.

What is the lowest temperature?

The lower temperature limit for most Brüel & Kjær charge accelerometers is specified as –74°C. While specifications have not been defined at temperatures below this, it is still possible to use general purpose accelerometers at even lower temperatures. For example, vibration measurements on structures have been made at the temperature of liquid nitrogen (–196°C).



Definitions of Given Accelerometer Specifications

Sensitivity:

- At 159.2 Hz
- Units: pC/ms^{-2} (pC/g) or mV/ms^{-2} (mV/g)

The output of the accelerometer at 159.2 Hz (ω = 1000 s^{-1}) with 20 ms^{-2} RMS acceleration at room temperature. For CCLD accelerometers the supply current is 4 mA.

Frequency range:

- ±10%
- Unit: Hz

The range within which the sensitivity does not deviate more than 10% from the value at 159.2 Hz. The lower usable frequency range is determined by the lower-limiting frequency of the amplifier used or the frequency at which the temperature, cable and other noise sources make usage impractical (for charge types). The upper usable frequency range is normally determined by the mounted resonance frequency and in a few cases the upper frequency cut-off of the amplifier or other structural resonances.

Mounted resonance frequency:

- Unit: kHz

The resonance frequency of an accelerometer being mounted on a 180 gram steel block. For damped accelerometers no mounted resonance is given.

Operating temperature range:

- Unit: °C and °F

The temperature range within which the accelerometer can be used continuously.

Measuring range (± peak)

- Unit: g

The peak vibration range the accelerometer can measure with less than 1% distortion. At slightly higher amplitudes clipping might occur.

Maximum non-destructive shock (± peak):

- Unit: g

The peak shock the accelerometer can withstand repeatedly without being damaged. The shock duration shall be longer than 10 times the reciprocal mounted resonance frequency.

Uniaxial Piezoelectric Charge Accelerometers

A charge-type piezoelectric accelerometer is a robust unit designed specifically for high-temperature vibration measurement on structures and objects. Its unique sensor design allows high dynamic range, long-term stability and ruggedness in the same package. For direct interchangeability and easy system calibration, most Brüel & Kjær charge accelerometers are Uni-Gain types having a measured sensitivity within 2% of a practical nominal value.

For accelerometer dimensions go to page 147.





Type Number		4374	4517-C	4517-C-003	4517-C - 001	4375*
Weight	gram (oz)	0.75 (0.026)	0.6 (0.021)	0.85 (0.03)	1 (0.035)	2.4 (0.085)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	0.15 (1.5)	0.18 (1.8)	0.18 (1.8)	0.18 (1.8)	0.316 (3.1)
Frequency Range (±10%)†	Hz	1 to 26000	1 to 10000	1 to 9000	1 to 20000	0.1 to 16500
Mounted Resonance Frequency	kHz	85	80	>30	75	55
Operating Temperature Range	°C	–74 to +250	–51 to +177	–51 to +177	–51 to +177	–74 to +250
	°F	–101 to +482	–60 to +350	–60 to +350	–60 to +350	–101 to +482
Maximum Sinusoidal Vibration (peak)	g	5000	1000	1000	1000	5000
Maximum Operational Shock (± peak)	g	25000	5000	5000	5000	25000
Connector		10–32 UNF	3–56 UNF	3–56 UNF	3–56 UNF	10–32 UNF
Mounting		Adhesive	Adhesive	Adhesive	Adhesive	M3 Stud

* Unigain with ±2% sensitivity tolerance
† Lower frequency limited is determined by the amplifier used

Type Number		4393*†	8309	4521-C	4501-A	4500-A
Weight	gram (oz)	2.4 (0.085)	3 (0.11)	2.7 (0.1)	4.0 (0.141)	4.1 (0.145)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	0.316 (3.1)	0.004 (0.04)	1.02 (10)	0.30 (2.9)	0.30 (2.9)
Frequency Range (±10%)	Hz	0.1 to 16500	1 to 54000	1 to 9000	1 to 10000	1 to 15000
Mounted Resonance Frequency**	kHz	55	180	35	30	45
Operating Temperature Range	°C	–74 to +250	–74 to +180	–51 to +230	–55 to +175	–55 to +175
	°F	–101 to +482	–101 to +356	–60 to +446	–67 to +347	–67 to +347
Maximum Sinusoidal Vibration (peak)	g	5000	15000	2000	3000	3000
Maximum Operational Shock (± peak)	g	25000	100000	5000	3000	3000
Connector		M3	10–32 UNF	M3	10–32 UNF	10–32 UNF
Mounting		M3 Stud	Integral M5 Stud	Insulated M2 Screw	Clip or Adhesive	Clip or Adhesive

* Unigain with ±2% sensitivity tolerance
† Also available as V type with relaxed sensitivity tolerance
** Lower frequency limited is determined by the amplifier used

Type Number		4507-C	4508-C	4505-A	4505-001	4371*†	4384*†
Weight	gram (oz)	4.5 (0.16)	4.5 (0.16)	4.9 (0.17)	4.9 (0.17)	11 (0.39)	11 (0.39)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	0.45 (4.4)	0.45 (4.4)	0.30 (2.9)	0.067 (0.66)	1.0 (9.8)	1 (9.8)
Frequency Range (±10%)	Hz	0.1 to 6000	0.1 to 8000	1 to 12000	1 to 9000	0.1 to 12600	0.1 to 12600
Mounted Resonance Frequency**	kHz	18	25	45	45	42	42
Operating Temperature Range	°C	–74 to +250	–74 to +250	–55 to +230	–55 to +230	–55 to +250	–74 to +250
	°F	–101 to +482	–101 to +482	–67 to +446	–67 to +446	–67 to +482	–101 to +482
Maximum Sinusoidal Vibration (peak)	g	2000	2000	3000	3000	6000	6000
Maximum Operational Shock (± peak)	g	5000	5000	3000	3000	20000	20000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		Clip or Adhesive	Clip or Adhesive	Integral 10–32 UNF Stud	Integral 10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud

* Unigain with ± 2% sensitivity tolerance
† Also available as V type with relaxed sensitivity tolerance
** Lower frequency limited is determined by the amplifier used

Type Number		4382*†	4383*†	4381*†	4370*†	8346-C
Weight	gram (oz)	17 (0.6)	17 (0.6)	43 (1.52)	54 (1.9)	176 (6.2)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	3.16 (31)	3.16 (31)	10 (98)	10 (98)	38 (372)
Frequency Range (±10%)**	Hz	0.1 to 8400	0.1 to 8400	0.1 to 4800	0.1 to 4800	0.1 to 3000
Mounted Resonance Frequency	kHz	28	28	16	16	10
Operating Temperature Range	°C	–74 to +250	–74 to +250	–74 to +250	–74 to +250	–50 to +250
	°F	–101 to +482	–101 to +482	–101 to +482	–101 to +482	–58 to +482
Maximum Sinusoidal Vibration (peak)	g	2000	2000	2000	2000	2000
Maximum Operational Shock (± peak)	g	5000	5000	2000	2000	5000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud

* Unigain with ±2% sensitivity tolerance
† Also available as V type with relaxed sensitivity tolerance
** Lower limiting frequency is determined by the amplifier used

CCLD Accelerometer Types 4507 and 4508 are specifically designed to withstand rough environments. A combination of high sensitivity, low mass and small physical dimensions make them ideal for modal measurements, such as automotive body and power-train measurements, as well as for modal analysis on aircraft, trains and satellites. The main difference between the two types is the position of the coaxial connector which is on the top surface perpendicular to the main axis for Type 4508, and on the side surface parallel to the main axis for Type 4507.

Triaxial Piezoelectric Charge Accelerometers

Type Number		4326-A	4326-A-001	4326-001	4321*†
Description		Triaxial	Triaxial	Dielectric rigidity >1000 V	Triaxial
Weight	gram (oz)	13 (0.46)	17 (0.6)	17 (0.6)	55 (1.94)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	0.30 (2.9)	0.30 (2.9)	0.30 (2.9)	1 (9.8)
X Frequency Range (±10%)**	Hz	1 to 9000	1 to 9000	1 to 9000	0.1 to 12000
Y Frequency Range (±10%)**	Hz	1 to 8000	1 to 8000	1 to 8000	0.1 to 12000
Z Frequency Range (±10%)**	Hz	1 to 16000	1 to 16000	1 to 16000	0.1 to 12000
Mounted Resonance Frequency	kHz	X:27, Y: 24, Z: 48	X:27, Y: 24, Z: 48	X:27, Y: 24, Z: 48	X, Y, Z: 40
Operating Temperature Range	°C	–55 to +175	–55 to +230	–55 to +230	–74 to +250
	°F	–67 to +347	–67 to +446	–67 to +446	–101 to +482
Maximum Sinusoidal Vibration (peak)	g	3000	3000	3000	500
Maximum Operational Shock (± peak)	g	3000	3000	3000	1000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		M2 Screw/M3 Stud/Clip/Adhesive	M2 Screw/M3 Stud/Clip/Adhesive	M2 Screw/M3 Stud/Clip/Adhesive	10–32 Stud/M4 Screw

* Unigain with ±2% sensitivity tolerance
† Also available as V type with relaxed sensitivity tolerance
** Lower limiting frequency is determined by the amplifier used

Uniaxial CCLD Accelerometers

A CCLD accelerometer is designed specifically to make vibration measurement easy because the needed preamplifier is built into the accelerometer unit. It features low impedance output enabling the use of inexpensive cable and can drive long cables.

Type Number		4517	4517-002	4516	4516-001	4518	4518-001
Weight (excluding cable)	gram (oz)	0.65 (0.02)	1 (0.035)	1.5 (0.053)	1.5 (0.053)	1.5 (0.053)	1.45 (0.051)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1.02 (10)	1.02 (10)	1.02 (10)	0.51 (5)	1.02 (10)	10.2 (100)
Frequency Range (±10%)	Hz	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000
Mounted Resonance Frequency	kHz	80	80	60	60	60	60
Operating Temperature Range	°C	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–51 to +100
	°F	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–60 to +212
Measuring Range (± peak)	g	500	500	500	1000	500	50
Residual Noise Level*	µg	6000	6000	6000	6000	2000	900
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000	5000	3000	3000
Connector		3–56	3–56	10–32 UNF Female	10–32 UNF Female	M3	M3
Mounting		Adhesive	Adhesive	Adhesive	Adhesive	Integral M3 Stud	Integral M3 Stud

* Measured in specified frequency range

Type Number		4518-002	4518-003	4519	4519-001	4519-002	4519-003
Weight	gram (oz)	1.45 (0.051)	1.45 (0.051	1.6 (0.056)	1.6 (0.056)	1.5 (0.053)	1.5 (0.053)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1.02 (10)	10.2 (100)	1.02 (10)	10.2 (100)	1.02 (10)	10.2 (100)
Frequency Range, (±10%)	Hz	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000
Mounted Resonance Frequency	kHz	60	60	45	45	45	45
Operating Temperature Range	°C	–51 to +121	–51 to +100	–51 to +121	–51 to +100	–51 to +121	–51 to +100
	°F	–60 to +250	–60 to +212	–60 to +250	–60 to +212	–60 to +250	–60 to +212
Measuring Range (± peak)	g	500	50	500	50	500	50
Residual Noise Level*	µg	2000	900	2000	900	2000	900
Maximum Shock (± peak)	g	3000	3000	3000	3000	3000	3000
Connector		M3	M3	M3	M3	M3	M3
Mounting		Adhesive	Adhesive	Integral M3 Stud	Integral M3 Stud	Adhesive	Adhesive

* Measured in specified frequency range

Type Number		4397	4394**	4521	4507
Weight	gram (oz)	2.4 (0.085)	2.9 (0.102)	2.7 (0.095)	4.8 (0.17)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	1 (9.8)	1.02 (10)	10 (98)
Frequency Range (±10%)	Hz	1 to 25000	1 to 25000	1 to 9000	0.3 to 6000
Mounted Resonance Frequency	kHz	53	52	35	18
Operating Temperature Range	°C	–50 to +125	–50 to +125	–51 to +121	–54 to +121
	°F	–58 to +257	–58 to +257	–60 to +250	–65 to +250
Measuring Range (± peak)	g	750	750	500	70
Residual Noise Level*	µg	1500	2500	6000	350
Maximum Non-destructive Shock (± peak)	g	10000	10000	2000	5000
Connector		M3	M3	M3	10–32 UNF
Mounting		M3 Stud	M3 Stud	Insulated M2 Centre Bolt	Clip/Adhesive

* Measured in specified frequency range
** With a ceramic isolated base

Type Number		4507-001	4507-002	4507-B	4507-B-001	4507-B-002	4507-B-003
Weight	gram (oz)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	100 (980)	10 (98)	1 (9.8)	100 (980)	10 (98)
Frequency Range (±10%)	Hz	0.1 to 6000	0.4 to 6000	0.3 to 6000	0.1 to 6000	0.4 to 6000	0.3 to 6000
Mounted Resonance Frequency	kHz	18	18	18	18	18	18
Operating Temperature Range	°C	–54 to +121	–54 to +100	–54 to +121	–54 to +121	–54 to +100	–54 to +121
	°F	–65 to +250	–65 to +212	–65 to +250	–65 to +250	–65 to +212	–65 to +250
Measuring Range (± peak)	g	700	7	70	700	7	70
Residual Noise Level*	µg	800	150	350	800	150	350
Maximum Shock (± peak)	g	5000	5000	5000	5000	5000	5000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Adhesive

* Measured in specified frequency range

Type Number		4507-B-004	4507-B-005	4507-B-006	4508	4508-001	4508-002
Weight	gram (oz)	4.6 (0.16)	4.6 (0.16)	4.6 (0.16)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	10 (98)	100 (980)	50 (490)	10 (98)	1 (9.8)	100 (980)
Frequency Range (±10%)	Hz	0.3 to 6000	0.4 to 6000	0.2 to 6000	0.3 to 8000	0.1 to 8000	0.4 to 8000
Mounted Resonance Frequency	kHz	18	18	18	25	25	25
Operating Temperature Range	°C	–54 to +121	–54 to +100	–54 to +100	–54 to +121	–54 to +121	–54 to +100
	°F	–65 to +250	–65 to +212	–65 to +212	–65 to +250	–65 to +250	–65 to +212
Measuring Range (± peak)	g	70	7	14	70	700	7
Residual Noise Level*	µg	350	150	160	350	800	150
Maximum Shock (± peak)	g	5000	5000	5000	5000	5000	5000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Clip/Adhesive

* Measured in specified frequency range

Type Number		4508-B	4508-B-001	4508-B-002	4508-B-003	4508-B-004	4526
Weight	gram (oz)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	4.8 (0.17)	5 (0.18)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	10 (98)	1 (9.8)	100 (980)	10 (98)	50 (490)	10 (98)
Frequency Range (±10%)	Hz	0.3 to 8000	0.1 to 8000	0.4 to 8000	0.3 to 8000	0.2 to 8000	0.3 to 8000
Mounted Resonance Frequency	kHz	25	25	25	25	25	25
Operating Temperature Range	°C	–54 to +121	–54 to +121	–54 to +100	–54 to +121	–54 to +100	–54 to +180
	°F	–65 to +250	–65 to +250	–65 to +212	–65 to +250	–65 to +212	–65 to +356
Measuring Range (± peak)	g	70	700	7	70	14	70
Residual Noise Level*	µg	350	800	150	350	160	350
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000	5000	5000	5000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		Clip/Adhesive	Clip/Adhesive	Clip/Adhesive	Adhesive	Clip/Adhesive	10–32 UNF Stud

* Measured in specified frequency range

Type Number		4526-001	4526-002	8339	8339-001	4534-B	4534-B-001
Weight	gram (oz)	5 (0.18)	5 (0.18)	5.8 (0.204)	5.8 (0.204)	8.6 (0.3)	8.6 (0.3)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	10 (98)	0.025 (0.25)	0.01 (0.1)	1 (9.8)	10 (98)
Frequency Range (±10%)	Hz	0.1 to 8000	0.3 to 8000	1 to 20000	1 to 20000	0.2 to 12800	0.2 to 12800
Mounted Resonance Frequency	kHz	25	25	>130	>130	38	38
Operating Temperature Range	°C	–54 to +180	–54 to +165	–51 to +121	–51 to +121	–55 to +125	–55 to +125
	°F	–65 to +356	–65 to +329	–60 to +250	–60 to +250	–67 to +257	–67 to +257
Measuring Range (± peak)	g	700	700	20000	50000	700	70
Residual Noise Level*	µg	800	350	150	350	500	130
Maximum Non-destructive Shock (± peak)	g	5000	5000	80000	80000	10000	10000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		10–32 UNF Stud	Adhesive	Integral 10–32 Stud	Integral 10–32 Stud	10–32 UNF Stud	10–32 UNF Stud

* Measured in specified frequency range

Type Number		4534-B-002	4534-B-004	4533-B	4533-B-001	4533-B-002	4533-004
Weight	gram	8.6 (0.3)	8.6 (0.3)	8.6 (0.3)	8.6 (0.3)	8.6 (0.3)	8.6 (0.3)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	50 (490)	5 (49)	1 (9.8)	10 (98)	50 (490)	5 (49)
Frequency Range (±10%)	Hz	0.3 to 12800	0.2 to 12800	0.2 to 12800	0.2 to 12800	0.3 to 12800	0.2 to 12800
Mounted Resonance Frequency	kHz	38	38	38	38	38	38
Operating Temperature Range	°C	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125
	°F	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257
Measuring Range (± peak)	g	14	140	700	70	14	140
Residual Noise Level*	µg	100	140	500	130	100	140
Maximum Non-destructive Shock (± peak)	g	10000	10000	10000	10000	10000	10000
Connector		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting		10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud	10–32 UNF Stud

* Measured in specified frequency range

Type Number		4511 - 001	4511-006	4523
Weight	gram (oz)	35 (1.23)	35 (1.23)	13.3 (0.47)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	1 (9.8)	1 (9.8)
Frequency Range (±10%)	Hz	1 to 15000	2 to 25000	1 to 15000
Mounted Resonance Frequency	kHz	43	43	43
Operating Temperature Range	°C	–54 to +150	–54 to +150	–54 to +150
	°F	–65 to +302	–65 to +302	–65 to +302
Measuring Range (± peak)	g	500	500	500
Residual Noise Level*	µg	1000	1000	2000
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000
Connector		3-pin HiRel	3-pin Series 800 Mighty Mouse	10–32 UNF
Mounting		M4 Centre Bolt/ 10–32 UNF Stud	M4 Centre Bolt	M4 Centre Bolt

* Measured in specified frequency range

Types 4511 and 4523 have been specifically designed for Health Usage Monitoring of gearboxes on helicopters, are flight-test certified, and all processes and materials comply with MIL-STD-11268. The primary design objective has been reliability under extreme conditions yielding very high robustness versus mechanical, electrical and environmental influences.

Type Number		5958-A*	5958-H*	8340	8344	8344-B-001
Weight	gram (oz)	44 (1.55)	44 (1.55)	775 (27.33)	176 (6.2)	176 (6.2)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	1 (9.8)	1020 (10000)	250 (2450)	50 (490)
Frequency Range (±10%)	Hz	0.3 to 11000	0.3 to 11000	0.1 to 1500	0.2 to 3000	0.05 to 3000
Mounted Resonance Frequency	kHz	45	45	7	10	10
Operating Temperature Range	°C	–50 to +100	–50 to +100	–51 to +74	–50 to +100	–58 to +212
	°F	–58 to +212	–58 to +212	–60 to +165	–58 to +212	–58 to +212
Measuring Range (± peak)	g	500	500	0.5	2.6	14
Residual Noise Level†	µg	1500	1500	25	18	18
Maximum Non-destructive Shock (± peak)	g	2000	2000	100	350	350
Connector		BNC	Open End	MIL-C-5015 Two-pin TNC	10–32 UNF	10–32 UNF
Mounting		Integral 1/4″–28 UNF Stud	Integral 1/4″–28 Stud	1/4″–28 UNF Stud	M5 Stud	M5 Stud

* Available in four versions. Cable lengths 10, 30, 50 and 100 m
† Measured in specified frequency range

Triaxial CCLD Accelerometers

Type Number		4520	4520-001	4520-002	4520-004	4524	4524-B
Weight	gram (oz)	2.9 (0.1)	4 (0.14)	3.6 (0.127)	4 (0.14)	4.4 (0.15)	4.8 (0.17)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1.02 (10)	1.02 (10)	1.02 (10)	0.1 (1)	10 (98)	10 (98)
Frequency Range (±10%)	Hz	X: 2 to 7000 Y: 2 to 7000 Z: 2 to 7000	X: 2 to 4000 Y: 2 to 4000 Z: 2 to 7000	X: 2 to 4000 Y: 2 to 4000 Z: 2 to 7000	X: 2 to 4000 Y: 2 to 4000 Z: 2 to 7000	X: 0.2 to 5500 Y: 0.25 to 3000 Z: 0.25 to 3000	X: 0.2 to 5500 Y: 0.25 to 3000 Z: 0.25 to 3000
Mounted Resonance Frequency	kHz	X, Y: 30, Z: 40	X: 20, Y: 25, Z: 30	X: 20, Y: 25, Z: 30	X: 20, Y: 25, Z: 30	X: 18, Y: 9, Z: 9	X: 18, Y: 9, Z: 9
Operating Temperature Range	°C	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–54 to +100	–54 to +100
	°F	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–65 to +212	–65 to +212
Measuring Range (± peak)	g	500	500	500	5000	50	50
Residual Noise Level*	µg	7000	7000	7000	56000	X: 400 Y: 200 Z: 200	X: 400 Y: 200 Z: 200
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000	5000	5000	5000
Connector		4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF
Mounting		Adhesive	M3/Adhesive	Clip/Adhesive	M3/Adhesive	Adhesive/Clip	Adhesive/Clip

* Measured in specified frequency range

Type Number		4524-B-001	4524-B-004	4535-B	4535-B-001
Weight	gram (oz)	4.8 (0.17)	4.8 (0.17)	6 (0.21)	6 (0.21)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	5 (49)	1 (9.8)	10 (98)
Frequency Range (±10%)	Hz	X: 0.2 to 5500 Y: 0.25 to 3000 Z: 0.25 to 3000	X: 0.2 to 5500 Y: 0.25 to 3000 Z: 0.25 to 3000	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800
Mounted Resonance Frequency	kHz	X: 18, Y: 9, Z: 9	X: 18, Y: 9, Z: 9	X: 30, Y: 30, Z: 42	X: 30, Y: 30, Z: 42
Operating Temperature Range	°C	–54 to +100	–54 to +100	–60 to +125	–60 to +125
	°F	–65 to +212	–55 to +212	–76 to +257	–76 to +257
Measuring Range (± peak)	g	500	100	700	70
Residual Noise Level*	µg	X: 500 Y: 400 Z: 400	X: 800 Y: 600 Z: 600	900	600
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000	5000
Connector		4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF
Mounting		Adhesive/Clip	Adhesive/Clip	M3 Stud/Adhesive	M3 Stud/Adhesive

* Measured in specified frequency range

Type Number		4527	4527-001	4528-B	4528-B-001	4506	4506-B
Weight	gram (oz)	6 (0.21)	6 (0.21)	6 (0.21)	6 (0.21)	15 (0.24)	15 (0.24)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	1 (9.8)	10 (98)	1 (9.8)	10 (98)	10 (98)	10 (98)
Frequency Range (±10%)	Hz	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800	X: 0.3 to 10000 Y: 0.3 to 10000 Z: 0.3 to 12800	X: 0.3 to 5500 Y: 0.6 to 3500* Z: 0.6 to 3500*	X: 0.3 to 5500 Y: 0.6 to 3500* Z: 0.6 to 3500*
Mounted Resonance Frequency	kHz	X: 30, Y: 30, Z: 42	X: 30, Y: 30, Z: 42	X: 30, Y: 30, Z: 42	X: 30, Y: 30, Z: 42	X: 18, Y, Z: 9.5	X: 19, Y, Z: 10
Operating Temperature Range	°C	–54 to +180	–54 to +180	–54 to +165	–54 to +165	–54 to +100	–54 to +100
	°F	–65 to 356	–65 to 356	–65 to 329	–65 to 329	– 65 to +212	– 65 to +212
Measuring Range (± peak)	g	510	51	510	51	70	70
Residual Noise Level*	µg	X: 900 Y: 500 Z: 400	X: 600 Y: 300 Z: 200	X: 900 Y: 500 Z: 400	X: 600 Y: 300 Z: 200	X: 400 Y: 200 Z: 200	X: 400 Y: 200 Z: 200
Maximum Non-destructive Shock (± peak)	g	5000	5000	5000	5000	5000	5000
Connector		4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF
Mounting		M3 Stud/Adhesive	M3 Stud/Adhesive	M3 Stud/Adhesive	M3 Stud/Adhesive	Clip/Adhesive	Clip/Adhesive

* Measured in specified frequency range

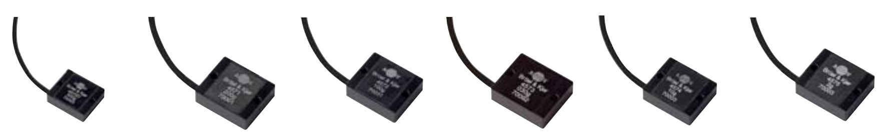
Type Number		4506-B-003	4504-A	4515-B	4515-B-002
Weight	gram (oz)	18 (0.63)	15 (0.24)	345 (12.2)	345 (12.2)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	50 (490)	1 (9.8)	10 (98)	10 (98)
Frequency Range (±10%)	Hz	X: 0.3 to 4000 Y: 0.3 to 2000 Z: 0.3 to 2000	X: 1 to 11000 Y: 1 to 9000 Z: 1 to 18000	X: 0.25 to 900 Y: 0.25 to 900 Z: 0.25 to900	X: 0.25 to 900 Y: 0.25 to 900 Z: 0.25 to 900
Mounted Resonance Frequency	kHz	X: 14, Y, Z: 7	X: 26, Y: 23, Z: 44	>2700	2700
Operating Temperature Range	°C	–54 to +100	–50 to +125	–10 to +70	–10 to +70
	°F	–65 to +212	–58 to +257	+14 to +158	+14 to +158
Measuring Range (± peak)	g	14	500	50	50
Residual Noise Level*	µg	X: 120 Y: 60 Z: 60	4000	X: 400 Y: 200 Z: 200	X: 400 Y: 200 Z: 200
Maximum Non-destructive Shock (± peak)	g	2000	3000	5000	5000
Connector		4-pin, 1/4″–28 UNF	10–32 UNF	3 × 10–32 UNF	4-pin LEMO

* Measured in specified frequency range

Amplified Piezoresistive Accelerometers

Amplified piezoresistive accelerometers are designed for measuring relatively low-level accelerations in aerospace and automotive environments. Typical applications require measurement of whole body motion immediately after the accelerometer is subjected to a shock motion, and in the presence of severe vibrational inputs. Brüel & Kjær's amplified piezoresistive accelerometers, the Type 457x series, include D versions with superior temperature stability:

- 457X and 457X-D: Open-ended
- 457X-001 and 457X-D-001: 7-pin LEMO termination
- 457X-002 and 457X-D-002: 9-pin sub D termination



Type Number		4570	4571	4572	4573	4574	4575
Maximum Linear Range (peak)	g	500	200	100	30	10	2
Frequency Range (±10%)	Hz	0 to 1850	0 to 1850	0 to 1850	0 to 850	0 to 500	0 to 300
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	0.4 (4)	1 (10)	2 (20)	6.7 (67)	20 (200)	100 (1000)
Residual Noise Level in Spec. Frequency Range	µg (RMS)	150000	65000	23000	11000	1800	500
Operating Temperature Range	°C	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121
	°F	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250
Maximum Non-destructive Shock (± peak)	g	10000	10000	10000	10000	10000	10000
Weight	gram (oz)	8 (0.28)	8 (0.28)	8 (0.28)	8 (0.28)	8 (0.28)	8 (0.28)
Cable/Connector		3 m Integral Cable	3 m Integral Cable	3 m Integral Cable	3 m Integral Cable	3 m Integral Cable	3 m Integral Cable
Mounting		4–40 or M3 Screws	4–40 or M3 Screws	4–40 or M3 Screws	4–40 or M3 Screws	4–40 or M3 Screws	4–40 or M3 Screws
Accessory Included		• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench	• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench	• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench	• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench	• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench	• 2 × 4–40 UNC Screw • QA-0013 Hex Wrench

Industrial Accelerometers

An industrial accelerometer with its rugged design is robust and reliable and covers a wide range of permanent vibration monitoring applications including operations in wet, dusty and potentially explosive areas. Charge and CCLD types are both available. Charge types are especially excellent for high-temperature measurements.

Industrial Piezoelectric Charge Accelerometers




Type Number		4391*	8315	8324-100	8347-C
Weight	gram (oz)	16 (0.56)	62 (2.18)	60 (2.1)	60 (2.1)
Charge Sensitivity @ 159.2 Hz	pC/ms^{-2} (pC/g)	1 (9.8)	10 (98)	1 (9.8)	1 (9.8)
Frequency Range (±10%)**	Hz	0.1 to 10000	1 to 10000	1 to 12800	1 to 12800
Mounted Resonance Frequency	kHz	40	28	39	39
Operating Temperature Range	°C	–60 to +180	–53 to +260	–196 to +482	–196 to +482
	°F	–76 to +356	–63 to +500	–321 to +900	–321 to +900
Maximum Sinusoidal Vibration (peak)	g	2000	2000	1000	1000
Maximum Operational Shock (± peak)	g	2000	2000	5000	5000
Connector		TNC	2-pin 7/16–27 UNS (2-pin TNC)	2-pin 7/16–27 UNS (2-pin TNC)	2-pin 7/16–27 UNS (2-pin TNC)
Mounting		10–32 UNF Stud	3 × M4 Screw	3 × M4 Screw 10–32 UNF Stud	3 × M4 Screw 10–32 UNF Stud

* Also available as V type with relaxed sensitivity tolerance
** Lower limiting frequency is determined by the amplifier used

Industrial CCLD Accelerometers





Type Number		8341	8324-G	8324-G-001	8324-G-002	8345
Description		Top Connector	TEDS Side Connector	TEDS Side Connector	TEDS Side Connector	Triaxial Side Connector
Weight	gram (oz)	41 (1.44)	91 (3.15)	91 (3.15)	91 (3.15)	50 (1.76)
Sensitivity @ 159.2 Hz	mV/ms^{-2} (mV/g)	10.2 (100)	1 (9.8)	1 (9.8)	1 (9.8)	10 (98)
Frequency Range (±10%)	Hz	0.3 to 10000	1 to 9000	100 to 9000	100 to 9000	2 to 2000
Mounted Resonance Frequency	kHz	27	30	30	30	18
Operating Temperature Range	°C	–51 to +121	–196 to +250	–196 to +250	–196 to +250	–45 to +125
	°F	–60 to +250	–321 to +482	–321 to +482	–321 to +482	–49 to +257
Measuring Range (± peak)	g	50	500	500	500	200
Maximum Shock (± peak)	g	5000	2000	2000	2000	5000
Connector		MIL-C-5015	BNC	BNC	LEMO	4-pin Series 800 Mighty Mouse
Mounting		1/4″–28 UNF Stud	3 × M4 Screw	3 × M4 Screw	3 × M4 Screw	3 × M4 Screw

Piezoelectric force transducers are designed to measure dynamic, short-duration forces in constructions. They are mounted so that the force to be measured is transmitted through the transducer. Used together with vibration or modal exciters they can measure and control the applied force, and can be used for the measurement of Frequency Response Functions in conjunction with an accelerometer. All Brüel & Kjær force transducers are of rugged construction, with high overall stiffness ensuring that they have a high resonance frequency without changing the mechanical characteristics of the test structure.

A convenient and economical means of exciting structures is an instrumented impact hammer fitted with a high-quality piezoelectric force transducer. Brüel & Kjær offers a complete range of instrumented impact hammers, capable of impacting and accurately measuring the force entering the structure under test.

Force Transducers

These transducers are designed specifically for use with vibration and modal exciters in structural dynamic testing. Their very high resonance frequency allows for the measurement of short duration, fast rise time, force transients.

Type Number		8230-003	8230-002	8230-001	8230	8230-C-003	8231-C
Transducer Type		CCLD	CCLD	CCLD	CCLD	Piezoelectric	Piezoelectric
Sensitivity	mV/N (mV/lbf)	0.2 (1)	2.2 (10)	22 (100)	110 (500)	–4 (–18)	–2 (–9)
Range, Full Scale	N (lbf)	+22000/–2200 (+5000/–500)	+2000/–2200 (+5000/–500)	+220/–220 (+50/–50)	+44/–44 (+10/–10)	22241 (5000) Compression	111205 (25000) Compression
Maximum Compression	N (lbf)	+66000 (+15000)	+44000 (+10000)	+4400 (+1000)	+880 (+200)	+67000 (+15000)	+268000 (+60000)
Maximum Tension	N (lbf)	–2200 (–500)	–2200 (–500)	–2200 (–500)	–880 (–200)	–2200 (–500)	–4448 (–1000)
Weight	gram	30	30	30	30	30	452
Operating Temperature Range	°C	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–73 to +260	–73 to +260
	°F	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–100 to +500	–100 to +500
Dimensions (Diameter × Height)	mm (inch)	19.1 × 15.9 (0.75 × 0.625)	19.1 × 15.9 (0.75 × 0.625)	19.1 × 15.9 (0.75 × 0.625)	19.1 × 15.9 (0.75 × 0.625)	19.1 × 15.9 (0.75 × 0.625)	50.8 × 31.8 (2.00 × 1.25)
Case Material		Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Connector, Electrical		10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting Provision		Top & Bottom: 1/4″– 28 UNF	Top & Bottom: 1/4″– 28 UNF	Top & Bottom: 1/4″– 28 UNF	Top & Bottom: 1/4″– 28 UNF	Top & Bottom: 1/4″–28 UNF	3/8″–16
Cables and Accessories Included		• Impact Cap • 1/4″–28 UNF Mounting Stud • 1/4″–28 UNF to 10–32 UNF Insert	• Impact Cap • 1/4″–28 UNF Mounting Stud • 1/4″–28 UNF to 10–32 UNF Insert	• Impact Cap • 1/4″–28 UNF Mounting Stud • 1/4″–28 UNF to 10–32 UNF Insert	• Impact Cap • 1/4″–28 UNF Mounting Stud • 1/4″–28 UNF to 10–32 UNF Insert	• Impact Cap • 1/4″–28 UNF Mounting Stud • 1/4″–28 UNF to 10–32 UNF Insert	• Impact Cap • 2 × 3/8″–16 UNC Mounting Stud

Force Transducer/Impact Hammer

Force Transducer/Impact Hammer Type 8203 is a unique structural testing kit designed for use with lightweight and delicate structures. The force transducer measures the force applied to the structure. It can be connected to the hammer kit for impact testing or to a small exciter (such as Brüel & Kjær Type 4810) via the stinger kit provided.

