PRODUCT DATA

Piezoelectric Charge Accelerometer Types 4326-A and 4326-A-001

Types 4326-A and 4326-A-001 are triaxial piezoelectric accelerometers with three independent outputs for simultaneous high-level measurements in three mutually perpendicular directions. The accelerometers feature the ThetaShear™ design and each transducing element is individually calibrated.

The accelerometers have the same rectangular shape and 10–32 UNF connectors. The main differences between the models lie in the housing material, weight, temperature range and dielectric strength (flash over voltage).

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Uses and Features

Uses
- General purpose vibration testing and analysis
- Multi-axis vibration and shock measurements
- Measurements in confined spaces
- Measurements in high-temperature environments

Features
- Triaxial
- High sensitivity-to-weight ratio
- Low sensitivity to environmental factors
- Electrically insulated for ground-loop protection
- High resonance frequency
- Easily fitted to test objects using mounting clips

Versions

Table 1
Comparison of Type 4326 versions

Type	Housing Material	Maximum Temperature	Weight	Sensitivity
4326-A	Hard-anodized aluminium	175 °C (347 °F)	13 grams	0.316 pC/ms^{-2} ±20%
4326-A-001	Titanium	230 °C (446 °F)	17 grams	0.316 pC/ms^{-2} ±20%

Description

These piezoelectric accelerometers may be treated as charge sources. Their sensitivity is expressed in terms of charge per unit acceleration (pC/ms^{-2}, pC/*g*).

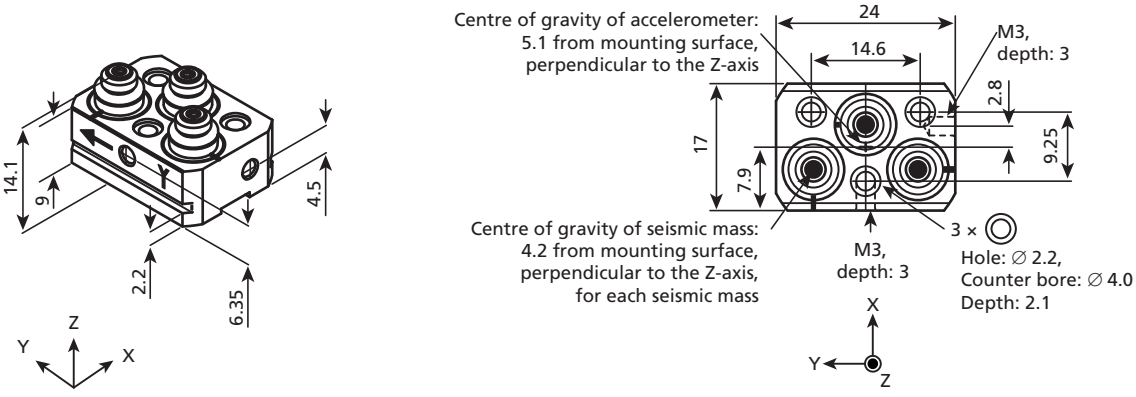
ThetaShear Design

The ThetaShear design consists of a slotted cylindrical post holding a central seismic mass flanked by two piezoelectric plates. This assembly is clamped rigidly by the cover. To ensure optimum accuracy and reliability, molecular adhesion is the only bonding agent used to hold the assembly together. The ThetaShear design provides a combination of high measurement stability, excellent sensitivity-to-weight ratio and low sensitivity to extraneous environmental effects.

Brüel & Kjær

A remarkable feature of the principle behind ThetaShear is that the transverse resonance frequency is always outside the 10% frequency limit. This ensures minimum interference from orthogonal vibration components in the useful frequency range of the accelerometer. The ThetaShear design also provides excellent immunity to other environmental effects such as base strains, magnetic fields and acoustic fields.

Fig. 1
Dimensions of Types 4326-A and 4326-A-001



All dimensions in millimetres

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Mounting

Types 4326-A and 4326-A-001 are mounted with adhesive, with or without the use of mounting clips, M2 screws or M3 studs.

