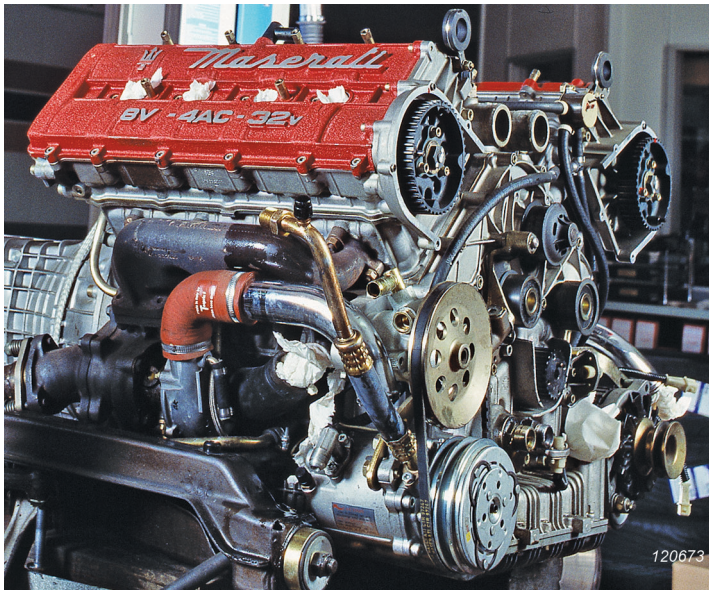
PRODUCT DATA

# Triaxial CCLD Accelerometer Types 4535-B, 4535-B-001 and 4535-B-003

General-purpose Accelerometers with TEDS

*Triaxial CCLD* Accelerometer Types 4535-B, 4535-B-001 and 4535-B-003 are designed to simplify testing by meeting most needs of a modern test lab. Their wide frequency range (0.3 Hz to 10 kHz) and light weight make them excellent general-purpose triaxial accelerometers. They feature TEDS (transducer electronic data sheet) and M3 stud mounting which speeds test set-up. Their small size and the option of a single-axis power supply make Types 4535-B, 4535-B-001 and 4535-B-003 the right choice, even when only a single- or bi-axis measurement is needed at a location.*



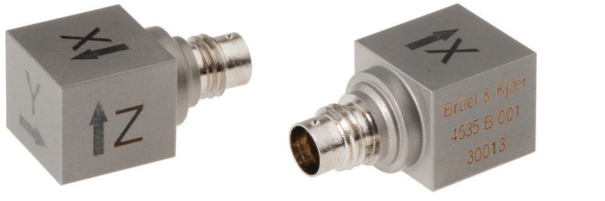

## Uses and Features

### Uses

- General purpose
- Structural testing
- Automotive body and powertrain measurements
- Acoustic fatigue testing
- Triaxial measurements in confined space

### Features

- Single axis supply makes single- or bi-axial measurement possible to save channels
- Wide frequency range from 0.3 Hz to 10 kHz on all three axes
- Low noise for structural testing
- Possibility for clip mounting with an adaptor speeds test set-up
- Titanium construction
- Hermetically sealed
- Reduce test set-up time with TEDS

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* CCLD: Constant current line drive, also known as DeltaTron®, (ICP and IEPE compatible)

Brüel & Kjær

## Description

Types 4535-B, 4535-B-001 and 4535-B-003 are designed for general-purpose triaxial measurements.

To provide the best performance on thin-walled structures, the accelerometer's design is planar shear. The planar shear design consists of two rectangular slices of piezoelectric material, PZ 23, and two seismic masses arranged on the broad sides of a rectangular centre post. The housing is made of titanium, which reduces weight and survives everyday use.

The accelerometers work on a low-impedance output, which enables the use of inexpensive cables. They are also compatible with a wide range of existing signal conditioning equipment. Types 4535-B, 4535-B-001 and 4535-B-003 feature a four-pin, industry-standard connector for maximum cable compatibility. The connector is hermetically sealed to keep out contamination and ensure a long life.

