Product Data

DeltaShear®

Piezoelectric DeltaShear® Accelerometers
Uni-Gain®, DeltaTron® and Special Types

"V" Types: 4321V, 4370V, 4371V, 4375V, 4381V, 4382V, 4383V, 4384V, 4391V and 4393V
Uni-Gain® Types: 4321, 4370, 4371, 4375, 4378, 4379, 4381, 4382, 4383, 4384, 4391, 4393,
Uni-Gain® DeltaTron® Types: 4394, 4395, 4396, 4397, 4398 and 4399
Special Types: 4326, 4374, 8305, 8309, 8318 and 8319

USES:

- Shock and vibration measurement and analysis
- Vibration monitoring
- Modal and structural analysis
- Vibration test control
- Production and quality control

FEATURES:

- Competitively priced DeltaShear® "V" Types, especially suitable for permanent set-ups
- Uni-Gain® types for easy interchangeability
- DeltaTron® and Line-drive types with integral preamplifer
- Acceleration ranges cover 20 μms^{-2} to 1000 kms^{-2}
- Frequency ranges cover from a fraction of a Hz to 60 kHz (+10% limit)
- Temperature ranges cover –74°C to +250°C (–101 to +482°F)
- Low sensitivity to extraneous environmental influences including temperature fluctuations
- Low sensitivity to base bending effects
- Individual calibration supplied
- Artificially aged for long term stability

The Brüel & Kjær transducer range incorporates accelerometers suitable for nearly all application requirements. In addition to the comprehensive range of piezoelectric accelerometers described in this Data Sheet, Brüel & Kjær supply accelerometers for heavy-duty industrial use and transducers specifically designed for special purpose applications.

A summary of other Brüel & Kjær accelerometers is given on the back cover and further details of these transducers are given in their respective Product Data sheets.

The active element of Brüel & Kjær accelerometers consists of piezoelectric discs or slices loaded by seismic masses and held in position by a clamping arrangement. When the accelerometer is subjected to vibration, the combined seismic mass exerts a variable force on the piezoelectric element. Due to the piezoelectric effect, this force produces a corresponding electrical charge.

For frequencies from DC up to approximately one third of the resonance frequency of the accelerometer assembly, the acceleration of the seismic mass is equal to the acceleration of the whole transducer. Consequently, the charge produced by the piezoelectric element is proportional to the acceleration to which the transducer is subjected.

The electrical signal output from Brüel & Kjær Accelerometers is self-generated, though the types with built-in preamplifiers require an external power supply for this signal to be measured.

All the piezoelectric accelerometer types described in this Product Data sheet are supplied with an individual calibration chart and in most cases an individually measured frequency response curve. Data from these charts are summarized in the Specifications.

"V" and Uni-Gain® Types

Some of the piezoelectric accelerometers described in this Product Data sheet are available both as "V" types as well as Uni-Gain® types. The DeltaShear® without Uni-Gain® types are recognized by the "V" suffix in the type name. The only difference between these two types is that all the specifications on the calibration chart for "V" types, except the sensitivity, are typical. In contrast the sensitivity and other parameters for the Uni-Gain® accelerometers are guaranteed within tight tolerances for easy interchangeability without recalibration (see specifications on page 16 and 17). Except for the sensitivity, everything in this Product Data applies to both types.

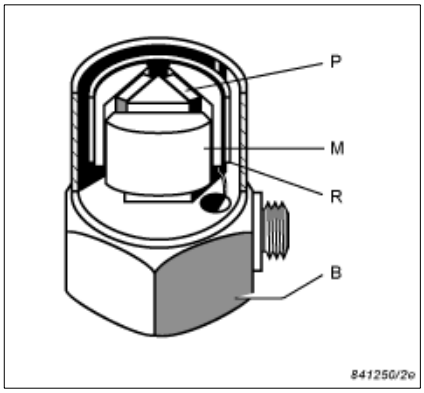


Fig.1 The unique Brüel & Kjær DeltaShear® design. M = Seismic Mass, P = Piezoelectric Element, B = base and R = Clamping Ring

Uni-Gain® Sensitivity

This designation indicates that the measured accelerometer sensitivity has been adjusted during manufacture to within 2% of a convenient value, for example (in 10 dB steps) 1, 3.16 or 10 pC/ms^{-2}.

Design and Construction

All the accelerometers except Types 4321, 4321V and 4326 measure uniaxial acceleration. These types measure accelerations in three mutually perpendicular directions.

With the exception of Triaxial Accelerometer Type 4326, Miniature Accelerometer Type 4374, Standard Reference Accelerometer Type 8305 and Shock Accelerometer Type 8309, all the piezoelectric accelerometers in this data sheet use the DeltaShear® design (see Fig. 1). Type 4374 uses the planar shear design, Type 8305 uses the inverted centre mounted compression design and Type 8309 uses the centre mounted compression design as shown in Fig. 3.

The piezoelectric elements of most of the accelerometers are PZ 23 lead zirconate titanate elements. The Shock Accelerometer Type 8309 has a specially formulated ferroelectric ceramic PZ 45. The Miniature Accelerometer Type 4374 and the High Sensitivity Accelerometers Types 4378 and 4379 have a lead zirconate titanate element PZ 27.

The housing material of all the accelerometers is the same as the base material (given in the Specifications) except Type 4374, which has an nickel-chromium alloy housing.

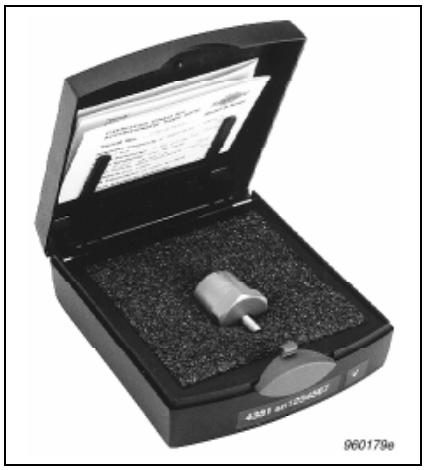


Fig.2 All DeltaShear® "V" types are supplied in a robust plastic box

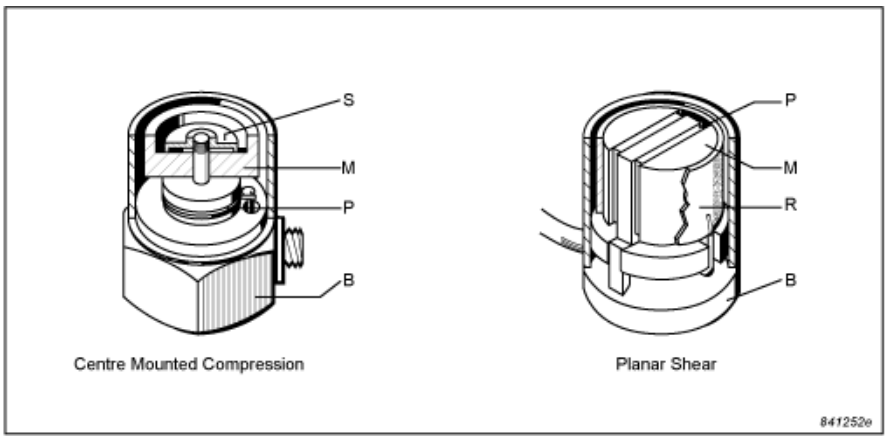


Fig.3 Comparison and PlanarShear designs. M = Seismic Mass, P = Piezoelectric Element, B = Base, R = Clamping Ring and S = Spring

Characteristics

Charge and Voltage Sensitivity
A piezoelectric accelerometer may be treated as a charge or voltage source. Its sensitivity is defined as the ratio of its output to the acceleration it is subjected to, and may be expressed in terms of charge per unit acceleration (e.g. pC/ms^{-2}) or in terms of voltage per unit acceleration (e.g. mV/ms^{-2}).

The sensitivities given in the individual Calibration Charts have been measured at 160 Hz with an acceleration of 100 ms^{-2}. For a 99.9% confidence level the accuracy of the factory calibration is ±2% and includes the influence of the connecting cable supplied with each accelerometer. With the exception of Triaxial Accelerometers Types 4321, 4321V and 4326, the direction of main axis sensitivity for these accelerometers is perpendicular to the base plane of the accelerometers. Types 4321, 4321V and 4326 have three mutually perpendicular axes of sensitivity.

DeltaShear® Accelerometers
The Delta design involves three piezoelectric elements and three masses arranged in a triangular configuration around a triangular centre post, as illustrated in Fig. 1. The Delta Shear® design gives a high sensitivity-to-mass ratio compared to other designs, a relatively high resonance frequency and high isolation from base strains and temperature transients. The excellent overall characteristics of this design make it ideal for both general purpose accelerometers and more specialized types.

DeltaTron® Accelerometers
DeltaTron® accelerometers operate on a constant-current power supply and give output signals in the form of voltage modulation on the power supply line. Types 4394, 4395 and 4396 have insulated base. All DeltaTron® accelerometers are individually calibrated Uni-Gain® types.

Line-drive Accelerometers
High Sensitivity Line Drive Accelerometer Type 8318 and Underwater Accelerometer Type 8319 have built-in preamplifiers and operate according to the principle of current modulation (constant voltage supply). The Line-drive principle allows cable lengths of up to 1 km.

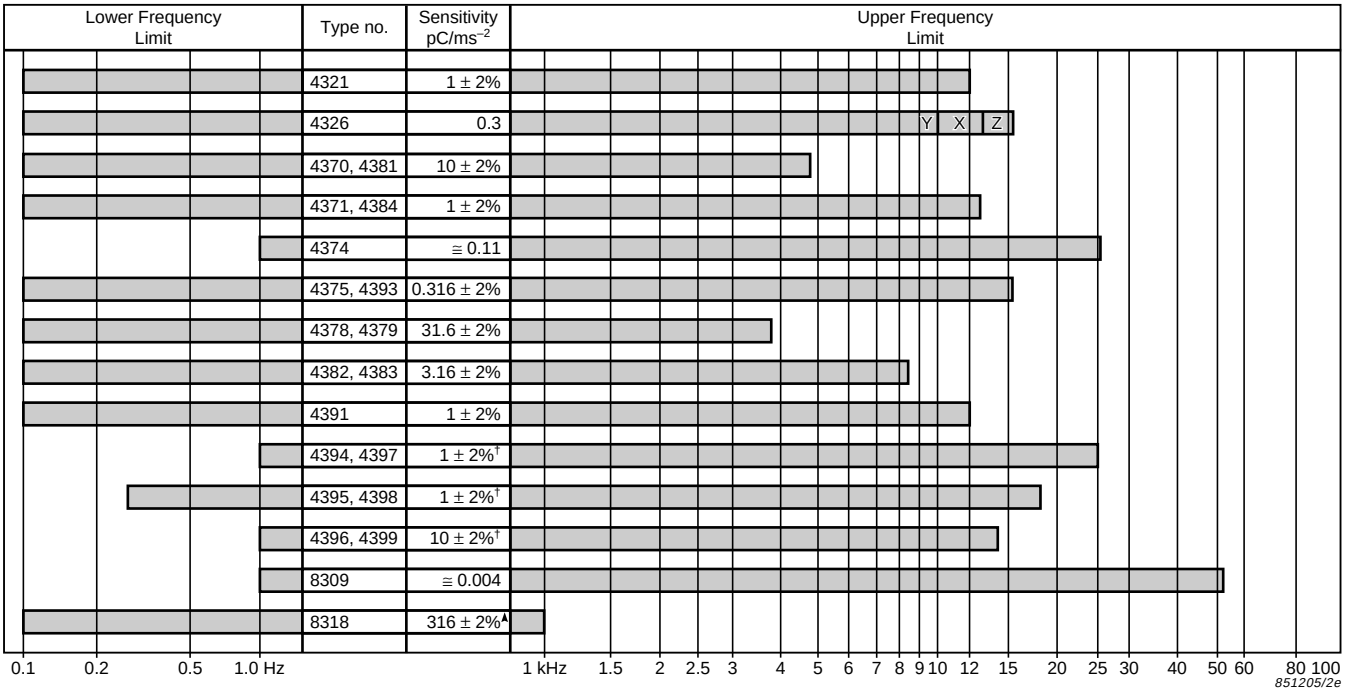


Fig. 4 Upper and lower frequency limits (10%) and sensitivities of accelerometers. ▲ denotes a line-drive type where the sensitivity is given in $\mu A/ms^{-2}$. Frequency limits also apply to "V" types

