PRODUCT DATA

High-sensitivity Triaxial CCLD Accelerometer Type 4506-B-003

Type 4506-B-003 is a high-sensitivity triaxial piezoelectric CCLD accelerometer. The accelerometer is housed in robust titanium and features a single, integrated Microtech-compatible connector.*

The accelerometer is engraved with a data matrix code. Scan the matrix code with your smartphone to:

- *Together with the Transducer Smart Setup app, simplify and automate multichannel test setups*
- *Quickly access the individual accelerometer's specifications, calibration information, etc.*

Uses and Features

Uses

- Structural analysis measurements
- Multichannel modal analysis measurements
- Modal measurements for automotive body and power-train applications

Features

- Transducer electronic data sheet (TEDS)
- Five mounting surfaces
- Easy mounting using a selection of mounting clips
- Robust titanium housing with integrated 4-pin titanium connector
- OrthoShear™ design providing a high sensitivity-to-weight ratio and a single point of reference for all axes
- Connects directly to CCLD power supply allowing the use of inexpensive cables
- Low output impedance enables the use of long cables
- Built-in low-noise preamplifiers with application-specific integrated circuits (ASICs) for a dynamic range exceeding 100 dB (100 mV/*g* sensitivity)
- Electrically insulated for ground-loop protection
- Data matrix code providing Web-based transducer-specific information and enabling Transducer Smart Setup

* CCLD: Constant current line drive, also known as DeltaTron® (ICP® and IEPE compatible). CCLD is a generic name for accelerometers and signal-conditioning products from Brüel & Kjær. It identifies products that operate on a constant-current power supply and give output signals in the form of voltage modulation on the power supply line. One of the advantages of this system is that it allows you to use inexpensive cables.

Brüel & Kjær

Type 4506-B-003 is a high sensitivity accelerometer with a low mass and small dimensions. It is ideally suited for triaxial modal analysis measurements of composite structures that require multiple measurement points, for example, automotive body and power-train measurements, or modal analysis on aircraft, trains and satellites. The grooves in the housing allow easy mounting on five sides of the accelerometer using mounting clips that fit easily to the test object.

Design

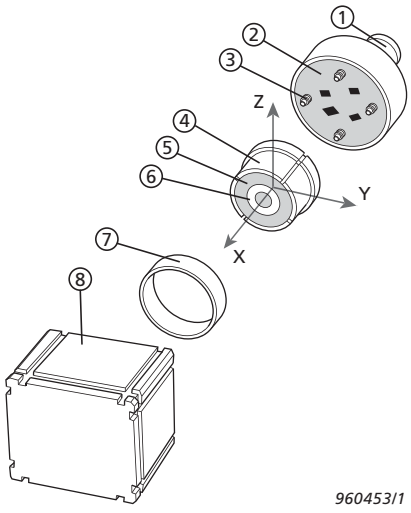


Fig. 1
Exploded view of Type 4506-B-003

Normally, triaxial accelerometers consist of three individual accelerometers mounted in a single housing. However, this limits the minimum size of the accelerometer and means that each axis has a different point of reference.

The OrthoShear™ design used in Type 4506-B-003 (see Fig. 1) uses a common seismic mass and piezoelectric element. This design results in a very compact triaxial accelerometer where all the axes have the same point of reference. The design also ensures accurate and consistent measurements, even when the accelerometer is exposed to complex vibration patterns.

The seismic mass (6) is surrounded by a piezoelectric ring (5), which is surrounded by four individually suspended, curved plates (4). This assembly is clamped together by an outer ring (7). The suspension pins (3) expose different sections of the assembly to shear forces based on the direction of acceleration. The output for an individual axis is obtained by the summation of the appropriate signals.

The preamplifiers (2), suspension pins and connector (1) form an integral part that is hermetically welded to the titanium housing (8). Also, Type 4506-B-003 is internally insulated from the housing. This reduces the risk of ground loops considerably, which can be troublesome in multichannel measurements.

CCLD

Type 4506-B-003 can be used with all vibration setups with CCLD (or equivalent) input modules.

The built-in, low-noise preamplifier is made using thick film technology. It comprises ASICs including a special reference voltage that ensures a very stable bias voltage over the entire operating temperature range. Special efforts have been made to minimize interference from RF (radio frequency) electromagnetic fields.

The low output impedance means that you can connect long cables between the accelerometer and measurement equipment.