Types 4535-B, 4535-B-001 and 4535-B-003 feature three individually powered, built-in preamplifiers, each working on a two-wire principle. This gives the possibility of saving channels with single- or bi-axial measurements. The preamplifiers give a wide dynamic range of 114 dB for Type 4535-B, 98 dB for Type 4535-B-001 and 116 dB for Type 4535-B-003, allowing measurements of both low- and high-level acceleration.

## Recommended Mounting

The design of the accelerometers is optimized to transmit vibration through the base of the unit. To achieve a flat frequency response from 0.3 Hz to 10 kHz on all three measurement axes, mount the accelerometer on its base (mounting surface for z-direction) using adhesive or an M3 stud.

The design supports a wide range of mounting techniques such as:

- M3 mounting stud – to achieve the highest frequency
- Adhesive pad – to extend the life of the transducer
- Direct adhesive – to mount the accelerometer quickly

## 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%.

## Temperature Response

Types 4535-B, 4535-B-001 and 4535-B-003 are specified to operate in the temperature range –60 to +125 °C. Fig. 1 shows the typical temperature response for the accelerometers.

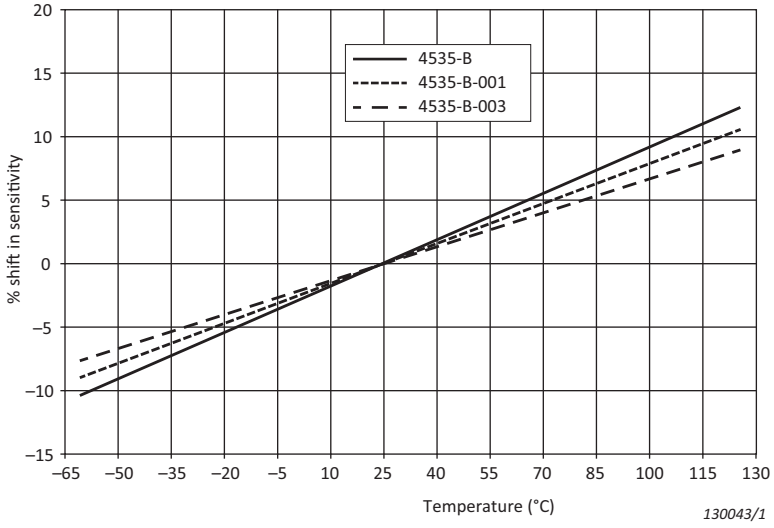



***Fig. 1***
*Typical temperature response of Types 4535-B, 4535-B-001 and 4535-B-003*

## Maximum Cable Length

The maximum output voltage of a CCLD accelerometer when driving long cables depends on the supply current at which it is operating, and on the capacitive load due to the connecting cable. The maximum cable length in metres (for distortion ≤1%) is given by:

$$L = 140000 \times \frac{I_s - 1}{f \times V_o \times C_m}$$

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

Types 4535-B, 4535-B-001 and 4535-B-003 are part of a family of triaxial CCLD accelerometers. From dedicated modal testing to high-temperature applications, Brüel & Kjær has an accelerometer to meet your needs – including a family of triaxial charge accelerometers for measurments at temperatures higher than 180 °C.

***Table 1*** *Overview of Brüel & Kjær's family of triaxial CCLD accelerometers. (More variants can be found on bksv.com)*