Type Number		8203††
Transducer Type		Piezoelectric
Sensitivity	pC/lbf (pC/N)	16 (3.6)
Maximum Compression	lbf (N)	225 (1000)* 281 (1250)†
Maximum Tension	lbf (N)	56 (250)
Resonance Frequency with 5 gram Load	kHz	21* 30†
Head Mass	lb (g)	0.0077 (3.5)* 0.0042 (1.9)†
Weight	lb (g)	0.0071 (3.2)* 0.0035 (1.6)†
Operating Temperature Range	°C	–196 to +150
	°F	–321 to +302
Overall Length	inch (mm)	4.17 (106)
Dimensions (diameter × height)	inch (mm)	0.35 × 0.62 (9 × 15.8)
Handle Material		Anodised Aluminium
Case Material		Titanium & Steel AISI 303
Connector		Coaxial M3
Mounting Provision		Top & Bottom: M 3 (with pre-loading nuts)
Included Cables and Accessories		• AO-0339 Cable • DB-3041 Steel Tip • UC-0205 Plastic Tip • YS-9202 Tip Mounting Screw • UC-5322 Pre-loading Nut • YM-0249 Pre-loading Nut • DB-425 M 3/10–32 UNF Adaptor • YQ-2004 M 3 Screw for DB-1425 • QA-0041 Tap for M 3 Thread • QA-0186 5 mm Spanner • QA-0042 Allen Key • Complete Stinger Accessory Kit

* With pre-loading nuts
† Without pre-loading nuts
†† Force transducer can be removed to use separately

Impedance Heads

Impedance heads offer a simple approach to the measurement of point mechanical mobilities and impedances. They can be used on a wide range of structures, including rotor blades, polymers, the human body, artificial mastoids, welds, wood and metal panels.

Type Number		8001
Transducer Type		Piezoelectric
Sensitivity, Force Gauge	pC/lbf (pC/N)	1645 (370)
Sensitivity, Accelerometer	pC/ms^{-2} (pC/g)	3 (30)
Maximum Compression	lbf (N)	449.6 (2000)
Maximum Tension	lbf (N)	67.4 (300)
Frequency Range (±10%)	kHz	0.001 to 10
Weight	lb (g)	0.064 (29)
Operating Temperature Range	°C	–196 to +260
	°F	–321 to +500
Dimensions (diameter × height)	inch (mm)	0.71 × 1.26 (18 × 32)
Case Material		Titanium
Connector		Two 10–32 UNF
Mounting Provision		Top & Bottom: 10–32 UNF
Included Cables and Accessories		• 2 × AO-0038 Low-noise cable, 1.2 m (4 ft) • 4 × YQ-2962 Threaded Steel Stud, 10–32 UNF • 3 × YO-0534 Mica Washer • 2 × YP-0150 Insulated Stud, 10–32 UNF • YM-0414 Nut, 10–32 UNF • QA-0029 Screw Tap, 10–32 UNF • QA-0013 Allen Key, 3/32″ for studs • 5 × YS-0514 Weakened Stud, 10–32 UNF

Impact Hammers

Impact hammer measurements are often conducted in difficult environments where dust, temperature fluctuations and high humidity frequently pose severe demands on the electrical and mechanical integrity of the instrumentation. All Brüel & Kjær impact hammers have been meticulously designed to meet the expectations for reliability in all such environments. With the ability to excite from the smallest of structures to various civil engineering structures, Brüel & Kjær has an impact hammer to suit even the most demanding application.

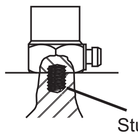
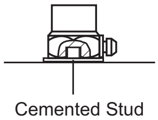
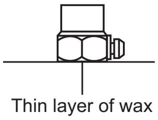
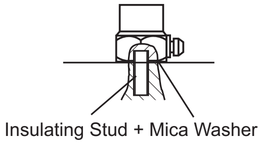
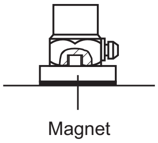
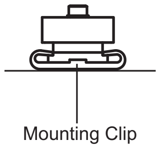
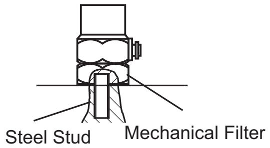
Type Number		8204	8206-003	8206-002	8206-001	8206	8207	8208	8210
Transducer Type		CCLD	CCLD	CCLD	CCLD	CCLD	CCLD	CCLD	CCLD
Sensitivity	mV/N (mV/lbf)	22.5 (100)	1.12 (5)	2.25 (10)	11.2 (50)	22.5 (100)	0.225 (1)	0.225 (1)	0.225 (1)
Range, Full Scale	N (lbf)	222 (50)	4448 (1000)	2224 (500)	445 (100)	222 (50)	22240 (5000)	22240 (5000)	22240 (5000)
Maximum Force	N (lbf)	890 (200)	8896 (2000)	4448 (1000)	4448 (1000)	4448 (1000)	35584 (8000)	35584 (8000)	35584 (8000)
Upper Frequency Limit, Typical*	kHz	60	10	10	10	10	1.2	1.2	1.2
Head Mass	lb (g)	0.0044 (2)	0.22 (100)	0.22 (100)	0.22 (100)	0.22 (100)	1.0 (454)	3.0 (1362)	12 (5448)
Operating Temperature Range	°C	–73 to +60	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–73 to +121	–73 to +121	–73 to +121
	°F	–100 to +140	–100 to +250	–100 to +250	–100 to +250	–100 to +250	–100 to +250	–100 to +250	–100 to +250
Overall Length	inch (mm)	4.8 (122)	8.76 (223)	8.76 (223)	8.76 (223)	8.76 (223)	11.7 (300)	15.2 (390)	35.3 (900)
Handle Material		Poly Extension	Fibreglass with Rubber Grip	Fibreglass with Rubber Grip	Fibreglass with Rubber Grip	Fibreglass with Rubber Grip	Hardwood	Hardwood	Hardwood
Case Material		Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Connector		10–32 UNF	BNC	BNC	BNC	BNC	BNC	BNC	BNC
Accessories Included		• Head Extender • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case	• Various Tips • Carrying Case

* Upper frequency limit depends upon structure under test and tip used. Typical values stated above are for a steel tip

Mounting Considerations

To measure vibration accurately, one must ensure that the useful frequency and dynamic range are not limited by poor accelerometer mounting. One of the main requirements for good accelerometer mounting is for a rigid mechanical contact between the accelerometer base and the surface to which it is to be attached. To achieve this, Brüel & Kjær has a wide variety of highly specialised mounting accessories. However, before choosing any accessory, you should keep in mind the considerations listed below.

Choosing the Right Mounting Method

Stud Mounting	
Mounting the accelerometer with a steel stud is the best mounting method because the highest mounted resonance frequency can be achieved. Hence, this mounting method should be used in all applications whenever possible.	
Cement Studs	
In places where it is not feasible or desirable to drill and tap fixing holes, a cementing stud may provide the optimum mounting solution. Such a cementing stud can be fixed onto the test object with the aid of epoxy or cyanoacrylate cement. The frequency response will be nearly as good as that obtained using a plain stud. Soft glues must be avoided as a significant reduction in coupling stiffness will greatly reduce the useful frequency range of the accelerometer.	
Mounting with the Aid of Beeswax	
For quick mounting of an accelerometer, for example for surveying vibration in various locations with a roving accelerometer, beeswax can be used for convenient mounting and dismounting of the accelerometer. Because beeswax becomes soft at high temperatures, the method is restricted to about 40°C.	
Insulated Mounting	
In places where it is desirable to electrically insulate the accelerometer from the test object, an insulated stud and a mica washer can be used. This could be either because the electrical potential of the test object is different from the ground potential of the test instrumentation, or because direct stud mounting will create a ground loop, which could affect the measurement. The latter is the most common reason for use of an insulated mounting method. Special insulated mounting pads made from ceramic and metal brazed together are also available for use at high temperatures.	
Mounting with the Aid of a Permanent Magnet	
A convenient method of mounting the accelerometer is by using a permanent magnet, which easily and rapidly can be shifted from one position to another – especially useful for surveying a large number of measurement points in the shortest possible test time. The method is restricted to use on clean and flat ferromagnetic surfaces and the dynamic range is limited due to the limited force of the magnet; yet, the method may give good high-frequency performance, especially on flat surfaces. Fitting a self-adhesive disc on the magnet will provide electrical insulation between the accelerometer and the surface to which it is attached.	
Mounting Clips and Swivel Bases	
Some accelerometer housings have slots, allowing the use of mounting clips so that the accelerometer can swiftly be fitted to the test object. Mounting clips are glued to the test object using hot glue or fitted with double-sided adhesive tape. A mounting clip with a unique swivel base construction is available, making it easy to align the accelerometer in accordance with the defined co-ordinate system. A spirit level is available for this purpose. Several other mounting clips are available, providing unique benefits in adverse mounting situations, such as a mounting clip with a thick base that can be filed down to conform to curved mounting surfaces. High-temperature mounting clips are also available, along with specially designed clips allowing swift accelerometer calibrations. All mounting clips have undergone extensive testing to ensure the utmost quality, reliability and consistency in the measurement data.	
Mechanical Filter	
The resonance peak on the accelerometer frequency response curve can be cut-off or reduced in amplitude with the aid of electronic filters in the measurement equipment. As most electronic filtering is made after the input stage in the preamplifier, this does not prevent overloading of the input stage or of the accelerometer. With the aid of a mechanical filter, mounted in between the accelerometer and the test object, an effective filtering of the mechanical vibration signal is obtained, protecting the whole measurement chain. The mechanical filter also provides electrical insulation between the accelerometer base and the mounting point.	

Use of a Hand-held Probe or Long Rod

A hand-held probe with the accelerometer mounted on top is very convenient for quick-check survey work and for accessing confined measurement locations. However, due to low overall mechanical stiffness and lack of adequate contact force to the test object, the mounted resonance frequency will typically be very low. With this method, there are potential risks for gross measurement errors.

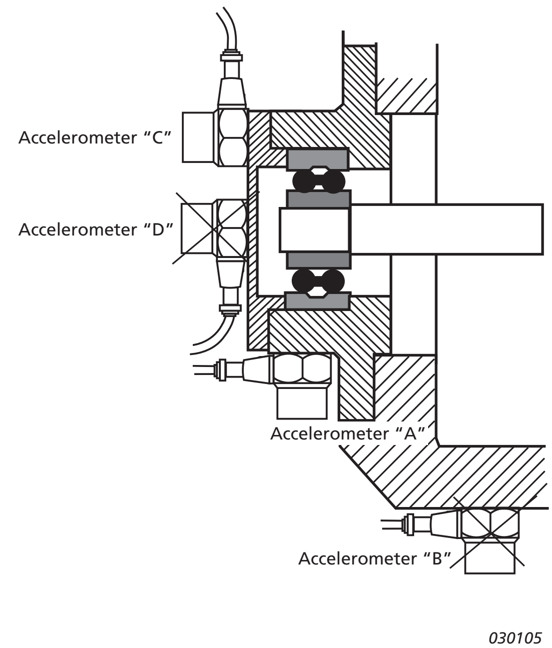
For measuring vibration in difficult-to-reach locations, the accelerometer can be mounted at the end of a steel pipe or rod within a rubber ring. A slightly rounded tip must be mounted onto the mounting surface of the accelerometer to ensure proper mechanical contact with the test object, even at slightly skewed angles. The response is far superior to the hand-held probe method.

Choosing a Mounting Position for the Accelerometer

The accelerometer should be mounted so that the desired measuring direction coincides with the main sensitivity axis. Accelerometers are slightly sensitive to vibrations in the transverse direction, but this can normally be ignored as the maximum transverse sensitivity is typically only a few percent of the main axis sensitivity. The reason for conducting vibration measurement tests will normally dictate the position of the accelerometer. In the drawing to the side, the purpose is to monitor the condition of the shaft and bearing. In this instance, the accelerometer should be positioned to maintain a direct path for the vibration from the bearing. Accelerometer ‘A’, thus, detects the vibration signal from the bearing predominant over vibrations from other parts of the machine, but accelerometer ‘B’ receives the bearing vibration modified by transmission through a joint, mixed with signals from other parts of the machine. Likewise, accelerometer ‘C’ is positioned in a more direct path than accelerometer ‘D’.

It is very difficult to give general rules about placement of accelerometers, as the response of mechanical objects to forced vibrations is a complex phenomenon, so that one can expect, especially at high frequencies, to measure significantly different vibration levels and frequency spectra, even on adjacent measuring points on the same machine element.

Accelerometer mounting position when monitoring the condition of the shaft and bearing



Loading the Test Object

When the accelerometer is mounted on the test object it will increase the mass of the vibrating system, thereby influencing the mechanical properties of the test object. As a general rule, the accelerometer mass should be no more than 1/10 of the ‘local’ dynamic mass of the vibrating part onto which it is mounted.

Modal and Vibration Test Solutions from Brüel & Kjær

Brüel & Kjær offers, as a single-source supplier, a wide range of tools for measurement and analysis in the vibration and structural dynamics testing disciplines including: accelerometers, impact hammers, force transducers, modal exciters (shakers), vibration exciters, power amplifiers, multi-channel analyzers, measurement software and post-processing software.

The family of exciters available through Brüel & Kjær range from small permanent magnet exciters for vibrating small test objects to larger floor-mounted types for vibrating assemblies and larger structures. They are designed for high-force levels and produce a clean vibration waveform with low cross-motion and distortion.

Modal Exciters

Based upon years of practical modal test experience, the line of modal exciters has been specifically developed to ensure the best possible modal test performance with minimum setup time.

The electrodynamic exciters provide precise, reliable, stable and long-lasting operation. Highest quality materials, stringent quality control and rugged construction assure a versatile means of modal excitation for any modal test.

Features include through-hole design, high force-to-weight ratio, low-mass armatures, wide frequency range, low total weight and small physical dimensions.

The exciters are available as:

- **Stand-alone units** supplied only with the appropriate trunnion, blower (except Type 4824) and connecting cable
- **Complete systems** with a matching power amplifier and DC static centring and field power supply units (Types 3627 and 3628 only)

Optional accessories include traditional push/pull stingers, tension wire stingers, lateral modal exciter stands, turnbuckles, hose and cable extension kits, chuck nut assemblies and various adaptors.

Note: The table shows selected modal exciters only. Exciters above 1000 N are available.





Type Number	Stand-alone		4824	4825	4826	4827	4828
	System		3624	3625	3626	3627	3628
Max. Force*, Sine (peak)		N (lbf)	100 (22)	200 (45)	400 (90)	650 (146)	1000 (225)
Max. Force*, Random (RMS)		N (lbf)	70 (15)	140 (31)	280 (63)	420 (94)	650 (146)
Max. Displacement, Pk-Pk		mm (in)	25.4 (1)	25.4 (1)	25.4 (1)	50.8 (2)	50.8 (2)
Effective Moving Mass		kg (lb)	0.23 (0.51)	0.23 (0.51)	0.40 (0.88)	1.3 (2.87)	1.3 (2.87)
Main Resonance Frequency		Hz	>6000	>6000	>4000	>3000	>3000
Useful Frequency Range		Hz	2 to 5000	2 to 5000	2 to 5000	2 to 5000	2 to 5000
Operating Frequency Range		Hz	DC to 5000	DC to 5000	DC to 5000	DC to 5000	DC to 5000
Max. Velocity, Sine (peak)		m/s (in/s)	1.5 (59)	1.5 (59)	1.5 (59)	1.5 (59)	1.5 (59)
Max. Velocity, Random (RMS)		m/s (in/s)	1.5 (59)	1.5 (59)	1.5 (59)	1.5 (59)	1.5 (59)
Max. Acceleration, Sine (peak)		m/s^2 (g)	432 (44)	863 (88)	981 (100)	500 (51)	765 (78)
Max. Acceleration, Random (RMS)		m/s^2 (g)	304 (31)	608 (62)	697 (71)	343 (35)	490 (50)
Rated Current		A	5.5	11.2	18	18	18
Suspension Stiffness		N/mm (lbf/in)	4 (23)	4 (23)	4 (23)	Adjustable†	
Weight with Trunnion		kg (lb)	21 (46.3)	21 (46.3)	21 (46.3)	80 (176)	80 (176)
Dimensions with Trunnion		mm (in)	306 × 220 × 241.5 (12 × 8.7 × 9.5)	306 × 220 × 241.5 (12 × 8.7 × 9.5)	306 × 220 × 241.5 (12 × 8.7 × 9.5)	394 × 400 × 540 (15.5 × 15.7 × 21.3)	394 × 400 × 540 (15.5 × 15.7 × 21.3)

* with forced air cooling
† Adjusted with DC Static Centring Unit Type 1056

Hand-held Exciter Type 5961		
Description	Type 5961 combines the advantages of using an impact hammer and a modal exciter for measuring on smaller structures. With its built-in battery-operated power amplifier, it just needs to be fed with an input signal from an external generator such as the PULSE mulit-analyzer system	
Frequency Range	45 Hz to 15 Hz	
Sensitivity	150 mN/V_{in} (typical and broadband) where V_{in} = 2.0 V RMS, Load mass = 2 kg	
Force Rating (RMS)	2 N (typical at resonance) 100 mN (typical at 10 kHz)	
Input Voltage	2.0 V RMS (distortion <3%) 3.5 V RMS (max. input)	
Battery Lifetime	Approx. 3 hours constant use	
Weight	500 g (17 oz), incl. battery	
Dimensions	Length: 155 mm (6.1″) Diameter: 52 mm (2.05″)	

Vibration Exciters

All permanent magnetic exciters are versatile and can be used for a range of applications including general vibration testing, mechanical impedance and mobility measurements, modal analysis or accelerometer calibration.

Matching power amplifiers and a range of accessories are available.

Type Number		**4808**	**4809**	**4810**
Max. Force, Sine (peak) (without cooling)	N (lbf)	112 (25)	44.5 (10)	10 (2.25) @ 65 Hz to 4 kHz 7 (1.5) @ 65 Hz to 18 kHz
Max. Force, Sine (peak) (with air cooling)	N (lbf)	187 (42)	60 (13.5)	–
Max. Displacement, Pk-Pk	mm (in)	12.7 (0.5)	8.0 (0.32)	6.0 (0.24)
Effective Moving Mass	kg (lb)	160 (5.64)	–	18 (0.63)
Frequency Range	Hz	5 to 10000	10 to 20000	DC to 18000
Max. Bare Table Acceleration (peak)	m/s^2 (g)	700 (71)	736 (75) 1000 (100) with air cooling	550 (56) @ 65 Hz to 4 kHz 383 (39) @ 65 Hz to 18 kHz
Coil Impedance	Ω	Approx. 0.8 @ 500 Hz with bare table and coils in parallel	Approx. 2 @ 500 Hz with bare table	3.5 @ 500 Hz
Max. Input Current	A RMS	15 with assisted air cooling at 25 A RMS	5 7 with forced air cooling	1.8
Weight	kg (lb)	35 (77.1)	8.3 (18.3)	1.1 (2.4)
Dimensions Diameter Height	mm (in)	215 (8.46) 200 (7.87)	149 (5.87) 143 (5.63)	76 (3) 75 (2.9)
Table Diameter	mm (in)	62.5 (2.45)	29 (1.14)	14 (0.55)
Power Amplifier		Type 2719	Type 2718	Type 2718

For more information on the use of vibration exciters to calibrate accelerometers, see Accelerometer Calibration.

Uniaxial Piezoelectric Charge Accelerometers

		General Purpose		High Sensitivity				
Type No.		**4382***	**4383***	**4370***	**4381***	**4371***	**4384***	**8346-C**
General								
Weight (excluding cable, wherever applicable)	gram	17	17	54	43	11	11	176
	oz	0.6	0.6	1.9	1.52	0.39	0.39	6.2
Charge Sensitivity (at 159.2 Hz)	pC/ms^{-2}	3.16	3.16	10	10	1	1	38
	pC/*g*	31.0	31.0	98	98	9.8	9.8	372
Frequency Range (± 10% limit)	Hz	0.1 to 8400	0.1 to 8400	0.1 to 4800	0.1 to 4800	0.1 to 12600	0.1 – 12600	0.1 – 3000
Mounted Resonance Frequency	kHz	28	28	16	16	42	42	10
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})	%	<4	<4	4	<4	<4	<4	<5
Transverse Resonance Frequency	kHz	10	10	4	5	15	15	3.5
Max. Operational Continuous Sinusoidal Acceleration (peak)	kms^{-2}	20	20	20	20	60	60	20
	g	2000	2000	2000	2000	6000	6000	2000
Electrical								
Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)	mms^{-2}	0.6	0.6	0.2	0.2	2.4	2.4	1
	m*g*	0.06	0.06	0.02	0.02	0.24	0.24	0.1
Capacitance (excluding cable)	pF	1100	1100	1100	1100	1100	1100	1100
Case (signal ground) Insulation to Base	MΩ							
Min. Leakage Resistance (at 20°C)	GΩ	20	20	20	20	20	20	>20
Environmental								
Operating Temperature Range	°C	–74 to +250	–74 to +250	–74 to +250	–74 to +250	–74 to +250	–74 to +250	–50 to +100
	°F	–101 to +482	–101 to +482	–101 to +482	–101 to +482	–101 to +482	–101 to +482	–58 to +212
Temperature Coefficient of Sensitivity	%/°C	0.05‡	0.05‡	0.05‡	0.05‡	0.05‡	0.05‡	0.12
Temperature Transient Sensitivity (3 Hz Low. Lim. Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	0.1	0.1	0.02	0.04	0.4	0.4	0.001
	g/°F	0.0055	0.0055	0.0011	0.0022	0.022	0.022	0.000055
Base Strain Sensitivity (at 250 με in the base plane)	ms^{-2}/με	0.01	0.01	0.003	0.003	0.02	0.02	0.002
	g/με	0.001	0.001	0.0003	0.0003	0.002	0.002	0.0002
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	1	1	1	1	4	4	0.5
	g/kGauss	0.01	0.01	0.01	0.01	0.04	0.04	0.005
Max. Non-destructive Shock (± peak)	kms^{-2}	50	50	20	20	200	200	50
	g	5000	5000	2000	2000	20000	20000	5000
Mechanical								
Case Material		Titanium ASTM Grade 2	Titanium ASTM Grade 2	Stainless Steel, AISI 316	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Stainless Steel AISI 316
Piezoelectric Sensing Element		PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 27
Construction		Delta-Shear®	Delta-Shear®	Delta-Shear®	Delta-Shear®	Delta-Shear®	Delta-Shear®	Delta-Shear®
Sealing		Welded	Welded	Welded	Welded	Welded	Welded	Hermetic
Electrical Connector		10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A
Mounting		10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF-2B × 3.2 mm threaded hole	10–32 UNF × 4.5 mm threaded hole

		High Frequency and Miniatures									
Type No.		**4374†**	**4374-L**	**4375***	**4393***	**4505-A**	**4505-001**	**4517-C**	**4517-C-001**	**4517-C-003**	**4521-C**
General											
Weight (excluding cable, wherever applicable)	gram	0.75	0.75	2.4	2.4	4.9	4.9	0.6	1	0.85	2.7
	oz	0.026	0.026	0.085	0.085	0.17	0.17	0.021	0.035	0.03	0.095
Charge Sensitivity (at 159.2 Hz)	pC/ms^{-2}	0.15	0.11	0.316	0.316	0.3	0.067	0.18	0.18	0.18	1
	pC/*g*	1.47	1.08	3.10	3.10	2.94	0.66	1.80	1.80	1.80	10
Frequency Range (± 10% limit)	Hz	1 to 26000	1 to 26000	0.1 to 16500	0.1 to 16500	1 to 12000	1 to 9000	1 to 10000	1 to 20000	1 to 9000	1 to 9000
Mounted Resonance Frequency	kHz	85	85	55	55	45	45	80	75	30	35
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})	%	<5	<5	<4	<4	<5	<5	<5	<5	<5	<5
Transverse Resonance Frequency	kHz	21	21	18	18	>20	>20				
Max. Operational Continuous Sinusoidal Acceleration (peak)	kms^{-2}	50	50	50	50	30	30	10	10	10	20
	g	5000	5000	5000	5000	3000	3000	1000	1000	1000	2000
Electrical											
Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)	mms^{-2}	18.5	18.5	5.2	5.2	7.6		5	5	5	1.6
	m*g*	1.85	1.85	0.52	0.52	0.76		0.5	0.5	0.5	0.16
Capacitance (excluding cable)	pF	800	700	625	590	1000	80	730	730	760	1300
Case (signal ground) Insulation to Base	MΩ					>10	>10				
Min. Leakage Resistance (at 20°C)	GΩ	20	20	20	20	>20	>20	>20	>20	>20	>20
Environmental											
Operating Temperature Range	°C	–74 to +250	–74 to +250	–74 to +250	–74 to +250	–55 to +230	–55 to +230	–51 to +177	–51 to +177	–51 to +177	–51 to +230
	°F	–101 to +482	–101 to +482	–101 to +482	–101 to +482	–67 to +446	–67 to +446	–60 to +350	–60 to +350	–60 to +350	–60 to +446
Temperature Coefficient of Sensitivity	%/°C	0.11	0.05‡	0.05‡	0.05‡	0.05‡		0.11	0.11	0.11	0.11
Temperature Transient Sensitivity (3 Hz Low. Lim. Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	10	10	5	5	1	4	4	4	2	0.55
	g/°F	0.55	0.55	0.275	0.275	0.055	0.227	0.22	0.22	0.2	0.030
Base Strain Sensitivity (at 250 με in the base plane)	ms^{-2}/με	0.01	0.01	0.005	0.005	0.02	0.02	5	0.5	0.01	1
	g/με	0.001	0.001	0.0005	0.0005	0.002	0.002	0.5	0.05	0.001	0.1
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	30	30	30	30	5	5	5.6	5	5	6
	g/kGauss	0.3	0.3	0.3	0.3	0.05	0.05	0.056	0.5	0.5	0.06
Max. Non-destructive Shock (± peak)	kms^{-2}	250	250	250	250	30	30	50	50	50	20
	g	25000	25000	25000	25000	3000	3000	5000	5000	5000	2000
Mechanical											
Case Material		Titanium ASTM Grade 2	Titanium ASTM Grade 3	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium	Titanium	Anodised Aluminium	Titanium Alloy
Piezoelectric Sensing Element		PZ 27	PZ 23	PZ 23	PZ 23	PZ 23	PZ 101	Ceramic	Ceramic	Ceramic	Ceramic
Construction		Planar Shear	Planar Shear	Delta-Shear®	Delta-Shear®	Theta Shear	Theta Shear®	Planar Shear	Planar Shear	Planar Shear	Planar Shear
Sealing		Sealed	Sealed	Welded	Welded	Welded	Welded	Hermetic	Hermetic	Epoxy sealed	Hermetic
Electrical Connector		Integral cable, 10–32 UNF-2B	Integral cable, 10–32 UNF-2B	Integral cable, 10–32 UNF-2B	M 3	10–32 UNF-2A	10–32 UNF-2A	Coaxial 3–56	Coaxial 3–56	Coaxial 3-56	M 3
Mounting		Adhesive	Adhesive	M 3 × 1.6 mm threaded hole	M 3 × 2.2 mm threaded hole	Integral 10–32 UNF stud	Integral 10–32 UNF stud	Adhesive	Adhesive	Adhesive	Insulated M 2 screw

		Industrial			Structural and Modal				Shock and Automative Crash Test	Reference	
Type No.		**4391***	**8315**	**8347-C**	**4500-A**	**4501-A**	**4507-C**	**4508-C**	**8309**	**8305**	**8305-001**
General											
Weight (excluding cable, wherever applicable)	gram	16	62	60	4.1	4.0	4.5	4.5	3	40	26
	oz	0.56	2.18	2.1	0.145	0.141	0.16	0.16	0.105	0.58	0.92
Charge Sensitivity (at 159.2 Hz)	pC/ms^{-2}	1	10	1	0.316	0.316	0.45	0.45	0.004	0.12	0.12
	pC/*g*	9.8	98	9.8	3.10	3.10	4.41	4.41	0.04	1.18	1.18
Frequency Range (± 10% limit)	Hz	0.1 to 10000	1 to 10000	1 to 12800	1 to 15000	1 to 10000	0.1 to 6000	0.1 to 8000	1 to 54000	0.2 to 4400 (±2%) 0.2 to 3100 (±1%)	0.2 to 4400 (±2%) 0.2 to 3100 (±1%)
Mounted Resonance Frequency	kHz	40	28	39	45	30	18	25	180	38	34
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})	%	<4	<3	<3	<5	<5	<5	<5	<5	<2	<2
Transverse Resonance Frequency	kHz	12	9.4	17	>20	>20	18	18	28		
Max. Operational Continuous Sinusoidal Acceleration (peak)	kms^{-2}	20	20	10	30	30	20	20	150	10	10
	g	2000	2000	1000	3000	3000	2000	2000	15000	1000	1000
Electrical											
Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)	mms^{-2}	2.3	18.6		7.6	7.6	1.7	1.8	230		
	m*g*	0.23	1.86		0.76	0.76	0.17	0.18	23		
Capacitance (excluding cable)	pF	1100		540	1000	1000	360	360	100	180	70
Case (signal ground) Insulation to Base	MΩ	>100		>100	>10	>10				Signal ground	Signal ground
Min. Leakage Resistance (at 20°C)	GΩ	>20	>10		>20	>20	>20	>20	>20	1000	1000
Environmental											
Operating Temperature Range	°C	–60 to +180	–53 to +260	–196 to +482	–55 to +175	–55 to +175	–74 to +250	–74 to +250	–74 to +180	–74 to +200	–74 to +200
	°F	–76 to +356	–63.4 to +500	–321 to +900	–67 to +347	–67 to +347	–101 to +482	–101 to +482	–101 to +356	–101 to +392	–101 to +392
Temperature Coefficient of Sensitivity	%/°C	0.05‡	±10% from –53°C to +125°C	0.03	0.05‡	0.1‡	0.1‡	0.1‡	0.043‡	–0.02‡	–0.02‡
Temperature Transient Sensitivity (3 Hz Low. Lim. Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	0.2	0.09**	1.5	0.4	0.4	0.2	0.6	400	0.50	0.50
	g/°F	0.011	0.055	0.083	0.022	0.022	0.011	0.033	22	0.028	0.028
Base Strain Sensitivity (at 250 με in the base plane)	ms^{-2}/με	0.005	0.008	0.02	0.001††	0.001††	0.005	0.005	2	Top: 0.01 Base: 0.003	Top: 0.01 Base: 0.003
	g/με	0.0005	0.0008	0.002	0.0001	0.0001	0.0005	0.0005	0.2	Top: 0.001 Base: 0.0003	Top: 0.001 Base: 0.0003
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	4	4	20	2	2	1	1	20	1	1
	g/kGauss	0.04	0.04	0.2	0.02	0.02	0.01	0.01	0.2	0.01	0.01
Max. Non-destructive Shock (± peak)	kms^{-2}	20	20	50	30	30	50	50	1000	10	10
	g	2000	2000	5000	3000	3000	5000	5000	100000	1000	1000
Mechanical											
Case Material		Titanium ASTM Grade 2	Stainless Steel 316 L	Inconel® 600	Anodised Aluminium	Anodised Aluminium	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Stainless Steel AISI 316	Stainless Steel AISI 316	Stainless Steel AISI 316
Piezoelectric Sensing Element		PZ 23	Piezite P-8®	PZ 101	PZ 23	PZ 23	PZ 23	PZ 23	PZ 46	Quartz	Quartz
Construction		Delta-Shear®	Shear	Shear	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Compression	Compression	Compression
Sealing		Welded	Hermetic	Hermetic	Welded	Welded	Welded	Welded	Epoxy sealed	Hermetic	Hermetic
Electrical Connector		7/16–28 UNEF-2A	2-pin TNC	2-pin TNC	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	Integral cable, 10–32	10–32 UNF	10–32 UNF
Mounting		10–32 UNF-2B × 3.2 mm threaded hole	ARINC (3 × M 4)	ARINC (3 × M 4)	Mounting clip or Adhesive	Mounting clip or Adhesive	Mounting clip or Adhesive	Mounting clip or Adhesive	Integral M 5 stud	10–32 UNF threaded hole	10–32 UNF threaded hole

* Also available as S type and V types
† Also available as S type
‡ In the temperature range –25°C to +125°C
** With 1 Hz high-pass filter
†† Mounted in mounting clip

Triaxial Piezoelectric Charge Accelerometers

		General Purpose			
Type No.		**4326-A**	**4326-A-001**	**4326-001***	**4321†**
General					
Weight (excluding cable, wherever applicable)	gram	13	17	17	55
	oz	0.46	0.6	0.6	1.94
Charge Sensitivity (at 159.2 Hz)	pC/ms^{-2}	0.316	0.316	0.316	1
	pC/g	3.10	3.10	3.10	9.8
Frequency Range (±10% limit)	Hz	X: 1 to 9000	X: 1 to 9000	X: 1 to 9000	X: 0.1 to 12000
		Y: 1 to 8000	Y: 1 to 8000	Y: 1 to 8000	Y: 0.1 to 12000
		Z: 1 to 16000	Z: 1 to 16000	Z: 1 to 16000	Z: 0.1 to 12000
Mounted Resonance Frequency	kHz	X: 27	X: 27	X: 27	X: 40
		Y: 24	Y: 24	Y: 24	Y: 40
		Z: 48	Z: 48	Z: 48	Z: 40
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})	%	<5	<5	<5	<4‡
Transverse Resonance Frequency	kHz	X: >20	X: >20	X: >20	X: 14
		Y: >20	Y: >20	Y: >20	Y: 14
		Z: >20	Z: >20	Z: >20	Z: 14
Max. Operational Continuous Sinusoidal Acceleration (peak)	kms^{-2}	30	30	30	5
	g	3000	3000	3000	500
Electrical					
Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)	mms^{-2}	3	5.6	5.6	2.3
	mg	0.3	0.56	0.56	0.23
Capacitance (excluding cable)	pF	1000	1000	1000	1100
Case (signal ground) insulation to base	MΩ	>10	>10	>10	
Min. Leakage Resistance (at 20°C)	GΩ	>20	>20	>20	>20
Environmental					
Operating Temperature Range	°C	–55 to +175	–55 to +230	–55 to +230	–74 to +250
	°F	–67 to +347	–67 to +446	–67 to +446	–101 to +482
Temperature Coefficient of Sensitivity	%/°C	X and Y: 0.08**, Z: 0.05**			0.5**
Temperature Transient Sensitivity (3 Hz Low-Limited Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	0.3	0.3	0.3	0.4
	g/°F	0.0165	0.0165	0.0165	0.022
Base Strain Sensitivity (at 250 με in base plane)	ms^{-2}/με	0.002††	0.002††	0.002††	0.2
	g/με	0.0002	0.0002	0.0002	0.002
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	5	5	5	4
	g/kGauss	0.05	0.05	0.05	0.04
Max. Non-destructive Shock (± peak)	kms^{-2}	30	30	30	10
	g	3000	3000	3000	1000
Mechanical					
Case Material		Anodised Aluminium	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2
Piezoelectric Sensing Element		PZ 23	PZ 23	PZ 23	PZ 23
Construction		Theta Shear®	Theta Shear®	Theta Shear®	Delta-Shear®
Sealing		Welded	Welded	Welded	Sealed
Electrical Connector		3 × 10–32 UNF-2A	3 × 10–32 UNF-2A	3 × 10–32 UNF-2A	3 × 10–32 UNF-2A
Mounting		Mounting clip, adhesive, M 2 screws or M 3 stud	Mounting clip, adhesive, M 2 screws or M 3 stud	Mounting clip, adhesive, M 2 screws or M 3 stud	10–32 UNF × 5 mm threaded hole, M 4 screw

* Dielectric rigidity: >1000 V
† Also available as S and V types
‡ Transverse sensitivity of V type is <5%
** In the temperature range –25°C to +125°C
†† Mounted in mounting clip

More Information

Variants in Charge Accelerometers

S Types
Uni-Gain accelerometers (sensitivity deviation ±2%) available from Brüel & Kjær in the form of a Set. The Set consists of a single accelerometer complete with cable and a range of accessories in a (mahogany) case.