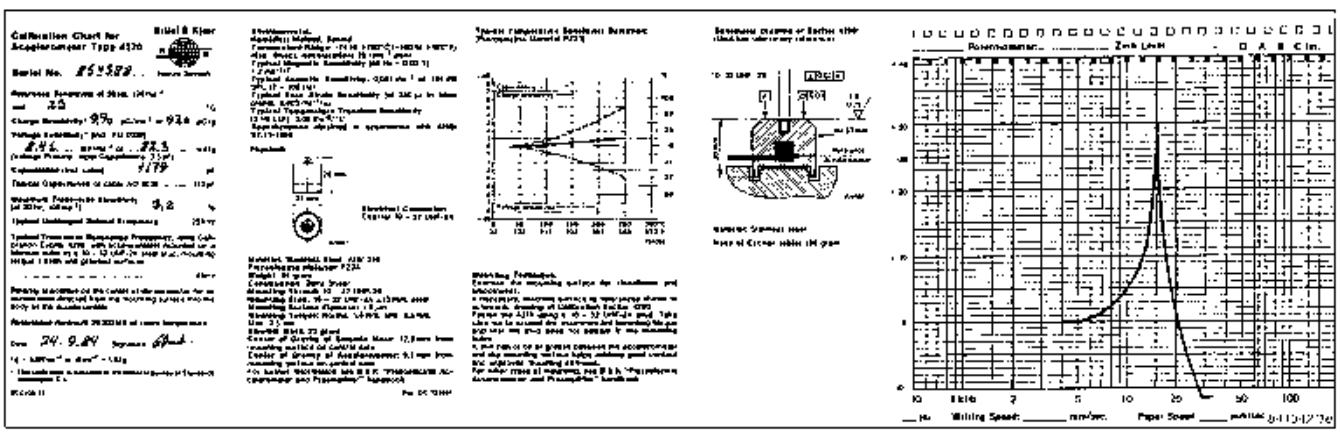


Fig. 5 Example of the calibration chart supplied with the Brüel & Kjær accelerometers, together with a frequency response curve

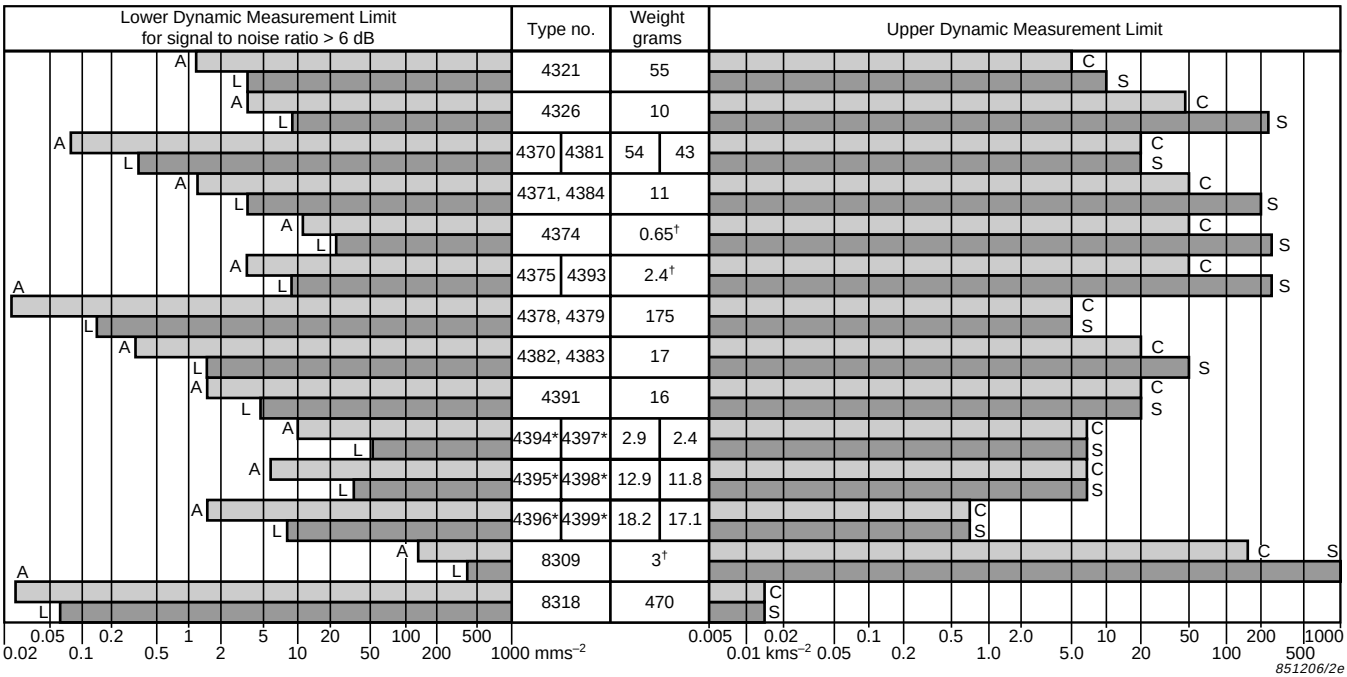


*Fig.6 Upper and lower dynamic measurement limits and weights of the accelerometers. Maximum limits (C = continuous sinusoidal vibration and S = shock) are peak values. Minimum limits (A = 1/3-octave bandwidth up to individual accelerometer +10% upper frequency limit and L = Lin 2 Hz to 22 kHz) are RMS values. The dynamic limits are typical measurable vibration levels using the accelerometers plus Brüel & Kjær Charge Amplifier Type 2635. † denotes cable weight excluded. * Upper limit for shock is measured in the axial direction. Limits also apply to "V" types*

Transverse Sensitivity

Accelerometers are slightly sensitive to acceleration normal to their main sensitivity axis. This transverse sensitivity is measured during the factory calibration process using a 30 Hz and 100 ms^{-2} excitation, and is given as a percentage of the corresponding main axis sensitivity.

Most Uni-Gain®-Delta Shear® types have an indication of the angle of minimum transverse sensitivity.

Frequency response

The upper frequency limits given in the specifications are calculated as 30% and 22% of the mounted resonance frequency to give errors of less than 10% and 5% respectively. These calculations assume that the accelerometer is properly fixed to the test specimen, as poor mounting can have a marked effect on the mounted resonance frequency.

The low-frequency response of an accelerometer depends primarily on the type of preamplifier used in the measurement set-up. A detailed discussion of the effects of the measuring system on the low-frequency response of an accelerometer is given in the Brüel & Kjær "Piezoelectric Accelerometers and Vibration Preamplifiers Handbook".

Line-drive Accelerometer Type 8318 and Underwater Accelerometer Type 8319 have a built-in preamplifier with a specified lower limiting frequency (LLF 10% limit) of 0.1 Hz and 0.3 Hz respectively.

Most of the standard piezoelectric accelerometers types are supplied with an individual frequency response curve attached to their calibration chart. Types 4374, 4375, 4393 and all Delta Shear® (without Uni-Gain®) types are not supplied with individual curves.

DeltaTron® types are supplied with individual frequency curves from 10 to 10000 Hz as well as typical curves above and below this range.

Transverse Resonance Frequency

Typical values for the transverse resonance frequency are obtained by vibrating the accelerometers mounted on the side of a steel or beryllium cube using a Calibration Exciter Type 4290.

Phase Response and Damping

The low damping of Brüel & Kjær Accelerometers leads to the single, well defined resonance peak plotted on the individual frequency response curves. Brüel & Kjær accelerometers can be used at frequencies up to 30% of their mounted resonance frequency without noticeable phase distortion being introduced. The phase response up to this frequency is 0° ±1°.

Dynamic Range

The dynamic range defines the range over which its electrical output is directly proportional to the acceleration applied to its base.

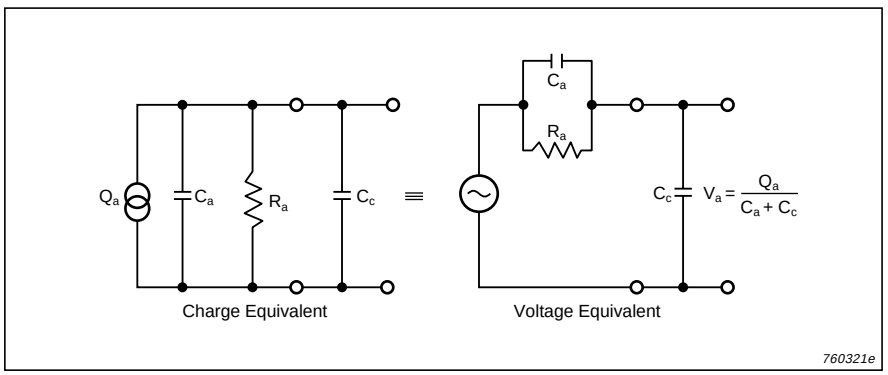


Fig.7 Equivalent circuit diagrams for accelerometers

Upper Limit

In general, the smaller the accelerometer the higher the vibration level at which it can be used. The upper limit depends on the type of vibration, and is determined by the prestressing of the piezoelectric element as well as by the mechanical strength of the element.

For accelerometers with built-in preamplifiers, the maximum shock and continuous vibration limits given in the Specifications are measuring limits. For transportation and handling the maximum shock (± Peak Transport) and maximum continuous sinusoidal acceleration (± Peak Transport) limits for the Type 8318 are 1 kms^{-2} and 0.3 kms^{-2} respectively.

The maximum shock and continuous vibration limits are specified for vibration in any direction and for frequencies of up to one third of the mounted resonance frequency.

When measuring short duration transient signals, care must be taken to avoid ringing effects due to the high-frequency resonance of the accelerometer. A general rule of thumb for a half sine shock pulse to obtain amplitude errors of less than 5%, is to ensure that the duration of the pulse exceeds $10/f_R$, where f_R is the mounted resonance frequency of the accelerometer.

Lower Limit

Theoretically, the output of a piezoelectric accelerometer is linear down to the acceleration of the seismic mass due to the thermal noise, but a practical lower limit is imposed by the noise level of the measurement system and by the environment in which measurements are made. Details concerning the selection of a suitable preamplifier, together with a discussion of environmental influences, can be found in the Brüel & Kjær "Piezoelectric Accelerometers and Vibration Preamplifiers" handbook.

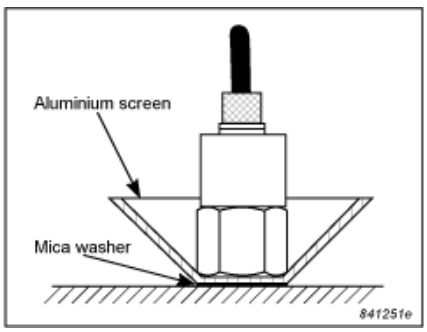


Fig.8 Aluminium screen used as a heat shield allowing the accelerometer to be operated at high temperatures (for example, Type 4370 up to 350°C

Electrical Impedance

Fig. 7 shows the equivalent circuit diagram for accelerometers without built-in preamplifiers. Since the leakage resistance is very high, the accelerometers can be regarded as purely capacitive and the capacitances given in the Specifications are measured at 160 Hz.

Line-drive accelerometers can be regarded as current sources, the ideal output impedance for a current source being infinite. The output impedance of these accelerometers is specified as a minimum resistance in Ohms (Ω).

DeltaTron® accelerometers can be regarded as voltage sources, the ideal output impedance for an output source being zero. The output impedance of these accelerometers is specified as a maximum resistance in Ohms (Ω).