The various mounting clips are designed to suit a variety of mounting surfaces and are attached to the test object with glue or double-sided adhesive tape. The accelerometer is mounted in a clip via grooves in its housing, making the accelerometer easy to fit or remove.

Common Specifications for Mounting Clips

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

Fig. 2
Mounting Clip UA-1408 (set of 100)

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Upper limiting frequency (±10%):
Mounted with grease: 2.0 kHz
Dry mounting: 1.2 kHz

Weight: 2.1 g

Fig. 3
*Mounting Clip with Thick Base UA-1474 (set of 100). The base can be filed down to suit your mounting surface (**far right**)*

Upper limiting frequency (±10%):
Mounted with grease: 2.0 kHz
Dry mounting: 1.2 kHz

Weight: 3.9 g

Fig. 4
Mounting Clip with Swivel Base UA-1473 (set of 100)

Upper limiting frequency (±10%):

The accelerometers are mounted with grease and excited along accelerometer's main axis of sensitivity with the mounting surface of the hemisphere:

Perpendicular to the direction of excitation: 1.3 kHz
At 45° to to the direction of excitation: 1.0 kHz

Weight: 5 g

Fig. 5
Spirit Level UA-1480

Max. dimensions: 85 × 23 × 17 mm
Material: Black, anodized aluminium

Specifications for High-temperature Mounting Clip

Temperature range:	–55 to +175 °C (–67 to +347 °F)
If discolouring can be accepted:	–55 to +250 °C (–67 to +482 °F)
Maximum acceleration:	10 *g* peak
Perpendicular to mounting surface:	50 *g* peak
Material	
Base:	Anodized aluminium
Spring:	Stainless steel
Weight:	11 g

Fig. 6 *High-temperature Mounting Clip UA-1563 (set of 5)*

Calibration

Each accelerometer is calibrated using random excitation and 1600-line FFT transformation to provide a high-resolution (amplitude and phase) frequency response. This yields a unique characterization and secures the integrity of your vibration measurements.

