Piezoelectric Charge Accelerometer Types 4500-A, 4501-A and 4501-A-001

Types 4500-A, 4501-A and 4501-A-001 are general purpose piezoelectric accelerometers that feature the ThetaShear™ design, giving them low sensitivity to environmental factors. These accelerometers are suitable for applications that require a large number of accelerometers such as structural and modal testing.

Uses and Features

**Uses**
- General purpose vibration and shock measurements
- Structural and modal analysis

**Features**
- Low sensitivity to environmental factors
- Electrically insulated for ground-loop protection
- High resonance frequency

Description

*Fig. 1*
**Left:** Dimensions of Type 4500-A  
**Right:** Dimensions of Type 4501-A

Types 4500-A, 4501-A and 4501-A-001 are piezoelectric charge accelerometers with ThetaShear design.

The accelerometers feature a 10–32 UNF connector. On Type 4500-A, the connector is on the top surface, perpendicular to its main sensitivity axis. On Types 4501-A and 4501-A-001, it is on the side surface, parallel to its main sensitivity axis.

The piezoelectric element used in Types 4500-A, 4501-A and 4501-A-001 is PZ 23 and the housing is made of anodized aluminium.

Ground Insulation

Types 4500-A, 4501-A and 4501-A-001 feature an inner and outer housing. The sensor is mounted to the inner housing with glue, providing electrical insulation. This avoids ground-loop noise, which can be a problem in multichannel measurements. The accelerometers are electrically insulated with respect to signal ground and have a resistance of more than 10 MΩ.
Characteristics

Types 4500-A, 4501-A and 4501-A-001 are piezoelectric accelerometers and may be treated as charge sources. Their sensitivity is expressed in terms of charge per unit acceleration (pC/ms$^{-2}$, pC/g).

**Fig. 2**
Exploded view of the ThetaShear design. Components are as follows:
1. 10–32 UNF connector
2. Top
3. Piezoelectric plates
4. Seismic mass
5. Clamping ring
6. Housing

Types 4500-A, 4501-A and 4501-A-001 have high measurement stability and excellent sensitivity-to-weight ratio due to the ThetaShear design. In addition, 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 environmental effects such as base strains, magnetic sensitivity and acoustic fields.

**ThetaShear Design**
The ThetaShear design consists of a slotted cylindrical frame that holds a central seismic mass flanked by two piezoelectric plates and clamped rigidly by a ring. To ensure optimum accuracy and reliability, no bonding agent other than molecular adhesion holds the assembly together.

Note that Fig. 2 uses a generic accelerometer to display the ThetaShear design and does not show the inner housing of Types 4500-A, 4501-A and 4501-A-001.

**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.

The lower frequency limits and phase response are determined by the built-in preamplifiers. The lower frequency limits are given in the specifications for deviations from reference sensitivity within ±10%.

**Fig. 3** Frequency response curves for Types 4500-A, 4501-A and 4501-A-001
Clip for Calibration
For field checking and system calibration, Calibration Clip DV-0459 can be used in combination with Calibration Exciter Type 4294.

![Fig. 4 Calibration Clip DV-0459](image)

**Material:**
- Base: Hardened stainless steel
- Spring: Stainless steel
- Mounting surface diameter: 21 mm
- Mounting thread: 10–32 UNF
- Weight: 17 g (0.59 oz)

Mounting
Types 4500-A, 4501-A and 4501-A-001 are mounted with adhesive, with or without the use of mounting clips.

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:**
  - For brief use (<1 hour): −54 to +80 °C (−65 to +176 °F)
  - Maximum acceleration:
    - Perpendicular to mounting surface: 70 g peak
- **Material:**
  - Glass reinforced polycarbonate

![Fig. 5 Mounting Clip UA-1407 (set of 100)](image)

**Upper limiting frequency (±10%):**
- Type 4500-A mounted with grease: 3.0 kHz
- Type 4500-A dry mounting: 1.5 kHz
- Type 4501-A mounted with grease: 4.0 kHz
- Type 4501-A dry mounting: 2.0 kHz
- Weight: 0.4 g

![Fig. 6 Mounting Clip with Thick Base UA-1475 (set of 100). The base can be filed down to suit the mounting surface](image)

**Upper limiting frequency (±10%):**
- Type 4500-A mounted with grease: 3.0 kHz
- Type 4500-A dry mounting: 1.5 kHz
- Type 4501-A mounted with grease: 4.0 kHz
- Type 4501-A dry mounting: 2.0 kHz
- Weight: 0.7 g
Cabling

When using miniature 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.