| | 4524-B-001 | 4520 | 4535-B | 4528-B | 4527 | 4529-B |
|---|---|---|---|---|---|---|
| **Application** | Modal test | General purpose | General purpose | High-temperature, general purpose | High-temperature, general purpose | General purpose |
| **Temperature (°C)** | –54 to +100 | –51 to +121 | –60 to +125 | –60 to +165 | –60 to +180 | –60 to +125 |
| **Weight (grams)** | 4.4 | 2.9 | 6 | 6 | 6 | 14.5 |
| **TEDS** | Yes | No | Yes | Yes* | No | Yes |
| **Isolation** | Yes by design | Yes with insulated adaptor | Yes with insulated adaptor | Yes with insulated adaptor | Yes with insulated adaptor | Yes by design |
| **Frequency Range (Hz)** | **X**: 0.20 to 5.5k<br>**Y:** 0.25 to 3.0k<br>**Z:** 0.25 to 3.0k | **X:** 2 to 7k<br>**Y:** 2 to 7k<br>**Z:** 2 to 7k | **X:** 0.3 to 10.0k<br>**Y:** 0.3 to 10.0k<br>**Z:** 0.3 to 12.8k | **X:** 0.3 to 10.0k<br>**Y:** 0.3 to 10.0k<br>**Z:** 0.3 to 12.8k | **X:** 0.3 to 10.0k<br>**Y:** 0.3 to 10.0k<br>**Z:** 0.3 to 12.8k | **X:** 0.3 to 12.8k<br>**Y:** 0.3 to 6.0k<br>**Z:** 0.3 to 6.0k |
| **Mounting** | Clip or adhesive | Adhesive | M3, clip or adhesive | M3, clip or adhesive | M3, clip or adhesive | Clip or adhesive |
| **Sensitivity ($mV/ms^{-2}$)** | 1 | 1 | 1 | 1 | 1 | 10 |
| **Noise Floor ($mm/s^{-2}$)** | 50 | 70 | 9 | 9 | 9 | 3 |
| **Product Data** | BP-2076 | BP-2072 | BP-2465 | BP-2451 | BP-2447 | BP-2517 |

* The TEDS data retention can work up to 165 °C. High-temperature usage can reduce the lifetime of the TEDS chip. This does not have any impact on the specifications of the accelerometer. TEDS is only recommended for use during the measurement set-up phase

## Compliance with Standards

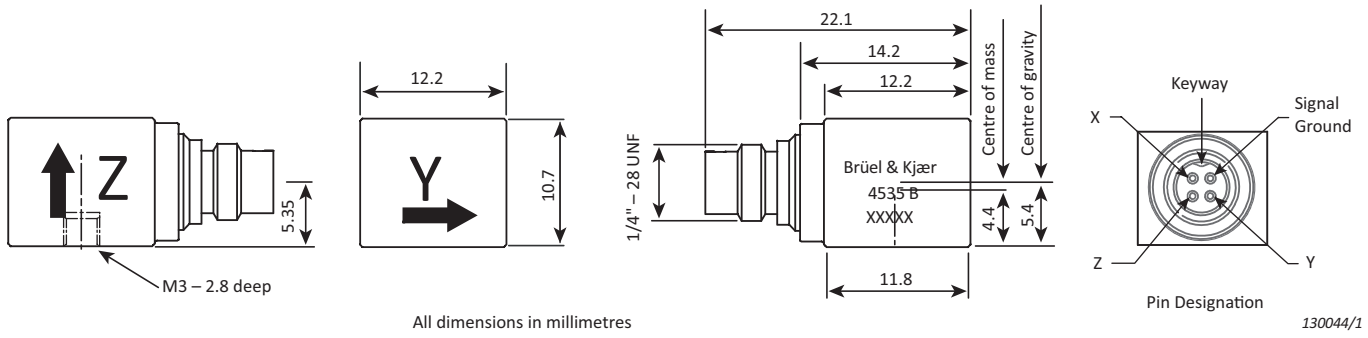
| | |
|---|---|
|  | The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives<br>RCM mark indicates compliance with applicable ACMA technical standards – that is, for telecommunications, radio communications, EMC and EME<br>China RoHS mark 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<br>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<br>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<br>EN/IEC 61000–6–4: Generic emission standard for industrial environments<br>CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits<br>FCC Rules, Part 15: Complies with the limits for a Class B digital device<br>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<br>EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments<br>EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements<br>**Note:** The above is only guaranteed using accessories listed in this Product Data sheet |
| **Temperature** | IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat<br>Operating Temperature: –60 to +125 °C (–76 to +257 °F) |
| **Mechanical** | Non-operating:<br>IEC 60068–2–6: Vibration: 0.3 mm, 20 $m/s^2$, 10 – 500 Hz<br>IEC 60068–2–27: Shock: 1000 $m/s^2$<br>IEC 60068–2–29: Bump: 1000 bumps at 250 $m/s^2$ |