Environmental Characteristics

Temperature

All Brüel & Kjær accelerometers are rated for a maximum operating temperature limit. At lower temperatures, the accelerometer piezoelectric element will exhibit temperature dependent variations in charge and voltage sensitivity, as well as impedance. Details of these variations are given on the individual calibration chart supplied with each accelerometer (see Fig. 5).

The lower temperature limit for most accelerometers is specified as –74°C (–101°F), though this does not preclude the use of the accelerometers at lower temperatures.

To make measurements on surfaces with very high temperatures some form of cooling is needed. Fig. 8 illustrates a method using a thin conductive plate and mica washer. For a 250°C (482°F) accelerometer this methods allows measurements to be made on surfaces with temperatures of up to 350°C (662°F). With extra cooling, achieved by directing a stream of cooling air at the plate, surface temperatures of up to 450°C (842°F) may be tolerated.

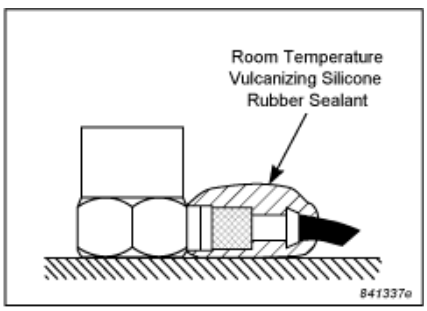


Fig.9 Sealing the accelerometer output connector for operation in humid environments

When the insulating stud YP 0150 is used to mount an accelerometer at operating temperatures greater than 80°C, creeping may occur causing a reduction in the mounted resonant frequency, and a lowering of the maximum shock capability.

Temperature Transients

Piezoelectric accelerometers exhibit a small sensitivity to temperature fluctuations. This effect is significant when low frequency, low level accelerations are being measured.

The temperature transient sensitivity is determined by attaching the accelerometer to an aluminium block, with a weight approximately ten times that of the accelerometer, and immersing these in a liquid bath where the temperature difference from room temperature is approximately 30°C. The maximum resulting output from the accelerometer is recorded, and the sensitivity given in $ms^{-2}/°C$ for a specified LLF. This output will be approximately inversely proportional to the LLF.

Humidity

Brüel & Kjær accelerometers are sealed with either a welded, or epoxy sealed housing giving a high resistance to the majority of corrosive agents found in industry. Use of moisture impervious Teflon cables and sealing, as shown in Fig. 9, will permit use in environments where heavy condensation is likely. Suitable sealants are Dow Corning's RTV 738 or similar compounds.

Acoustic Pressure

The acoustic sensitivity of Brüel & Kjær accelerometers is low and for most vibration measurement applications can be neglected. Normally the acoustically induced vibration signal from the structure being measured is much greater than the signal due to the acoustic sensitivity.

The acoustic sensitivity is specified as the equivalent acceleration given by a 154 dB sound pressure level and measured in the frequency range 2 to 100 Hz.

Nuclear Radiation

Except Types with built-in preamplifier all Brüel & Kjær accelerometers

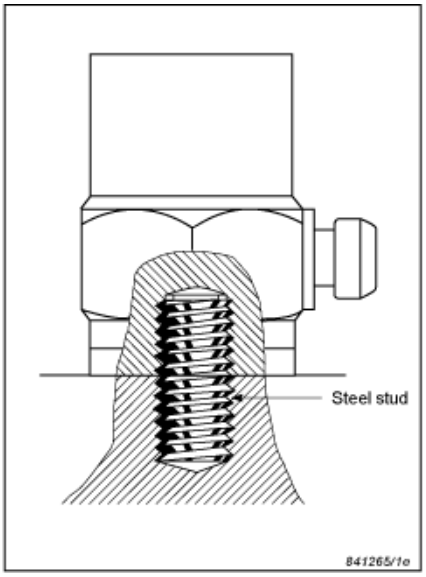


Fig.10 Recommended mounting technique using a steel stud

may be used under gamma radiation (100 Gy/h, 6 MeV) up to accumulated doses of 20 kGy (1 Gy = 100 Rad). Tests indicate that these accelerometers show less than 10% sensitivity change after such exposure. Normal types of accelerometer cable may be used, but special cables are recommended for accumulated doses exceeding 1 kGy. For greater exposure levels or for use under heavy neutron radiation, Industrial Accelerometer Type 8324 is recommended, and special cables are available (see separate Product Data sheet).

Base Strains

These may be introduced into the accelerometer by distortion of the structure being measured. To minimise base strain outputs the DeltaShear® design is used.

The base strain sensitivity of Brüel & Kjær accelerometers is measured by mounting the accelerometer on a cantilever beam, and producing a strain of 250 με at the point of attachment. The sensitivity is calculated from the resulting output, and is given in $ms^{-2}/\mu\varepsilon$.

Mounting

Brüel & Kjær accelerometers can be mounted with their main sensitivity axis aligned in any direction.

Recommended Mounting Technique

Fig. 10 shows the recommended mounting method for most of the accelerometer types. The accelerometers are screwed using a threaded steel stud onto a clean metal surface meeting the requirements specified in Fig. 11. Under normal circumstances the absolute minimum depth of 4 mm will not be sufficient to accommodate the mounting stud, but is the minimum depth required to hold a stud securely. The optimum torque for tightening 10–32 UNF steel studs is 1.8 Nm (15 lb in), for M3 steel studs it is 0.6 Nm (5 lb in) and for M8 steel studs it is 4.6 Nm (38 lb in).

This mounting method is used in obtaining the specifications of all the accelerometers with the following exceptions:

Type 4374 which, due to its small size, cannot be mounted using a stud. The recommended mounting technique, used to obtain the specifications, utilises a quick setting methyl cyanoacrylate cement (Brüel & Kjær no. QS 0007). The tolerances on the clean metal mounting surface shown in Fig. 11 are required.

Type 8309 has an M5 metric screw stud as an integral part of its base. The tolerances shown in Fig. 11 apply, and the optimum torque is 1.8 Nm (15 lb in).

When using the recommended technique, it should also be noted that if the mounting surface is not perfectly smooth, the application of a thin layer of grease to the base of the accelerometer before screwing it down on the mounting surface will improve the mounting stiffness.

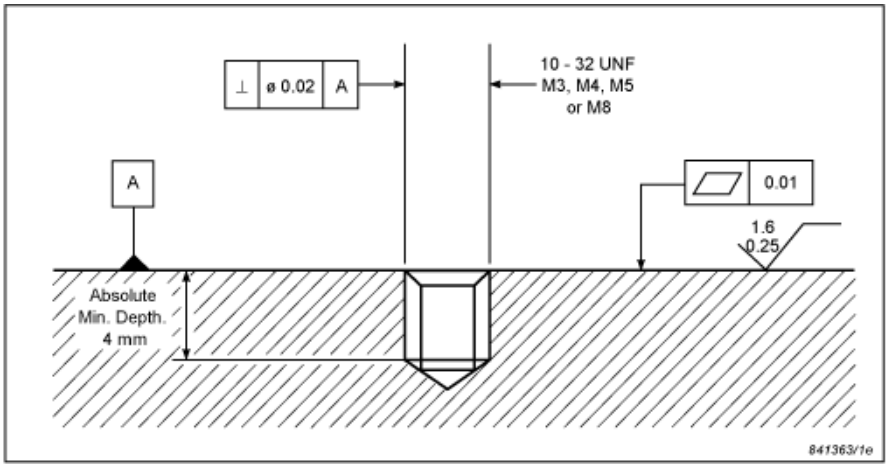


Fig.11 Recommended tolerances for the mounting surfaces. Dimensions and symbols in accordance with ISO 1101

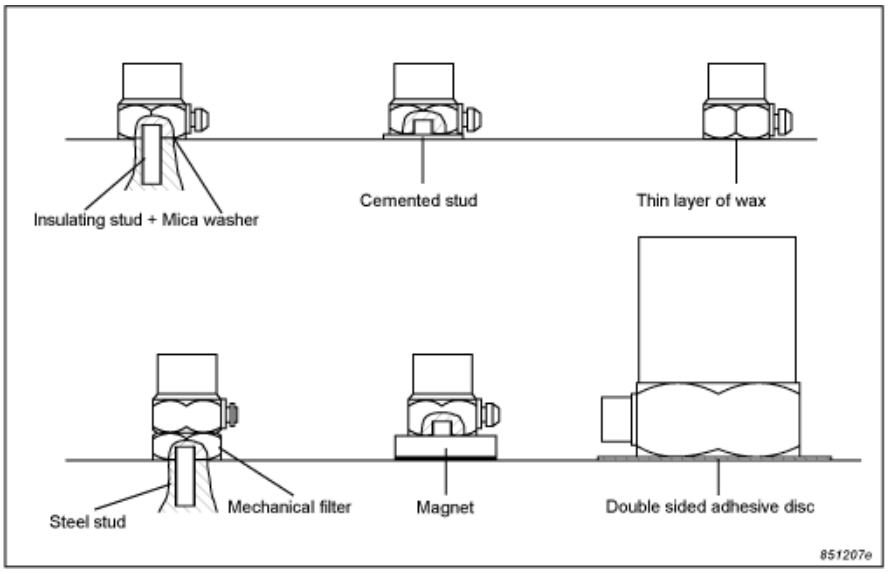


Fig.12 Alternative mounting techniques

Alternative Mounting Techniques

When mounting techniques other than the recommended technique are used, the accelerometer mounted resonance frequency will probably be lowered.

Fig. 12 shows some alternative mounting techniques. The section en-

titled Standard Accessories lists the mounting accessories that are supplied with the individual accelerometer types. These mounting techniques are described in more detail in the Brüel & Kjær "Piezoelectric Accelerometers and Vibration Preamplifiers" handbook, where the effects of the different methods on the frequency response curve of an accelerometer are illustrated.

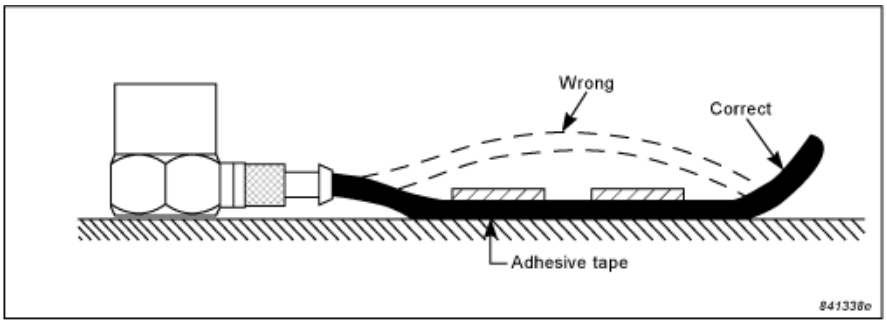


Fig.13 Clamping the accelerometer cable to minimize cable noise

Connecting Cables

A number of cables are available for connection of Brüel & Kjær accelerometers. Refer to page 19 and 20 for an overview of the various cables and connector types.

Types 4391, 4391V and 4391E require TNC connectors. Type 8318, which also requires a TNC connector, is supplied with a spiral, TNC to TNC connector, cable AO 0268. Type 8319 is supplied with a 10 m integral cable with a TNC connector. Miniature Accelerometers Types 4374, 4375 and 4375V have integral cables, with a minimum length of 0.32 m, and miniature coaxial plugs. Furthermore, extension connectors and cable AO 0038 are supplied.

Types 4393 and 4393V require subminiature connectors. Type 4393 is supplied with a subminiature to miniature plug coaxial cable AO 0283.

All cables include a special noise reduction treatment and are individually tested with regard to mechanical and electrical performance. The max. temperature rating is 260°C (500°F) except for cable AO 0268 which is rated at 85°C (185°F).

DeltaTron® accelerometers are supplied with a double-screened cable to reduce the electromagnetic interference to the absolute minimum.

The section entitled Standard Accessories lists the cables and connectors supplied with each accelerometer. Additional cable lengths and connectors can be ordered (see Additional Accessories Available and the Cables With and Without Connectors table). Details of the accelerometer connections and recommended plug clearances can be found in the section entitled Accelerometer Dimensions.