V Types
Variable Gain accelerometers (sensitivity deviation ±15%) that have a greater deviation (higher tolerance) in sensitivity triaxial piezoelectric charge accelerometers.

Mounting of Type 4326-A-001

Special effort has been put into making mounting as flexible as possible. For fast and easy mounting, Mounting Clips UA-1408, UA-1473 and UA-1474 can be used. Five of the accelerometers' six surfaces can be used for mounting with adhesive cement or mounting wax. Where threaded holes can be provided in the test piece, the accelerometer can be mounted from the top via mounting holes in the base using three M 2 screws. See the following series of images for mounting hole positions.

Uniaxial Piezoelectric CCLD Accelerometers

			Miniature and High Frequency														Structural and Modal																		High Temperature		
Type No.			4517	4517-002	4516	4516-001	4518	4518-002	4518-001	4518-003	4519	4519-002	4519-001	4519-003	4397-A	4394*	4507	4507-B	4507-001	4507-B-001	4507-002	4507-B-002	4507-B-003†	4507-B-004	4507-B-005	4507-B-006	4508	4508-B	4508-001	4508-B-001	4508-002	4508-B-002	4508-B-003†	4508-B-004	4526	4526-001	4526-002
General																																						
Weight (excluding cable, wherever applicable)		gram	0.65	0.7	1.5	1.5	1.5	1.45	1.5	1.45	1.6	1.5	1.6	1.5	2.4	2.9	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.6	4.6	4.6	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.8	5	5	5
		oz	0.02	0.025	0.05	0.05	0.053	0.051	0.053	0.051	0.056	0.053	0.056	0.053	0.085	0.102	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.18
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	1.02	1.02	1.02	0.51	1.02	1.02	10.2	10.2	1.02	1.02	10.2	10.2	1	1	10	10	1	1	100	100	10	10	100	50	10	10	1	1	100	100	10	50	10	1	10
		mV/*g*	10	10	10	5	10	10	100	100	10	10	100	100	9.8	9.8	98	98	9.8	9.8	980	980	98	98	980	490	98	98	9.8	9.8	980	980	98	490	98	9.8	98
Frequency Range	Amplitude (±10%)	Hz	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 20000	1 to 25000	1 to 25000	0.3 to 6000	0.3 to 6000	0.1 to 6000	0.1 to 6000	0.4 to 6000	0.4 to 6000	0.3 to 6000	0.3 to 6000	0.4 to 6000	0.2 to 6000	0.3 to 8000	0.3 to 8000	0.1 to 8000	0.1 to 8000	0.4 to 8000	0.4 to 8000	0.3 to 8000	0.2 to 8000	0.3 to 8000	0.1 to 8000	0.3 to 8000
	Phase (±5°)	Hz	2 to 5000	2 to 5000	4 to 5000	4 to 5000	2 to 10000	4 to 10000	2 to 10000	4 to 10000	2 to 10000	2 to 10000	2 to 10000	5 to 10000	4 to 2500	4 to 2500	2 to 5000	2 to 5000	0.5 to 5000	0.5 to 5000	2 to 5000	2 to 5000	2 to 5000	2 to 5000	2 to 5000	1 to 5000	2 to 5000	2 to 5000	0.5 to 5000	0.5 to 5000	2 to 5000	2 to 5000	2 to 5000	1 to 5000	2 to 5000	0.5 to 5000	2 to 5000
Mounted Resonance Frequency		kHz	80	80	40	40	62	62	62	62	62	62	62	62	53	52	18	18	18	18	18	18	18	18	18	18	25	25	25	25	25	25	25	25	25	25	25
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<4	<4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Transverse Resonance Frequency		kHz													17	15	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18	>18
Measuring range (± peak)		kms^{-2}	4.9	4.9	4.9	9.8	4.9	4.9	0.49	0.49	4.9	4.9	0.49	0.49	5 (7500 ms^{-2} when T <100°C)		0.7	0.7	7	7	0.07	0.07	0.7	0.7	0.07	0.14	0.7	0.7	7	7	0.07	0.07	0.7	0.15	0.7	7	0.7
		g	500	500	500	1000	500	500	50	50	500	500	50	50	500 (750 *g* when T <100°C)		70	70	700	700	7	7	70	70	7	14	70	70	700	700	7	7	71	14	70	714	70
TEDS		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No
Electrical																																						
Bias Voltage	at 25°C & 4 mA	V	10 ±1.5 V	10 ±1.5 V	10 ±1.5 V	10 ±1.5 V	12 ±1	12 ±1	12 ±1	12 ±1	12 ±1	12 ±1	12 ±1	12 ±1	12 ±0.5	12 ±0.5																			12 ±1	12 ±1	12 ±1
	at full temp. & curr. range	V	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 16	8 to 15	8 to 15	12 ±1	13 ±1	12 ±1	13 ±1	12 ± 2	13 ±2	13 ±1	13 ±1	13 ±2	13 ±2	12 ±1	13 ±1	12 ±1	13 ±1	12 ±2	13 ±2	13 ±1	13 ±2	9 to 13	9 to 13	9 to 13
Power Supply	Constant current	mA	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10 (2 to 20 mA if T <100°C)		2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 10	2 to 10
	Unloaded supply voltage	V	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30
Output Impedance		Ω	70	70	80	100	40	40	120	120	40	40	120	120	100	100	2	30	2	30	2	30	30	30	30	30	2	30	2	30	2	30	30	30	2	2	2
Start-up time (to final bias ±10%)		s	<0.7	<0.7	<1	<1	<0.3	<0.3	<4	<4	<0.3	<0.3	<1	<1	<5	<5	<5	<5	<50	<50	<5	<5	<5	<5	<5	<5	<5	<5	<50	<50	<5	<5	<5	<5	<5	<5	<5
Residual Noise (inherent RMS broadband noise in the specified frequency range)		µV	60	60	60	30	20	20	90	90	20	20	90	90	<15	25	<35	<35	<8	<8	<150	<150	<35	<35	<150	<80	<35	<35	<8	<8	<150	<150	<35	<80	<35	<8	<35
		µ*g*	6000	6000	6000	6000	2000	2000	900	900	2000	2000	900	900	<1500	2500	<350	<350	<800	<800	<150	<150	<350	<350	<150	<160	<350	<350	<800	<800	<150	<150	<350	<160	<350	<816	<350
Noise Spectral	10 Hz	mms^{-2}/sqrt (Hz) (µg/sqrt (Hz))	7 (700)	7 (700)	7 (700)	7 (700)	1 (100)	1 (100)	0.4 (40)	0.4 (40)	1 (100)	1 (100)	0.4 (40)	0.4 (40)	0.79 (79)	1.3 (130)	0.15 (15)	0.15 (15)	0.25 (25)	0.25 (25)	0.08 (8)	0.08 (8)	0.15 (15)	0.15 (15)	0.08 (8)	0.08 (8)	0.15 (15)	0.15 (15)	0.25 (25)	0.25 (25)	0.08 (8)	0.08 (8)	0.15 (15)	0.08 (8)	0.15 (15)	0.25 (25)	0.15 (15)
	100 Hz		0.7 (70)	0.7 (70)	1.5 (150)	1.5 (150)	0.3 (30)	0.3 (30)	0.1 (10)	0.1 (10)	0.3 (30)	0.3 (30)	0.1 (10)	0.1 (10)	0.21 (21)	0.45 (45)	0.035 (3.5)	0.035 (3.5)	0.06 (6)	0.06 (6)	0.02 (2)	0.02 (2)	0.035 (3.5)	0.035 (3.5)	0.02 (2)	0.02 (2)	0.035 (3.5)	0.035 (3.5)	0.06 (6)	0.06 (6)	0.02 (2)	0.02 (2)	0.035 (3.5)	0.02 (2)	0.035 (3.5)	0.06 (6)	0.035 (3.5)
	1000 Hz		0.07 (7)	0.07 (7)	0.5 (50)	0.5 (50)	0.1 (10)	0.1 (10)	0.5 (50)	0.5 (50)	0.1 (10)	0.1 (10)	0.05 (5)	0.05 (5)	0.14 (14)	0.17 (17)	0.02 (2)	0.02 (2)	0.035 (3.5)	0.035 (3.5)	0.01 (1)	0.01 (1)	0.02 (2)	0.02 (2)	0.01 (1)	0.01 (1)	0.02 (2)	0.02 (2)	0.035 (3.5)	0.035 (3.5)	0.01 (1)	0.01 (1)	0.02 (2)	0.01 (1)	0.02 (2)	0.035 (3.5)	0.02 (2)
Insulation Resistance (signal ground to case)		MΩ	Case grounded	Base isolated	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded	Case grounded																							
Environmental																																						
Operating Temperature Range		°C	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–51 to +100	–51 to +100	–51 to +121	–51 to +121	–51 to +100	–51 to +100	–50 to +125	–50 to +125	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +100	–54 to +100	–54 to +121	–54 to +121	–54 to +100	–54 to +100	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +100	–54 to +100	–54 to +121	–54 to +100	–54 to +180	–54 to +180	–54 to +165
		°F	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–60 to 212	–60 to 212	–60 to +250	–60 to +250	–60 to 212	–60 to 212	–58 to +257	–58 to +257	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +212	–65 to +212	–65 to +250	–65 to +250	–65 to +212	–65 to +212	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +212	–65 to +212	–65 to +250	–65 to +212	–65 to +356	–65 to +356	–65 to +329
Temperature Coefficient of Sensitivity		%/°C	0.05	0.05	0.11	0.11	0.2	0.07	0.07	0.07	0.23	0.23	0.23	0.23	0.05	0.04	0.09	0.09	0.09	0.09	0.18	0.18	0.09	0.09	0.18	0.18	0.06	0.06	0.06	0.06	0.12	0.12	0.06	0.12	0.09	0.09	0.09
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 B/oct))		ms^{-2}/°C	0.3	0.3	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2	2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
		g/°F	0.0165	0.0165	0.0055	0.0055	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.11	0.11	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	40	40	20	1	5	5	9	9	5	5	12	12	50	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		g/kGauss	0.4	0.4	0.2	0.01	0.05	0.05	0.09	0.09	0.05	0.05	0.12	0.12	0.5	0.1	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Base Strain Sensitivity (at 250 µε in base plane)		ms^{-2}/µε	0.8	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.005	0.005	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.005‡	0.001	0.001	0.005
		g/µε	0.08	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.0005	0.0005	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005‡	0.0005**	0.0005‡	0.0001	0.0001	0.0005
Max. Non-destructive Shock (± peak)		kms^{-2}	49	49	15	15	29	29	29	29	29	29	29	29	100 (axial) 50 (transverse)		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		g	5000	5000	1500	1500	3000	3000	3000	3000	3000	3000	3000	3000	10000 (axial) 5000 (transverse)		5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Mechanical																																						
Case Material			Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2
Piezoelectric Sensing Element			Quartz	Quartz	Quartz	Quartz	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 27	PZ 27	PZ 23	PZ 23	PZ 27	PZ 27	PZ 23	PZ 23	PZ 23	PZ 23	PZ 27	PZ 27	PZ 23	PZ 27	PZ 23	PZ 23	PZ 23
Construction			Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Planar Shear	Delta-Shear®	Delta-Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®	Theta Shear®
Sealing			Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Welded	Welded	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic
Electrical Connector			Coaxial 3–56	Coaxial 3–56	10–32 UNF-2A	10–32 UNF-2A	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	Coaxial M 3	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A	10–32 UNF-2A
Mounting			Adhesive	Adhesive	Adhesive	Adhesive	Integral M 3 stud × 3.8 mm	Adhesive	Integral M 3 stud × 3.8 mm	Adhesive	Integral M 3 stud × 2.8 mm	Adhesive	Integral M 3 stud × 3.8 mm	Adhesive	M 3 × 2.4 mm threaded hole	M 3 × 2 mm threaded hole	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Adhesive	3 pairs of slots for clip mounting form pseudo-triaxial measurements; Adhesive mounting also possible			Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Adhesive	Clip or Adhesive	Stud mount, 10–32 threaded hole	Stud mount, 10–32 threaded hole	Adhesive

* Same as Type 4397-S with insulated base
† Adhesive-mount version of B variant
‡ Mounted on adhesive tape 0.09 mm thick

			General Purpose							
Type No.			**4534-B**	**4534-B-001**	**4534-B-002**	**4534-B-004**	**4533-B**	**4533-B-001**	**4533-B-002**	**4533-B-004**
General										
Weight (excluding cable, wherever applicable)		gram	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
		oz	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	1	10	50	5	1	10	50	5
		mV/*g*	9.8	98	490	49	9.8	98	490	49
Frequency Range	**Amplitude (±10%)**		0.2 to 12800	0.2 to 12800	0.3 to 12800	0.2 to 12800	0.2 to 12800	0.2 to 12800	0.3 to 12800	0.2 to 12800
	Phase (±5°)	Hz	1 to 10000	1 to 5000	2 to 1500	1 to 5000	1 to 10000	1 to 5000	2 to 1500	1 to 5000
Mounted Resonance Frequency		kHz	38	38	38	38	38	38	38	38
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5	<5	<5	<5	<5	<5	<5	<5
Transverse Resonance Frequency		kHz								
Measuring range (± peak)		kms^{-2}	7	0.7	0.14	1.4	7	0.7	0.14	1.4
		g	714	71	14	143	714	71	14	14.3
TEDS			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Electrical										
Bias Voltage	**at 25°C and 4 mA**	V	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14
	at full temperature and current range		12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14	12 to 14
Power Supply	**Constant current**	mA	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20
	Unloaded supply voltage	V	21 to 32	21 to 32	21 to 32	21 to 32	21 to 32	21 to 32	21 to 32	21 to 32
Output Impedance		Ω	<15	<15	<15	<15	<15	<15	<15	<15
Start-up time (to final bias ±10%)		s	<30	<30	<30	<30	<30	<30	<30	<30
Residual Noise (inherent RMS broadband noise in the specified frequency range)		μV	5	13	50	7	5	13	50	7
		μ*g*	500	130	100	140	500	130	100	140
Noise Spectral	**10 Hz**	mms^{-2}/sqrt(Hz) (μ*g*/sqrt(Hz))	0.25 (25)	0.15 (15)	0.11 (11)	0.14 (14)	0.25 (25)	0.15 (15)	0.11 (11)	0.14 (14)
	100 Hz		0.07 (7)	0.025 (2.5)	0.022 (2.2)	0.03 (3)	0.07 (7)	0.025 (2.5)	0.022 (2.2)	0.03 (3)
	1000 Hz		0.044 (4.4)	0.01 (1)	0.009 (0.9)	0.014 (1.4)	0.044 (4.4)	0.01 (1)	0.009 (0.9)	0.014 (1.4)
Insulation Resistance (body to mounting surface)		MΩ	Base isolated	Base isolated	Base isolated	Base isolated	Base isolated	Base isolated	Base isolated	Base isolated
Environmental										
Operating Temperature Range		°C	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125	–55 to +125
		°F	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257	–67 to +257
Temperature Coefficient of Sensitivity		%/°C	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 dB/oct)		ms^{-2}/°C	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		g/°F	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	3	3	3	3	3	3	3	3
		g/kGauss	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Base Strain Sensitivity (at 250 με in base plane)		ms^{-2}/με	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
		g/με	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Max. Non-destructive Shock (± peak)		kms^{-2}	100	100	100	100	100	100	100	100
		g	10000	10000	10000	10000	10000	10000	10000	10000
Mechanical										
Case Material			Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Titanium
Piezoelectric Sensing Element			PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23
Construction			Shear	Shear	Shear	Shear	Shear	Shear	Shear	Shear
Sealing			Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic
Electrical Connector			10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF	10–32 UNF
Mounting			Stud mount, 10–32 UNF internal thread, depth 3.8 mm	Stud mount, 10–32 UNF internal thread, depth 3.8 mm	Stud mount, 10–32 UNF internal thread, depth 3.8 mm	Stud mount, 10–32 UNF internal thread, depth 3.8 mm	10–32 UNF × 3.8 mm threaded hole	10–32 UNF × 3.8 mm threaded hole	10–32 UNF × 3.8 mm threaded hole	10–32 UNF × 3.8 mm threaded hole

			Shock		360° Mounting				Underwater	High Sensitivity		
Type No.			**8339**	**8339-001**	**4521**	**4523**	**4511-001**	**4511-006**	**5958-A***	**8340**	**8344**	**8344-B-001**
General												
Weight (excluding cable, wherever applicable)		gram	5.8	5.8	4	13.3	35	29	44†	775	176	176
		oz	0.204	0.204	0.141	0.47	1.23	1.0	1.55†	27.33	6.2	6.2
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	0.025	0.01	0.98	1	1	1	1	1020	250	50
		mV/*g*	0.25	0.1	10	9.8	9.8	9.8	9.8	10000	2450	490
Frequency Range	**Amplitude (±10%)**		1 to 20000	1 to 20000	1 to 10000	1 to 15000	1 to 15000	2 to 25000	0.3 to 11000	0.1 to 1500	0.2 to 3000	0.05 to 3000
	Phase (±5°)	Hz	5 to 8000	5 to 8000	5 to 5000	2 to 10000	2 to 10000	2 to 10000	5 to 10000	5 to 200	0.5 to 5000	0.5 to 5000
Mounted Resonance Frequency		kHz	130	130	35	43	43	43	45	7	10	10
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<10	<10	<5	<5	<5	<5	<5	<1	<5	<5
Transverse Resonance Frequency		kHz							14		3.5	3.5
Measuring range (± peak)		kms^{-2}	200	500	4.9	5	5	5	5	0.0049	0.026	0.137
		g	20000	50000	500	500	500	500	500	0.5	2.6	14
TEDS			No	No	No	No	No	No	No	No	Yes	Yes
Electrical												
Bias Voltage	**at 25°C and 4 mA**	V	9 ±1	9 ±1	8.5 to 11.5	12 ±1	11 ± 0.5	12 ±1	12 ± 0.5	12 ±1	13 ±1	13 ±1
	at full temperature and current range		7.5 to 10	7.5 to 10	8 to 16	12 ±2	8.5 to 14	12 ±2	10 to 15	10 to 14	13 ±1	13 ±1
Power Supply	**Constant current**	mA	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20
	Unloaded supply voltage	V	24 to 30	24 to 30	24 to 30	18 to 30	18 to 30	23 to 32	24 to 30	24 to 30	24 to 30	24 to 30
Output Impedance		Ω	100	100	60	2	100	100	100	200	30	30
Start-up time (to final bias ±10%)		s	<0.1	<0.1	<1	<5	<2	<2		<8	<30	120
Residual Noise (inherent RMS broadband noise in the specified frequency range)		µV	35	35	60	20	<10	<10	<15	25	113: 0.2 to 3000 Hz	9: 0.3 to 3000 Hz 5: 1 to 3000 Hz
		µ*g*	150000	350000	6000	2000	<1000	<1000	<1500	2.5	45: 0.2 to 3000 Hz	18: 0.3 to 3000 Hz 10: 1 to 3000 Hz
Noise Spectral	**10 Hz**	mms^{-2}/sqrt (Hz) (µg/sqrt (Hz))	60 (6000)	150 (15000)		0.9 (90)	1.6 (160)	1.6 (160)		0.015 (1.5)	0.00775 (0.78)‡	0.011 (1.1)**
	100 Hz		15 (1500)	35 (3500)		0.15 (15)	0.5 (50)	0.5 (50)		0.015 (1.5)	0.000775 (0.078)‡	0.002 (0.2)**
	1000 Hz		10 (1000)	25 (2500)		0.029 (2.9)	0.16 (16)	0.16 (16)		0.0005 (0.05)	0.000846 (0.035)‡	0.0009 (0.09)**
Insulation Resistance (body to mounting surface)		MΩ	Base isolated	Base isolated	Base isolated	>100	>100	>100	>10	Case isolated		
Environmental												
Operating Temperature Range		°C	–51 to +121	–51 to +121	–51 to +121	–54 to +150	–54 to +150	–54 to +150	–50 to +100	–51 to +74	–50 to +100	–50 to +100
		°F	–60 to +250	–60 to +250	–60 to +250	–65 to +302	–65 to +302	–65 to +302	–58 to +212	–60 to +165	–58 to +212	–58 to +212
Temperature Coefficient of Sensitivity		%/°C	0.03	0.03	0.11	0.09	0.09	0.09	0.05	0.25	0.05	0.05
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 dB/oct)		ms^{-2}/°C	30	30	0.21	0.2	1	1	1	0.003	0.001	0.001
		g/°F	1.65	1.65	0.01155	0.011	0.055	0.055	0.055	0.000165	0.000055	0.000055
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	2000	2000	6	24	20	20	20	0.7	0.5	2.5
		g/kGauss	20	20	0.06	0.24	0.2	0.2	0.2	0.007	0.005	0.025
Base Strain Sensitivity (at 250 µε in base plane)		ms^{-2}/µε	1.3	1.3	0.06	0.2	0.05	0.2	0.01	0.0002	0.002	0.002
		g/µε	0.13	0.13	0.006	0.02	0.005	0.02	0.001	0.00002	0.0002	0.0002
Max. Non-destructive Shock (± peak)		kms^{-2}	816	816	20	51	51	51	20	0.98	3.6	3.6
		g	80000	80000	2000	5000	5000	5000	2000	100	350	350
Mechanical												
Case Material			17–4 PH Stainless steel	17–4 PH Stainless steel	Titanium	Stainless steel AISI 316-L	Stainless steel AISI 316-L	Stainless steel AISI 316-LS	Stainless steel AISI 404L	Stainless steel	Stainless steel AISI 316-L	Stainless steel AISI 316-L
Piezoelectric Sensing Element			Quartz	Quartz	Quartz	PZ 23	PZ 23	PZ 23	PZ 23	Ceramic	PZ 27	PZ 27
Construction			Compression	Compression	Planar Shear	Annular Shear, base insulated	Annular Shear, case insulated	Annular Shear, case insulated	Delta-Shear®	Annular Shear	Delta-Shear®	Delta-Shear®
Sealing			Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic

Table continues on next page

		Shock		360° Mounting				Underwater	High Sensitivity		
Type No.		**8339**	**8339-001**	**4521**	**4523**	**4511-001**	**4511-006**	**5958-A***	**8340**	**8344**	**8344-B-001**
Electrical Connector		10–32 UNF-2A	10–32 UNF-2A	M 3	10–32 UNF-2A	3-pin HiRel	3-pin Glenair® 800-series	BNC	2-pin MIL-C-5015	10–32 UNF	10–32 UNF
Mounting		Integral 10–32 UNF stud	Integral 10–32 UNF stud	Insulated M 2 centre bolt	M 4 centre bolt	M 4 centre bolt or 10–32 UNF stud	M 4 centre bolt	1/4″–28 UNF-2A integrated	Stud mount, 1/4″–28 UNF-2A threaded hole	M 5 × 4.5 threaded hole	M 5 × 4.5 threaded hole

* Also available as Type 5958-H with open end
† In air, including 0.15 m cable
‡ Type 8344 noise spectral at 1 Hz = 0.11 $ms^{-2}/\sqrt{Hz}$ (11 $\mu g/\sqrt{Hz}$)
** Type 8344-B-001 noise spectral at 1 Hz = 0.09 $ms^{-2}/\sqrt{Hz}$ (9 $\mu g/\sqrt{Hz}$)

Triaxial Piezoelectric CCLD Accelerometers

			Structural and Modal							
Type No.			**4520**	**4520-002**	**4520-001**	**4520-004**	**4524***	**4524-B***	**4524-B-001***	**4524-B-004***
General										
Weight (excluding cable, wherever applicable)		gram	2.9	3.6	4	4	4.4	4.4	4.4	4.4
		oz	0.1	0.127	0.14	0.14	0.15	0.15	0.15	0.15
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	1.02	1.02	1.02	0.1	10	10	1	5
		mV/*g*	10	10	10	1	98	98	9.8	49
Frequency Range	**Amplitude (±10%)**	Hz	X: 2 to 7000	X: 2 to 4000	X: 2 to 4000	X: 2 to 4000	X: 0.2 to 5500	X: 0.2 to 5500	X: 0.2 to 5500	X: 0.2 to 5500
			Y: 2 to 7000	Y: 2 to 4000	Y: 2 to 4000	Y: 2 to 4000	Y: 0.25 to 3000	Y: 0.25 to 3000	Y: 0.25 to 3000	Y: 0.25 to 3000
			Z: 2 to 7000	Z: 2 to 7000	Z: 2 to 7000	Z: 2 to 7000	Z: 0.25 to 3000	Z: 0.25 to 3000	Z: 0.25 to 3000	Z: 0.25 to 3000
	Phase (±5°)	Hz	X: 5 to 5000	X: 5 to 3000	X: 5 to 3000	X: 5 to 3000	X: 1.5 to 3000	X: 1.5 to 3000	X: 1.5 to 3000	X: 1.5 to 3000
			Y: 5 to 5000	Y: 5 to 3000	Y: 5 to 3000	Y: 5 to 3000	Y: 1.5 to 3000	Y: 1.5 to 3000	Y: 1.5 to 3000	Y: 1.5 to 3000
			Z: 5 to 5000	Z: 5 to 3000	Z: 5 to 3000	Z: 5 to 3000	Z: 1.5 to 3000	Z: 1.5 to 3000	Z: 1.5 to 3000	Z: 1.5 to 3000
Mounted Resonance Frequency		kHz	X: 40 Y: 30 Z: 30	X: 20 Y: 25 Z: 30	X: 20 Y: 25 Z: 30	X: 20 Y: 25 Z: 30	X:18 Y: 9 Z: 9	X:18 Y: 9 Z: 9	X:18 Y: 9 Z: 9	X:18 Y: 9 Z: 9
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5	<5	<5	<5	<5	<5	<5	<5
Transverse Resonance Frequency		kHz					X: 9 Y: 9 Z: 9	X: 9 Y: 9 Z: 9	X: 9 Y: 9 Z: 9	X: 9 Y: 9 Z: 9
Measuring range (± peak)		kms^{-2}	4.9	4.9	4.9	49	0.5	0.5	5	1
		g	500	500	500	5000	50	50	500	100
TEDS			No	No	No	No	No	Yes	Yes	Yes
Electrical										
Bias Voltage	**at 25°C and 4 mA**	V	8.5 to 11.5	8.5 to 11.5	8.5 to 11.5	8.5 to 11.5				
	at full temperature and current range		8 to 16	8 to 16	8 to 16	8 to 16	12 ±1	13 ±1	13 ±1	13 ±1
Power Supply	**Constant current**	mA	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10
	Unloaded supply voltage	V	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 30	24 to 3
Output Impedance		Ω	<80	<100	<100	<100	<2	<30	<30	30
Start-up time (to final bias ± 10%)		s	<1	<1	<1	<1	<10	<10	<10	<10
Residual Noise (inherent RMS broadband noise in the specified frequency range)		µV	<70	<70	<70	<56	X: <40 Y: <20 Z: <20	X: <40 Y: <20 Z: <20	X: 50 Y: 40 Z: 40	X: 40 Y: 30 Z: 30
		µ*g*	<7000	<7000	<7000	<56000	X: <400 Y:<200 Z: <200	X: <400 Y:<200 Z: <200	X: 500 Y: 400 Z: 400	X: 800 Y: 600 Z: 600

			High Temperature				General Purpose						Human Body Vibration		Industrial
Type No.			**4528-B**	**4528-B-001**	**4527**	**4527-001**	**4535-B**	**4535-B-001**	**4504-A**	**4506***	**4506-B***	**4506-B-003***	**4515-B**	**4515-B-002***	**8345**
General															
Weight (excluding cable, wherever applicable)		gram	6	6	6	6	6	6	15	15	15	18	345	345	40
		oz	0.21	0.21	0.21	0.21	0.21	0.21	0.54	0.54	0.54	0.63	12.2	12.2	1.41
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	1	10	1	10	1	10	1	10	10	50	10	10	10
		mV/*g*	9.8	98	9.8	98	9.8	98	9.8	98	98	490	98	98	98
Frequency Range	**Amplitude (±10%)**	Hz	X: 0.3 to 10000	X: 0.3 to 10000	X: 0.3 to 10000	X: 0.3 to 10000	X: 0.3 to 10000	X: 0.3 to 10000	X: 1 to 11000	X: 0.3 to 5500	X: 0.3 to 5500	X: 0.3 to 4000	X: 0.25 to 900	X: 0.25 to 900	X: 2 to 2000
			Y: 0.3 to 10000	Y: 0.3 to 10000	Y: 0.3 to 10000	Y: 0.3 to 10000	Y: 0.3 to 10000	Y: 0.3 to 10000	Y: 1 to 9000	Y: 0.6 to 3000	Y: 0.6 to 3000	Y: 0.3 to 2000	Y: 0.25 to 900	Y: 0.25 to 900	Y: 2 to 2000
			Z: 0.3 to 12800	Z: 0.3 to 12800	Z: 0.3 to 12800	Z: 0.3 to 12800	Z: 0.3 to 10000	Z: 0.3 to 12800	Z: 1 to 18000	Z: 0.6 to 3000	Z: 0.6 to 3000	Z: 0.3 to 2000	Z: 0.25 to 900	Z: 0.25 to 900	Z: 2 to 2000
	Phase (±5°)	Hz	X: 2 to 10000	X: 2 to 10000	X: 2 to 10000	X: 2 to 10000	X: 2 to 12800	X: 2 to 10000	X: 4 to 2500	X: 3 to 3000	X: 3 to 3000	X: 2 to 2500	X: 1.5 to 3000	X: 1.5 to 3000	X: 2 to 2000
			Y: 2 to 10000	Y: 2 to 10000	Y: 2 to 10000	Y: 2 to 10000	Y: 2 to 10000	Y: 2 to 10000	Y: 4 to 2500	Y: 3 to 3000	Y: 3 to 3000	Y: 2 to 2500	Y: 1.5 to 3000	Y: 1.5 to 3000	Y: 2 to 2000
			Z: 2 to 12800	Z: 2 to 12800	Z: 2 to 12800	Z: 2 to 12800	Z: 2 to 12800	Z: 2 to 12800	Z: 4 to 2500	Z: 3 to 3000	Z: 3 to 3000	Z: 2 to 2500	Z: 1.5 to 3000	Z: 1.5 to 3000	Z: 2 to 2000
Mounted Resonance Frequency		kHz	X: 30 Y: 30 Z: 42	X: 30 Y: 30 Z: 42	X: 30 Y: 30 Z:42	X: 30 Y: 30 Z:42	X: 30 Y: 30 Z: 42	X: 30 Y: 30 Z: 42	X: 26 Y: 23 Z: 44	X: 18 Y: 9.5 Z: 9.5	X: 18 Y: 9.5 Z: 9.5	X: 14 Y: 7 Z: 7	X: 18 Y: 9 Z: 8.9	X: 18 Y: 9 Z: 8.9†	X, Y, Z: >18
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Transverse Resonance Frequency		kHz											X: 9 Y: 9 Z: 9	X: 9 Y: 9 Z: 9†	X, Y & Z: >20
Measuring range (± peak)		kms^{-2}	7000	700	7000	700	7	0.7	5000	700	700	140	5	5	500
		g	714	71	714	71	714	71	500	70	70	14	500	500	51
TEDS			Yes	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Electrical															
Bias Voltage	**at 25°C and 4 mA**	V	13 ±1	13 ±1	12 ±1	12 ±1	13 ±1	13 ±1	12 ±0.5						
	at full temperature and current range		11 to 14	11 to 14	8.5 to 14	8.5 to 14	12 to 14	12 to 14	8 to 15	12 ±1	13 ±1	13 ±1	13 ±1	13 ±1	12 ±1
Power Supply	**Constant current**	mA	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 20	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10	2 to 10
	Unloaded supply voltage	V	20 to 30	20 to 30	20 to 30	20 to 30	22 to 30	22 to 30	+24 to +30	+24 to +30	+24 to +30	+24 to +30	24 to 30	24 to 30	23 to 32
Output Impedance		Ω	50	50	30	30	50	50	<100	< 2	<30	<30	<30	<30	<2
Start-up time (to final bias ± 10%)		s	<10	<10	<10	<10	<10	<10	<2	<10	<10	<10	<10	<10	<10
Residual Noise (inherent RMS broadband noise in the specified frequency range)		µV	9.0	60	9.0	60	9	60	<40	X: <40 Y: <20 Z: <20	X: <40 Y: <20 Z: <20	X: <60 Y: <30 Z: <30	X: <40 Y: <20 Z: <20	X: <40 Y: <20 Z: <20	X, Y, Z: <100
		µ*g*	900	600	900	600	900	600	<4000	X: <400 Y: <200 Z: <200	X: <400 Y: <200 Z: <200	X: <120 Y: <60 Z: <60	X: <400 Y: <200 Z: <200	X: <400 Y: <200 Z: <200	X, Y, Z: <1000