Brüel & Kjær’s Uniaxial Charge Accelerometers

Types 4500-A, 4501-A and 4501-A-001 are part of a family of uniaxial charge accelerometers. To find the uniaxial accelerometer that fits your needs, visit www.bksv.com.

| Table 1 | Comparison of Brüel & Kjær uniaxial charge accelerometers for clip mounting |
|---------|-------------------------------------------------|------------------|-----------------|-----------------|-----------------|
|         | 4500-A | 4501-A | 4501-A-001 | 4507-C | 4508-C |
| Temperature °C (°F) | 175 (347) | 250 (482) |
| Number of connectors | | 1 | |
| Weight g | 4.1 | 4 | 4.5 |
| Isolated | Yes | No | |
| Capacitance pF | 1000 | 360 | |
| Frequency range Hz | 1 to 15000 | 1 to 10000 | 0.1 to 6000 | 1 to 8000 |
| Mounting | Mounting clip or adhesive | | |
| Sensitivity pC/ms² | 0.316 | 0.45 | |
| Product Data | BP 1427 | | BP 1841 |
Specifications – Piezoelectric Charge Accelerometer Types 4500-A, 4501-A and 4501-A-001

<table>
<thead>
<tr>
<th>Type No.</th>
<th>4500-A</th>
<th>4501-A</th>
<th>4501-A-001</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>g</td>
<td>4.100</td>
<td>4.000</td>
</tr>
<tr>
<td></td>
<td>oz</td>
<td>0.145</td>
<td>0.141</td>
</tr>
<tr>
<td>Charge Sensitivity (at 159.2 Hz)</td>
<td>pC/ms^-2</td>
<td>0.316 ± 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pC/g</td>
<td>3.10 ± 20%</td>
<td></td>
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<tr>
<td>Frequency Range</td>
<td>±10% limit</td>
<td>Hz</td>
<td>1 to 15000</td>
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<tr>
<td></td>
<td>±5% limit</td>
<td>Hz</td>
<td>1 to 8000</td>
</tr>
<tr>
<td>Mounted Resonance Frequency</td>
<td>kHz</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>Max. Transverse Sensitivity (at 30 Hz, 100 ms^-2)</td>
<td>%</td>
<td>&lt;5</td>
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<tr>
<td>Transverse Resonance Frequency</td>
<td>kHz</td>
<td>&gt;20</td>
<td></td>
</tr>
<tr>
<td>Max. Operational Continuous Sinusoidal Acceleration (peak)</td>
<td>kms^-2</td>
<td>30</td>
<td>3000</td>
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<td>Electrical</td>
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<tr>
<td>Residual Noise Level (measured with NEXUS Type 2692-001 in the specified frequency range)</td>
<td>mms^-2</td>
<td>7.60</td>
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</tr>
<tr>
<td></td>
<td>mg</td>
<td>0.77</td>
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<tr>
<td>Capacitance (excluding cable)</td>
<td>pF</td>
<td>1000</td>
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<tr>
<td>Case (signal ground) Insulation to Base</td>
<td>MΩ</td>
<td>&gt;10</td>
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<tr>
<td>Min. Leakage Resistance (at 20 °C)</td>
<td>GΩ</td>
<td>&gt;20</td>
<td></td>
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<td>Environmental</td>
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<tr>
<td>Operating Temperature Range</td>
<td>°C</td>
<td>–55 to +175</td>
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<tr>
<td></td>
<td>°F</td>
<td>–67 to +347</td>
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<tr>
<td>Temperature Coefficient of Sensitivity</td>
<td>%/°C</td>
<td>0.05</td>
<td>0.1</td>
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<tr>
<td>Temperature Transient Sensitivity (3 Hz Low. Lim. Freq. (~3 dB, 6 dB/octave))</td>
<td>ms^-2/°C</td>
<td>0.4</td>
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<td></td>
<td>g/°F</td>
<td>0.02</td>
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<tr>
<td>Base Strain Sensitivity (at 250 με in the base plane)</td>
<td>ms^-2/με</td>
<td>0.001</td>
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<tr>
<td></td>
<td>g/με</td>
<td>0.0001</td>
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<tr>
<td>Magnetic Sensitivity (50 Hz, 0.038 T)</td>
<td>ms^-2/T</td>
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<tr>
<td></td>
<td>g/kG</td>
<td>0.02</td>
<td></td>
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<tr>
<td>Max. Non-destructive Shock (± peak)</td>
<td>kms^-2</td>
<td>30</td>
<td>3000</td>
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<tr>
<td>Mechanical</td>
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<tr>
<td>Housing Material</td>
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<td>Anodized Aluminium</td>
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<tr>
<td>Piezoelectric Sensing Element</td>
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<td>PZ 23</td>
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<td>Construction</td>
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<td>ThetaShear</td>
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<td>Sealing</td>
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<td>Welded</td>
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<td>Electrical Connector</td>
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<td>10–32 UNF-2A</td>
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<tr>
<td>Mounting</td>
<td></td>
<td></td>
<td>Mounting clip or Adhesive</td>
</tr>
</tbody>
</table>