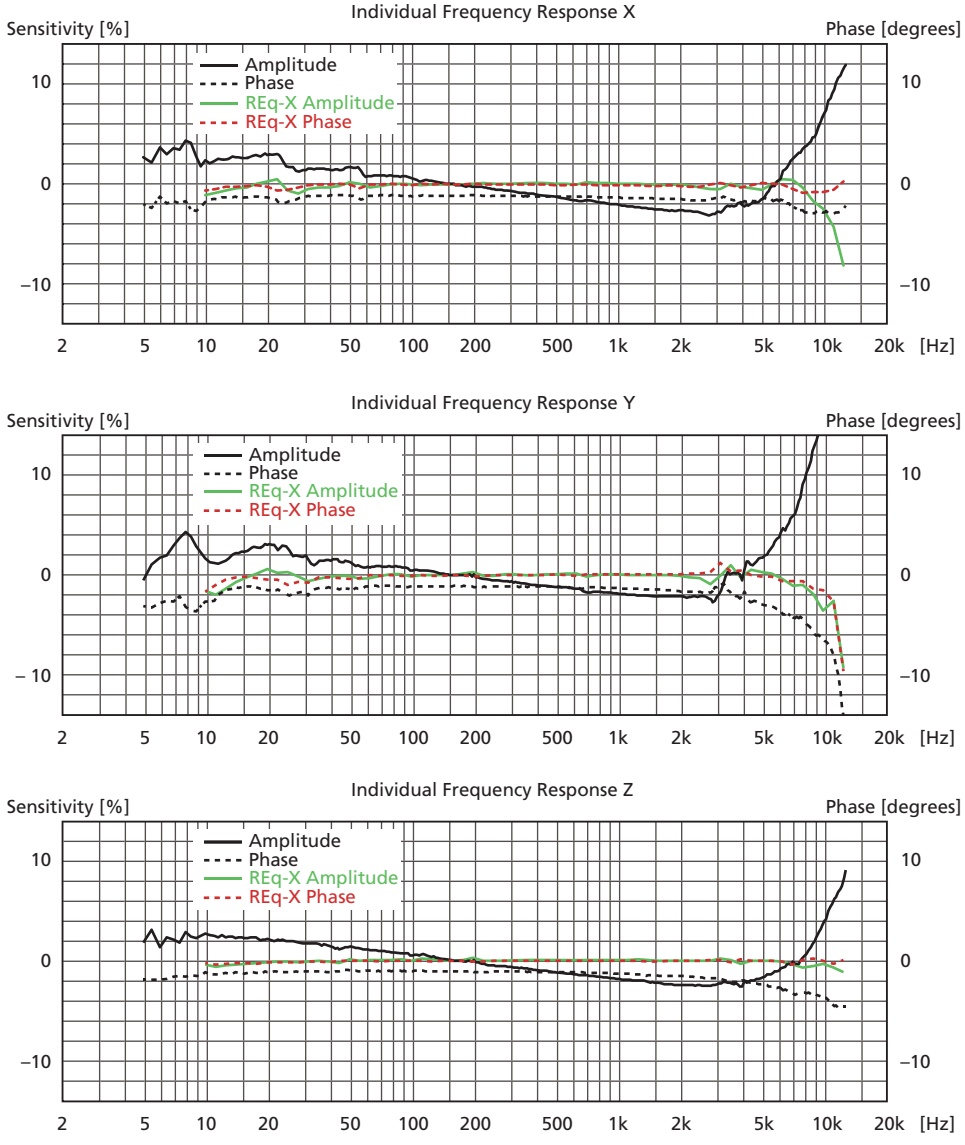
The sensitivity given on the calibration chart is measured at 159.2 Hz with 95% confidence level using coverage factor *k* = 2.

The upper frequency limits given on the calibration chart are frequencies where the deviation from the reference sensitivity at 159.2 Hz is within ±10%. The upper frequency limit is approximately 30% of the mounted resonance frequency. This assumes that the accelerometer is correctly mounted on the test structure – poor mounting can have a marked effect on the mounted resonance frequency.

Frequency Compensation for REq-X

REq-X stands for Response Equalization Extreme, which is a technique that allows you to flatten the frequency response of a transducer in real time (see Fig. 7). This flattening is done by filtering the time signal of a transducer by the inverse of the frequency response.

Fig. 7
Individual frequency responses for each axis with and without REq-X applied



The calibration chart includes individual TEDS values that, together with a general formula, best fit the measured frequency response. The expression can be used for frequency response compensation in the specified frequency range. The relative frequency response, including amplitude and phase is:

$$S_{rel}(f) = \frac{j\frac{f}{f_{hp}}}{\left(1+j\frac{f}{f_{hp}}\right)} \times \frac{1}{\left(1+j\frac{f}{f_{lp}}\right)} \times \frac{1}{\left(1+\left(j\frac{f}{f_{res}}\right)^2+j\frac{f}{Qf_{res}}\right)} \times \left(j\frac{f}{f_{ref}}\right)^{\frac{a}{\ln 10}}$$

where

f = Frequency
Q = Quality Factor
f_{lp} = Low-pass Cut-off Frequency
f_{hp} = High-pass Cut-off Frequency
f_{res} = Resonance Frequency
f_{ref} = Reference Frequency
a = Relative Change/Decade

Combining this equation with the amplitude sensitivity S_{ref} and f_{ref}, results in:

$$S(f) = S_{ref} \times \frac{S_{rel}(f)}{|S_{rel}(f_{ref})|}$$

Implementation of this formula in either real-time data acquisition systems or in post-processing will extend the usable frequency range, improve accuracy or allow a combination of the two.

Brüel & Kjær's Triaxial Charge Accelerometer Family

Types 4326-A and 4326-A-001 are part of a family of triaxial charge accelerometers. To find the triaxial accelerometer that fits your needs, visit www.bksv.com.