CCLD Power Supply

It is possible to use Type 4506-B-003 with only two powered axes provided they are the y- and z-axes. Single axial supply is not possible.

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

Frequency Response

The following information on frequency response is included on the accelerometer's accompanying calibration chart and in its TEDS.

The upper frequency limits given in the specifications are the frequencies where the deviation from the reference sensitivity is less than 10%. It is approximately 30% of the mounted resonance frequency. This assumes that the accelerometer is correctly mounted onto the test structure – a 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 of less than 10%.

Increased measurement accuracy can be achieved by dividing the actual measurement with the individual frequency response. The calibration chart includes the 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:

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

where:

Sign = Polarity
T = Temperature
f = Frequency
f_{lp} = Low-pass cut-off frequency
f_{ref} = Reference frequency
a = Amplitude slope/decade
b = Temperature coefficient
T_{ref} = Reference temperature
f_{hp} = High-pass cut-off frequency
f_{res} = Resonance frequency
Q = Quality factor

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

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

Implementation of this formula in either real-time data acquisition systems or in post-processing will support an automatic update of amplitude and/or phase.

Transducer Smart Setup

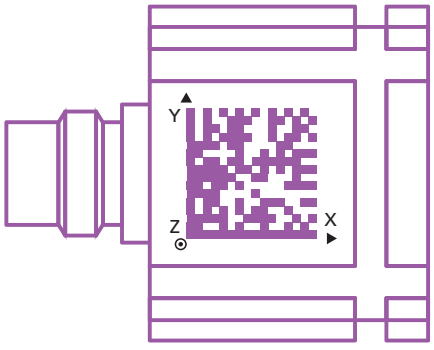


Fig. 2
Labelled symbols indicate the orientation of the triaxial accelerometer

Transducer Smart Setup is a mobile app that works in combination with the data matrix code engraved on the transducer. With the Transducer Smart Setup app, you can scan the data matrix code using your smartphone's camera. It will then recognize the transducer and allow you to add associated data such as location and orientation, minimizing the risk of data entry errors. The data can be imported into BK Connect™ as hardware setup tables for easy front-end configuration. If you change connections, just reimport the setup and the configuration will align as necessary – no need to trace cables.

The Transducer Smart Setup app is available for free in the App Store℠.

Use the Data Matrix Code to Access Transducer Information

Even without the app, scanning the data matrix code on the transducer provides fast and easy access to detailed product information such as:

- Specifications
- Technical documentation
- Specific calibration data
- Information about Transducer Smart Setup

Type 4506-B-003 is mounted with adhesive, with or without the use of mounting clips.

The various mounting clips are designed to suit a range 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.

High-temperature Mounting Clip

For mounting in high temperatures, use High-temperature Mounting Clip UA-1563.

160220

180172

- **Temperature range:**
  - Typical: –55 to +175 °C (–67 to +347 °F)
  - If discolouring is acceptable: –55 to +250 °C (–67 to +482 °F)
- **Maximum acceleration:**
  - With a 17 g accelerometer: 10 g peak
  - Perpendicular to mounting surface: 50 g peak
- **Base material:** Anodised aluminium
- **Spring material:** Stainless steel
- **Weight:** 11 g (0.83 oz)

Thin, Polycarbonate Mounting Clip

For mounting on planes and similar surfaces, use Mounting Clip UA-1408. Use the mounting clip to secure the cable and reduce the risk of cable-induced noise.

980499/2

980560e

- **Upper limiting frequency (10%):** 1.2 kHz
- **Weight:** 2.1 g (0.7 oz)

Thick-base Mounting Clip

To shape and customize the mounting to fit your needs, use Mounting Clip with Thick Base UA-1474. The thick base can be filed down as needed.

980480/2

170074

- **Upper limiting frequency (10%)**: 1.2 kHz
- **Weight:** 3.9 g (0.13 oz)

Swivel-base Mounting Clip

To align and realign the accelerometer without changing the coordinate system, use Big Swivel Base Clip UA-1473. Together with Spirit Level UA-1480, you can change the accelerometer's direction and still maintain the coordinate system.

Excitation must be along one of the accelerometer's axes of sensitivity but with the mounting surface of the hemispherical part at 45° to the direction of the excitation.