It is good practice to clamp down loose cables, as shown in Fig. 13, and this will also help to reduce any possibility of dynamically induced noise being generated by the cables.

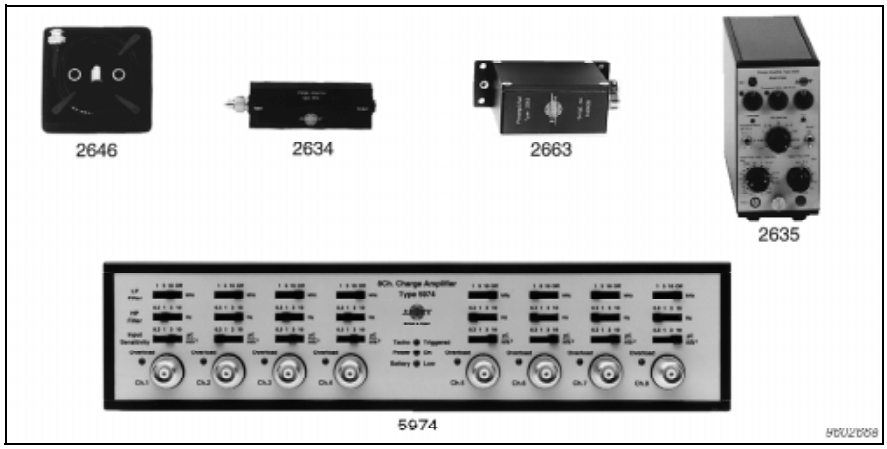


Fig.14 Brüel & Kjær vibration preamplifiers with charge input

Fig.15 Calibration instrumentation

Preamplifiers and Power Supplies

With the exception of DeltaTron® accelerometers that have built-in preamplifiers, the outputs from Brüel & Kjær charge accelerometers need to be fed through a preamplifier. Charge amplifiers are recommended, and Brüel & Kjær produce a wide selection of high performance preamplifiers for this purpose (see Fig. 14). Details of these can be found in their respective Product Data sheets.

DeltaTron® accelerometers require Single Channel DeltaTron® Power Supply WB 1372 or 8 Channel DeltaTron® Supply Type 5963. DeltaTron® Amplifier Type 2646 is a miniature charge to DeltaTron® amplifier.

Line Drive Accelerometer Type 8318 and Underwater Accelerometer Type 8319 have a built-in preamplifier, but require Preamplifier EQ 2126 and Power Supply EQ 2127 due to the line drive principle. Type 8318 can also be supplied as 8318/WH 2146 with charge output.

Using charge preamplifiers, very long connection cables can be used without altering the specified sensitivity of the accelerometer and preamplifier combination.

Since ease of calibration and measurement are usually just as important as overall gain and frequency range, most Brüel & Kjær Preamplifiers have one or more of the following signal conditioning aids:

Sensitivity Conditioning Networks
Allow direct dial-in of transducer sensitivity on the preamplifier, giving unified system sensitivities.

Integration Networks
Automatically convert measured acceleration to a velocity and/or displacement proportional signal.

High- and Low-pass Filters
Permit selection of different lower and upper frequency limits on the preamplifier to exclude unwanted signals and the influence of the accelerometer resonance from measurements.

Calibration

Factory Calibration
Brüel & Kjær accelerometers are thoroughly checked and examined at all stages of manufacture and assembly. Each accelerometer undergoes an extensive calibration procedure and artificial ageing process so as to ensure completely predictable performance and stable operation. Accurate numerical details of the calibration are reported on the calibration chart supplied with each transducer (see Fig. 5).

Calibration of Brüel & Kjær Piezoelectric Accelerometers is by back-to-back comparison with a primary reference standard accelerometer calibrated at the Danish Primary Laboratory of Acoustics (DPLA), regularly checked by the American National Institute of Science and Technology (NIST), the German Physikalisch–Technische Bundesanstalt (PTB) for traceability. The overall accuracy of the back-to-back comparison is 2% with a 99.9% confidence level (1.6% for a 99% confidence level), while for the interferometry method the accuracy is better than ±0.6% with a 99% confidence level.

Subsequent Calibration
Regular calibration of accelerometers helps maintain confidence in the measurements taken and indicates whether accelerometers have been damaged. To help users perform their own frequency response, sensitivity and system calibration, Brüel & Kjær manufacture the apparatus shown in Fig. 15, for which separate Product Data sheets are available.

Individual Brüel & Kjær Accelerometer Types

Dimensions and specifications for the accelerometers can be found in the schemes given towards the end of this Product Data sheet. In addition to the general features so far described, some of these accelerometers have been designed for more specialized applications, and the special features of these accelerometers are discussed below.

Accelerometers with an Insulated Base

Types 4391, 4391V and 4391E
See Fig. 16. Industrial Accelerometer Type 4391V is also available as Uni-Gain® Accelerometer Type 4391. The Uni-Gain® version has a tolerance of ±2%. Both types are suitable for most vibration measurement applications and are certified intrinsically safe to EEx ia IIA T4, T5 and T6. Intrinsically Safe Accelerometer Type 4391E is a special version that is certified intrinsically safe to EEx ia I/IIC T4, T5 and T6.

The base of Types 4391/V/E is electrically insulated to prevent ground loops which might otherwise distort the vibration signal being measured. The accelerometers are tested at 500 V and typically show that the resistance to ground loop effects is 50 MΩ.

Connection to other instruments is made using a sturdy top mounted TNC connector. A strong spiral-wound mini-noise cable AO 0268 is available for use with these accelerometers.

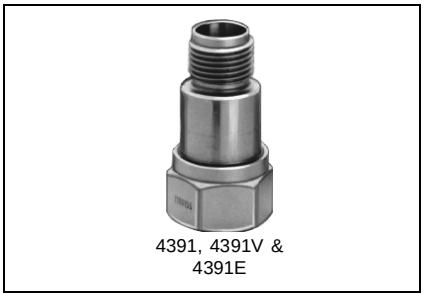

4391, 4391V & 4391E

Fig. 16

Fig. 17

DeltaTron® Accelerometers Types 4394, 4395, 4396, 4397, 4398 and 4399
The DeltaTron® accelerometers (Fig. 17) are constructed to the proven Brüel & Kjær DeltaShear® design with the addition of an integral preamplifier. They require an external constant-current power supply and operate as voltage sources.

DeltaTron® accelerometers operate over a frequency range from below 1 Hz to approximately half the resonance frequency of the accelerometer assembly. They are available in two forms, with or without an insulated base. For further details see the separate Product Data sheet.

Triaxial Accelerometers Types 4321 and 4321V
Consist of three separate Delta Shear® Accelerometers in a single housing which are accurately aligned so that vibration in three mutually perpendicular directions can be measured (Fig. 18).

Triaxial Accelerometer Type 4326
Type 4326 (Fig. 19) has three separate ThetaShear® accelerometers in a miniature housing. Its size and weight make it ideal for use in confined spaces or with delicate structures. Type 4326 has M3


4321 & 4321V

Fig. 18

Fig.19

subminiature connectors made of titanium.

High Sensitivity Line-drive Accelerometer Type 8318

Type 8318 (Fig. 20) is a very high sensitivity DeltaShear® accelerometer with a built-in line-drive preamplifier. The Uni-Gain® sensitivity is 316 μA/ms^{-2}.

The high sensitivity of this accelerometer makes it suitable for measuring very low level vibrations over a frequency range of 0.1 Hz to 1 kHz (10% limit). With a third octave or narrow band filter included in the measuring arrangement, measurement of vibration levels down to 0.000 02 ms^{-2} is possible. Principal applications are in vibration investigations on large structures such as buildings, bridges and ships. It is also useful for seismic work.

Due to the line drive principle a Preamplifier Type EQ 2126 and a Power Supply EQ 2127 are required. 8318/WH 2146 is a special version of 8318 with charge output.

Connection to measuring instruments is made via a TNC connector, and a 1.1 m long spiral TNC to TNC cable is supplied with the accelerometer. The spiral cable can stretch to approx. 4 m without being damaged.

For mounting the 8318, 16 mm long M8 threaded steel studs are supplied with the accelerometer as standard accessories. Four self-adhesive mounting discs DU 0079 are also supplied.

Fig.20

Fig.21

Miniature Accelerometer Type 4374

This accelerometer (Fig. 21) has been designed to measure the vibration of very lightweight structures where high level, high frequency vibration signals are commonly encountered, and where the use of heavier transducers would alter the mode of vibration, invalidating measurements. Typical application areas are measurements on thin vibrating panels, model testing, work in confined spaces and measurement of moderately high level shock.

Type 4374 features a planar shear construction, weighs 0.65 grams (excluding cable) and is suitable for measurement at frequencies up to 26 kHz (10% limit). The accelerometer has an integral 32 to 40 cm long connection cable with miniature coaxial plug attached, and has a plane base for wax or cement mounting.

Miniature Accelerometers Types 4375, 4375V, 4393 and 4393V

These accelerometers (Fig. 22) are suitable for measurements on lightweight structures where relatively high level, high frequency vibrations are found. The principal application areas are similar to those of the Type 4374.

Types 4375, 4375 V, 4393 and 4393 V have a DeltaShear® construction. Types 4375 and 4393 are Uni-Gain® types. All types weigh 2.4 grams (excluding cable), and can be used for measurement of frequencies up to 16.5 kHz (10% limit).

Types 4375 and 4375 V have an integral 32 to 40 cm long connection cable with miniature coaxial plug attached. Types 4393 and 4393 V have a sub-miniature coaxial socket for cable connection. All accelerometer types have M3 screw threads for stud mounting. Types 4375 and 4375 V are used for more permanent vibration monitoring applications on

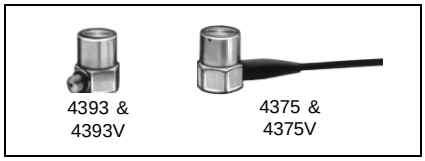


Fig.22

Fig.23

very light structures in preference to Types 4393 and 4393 V.

Shock Accelerometer Type 8309

Accelerometer Type 8309 (Fig. 23) is especially intended for measurement of very high level continuous vibration and mechanical shock up to 150 kms^{-2} and 1000 kms^{-2} peak, respectively.

The 8309 is of a particularly sturdy construction necessary for withstanding very high level continuous vibration and shock. Its PZ 45 piezoelectric element is prepared and treated to withstand very high dynamic stress with negligible problems of "zero shift". Type 8309 has an integral 32 to 40 cm long output cable, which gives the advantage of a reliable output connection at very high shock levels.

For rigid mounting, the base of the 8309 has an integral M5 threaded fixing stud which is adequately dimensioned to transmit the full motion of the test object to the piezoelectric element without distortion.

What to Order

Uni-Gain® accelerometers available from Brüel & Kjær can be supplied in the form of a **Set**. An **Accelerometer Set** (suffix S after type number) consists of a single accelerometer complete with cable and a range of accessories in a mahogany case such as shown in Fig.16.

Accelerometer Type 8318 is supplied only as an Accelerometer Set.

