

PRODUCT DATA

Piezoelectric Accelerometer Miniature Triaxial DeltaTron[®] Accelerometers — Types 4524, 4524-B and 4524-B-001

Type 4524 series consists of lightweight triaxial piezoelectric OrthoShear[®] accelerometers, each with three independent outputs for simultaneous measurements in three mutually perpendicular directions. Type 4524 series utilise a 4-pin connector.

The clip mounting facility combined with the ability to mount the transducer on five of its six surfaces makes mounting on structures very flexible and quick and thus ideal for structural and modal analysis measurements.

The light compact construction is an improved design covered by the OrthoShear patent.



USES AND FEATURES

USES

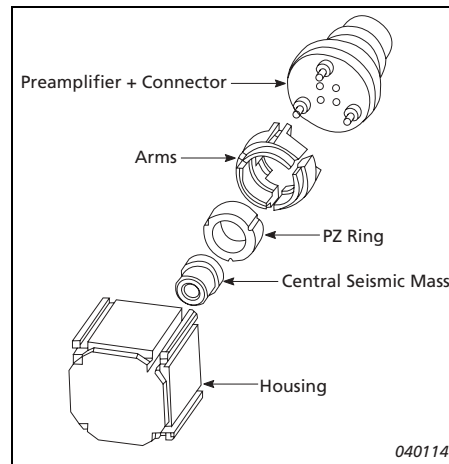
- Structural analysis measurements
- Multichannel modal analysis measurements
- Modal measurements for automotive body and power-train applications
- Hand and arm measurements (4524-B-001)

FEATURES

- High sensitivity-to-weight ratio
- Light weight (<5 gram)
- Excellent low-frequency response
- Electrically insulated
- Hermetically sealed
- Easy mounting on five of six surfaces
- B-versions utilise TEDS

Characteristics

Fig. 1
Exploded view of Type
4524



The piezoelectric accelerometer features a built-in preamplifier. The sensitivity is expressed in terms of voltage per unit acceleration (mV/g).

The OrthoShear design used in Type 4524 (Fig. 1) is built around a common seismic mass. This uni-mass design results in a very compact triaxial accelerometer where all the axes have the same point of reference and ensures accurate and consistent measurements, even when the accelerometer is exposed to complex vibration patterns. The seismic mass is surrounded by a piezoelectric ring, which is surrounded by three individually suspended, curved arms. Because of the suspension pins, different sections are exposed to shear forces for different directions of acceleration. By appropriate summation of the signals, the outputs for the X-, Y- and Z-axes are obtained.

Versions

Types 4524-B and 4524-B-001 include a Transducer Electronic Data Sheet (TEDS) containing sensor- and application-specific information, including frequency response compensation.

Mounting

Special effort has been put into making mounting as flexible as possible. The accelerometer housing has slots that allow the use of mounting clips. The accelerometers can be easily fitted to or removed from a number of different test objects.

In addition to adhesive mounting directly on the test specimen, there are four clip-mounting possibilities:

- A high-temperature mounting clip
- A thin, polycarbonate mounting clip for use on plane surfaces
- A mounting clip with a thick base can be modified, before use, to suit the mounting surface on the test object
- A mounting clip with swivel base and a spirit level, which make it easy to align the accelerometer in order to retain the coordinate system

Fig. 2

High-temperature Mounting Clip UA-1564 Specifications:

| | |
|--------------------------------------|-----------------------------------|
| Temperature range: | Full operating range of Type 4524 |
| Maximum acceleration | |
| – with a 5g accelerometer: | 50g peak |
| – perpendicular to mounting surface: | 250g peak |
| Base Material: | Anodised aluminium |
| Spring Material: | Stainless steel spring |
| Weight: | 5.7g |



Fig. 3

Mounting Clip UA-1407 Specifications:

| | |
|--------------------------------|---------|
| Upper limiting frequency (10%) | |
| – X-axis: | 2.7 kHz |
| – Y- and Z-axes: | 2.0 kHz |
| Weight: | 0.4g |