Big Swivel Base Clip

- **Upper limiting frequency (10%)**: 0.8 kHz (mounted with grease)
- **Weight:** 5.0 g (0.18 oz)

Spirit Level

- **Max. dimensions:** 85 × 23 × 17 mm (3.35 × 0.9 × 0.67 in)
- **Material:** Black, anodised aluminium

Common Specifications for UA-1408, UA-1474 and UA-1473

- **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

Calibration

Calibration Clip DV-0460

- **Mounting surface diameter:** 29 mm (1.14″)
- **Mounting thread:** 10−32 UNF
- **Base material:** Stainless steel (hardened)
- **Spring material:** Stainless steel
- **Weight:** 44 g (1.55 oz)

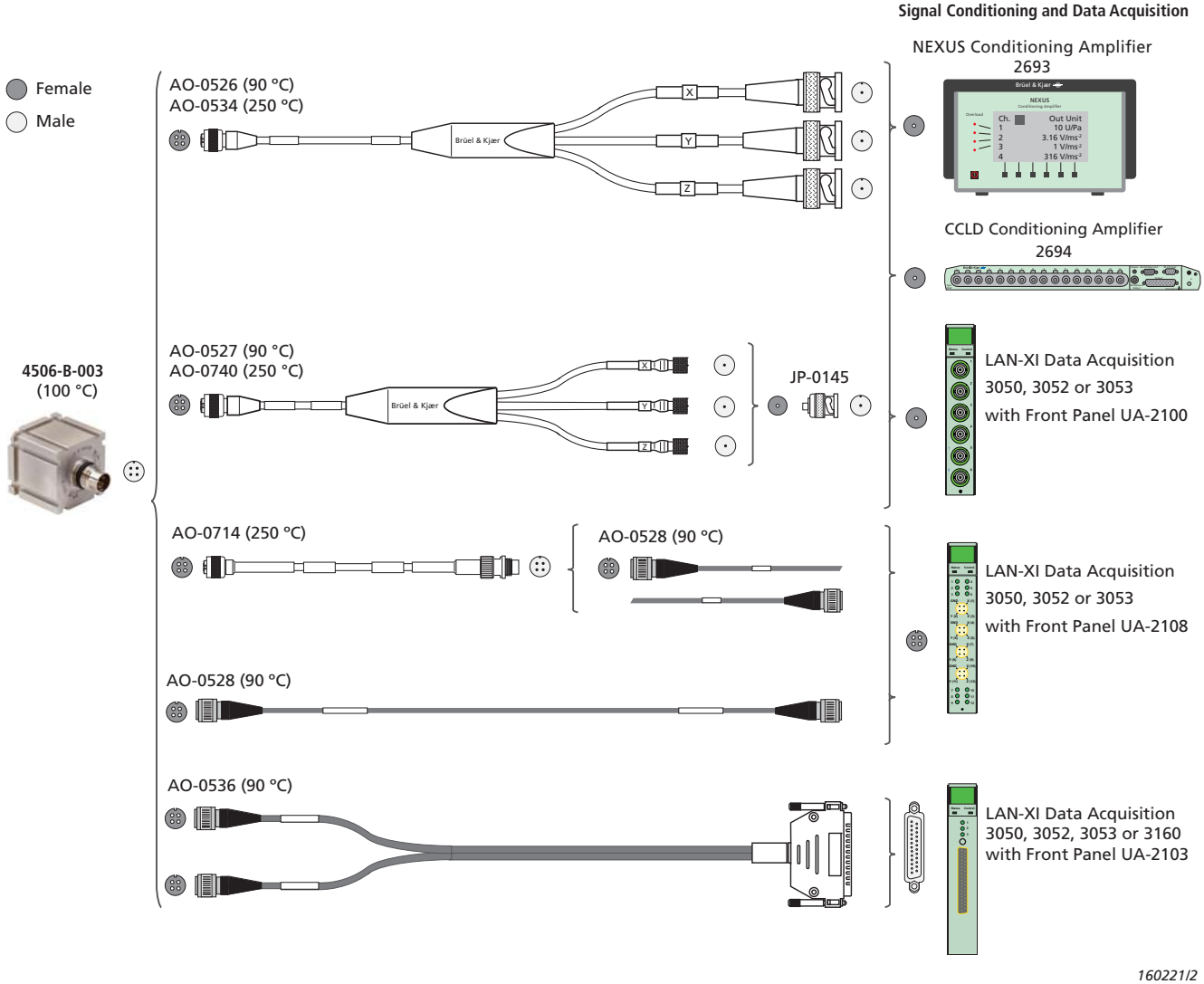
Each accelerometer is individually calibrated and supplied with a comprehensive calibration chart. Long-term stability and reliability are ensured by artificial ageing during the production process. Field checking and system calibration are straightforward using Brüel & Kjær's hand-held Vibration Calibrator Type 4294 (see product data BP 2101).