Fig.24 Accelerometer set

Standard Accessories

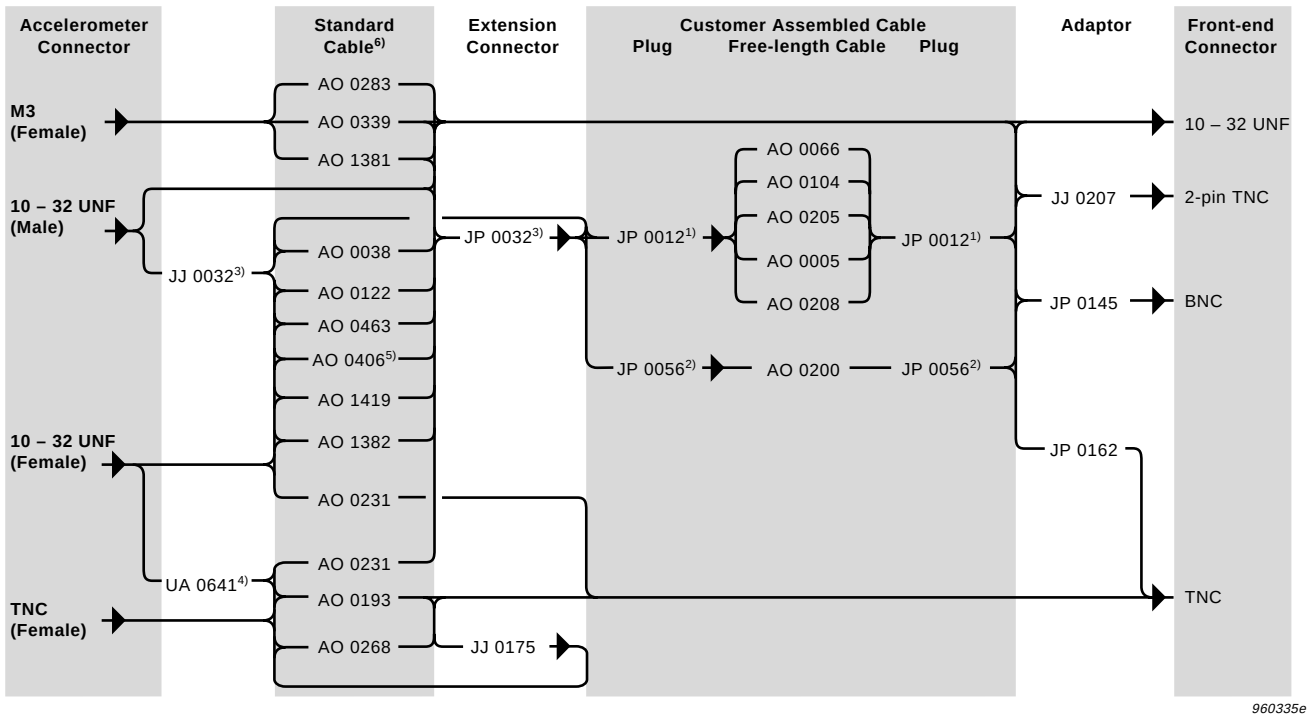
Brüel & Kjær Part No.	Standard Accessories	4370/1 4381/2/3/4 4370V/1V 4381V/2V/ 3V/4V		4321 4321V		4326	4374		4375 4375V 4393 4393V		4391 4391V 4391E		4378 4379		8318	8309	
	S model includes accessory set (UA xxxx) in addition to standard accessories (–):	UA 0078		UA0146			UA1079		UA0629		UA0844		UA0856			UA0415	
		–		–		–	–		–		–		–		–	–	
AO 0038	260°C (500°F) Teflon® super-low-noise cable, AC 0005 (∅2 mm) fitted with 10–32 UNF connectors JP 0012. Length 1.2 m (4 ft)	1*		3*			1		1†				1			1	
AO 0231	260°C (500°F) Teflon® super-low-noise cable, AC 0005 fitted with one 10–32 UNF connector and one TNC connector. Length 3 m (10 ft)											1					
AO 0268	85°C (185°F) spiralized low-noise cable, AC 0205 with polyurethane jacket, fitted with TNC connectors. Length 1.1 to 4 m. Spiral ∅12.5 mm.														1		
AO 0283	260°C (500°F) Teflon® super-low-noise cable, AC 0205 (∅1.5 mm) fitted with 10–32 UNF and M3 connectors. Length 1.2 m (4 ft)					3*			1‡								
UA 1243	3×30 pcs. of red/green/yellow cable markers					1*											
JJ 0032	Extension connector for Brüel & Kjær cables fitted with 10–32 UNF connectors JP 0012						1	3	1†	3						1	3
JP 0162	10–32 UNF to TNC connector adaptor		1		3			1		1				1			1
YQ 2960	10–32 UNF threaded steel stud. Length 0.5 in.	1	4	1	5						1	3	1	5			
YP 0150	10–32 UNF insulated stud. Length 0.5 in.		1		1									1			
YQ 2007	M3 threaded steel stud. Length 8 mm					3*				2							
YQ 2003	M3 threaded steel stud. Length 5 mm								1	3							
YQ 9335	M8 steel stud. Length 16 mm														4		
DB 0756	Cement stud 10–32 UNF. ∅14 mm		1		1							1					
DB 2790	Cement stud 10–32 UNF. ∅25 mm													1			
DB 0757	Cement stud M3. ∅8 mm									2							
UA 0642	Mounting magnet & 2 insulating discs DS 0553		1									1		1			
UA 1077	Small mounting magnet & 2 insulating discs DS 0786									1							
DU 0079	1 × adhesive mounting disc. ∅40 mm														4		
YO 0073	25 × adhesive mounting disc. ∅5.5 mm							1		1							
QS 0007	Tube of cyanoacrylate adhesive							1		1							
YJ 0216	Beeswax for mounting		1		1			1		1				1	1		1
YO 0534	Insulating mica washer ∅15, ∅5 mm		1		1	1*											
YO 0746	Insulating mica washer ∅25, ∅5 mm													5			
QA 0029	Tap for 10–32 UNF thread		1		1							1		1			
QA 0041	Tap for M3 thread									1							
QA 0068	Tap for M5 thread																1
QA 0141	Tap for M8 thread														1		
QA 0013	Hexagonal key for 10–32 UNF studs		1		1							1		1			
QA 0042	Hexagonal key for M3 studs					1*				1							
QA 0038	Hexagonal key for M4 studs				1												
QA 0121	Hexagonal key for M8 studs														1		
QA 0220	Cable connecting/removal tool					1*											
YM 0334	M3 nut									1							
YM 0414	10–32 UNF nut		1		1									1			
YQ 0093	M4 threaded steel screw. Length 16 mm			1	1												
YQ 8941	M2×10 steel screw					3*											
YP 0080 DB 0544	Probe with sharp tip. 10–32 UNF Round tip		1														
	Individual calibration chart	1		1		1	1		1		1		1		1	1	
	Individual frequency response curve	1*		1*							1*		1		1		

* Only for types with no suffix ("V", "A" and "E" types)
† Only Type 4375
‡ Only Type 4393

DeltaTron® **Accessories**

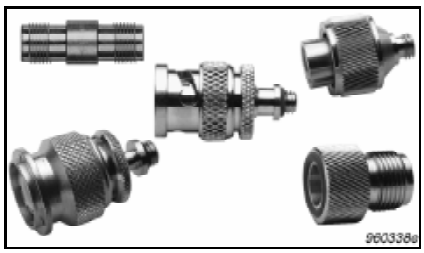
Brüel & Kjær Part No.	Standard Accessories	4394		4395		4396		4397		4398		4399	
	S model includes accessory set (UA xxxx) in addition to standard accessories (–):	UA 1218 –		UA 1219 –		UA 1219 –		UA 1218 –	1	UA 1219 –		UA 1219 –	
AO 1381	Teflon low-noise cable, double screened AC 0104 (∅1.6 mm). Fitted with 10–32 UNF and M3 connectors. Length 1.2 m (4 ft)	1						1					
AO 1382	Teflon low-noise cable, double screened AC 0104 (∅1.6 mm). Fitted with 10–32 UNF connectors. Length 1.2 m (4 ft)			1		1				1		1	
JJ 0032	Extension connector for cables fitted with 10–32 UNF connectors		3		3		3		3		3		3
JP 0145	10–32 UNF to BNC connector adaptor		1		1		1		1		1		1
YS 8321	Steel stud M3/M3 (UA 1221 is a set of 25 of these studs)		3										
YQ 2003	Steel Stud M3, 5 mm long								3				
YQ 2960	10–32 UNF threaded steel stud. Length 0.5 in.				2		2				2		2
YQ 2962	10–32 UNF threaded steel stud. Length 0.3 in.				3		3				3		3
DB 0757	Cement stud M3. ∅8 mm		1						1				
DB 0756	Cement stud 10–32 UNF. ∅14 mm				1		1				1		1
YG 0150	Steel stud 10–32 UNF/10–32 UNF with flange			1	2	1	2			1	2	1	2
UA 0642	Mounting magnet & 2 insulating discs DS 0553				1		1				1		1
YJ 0216	Beeswax for mounting		1		1		1		1		1		1
YO 0073	25 × adhesive mounting disc. ∅5.5 mm		1						1				
QS 0007	Tube of cyanoacrylate adhesive		1						1				
QA 0041	Tap for M3 thread		1						1				
QA 0029	Tap for 10–32 UNF thread				1		1				1		1
QA 0042	Hexagonal key for M3 studs		1						1				
QA 0013	Hexagonal key for 10–32 UNF studs				1		1				1		1
YM 0414	10–32 UNF nut				1		1				1		1
BC 0200	Individual calibration chart	1		1		1		1		1		1	
	Individual frequency response curve	1		1		1		1		1		1	

Cable Assembly Overview

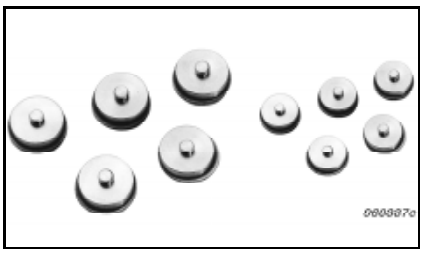


1) Available in set with 25 pcs. as UA 0130
2) Available in set with 25 pcs. as UA 0730
3) Available in set with 25 pcs. as UA 0186
4) For accelerometers with top connector
5) AO 0406 includes JP 0145
6) See also table on last page

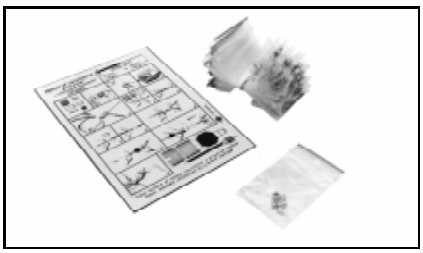
Additional Accessories Available



JJ 0175: Extension connector for TNC to TNC cable**. JJ 0207:** 2-pin TNC to 10–32 UNF plug adaptor. **JP 0145:** 10–32 UNF to BNC plug adaptor. **JP 0162:** 10–32 UNF to TNC plug adaptor. **UA 0641:** 10–32 UNF to BNC extension connector for accelerometers with top connector.

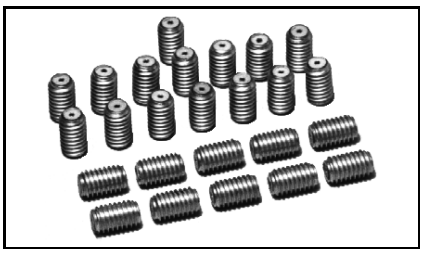


UA 0643: Set of 5 10–32 UNF mounting magnets UA 0642, ∅ 24.45 mm. Includes PTFE self adhesive discs DS 0553 for electrical insulation.
UA 1075: Set of 5 UA 1077, M3 ∅ 10.2 mm. Includes PTFE self adhesive discs DS 0786 for electrical insulation.

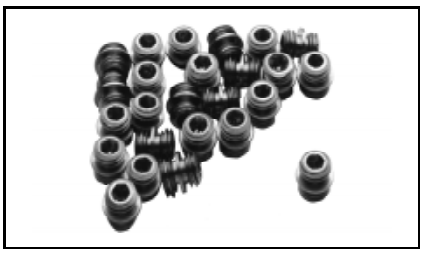


UA 0130: Set of 25 plugs JP 0012 for cable AC 0104 and AC 0005.
UA 0730: Set of 25 plugs JP 0056 for cable AC 0200. For mounting the plugs, the assembly tool QA 0035 is required.

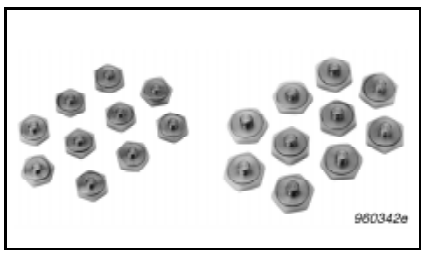
QA 0035: Assembly tool for mounting miniature plugs on accelerometer cables.