Table continues on next page

		Structural and Modal							
Type No.		**4520**	**4520-002**	**4520-001**	**4520-004**	**4524***	**4524-B***	**4524-B-001***	**4524-B-004***
Noise Spectral – **10 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))				30 (3)	X: 0.16 (16) Y: 0.08 (8) Z: 0.08 (8)	X: 0.16 (16) Y: 0.08 (8) Z: 0.08 (8)	X: 0.2 (20) Y: 0.16 (16) Z: 0.16 (16)	X: 0.1 (10) Y: 0.07 (7) Z: 0.07 (7)
Noise Spectral – **100 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))				10 (1)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.05 (5) Y: 0.04 (4) Z: 0.04 (4)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)
Noise Spectral – **1000 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))				6 (0.6)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X: 0.025 (2.5) Y: 0.02 (2) Z: 0.02 (2)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)
Insulation Resistance (body to mounting surface)	MΩ								
Insulation Resistance (signal ground to case)	GΩ	Case grounded	Case grounded	Case grounded	Case grounded	>1 (Signal ground is isolated from the housing)			
Environmental									
Operating Temperature Range	°C	–51 to +121	–51 to +121	–51 to +121	–51 to +121	–54 to +100	–54 to +100	–54 to +100	–54 to +100
	°F	–60 to +250	–60 to +250	–60 to +250	–60 to +250	–65 to +212	–65 to +212	–65 to +212	–65 to +212
Temperature Coefficient of Sensitivity	%/°C	0.05	0.05	0.05	0.05	0.14	0.14	0.08	0.14
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	0.09	0.09	0.09	3.6	0.002	0.002	0.05	0.002
	g/°F	0.00495	0.00495	0.00495	0.36	0.00011	0.00011	0.00275	0.00011
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	40	40	40	40	20	20	20	20
	g/kGauss	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2
Base Strain Sensitivity (at 250 µε in base plane)	ms^{-2}/µε	0.3	0.15	0.15	0.15	0.0005‡	0.0005‡	0.0005‡	0.0005‡
	g/µε	0.03	0.015	0.015	0.015	0.00005‡	0.00005‡	0.00005‡	0.00005‡
Max. Non-destructive Shock (peak)	kms^{-2}	49	49	49	49	50	50	50	50
	g	5000	5000	5000	5000	5000	5000	5000	5000
Mechanical									
Case Material		Titanium	Titanium	Titanium	Titanium	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2
Piezoelectric Sensing Element		Quartz	Quartz	Quartz	Quartz	PZ 27	PZ 27	PZ 23	PZ 27
Construction		Planar Shear	Planar Shear	Planar Shear	Planar Shear	Ortho Shear®	Ortho Shear ®	Ortho Shear ®	Ortho Shear ®
Sealing		Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic
Electrical Connector		4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF
Mounting		Adhesive	Adhesive or Clip mounting	M 3 threaded hole or Adhe-sive	M 3 threaded hole or Adhe-sive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive	Clip or Adhesive

		High Temperature				General Purpose						Human Body Vibration		Industrial
Type No.		**4528-B**	**4528-B-001**	**4527**	**4527-001**	**4535-B**	**4535-B-001**	**4504-A**	**4506***	**4506-B***	**4506-B-003***	**4515-B**	**4515-B-002***	**8345**
Noise Spectral – **10 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))	0.30 (30)	0.2 (20)	0.30 (30)	0.2 (20)	0.30 (30)	0.2 (20)	2.1 (210)	X: 0.2 (20) Y: 0.1 (10) Z: 0.1 (10)	X: 0.2 (20) Y: 0.1 (10) Z: 0.1 (10)	X: 0.1 (10) Y: 0.06 (6) Z: 0.06 (6)	X: 0.16 (16) Y: 0.08 (8) Z: 0.08 (8)	X: 0.16 (16) Y: 0.08 (8) Z: 0.08 (8)	X, Y, Z: 0.16 (16)
Noise Spectral – **100 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))	0.06 (6)	0.04 (4)	0.06 (6)	0.04 (4)	0.06 (6)	0.04 (4)	0.75 (75)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X: 0.04 (4) Y: 0.02 (2) Z: 0.02 (2)	X, Y, Z: 0.04 (4)
Noise Spectral – **1000 Hz**	mms^{-2}/ sqrt(Hz) (µg/ sqrt(Hz))	0.04 (4)	0.02 (2)	0.04 (4)	0.02 (2)	0.04 (4)	0.02 (2)	0.28 (28)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X: 0.018 (1.8) Y: 0.008 (0.8) Z: 0.008 (0.8)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X: 0.02 (2) Y: 0.01 (1) Z: 0.01 (1)	X, Y, Z: 0.02 (2)
Insulation Resistance (body to mounting surface)	MΩ							>10						
Insulation Resistance (signal ground to case)	GΩ	Signal ground is connected to case				Signal ground is connected to case			>1	>1	>1	>1	>1	>0.1
Environmental														
Operating Temperature Range	°C	–60 to +165	–60 to +165	–60 to +180	–60 to +180	–60 to +125	–60 to +125	–50 to +125	–54 to +100	–54 to +100	–54 to +100	–10 to +70 (short periods: –60 to +100)		–54 to +125
	°F	–76 to +329	–76 to +329	–76 to +356	–76 to +356	–76 to +257	–76 to +257	–58 to +257	–65 to +212	–65 to +212	–65 to +212	+14 to +158 (short periods: –76 to +212)		–65 to +257
Temperature Coefficient of Sensitivity	%/°C	0.12	0.1	0.12	0.1	0.12	0.1	X: 0.1 Y: 0.1 Z: 0.08	X: 0.05 Y: 0.1 Z: 0.1	X: 0.05 Y: 0.1 Z: 0.1	X: 0.15 Y: 0.12 Z: 0.12	0.14	0.14	0.09
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 dB/oct)	ms^{-2}/°C	0.02	0.02	0.02	0.02	0.02	0.02	0.5	3	3	5	0.002	0.002	1
	g/°F	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0275	0.165	0.165	0.275	0.00011	0.00011	0.055
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	15	8	15	8	15	8	10	6	6	6	20	20	20
	g/kGauss	0.15	0.08	0.15	0.08	0.15	0.08	0.1	0.06	0.06	0.06	0.2	0.2	0.2
Base Strain Sensitivity (at 250 µε in base plane)	ms^{-2}/µε	0.1	0.1	0.1	0.1	0.1	0.1	0.001**	0.03‡	0.03‡	0.02‡	0.0005‡	0.0005‡	0.01
	g/µε	0.01	0.01	0.01	0.01	0.01	0.01	0.0001**	0.003‡	0.003‡	0.002‡	0.00005‡	0.00005‡	0.001
Max. Non-destructive Shock (peak)	kms^{-2}	50	50	50	50	50	50	30	50	50	20	50	50	50
	g	5100	5100	5100	5100	5100	5100	3000	5000	5000	2000	5000	5000	5100
Mechanical														
Case Material		Titanium	Titanium	Titanium	Titanium	Titanium	Titanium	Anodised Aluminium	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Titanium ASTM Grade 2	Oil resistant nitrile rubber	Oil resistant nitrile rubber	Stainless steel AISI 316-LS
Piezoelectric Sensing Element		PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 23	PZ 27	PZ 27 (built-in accelerometer)		PZ 23
Construction		Shear	Shear	Shear	Shear	Shear	Shear	Theta Shear®	Ortho Shear®	Ortho Shear®	Ortho Shear®	Ortho Shear® (built-in accelerometer)		Shear
Sealing		Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Welded	Welded	Welded	Welded	Hermetic (built-in accelerometer)		Hermetic
Electrical Connector		4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	4-pin, 1/4″–28 UNF	3 × 10–32 UNF -2A	Microtech-com-patible, 4-pin, 1/4″–28 UNF (titanium)	Microtech-com-patible, 4-pin, 1/4″–28 UNF (titanium)	Microtech-com-patible, 4-pin, 1/4″–28 UNF (titanium)	3 × 10–32 UNF -2A	4-pin LEMO	4-pin Glenair® 800 series
Mounting		M 3 threaded hole or Adhe-sive	M 3 threaded hole or Adhe-sive	M 3 threaded hole or Adhe-sive	M 3 threaded hole or Adhe-sive	M3 threaded hole or Adhe-sive	M 3 threaded hole or Adhe-sive	Mounting clip, adhesive, M 2 screws or M 3 stud	1 × 1.6 mm slots for clip mounting on five sides	1 × 1.6 mm slots for clip mounting on five sides	1 × 1.6 mm slots for clip mounting on five sides	Strapped, pressed or glued	Strapped, pressed or glued	3 × M 4 in isosceles triangle

* All three axes must be powered. Single or dual-axis supply is not available.
† Built-in accelerometer
‡ Mounted in mounting clip or on adhesive tape 0.09 mm thick
** Mounted in mounting clip

Industrial Piezoelectric CCLD Accelerometers

			Industrial Applications	
Type No.			**8341**	**8324-G***
General				
Weight (excluding cable, wherever applicable)		gram	41	91
		oz	1.44	3.15
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	10	1
		mV/*g*	100	9.8
Frequency Range: Amplitude (±10% limit)		Hz	0.3 to 10000	9000
Mounted Resonance Frequency		kHz	27	30
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5	<3
Transverse Resonance Frequency		kHz		9
Measuring range (± peak)		kms^{-2}	490	20
		g	50	2000
Electrical:				
Bias Voltage	**at 25°C and 4 mA**	V		
	at full temperature and current range		8 to 16	13 ±1
Power Supply	**Constant current**	mA	2 to 10	2 to 20
	Unloaded supply voltage	V	24 to 30	24 to 28
Output Impedance		Ω	60	<100
Start-up time (to final bias ±10%)		s	<3	<2
Residual Noise (inherent RMS broadband noise in the specified frequency range)		μV	20	4
		μ*g*	200	0.4
Isolation			Case grounded	Case insulated
Environmental:				
Operating Temperature Range		°C	–51 to +121	Accelerometer: –60 to +480 Charge Converter: –40 to +85
		°F	–60 to +250	Accelerometer: –76 to +896 Charge Converter: –40 to +185
Temperature Coefficient of Sensitivity		%/°C	0.11	0.11
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. 20 dB/decade)		$ms^{-2}/°C$	0.2	20
		g/°F	0.011	1.1
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	25	25
		g/kGauss	0.25	0.25
Base Strain Sensitivity (in the base plane at 250 με)		$ms^{-2}/με$	0.1	0.2
		g/με	0.01	0.02
Max. Non-destructive Shock (± peak)		kms^{-2}	50	20
		g	5000	2000
Mechanical				
Case Material			Stainless Steel	Inconel® 600
Piezoelectric Sensing Element			Ceramic	Piezoelectric type PT
Construction			Planar Shear	Compression
Sealing			Hermetic	Hermetic
Electrical Connector			MIL-C-5015	BNC (connector at the cable end)
Mounting			1/4″–28 UNF × 6.35 mm threaded hole	ARINC, 8–32 UNC 3 × M 4

* The accelerometer comes with high temperature cable, integrated charge converter/filter and TEDS.

More Information

Variants in CCLD Accelerometers

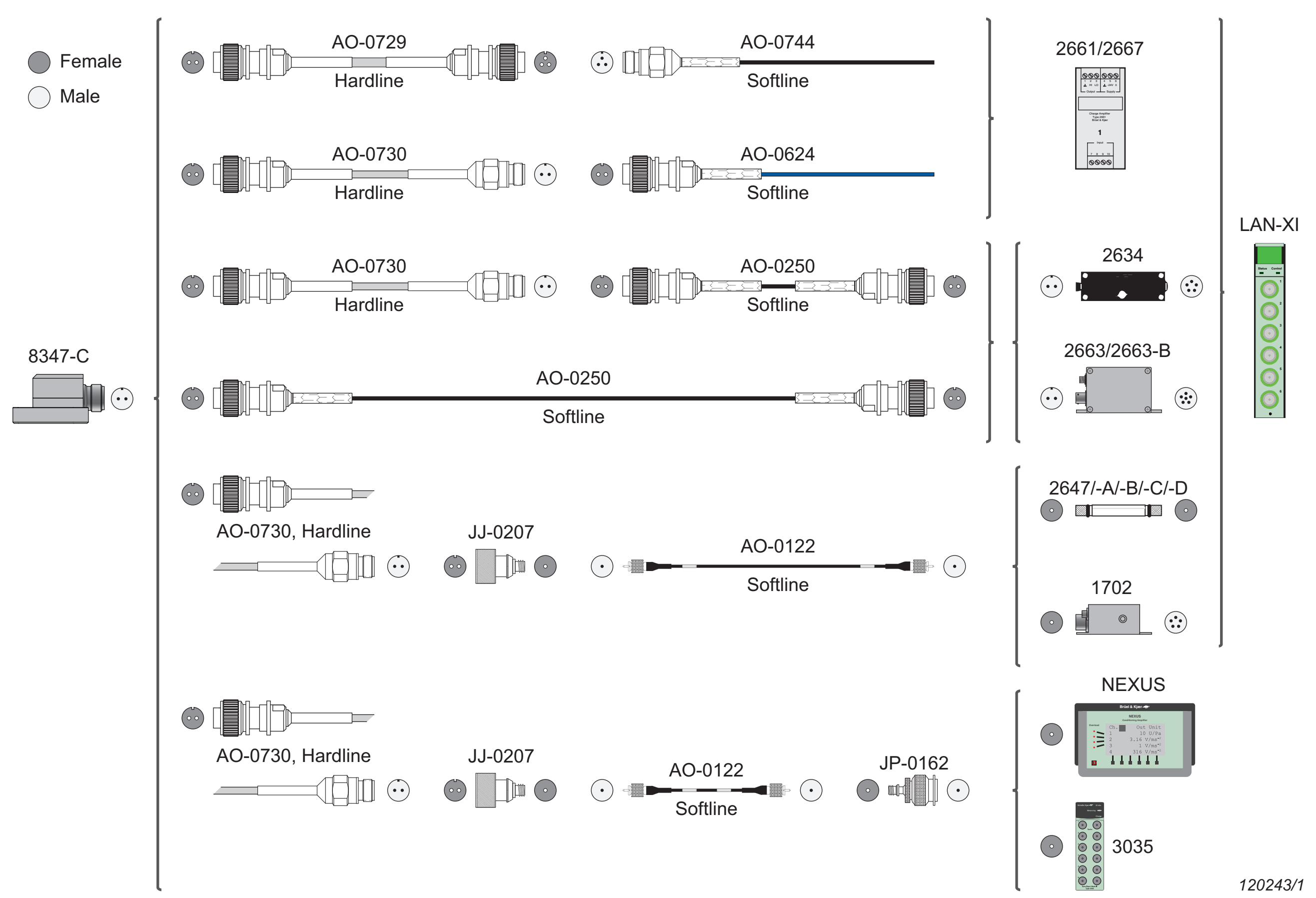
S Types
Accelerometers available from Brüel & Kjær in the form of a Set. The Set consists of a single accelerometer complete with cable and mounting studs in a case.

V Types
Variable Gain accelerometers (sensitivity deviation ±15%) that have a greater deviation (higher tolerance) in sensitivity.

B Types
Accelerometers with built in TEDS (Transducer Electronic Data Sheet).

Configuration Options for Types 8347-C

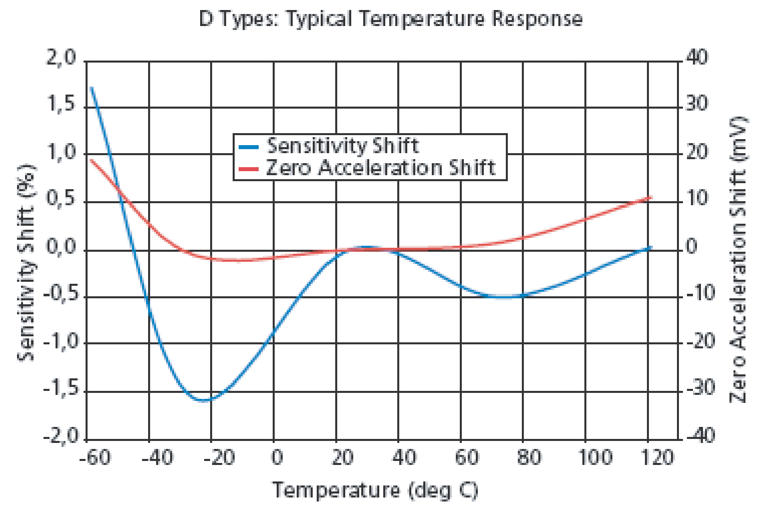
The following illustration shows typical configurations using Type 8347-C together with Brüel & Kjær measurement and analysis instruments.



Uniaxial Piezoresistive Accelerometers

Type No.			4570	4570-D	4571	4571-D	4572	4572-D	4573	4573-D	4574	4574-D	4575	4575-D
General														
Weight (excluding cable, wherever applicable)		gram	8	8	8	8	8	8	8	8	8	8	8	8
		oz	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	0.4	0.4	1	1	2	2	6.7	6.7	20	20	100	100
		mV/*g*	4	4	10	10	20	20	67	67	200	200	1000	1000
Frequency Range: Amplitude (±10% limit)		Hz	0 to 1850	0 to 1850	0 to 1850	0 to 1850	0 to 1850	0 to 1850	0 to 850	0 to 850	0 to 500	0 to 500	0 to 300	0 to 300
Frequency Range: Phase (±5° limit)		Hz	0 to 160	0 to 160	0 to 160	0 to 160	0 to 160	0 to 160	0 to 75	0 to 75	0 to 45	0 to 45	0 to 25	0 to 25
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Max. Zero Acceleration Output (relative to V_{ref})		mV	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Measuring range (± peak)		ms^{-2}	5000	5000	2000	2000	1000	1000	300	300	100	100	20	20
		g	500	500	200	200	100	100	30	30	10	10	2	2
Electrical														
V_{ref} at full temperature and current range		V	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005	2.5 ±0.005
Power Supply	Current consumption	mA	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Unloaded supply voltage	V	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24	8 to 24
Output Impedance		Ω	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Start-up time (to final bias ±10%)		s	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Residual Noise (inherent RMS broadband noise in the specified ±10% frequency range)		μV	<600	<600	<650	<650	<450	<450	<700	<700	<350	<350	<500	<500
		m*g*	<150	<150	<65	<65	<22.5	<22.5	<10.45	<10.45	<1.75	<1.75	<0.5	<0.5
Spectral Noise	10 Hz	mms^{-2}/Hz (mg/Hz)	35 (3.5)	35 (3.5)	15 (1.5)	15 (1.5)	5 (0.5)	5 (0.5)	3.5 (0.35)	3.5 (0.35)	0.750 (0.075)	0.750 (0.075)	0.300 (0.030)	0.300 (0.030)
	100 Hz		35 (3.5)	35 (3.5)	15 (1.5)	15 (1.5)	5 (0.5)	5 (0.5)	3.5 (0.35)	3.5 (0.35)	0.750 (0.075)	0.750 (0.075)	0.300 (0.030)	0.300 (0.030)
	1000 Hz		35 (3.5)	35 (3.5)	15 (1.5)	15 (1.5)	5 (0.5)	5 (0.5)	3.5 (0.35)	3.5 (0.35)	0.750 (0.075)	0.750 (0.075)	0.300 (0.030)	0.300 (0.030)
Insulation Resistance (body to mounting surface)		MΩ	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
Environmental														
Operating Temperature Range		°C	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121	–55 to +121
		°F	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250	–67 to +250
Zero Acceleration Shift	(–20°C to +85°C)	mV	<40		<40		<40		<40		<40		<40	
	(–20°C to +121°C)			<40		<40		<40		<40		<40		<40
Temperature Coefficient of Sensitivity	(–20°C to +85°C)	%/°C	±2.1		±2.1		±2.1		±2.1		±2.1		±2.1	
	(–20°C to +121°C)			±3		±3		±3		±3		±3		±3
Temperature Transient Sensitivity (3 Hz Lower Limiting Freq., 20 dB/decade)		ms^{-2}/°C	0.5	0.5	0.5	0.5	0.5	0.5	0.2	0.2	0.1	0.1	0.5	0.5
		g/°F	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.011	0.011	0.01	0.01	0.0275	0.0275
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	400	400	120	120	70	70	40	40	20	20	4	4
		g/kGauss	40	40	1.2	1.2	0.7	0.7	0.4	0.4	0.2	0.2	0.04	0.04
Base Strain Sensitivity (in the base plane at 250 με)		ms^{-2}/με	0.2	0.2	0.2	0.2	0.2	0.2	0.03	0.03	0.05	0.05	0.06	0.06
		g/με	0.02	0.02	0.02	0.02	0.02	0.02	0.003	0.003	0.005	0.005	0.006	0.006
Max. Non-destructive Shock (± peak)		kms^{-2}	100	100	100	100	100	100	100	100	100	100	100	100
		g	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Mechanical														
Case Material			Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium	Anodised Aluminium
Sensing Element			Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors	Piezo resistors
Construction			4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge	4-arm wheat-stone bridge
Sealing			Sensing element: Hermetically sealed Housing: Epoxy sealed											
Electrical Connector			Integral cable 3 options available: 457X terminating in an open end; 457X-001 with 7-pin LEMO connector: 457X-002 with 9-pin sub D connector)											
Mounting			Through holes for 2 × 4–40 Head cap screw, (11 mm) with washer											

D-versions are available offering high thermal stability from –55° to +121°C. For standard versions, the thermal zero shift and thermal sensitivity shift are specified in the temperature range –20° to +85°C. For high thermal stability the D-versions are compensated from –55° to +121°C.



Non-contact Transducers for Speed, Velocity and Displacement

Brüel & Kjær's non-contact transducers are used for contact-free target detection, velocity and displacement detection without loading the structure under test. Another common use for the transducer signal is as an input to a tachometer to measure rotational speed (RPM). In some applications, Magnetic Transducer MM-0002 can even be used to excite the test structure using the transducer as a miniature contact-free electromagnetic vibration exciter for non-contact vibration excitation. This is used for determination of elastic properties of materials.



Type Number		MM-0002	MM-0004	2981	2981-A*
Signal Outputs		Velocity or Trigger for Tachometer	Displacement or Trigger for Tachometer	Trigger for Tachometer	Trigger for Tachometer
Detection Principle		Variable Reluctance	Capacitive	Visible Laser and Receiver	Visible Laser and Receiver through Fiber Optic Cable
Conditioning		None (self-generating)	200 V from Type 2669 or similar	CCLD	CCLD
Frequency Range	Hz	0 to 2000	20 to 200000	0 to 300000	0 to 300000
Typical Working Distances	mm	2	0.5	15 to 700	2 to 50
Operating Temperature Range	°C	–150 to +250	up to +250	–10 to +50	–60 to +130 (Fiber)
	°F	–238 to +482	up to +482	+14 to +122	–76 to +266
Dimensions	mm	21 × 29.5	21 × 29.5	22.5 × 91	6 × 21 (Fiber tip)
Connector		10–32 UNF	11.7 mm 60 UNS (½″ microphone)	SMB	SMB
Mounting Provision		M16–1 thread with two included nuts	M16–1 thread with two included nuts	¼″–20 UNC (camera tripod), 10–32 UNF, M4, M22–1 thread with flange	M6–0.75 thread with two included nuts
Further information		BP 0298	BP 0578	BP 2448	BP 2448

* Type 2981-A consists of CCLD Laser Tacho Probe Type 2981, Fibre Adaptor UA-2144 and Optional Fibre AE-4003-D-020

Designed for contact-free speed measurements on rotating or reciprocating machine parts, Type 2981 produces a voltage pulse for each rotation of a shaft or cycle of a machine part.

Used with retroreflective tape like its included QS-0056, the probe has the advantage that it can be located any distance from 1.5 to at least 70 cm (0.6 to 27 inches) from the test object, thus safely separating the probe from possible contact with moving parts or an otherwise hazardous environment.

Clip Mounting

For modal and other applications requiring easy, flexible, and fast mounting, Brüel & Kjær has specifically developed a line of mounting clips. The housing of some accelerometers has slots that allow the use of mounting clips. The clips are attached to the object with glue or double-sided adhesive tape and can be easily fitted and moved to or from a number of different test objects. With glass reinforced polycarbonate clips, the upper frequency limit will be reduced depending on the accelerometer. For detailed mounting techniques and specifications, see the individual accelerometer product data sheets.

Type No.	Description	Used with
UA-1407	Set of 100 small mounting clips	Types 4507, 4508, 4524, 4500-A, 4501-A
UA-1475	Set of 100 small thick-base clips	
UA-1564	Set of 5 small high-temperature clips, insulated with 10 – 32 UNF holes	
UA-1478	Set of 100 small swivel bases	
DV-0459	Small calibration clip	
UA-1408	Set of 100 big mounting clips	Types 4504, 4506, 4326-A, 4326-A-001, 4573, 4574, 4575, 4535, 4528, 4527 with adaptor UA-2219
UA-1474	Set of 100 big thick bases	
UA-1563	Set of 5 big high-temperature clips, insulated with 10 –32 UNF holes	
UA-1473	Set of 100 big swivel bases	
DV-0460	Big calibration clip	
UA-1480	Spirit level for swivel base	All swivel bases

.

		UA-1407	UA-1408
Description		Clips for mounting directly on object surface	
Temperature Range		–54° to +50°C (–65° to +122°F) For brief use (<1 hour): up to +80°C (+176°F)	
Maximum Acceleration		10 g peak Perpendicular to mounting surface: 70 g peak	
Material		Glass reinforced polycarbonate	
Upper Limiting Frequency, 10%	with Type 4506	–	Mounted with grease on the accelerometer: 2 kHz Mounted dry: 1.2 kHz
	with Type 4506-B-003	–	Mounted with grease: 1.2 kHz
	with Type 4507	Mounted with grease: 3 kHz Mounted dry: 1.5 kHz	–
	with Type 4508	Mounted with grease: 4 kHz Mounted dry: 2 kHz	–
	with Type 4524	Mounted with grease: x: 2.7 kHz, y and z 2.0 kHz	–
Weight		0.4 g (0.014 oz)	3.9 g (0.13 oz)

		UA-1475	UA-1474
Description		Clips with thick base that can be filed down to suit your mounting surface	
Temperature Range		–54° to +50°C (–65° to +122°F) For brief use (<1 hour): up to +80°C (+176°F)	
Maximum Acceleration		10 g peak Perpendicular to mounting surface: 70 g peak	
Material		Glass reinforced polycarbonate	
Upper Limiting Frequency, 10%	with Type 4506	–	Mounted with grease on the accelerometer: 2 kHz
	with Type 4506-B-003	–	Mounted with grease: 1.2 kHz
	with Type 4507	Mounted with grease: 3 kHz Mounted dry: 1.5 kHz	–
	with Type 4508	Mounted with grease: 3 kHz Mounted dry: 1.5 kHz	–
	with Type 4524	Mounted with grease: x: 2.7 kHz, y and z 2.0 kHz	–
Weight		0.7 g (0.02 oz)	3.9 g (0.13 oz)

	UA-1473		UA-1478		UA-1480	
Description	Swivel bases				Spirit level for aligning accelerometers in order to retain coordinate system	
Maximum Dimensions					85 × 23 × 17 mm (3.3 × 0.9 × 0.6″)	
Weight	5 g (0.18 oz)		0.8 g (0.03 oz)			
Temperature Range	–54° to +50°C (–65° to +122°F) For brief use, <1 hour: –54° to +80°C (–65° to +176°F)					
Maximum Acceleration	10 g peak Perpendicular to mounting surface: 70 g peak					
Material	Glass reinforced polycarbonate				Black anodised aluminium	
Upper Limiting Frequency, 10%	with Type 4506-B	Mounted with grease: Excited along one of the accelerometer's axes of sensitivity and with mounting surface of hemi-spherical part at 45° to excitation direction: 1 kHz	with Type 4524	Mounted with grease: Excited along one of the accelerometer's axes of sensitivity and with mounting surface of hemi-spherical part at 45° to excitation direction: x: 2.5 kHz y and z: 1.9 kHz	–	–
	with Type 4506-B-003	Mounted with grease: Excited along one of the accelerometer's axes of sensitivity and with mounting surface of hemi-spherical part at 45° to excitation direction: 0.8 kHz	with Type 4507	Mounted with grease: Excited along one of the accelerometer's axes of sensitivity and with mounting surface of hemi-spherical part at 45° to excitation direction: 2.3 kHz	–	–
	–	–	with Type 4508	Mounted with grease: Excited along one of the accelerometer's axes of sensitivity and with mounting surface of hemi-spherical part at 45° to excitation direction: 1.7 kHz	–	–

	UA-1564	UA-1563
Description	High-temperature mounting clips	
Temperature Range	–55° to +175°C (–67° to +347°F) If discolouring is acceptable: up to +250°C (+482°F)	
Maximum Acceleration (5 gram accelerometer)	50 g peak Perpendicular to mounting surface: 250 g peak	10 g peak Perpendicular to mounting surface: 50 g peak
Material **Base Spring**	Anodised aluminium Stainless steel spring	
Weight	5.7 g (0.20 oz)	11 g (0.38 oz)
Mounting Thread	10–32 UNF	

	DV-0459	DV-0460
Description	Calibration clip for mounting accelerometers during calibration	
Mounting Surface Diameter	21 mm (0.83″)	29 mm (1.14″)
Mounting Thread	10–32 UNF	10–32 UNF
Weight	17 g (0.59 oz)	44 g (1.55 oz)
Base Material	Hardened stainless steel	Hardened stainless steel
Spring Material	Stainless steel	Stainless steel

Example of an accelerometer mounted on Calibration Exciter Type 4294 using a calibration clip

	UA-1417	UA-1418
Description	Set of 25 dummy accelerometers	
Used with	Big clips	Small clips

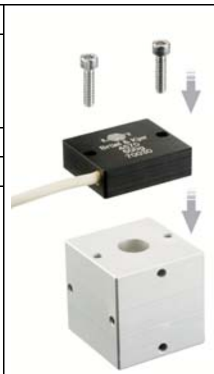
Mounting Blocks and Brackets

For specific applications, such as hand-arm and whole body vibration, or with relation to specific designs, Brüel & Kjær offers a range of blocks and brackets developed with customers to ease mounting or dismounting and obtain the best possible measurement results. The products shown are just some of the solutions developed over the years. So if your need is not addressed please ask our sales personnel for other available options.

	UA-2083
Description	Adaptor for Clip mounting of DC Response Accelerometers (Type 4571 – 5 series) Includes 5 thin mounting clips
Material	Black anodised aluminium
Mounting Surface	26 × 15 mm (1 × 0.5″)
Tapped Holes	2 × 4–40 UNC

Mounting an accelerometer

	UA-2079
Description	Triaxial Mounting Block for DC Response Accelerometers (Type 4571 – 5 series) The adaptor includes a 10–32 UNF mounting stud and 4–40 UNC screws (25 pcs)
Material	Clear anodised aluminium
Mounting Surface	26 × 26 mm (1 × 1″)
Mounting Provision	10–32 UNF stud, 6–32 UNF, M4 screw, Adhesive



Mounting an accelerometer

	UA-3014
Description	High-temperature mounting block (cooling unit) This water cooled unit is specifically designed for use on high-temperature surfaces up to 600 ºC (1112ºF), such as exhaust manifold including lambda probe position. The cooling water is suspended above the unit and led through the hose by gravity (pumps or similar vibration generating devices are not recommended)
Compatible with	Type 4326-A-001 Can be used at reduced temperatures with Types 4505-A and 4326-A
Includes	1 m hoses (5.5 mm (0.2″) outer Ø) (2 pcs) M2 × 10 screws (6 pcs)
Material	Stainless steel, AISI 304
Weight	<32 g (1.12 oz)

Blocks and Brackets for Human Vibration

The following accessories are specifically designed to enable mounting of a transducer for quick and easy hand-arm and/or whole body vibration analysis.