Table 1
Comparison of Brüel & Kjær triaxial charge accelerometers

		4326-A	4326-A-001	4321	4527-C
Temperature	°C (°F)	175 (347)	230 (446)	250 (482)	230 (446)
Number of Connectors		3			1
Weight	g	13	17	55	6
Isolated		Yes		No	No
Capacitance	pF	1000		1100	290
Frequency Range*	Hz	X: 1 to 9000 Y: 1 to 8000 Z: 1 to 16000		X: 0.1 to 10000 Y: 0.1 to 10000 Z: 0.1 to 10000	X: 1 to 10000 Y: 1 to 10000 Z: 1 to 12800
Mounting		Mounting clip Adhesive M2 screws M3 stud		M4 screws	M3 stud Adhesive
Sensitivity	pC/ms^{-2}	0.316		1.0	0.316
Product Data		BP 1341		BP 2034	BP 2535

* Lower limiting frequency is determined by the amplifier used

Ground Insulation

Ground-loop noise, particularly troublesome in multichannel measurements, is avoided by electrically insulating the sensing elements from the common housing. Types 4326-A and 4326-A-001 are electrically insulated with respect to signal ground and have a resistance of more than 10 MΩ.

The electrical insulation of Type 4326-A comes from its fully hard-anodized common housing with insulation at the three cylindrical mounting holes. The hard-anodized mounting surfaces provide additional insulation.

The electrical insulation of Types 4326-A-001 comes from the special mounting technique for the three sensing elements. A non-conductive glue is used to bond the sensing elements to the holes in the common housing. The three individually insulated sensing elements ensure that no ground-loop currents are induced in the measurement setup. This is particularly beneficial to engine test applications.

Cabling

When using accelerometers, the cable can affect the measurement result. Forces exerted on the connector by the cable can cause amplitude irregularities in the output at frequencies up to approximately 200 Hz. This can be reduced by using a flexible cable.

To effectively reduce the problem at low frequencies, it is recommended to clamp the cable. One way of doing this is to make a small loop in the cable close to the accelerometer (max. diameter 30 mm) and clamp the cable beside the base of the accelerometer with mounting wax or double-sided tape. This also reduces the possibility of dynamically induced noise generated by the cable.

Compliance with Standards

	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 This ISM device complies with Canadian ICES−001 (standard for interference-causing equipment)
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 document
Temperature	IEC 60068−2−1 & IEC 60068−2−2: Environmental Testing. Cold and Dry Heat Operating Temperature: 4326-A: −55 to +175 °C (−67 to +347 °F) 4326-A-001: −55 to +230 °C (−67 to +446 °F) Storage Temperature: −25 to +70 °C (−13 to +158 °F)
Humidity	IEC 60068−2−78: Damp Heat: 90% RH (non-condensing at 40 °C (104 °F))