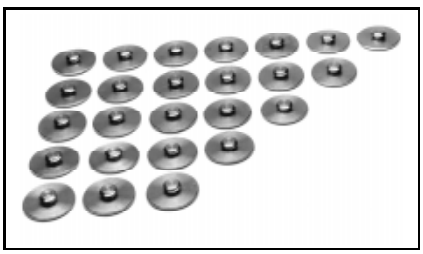
UA 0186: Set of 25 extension connectors JJ 0032 for miniature cables with plugs JP 0012 and JP 0056.



UA 1221: Set of 25 M3/M3 steel studs YS 8321.



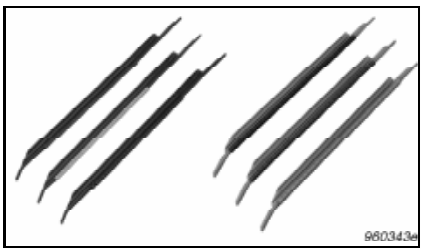
UA 1192: Set of 10 10–32 UNF/ 10–32 UNF insulating studs UA 1215
UA 1193: Set of 10 M3/M3 insulating studs UA 1216.



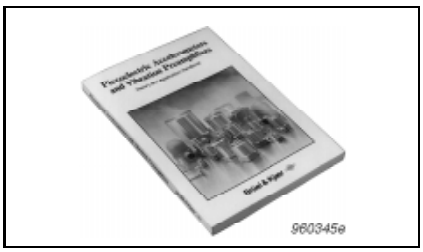
UA 0866: Set of 25 10–32 UNF cement studs DB 0756
UA 0867: Set of 25 M3 cement studs DB 0757.

UA 0125: Set of 10 insulating studs YP 0150, 10 steel studs YQ 2960, 10 nuts YM 0414, 10 mica washers YO 0534 plus 10–32 UNF tap and hexagonal key for 10–32 UNF studs.

UA 0553: Set of 5 electrically insulated Mechanical Filters UA 0559, plus a tommy bar for mounting. Also available with M3 thread as WA 0224 (only 1 pc.).



UA 1243: 3×30 red/green/yellow cable markers for AC 0205/AC 0104
UA 1244: 3×30 red/green/yellow cable markers for AC 0005/AC 0208.

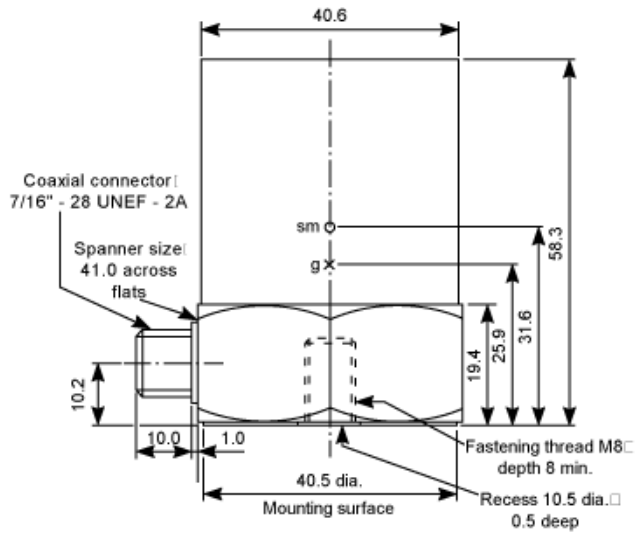


BB 0694: Piezoelectric Accelerometers and Vibration Preamplifiers, Theory and Application Handbook.