| Type No. | | | 4535-B | 4535-B-001 | 4535-B-003 |
|---|---|---|---|---|---|
| **General** | | | | | |
| **Weight** | | gram (oz) | 6 (0.21) | | 4.8 (0.17) |
| **Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)** | | $mV/ms^{-2}$ | 1.0 ± 10% | 10 ± 10% | 0.1 ± 10% |
| | | mV/*g* | 9.8 ± 10% | 98 ± 10% | 0.98 ± 10% |
| **Frequency Range** | Amplitude (±10%)* | Hz | **X,Y:** 0.3 to 10000, **Z:** 0.3 to 12800 | | |
| | Amplitude (±10%)† | | **X,Y:** 0.3 to 5500, **Z:** 0.3 to 12800 | | |
| | Amplitude with Req-X (± 10%)‡ | | **X,Y:** 0.3 to 10000, **Z:** 0.3 to 12800 | | |
| | Phase (±5°)* | | **X, Y, Z:** 2 to 5500 | | |
| | Phase (±5°)† | | **X, Y, Z:** 2 to 5500 | | |
| **Mounted Resonance Frequency** | | kHz | **X, Y:** 30, **Z:** 42 | | |
| **Max. Transverse Sensitivity (at 30 Hz, 100 $ms^{-2}$)** | | % | <5 | | |
| **Max. Operational Continuous Sinusoidal Acceleration (peak)** | | $ms^{-2}$ | 7000 | 700 | 50000 |
| | | *g* | 714 | 71 | 5100 |
| **TEDS** | | | Yes | | |
| **Electrical** | | | | | |
| **Bias Voltage** | At 25 °C and 4 mA | V | 13 ± 1 | | |
| | At full temperature and current range | | 12 to 14 | | |
| **Power Supply** | Constant current | mA | 2 to 20 | | |
| | Unloaded supply voltage | V | 22 to 30 | | |
| **Output Impedance** | | Ω | <50 | | <20 |
| **Start-up time (to final bias ± 10%)** | | s | <10 | | <5 |
| **Residual Noise (inherent RMS broadband noise in the specified frequency range)** | 0.3 Hz to 10 kHz | µV (µ*g*) | 9 (900) | 60 (600) | 6 (6000) |
| | 1 Hz to 10 kHz | | 5 (500) | 30 (300) | 3 (3000) |
| | 2 Hz to 10 kHz | | 4 (400) | 20 (200) | |
| **Noise Spectral** | 10 Hz | $mms^{-2}/\sqrt{Hz}$ (µg/√Hz) | 0.30 (30) | 0.2 (20) | 1.7 (170) |
| | 100 Hz | | 0.06 (6) | 0.04 (4) | 0.5 (50) |
| | 1000 Hz | | 0.04 (4) | 0.02 (2) | 0.3 (30) |
| **Insulation Resistance (signal ground to case)** | | GΩ | Signal ground is connected to case | | |
| **Environmental** | | | | | |
| **Operating Temperature Range** | | °C (°F) | –60 to +125 (–76 to +257) | | |
| **Temperature Coefficient of Sensitivity** | | %/ °C | +0.12 | +0.1 | +0.10 |
| **Temperature Transient Sensitivity (3 Hz Lower Limiting Freq. (–3 dB, 6 dB/octave))** | | $ms^{-2}$/ °C | 0.02 | | 0.025 |
| | | *g*/ °F | 0.0011 | | 0.0014 |
| **Magnetic Sensitivity (50 Hz, 0.038 T)** | | $ms^{-2}$/T | 15 | 8 | 100 |
| | | *g*/kG | 0.15 | 0.08 | 1 |
| **Base Strain Sensitivity (at 250 µε in base plane)** | | $ms^{-2}$/µε | 0.1 | | 0.010 |
| | | *g*/µε | 0.01 | | 0.001 |
| **Max. Non-destructive Shock (peak)** | | $kms^{-2}$ (*g*) | 50 (5100) | | |
| **Mechanical** | | | | | |
| **Case Material** | | | Titanium ASTM Grade 5 | | |
| **Piezoelectric Sensing Element** | | | PZ 23 | | |
| **Construction** | | | Shear | | |
| **Sealing** | | | Hermetic | | |
| **Electrical Connector** | | | 1/4"–28 UNF 4-pin (M) | | |
| **Mounting** | | | M3 × 2.8 mm threaded hole or adhesive | | |