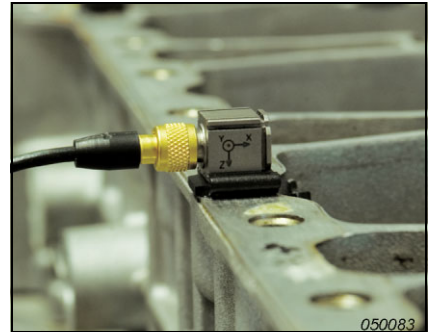
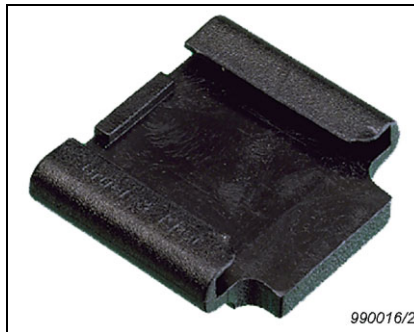
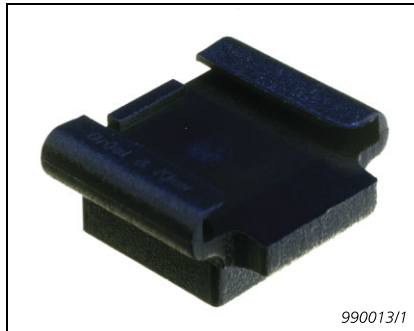


Fig. 4

Mounting Clip with Thick Base UA-1475 Specifications:

| | |
|--------------------------------|---------|
| Upper limiting frequency (10%) | |
| – X-axis: | 2.7 kHz |
| – Y- and Z-axes: | 2.0 kHz |
| Weight: | 0.7g |



Common Specifications for all Plastic Mounting Clips (UA-1407, UA-1475 and UA-1478)

| | |
|--------------------------------------|--------------------------------|
| 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: | 10g peak |
| (Perpendicular to mounting surface): | 70g peak |
| Material: | Glass-reinforced polycarbonate |

Fig. 5

Swivel Base UA-1478 Specifications:
Excitation must be along one of the accelerometer's axes of sensitivity but with mounting surface of the hemispherical part at 45° to the direction of the excitation:

- X-axis: 2.5 kHz
 - Y- and Z-axes: 1.9 kHz
- Weight: 0.8 g



Fig. 6

Spirit Level UA-1480 Specifications:

Max. dimensions: 85 × 23 × 17 mm
(3.35 × 0.9 × 6.7 in)

Material: Black, anodised aluminium



Calibration

Fig. 7

Calibration Clip DV-0459 Specifications:

Mounting-surface diameter: 21 mm

Mounting thread: 10–32 UNF

Base Material: Stainless steel (hardened)

Spring Material: Stainless steel spring

Weight: 17 g



The transducers are individually calibrated and supplied with a comprehensive calibration chart, using state-of-the art, random FFT technology, providing an 1600-point high-resolution calibration (magnitude and phase) ultimately giving a unique characterization and securing the integrity of the vibration measurement.

The sensitivity given on the calibration chart has been measured at 159.2 Hz with a 95% confidence level, using a coverage factor $k = 2$.

Frequency Compensation – REq-X

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

The calibration chart also 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:

$$S_{rel}(f, T) = (Sign) \times (1 + b(T - T_{ref})) \times \frac{j \frac{f}{f_{hp}}}{\left(1 + j \frac{f}{f_{hp}}\right)} \times \frac{1}{\left(1 + j \frac{f}{f_{lp}}\right)} \times \frac{1}{\left(1 + \left(j \frac{f}{f_{res}}\right)^2 + j \frac{f}{Q f_{res}}\right)} \times \left(j \frac{f}{f_{ref}}\right)^{\frac{a}{\ln 10}}$$

- | | |
|---------------------------------------|--|
| $Sign$ = Polarity | b = Temperature Coefficient |
| T = Temperature | T_{ref} = Reference Temperature |
| f = Frequency | f_{hp} = High-pass Cut-off Frequency |
| f_{lp} = Low-pass Cut-off Frequency | f_{res} = Resonance Frequency |
| f_{ref} = Reference Frequency | Q = Quality Factor |
| a = Amplitude Slope/Decade | |