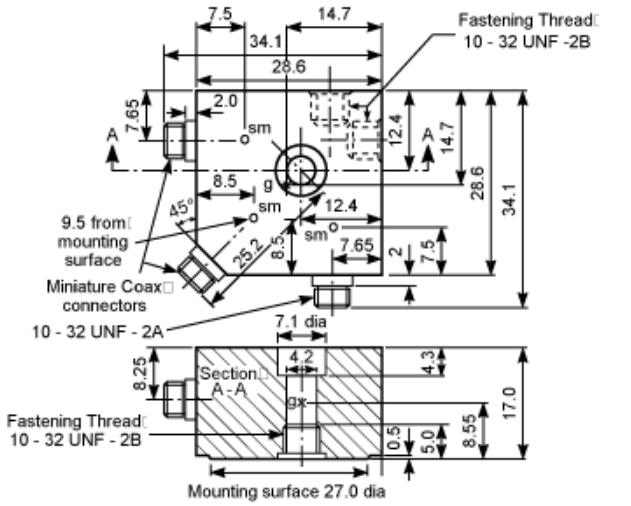
Accelerometer Dimensions

All dimensions in mm

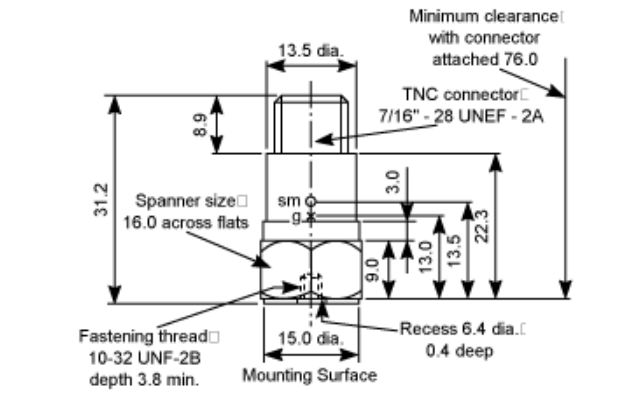
Type 8318



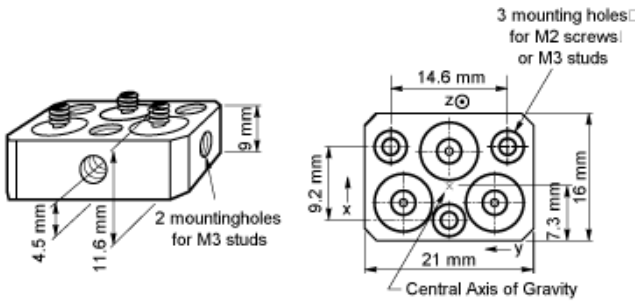
Types 4321 & 4321V



Types 4391 & 4391V

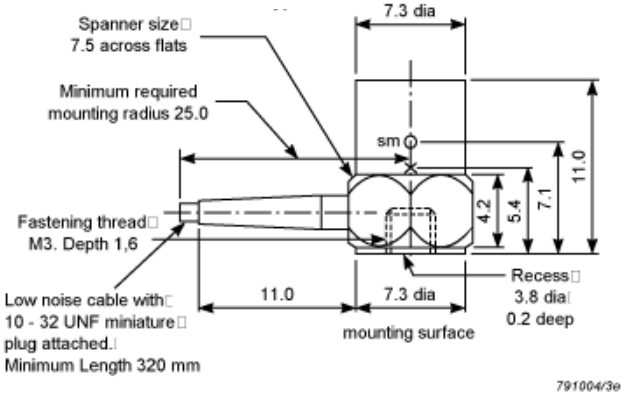


Type 4326

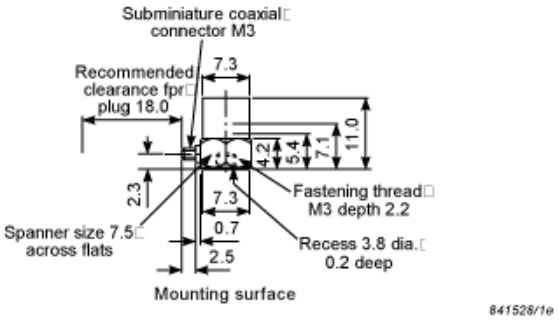


Type 4326 has M3 sub-miniature connectors

Types 4375 & 4375V



Types 4393 & 4393V

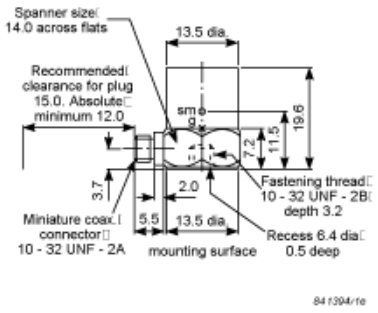


Centre of gravity: “o” seismic mass — “x” whole assembly

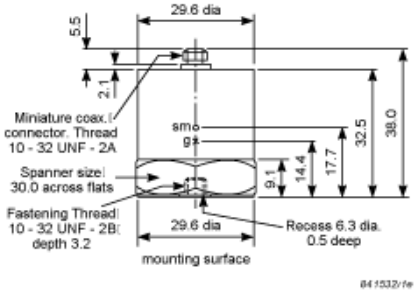
Accelerometer Dimensions

All dimensions in mm

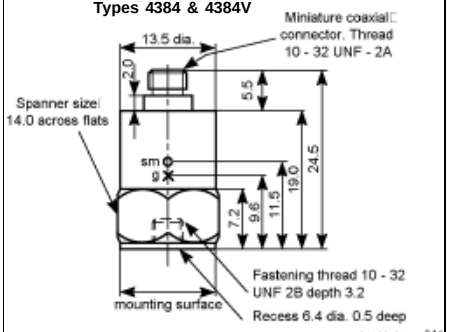
Types 4371 & 4371V



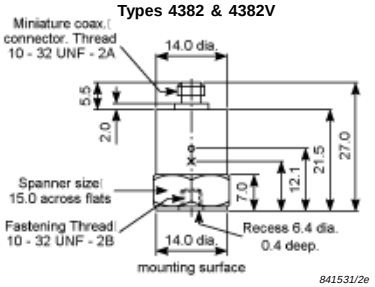
Types 4378 & 4378V



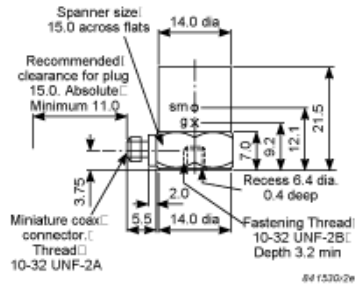
Types 4384 & 4384V



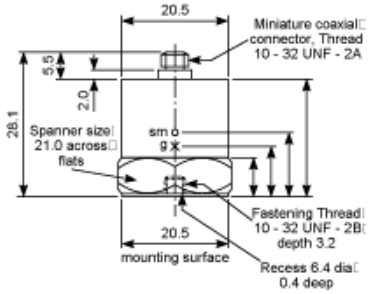
Types 4382 & 4382V



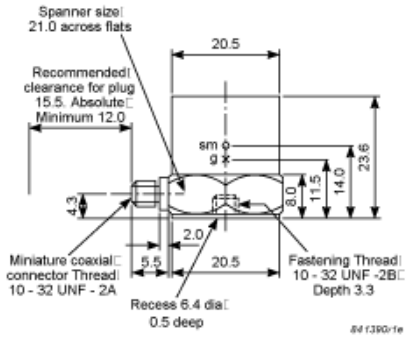
Types 4383 & 4383V



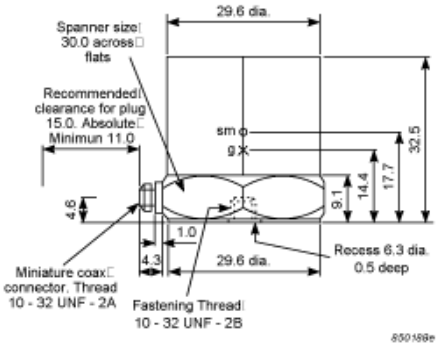
Types 4370 & 4370V



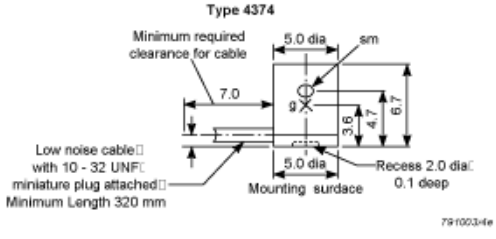
Types 4381 & 4381V



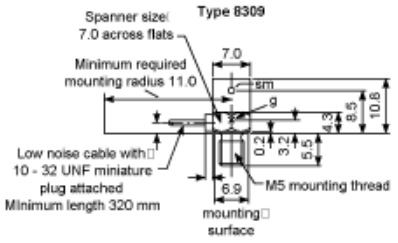
Type 4379



Type 4374



Type 8309

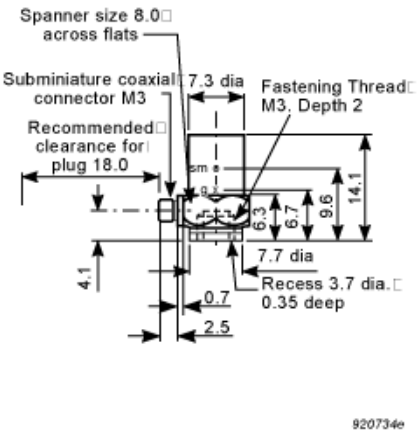


Centre of gravity: “o” seismic mass — “x” whole assembly

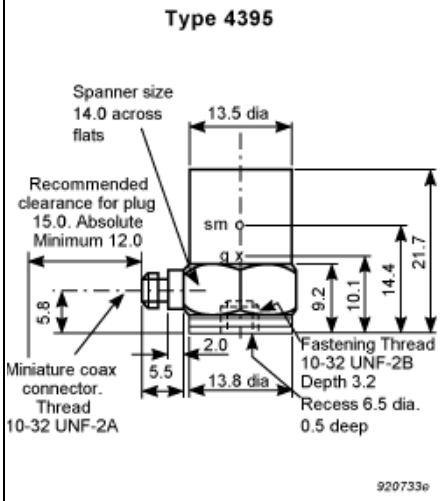
DeltaTron® Accelerometer Dimensions

All dimensions in mm

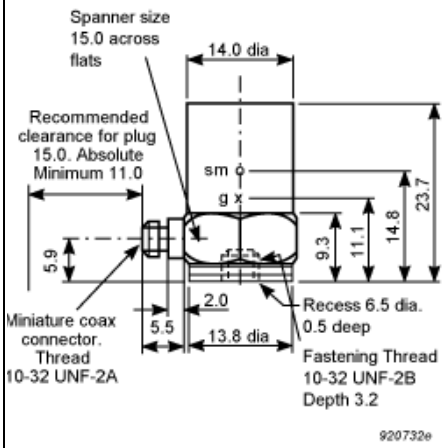
Type 4394



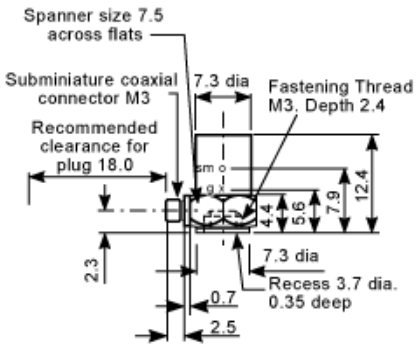
Type 4395



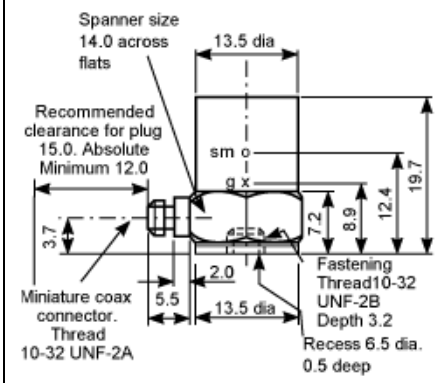
Type 4396



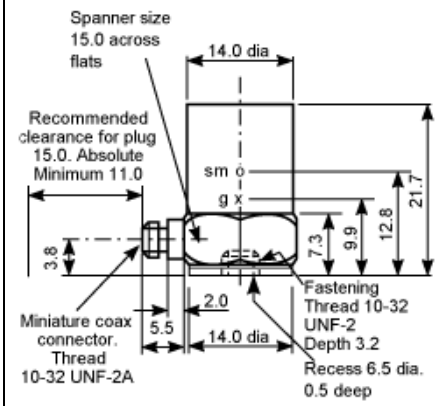
Type 4397



Type 4398



Type 4399



Centre of gravity: “o” seismic mass — “x” whole assembly

Specifications[1]

		 4375 4375V	4393 4393V	 4384 4384V	 4371 4371V	 4391 4391V	 4382 4382V	 4383 4383V	 4370 4370V	 4381 4381V
Weight	grams	2.4[10]		11		16	17		54	43
Charge Sensitivity for Uni-Gain®-DeltaShear® types[2, 5]	pC/ms^{-2}	0.316 ±2%		1 ±2%		1 ±2%	3.16 ±2%		10 ±2%	
	pC/g	3.1 ±2%		9.8 ±2%		9.8 ±2%	31 ±2%		98 ±2%	
Voltage Sensitivity for Uni-Gain®-DeltaShear® types[5]	mV/ms^{-2}	0.48		0.8		0.8	2.6		8	
	mV/g	4.8		8		8	26		80	
Charge Sensitivity for DeltaShear® "V" types	pC/ms^{-2}	0.3 ±15%		1 ±15%		1 ±15%	3 ±15%		10 ±15%	
	pC/g	3 ±15%		10 ±15%		10 ±15%	31 ±15%		98 ±15%	
Voltage Sensitivity for DeltaShear® "V" types	mV/ms^{-2}	0.5		0.8		0.8	2.6		8	
	mV/g	5		8		8	26		80	
Mounted Resonance[5, 6]	kHz	55		42		40	28		16	
Frequency Range[5, 6, 9]	5% Hz	0.2 – 12 000		0.2 – 9100		0.2 – 8700	0.2 – 6100		0.2 – 3500	
	10% Hz	0.1 – 16 500		0.1 – 12 600		0.1 – 12 000[4]	0.1 – 8400		0.1 – 4800	
Capacitance[5, 7]	pF	650		1200		1200	1200		1200	
Max. Transverse Sensitivity[1, 5, 8]	%	<4		<4		<4	<4		<4	
Transverse Resonance	kHz	18		15		12	10		4	
Piezoelectric Material		PZ 23		PZ 23		PZ 23	PZ 23		PZ 23	
Construction		DeltaShear®		DeltaShear®		DeltaShear®	DeltaShear®		DeltaShear®	
Base Strain Sensitivity (in base plane at 250 με)	ms^{-2}/με	0.005		0.02		0.005	0.01		0.003	
	g/με	0.0005		0.002		0.0005	0.001		0.0003	
Temperature Transient Sensitivity (3 Hz LLF, 20 dB/decade)	ms^{-2}/°C	5		0.4		0.2	0.1		0.02	0.04
	g/°F	0.28		0.022		0.011	0.0056		0.0011	0.0022
Magnetic Sensitivity (50 Hz – 0.03 T)	ms^{-2}/T	30		4		4	1		1	
	g/kGauss	0.3		0.04		0.04	0.01		0.01	
Acoustic Sensitivity Equiv. Acc. at 154 dB SPL (2 – 100 Hz)	ms^{-2}	0.04		0.01		0.01	0.002		0.001	
	g	0.004		0.001		0.001	0.0002		0.0001	
Min. Leakage Resistance at 20°C	GΩ	20		20		20	20		20	
Ambient Temperature Range	°C	−74 to 250		−74 to 250		−60 to 180	−74 to 250		−74 to 250	
Max. Operational Shock (±Peak)	kms^{-2}	250		200		20	50		20	
	g	25000		20000		2000	5000		2000	
Max. Operational Continuous Sinusoidal Acceleration (Peak)	kms^{-2}	50		60		20	20		20	
	g	5000		6000		2000	2000		2000	
Max. Acceleration (Peak) with mounting magnet	kms^{-2}	–		1.5		1.2	1.2		0.6	
	g	–		150		120	120		60	
Base Material		Titanium ASTM Gr. 2		Titanium ASTM Gr. 2		Titanium ASTM Gr. 2	Titanium ASTM Gr. 2		Steel AISI 316	Titanium ASTM Gr. 2

1 Data obtained in accordance with ANSI S2. 11-69 and ISO/DIS 5347
2 Uni-Gain® measured sensitivity adjusted to ±2%
3 Built-in Line-drive preamplifier. Sensitivity in μA/ms^{-2}
4 Local resonances of up to ±1.5 dB permitted
5 Individual specifications given on the calibration chart for Uni-Gain® types
6 Individual curves not supplied with 4375, 4393, 4374, 4321 and 8309 or DeltaShear®"V" types
7 With cable supplied as standard accessory, or integral cable
8 Axis of minimum transverse sensitivity indicated for Uni-Gain® types (except 4321, 4374, 8309)
9 The low frequency cut-off is determined by the preamplifier and environmental conditions

Note: All values are typical at 25°C (77°F), unless measurement uncertainty or tolerance field is specified. All uncertainty values are specified at 2σ (i.e. expanded uncertainty using a coverage factor of 2)

Specifications[1]

		 4378 4379	 8318	 4374[15]	 4321 4321V	 4326	 8309
Weight	grams	175	470	0.65[10)]	55	10	3[10]
Charge Sensitivity for Uni-Gain®-DeltaShear® types[2, 5]	pC/ms^{-2}	31.6 ±2%	–	–	1 ±2%	–	–
	pC/g	310 ±2%	–	–	9.8 ±2%	–	–
Voltage Sensitivity for Uni-Gain®-DeltaShear® types[5]	mV/ms^{-2}	26	316 ±2%[3]	–	0.8	–	–
	mV/g	260	3100[3]	–	8	–	–
Charge Sensitivity for DeltaShear® "V" types	pC/ms^{-2}	–	–	0.11	1 ±15%	0.3	0.004
	pC/g	–	–	1.1	9.8 ±15%	3	0.04
Voltage Sensitivity for DeltaShear® "V" types	mV/ms^{-2}	–	–	0.18	0.8	–	0.04
	mV/g	–	–	1.8	8	–	0.4
Mounted Resonance[5, 6]	kHz	13	6.5	85	40	X: 40, Y: 30, Z: 50 kHz	180
Frequency Range[5, 6, 9]	5% Hz	0.2 – 2800	10% 0.1 – 1000[14)]	1 – 18 500	0.2 – 8700[11)]	-	1– 39 000
	10% Hz	0.1 – 3900	3 dB 0.06 – 1250[14)]	1 – 26 000	0.1– 12 000[11]	3 Hz to X: 13.3, Y: 10, Z: 16.6 kHz	1 – 54 000
Capacitance[5, 7]	pF	1200	–	600	1200	1000	100
Max. Transverse Sensitivity[1, 5, 8]	%	<4	<5	<5	<4	<5	<5
Transverse Resonance	kHz	3.8	1.6	21	14	X: 18, Y: 18, Z: 20 kHz	28
Piezoelectric Material		PZ 27	PZ 23	PZ 27	PZ 23	PZ 23	PZ 45
Construction		DeltaShear®	DeltaShear®	Planar Shear	DeltaShear®	ThetaShear®	Centre Mount. Compression
Base Strain Sensitivity (in base plane at 250 με)	ms^{-2}/με	0.002	0.0003	0.005	0.02	0.055	2
	g/με	0.0002	0.000 03	0.0005	0.002	0.0055	0.2
Temperature Transient Sensitivity (3 Hz LLF, 20 dB/decade)	ms^{-2}/°C	0.001	0.0001	10	0.4	1	400
	g/°F	0.000 056	0.000 005 6	0.56	0.022	0.056	22
Magnetic Sensitivity (50 Hz – 0.03 T)	ms^{-2}/T	0.5	1	30	4	12	20
	g/ kGauss	0.005	0.01	0.3	0.04	0.12	0.2
Acoustic Sensitivity Equiv. Acc. at 154 dB SPL (2 – 100 Hz)	ms^{-2}	0.001	0.001	0.1	0.01	0.035	4
	g	0.0001	0.0001	0.01	0.001	–	0.4
Min. Leakage Resistance at 20 °C	GΩ	20	–	20	20	10	20
Ambient Temperature Range	°C	–40 to 250	–50 to 85	–74 to 250	–74 to 250	–55 to 175	–74 to 180
Max. Operational Shock (±Peak)	kms^{-2}	5	0.015[12]	250	10	30	1000
	g	500	1.5[12]	25 000	1000	3000	100 000
Max. Operational Continuous Sinusoidal Acceleration (Peak)	kms^{-2}	5	0.015[12]	50	5	–	150
	g	500	1.5[12]	5000	500	–	15 000
Max. Acceleration (Peak) with mounting magnet	kms^{-2}	0.2	–	–	0.6	–	–
	g	20	–	–	60	–	–
Base Material		Stainless Steel AISI316	Stainless Steel AISI303	Beryllium[13]	Titanium ASTM Gr. 2	Aluminium case, titanium sockets	Stainless Steel AISI316