* Mounted on unit base (mounting surface for z-direction)
† Verified amplitude response during calibration with reduced useful frequency response on x- and y-axes due to mounting on unintended mounting surface
‡ Applying REq-X on x- and y-axes is not recommended

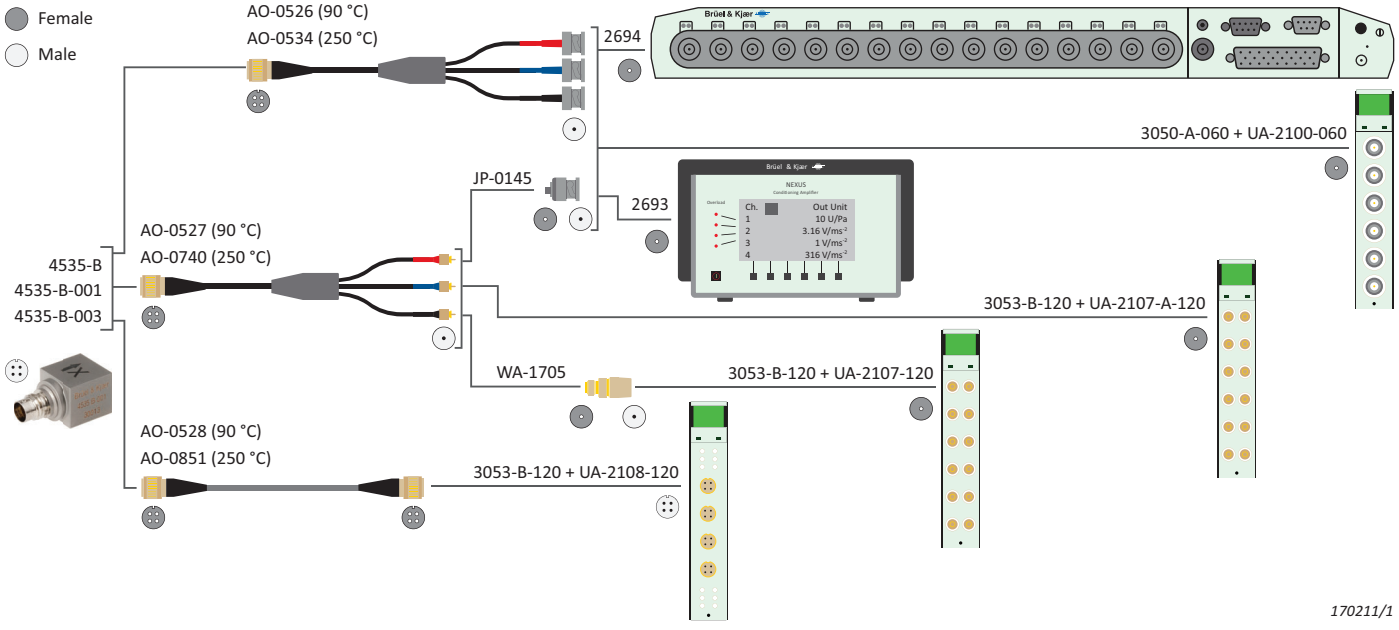
All values are typical at 25 °C unless measurement uncertainty is specified

***Fig. 2*** *Physical dimensions, axes orientation and pin designation of Types 4535-B, 4535-B-001 and 4535-B-003, shown resting on its base*