Combining this equation with the amplitude sensitivity S_{ref} and f_{ref} and T_{ref} we have:

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

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

Fig. 8
Typical frequency responses with and without REq-X applied

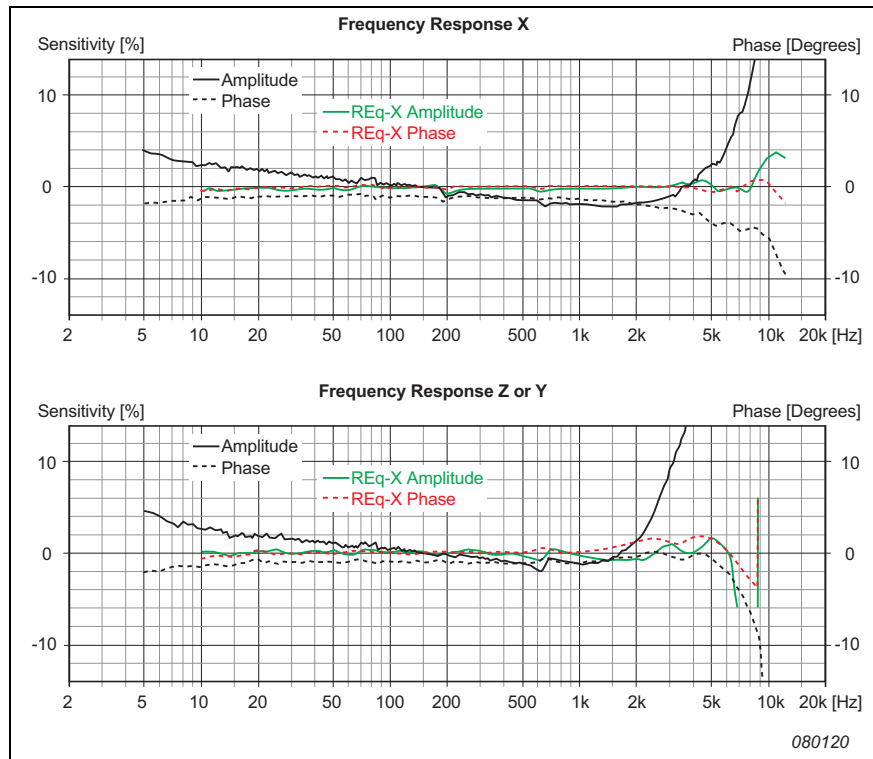
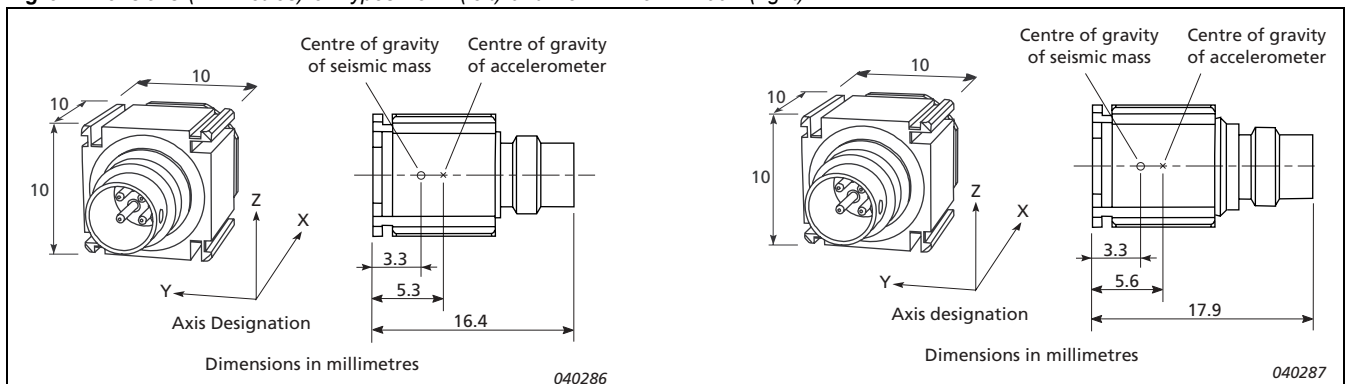