[10] Excluding cable
[11] The transverse resonance frequency may limit the useful frequency range further
[12] Measurement limits. Handling limits given in the Dynamic Range section (pages 4 and 5)
[13] Toxic hazard in finely divided form
[14] Including Preamplifier EQ 2126 and Power Supply EQ 2727
[15] 4374 Pat. USA 4211951, DK 138768 and GB 1522785. DeltaShear Pat. DK 131401

Specifications
Common to Both Types of DeltaTron® Accelerometer

			Type 4394 Type 4397	Type 4395 Type 4398	Type 4396 Type 4399
Sensitivity (axial) at 159.2 Hz, 100 ms^{-2} (10.2g), 25°C (77°F), 4 mA		mV/ms^{-2} (g)	1.00 (9.807) ±2 %		10.0 (98.07) ±2 %
Measuring Range (peak)	temperature <100°C (212°F)	ms^{-2} (g)	±7500 (765)		±750 (76)
	temperature <125°C (257°F)	ms^{-2} (g)	±5000 (510)		±500 (51)
Frequency Range (±10%)		Hz	1 to 25000	0.3 to 18000	1 to 14000
Maximum Transverse Response		%	<4		
Constant Current Supply	temperature <100°C (212°F)	mA	+2 to +20		
	temperature <125°C (257°F)	mA	+2 to +10	+2 to +20	
Supply Voltage, unloaded	for full specification	V DC	+24 to +30		
	minimum (reduced specification)	V DC	+18		
Output Impedance		W	<100		
Bias Voltage	at 25°C (77°F), 4 mA	V	12 ±0.5		
	full temperature and current range	V	8 to 15		
Residual Noise	from 1 to 22000 Hz	µV	<25	<15	<40
	equivalent acceleration	ms^{-2} (g)	<0.025 (0.0026)	<0.015 (0.0015)	<0.004 (0.0004)
Polarity (acceleration directed from base into body)			Positive		
Recovery time from Overload (2×maximum level)		µs	<20	<15	<25
Maximum Non-destructive Shock (peak)	Axial	ms^{-2} (g)	100000 (10200)	50000 (5100)	20000 (2040)
	Transverse	ms^{-2} (g)	50000 (5100)	20000 (2040)	10000 (1020)
Temperature Range		°C (°F)	−50 to +125 (−58 to +257)		
Humidity			Welded, sealed		
Temperature Transient Sensitivity		ms^{-2}/°C	2	0.2	0.1
		g/°F	0.11	0.011	0.0056
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}(g)/T	10 (1)	20 (2)	5 (0.5)
Acoustic Sensitivity (154 dB SPL)		ms^{-2} (g)	0.01 (0.001)	0.005 (0.0005)	0.002 (0.0002)
Construction			DeltaShear		
Piezoelectric Material			PZ 23		
Case Material		Titanium	ASTM Gr. 2		
Connector		Coaxial	M3 miniature	10−32 UNF	
Mounting Thread		Tapped center-hole	M3	10−32 UNF	
Mounting Torque		Nm (lb.in)	0.2 to 0.6 (1.8 to 5.3)	0.5 to 3.5 (4.4 to 31)	

Specifications
DeltaTron® — Insulated Base

		 4394	 4395	 4396
Mounted Resonance Frequency	kHz	52	37	28
Transverse Resonance Frequency	kHz	15	13	9
Case Insulation to Ground	MΩ	>10		
Base Strain Sensitivity	$ms^{-2}(g)/\mu\varepsilon$	0.005 (0.0005)	0.01 (0.001)	0.005 (0.0005)
Weight	gram (oz.)	2.9 (0.10)	12.9 (0.46)	18.2 (0.64)
Height	mm (in)	14.0 (0.55)	21.7 (0.85)	23.7 (0.93)
Spanner Size	mm (in)	8.0 (0.31)	14.0 (0.55)	15.0 (0.59)

Specifications
DeltaTron® — Uninsulated Base

		 4397	 4398	 4399
Mounted Resonance Frequency	kHz	53	38	29
Transverse Resonance Frequency	kHz	17	14	10
Base Strain Sensitivity	$ms^{-2}(g)/\mu\varepsilon$	0.005 (0.0005)	0.02 (0.002)	0.01 (0.001)
Weight	gram (oz.)	2.4 (0.09)	11.8 (0.45)	17.1 (0.63)
Height	mm (in)	12.4 (0.49)	19.7 (0.77)	21.7 (0.85)
Spanner Size	mm (in)	7.5 (0.30)	14.0 (0.55)	15.0 (0.59)

Specifications for Cables for Use With Standard Accelerometers

	AC 0005	AC 0066	AC 0104	AC 0200	AC 0205	AC 0208
Temperature (°C)	–75 to +250	–75 to +250	–50 to +100	–75 to +250	–75 to +250	Moveable: –5 to +70 Fixed: –20 to +70
Noise	Super low noise	Low noise	Low noise	Super low noise	Super low noise	–
Insulator material/Coating	PTFE/PFA	PTFE/PFA	PTFE/PFA	PTFE/PFA	PTFE/PFA	PE/PVC
Screen	Single	Single	Double	Double	Single	Single
Capacitance (pF/m)	106	95	105	95	100	100
Dimension (mm)	Ø2.0	Ø1.0	Ø1.6	Ø3.2	Ø1.5	Ø2.0
10 – 32 plug for self-mounting	JP 0012	JP 0012	JP 0012	JP 0056	JP 0012	JP 0012

Specifications for Reference and Underwater Accelerometers

8305

8319[2]

		8305	8319[2]
Weight	grams	40	44 (with 0.15 m cable)
Charge Sensitivity for DeltaShear® "V" types	pC/ms^{-2}	0.12[4]	–
	pC/g	1.2[4]	–
Current Sensitivity[2] Uni-Gain® Line Drive types	$\mu A/ms^{-2}$	–	1 ±2%[3, 4]
	µA/g	–	9.8 ±2%[3, 4]
Mounted Resonance	kHz	30 (with 20 g load)[4]	>35
Frequency Range[7]	Hz	0.2 – 3100 (1%)[4] 0.2 – 4400 (2%)[4]	0.3 – 11 000 (10%)
Capacitance[5]	pF	180	–
Max. Transverse Sensitivity	%	<2[4, 6]	<4
Transverse Resonance	kHz	–	14
Piezoelectric Material		Quartz	PZ 23
Construction		Inverted Centre Mounted Comp.	DeltaShear®
Base Strain Sensitivity[1] (in base plane at 250 µε)	$ms^{-2}/\mu\varepsilon$	Top: 0.01 Base: 0.003	0.01
	g/µε	Top: 0.001 Base: 0.0003	0.001
Temperature Transient Sensitivity[1] (3 Hz LLF, 20 dB/decade)	$ms^{-2}/°C$	0.5	1
	g/°F	0.028	0.056
Magnetic Sensitivity[1] (50 Hz – 0.03 T)	ms^{-2}/T	1	7
	g/kGauss	0.01	0.07
Acoustic Sensitivity[1] Equiv. Acc. at 154 dB SPL (2 – 100 Hz)	ms^{-2}	0.008	0.01
	g	0.0008	0.001
Min. Leakage Resistance at 20°C	GΩ	1000 (10 at 200°C)	–
Ambient Temperature Range	°C	–74 to +200	–50 to +100
Max. Operational Shock (±Peak)[1]	kms^{-2}	10	20 (axial)
	g	1000	2000 (axial)
Max. Operational Continuous Sinusoidal Acceleration (Peak)	kms^{-2}	10	–
	g	1000	–
Max. Acceleration (Peak) with mounting magnet	kms^{-2}	1	–
	g	100	–
Base Material		Stainless Steel AISI 316	Stainless UHB 904L

1 Data obtained in accordance with ANSI S2. 11-69 and ISO/DIS 5347
2 Uni-Gain® measured sensitivity adjusted to ±2%
3 Built-in Line-drive preamplifier
4 Individual specifications given on the calibration chart
5 With integral cable supplied as standard
6 Axis of minimum transverse sensitivity indicated
7 The low frequency cut-off is determined by the preamplifier and environmental conditions

Brüel&Kjær reserves the right to change specifications and accessories without notice

Cables with and without connectors

Free-length Cable Type	Length (m)	Connector Type	Order No.
AC 0005	3	10–32 UNF/TNC	AO 0231
	1.2	TNC/TNC	AO 0193
	1.2	10–32 UNF/10–32 UNF	AO 0038
	3	10–32 UNF/10–32 UNF	AO 038F
	5	10–32 UNF/10–32 UNF	AO 0038G
	10	10–32 UNF/10–32 UNF	AO 0038H
	30	10–32 UNF/10–32 UNF	AO 0038K
	x	10–32 UNF/10–32 UNF	AO 0038V-AC 0005-x
	30		AC 0005K
	50		AC 0005L
	100		AC 0005M
	200		AC 0005N
AC 0200	3	10–32 UNF/10–32 UNF	AO 0122
	5	10–32 UNF/10–32 UNF	AO 0122G
	10	10–32 UNF/10–32 UNF	AO 0122H
	30	10–32 UNF/10–32 UNF	AO 0122K
	x	10–32 UNF/10–32 UNF	AO 0122V-AC 0200-x
	30		AC 0200K
	100		AC 0200M
	200		AC 0200N
AC 0104	1.2	M3/10–32 UNF	AO 1381
	1.2	10–32 UNF/10–32 UNF	AO 1382
	3	10–32 UNF/10–32 UNF	AO 1382F
	5	10–32 UNF/10–32 UNF	AO 1382G
	5	10–32 UNF/10–32 UNF*	AO 0406
	10	10–32 UNF/10–32 UNF	AO 1382H
	30	10–32 UNF/10–32 UNF	AO 1382K
	x	10–32 UNF/10–32 UNF	AO 1382V-AC 0104-x
	30		AC 0104K
	100		AC 0104M
AC 0208	1.2	10–32 UNF/10–32 UNF	AO 0463
	3	10–32 UNF/10–32 UNF	AO 0463F
	5	10–32 UNF/10–32 UNF	AO 0463G
	10	10–32 UNF/10–32 UNF	AO 0463H
	30	10–32 UNF/10–32 UNF	AO 0463K
	x	10–32 UNF/10–32 UNF	AO 0463V-AC 0208-x
	200		AC 0208N
AC 0205	1.2	M3/10–32 UNF	AO 0283
	3	M3/10–32 UNF	AO 0283F
	5	M3/10–32 UNF	AO 0283G
	10	M3/10–32 UNF	AO 0283H
	30	M3/10–32 UNF	AO 0283K
	x	M3/10–32 UNF	AO 0283V-AC 0205-x
	30		AC 0205K
	100		AC 0205M
AC 0066	1.2	10–32 UNF/10–32 UNF	AO 1419
	1.2	M3/10–32 UNF	AO 0339
	x	M3/10–32 UNF	AO 0339V-AC 0066-x
	30		AO 0066K
Spiral	1.1 – 4	TNC–TNC	AO 0268

* Includes 10–32 UNF/BNC Adaptor JP 0415

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