	UA-3015	UA-3016	UA-3017
Description	Hand Adaptor (T-shaped) The hand adaptor is designed to be hand fixed between two fingers and the grip surface. Mounting and dismounting are easily done by using the clip principle.	Handle Adaptor (L-shaped) The handle adaptor is placed on a tool grip/handle and accommodates accelerometers for clip mounting. The handle adaptor is specifically recommended for percussive tools with high g-levels.	Direct Mounting Adaptor This block features accelerometer clip mounting and is fastened to the test object by use of strips. This makes for very versatile mounting options, including steering wheels, handles, pipes, etc.
Compatible with	Types 4520-002, 4524-B, 4507-B-001 and 4508-B-001	Types 4520-002, 4524-B, 4507-B-001 and 4508-B-001	Types 4520-002, 4524-B, 4507-B-001 and 4508-B-001
Performance	Useful Frequency Range: 0 to >5000 Hz	Useful Frequency Range: 0 to >5000 Hz	Useful Frequency Range: 0 to >5000 Hz
	Max. Acceleration: 2500 m/s^2 (~25 g)	Max. Acceleration: 2500 m/s^2 (~250 g)	Max. Acceleration: 2500 m/s^2 (~250 g)
Standards	ISO 8041, ISO 5349	ISO 8041, ISO 5349	ISO 8041, ISO 5349
Material	Anodized aluminium	Anodized aluminium	Anodized aluminium
Weight	15 g (0.5 oz)	30 g (1 oz)	12 gram (0.4 oz)

	Type 4392	Type 4447
Description	Hand-arm Transducer Set The Hand-arm Transducer Set includes hand and handle adaptors designed for the included Accelerometer Type 4374. The accelerometer has a very wide frequency and dynamic range enabling both low level vibration and/ or high percussive vibration. See Type 4392's product data for additional information (BP 0582)	Human Vibration Analyzer A complete portable system for acquisition, measurement and evaluation of human vibration and comfort, and includes a range of adaptors for sensor mounting and appropriate accelerometers. See Type 4447's product data for additional information (BP 2147)
Uses	Hand-arm vibration measurements (2 to 1250 Hz)	• Hand-arm vibration measurements (2 to 1250 Hz) • Whole-body vibration measurements (1 to 80 Hz) • Low-frequency, whole-body vibration measurements down to 0.4 Hz • Linear mode (0.4 to 1250 Hz) for calibration
Standards	ISO 5349	• ISO 8041.2005 Technical specification • ISO 5349.2: 2001 Hand-arm • ISO 2631.1: 1997 Whole-body • EN 1032.2003: Mechanical vibration • EU Directive 2002/44/EC

Other Accessories

Studs

Thread	Type No.	Description
10–32 UNF	UA-2063	Set of 10 pieces, fully threaded 10–32 UNF steel stud, length 7.9 mm (0.31″); see Fig. 1
	UA-2064	Set of 10 pieces, double end threaded 10–32 UNF steel stud, with flange, length 5.3 mm (0.21″); see Fig. 2
1/4″–28 UNF	UA-2068	Set of 10 pieces, fully threaded 1/4–28 UNF, length 9.7 mm (0.38″); see Fig. 3
	UA-2056	Set of 10 pieces, fully threaded 1/4–28 UNF with flange, length 8.7 mm (0.34″); see Fig. 4
3/8″–16 UNF	UA-2061	Set of 10 pieces, fully threaded 3/8–16 UNF, length 12.7 mm (0.5″); see Fig. 5
M3	UA-2065	Set of 10 pieces, fully threaded M3 steel studs, length 5.0 mm (0.2″); see Fig. 6
	UA-1221	Set of 10 pieces, double end threaded M3 steel studs, with flange, length 3.5 mm (0.13″); see Fig. 7

Insulated Studs

Thread	Type No.	Description
10–32 UNF	YP-0150	Insulated fully threaded stud, length 13 mm (0.5″); see Fig. 8
10–32 UNF	UA-1192	Set of 10 insulated studs, double-end threaded with flange, length 10 mm (0.4″), 200°C/392°F; see Fig. 9
10–32 UNF	UA-1444	Set of 10 insulated studs, thread with flange, length 2.1 mm (0.08″); 120°C/ 248°F see Fig. 10
M 3	UA-1193	Set of 10 insulated studs, double-end threaded with flange, length 5.4 mm (0.2″), 200°C/392°F; see Fig. 11

Cement Studs

Thread	Type No.	Description
10–32 UNF	UA-0866	Set of 25 cement studs; ∅ 14 mm (0.55″); see Fig. 12
M 3	UA-0867	Set of 25 cement studs; ∅ 8 mm (0.3″); see Fig. 13

Mechanical Filters

Thread	Type No.	Description
10–32 UNF stud/ hole	UA-0553	Set of 5 mechanical filters Temperature range: –50 ºC to +100ºC (– 58ºF to +212ºF) Material: Stainless steel AISI 303, Butyl rubber See Fig. 14
M3 stud/hole	WA-0224	Mechanical filter; see Fig. 15

Magnets

Thread	Type No.	Description
10–32 UNF	UA-0643	Set of 5 mounting magnet and 2 insulating discs, diameter 24 mm (0.9″), stud length 3.1 mm (0.1″); see Fig. 16
M 3	UA-1075	Set of 5 mounting magnet and 2 insulating discs, diameter 10 mm (0.3″), stud length 1.6 mm (0.06″), glue the disc on non-magnetic structure; see Fig. 17
1/4″– 28 to 10 – 32	UA-1281	Mounting Magnet; see Fig. 18

Adaptors

Thread	Type No.	Description
10–32 UNF to M3	DB-1425	Berylco adaptor, M3 internal threaded; see Fig. 20
1/4″–28 to 10–32 UNF	UA-2062	Set of 10 mounting studs with flange; see Fig. 21
	UA-2052	Set of 10 stud adaptors; see Fig. 22
	UA-2054	Set of 20 bushing adaptors; see Fig. 23
10–32 UNF to M6	WA-1668	Stainless steel adaptor, M6 internal threaded; see Fig. 23
10–32 UNF to M8	WA-1667	Stainless steel adaptor, M8 internal threaded; see Fig. 24
10–32 UNF to M10	WA-1666	Stainless steel adaptor, M10 internal threaded; see Fig. 25
10–32 UNF to M12	WA-1665	Stainless steel adaptor, M12 internal threaded; see Fig. 26
Flat to M3	UA-2219	Anodised aluminium adaptor, used to mount M3 threaded accelerometers to mounting clip, see Fig. 27

Nuts

Thread	Type No.	Description
10–32 UNF	UA-2066	Set of 20 nuts
M3	UA-2067	Set of 20 nuts

Adhesives

Used With	Type No.	Description
General purpose accelerometers	YJ-0216	Beeswax for mounting
General purpose accelerometers	QS-0007	Tube of cyanoacrylate adhesive
	QS-0003	Loctite 222 threadlocker, purple, low strength, 10 ml (0.34 oz)
	EL-2019 EL-2330	HBM-X-60 Bonds
Types 4374, 4375, 4393, 4394, 4397-A	YO-0073	25 × Double adhesive mounting disc; Diameter: 5 mm (0.2″)
	DU-0079	1 × Double adhesive mounting disc; Diameter: 40 mm (1.6″)

O-ring

Used With	Type No.	Description
Accelerometers with 10–32 UNF connector	UA-2222	Ø3.10 mm × Ø1.60 mm Black, SIL 50
Accelerometers with M3 connector	UA-2221	Ø2.25 mm × Ø0.65 mm Black, NBR 70
Accelerometers with 1/4″–28 UNF connector (Triaxial)	UA-2220	Ø5.00 mm × Ø1.00 mm Black, FPM 75

Screws

Thread	Type No.	Description
M2 × 10 mm	YQ-8941	Steel screw, hex socket head cap, DIN 912 Used with Types 4326-A, 4326-A-001, 4326-001
M4 × 16 mm	YQ-0093	Steel screw, hex socket head cap, DIN 912 Used with Types 4321, 4321-V
M4 × 22 mm	YS-9901	Stainless steel screw with hole for thread fastening Used with Type 4511-001
M4 × 15 mm partially threaded	YS-0449	Screw, socket head cap, titanium for tool 3.0 mm hex Used with Type 4523
M4 × 12 mm	YS-8406	Screw, with lock wire holes, hex socket head cap, stainless steel Used with Type 8347-C
2–56 UNF	UA-2055	Set of 10 mounting screws, length 9.5 mm 0.37″) Used with Types 4521, 4521-C
4–40 in	UA-2080	Set of 25 head cap screws, length 11 mm (0.42″) with washer Used with Types 4570, 4571, 4572, 4573, 4574, 4575
M2 × 10 mm	UA-2069	Set of 10 mounting screws, length 10 mm (0.39″)
	YK-1110	Screw, pan head, Pozidriv® DIN 7985 A, stainless steel
M2 × 4 mm	YS-0290	Screw, special PH, black
M2.5 × 6 mm	YK-2206	Screw, flat head, Pozidriv DIN 965 A, stainless steel
M3 × 5 mm	YQ-2003	Screw, hex socket set with cup point, DIN 916, steel
M3 × 8 mm	YQ-2007	Screw, hex socket set with cup point, DIN 916, steel
M4 × 10 mm	YK-1410	Screw, pan head, Pozidriv DIN 7985 A, stainless steel
M4	YS-0045	Finger screw
M5 × 10 mm	YQ-9209	Screw, hex socket low head cap, DIN 6912 steel
M5 × 16 mm	YQ-9215	Screw, hex socket head cap, DIN 912, stainless steel
M5	YS-0810	Inset screw
1/4″–28	UA-2053	Set of 10 mounting screws, length 28.6 mm (1.13″)
1/6″ × 9.0 mm	YS-0067	Screw, special contact B&K type, gold plated
10–32 UNF × 1/2″ (12.8 mm)	YQ-2960	Screw socket set screw, flat end, steel
10–32 UNF × 5/16″ (7.7 mm)	YQ-2962	Screw socket set screw, flat end, steel
10–32 UNF × 3/8″	YQ-8168	Screw hex socket countersunk, flat head, black steel
10–32 UNF	YS-0811	Inset screw

Impact Tips and Caps

Used with	Type No.	Description
Type 8207	UA-2057	Set of four impact tips
Type 8208	UA-2058	Set of four impact tips
Types 8206, 8206-001, 8206-002, 8206-003	UA-2059	Set of three impact tips
Type 8210	UA-2060	Set of four impact tips
Types 8230 , 8230-001, 8230-002, 8230-003, 8230-C-003	DB-3989	Impact cap with 1/4″–28 UNF threaded stud, stainless steel

Probes

Type No.	Description
YP-0080	Probe with sharp tip, 10–32 UNF; Test pin
DB-0544	Probe with round tip

Tools

Type No.	Description
QA-0029	Tap for 10–32 UNF thread
QA-0231	Tap for 2–56 UNF thread
QA-0041	Tap for M3 thread
QA-0068	Tap for M5 thread
QA-0141	Tap for M8 thread
QA-0013	Hexagonal key for 10–32 UNF studs
QA-0042	Hexagonal key for M3 studs
QA-0038	Hexagonal key for M4 studs
QA-0121	Hexagonal key for M8 studs
QA-0220	Cable connecting/removal tool
QA-0230	Removal wrench for teardrop type accelerometers

Accessory Sets

Type No.	Description	Used With
UA-0078	1 × Probe with round tip, 10–32 UNF 1 × Cementing Stud 10–32 UNF; Ø14 mm (0.55″) 1 × Plug Adaptor 10–32 UNF to TNC 1 × Hexagonal Key for 10–32 UNF studs 1 × Tap for 10–32 UNF thread 1 × Mounting Magnet and two Insulating Discs 1 × Beeswax for mounting 1 × Steel Nut 10–32 UNF 1 × Insulating Mica Washer 1 × Probe with sharp tip 1 × Insulated Stud 10–32 UNF; Length: 12.7 mm (0.5″) 4 × Steel Stud 0–32 UNF thread; Length: 12.7 mm (0.5″)	4370, 4371 4381, 4382 4383, 4384
UA-0125	1 × Hexagonal Key for 10–32 UNF studs 1 × Tap for 10–32 UNF thread 10 × Steel Nut 10–32 UNF 10 × Insulating Mica Washer 10 × Insulated Stud 10–32 UNF; Length: 12.7 mm (0.5″) 10 × Steel Stud 0–32 UNF thread; Length: 12.7 mm (0.5″)	General purpose accelerome-ters
UA-0146	1 × Cementing Stud 10–32 UNF; Ø14 mm (0.55″) 3 × Plug Adaptor 10–32 UNF to TNC 1 × Hexagonal Key for 10–32 UNF studs 1 × Tap for 10–32 UNF thread 1 × Hexagonal Key for M 4 screws 1 × Beeswax for mounting 1 × Steel Nut 10–32 UNF 3 × Insulating Mica Washer 1 × Insulated Stud 10–32 UNF; Length: 12.7 mm (0.5″) 11 × Steel Screw M4 thread; Length: 16 mm (0.6″) 5 × Steel Stud 0–32 UNF thread; Length: 12.7 mm (0.5″)	4321
UA-0629	2 × Cement Stud, M3, Ø 8.0 mm (0.3″) 3 × Extension Connector for cables, 10–32 UNF to 10–32 UNF 1 × Plug Adaptor 10–32 UNF to TNC 1 × Tap for M3 thread 1 × Hexagonal Key for M 3 studs 1 × Tube of Cyanoacrylate Adhesive 1 × Mounting Magnet M3 thread and two Insulating Discs 1 × Beeswax for mounting 1 × M3 Nut 1 × Adhesive Mounting Disc 3 × M3 Steel Stud; Length: 5 mm (0.1″) 2 × M3 threaded Steel Stud; Length: 8 mm (0.3″)	4375, 4393

Type No.	Description	Used With
UA-0844	1 × Cementing Stud 10–32 UNF; Ø14 mm (0.55″) 1 × Hexagonal Key for 10–32 UNF studs 1 × Tap for 10–32 UNF thread 1 × Mounting Magnet and two Insulating Discs 3× Steel Stud 0–32 UNF thread; Length: 12.7 mm (0.5″)	4391
UA-1079	3 × Extension Connector for cables, 10–32 UNF to 10–32 UNF 1 × Plug Adaptor 10–32 UNF to TNC 1 × Tube of Cyanoacrylate Adhesive 1 × Beeswax for mounting 1 × Adhesive Mounting Disc	4374
UA-1218	3 × Extension Connector for cables, 10–32 UNF to 10–32 UNF 1 × Plug Adaptor, BNC to 10–32 UNF 1 × Tap for M3 thread 1 × Hexagonal Key for M 3 studs 1 × Tube of Cyanoacrylate Adhesive 1 × Beeswax for mounting 1 × Adhesive Mounting Disc	4394, 4397

UA-2063

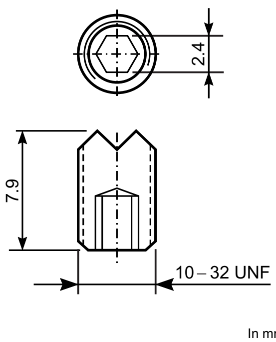


Fig. 1

UA-2064

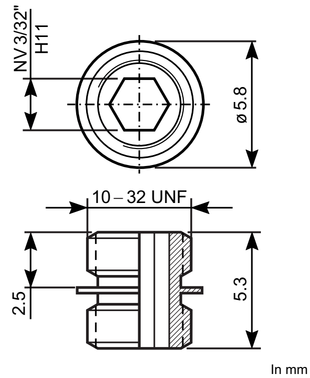


Fig. 2

UA-2068

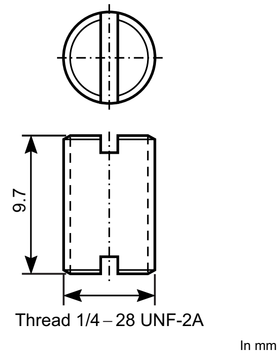


Fig. 3

UA-2056

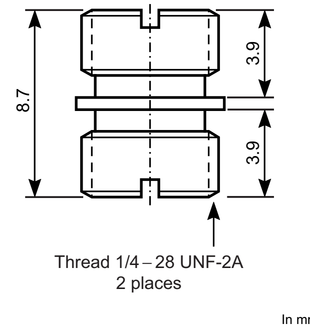


Fig. 4

UA-2061

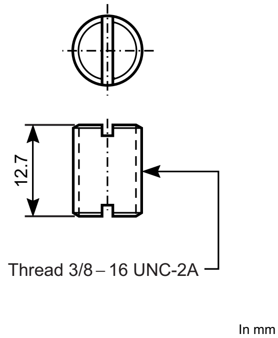


Fig. 5

UA-2065

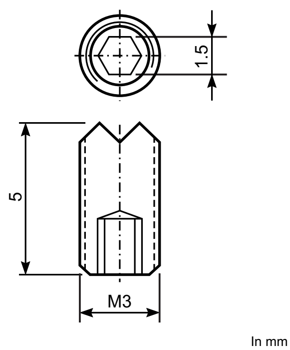


Fig. 6

UA-1221

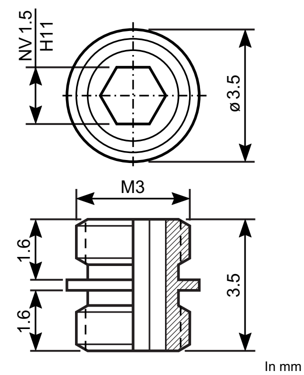


Fig. 7

YP-0150

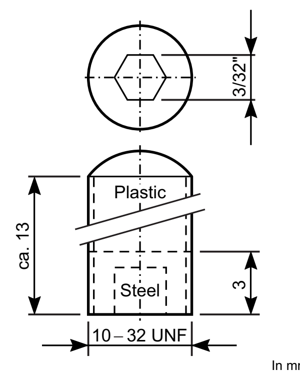


Fig. 8

UA-1192

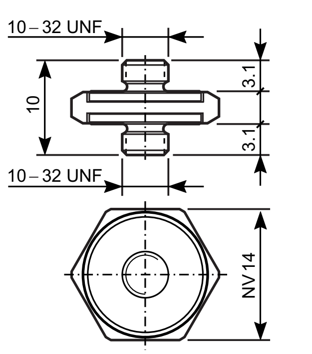


Fig. 9

UA-1444

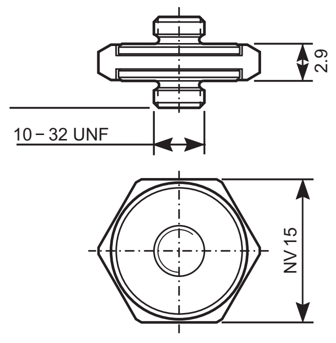


Fig. 10

UA-1193

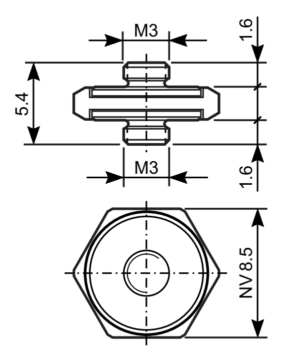


Fig. 11

UA-0866

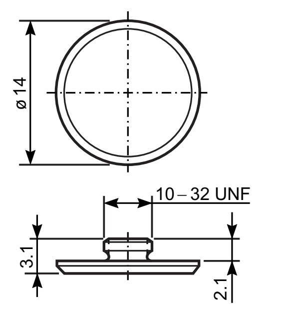


Fig. 12

UA-0867

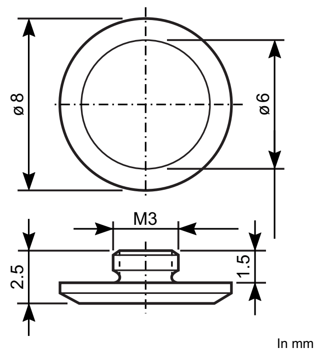


Fig. 13

UA-0553

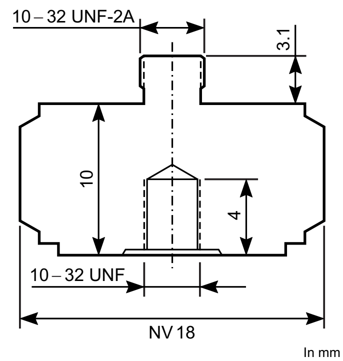


Fig. 14

WA-0224

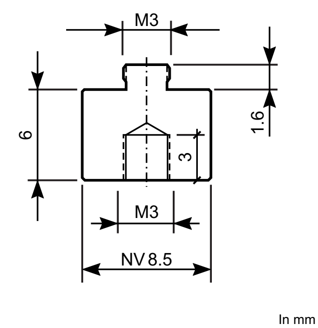


Fig. 15

UA-0643

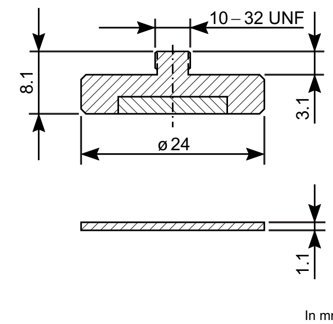


Fig. 16

UA-1075

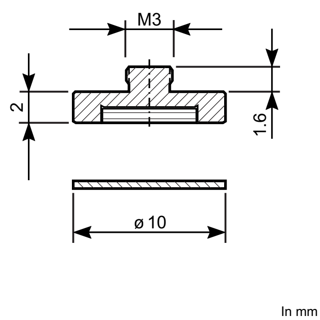


Fig. 17

UA-1281

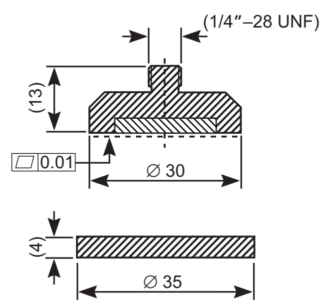


Fig. 18

DB-1425

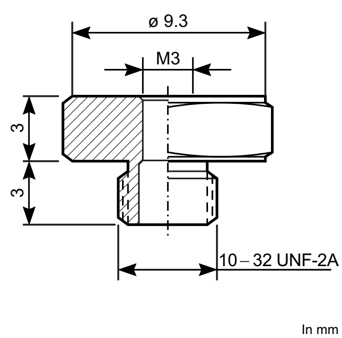


Fig. 19

UA-2062

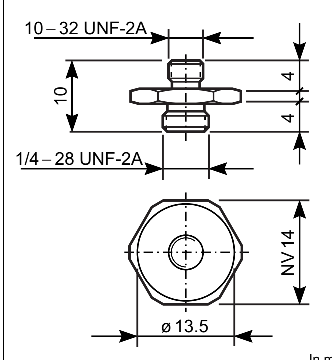


Fig. 20

UA-2052

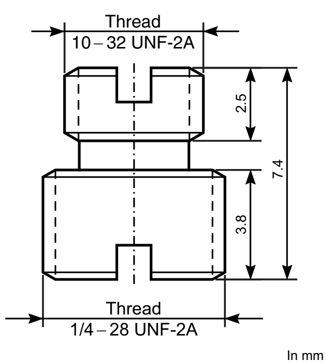


Fig. 21

UA-2054

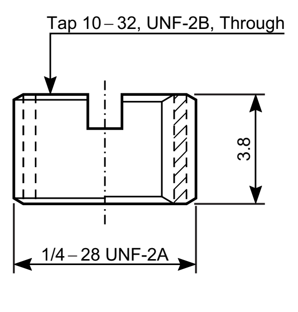


Fig. 22

WA-1668

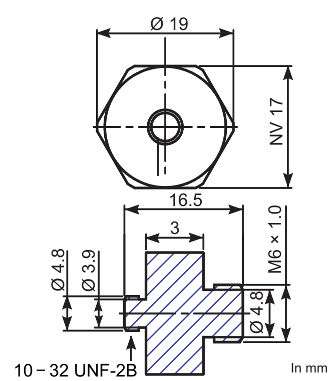


Fig. 23

WA-1667

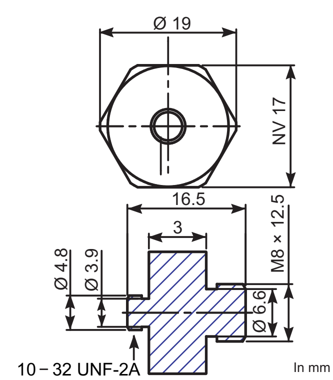


Fig. 24

WA-1666

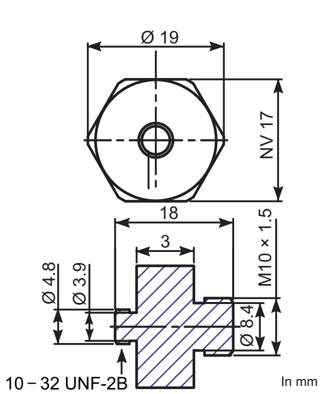


Fig. 25

WA-1665

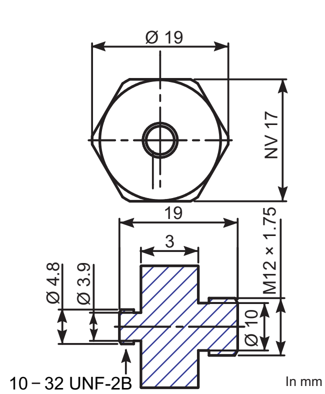


Fig. 26

UA-2219

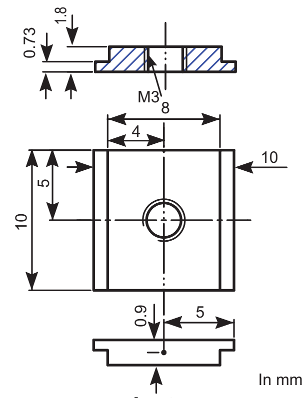


Fig. 27

Brüel & Kjær Cables

A combination of measurement requirements, physical limitations, and environmental conditions usually determines the best choice of cable type. Brüel & Kjær provides a wide variety of high-quality cables and adaptors to ensure optimal electrical connections throughout the measurement setup.

Most cables employ a combination of a PTFE* insulator and PFA† jacket, providing advantageous properties such as low coefficient of friction, mechanical strength, excellent dielectric insulation, wide temperature range, low gas permeability, and chemical and flame resistance.

The Super Low Noise (SLN) and Low Noise (LN) cables feature Brüel & Kjær's proprietary and unique noise treatment, which has set the industry standard for cables used with charge sensors (high-impedance) to avoid triboelectric noise. The low-cost cables cover flexible industry standard coaxial cables only recommended for sensors with integrated electronics.

In addition to the standard cable lengths, which are available from stock for immediate shipment, Brüel & Kjær offers cables with custom cable lengths. Please consult your local representative for further information.

AO-XXXX-Y-ZZZ where:
- **AO-XXXX** is the basic cable type
- **Y** is length units in D (decimetre 0.1 m) or M (metre)
- **ZZZ** is the length value

Maximum Cable Length (CCLD)

The maximum output voltage of a CCLD accelerometer when driving long cables depends on the supply current at which it is operating, and on the capacitive load due to the connecting cable.

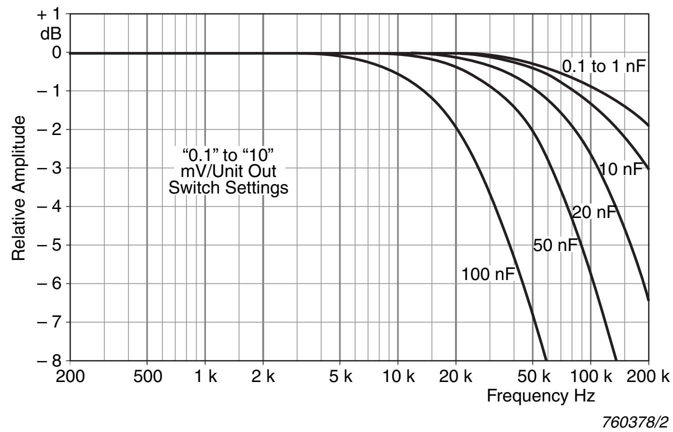
The maximum cable length in metres (for distortion ≤1%) is given by:

$$L = 140\,000 \times \frac{I_s - 1}{f \times V_o \times C_m}$$

where:
I_s = supply current (mA)
f = frequency (kHz)
V_o = output voltage (V_{peak})
C_m = cable capacitance (pF/m)

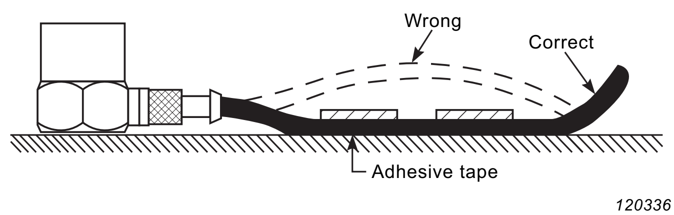
Maximum Cable Length (Charge)

- The figure below shows the influence of the input load capacitance on the high frequency response of a Brüel & Kjær charge amplifier.



How to Use Cables

When measuring low level vibrations where it appears in the form of noise:
- Use special coaxial cables with a noise reduction treatment. This is a standard feature of all accelerometer cables supplied by Brüel & Kjær
- Avoid sharp bending cable or twist cable because this will not only reduce the noise reduction treatment but also damage the connectors
- The cable should be clamped to the test specimen to avoid relative movement which causes triboelectric noise



How to handle very strong electromagnetic field causing extraneous noise in the measurement signal:
- Carefully route the cable away from sources of high electromagnetic fields
- Use a balanced accelerometer such as Types 8315 and 8347-C and special cable

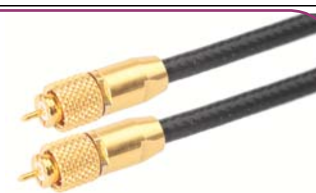
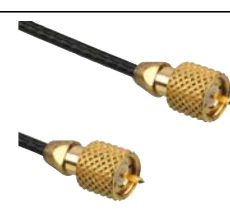
Bending Radius – Rule of Thumb

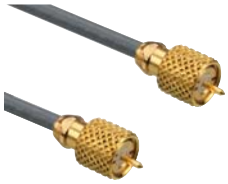
- Softline cable: 10 times the outer diameter of the jacket
- Hardline cable: 5 times the outer diameter of the jacket

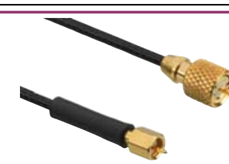
* Polytetrafluoroethylene
† Perfluoroalkoxy

Coaxial Cable Assemblies for Uniaxial Accelerometers

Our most popular cables are highlighted. These offer the best delivery times and prices.

Connector A	Connector B	Temperature	Type No.	Description	
10–32 UNF Male	10–32 UNF Male	–75 to +250°C –103 to +482°F	AO-0038	Super low-noise coaxial cable All-round use Raw cable: AC-0005 Recommended for all transducers	
10–32 UNF Male Straight	10–32 UNF Male Right angle	–75 to +250°C –103 to +482°F	AO-0741	AO-0038 with right-angle connector at one end Super low-noise coaxial cable Raw cable: AC-0005 Recommended for all transducers	
10–32 UNF Male	10–32 UNF Male	–40 to +120°C –40 to +248°F	AO-0687	AO-0038 with extensive molded connector relief All round use, especially suitable for rough handling Raw cable: AC-0005 Recommended for all transducers	
10–32 UNF Male	10–32 UNF Male	–40 to +100°C –40 to +212°F	AO-0692	Rated IP67 Super low-noise, coaxial cable Raw cable: AC-0005 Recommended for temporary underwater submersion	
10–32 UNF Male	10–32 UNF Male	–75 to +250°C –103 to +482°F	AO-0122	Robust cable Double-screened Raw cable: AC-0200 Recommended for harsh environments and rough handling	
10–32 UNF Male	10–32 UNF Male	–75 to +135°C –103 to +275°F	AO-0755	Robust cable with extensive relief at connectors Double-screened Raw cable: AC-0200 Recommended for harsh environments and rough handling	
10–32 UNF Male	10–32 UNF Male	–50 to +250°C –58 to +482°F	AO-1382	Low-noise coaxial cable, double-screened Light and flexible Raw cable: AC-0104 Recommended for flexibility	

Connector A	Connector B	Temperature	Type No.	Description	
10–32 UNF Male	10–32 UNF Male	–75 to +250°C –103 to +482°F	AO-1419	Low-noise coaxial cable, single-screened Very light and flexible Raw cable: AC-0066 Recommended for miniature transducers	
10–32 UNF Male	10–32 UNF Male	–20 to +70°C –4 to +158°F	AO-0463	Low-cost coaxial cable Single-screened Raw cable: AC-0208 **Not** recommended for charge transducers	
10–32 UNF Male	10–32 UNF Male	–65 to +150°C –85 to +302°F	AO-0704	White With low out-gassing properties Low-noise coaxial cable Raw cable: AC-0195 Recommended for high vacuum environments	
10–32 UNF Male	BNC Male	–55 to +250°C –58 to +482°F	AO-0406	Light and flexible double-screened Raw cable: AC-0104 Includes JP-0145 (10–32 to BNC plug adaptor)	
10–32 UNF Male	BNC Male	–20 to +70°C –4 to +158°F	AO-0531	Low-cost coaxial cable Single-screened Raw cable: AC-0208 **Not** recommended for charge transducers	

Connector A	Connector B	Temperature	Type No.	Description	
10–32 UNF Male	SMB Female	–75 to +250°C –103 to +482°F SMB end: Max 135°C (275°F)	AO-0699	Super low-noise Single-screened coaxial cable Raw cable: AC-0005 Recommended for all round use	
10–32 UNF Male	SMB Female	–20 to +70°C –4 to +158°F	AO-0691	Low-cost coaxial cable Single-screened Raw cable: AC-0208 **Not** recommended for charge transducers	
10–32 UNF Male	TNC Male	–75 to +250°C –103 to +482°F TNC end: Max. 120°C (248°F)	AO-0231	Super low-noise coaxial cable Single-screened Raw cable: AC-0005 Recommended for all-round use	
10–32 UNF Male	Open end	–75 to +250°C –103 to +482°F	AO-0482	Low-noise coaxial cable Extremely lightweight and flexible Single-screened Raw cable: AC-0066 Recommended for all-round use	
10–32 UNF Male	Circular-00 2-pin Male	–75 to +250°C –103 to +482°F Circular-00 2-pin end: Max. 90°C (194°F)	AO-0695	Super low-noise coaxial cable Raw cable: AC-0005 Recommended for all accelerometers to connect with Human Vibration Analyzer Type 4447	
M3 Male	10–32 UNF Male	–75 to +250°C –103 to +482°F	AO-0283	Super low-noise coaxial cable Single-screened Raw cable: AC-0205 Recommended for all-round use for accelerometers with M3 connectors	
M3 Male	10–32 UNF Male	–75 to +250°C –103 to +482°F	AO-0339	Extremely lightweight and flexible Low-noise coaxial cable, single-screened Raw cable: AC-0066 Recommended for all-round use for accelerometers with M3 connectors	
M3 Male	10–32 UNF Male	–50 to +250°C –58 to +482°F	AO-1381	Low-noise coaxial cable Flexible double-screened Raw cable: AC-0104 Recommended for Types 4394,4397, 4518, 4519, 4521	

Connector A	Connector B	Temperature	Type No.	Description	
M 3 Male	10–32 UNF Male	–65 to +150°C –85 to +302°F	AO-0703	White With low out-gassing properties Super low-noise coaxial cable Raw cable: AC-0195 Recommended for high vacuum environments	
M3 Male	BNC Male	–75 to +250°C –103 to +482°F BNC end: Max. 120°C (248°F)	AO-0641	Low-cost coaxial cable **Not** recommended for charge transducers Raw cable: AC-0205 Recommended for Types 4518, 4519, 4397, 4394, 4521	
M3 Male	SMB Female	–75 to +250°C –103 to +482°F SMB end: Max. 135°C (275°F)	AO-0698	Super low-noise Single-screened coaxial cable Raw cable: AC-0205 Recommended for Types 4518, 4519, 4397, 4394, 4521	
3–56 UNF Male	10–32 UNF Female	–30 to +200°C –22 to +392°F	AO-0638	Low-noise coaxial cable Light and flexible Recommended for miniature transducers (Type 4517 family) with 3–56 UNF threaded connector	
3-pin MIL-C-5015 Female	Open end	–75 to +250°C –103 to +482°F	AO-0642	3-wire (twisted) shielded cable Electrically and environmentally robust Raw cable: AC-0294 Durable for permanent installations Recommended for Type 4511-001	
Circular-1B Female	Circular-0B Male	–20 to +80°C –4 to +176°F	AO-0700	For DC response transducers with 7-pin circular LEMO connector PUR jacket Recommended for Types 457X-001 and 457X-D-001 and differential amplifier Type 2697	
Circular-1B Female	Circular-1B Male	–20 to +80°C –4 to +176°F	AO-0414	Extension cable for DC response transducers with 7-pin circular LEMO connector PUR jacket Recommended for Types 457X-001 and 457X-D-001 and differential amplifier Type 2697	
Series 800 3-pin Female	BNC Male	–75 to +150°C –103 to +302°F BNC end: max 135°C (275°F)	AO-0746	Robust cable for permanent installation Raw cable: AC-0294 Recommended for Type 4511-006	

Coaxial Cable Assemblies for Triaxial Accelerometers

Our most popular cables are highlighted. These offer the best delivery times and prices.