Specifications – Piezoelectric Charge Accelerometer Types 4326-A and 4326-A-001

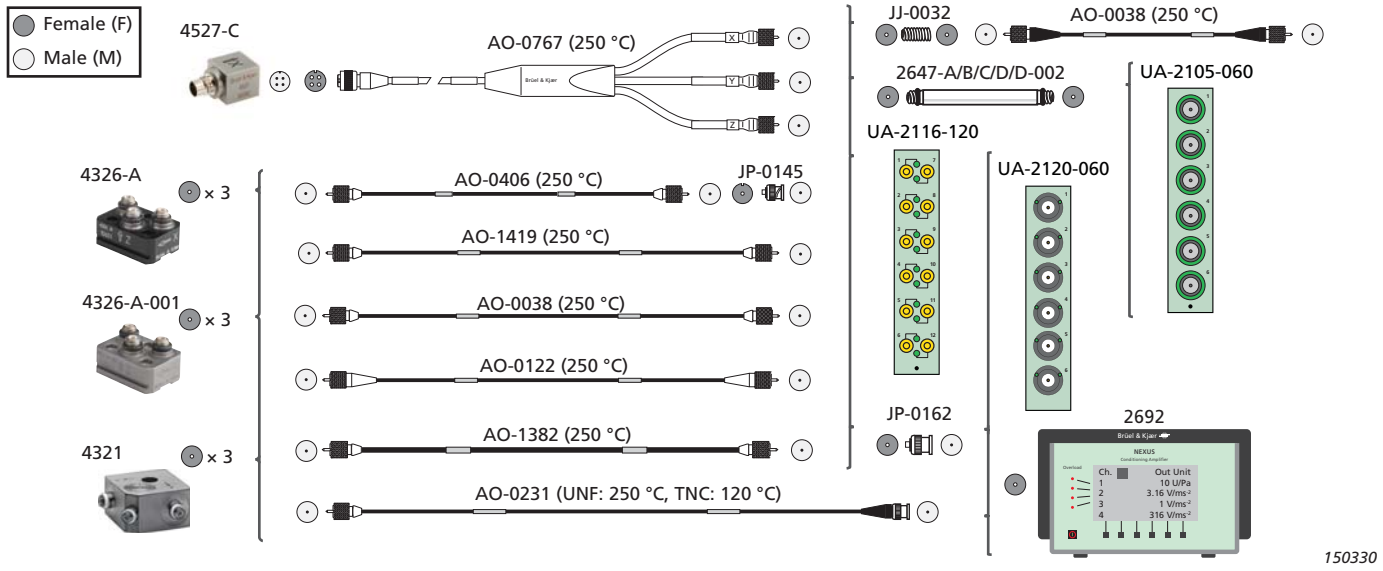
All values are typical at 25 °C unless measurement uncertainty is specified

Type Number		**4326-A**	**4326-A-001**
General			
Weight	gram (oz)	13 (0.46)	17 (0.6)
Charge Sensitivity (at 159.2 Hz)	pC/ms^{-2}	0.316 ±20%	
	pC/g	3.10 ±20%	
Frequency Range (±10% limit)	Hz	**X**: 1 to 9000 **Y**: 1 to 8000 **Z**: 1 to 16000	
Mounted Resonance Frequency	kHz	**X**: 27 **Y**: 24 **Z**: 48	
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})	%	<5	
Transverse Resonance Frequency	kHz	**X**, **Y**, **Z**: >20	
Max. Operational Continuous Sinusoidal Acceleration (peak)	kms^{-2}	30	
	g	3000	
Electrical			
Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)	mms^{-2}	3.0	5.60
	mg	0.3	0.56
Capacitance (excluding cable)	pF	1000	
Case (signal ground) Insulation to Base	MΩ	>10	
Min. Leakage Resistance (at 20 °C)	GΩ	>20	
Environmental			
Operating Temperature Range	°C	−55 to +175	−55 to +230
	°F	−67 to +347	−67 to +446
Temperature Coefficient of Sensitivity	%/°C	**X** and **Y**: 0.08* **Z**: 0.05*	
Temperature Transient Sensitivity (3 Hz Low. Lim. Freq. (−3 dB, 6 dB/octave))	ms^{-2}/°C	0.30	
	g/°F	0.02	
Base Strain Sensitivity (at 250 με in the base plane)	$ms^{-2}/\mu\varepsilon$	0.002†	
	$g/\mu\varepsilon$	0.0002	
Magnetic Sensitivity (50 Hz, 0.038 T)	ms^{-2}/T	5.00	
	g/kG	0.05	
Max. Non-destructive Shock (± peak)	kms^{-2}	30	
	g	3000	
Mechanical			
Housing Material		Anodized Aluminium	Titanium ASTM Grade 2
Piezoelectric Sensing Element		PZ 23	
Construction		ThetaShear	
Sealing		Welded	
Electrical Connector		3 × 10−32 UNF-2A	
Mounting		Mounting clip, adhesive, M2 screws or M3 studs	