Fig. 9 Dimensions (millimetres) of Types 4524 (left) and 4524-B/4524-B-001 (right)



DeltaTron Power Supply

Types 4524, 4524-B and 4524-B-001 require all three axes to be powered for operation. Single or dual axial supply is not possible. The accelerometers can be used with any constant current (2 to 10 mA) power supply setup.

For a cost-effective and reliable power supply, WB-1453 is a 3-channel, battery-operated power supply for DeltaTron accelerometers. The frequency range covers the full frequency range for the accelerometers and the transducer current is 3 mA \pm 20%. Both input and output are supplied with 4-pin, Microtech-compatible connectors.

Specifications – Miniature Triaxial DeltaTron Accelerometers Types 4524, 4524-B and 4524-B-001

| | Units | 4524 | 4524-B | 4524-B-001 |
|---|---|---|-----------------|---------------------------------------|
| Dynamic Characteristics | | | | |
| Voltage Sensitivity (@ 159.2Hz) | mV/ms ⁻² (mV/g) | 10 \pm 5% (100 \pm 3%) | | 1 \pm 10% (10 \pm 3%) |
| Measuring Range | ms ⁻² (g) | \pm 500 (\pm 50) | | \pm 5000 (\pm 500) |
| Frequency Response | | See typical Frequency Response (Fig. 8) | | |
| Mounted Resonance Frequency | kHz | x: 18 y: 9 z: 9 | | |
| Amplitude Response \pm 10% | Hz | x: 0.2 to 5500 | y: 0.25 to 3000 | z: 0.25 to 3000 |
| Amplitude Response \pm 10% with REq-X | Hz | x: 0.2 to 10000 | y: 0.25 to 5000 | z: 0.25 to 5000 |
| Phase Response \pm 5° | Hz | 1.5 to 3000 | | |
| Temperature Response | %/°C (%/°F) | 0.14 (0.08) | | 0.11 (0.05) |
| Residual Noise (1 to 6000 Hz) Br. Band | mg | x: <0.4 | y: <0.2 | z: <0.2 x: <0.7 y: <0.7 z: <0.9 |
| Transverse Sensitivity | % | < 5 | | |
| Electrical Characteristics | | | | |
| DC Output Bias Voltage | V DC | +12 \pm 1 | +13 \pm 1 | |
| Output Impedance | Ω | <2 | <30 | |
| Grounding | | Insulated from case | | |
| Power Requirements Note: All three axes must be powered during operation | | | | |
| Supply Voltage (Unloaded) | V DC | 24 to 30 | | |
| Constant Current Supply | mA | 2 to 10 | | |
| Warm-up Time (90% of stabilised bias) | s | 10 | | |
| Environmental Characteristics | | | | |
| Temperature Range | °C (°F) | -54 to +100 (-65 to +212) | | |
| Humidity | | Hermetic | | |
| Max. Operational Sinusoidal Vibration (peak) | ms ⁻² (g) | 5000 (500) | | |
| Max. Operational Shock (\pm peak) | ms ⁻² (g) | 50 000 (5000) | | |
| Base Strain Sensitivity | Equiv. ms ⁻² /μ strain (g/μ strain) | Mounted in clip: 0.0005 (0.00005) Cemented to measuring object: 0.02 (0.002) | | |
| Thermal Transient Sensitivity | Equiv. ms ⁻² /°C (g/°F) | 0.1 (0.005) | | |
| Magnetic Sensitivity (50 Hz – 0.03 tesla) | ms ⁻² /T (g/T) | 20 (2) | | 30 (3) |
| Physical Characteristics | | | | |
| Dimensions | | See outline drawing (Fig. 9) | | |
| Weight | g (oz.) | 4.4 (0.15) | 4.8 (0.17) | |
| Case Material | | Titanium | | |
| Connector | | Hermetic 4-pin receptacle ¼–28 UNF-2A | | |
| Mounting | | Adhesive or clip | | |