Table 1 *Cables compatible with Type 4506-B-003*

Cable No.	Connector A	Connector B	Temperature	Notes
AO-0526	¼″–28 UNF 4-pin (F)	BNC (M)	90 °C (194 °F)*	• Flexible • Single cable to 3 × super low-noise cables
AO-0527		10–32 UNF (M)	90 °C (194 °F)*	• Flexible • Single cable to 3 × super low-noise cables
AO-0534		BNC (M)	250 °C (482 °F)*	• Flexible • Single cable to 3 × super low-noise cables
AO-0740		10–32 UNF (M)	250 °C (482 °F)	• Flexible • Four-wire cable • Single-screened, coaxial
AO-0528		¼″–28 UNF 4-pin (F)	90 °c (194 °F)	• Flexible
AO-0714		¼″–28 UNF 4-pin (M)	250 °C (482 °F)	• Flexible • Four-wire cable • Single-screened, coaxial
AO-0536		D-sub 37-pin (F)	90 °c (194 °F)	• Flexible • Connects two triaxial accelerometers

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

Fig. 3 *Typical configurations for Type 4506-B-003*



Specifications – High-sensitivity Triaxial CCLD Accelerometer Type 4506-B-003

Note: Except for the frequency range, all values are typical at 25 °C (77 °F), unless measurement uncertainty is specified. All uncertainty values are specified at 2σ (that is, expanded uncertainty using a coverage factor of 2)

		Unit	4506-B-003
General			
Weight		gram (oz)	18 (0.63)
Voltage Sensitivity (at 159.2 Hz and 4 mA supply current)		mV/ms^{-2}	50 ± 10%
		mV/*g*	490 ± 10%
Frequency Range	**Amplitude (±10%)**	Hz	**X:** 0.3 to 4000, **Y, Z:** 0.3 to 2000
	Phase (±5°)	Hz	**X, Y, Z:** 2 to 2500
Mounted Resonance Frequency		kHz	**X:** 14, **Y, Z:** 7
Max. Transverse Sensitivity (at 30 Hz, 100 ms^{-2})		%	<5
Measuring Range (± peak)		kms^{-2} (*g*)	140 (14)
TEDS			Yes
Electrical			
Bias Voltage (at full temperature and current range)		V	13 ±1
Power Supply	**Constant current***	mA	2 to 10
	Unloaded supply voltage (full specification range)	V DC	+24 to +30†
Output Impedance		Ω	<30
Start-up Time (to final bias ±10%)		s	<10
Residual Noise (inherent RMS broadband noise in the specified frequency range)		µV	**X:** <60, **Y, Z:** <30
		µ*g*	**X:** <120, **Y, Z:** <60
Noise Spectral	**10 Hz**	$mms^{-2}/\sqrt{Hz}$	**X:** 0.1, **Y, Z:** 0.06
		µ*g*/√Hz	**X:** 10, **Y, Z:** 6
	100 Hz	$mms^{-2}/\sqrt{Hz}$	**X:** 0.04, **Y, Z:** 0.02
		µ*g*/√Hz	**X:** 4, **Y, Z:** 2
	1000 Hz	$mms^{-2}/\sqrt{Hz}$	**X:** 0.018, **Y, Z:** 0.008
		µ*g*/√Hz	**X:** 1.8, **Y, Z:** 0.8
Insulation Resistance (signal ground to case)		GΩ	>1
Polarity			Positive (on the X-, Y- and Z-axes) for an acceleration in the direction of the engraved arrows
Environmental			
Operating Temperature Range		°C	−54 to +100
		°F	−65 to +212
Temperature Coefficient of Sensitivity		%/°C	**X:** 0.15, **Y, Z:** 0.12
Temperature Transient Sensitivity (3 Hz lower limiting freq. (−3 dB, 6 dB/octave))		ms^{-2}/°C	5
		g/°F	0.275
Magnetic Sensitivity (50 Hz, 0.038 T)		ms^{-2}/T	6
		g/kG	0.06
Base Strain Sensitivity (at 250 µε in base plane)†		ms^{-2}/µε	0.02
		g/µε	0.002
Max. Non-destructive Shock (peak)		kms^{-2}	20
		g	2000
Mechanical			
Case Material			Titanium ASTM Grade 2
Piezoelectric Sensing Element			PZ 27
Construction			OrthoShear
Sealing			Welded
Electrical Connector			Microtech-compatible, circular 4-pin, 1/4″–28 UNF (titanium)
Mounting			Adhesive or mounting clips