* In the temperature range −25 to +125 °C
† Mounted in mounting clip

Equipment Configuration

Fig. 8 *Configurations for Brüel & Kjær's family of triaxial charge accelerometers*



Ordering Information

Type 4326-A **Triaxial piezoelectric charge accelerometer**
Type 4326-A-001 **Triaxial piezoelectric charge accelerometer**
All types include the following accessories:

- Carrying box
- Calibration chart
- One mounting clip

Optional Brüel & Kjær Accessories

CABLING

AO-0038-x-yyy*	Super low-noise cable, 2 × 10–32 UNF (M), 250 °C (482 °F)
AO-0122-x-yyy*	Super low-noise, robust double-screened cable, 2 × 10–32 UNF (M), 250 °C (482 °F)
AO-0231-x-yyy*	Super low-noise cable, 10–32 UNF (M) to TNC (M), 180 °C (356 °F)
AO-0406-x-yyy*	Low-noise, double-screened cable, 10–32 UNF (M) to BNC (M), 250 °C (482 °F). Includes JP-0145
AO-1382-x-yyy*	Low-noise, double-screened cable, 2 × 10–32 UNF (M), 250 °C (482 °F)
AO-1419-x-yyy*	Very light and flexible low-noise coaxial cable with 2 × 10–32 UNF (M), 250 °C (482 °F)
JP-0145	Plug adapter, 10–32 UNF (F) to BNC (M)
JP-0192	Adapter, 10–32 UNF (M) to 2-pin (F)
QA-0035	Cable accessory set, tools for cable and connector assembly
UA-0130	Connector, 10–32 UNF (M) for ∅ 1 mm to 3 mm cable jacket (set of 25)
UA-0186	Extension connector, 10–32 UNF (F) (set of 25)
UA-0730	Connector, 10–32 UNF (M) for ∅ 3 mm (max.) cable jacket (set of 25)
UA-1244	Red/green/yellow cable markers, for ∅ 1.9 mm to 2.2 mm cable jacket (3 × 30 pieces)

* x = D (decimetres) or M (metres); yyy = length in decimetres or metres
Please specify cable length when ordering

MOUNTING

QS-0007	Tube of cyanoacrylate adhesive
UA-1075	Mounting magnet and two insulating discs, M3, ∅ 10 mm, length 1.6 mm (set of 5)
UA-1408	Mounting clip, big (set of 100)
UA-1473	Mounting clip with swivel base, big (set of 100)
UA-1474	Mounting clip with thick base, big (set of 100)
UA-1480	Spirit level for all swivel bases
UA-1563	High-temperature mounting clip, big (set of 5)
UA-2065	Steel stud, M3 × 5 mm (set of 10)
YJ-0216	Beeswax for mounting
YQ-0851	Screw, stainless steel, M2 × 12.0 mm
YQ-2007	Screw, hex socket set with cup point, M3 × 8 mm

CONDITIONING AND FRONT ENDS

Type 3053-B-120	LAN-XI 12-ch. Input Module 25.6 kHz (CCLD, V)
UA-2116-120	LAN-XI Front Panel, 12-channel Charge, 12 × 10–32 UNF (F) microdot connectors (Gain: 1 mV/pC)
Type 3050-A-060	LAN-XI 6-ch. Input Module 51.2 kHz (Mic, CCLD, V)
UA-2105-060	LAN-XI Front Panel, Charge Accelerometer, 6-ch. for the family of Charge to CCLD Converter Type 2647
Type 2647-A/B	Charge to CCLD Converter
Type 2692	NEXUS Conditioning Amplifier

CALIBRATION

Type 4294	Vibration Exciter
DV-0460	Calibration clip, big

Brüel & Kjær Calibration Services

ACC-T-CAI	Accredited initial calibration
ACC-T-CAF	Accredited calibration
ACC-T-CFF	Factory standard calibration
ACC-T-CTF	Traceable calibration

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