Connector A	Connector B	Temperature	Type No.	Description	
Circular 4-pin Female	3 × 10–32 UNF Male	–75 to +90°C –103 to +194°F Splitter*: –40 to +150°C –40 to +302°F	AO-0527	Single-screened coaxial cable with four wires PUR jacket Raw cable: AC-0220/AC-0005 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
Circular 4-pin Female	3 × 10–32 UNF Male	–75 to +250°C –103 to +482°F Splitter*: –40 to +150°C –40 to +302°F	AO-0740	Single-screened coaxial cable with four wires Raw cable: AC-0223/AC-0005 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
Circular 4-pin Female	3 × BNC Male	–75 to +90°C –103 to +194°F Splitter*: –40 to +150°C –40 to +302°F	AO-0526	Single-screened coaxial cable with four wires Raw cable: AC-0220/AC-0005 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
Circular 4-pin Female	3 × BNC Male	–75 to +250°C –103 to +482°F Splitter*: –40 to +150°C –40 to +302°F	AO-0534	Single-screened coaxial cable with four wires Raw cable: AC-0223/AC-0005 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
Circular 4-pin Female	3 × SMB Female	–75 to +90°C –103 to +194°F SMB end: Min. –20°C (–4°F), max. +70°C (158°F) Splitter*: –40 to +150°C –40 to +302°F	AO-0690	Single-screened coaxial cable with four wires Raw cable: AC-0220/AC-0208 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
Circular 4-pin Female	Circular 4-pin Male	–75 to +250°C –103 to +482°F	AO-0714	Single-screened coaxial cable with four wires Raw cable: AC-0223 Recommended for high-temperature usage as an extension cable for Types 4527 and 4528	
Circular 4-pin Female	Circular 4-pin Female	–75 to +90°C –103 to +194°F	AO-0528	Single-screened coaxial cable with four wires Raw cable: AC-0220 Recommended for all Brüel & Kjær CCLD triaxial accelerometers as an extension cable	
Circular 4-pin Female	Circular-00 4-pin Male	–75 to +90°C –103 to +194° Circular-00 4-pin end: –40 to +80°C (–40 to +176°F)	AO-0693	Single-screened coaxial cable with four wires Raw cable: AC-0220 Recommended for all Brüel & Kjær CCLD triaxial accelerometers connecting to Human Vibration Analyzer Type 4447	

Connector A	Connector B	Temperature	Type No.	Description	
Circular 4-pin Female	Circular-00 3-pin Male	–20 to +90°C –4 to +194°F	AO-1454	Electrically and environmentally robust Durable for permanent installations Raw cable: AC-0220 Recommended for all Brüel & Kjær CCLD triaxial accelerometers connecting to Hand-held Analyzer Types 2250 and 2270	
Circular-00 4-pin Male	3 × 10–32 UNF Male	–75 to +90°C –103 to +194° Circular-00 4-pin end: –40 to +80°C (–40 to +176°F) Splitter*: –40 to +150°C –40 to +302°F	AO-0694	Single-screened coaxial cable with four wires Raw cable: AC-0220 Recommended for connecting accelerometers to Human Vibration Analyzer Type 4447	
3 × 10–32 UNF Male	3 × 10–32 UNF Male	–75 to +250°C –103 to +482°F Splitter*: –40 to +150°C –40 to +302°F	AO-0688	4-wire coaxial cable terminating in three single-wire coaxial cables at each end Raw cable: AC-0220/AC-0223 Recommended for all Brüel & Kjær CCLD triaxial accelerometers	
2 × Circular 4-pin Female	Sub-D 37-pin Female	–75 to +90°C –103 to +194°F	AO-0536	Single-screened coaxial cable with four wires for two triaxial accelerometers Raw cable: AC-0220 Recommended for all Brüel & Kjær CCLD triaxial accelerometers to PULSE multi-analyzer	
Serial-800 4-pin Female	3 × BNC Male	–75 to +250°C –103 to +482°F Splitter*: –40 to +150°C –40 to +302°F	AO-0745	Robust cable suitable for permanent monitoring Raw cable: AC-0294/AC-0005 Recommended for Brüel & Kjær triaxial industrial accelerometer Type 8345 family	
3 × 10–32 UNF Male	3 × BNC Male	–75 to +250°C –103 to +482°F Splitter*: –40 to +150°C –40 to +302°F	AO-0759	Low-noise cable Raw cable: AC-0223/AC-0005 Recommended for all transducers	

* Close-up of cable splitter:

Cable Assemblies for Industrial and Monitoring Applications

Connector A	Connector B	Temperature	Type No.	Description	
2-pin MIL-C-5015 Female	BNC Male	–40 to +150°C –40 to +302°F	AO-0608	Black coaxial cable, ETFE jacket 2 wires and double braided shielding Raw Cable: AC-0141 Recommended for harsh environments	
2-pin MIL-C-5015 Female	BNC Male	–40 to +150°C –40 to +302°F	AO-0616	Blue coaxial cable, ETFE jacket 2 wires and double braided shielding Raw Cable: AC-0194 Recommended for explosive area	
2-pin MIL-C-5015 Female	Open end	–40 to +150°C –40 to +302°F	AO-0612	Black coaxial cable, ETFE jacket 2 wires and double braided shielding Raw Cable: AC-0141 Recommended for harsh environments	
2-pin MIL-C-5015 Female	Open end	–40 to +150°C –40 to +302°F	AO-0623	Blue coaxial cable, ETFE jacket 2 wires and double braided shielding Raw Cable: AC-0194 Recommended for explosive area	
2-pin MIL-C-5015 Female	Triax-00 LEMO Male	–40 to +85°C –40 to +185°F	AO-0722	Black coaxial cable, PVC Raw cable: AC-0201 Recommended for harsh environment Connects to Hand-held Analyzer Type 2250/2270	
2-pin 7/16–27 UNS Female	2-pin 7/16–27 UNS Female	–55 to +250°C –67 to +482°F	AO-0250	Black coaxial cable 2 wires and double braided shielding Raw Cable: AC-0077 Recommended for harsh environments	
2-pin 7/16–27 UNS Female	Open end	–55 to +250°C –67 to +482°F	AO-0624	Blue coaxial cable 2 wires and double braided shielding Raw Cable: AC-0087 Recommended for explosive areas	
2-pin 7/16–27 UNS Female	3-pin MIL-26482 Male	–55 to +250°C –67 to +482°F	WL-1248	Black coaxial cable 2 wires and double braided shielding Raw Cable: AC-0077 Recommended for harsh environments	
2-pin 7/16–27 UNS Female	Open end	–55 to +250°C –67 to +482°F	AO-0757	Black coaxial cable 2 wires and double braided shielding Raw cable: AC-0077 Recommended for harsh environment	

Connector A	Connector B	Temperature	Type No.	Description	
3-pin MIL-26482 Male	Open end	−55 to +250°C −67 to +482°F	AO-0744	Black co-axial cable 2 wires and double braided shielding Raw cable: AC-0077 Recommended for harsh environments	
2-pin 7/16−27 UNS Male	TNC Male	−55 to +250°C −67 to +482°F	AO-0747	Black coaxial cable 2 wires and double braided shielding Raw Cable: AC-0077 Recommended for harsh environments	
2-pin 7/16−27 UNS Female	2-pin 7/16−27 UNS Male	−200 to +500°C −328 to +932°F Male end: Max. 250°C (482°F)	AO-0730	Hardline cable Single-shielded Raw Cable: AC-0202 Recommended for harsh environments	
2-pin 7/16−27 UNS Female	2-pin 7/16−27 UNS Female	−200 to +500°C −328 to +932°F	AO-0753	Hardline cable Single-shielded Raw Cable: AC-0202 Recommended for harsh environments	
2-pin 7/16−27 UNS Female	3-pin MIL-26482 Female	−200 to +500°C −328 to +932°F	AO-0729	Hardline cable Double-shielded Raw Cable: AC-0306 Recommended for harsh environments	

Cable Accessories

Accessory Sets

Type No.	Description
QA-0035	Tool set for assembly 10–32 UNF connector JP-0012 and JP-0056 on cables
QA-0220	Cable mounting tool to mount the cable with M3 connector and assemble on an accelerometer
UA-0130	25 × JP-0012 (Male) connector, 10–32 UNF Plug for cables with cable jacket diameter from 1 mm to 3 mm. Recommended for AC-0005, AC-0066, AC-0104, AC-0205 and AC-0208
UA-0730	25 × JP-0056 (Male), connector 10–32 UNF plug for cable with maximum cable jacket diameter 3 mm. Recommended for AC-0200
UA-1723	10 × JP-0196 (Male) 10–32 UNF Plug Stainless steel for cables with cable jacket diameter 1 mm to 2 mm. Recommended for AC-0005, AC-0066, AC-0104, AC-0205 and AC- 0208. Designed and manufactured for high vacuum environments
UA-1243	3 × 30 Pieces of 1/2/3 Cable Markers for cable jacket diameter 1.6 mm Recommended for AC-0205 and AC-0104
UA-1244	3 × 30 Pieces of Red/Green/Yellow Cable Markers for cable jacket diameter between 1.9 mm and 2.2 mm, –65 to +105°C Recommended for AC-0005 and AC-0208

Connectors

Connector Thread	Type No.	Description
10–32 UNF (Female) to 10–32 UNF (Female)	UA-0186	Set of 25 JJ-0032 extension connectors for cables
10–32 UNF (Female) to BNC (Male)	JP-0145	Plug adaptor
10–32 UNF (Female) to BNC (Female)	UA-0245	Adaptor
10–32 UNF (Female) to TNC (Male)	JP-0162	Plug adaptor
B&K 10–32 UNF (Male) to BNC (Female)	UA-1555	Adaptor
10–32 UNF (Female) to SMB (Female)	WA-1705	Plug adaptor
2-pin TNC (Female) to 10–32 UNF (Female)	JJ-0207	Plug adaptor
2-pin TNC (Male) to 10–32 UNF (Female)	WA-0214	Plug adaptor for AO-0250
Solder pin 10–32 UNF	JP-0192	Solder connector adaptor
BNC to BNC	JJ-0152	“T” connector, 1 male and 2 female connectors
TNC to TNC	JJ-0175	Extension Connector
B&K Coaxial to 10–32 UNF (Female)	JP-0028	Input adaptor
B&K Coaxial to BNC (Female)	JP-0144	Adaptor

Raw Cables

Illustrations of the individual cables follow – see the referenced figure number in the table.

Some of the more unfamiliar jacket materials used are explained here:

- **PTFE:** Insulation and sheathing material. Can be used for many high-temperature applications such as gas turbines, high-voltage applications and many aerospace applications including use in vacuum environment
- **PFA:** Insulation and sheathing material. Can be used for high-temperature industrial applications such as gas turbines. Low halogen
- **ETFE:** Insulation and sheathing material, chemically resistant, flame retardant, low smoke generation. Ideal for all round, general purpose use and radiation environment
- **FEP:** Good insulation material for cable jacket. It has excellent non-ageing characteristics and a broad useful temperature range
- **PE:** Insulation, dielectric (LDPE) or jacket material (HDPE). This material is light, tough, permanently flexible, has good resistance to chemicals, non-oxidising acids and aromatic solvents, a low moisture absorption and good tensile and tear strength
- **PVC:** Insulation or jacket material which exhibits the property of high electrical resistivity, good dielectric strength, excellent mechanical toughness, superior resistance against oxygen, ozone, most common acids, alkalis and chemicals. Flame resistance, oil resistance and the temperature range depend on the compound
- **PUR:** Extruded jacket. Exhibits extreme toughness and abrasion resistance

Raw Coaxial Cables for Piezoelectric and CCLD Accelerometers

Type No.	Description	Insulator/ Jacket	Screen	Number of Wires	Diameter		Max. Temp		Min. Temp		Capacitance pF/m	Impedance Ω
					mm	inches	°C	°F	°C	°F		
AC-0005 (Fig. 1)	Super low noise	PTFE/PFA	Single	1	2	0.08	+250	+482	–75	–103	106	60
AC-0066 (Fig. 2)	Low noise	PTFE/PFA	Single	1	1	0.04	+250	+482	–75	–103	106	50
AC-0104 (Fig. 3)	Low noise	PTFE/PFA	Double	1	1.6	0.06	+250	+482	–50	–58	100	50
AC-0195	Flexible low out-gassing, white	FEP/PTFE	Single	1	1.70	0.06	+150	+302	–65	–85		
AC-0200 (Fig. 4)	Super low noise	PTFE/PFA	Double	1	3.2	0.13	+250	+482	–75	–103	106	60
AC-0205 (Fig. 5)	Super low noise	PTFE/PFA	Single	1	1.5	0.06	+250	+482	–75	–103	110	50
AC-0208 (Fig. 6)	Flexible, grey	PE/PVC	Single	1	2	0.08	+70	+158	–20	–4	100	50
AC-0220 (Fig. 7)	Flexible	ETFE/PUR	Single	4	2.4	0.09	+90	+194	–75	–103	106	50
AC-0223 (Fig. 8)	Flexible	ETFE/PTFE	Single	4	2.1	0.09	+250	+482	–75	–103	106	50
AC-0080 (Fig. 9)	Spiral	PUR/PFA	Single	1	14	0.55	+85	+185	–40	–40	100	50

AC-0005

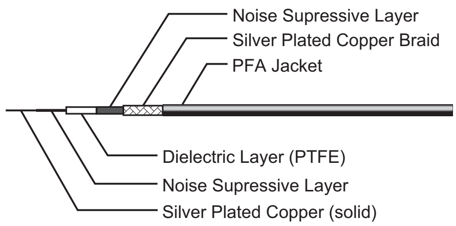


Fig. 1

AC-0066

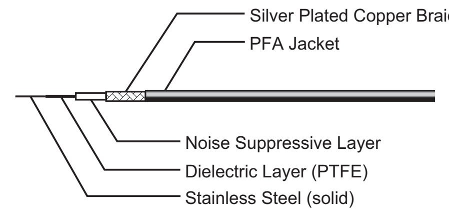


Fig. 2

AC-0104

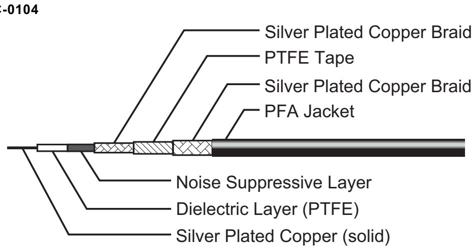


Fig. 3

AC-0200

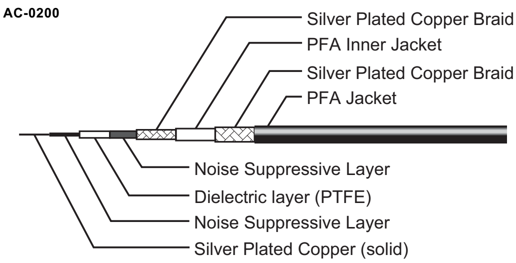


Fig. 4

AC-0205

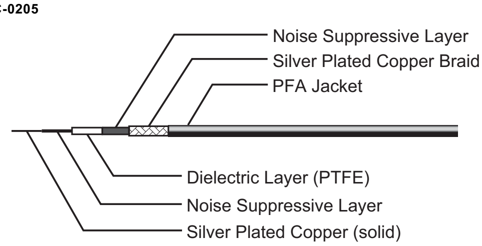


Fig. 5

AC-0208

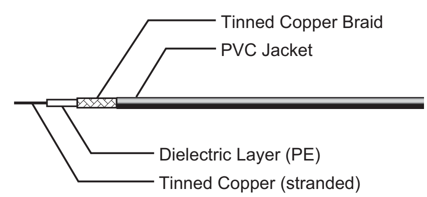


Fig. 6

AC-0220

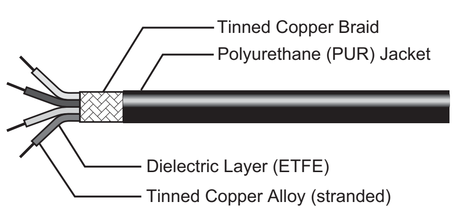


Fig. 7

AC-0223

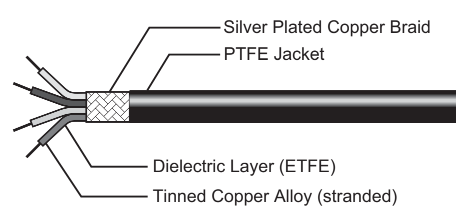


Fig. 8

AC-0080

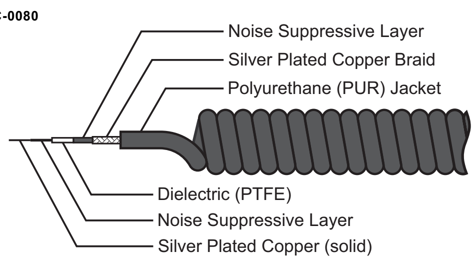


Fig. 9

Raw Cables for Conditioning Monitoring Accelerometers

Type No.	Description	Insulator/ Jacket	Screen	Number of Wires	Diameter		Max. Temp		Min. Temp		Capacitance pF/m	Impedance Ω
					mm	inches	°C	°F	°C	°F		
AC-0077 (Fig. 10)	For Charge types; Low noise	PTFE/PFA, Black	Double	2	6	0.24	+250	+482	–55	–67	106	50
AC-0087 (Fig. 11)	For Charge types; Low noise	PTFE/PFA, Blue	Double	2	6	0.24	+250	+482	–55	–67	105	50
AC-0141 (Fig. 12)	General purpose	ETFE, ETFE Black	Double	2	6	0.24	+125	+257	–40	–40	135	40
AC-0194 (Fig. 13)	General purpose	ETFE, ETFE Blue	Double	2	6	0.24	+125	+257	–40	–40	135	40
AC-0202 (Fig. 14)	Hardline	MgO	Single	2	3	0.12	+600	+1112	–200	–328		
AC-0306 (Fig. 15)	Hardline	MgO	Double	2	4.8	0.19	+600	+1112	–200	–328		

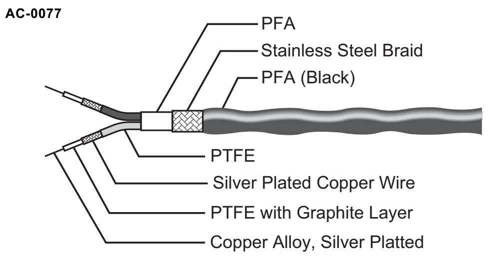


Fig. 10

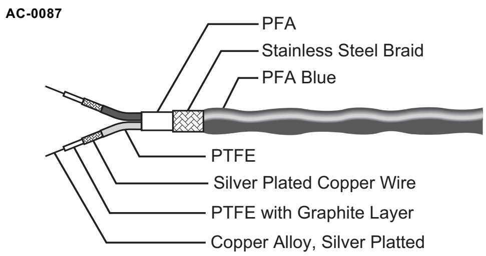


Fig. 11

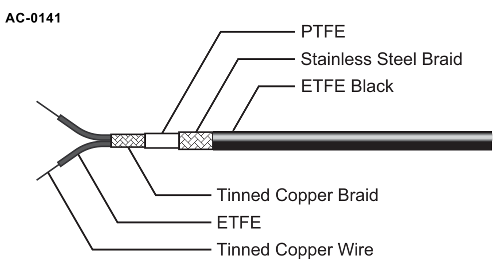


Fig. 12

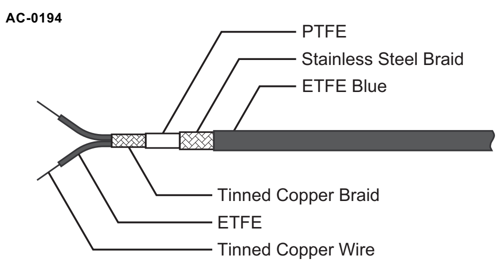


Fig. 13

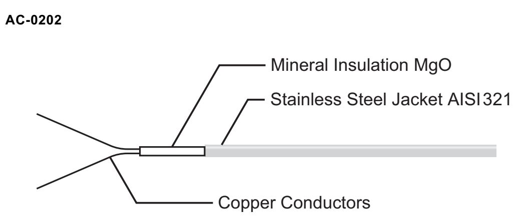


Fig. 14

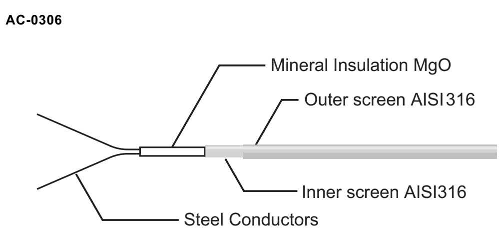


Fig. 15

The most important parameter for any measurement device is sensitivity. The sensitivity is the ratio of the output parameter to the input parameter (the measurand). To determine the sensitivity is to calibrate the device. For vibration transducers the output is normally charge (pC) or voltage with acceleration (m/s^2 or g) or velocity (m/s or inch/s) as the input parameter.

Brüel & Kjær offers a range of instruments suited for calibration of shock and vibration transducers. The most commonly used are the reference transducers used to make comparison calibrations according to ISO 16063–21 (formerly ISO 5347–3). Another solution is the automated Vibration Transducer Calibration System Type 3629 with different software options based on proven Brüel & Kjær's PULSE™ multi-analyzer technology. It provides fast and accurate magnitude and phase calibration according to ISO 16063–21. Primary magnitude and phase calibration according to ISO 16063–11 Method 3 is available using a commercial laser interferometer.

Reference Accelerometers

Type Number		8305	8305-001	3506 (8305 and 2525)
Nominal Sensitivity	pC/(ms^{-2}) (pC/g)	0.125 (1.23)	0.125 (1.23)	1 mV/ms^{-2}) +30/–20 dB (10 mV/g +30/–20 dB)
Frequency Range ±10% limits	Hz	0.2 to 11500 with 20 g load	0.2 to 10300	0.2 to 10300
Transverse Sensitivity	%	2	2	2
Height Spanner Size	mm (inch)	29/1.15 16/0.63	22.3/0.88 16/0.63	29/1.15 16/0.63
Weight	grams	40	26	40
Thread, Top		10–32 UNF	None	10–32 UNF
Thread, Bottom		10–32 UNF	10–32 UNF	10–32 UNF
Calibration Included		DPLA* Primary Laser Calibration at 160 Hz Uncertainty ±0.5% Frequency Response Curve		
Max. Shock	km/s^2(g)	10 (1000)		

* DPLA is the Danish Primary Laboratory of Acoustics

Calibrators and Calibration Systems

Vibration Transducer Calibration System Type 3629	
Description	Comparison calibration according to ISO 16063–21 Very low expanded calibration uncertainty Automated calibration provides ease of use, yet fault-proof results Choice of random or sine excitation Based on proven Brüel & Kjær PULSE technology
Frequency Range	0.1 Hz to 25 kHz (optionally 100 kHz depending on shaker and reference
Calibrates	Transducer types: • Charge • DeltaTron (constant current) • Piezoresistive • Variable Capacitance • Voltage • Servo • Electrodynamic Charge conditioners using reference capacitor
Primary Calibration	According to ISO 16063–11 method 3 using commercial laser interferometer (optional, requires Type 5309 software)
Typical Calibration Accuracy	3 – 2 kHz: 0.6% 2 – 5 kHz: 0.9% 5 – 7 kHz: 1.1% 7 – 10 kHz: 1.6% (one point 0.5% reference calibration and including influence from the transducer to be calibrated)
Software Control	Vibration Transducer Calibration Software Type 5308
Additional	Uses standard PC/laptop with Microsoft® Windows® and Microsoft® Office. Customer database for handling of data and inventory following ISO 17025

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Calibration Exciter Type 4294	
Description	Hand-held calibration exciter with built-in reference accelerometer and compressor loop
Calibration Level	10.0 m/s^2 rms ±3% 10.0 mm/s rms ±3% 10.0 μm rms ±3%
Calibration Frequency	159.15 Hz ±0.02%
Maximum Load	70 g (2.4 oz)
Mounting Thread	10–32 UNF
Transverse Vibration	<5% of main axis
Distortion	<2% (10 to 70 g load) <7% (0 to 10 g load)
Signal Duration	103 ±1 second with autostop
Battery Life	>200 calibrations
Temperature Range	+10 to 40°C (+50 to 104°F)
Weight	500 g, all included
Dimensions	Length: 155 mm (6.1″) Diameter: 52 mm (2.05″)
High-load Version Type 4294-002	3.16 m/s^2 ±3%, 200 g (7.1 oz) max. load

Vibration and Shock Calibration Exciters



Type Number		4808	4809	WQ-2347 (APS 500)
Frequency Range	Hz	5 – 10000	10 – 20000	0.1 – 200
Max. Sine Force	N peak	112 (187 with air cooling)	44 (60 with air cooling)	89
First Axial Resonance	kHz	10	20	0.2
Moving Element mass	gram	160	60	1100
Stroke	mm-p-p	12.7	8	155
Built-in Reference Accelerometer		No	No	No

Calibration Accessories

WA-0567	Calibration Fixture and Adaptor Plates (WS-3104, etc.) for Type 4808
11-0684	1 nF Precision Adaptor (used to calibrate charge amplifiers)

Multi-pin Signal Conditioners for Microphones

Multi-pin preamplifiers cover the widest range of acoustic applications. Signal conditioners condition the microphone signals from the microphone preamplifiers. In this case, you must take into account the preamplifier's supply voltage. For very high sound pressure level measurements, the conditioner's supply voltage may limit the measurement system's maximum measurable level. The maximum measurable sound pressure level is a function of several parameters:

- Frequency content of the sound
- Sensitivity of microphone (including influence of polarization voltage for externally polarized microphones)
- Preamplifier’s voltage drop
- Capacitance of cable between preamplifier and conditioner
- Supply voltage and current from conditioner
- Gain or attenuation in conditioner or preamplifier
- Peak input range of data acquisition

Type No.	2250	2829	5935-L	2690-A	2691-A
Description	Hand-held Analyzer	Microphone Conditioner	Microphone Conditioner	NEXUS Microphone Conditioner	NEXUS (Single Probe) Intensity Conditioner
Channels Min./Max.	1	4	2	1/4	2
Preamplifier Supply Voltage	±18	±50	24	±14 and ±40	±14 and ±40
Polarization Control	0 and 200 V	0 and 200 V	0, 28 and 200 V	0 and 200 V	0 and 200 V
Manual Control	Yes	No	Yes	Yes	Yes
Computer Control	Yes	No	No	Yes	Yes
Maximum Number of Channels from One PC	Multiple from USB or LAN port	–	–	99 per COM or USB port	99 per COM or USB port
CIC	No	Via external connector	Via external connector	No	No
Maximum Frequency (kHz at filters –5% point)	20	–	100	100	100
A-weighting	Yes	No	Yes	Yes	Yes
B-, C- and D-weighting	Yes (B- and C-)	No	No	Optional	No
Adjustable Filters	No	No	No	Yes	Yes
Alarms	Yes	–	–	–	–
Maximum Gain	× 1000 (60 dB)	–	× 316 (50 dB)	× 10000 (80 dB)	× 10000 (80 dB)
Minimum Gain	× 0.01 (–60 dB)	× 1 (0 dB)	× 1 (0 dB)	× 0.1 (–20 dB)	× 0.1 (–20 dB)
Uni (Fine) Gain Adjustment	Yes	No	Yes	Yes Automatic from TEDS	Yes Automatic from TEDS
Reads TEDS	No	Via external connector	No	Yes	Yes
Channels per 19″ Rack	–	–	6	12	12
Mains (AC) Power	Yes	Yes	Yes	Yes	Yes
Battery Power	Yes	No	Yes	Optional	Optional
Product Data	BP 2025	BP 1895	BP 1338	BP 1702	BP 1702

CCLD Signal Conditioners for Microphones and Accelerometers

Constant Current Supply (mA) – called CCLD – conditioning is used on a wide range of transducers including accelerometers, microphones, and tacho probes. CCLD is a not a standardised system. Some CCLD transducers, like CCLD Laser Tacho Probe Type 2981, require more current for power than can be sourced from some CCLD conditioners.

Current is also one of the parameters related to a CCLD system's maximum frequency range. Use the supply current from the following equation:

$$L = 140\,000 \times \frac{I_s - 1}{f \times V_o \times C_m}$$

where:
I_s = supply current (mA)
f = frequency (kHz)
V_o = output voltage (V_{peak})
C_m = cable capacitance (pF/m)

2250

2525

2693-A

2694-A

Type No.	2250	2525	2693-A	2694-A
Description	Hand-held Analyzer	Measuring Amplifier	NEXUS CCLD Signal Conditioner	CCLD Signal Conditioner
Channels Min./Max.	1	1	1/4	16
Constant Current Supply (mA)	4	4	4 or 10	6
AC Acceleration Output	Yes	Yes	Yes	Yes
AC Velocity & Displacement Output (single and double integration filters)	No	Yes	Optional	Optional
DC RMS Output	Yes	Yes	No	No
DC Peak Output	No	Yes	No	No
Alarms	Yes	Yes	No	No
Manual Control	Yes	Yes	Yes	No
Computer Control	Yes	Yes	Yes	Yes
Maximum Number of Channels from One PC	Multiple from USB or LAN port	1 per COM or USB port 15 per IEEE 488 port	99 per COM or USB port	256 per COM or USB port
Multiplexer Output*	No	No	No	Yes
Maximum Frequency (kHz at filters –5% point)	20	100 (–20%)	100 (–10%)	50 (–10%)
Minimum Frequency (Hz at filters –5% point)	1.5	0.2 (–10%)	0.1 (–10%)	0.1 (–10%)
A-weighting	Yes	No	Yes	Optional
B-, C- and D-weighting	Yes (B- and C-)	No	Optional	No
Adjustable Filters	No	Yes	Yes	Yes
Maximum Gain	× 1000 (60 dB)	× 10000 (80 dB)	× 10000 (80 dB)	× 100 (40 dB)
Minimum Gain	× 0.001 (–60 dB)	× 0.1 (–20 dB)	× 0.1 (–20 dB)	× 0.316 (–10 dB)
Uni (Fine) Gain Adjustment	Yes	Yes	Yes (automatic from TEDS)	No
Reads TEDS	No	No	Yes	Yes
Channels per 19″ Rack Mount	–	3	12	16
Mains (AC) Power	Yes	Yes	Yes	Yes

Type No.	2250	2525	2693-A	2694-A
Power from PC's USB Port	Yes	No	No	No
Battery Power	Yes	No	No	No
Product Data	BP 2025	BP 1483	BP 1702	BP 1882

* For multi-channel tests, a multiplexer or computer controlled switch can reduce the number of data acquisition channels required for time invariant or stationary systems.

Type No.	1704-A	1704-C-102	WB-1372	WB-1453
Description	CCLD Signal Conditioner	CCLD Signal Conditioner	CCLD Signal Conditioner	CCLD Signal conditioner
Channels Min./Max.	1/2	2	1	3
Constant Current Supply (mA)	3 – 4.1	3 – 4.1	3	3
AC Acceleration Output	Yes	Yes	Yes	Yes
AC Velocity & Displacement Output (single and double integration filters)	No	No	No	No
DC RMS Output	No	No	No	No
DC Peak Output	No	No	No	No
Alarms	No	No	No	No
Manual Control	Yes	Yes	No	No
Computer Control	No	No	No	No
Maximum Number of Channels from One PC	–	–	–	–
Multiplexer Output*	No	No	No	No
Maximum Frequency (kHz at filters –5% point)	55	55	25	25
Minimum Frequency (Hz at filters –5% point)	2.2	2.2	0.1	0.1
A-weighting	Yes	No	No	No
B- , C- and D-weighting	No	No	No	No
Adjustable Filters	Yes	Yes	× 1 (0 dB)	No
Maximum Gain	× 100 (40 dB)	× 100 (40 dB)	× 1 (0 dB)	–
Minimum Gain	× 1 (0 dB)	× 1 (0 dB)	–	× 1 (0 dB)
Uni (Fine) Gain Adjustment	No	No	No	No
Reads TEDS	No	No	No	No
Channels per 19″ Rack Mount	–	–	–	–
Mains (AC) Power	Yes	Yes	No	No
Power from PC's USB Port	Yes	Yes	Yes	No
Battery Power	Yes	No	Yes	Optional
Product Data	BP 2387	BP 2384	N/A	N/A

* For multi-channel tests, a multiplexer or computer controlled switch can reduce the number of data acquisition channels required for time invariant or stationary systems.

Charge Signal Conditioners for Accelerometers

Charge accelerometers offer the greatest flexibility in regards to temperature and dynamic range. Within this group you have either single-ended or differential charge accelerometers. Single-ended accelerometers are used in many applications, while differential accelerometers offer improved immunity to noise and ground loops. Signal conditioners are usually compatible with one or the other, in rare cases, the conditioner can be used with both types of accelerometer.