All values are typical at 25°C (77°F) unless measurement uncertainty is specified
All values are valid with 4 mA supply current and all three axes powered

COMPLIANCE WITH STANDARDS



Compliance with EMC Directive of the EU



Compliance with the EMC requirements of Australia and New Zealand

Ordering Information

ACCESSORIES INCLUDED

- Carrying Box
- Calibration Chart
- One Mounting Clip

OPTIONAL ACCESSORIES

| | |
|---------------|--|
| AO-0526-D-050 | Cable with 4-pin to 3 × BNC connectors, 5 m (16 ft), 85°C (185°F) |
| AO-0527-D-050 | Cable with 4-pin to 3 × 10–32 UNF connectors, 5 m (16 ft), 85°C (185°F) |
| AO-0528-D-050 | Cable with 4-pin to 4-pin connectors, 5 m (16 ft), 85°C (185°F) |
| AO-0534-D-050 | Cable with 4-pin to 3 × BNC connectors, 5 m (16 ft), 120°C (248°F) |
| AO-0536-D-100 | Cable with 37-pin D-range sub-connector to 2 × 4-pin, 10 m (33 ft), 85°C (185°F) |
| DV-0459 | Calibration Clip |
| UA-1407 | Set of 100 Mounting Clips |
| UA-1418 | Set of 25 Dummy Accelerometers for mass loading |
| UA-1475 | Set of 100 Mounting Clips with thick base |
| UA-1478 | Set of 100 Swivel Base Clips |

| | |
|---------|--|
| UA-1480 | Spirit Level Set (including 100 Swivel Base Clips) |
| UA-1564 | Set of 5 High-temperature Mounting Clips |
| UA-3015 | Hand Adaptor (clip) T-shaped |
| UA-3016 | Handle Adaptor (clip) L-shaped |
| UA-3017 | Mounting Adaptor with strips (clip) |
| WB-1453 | DeltaTron Power Supply |
| YJ-0216 | Mounting Wax |

Service

ACCREDITED CALIBRATION

| | |
|------------|--------------------------------|
| 4524-CAI | Accredited Initial Calibration |
| 4524-B-CAI | Accredited Initial Calibration |
| 4524-CAF | Accredited Calibration |
| 4524-B-CAF | Accredited Calibration |

TRACEABLE CALIBRATION

| | |
|------------|-------------------------------|
| 4524-CTI | Traceable Initial Calibration |
| 4524-B-CTI | Traceable Initial Calibration |
| 4524-CTF | Traceable Calibration |
| 4524-B-CTF | Traceable Calibration |

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

HEADQUARTERS: DK-2850 Nærum · Denmark · Telephone: +45 4580 0500
Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Australia (+61) 2 9889-8888 · Austria (+43) 1 865 74 00 · Brazil (+55) 11 5188-8161
Canada (+1) 514 695-8225 · China (+86) 10 680 29906 · Czech Republic (+420) 2 6702 1100
Finland (+358) 9-755 950 · France (+33) 1 69 90 71 00 · Germany (+49) 421 17 87 0
Hong Kong (+852) 2548 7486 · Hungary (+36) 1 215 83 05 · Ireland (+353) 1 807 4083
Italy (+39) 0257 68061 · Japan (+81) 3 5715 1612 · Republic of Korea (+82) 2 3473 0605
Netherlands (+31) 318 55 9290 · Norway (+47) 66 77 11 55 · Poland (+48) 22 816 75 56
Portugal (+351) 21 4169 040 · Singapore (+65) 6377 4512 · Slovak Republic (+421) 25 443 0701
Spain (+34) 91 659 0820 · Sweden (+46) 33 225 622 · Switzerland (+41) 44 8807 035
Taiwan (+886) 2 2502 7255 · United Kingdom (+44) 14 38 739 000 · USA (+1) 800 332 2040

Local representatives and service organisations worldwide

Brüel & Kjær 