* The Y- and Z-axes must be powered. If you only need two powered axes, you must choose the Y- and Z-axes. Single axial supply is not possible

† Mounted on mounting clip or on adhesive tape 0.09 mm (0.0035″) thick

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 meters (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)

Ordering Information

Type 4506-B-003 High-sensitivity Triaxial CCLD Accelerometer includes the following accessories:

- Carrying box
- Individual calibration chart
- 1 × mounting clip

Optional Accessories

CABLES AND ADAPTERS

AO-0526-D-xxx*	Cable with circular 4-pin to 3 × BNC connectors, 90 °C (194 °F)
AO-0526-M-100	Cable with circular 4-pin to 3 × BNC connectors, 100 m (333 ft), 90 °C (194 °F)
AO-0527-D-xxx*	Cable with 4-pin to 3 × 10−32 UNF connectors, 90 °C (194 °F)
AO-0528-D-xxx*	Cable with circular 4-pin (F) to 4-pin (F) connectors, 90 °C (194 °F)
AO-0534-D-xxx*	Cable with circular 4-pin to 3 × BNC connectors, 250 °C (482 °F)
AO-0536-D-050	Cable with to 2 × circular 4-pin to 37-pin D-sub-connectors, 5 m (16.7 ft), 90 °C (194 °F)
AO-0536-D-100	Cable with to 2 × circular 4-pin to 37-pin D-sub-connectors, 10 m (33 ft), 90 °C (194 °F)
AO-0714-D-xxx*	Cable with circular 4-pin (F) to 4-pin (M) connectors, 250 °C (482 °F)
AO-0740-D-xxx*	Cable with 4-pin to 3 × 10−32 UNF connectors, 250 °C (482 °F)
WA-1705	Plug Adapter, 10−32 UNF (F) to SMB (F)
JP-0145	Plug Adapter, 10−32 UNF (F) to BNC (M)

TRANSDUCER SMART SETUP

Free download from the App Store (requires iOS 8.0 or later)

CALIBRATION

DV-0459	Calibration Clip
Type 4294	Vibration Calibrator

MOUNTING

UA-1408	Mounting Clip (set of 100)
UA-1474	Mounting Clip, thick base (set of 100)
UA-1473	Mounting Clip, swivel base (set of 100)
UA-1480	Spirit Level
UA-1563	High-temperature Mounting Clip (set of 5)
DV-0460	Calibration Clip
UA-1417	Dummy Accelerometer, for mass loading (set of 25)
YJ-0216	Beeswax

POWER SUPPLY

WB-1453	CCLD Power Supply

SIGNAL CONDITIONING AND DATA ACQUISITION†

Type 2693	NEXUS Conditioning Amplifier
Type 2694-A/B/C/D	16-channel CCLD Conditioning Amplifier
Type 3050	LAN-XI 4/6-ch. Input Module, 51.2 kHz
Type 3052	LAN-XI 3-ch. Input Module, 102.4 kHz
Type 3053	LAN-XI 12-ch. Input Module 25.6 kHz
Type 3160	LAN-XI Generator, Input/Output Module, 51.2 kHz
UA-2100-0xy	LAN-XI General Purpose Front Panel, BNC connectors (2 to 6 channels: x = no. of input channels, y = no. of output channels)
UA-2103	LAN-XI 6-channel D-sub Connector Front Panel
UA-2107-120	LAN-XI 12-channel High-density Front Panel, SMB connectors
UA-2107-A-120	LAN-XI 12-channel High-density Front Panel, Microdot (10−32 UNF) connectors
UA-2108-xx0	LAN-XI Triaxial Accelerometer Front Panel, 4-pin connectors (6 or 12 input channels, x = no. of channels)

Calibration Services

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

* Available in various lengths. D = decimetres, xxx = length. Please specify when ordering

† For more information, see the individual product data: NEXUS conditioning amplifier, see BP 1702; CCLD conditioning amplifiers, see BP 1882; LAN-XI data acquisition modules, see BP 2215; and LAN-XI interchangeable front panels, see BP 2421

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