Maximum Charge Input

For applications where shocks and impulses occur such as gas turbine and munitions, the conditioner's maximum charge input may limit the measurement system's maximum measurable level. The maximum measurable acceleration level is a function of several parameters:

- Frequency content of the signal
- Sensitivity of accelerometer
- Capacitance of cable between accelerometer and conditioner
- Gain or attenuation in conditioner or preamplifier
- Peak input range of data acquisition

Type No.	**1702**	**2525**	**2634**	**2663/2663-B**
Description	Range of Charge Amplifiers	Measuring Amplifier	Charge Amplifier	Charge Amplifier
Channels Min./Max.	1	1	1	1
Single-ended Charge	Yes	Yes	Yes	Yes
Differential Charge	No	No	Yes	Yes
Maximum Charge Input	–	50000 pC	~1000 pC	5000 pC peak
AC Acceleration Output	Yes	Yes	Yes	Yes
AC Velocity & Displacement Output (single and double integration filters)	No	Yes	No	NO
RMS and Peak Outputs	No	Yes	No	No
Alarms	No	Yes	No	No
Manual Control	Yes	Yes	Yes	No
Computer Control	No	Yes	No	No
Maximum Number of Channels from One PC	–	1 per COM or USB port 15 per IEEE 488 port	–	–
Maximum Frequency (kHz at filters –5% point)	5	100 (–20%)	>200 (–3 dB)	200
Minimum Frequency (Hz at filters –5% point)	5	0.2 (–10%)	1 (–3 dB)	0.5 (–3 dB)
Adjustable Filters	No	Yes	No	Optional
Maximum Gain	× 50 (14 dB)	× 10000 (80 dB)	× 10 (20 dB)	× 100 (40 dB)
Minimum Gain	× 0.5 (–6 dB)	× 0.1 (–20 dB)	× 1 (0 dB)	× 1 (0 dB)
Uni (Fine) Gain Adjustment	Yes	Yes	No	No
Channels per 19″ Rack Mount	–	3	–	–
Mains (AC) Power	No	Yes	No	No
DC Power	Yes	No	Yes	Yes
Battery Power	No	No	No	No
Product Data	BP 2289	BP 1483	BP 0198	BP 0789

Type No.	2635	2692-A	2692-C
Description	Charge Amplifier	NEXUS Charge Amplifier	NEXUS Charge Amplifier (very high input)
Channels Min./Max.	1	1/4	1/4
Single-ended Charge	Yes	Yes	Yes
Differential Charge	No	No	No
Maximum Charge Input	~10000 pC	10000 pC	100000 pC
AC Acceleration Output	Yes	Yes	Yes
AC Velocity & Displacement Output (single and double integration filters)	Yes	Optional	Optional
RMS and Peak Outputs	No	No	No
Alarms	No	No	No
Manual Control	Yes	Yes	Yes
Computer Control	No	Yes	Yes
Maximum Number of Channels from One PC	–	99 per COM or USB port	90 per COM or USB port
Maximum Frequency (kHz at filters –5% point)	200	100 (–10%)	100 (–10%)
Minimum Frequency (Hz at filters –5% point)	0.2	0.1 (–10%)	0.1 (–10%)
Adjustable Filters	Yes	Yes	Yes
Maximum Gain	× 10000 (80 dB)	× 10000 (80 dB)	× 10000 (80 dB)
Minimum Gain	× 0.01 (–40 dB)	× 0.1 (–20 dB)	× 0.1 (–20 dB)
Uni (Fine) Gain Adjustment	Yes	Yes	Yes
Channels per 19″ Rack Mount	6	12	12
Mains (AC) Power	Yes	Yes	Yes
DC Power	No	Yes	Yes
Battery Power	Yes	Optional	Optional
Product Data	BP 0099	BP 1702	BP 1976

Type No.	2647	2647-A	2647-B	2647-C	2647-D	2647-D-001*	2647-D-002	2647-D-003	2647-D-004†	2647-E
Description	Range of Charge to CCLD Converters									
Channels Min./Max.	1	1	1	1	1	1	1	1	1	1
Single-ended Charge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Differential Charge	No	No	No	No	No	No	No	No	No	No
Maximum Charge Input	–	–	–	–	–	–	–	–	–	–
AC Acceleration Output	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AC Velocity & Displacement Output (single and double integration filters)	No	No	No	No	No	No	No	No	No	No
RMS and Peak Outputs	No	No	No	No	No	No	No	No	No	No
Alarms	No	No	No	No	No	No	No	No	No	No
Manual Control	No	No	No	No	No	No	No	No	No	No
Computer Control	No	No	No	No	No	No	No	No	No	No
Maximum Number of Channels from One PC	–	–	–	–	–	–	–	–	–	–
Maximum Frequency (kHz at filters –5% point)	50 (–10%)									
Minimum Frequency (Hz at filters –5% point)	0.17 (–10%)									
Lower Limiting Frequency (–10%, –1 dB)	0.17 Hz			1.0 Hz			80 Hz			0.17 Hz
Upper Limiting Frequency (–10%, –1 dB)	50 kHz			10 kHz‡						50 kHz
Adjustable Filters	No	No	No	No	No	No	No	No	No	No
Gain (mV/pC)	1 and 10	1	10	0.1	1					5
Maximum Gain	–	–	–	–	–	–	–	–	–	–
Minimum Gain	–	–	–	–	–	–	–	–	–	–
Uni (Fine) Gain Adjustment	No	No	No	No	No	No	No	No	No	No
Channels per 19″ Rack Mount	–	–	–	–	–	–	–	–	–	–
Mains (AC) Power	No	No	No	No	No	No	No	No	No	No
DC Power	Yes (from CCLD)									
Battery Power	No	No	No	No	No	No	No	No	No	No
Extended Functionality**	Yes	No	No	No	No	No	No	No	No	No
Product Data	BP 1874									

* Cable integrated for use with accelerometers that have a 2-pin TNC connector, BNC connector (M)
† Cable integrated for use with accelerometers that have a 2-pin TNC connector, 2250 LEMO connector (M)
‡ Depends on input load capacitance. Figures apply to 1.5 nF (for example, 1 nF accelerometer capacitance plus 5 m cable)
** Switch between gain 1, 10 and passive mode

What are the Benefits of Signal Conditioning?

Signal Conditioning improves the performance and reliability of the measurement system with a variety of functions such as signal amplification, attenuation, electrical isolation, filtering, powering of your transducers, overload detection and Transducer Electronic Data Sheet (TEDS) support.

Brüel & Kjær provides a number of signal conditioning solutions. When determining which conditioner to use, you should consider the type of transducer as well as the conditioner's benefits to the measurement system, including the following critical features and characteristics. For further comparisons, see the individual conditioner's product data for in-depth specifications.

Number of Channels

For multi-channel tests, having more channels in the signal conditioner makes for a simpler system (for example, one power supply or battery for all the conditioned channels).

Channel Control

For units with adjustable settings, manual control is the easiest way to change configuration. In automated or multi-channel systems, computer control offers big time savings.

For very large systems, it is desirable to control as many channels as possible from a single PC.

Maximum and Minimum Frequency and Adjustable Filters

Besides needing to cover the measurement's frequency range, a conditioner's analogue filter can remove portions of the signal outside the range of interest. For example, in-vehicle measurements of sound often have very strong low-frequency content below 20 Hz. A 20 Hz high-pass filter will attenuate the signal below the audio range which may improve the measurement system's noise floor at mid to high frequencies.

Minimum and Maximum Gain

When using data acquisition equipment with adjustable input ranges, the noise floor of the complete measurement system (from transducer through conditioning to data acquisition) can be improved by adding gain in the conditioner.

Uni (Fine) Gain Adjustment

The sensitivity of a transducer in engineering units or volts typically varies significantly between individual transducers. Compensating for the individual sensitivities using fine gain control in the conditioner removes this error.

Transducer Electronic Data Sheet (TEDS)

Significant measurement errors can be automatically avoided when the fine gain adjustment of the conditioner is read from the transducer's built-in Transducer Electronic Data Sheets (TEDS).

Multi-unit Design

Rack mounting is a convenient way of organising laboratory-based measurement systems where all the conditioning and data acquisition can be combined into one frame. For most signal conditioners, you can order an optional 19-inch rack and/or a multi-unit frame, with which 1 or more conditioner can be mounted.

Other Useful Features for Acoustic Transducers

Polarization Control

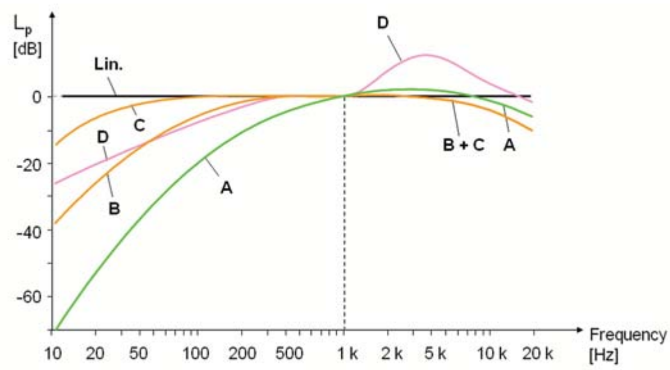
The working principle of the condenser microphone is based on a fixed charge. This charge is established, either with a very stable external polarization voltage, typically 200 V, via a large resistor, or by an electret layer deposited on the microphone's backplate, in which case the external polarization voltage should be set to 0 V.

CIC

Charge Injection Calibration (CIC) is a technique for on-line verification of the integrity of the entire measurement chain, for example, microphone, preamplifier and cabling. Even microphones remote from the input stage/conditioning amplifier can be verified. The basic philosophy behind CIC is that if we have a known condition (for example, a properly calibrated microphone) and establish a reference measurement, then as long as the reference value does not change, nothing has changed, for example, the microphone calibration will still be valid. Additionally CIC verifies the cable and preamplifier.

Filtering

Acoustic weighting curves



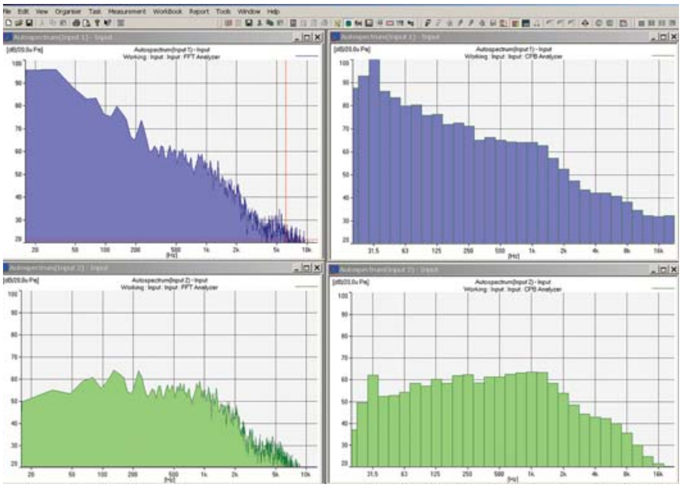
A-weighting Filters

Sound measurements often specify A-weighting to reflect the acuity of the human ear, which does not respond equally to all frequencies. Using analogue A-weighting filters can also have the same benefit of improving the measurement system's noise floor at mid to high frequencies for in-vehicle measurements.

B-, C-, and D-weighting Filters

Sound measurements can also specify B-, C- or D-weighting instead of the more common A-weighting. These additional weightings also reflect the acuity of the human ear, which does not respond equally to all frequencies, but also has a different response at different sound pressure levels.

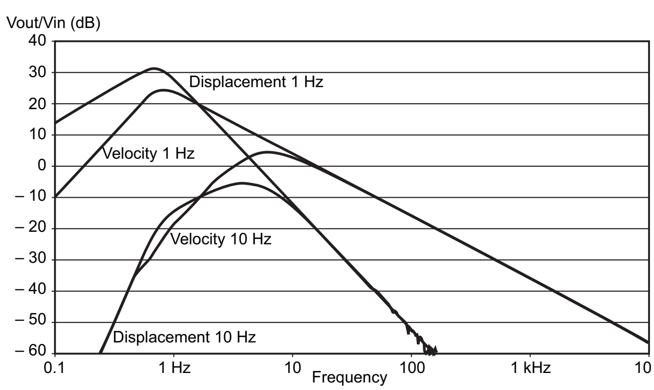
Example of the benefits of analogue filtering for in-vehicle measurements



Other Useful Features for Vibration Transducers

AC Acceleration Output
This is the "raw time" output from an accelerometer through any gain and filtering in the conditioner.

Analogue velocity and acceleration filters

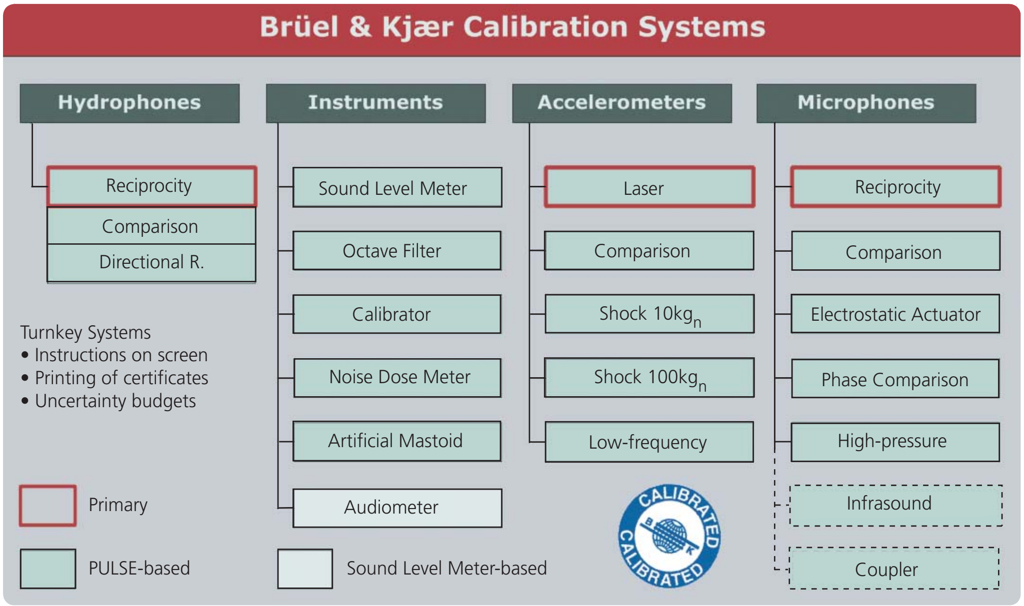


AC Velocity and Displacement Output (Single and Double Integration Filters)
In some measurements, such as machine health monitoring according to ISO 10816, the velocity or displacement is of more interest than the acceleration from an accelerometer. A single and double integration filter easily converts an acceleration signal to velocity or displacement in the time domain.

Converting to velocity or displacement in the conditioner makes further analysis easier.

DC RMS and Peak Outputs and Alarms
Some analysis techniques use averaged (RMS) or Peak measurements instead of the "raw time" signal. Conditioners with this capability are often called "measuring amplifiers" because they provide the needed measured parameter without need for additional instrumentation. Besides being displayed on the unit's screen, the averaged (RMS) or Peak values can be sent to other measurement devices as a DC voltage. A TTL alarm output can be sent from the measuring amplifier when a limit is exceeded.

Overview of Brüel & Kjær's calibration system products



Primary Calibration Systems

Microphone Reciprocity Calibration System

Reciprocity Calibration System Type 9699 performs reciprocity calibration according to the method described in IEC 61094–2 to determine the pressure sensitivity of microphones described in IEC 61094–1 (Laboratory Standard Microphones).

This system is intended for National Metrology Institutes and other high-level laboratories. It is a turnkey system for routine measurements that can be set up to meet the requirements of the user. The system can work in a "normal" laboratory environment with no specific precautions with respect to background noise and vibration.

It is a very flexible system that can be used for calibration research and at primary calibration laboratories, calibration service centres and larger organisations with their own calibration facilities.

Vibration Transducer Calibration System

Vibration Transducer Calibration System Type 3629 together with Laser-interferometric Calibration System Software Type 5309 are designed for absolute calibration of a variety of vibration and shock transducers. The combined system is generally used by national primary laboratories or as reference by clients utilising advanced technology.

The system performs absolute calibration according to the method described in ISO 16063–11:1999. Type 5309 uses Method 3, sine approximation, and calibrates practically all transducer types: charge, DeltaTron (constant current supplied transducers), piezoresistive, variable capacitance, voltage, servo and electrodynamic (for example, velocity pick-ups).

Hydrophone Calibration System

Hydrophone Calibration System Type 9718 performs free-field calibration in a water tank as described in IEC 60565.

The system is generally used by national primary laboratories or as reference by clients utilising advanced technology for calibration of underwater transducers both at the primary and secondary level.

Secondary calibration used by laboratories who need to calibrate large numbers of hydrophones with minimum time consumption, is based on the substitution principle and performed in two steps:

- First: A calibration is performed by means of a known reference hydrophone
- Second: A calibration is performed with the unknown unit under calibration

The measurement principle used is gated selective FFT for optimum signal-to-noise ratio. The complex impedance can also be measured and reported.

The reciprocity system can perform calibration without use of a reference transducer, this is called absolute calibration. The reciprocity calibration is used for calibration of such reference transducers.

Directivity Calibration Software
The directivity calibration software option complements Hydrophone Calibration System Type 9718. The hydrophone to be calibrated is mounted on Turntable Type 9640 capable of handling payloads up to 100 kg. A rotation controller turns the turntable and provides accurate information of the angle. For each angle, the hydrophone output is measured and printed in a polar plot. The polar plot may be repeated at different frequencies as needed.

Secondary Calibration

Shock & Vibration Transducer System Type 3629

With Comparison Calibration System Software Type 5308
The system performs comparison calibration according to the method described in ISO 16063–21:2003

Vibration Transducer Calibration System Type 3629 and Type 5308 software are designed for comparison calibration of a variety of vibration and shock transducers and is generally used by calibration service centres and larger organisations with their own calibration facilities.

Type 3629 calibrates practically all transducer types – charge, DeltaTron® (constant current supplied transducers), piezoresistive, variable capacitance, voltage, servo and electrodynamic (for example, velocity pick-ups).

With Shock Transducer Calibration Software Type 5310
The calibration is performed in accordance with ISO 16063–22.

This system is normally used with a POP shock calibrator that works at shock levels from 20 g to 10000 g and shares a number of user interface features and components with Comparison Calibration Software Type 5308. For shocks below 100 g it is even possible to use a special feature to generate them on a shaker.

High-shock Transducer Calibration

The calibration is performed in accordance with ISO 16063–22 using High Shock Transducer Calibration Software Type 5311.

It is normally used with a Hopkinson Bar that works at shock levels from 10 to 100 kg and shares a number of user interface features and components with Comparison Calibration Software Type 5308.

Microphone Calibration System Type 9721

Microphone Calibration System Type 9721 can calibrate measurement and laboratory standard microphones of commonly used models and brands, including those that fulfil IEC standards 61094–4 (Working Standards) and 61094–1 (Laboratory Standards). Microphones of non-standard dimensions can also be calibrated, but might require additional mechanical accessories.

Type 9721 is a general-purpose microphone calibration system that calibrates microphones with or without preamplifiers in accordance with IEC 61094–5 and IEC 61094–6.

The system is intended for calibration service centres and larger organisations with their own calibration facilities. It is a flexible, turnkey system for routine measurements that can be set up to meet the requirements of the user. The system can work in a "normal" laboratory environment with no specific precautions with respect to background noise and vibration.

Option:
- Phase Response Comparison Calibration with Application Software WT-9651 and coupler WA-1544 or WA-1545

In order to provide you with a Best in Class customer service experience, we continuously expand the Brüel & Kjær offerings and improve our internal processes to ensure the same standards around the globe.

What You Gain When You Partner with Brüel & Kjær

Single Point of Contact
This speeds up your enquires, by connecting you to the right contact the very first time! The multilingual Customer Care organization is eager to assist you in every request you may have. Our customer-friendly team will submit your request for calibration, track your order end-to-end, and inform you pro-actively about status and delivery schedule. If you need to receive technical support, they will route you to the dedicated contact.

Expert Calibration
Your equipment will be expertly calibrated and repaired in Brüel & Kjær accredited calibration centres. The Product Care team is regularly trained and certified to perform factory calibrations and repairs of instrumentation to ensure the same high standards as new equipment.

Knowledgeable Service
Global Field Service engineers are at your disposal when it comes to on-site field services including installation, system configuration, fault resolution, calibration and preventative maintenance of your entire systems. A range of services accompany the solution to reduce the risk of faults occurring during use. We know our products best!

Team of Specialists
The local teams are supported by a global group of engineering specialists who can advise on and solve all kinds of sound and vibration measurement and analysis problems you might have. Professional Project Management and Engineering Test Services combined with experienced Technical Support ensure smooth operation of your solution and provide additional value to you.

Brüel & Kjær Calibration and Repair Services

Brüel & Kjær’s 15 calibration centres perform more than 40000 high-level, quality calibrations a year. The global team of highly skilled calibration technicians:

- Maintain an intimate knowledge of all Brüel & Kjær branded products
- Excel at carrying out a wide range of calibrations run on dedicated test benches
- Deliver complete calibration schedules

The calibration centres can also calibrate other manufacturer's equipment.

Calibration of Reference Equipment

There are two levels of reference calibration available at Brüel & Kjær: Primary Calibration – performed by *Danish Primary Laboratory of Acoustics (DPLA)* – and Secondary Calibration. The level you select depends on the accuracy you require for your reference equipment.

Primary Calibration

DPLA annually performs hundreds of primary accredited calibrations of reference microphones and accelerometers for metrology institutes, test houses, and industry organisations requiring high-accuracy calibrations.

Secondary Calibration

If your sensitivity requirements are not as high as primary calibration, we recommend that you maintain your reference equipment with annual accredited calibrations in one of our ISO/IEC 17025 accredited laboratories. This is, for example, performed for industrial companies who perform in-house calibrations, tests or any acoustic or vibration measurements.

Accredited Calibration

Our network of calibration centres operates within the EA and ILAC guidelines for accreditation. Our ISO/IEC 17025 accreditations have been awarded by accreditation bodies that are signatories to the EA-MLA and the ILAC-MRA. This allows us to deliver the same high level of quality, competence and confidence, together with international recognition, wherever the accredited calibration is performed.

Where accredited calibration is not available, Brüel & Kjær centres offer Traceable Calibration.

Initial Accredited Calibration

Sensitivity data are included with the delivery of every new Brüel & Kjær microphone and accelerometer. However, accredited calibration can be ordered, where required, to start the measurement history from day one – for example, if stipulated by quality procedures, external audits or other requirements.

Traceable Calibration

You can also order traceable calibration, which means that the measurements are traceable to national standards – at the same level as accredited calibration, only without the formal third-party recognition.

To optimise uptime and minimise costs, we recommend combining calibration with a Hardware Maintenance Agreement.

Regular Calibration

When you send in your accelerometers and microphones for calibration regularly, you benefit from reliable measurement data; you can compare data over time, provide proof to customers, and fulfil your internal or external quality requirements.

To minimise the errors due to faulty or inaccurate measurements and the related costs, we recommend annual calibration in one of our ISO/IEC 17025 accredited laboratories.

This will give you a continuous calibration history to use as reference for internal requirements, for audit purposes required by authorities or just as a request from your customers. You can also follow the history of sensitivity for your equipment over a period of time and detect any questionable trends up-front.

Service Agreements

With a Service Agreement you can save both time and money.

The value of a service agreement lies in a combination of the following:

- Assurance that the time your equipment is away for service is minimised
- Attractive total service price

You can combine a range of services in one agreement over several years. You get priority at the time you need service and a predictable maintenance budget. With planned service, your equipment is always ready for use and you preserve your unbroken sensitivity history.

If the Brüel & Kjær technician detects a need for repair or replacement while your equipment is in for calibration, it will be performed immediately and free of charge, provided your service agreement covers such maintenance. This means that you do not have to be without your equipment several times, that there is no unnecessary communication back and forth to decide what should be done to the equipment, and no large surprises to your budget.

Examples of what a service agreement can contain:

- Your equipment can be calibrated and maintained at the same time
- Multiple calibrations – to give the most favourable price
- Priority calibration
- Priority repair – or replacement
- Extension of manufacturer's warranty
- Loan of an equivalent product while your equipment is being calibrated or repaired

Rentals

Brüel & Kjær offers rental services for a large number of our products. For further details, please contact your local sales representative.

Learn More

To learn more about Brüel & Kjær services, including FAQs and how to order calibration or repair, please visit www.bksv.com/services.

General Compliance

CE, RCM, China RoHS, WEEE marks	The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives RCM mark indicates compliance with applicable ACMA technical standards – that is, for telecommunications, radio communications, EMC and EME China RoHS mark indicates compliance with administrative measures on the control of pollution caused by electronic information products according to the Ministry of Information Industries of the People's Republic of China WEEE mark indicates compliance with the EU WEEE Directive
Safety	EN/IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use. ANSI/UL 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN/IEC 61000–6–3: Generic emission standard for residential, commercial and light industrial environments. EN/IEC 61000–6–4: Generic emission standard for industrial environments. CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
EMC Immunity	EN/IEC 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments. EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments. EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements. **Note:** The above is only guaranteed using accessories listed in this Catalogue.

Relevant Microphone Standards

Laboratory reference microphones are specified in the international standard IEC 61094–1:2000.

Measurement microphones are specified in the international standard IEC 61094–4:1995.

These standards use the abbreviation WS for working standards, for example, measurement microphones used in daily routine measurements, while the abbreviation LS denotes laboratory standards.

The digits following "WS" indicate as follows:
- 1 = 1-inch microphone
- 2 = 1/2-inch microphone
- 3 = 1/4-inch microphone

The letter "F" denotes a free-field type and "P" a pressure- field type.

Electroacoustic Standards

The most relevant electroacoustic standard is the IEC 61672:2002 "Electroacoustics – Sound Level Meters". Although the microphone is an important component in any system that has to comply with IEC 61672 there are many other factors to consider.

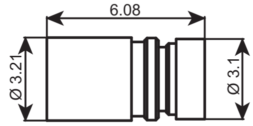
It is also worth considering other parameters such as phase response, venting, environmental exposure and documentation

The tables in the Microphone section show which microphones are comply with the various electroacoustic standards including those that are suitable to be used in system solutions that have to fulfill the requirements of IEC 61672. The following overview shows the coding used to display the relevant standard..

	IEC 61094		IEC 61672		ANSI
A	IEC 61094–4 WS1F	**I**	IEC 61672 Class 1	**K**	ANSI S1.4 Type 1
B	IEC 61094–4 WS2F	**J**	IEC 61672 Class 2	**L**	ANSI S1.4 Type 2
C	IEC 61094–4 WS3F			**M**	ANSI S1.12 Type M
D	IEC 61094–4 WS1P				
E	IEC 61094–4 WS2P				
F	IEC 61094–4 WS3P				
G	IEC 61094–1 LS1P				
H	IEC 61094–1 LS2P				

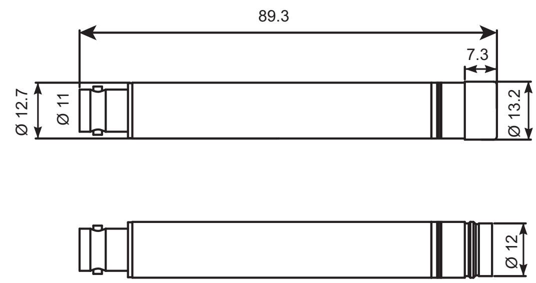
Microphone Dimensions

The following table shows the dimensions of the most popular Brüel & Kjær microphones. In most cases, a TEDS combination is displayed (with a preamplifier). All dimensions are in millimetres.

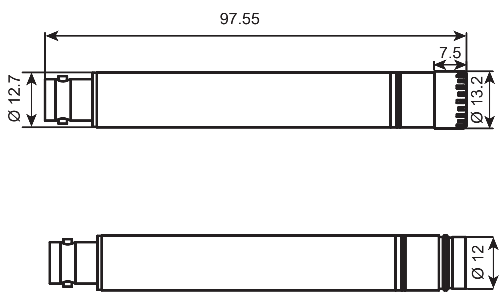


(preamplifier not shown)

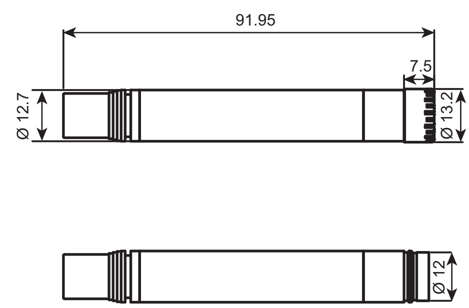
Type 4138



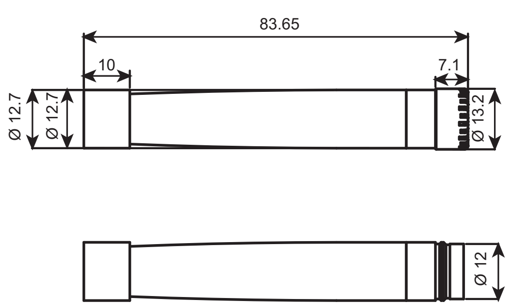
Type 4188



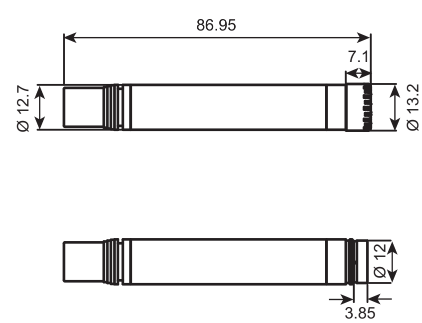
Type 4189



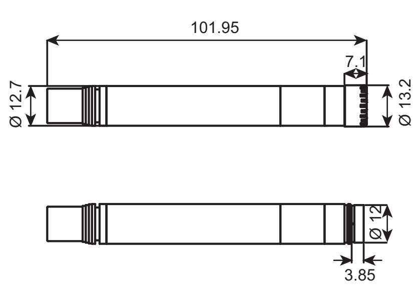
Type 4190



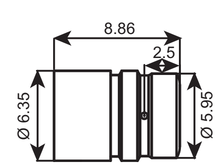
Type 4191



Type 4192

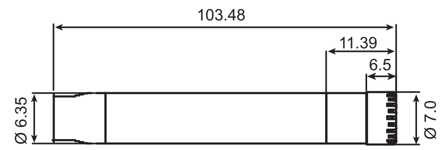


Type 4193

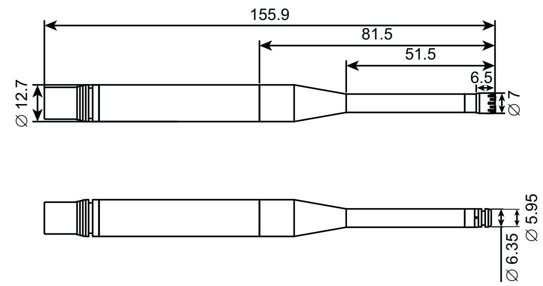


(preamplifier not shown)

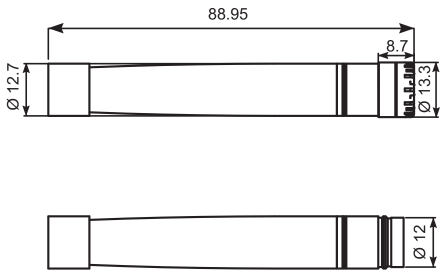
Type 4938



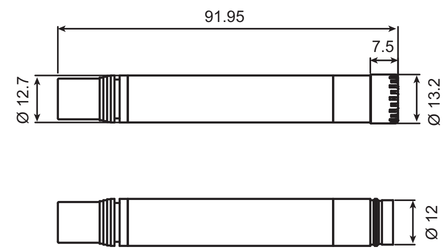
Type 4939



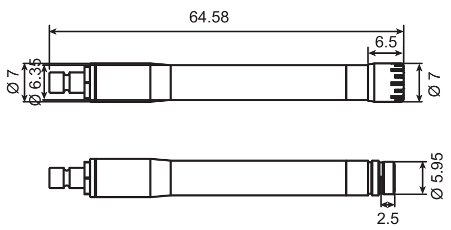
Type 4941



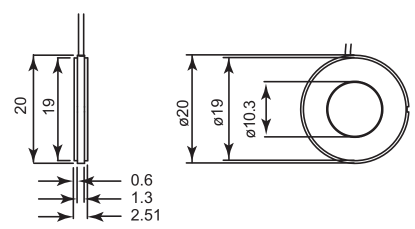
Type 4942



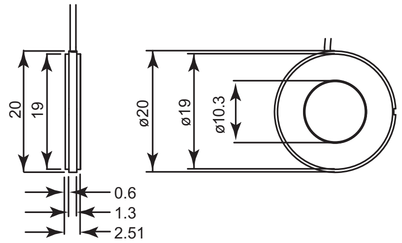
Type 4943



Type 4944



Type 4948



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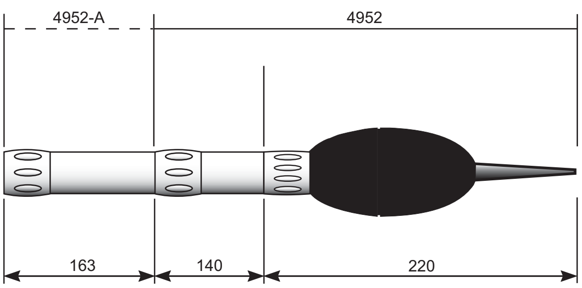

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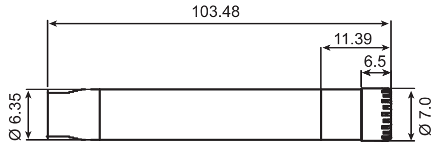

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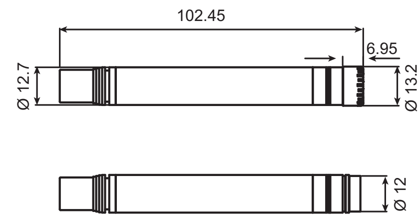

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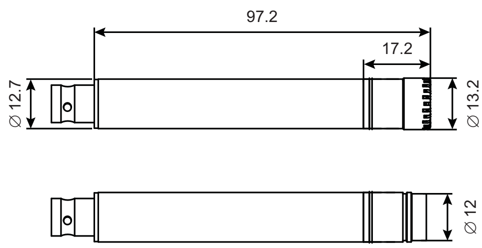

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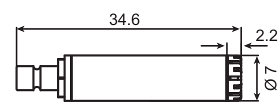