* In the temperature range –25 to +125 °C (–13 to +257 °F)
† Mounted in mounting clip

All values are typical at 25 °C (77 °F) unless measurement uncertainty is specified.
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 61010–1 and IEC 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

Note 1: The above is only guaranteed using accessories listed in this Product Data sheet.
Note 2: The above is only guaranteed when the AC output is not in use.

Temperature
Operating Temperature: –55 to +175 °C (–67 to +347 °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)).

Configuration Examples

Fig. 9 Cabling, signal conditioning and data acquisition hardware options for uniaxial piezoelectric charge accelerometers.
Ordering Information

Type 4500-A  Piezoelectric charge accelerometer with top connector
Type 4501-A  Piezoelectric charge accelerometer with side connector
Type 4501-A-001 Piezoelectric charge accelerometer with side connector (without grooves in housing)

Each accelerometer includes the following accessories:
- Carrying box
- Calibration chart
- One mounting clip

Optional 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, 10 – 32 UNF, 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 adaptor, 10 – 32 UNF (F) to BNC (M)
QA-0035  Cable accessory set, tools for cable and connector assembly
QA-0220  Tool, cable connecting and removal
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-1243  Red/green/yellow cable markers for 1.6 mm cable jacket (3 × 30 pieces)
UA-1244  Red/Green/Yellow Cable markers for 1.9 mm to 2.2 mm cable jacket (3 × 30 pieces)

MOUNTING
QS-0007  Tube of cyanoacrylate adhesive
UA-1407  Mounting clip, small (set of 100)
UA-1475  Mounting clip with thick base, small (set of 100)
UA-1478  Mounting base with swivel base, small (set of 100)
UA-1564  Spirit level for all swivel bases
UA-1564  High-temperature mounting clip, small (set of 5)
YI-0216  Beeswax for mounting

CONDITIONING AND DATA ACQUISITION HARDWARE
Type 3053-B-120  12-ch. Input Module LAN-XI 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  6-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V)
UA-2105-060  LAN-XI Front Panel, Charge Accelerometer, 6-ch. for the family of Charge to CCLD Convertor Type 2647
Type 2647-A/B  Charge to CCLD Convertor
Type 2692  NEXUS Conditioning Amplifier

CALIBRATION
Type 4294  Calibration exciter
DV-0459  Calibration clip, small

Calibration Services

SERVICES FOR UNIAXIAL ACCELEROMETERS
ACC-M-CAF  Accredited calibration
ACC-M-CAI  Accredited initial calibration
ACC-M-CFF  Factory standard calibration
ACC-M-CTF  Traceable calibration

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