## Equipment Configuration

***Fig. 3*** *Typical configurations with Types 4535-B, 4535-B-001 and 4535-B-003*



**Type 4535-B** **Triaxial CCLD Accelerometer** (voltage sensitivity 1.0 mV/ms$^{-2}$)
**Type 4535-B-001** **Triaxial CCLD Accelerometer** (voltage sensitivity 10 mV/ms$^{-2}$)
**Type 4535-B-003** **Triaxial CCLD Accelerometer** (voltage sensitivity 0.1 mV/ms$^{-2}$)

Include the following accessories:
- Carrying box
- Calibration chart
- M3 mounting stud

## Optional Accessories

### CABLING

| | | |
|---|---|---|
| **AO-0851-x-yyy*** | Flexible cable | • ¼″–28 UNF 4-pin (F) connectors<br>• 250 °C (482 °F) |
| **AO-0528-x-yyy*** | Flexible cable | • ¼″–28 UNF 4-pin (F) connectors<br>• 90 °C (194 °F) |
| **AO-0534-x-yyy*** | Flexible cable | • ¼″–28 UNF 4-pin (F) connector to 3 × super low-noise cables with BNC (M) connectors<br>• 250 °C (482 °F)† |
| **AO-0526-x-yyy*** | Flexible cable | • ¼″–28 UNF 4-pin (F) connector to 3 × super low-noise cables with BNC (M) connectors<br>• 90 °C (194 °F)† |
| **AO-0740-x-yyy*** | Flexible, single-screened coaxial cable | • Four-wire cable<br>• ¼″–28 UNF 4-pin (F) to 3 × 10–32 UNF (M) connectors<br>• 250 °C (482 °F)† |
| **AO-0527-x-yyy*** | Flexible cable | • ¼″–28 UNF 4-pin (F) connector to 3 × super low-noise cables with 10–32 UNF (M) connectors<br>• 90 °C (194 °F)† |
| **AO-0536-x-yyy*** | Flexible cable for connecting two triaxial accelerometers | • 2 × circular 4-pin (F) to 37-pin D-sub (F)<br>• 90 °C (194 °F) |

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

† This cable has a splitter with an operating temperature range of – 40 to + 150 °C (– 40 to + 302 °F)

| | |
|---|---|
| JP-0145 | Plug Adaptor, 10–32 UNF (F) to BNC (M) |
| WA-1705 | Plug Adaptor, 10–32 UNF (F) to SMB (F) |

### MOUNTING

| | |
|---|---|
| QS-0007 | Tube of cyanoacrylate adhesive |
| QS-0090 | Glue X-60, two components |
| UA-0867 | Cementing stud, M3 stud with ∅ 8 mm (0.3″) cementing pad (set of 25) |
| UA-1075 | Mounting magnet and two insulating discs, M3, ∅ 10 mm, length 1.6 mm (set of 5) |
| UA-1193 | Insulated stud, M3, double end with flange, 200 °C (392 °F), length 5.4 mm (set of 10) |
| UA-2065 | Stud, M3, length 5 mm (set of 10) |
| WA-0224 | Mechanical Filter, M3 stud and hole |
| YJ-0216 | Beeswax for mounting |

### CONDITIONING AND DATA ACQUISITION

| | |
|---|---|
| Type 2693 | NEXUS CCLD Conditioning Amplifier |
| Type 2694-A | 16-ch. CCLD Conditioning Amplifier |
| Type 3050-A-060 | 6-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V), includes UA-2100-060 |
| Type 3053-B-120 | 12-ch. Input Module LAN-XI 25.6 kHz (CCLD, V), includes UA-2107-120 |
| UA-2100-060 | LAN-XI Front Panel with six BNC connectors |
| UA-2103 | LAN-XI Front Panel with six-channel, 37-pin D-sub connector |
| UA-2107-120 | LAN-XI Front Panel with 12 SMB connectors |
| UA-2107-A-120 | LAN-XI Front Panel with 12 10–32 UNF connectors |
| UA-2108-120 | LAN-XI Front Panel with four triaxial accelerometer connectors (4-pin) |

## Calibration Services

### SECONDARY CALIBRATION

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

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