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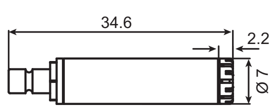

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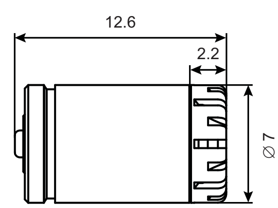

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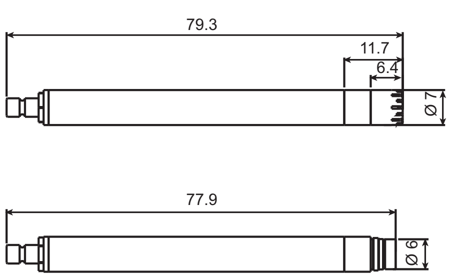

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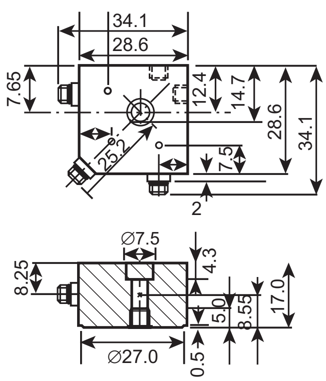
Accelerometer Dimensions

The following table shows the dimensions of the most popular Brüel & Kjær accelerometers. All dimensions are in millimetres



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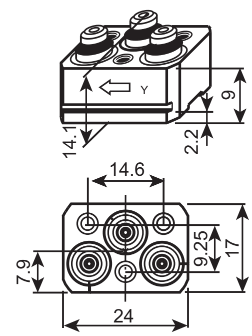

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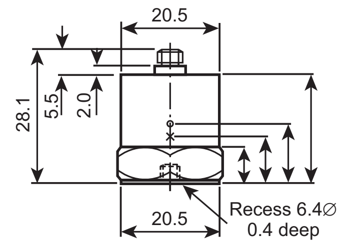

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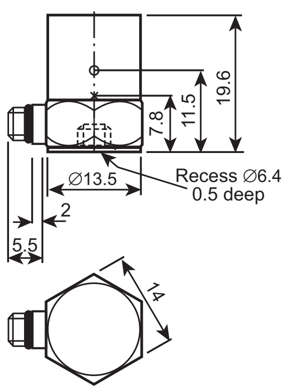

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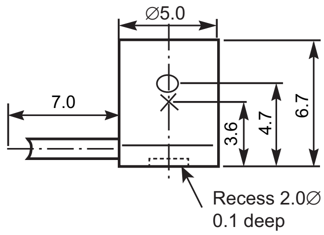

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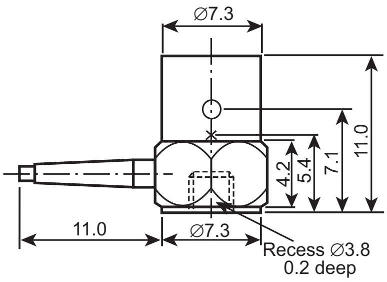

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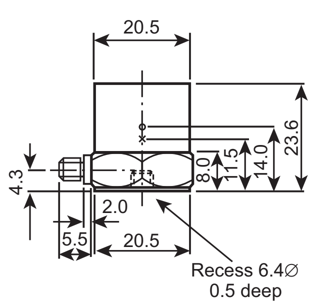

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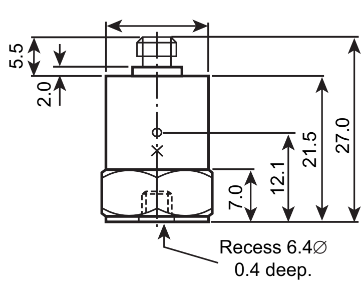

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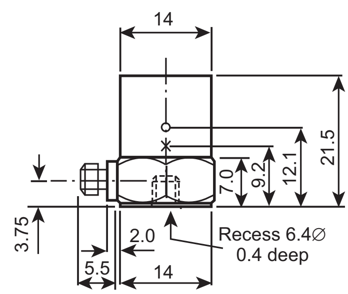

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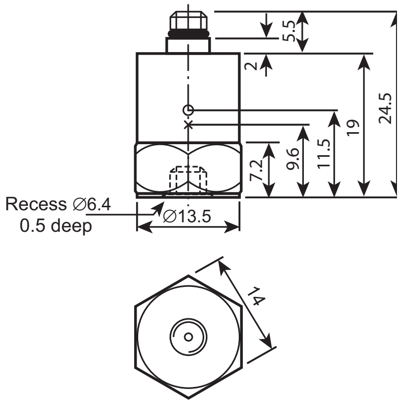

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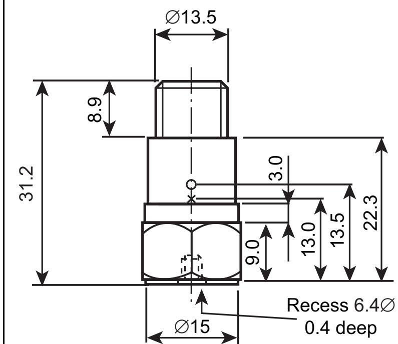

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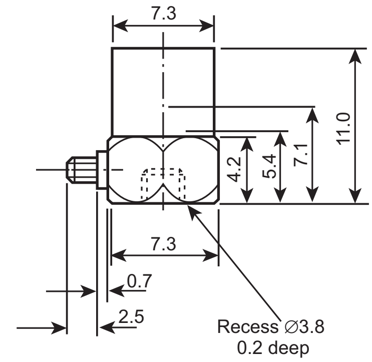

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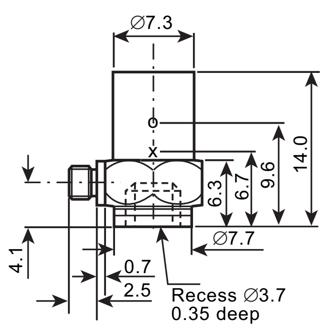

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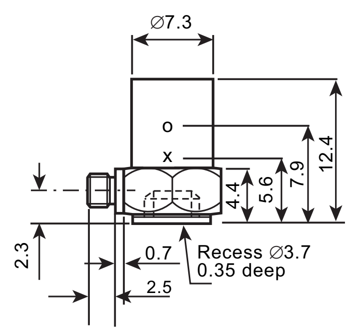

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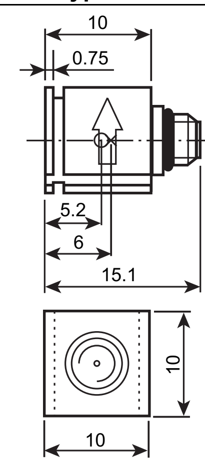

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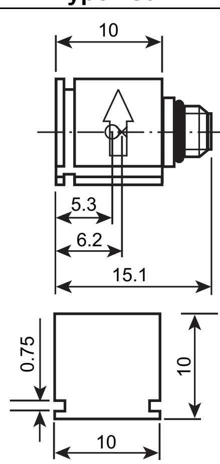

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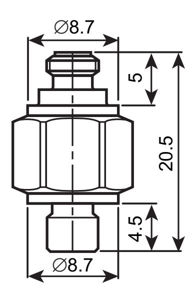

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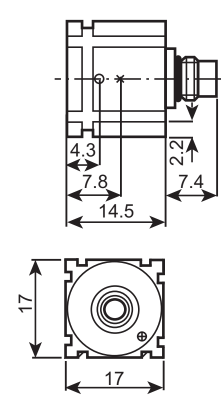

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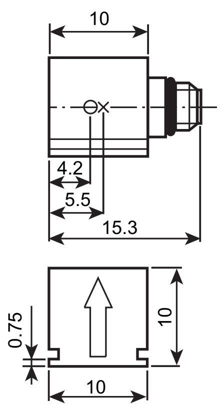

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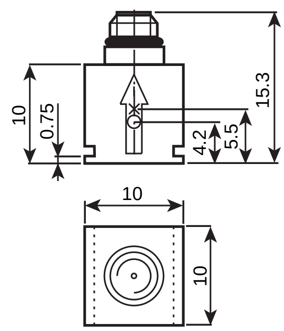

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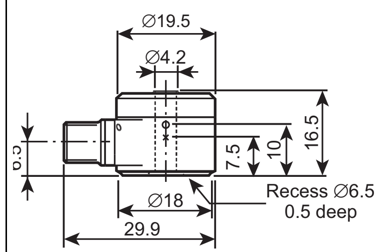

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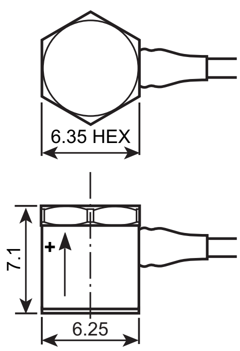

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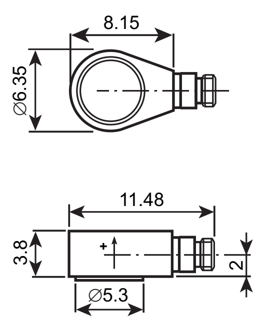

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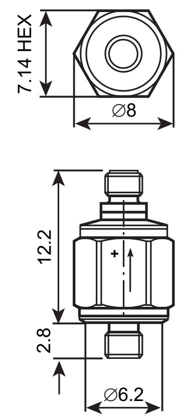

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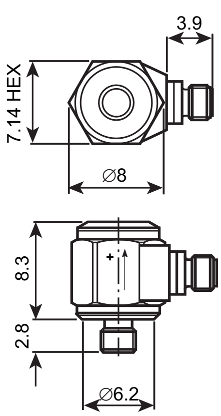

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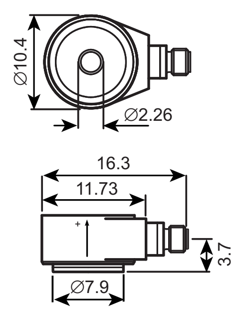

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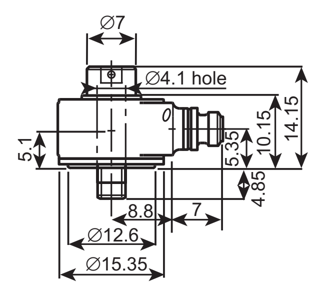

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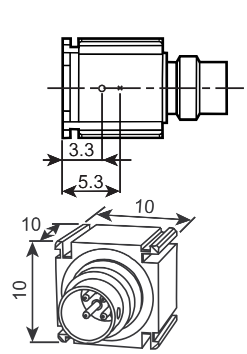

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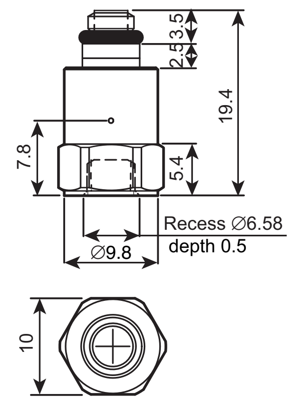

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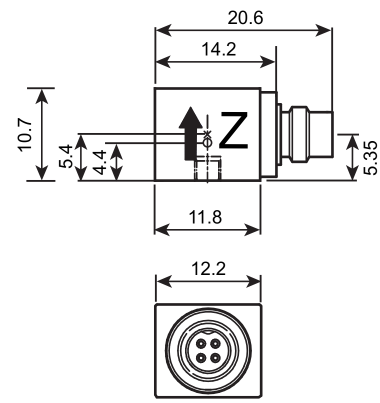

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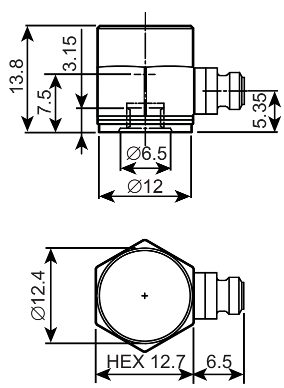

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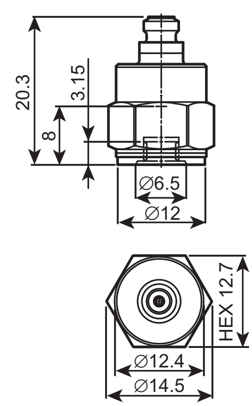

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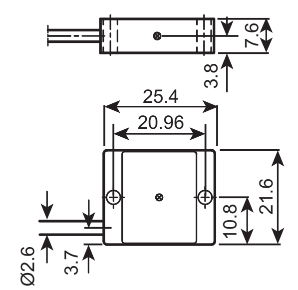

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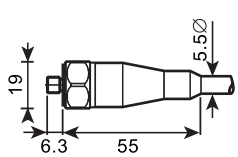

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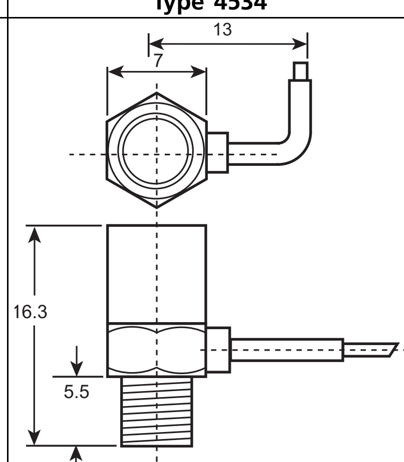

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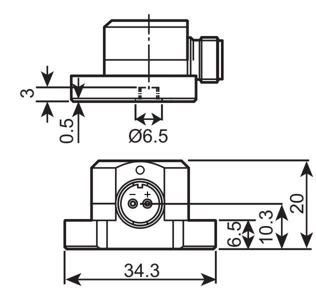
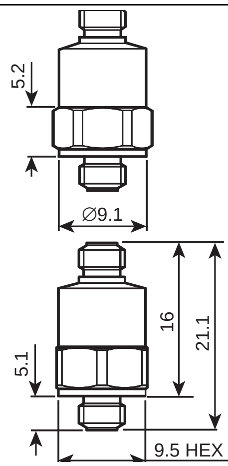


Type 8324-100 and 8347-C



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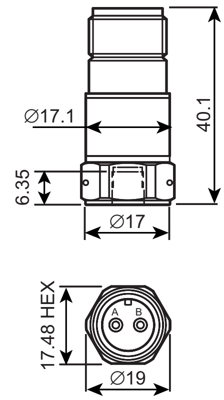

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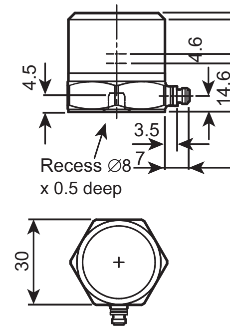

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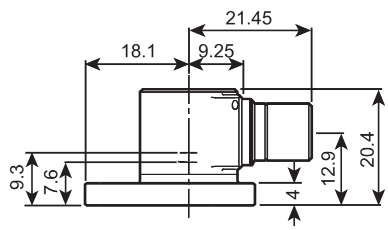

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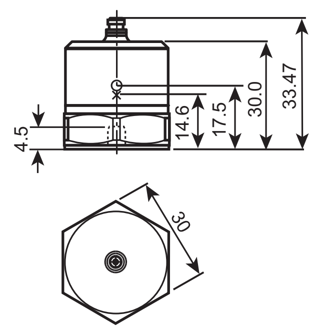

Type 8346-C

Absorption
The conversion of sound energy into another form of energy, usually heat when passing through an acoustical medium.

Absorption coefficient
Ratio of sound absorbing effectiveness at a specific frequency, of a unit area of acoustical absorbent to a unit area of perfectly absorptive material.

Acceleration
Vector quantity that describes the time-derivative of velocity, mathematically: $a = dv/dt$. The SI unit is m/s^2 (metres per second squared). In the imperial system, the unit g or more correctly g_n is used, where the definition is that $1\ g_n \equiv 9.80665\ m/s^2$.

Acceleration can be oscillatory (and then often called vibration), in which case simple harmonic components can be defined by the acceleration amplitude (and frequency), or random, in which case the rms acceleration (and bandwidth and probability density distribution) can be used to define the probability that the acceleration will have values within any given range. Accelerations of short time duration are defined as transient accelerations. Non-oscillatory accelerations are defined as sustained accelerations, if of long duration, or as acceleration pulses, if of short duration.

In the case of time-dependent accelerations various self-explanatory modifiers, such as peak, average, and rms (root-mean-square), are often used. The time intervals over which the average or root-mean-square values are taken should be indicated or implied

Accelerometer
A transducer that converts an input acceleration to an output (usually electrical) that is proportional to the input acceleration.

Acoustics
The science of the production, control, transmission, reception and effects of sound and of the phenomenon of hearing.

Active sound field
A sound field in which the particle velocity is in phase with the sound pressure. All acoustic energy is transmitted, none is stored. A plane wave propagating in a free field is an example of a purely active sound field and constitutes the real part of complex sound field.

Ambient noise
All-pervasive noise associated with a given environment.

Amplitude
The instantaneous magnitude of an oscillating quantity such as sound pressure. The peak amplitude is the maximum value.

In a vibrating object, amplitude is measured and expressed in three ways: Displacement, Velocity and Acceleration. Amplitude is also the y-axis of the vibration time waveform and spectrum; it helps define the severity of the vibration.

Amplitude distribution
A method of representing time-varying noise by indicating the percentage of time that the noise level is present in a series of amplitude intervals.

Anechoic room
A room whose boundaries effectively absorb all incident sound over the frequency range of interest, thereby creating essentially free field conditions.

Audibility threshold
The sound pressure level, for a specified frequency at which persons with normal hearing begin to respond.

Background noise
The ambient noise level above which signals must be presented or noise sources measured.

CCLD (Constant Current Line Drive)
Generic name for a constant current power supply for accelerometers with built-in electronics and for these accelerometers. Used in Brüel & Kjær analyzers and literature. See also DeltaTron.

Charge amplifier
An amplifier that converts the charge output of a piezoelectric accelerometer into a proportional low-impedance voltage signal.

Charge converter
A device that converts a piezoelectric accelerometer's high-impedance charge output to a low-impedance voltage proportional to the charge input. A charge converter typically requires a constant current power supply.

Also called 'in-line charge converter'.

Complex intensity
Complex intensity is the combined intensity and imaginary intensity.

Conditioning (signal conditioning)
The conversion or alteration of an accelerometer signal to a suitable or desirable level, range or bandwidth. Signal conditioning includes amplification, filtering, differential applications, isolation, transducer tests and more.

Cumulative distribution
A method of representing time-varying noise by indicating the percentage of time that the noise level is present above (or below) a series of amplitude levels.

Damping (1)
The action of frictional or dissipative forces on a dynamic system causing the system to lose energy and reduce the amplitude of movement.

Damping (2)
Removal of echoes and reverberation by the use of sound absorbing materials. Also called sound proofing.

DC response
Accelerometers respond to a fairly wide frequency range, most down to 1 or 2 Hz. Some special accelerometers respond to zero frequency and are, therefore, said to exhibit a 'DC response'.

Decibel scale
A linear numbering scale used to define a logarithmic amplitude scale, thereby compressing a wide range of amplitude values to a small set of numbers.

DeltaTron
Brüel & Kjær's proprietary name for accelerometers with built-in electronics and the constant current power supply for these. Brüel & Kjær also uses the generic name CCLD (Constant Current Line Drive). It corresponds to IEPE (Integrated Electronics Piezo Electric) often used for accelerometers requiring this kind of power supply. Other similar proprietary names are ISOTRON®, PIEZOTRON® and ICP®.

Other types of accelerometers with different powering principles exists, for example, Brüel & Kjær's CVLD (Constant Voltage Line Drive) that is used for maximum EMC immunity.

Differentiation
In vibration analysis, the three physical parameters, displacement, velocity and acceleration, are mathematically related. Differentiation is a mathematical operation that converts one parameter to another (for example, a displacement signal to a velocity signal, or velocity signal to an acceleration signal). See also Integration, which is the inverse of differentiation.

Diffraction
The scattering of radiation at an object smaller than one wavelength and the subsequent interference of the scattered wavefronts.

Diffuse-field
A sound field in which the sound pressure level is the same everywhere and the flow of energy is equally probable in all directions.

Diffuse sound
Sound that is completely random in phase; sound which appears to have no single source.

Directivity factor
The ration of the mean-square pressure (or intensity) on the axis of a transducer at a certain distance to the mean-square pressure (or intensity) which a spherical source radiating the same power would produce at that point.

Displacement
Time-varying quantity that specifies the change in position of a point on a body with respect to a reference frame. In the SI system it is measured in metres (m). In the imperial system thousands of an inch is often used (mils).

Dynamic capability
The dynamic capability of an intensity measurement system is determined by adding normally 5 dB (for a measuring error less than 2 dB) to the Residual Intensity Index.

Dynamic range
Range of values that can be measured.

Normally expressed as the ratio in dB between the smallest signal level an instrument can sense to the largest signal it will accept without an overload occurring. Modern vibration analysis instrumentation can have a dynamic ranges up to 160 dB.

Excitation
External force (or other input) applied to a system that causes the system to respond in some way.

Far-field
Distribution of acoustic energy at a very much greater distance from a source than the linear dimensions of the source itself; the region of acoustic radiation used to the source and in which the sound waves can be considered planar.

Filter
An electrical circuit that intercepts input signals and blocks those that are above or below a specific frequency band or a mechanical filter that suppresses vibration amplitude levels at certain frequencies.

Forced vibration
Vibration of a system due to an external time dependent force.

Free-field
An environment in which there are no reflective surfaces within the frequency region of interest.

Frequency response
Response within a given frequency range when the complex sensitivity of the transducer for a given excitation is not constant over that range. Often given as the magnitude and phase.

Frequency response function
Frequency-dependent ratio of the motion-response Fourier transform to the Fourier transform of the excitation force of a linear system. Frequency response measurements are used extensively in modal analysis of mechanical systems.

g_n (g)
Standard acceleration due to gravity.

Value adopted in the International Service of Weights and Measures and confirmed in 1913 by the 5th CGPM as the standard for acceleration due to gravity.

- Unit: 9.80665 meters per second-squared (9.80665 m/s^2)
- Symbol: g_n (in vibration literature, this if often shorted to g but should not be misunderstood as the gravitational force mentioned below)

This "standard value" (g_n = 9.80665 m/s^2 ≈ 386.089 in/s^2 ≈ 32.1740 ft/s^2) should be used for reduction to standard gravity of measurements made in any location on Earth.

Frequently, the magnitude of acceleration is expressed in units of g_n.

Note: The actual acceleration produced by the force of gravity at or below the surface of the Earth varies with the latitude and elevation of the point of observation. This variable often is expressed using the symbol g. Caution should be exercised if this is done so as not to create an ambiguity with this use and the standard symbol for the unit of the gram.

Ground loop
In instrumentation systems, such as vibration measurement data collection systems, it is often required to mount a transducer on a machine whose structure or "ground" may have an electrical voltage present on it caused by current leakage in motor windings, etc. The transducer cable shield is normally connected to the housing, and is then electrically connected to this voltage when the transducer is mounted. If the instrument to which the transducer is connected is connected to a different ground, such as a power line neutral, this difference in the ground potentials will cause a current in the shield, and this will add interference to the measured signal. The interference will be at 50 or 60 Hz and harmonics, and it reduces the signal to noise ratio of the measurement. This condition is called a ground loop, and there are several ways to avoid it. One is to use an insulating disc between the transducer and the machine, another is to use a battery operated instrument that is not connected to a power line.

Harmonics
Harmonic vibration, the frequency of which is an integral multiple of the fundamental frequency.

Hearing loss
An increase in the threshold of audibility due to disease, injury, age or exposure to intense noise.

Hertz (Hz)
The unit of frequency representing cycles per second.

High-pass filter
An electrical circuit that intercepts input signals and blocks those that are below a specific frequency band. Besides eliminating low-frequency noise, a high-pass filter separates a signal alternating components from its direct (DC) components.

IEPE
Integral Electronics Piezoelectric is a generic term for transducers with built-in electronics. A number of proprietary systems such as DeltaTron®, ISOTRON®, ICP® and PIEZOTRON® exist. See also CCLD.

Imaginary intensity
Imaginary intensity is the non-propagating part of the sound field (sometimes called the reactive part).

Impact test
Impact testing provides a method of determining the frequency response function of a structure. Accelerometers are placed on the structure, and an object, such as a specially constructed impact hammer, is used to hit the structure. The hammer is instrumented to measure the input force pulse, while the accelerometers pick up the response of the structure. From this vibrational response, it is important to be aware of excitation frequencies that coincide with the natural frequencies of the structure (resonances), as these point to dangerous operating levels.

Impedance, specific acoustic
The complex ration of dynamic pressure to particle velocity at a point in an acoustic medium.

Measured in rayls (1 rayl = 1 N · **S**/m^3)

Impedance, mechanical
The complex ratio of force to velocity at a specified point and degree-of-freedom in a mechanical system. It is a measure of how much a structure resists motion.

Infrasound
Sound at frequencies below the audible range, that is, below about 16 Hz.

Integration
Integration is the inverse of differentiation. See Differentiation.

Intensity
Intensity is the real part of the complex intensity and is the propagating part of the sound field (sometimes called the active part).

Isolation
A decreased tendency to respond to or transmit a sound through the use of resilient materials and structures.

Leakage, spectral
The broadening of a peak in the frequency domain caused by window function with the Fourier transform.

Leakage error
Error in frequency description caused by truncation of signal.

Leakage can be reduced using time weighting functions such as Hanning Window.

Level (of a quantity)
The logarithm of the ratio of the quantity to a reference of the same kind.

In vibration terminology, the term level is sometimes used to denote amplitude, average value, root-mean- square value, or ratios of these values. Use of these terms is depreciated.

.Linear system
A system in which the magnitude of the response is proportional to the magnitude of the excitation.

Loudness
Subjective impression of the intensity of a sound.

Low-pass filter
An electrical circuit that intercepts input signals and blocks those that are above a specific frequency called the 'cut-off frequency'. An example is the anti-aliasing filter.

Masking
The process by which threshold of audibility of one sound is raised by the presence of another (masking) sound.

Mobility (mechanical mobility)
The complex ratio of the velocity, taken at a point in a mechanical system, to the force, taken at the same or another point in the system. Mechanical mobility is the matrix inverse of mechanical impedance. It is a measure of how easily a structure is able to move in response to an applied force.

Modal analysis
Vibration analysis method that characterises a complex structural system by its modes of vibration, that is, its natural frequencies, modal damping and mode shapes, and based on the principle of superposition.

Near-field
That part of a sound field, usually within about two wavelengths from a noise source, where there is no simple relationship between sound level and distance.

Newton
The force required to accelerate a kg mass at 1 m/s^2. Approximately equal to the gravitational force on a 100 g mass.

Noise emission level
The dB(A) level measured at a specified distance and direction from a noise source, in an open environment, above a specified type of surface. Generally follows the recommendation of a national or industry standard.

Noise reduction coefficient, NRC
The arithmetic average of the sound absorption coefficients of a material at 250, 500, 1000 and 2000 Hz.

Noy
A linear unit of noisiness or annoyance.

Particle velocity
The velocity of air molecules about their rest position due to a sound wave.

Pascal, Pa
A unit of pressure corresponding to a force of 1 newton acting uniformly upon an area of 1 square metre. Hence:
1 Pa = 1 N/m^2

Peak
A measurement's maximum instantaneous value (displacement, velocity, acceleration or voltage) in a given period. Peaks can be both negative and positive in direction.

- peak value
- peak magnitude
- positive peak value
- negative peak value

Note: A peak value of vibration is usually taken as the maximum deviation of that vibration from the mean value. A positive peak value is the maximum positive deviation and a negative peak value is the maximum negative deviation.

Peak-to-peak value (of a vibration)
Difference between the maximum positive and maximum negative values of a vibration during a specified interval.

Phase
Argument of a complex vibration.

Phase mismatch (in acoustic measurements)
The relative phase mismatch between the two channels in an intensity measuring system.

Phon
The loudness level of a sound. It is numerically equal to the sound pressure level of a 1 kHz free progressive wave, which is judged by reliable listeners to be as loud as the unknown sound.

Pink noise
Broadband noise whose energy content is inversely proportional to frequency (–3 dB per octave or –10 dB per decade).

Power spectrum level
The level of the power is a band one hertz wide referred to a given reference power.

Pressure Residual Intensity Index, $L_{K,0}$
The pressure residual intensity index for a given measurement system is defined as the difference between the measured pressure level and the indicated sound intensity level when exactly the same signal is fed into the two channels of an intensity analysing system.

Random noise
Noise, whose instantaneous amplitude is not specified at any instant of time. Instantaneous amplitude can only be defined statistically by an amplitude distribution function.

Relative velocity
The rate of change of displacement. It is expressed in units of distance per unit of time. In terms of vibration signals, it would be millimetres per second or inches per second.

In general, velocity is time-dependent. A velocity is designated as relative velocity if it is measured with respect to a reference frame other than the primary reference frame designated in a given case. The relative velocity between two points is the vector difference between the velocities of the two points. Velocity can be oscillatory, in which case simple harmonic components can be defined by the velocity amplitude (and frequency), or random, in which case the root-mean-square (rms) velocity (and band-width and probability density distribution) can be used to define the probability that the velocity will have values within any given range. Velocities of short time duration are defined as transient velocities. Non-oscillatory velocities are defined as sustained velocities, if of long duration.

Residual Intensity Index
Residual Intensity Index in a given direction at a point is defined as the difference between the sound level and the sound pressure level measured in the given direction at that point. In practice L_K is normally negative.

Residual Intensity, $L_{I,R}$
The sound intensity level measured when the same signal is fed to both channels of a sound intensity measuring system, or it is exposed to a pure reactive field.

Residual Noise
For charge accelerometers, the noise is a function of the preamplifier and given within the specified frequency range. The specified noise level is measured with NEXUS Conditioning Amplifier Type 2692-001. For accelerometers with integrated electronics, the noise is given within specified frequency range.

Resonance
State of a system in forced oscillation when any change, however small, in the frequency of excitation causes a decrease in a response of the system.

Resonance frequency
Frequency at which resonance exists.

Reverberation
The persistence of sound in an enclosure after a sound source has been stopped. Reverberation time is the time, in seconds required for sound pressure at a specific frequency to decay 60 dB after a sound source is stopped.

RMS (Root Mean Square)
The square root of the arithmetic average of a set of squared instantaneous values.

Sabin
A measure of sound absorption of a surface. One metric sabine is equivalent to 1 square metre of perfectly absorptive surface.

Seismic
When accelerated, a seismic transducer such as a piezoelectric accelerometer or a velocity transducer, uses the inertial force produced by its seismic mass to generate a signal.

Semi-anechoic field
A free field above a reflective plane.

Sensitivity (of a transducer)
Ratio of a specified output quantity to a specified input quantity.

For an accelerometer, it is expressed in millivolts per m/s^2 or per g (mV/ms^{-2} or mV/g) or picocoulombs per m/s^2 or g (pC/ms^{-2} or pC/g). The sensitivity of a transducer is usually determined as a function of frequency using sinusoidal excitation.

Shielding
Enclosure of test equipment and cables to prevent the occurrence of noise in a signal (such as interference, interaction or current leaks).

Shock
Sudden change of force, position, velocity or acceleration that excites transient disturbances in a system.

The change is normally considered sudden if it takes place in a time that is short compared with the fundamental periods of concern.

Sone
A linear unit of loudness. The ration of loudness of a sound to that of a 1 kHz tone 40 dB above the threshold of hearing.

Sound
Energy that is transmitted by pressure waves in air or other materials and is the objective cause of the sensation of hearing. Commonly called noise if it is unwanted.

Sound intensity
The rate of sound energy transmission per unit area in a specified direction.

Sound level
The level of sound measured with a sound level meter and one of its weighting networks. When A-weighting is used, the sound level is given in dB(A).

Sound level meter
An electronic instrument for measuring the RMS level of sound in accordance with an accepted national or international standard.

Sound power
The total sound energy radiated by a source per unit time.

Sound power level
The fundamental measure of sound power. Defined as:

$$L_W = 10 \log \frac{P}{P_0} \text{dB}$$

Where P is the RMS value of sound power in watts, and P_0 is 1 pW.

Sound pressure
A dynamic variation in atmospheric pressure. The pressure at a point in space minus the static pressure at that point.

Sound pressure level
The fundamental measure of sound pressure. Defined as:

$$L_p = 20 \log \frac{p}{p_0} \text{dB}$$

Where p is the RMS value (unless otherwise stated) of sound pressure in pascals, and p_0 is 20 μPa for measurements in air.

Sound transmission class, STC
A single-number rating for describing sound transmission loss of a wall or partition.

Sound transmission loss
Ratio of the sound energy emitted by an acoustical material or structure to the energy incident upon the opposite side.

Standing wave
A periodic wave having a fixed distribution in space which is the result of interference of progressive waves of the same frequency and kind. Characterised by the existence of maxima and minima amplitudes that are fixed in space.

Transducer
A device designed to convert energy from one form to another in such a manner that the desired characteristics of the input energy appear at the output. Includes accelerometers, eddy current probes, loudspeakers, microphones and velocity transducers.

Note 1: The output is usually electrical.
Note 2: The use of the term "pick-up" is deprecated.

Transient vibration
Vibration that decays with time. This term is basically associated with mechanical shock.

Triaxial
Three axes. A triaxial accelerometer is a single instrument with three sensing elements oriented to measure vibration in three axes.

Triboelectric Noise
Generated by movement in the cable's components, resulting in charge or voltage noise signals. Mechanically induced noise is a critical and frequent concern when using charge accelerometers.

Trigger
An electric impulse that is used as a timing reference, generally for purposes of initiating a process or measurement.

Ultrasound
Sound at frequencies above the audible range, that is, above about 20 kHz.

Unigain
The sensitivity of Unigain accelerometers are guaranteed within tight tolerances for easy interchangeability without recalibration. This designation indicates that the measured accelerometer sensitivity has been adjusted during manufacture to within 2% of a convenient value.

Velocity
The rate of change of position or displacement in relation to time along a specified axis.

Vibration
Mechanical oscillations about an equilibrium point. The oscillations may be periodic or random.

Wavelength
The distance measured perpendicular to the wavefront in the direction of propagation between two successive points in the wave, which are separated by one period. Equals the ratio of the speed of sound in the medium to the fundamental frequency.

Weighting network
An electronic filter in a sound level meter which approximates under defined conditions the frequency response of the human ear. The A-weighting network is most commonly used.

White noise
Broadband noise having constant energy per unit of frequency.

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