

PRODUCT INFORMATION

Range of HUMS and Engine-monitoring Accelerometers Type 4511-001, 4511-006, 4523, 8345 and 8347-C

Health Usage Monitoring Systems (HUMS) are being used more frequently in monitoring critical helicopter gearboxes, and also increasingly for gas-turbines – both those in helicopters and certain fixed-wing aircraft.

Vibration monitoring is a well-proven technology for preventing catastrophic failures of rotating components, with the piezoelectric accelerometer proving to be the best sensor for these applications.

Brüel & Kjær supplies a range of HUMS and engine-monitoring accelerometers, the design of which is focused on guaranteeing a highly robust and highly reliable sensor. Sensors must continuously operate in demanding environmental conditions, yet be sensitive enough to be able to detect incipient bearing and gear failures. Size and ease of mounting are equally important considerations for these applications.



Uses and Features

Uses

- Gearbox HUMS
- Engine monitoring
- Engine maintenance
- Active control response
- Pilot comfort
- Rotor balance
- Flight test

Features

- Flight certified
- Piezoelectric Shear designs
- Case isolated and internally shielded
- Wide frequency and temperature ranges
- CCLD (IEPE) and charge output types
- Low sensitivity to EMI

Accelerometer Design and Manufacturing

HUMS accelerometers typically have very specialised performance and reliability requirements. Strict environmental standards such as DO-160 "Environmental Conditions and Test Procedures for Airborne Equipment" must be adhered to, together with aircraft specific requirements.

Brüel & Kjær understands market needs and the production and quality management processes necessary to ensure absolute reliability. Our extensive R&D, QA and production capabilities enable us to design and manufacture HUMS accelerometers to comply with specific tasks requirements.

We can provide:

- Comprehensive R&D design and test facilities
- Aerospace standardised quality management
- Optimised production processes
- Worldwide support and service
- Accredited calibration laboratories
- Extensive domain expertise

Research and Development

Product development starts with Finite Element Model (FEM) and other simulation tools. From these models we can begin to optimise the performance of the new design. This not only reduces design time and cost, it provides a greater understanding of the accelerometer operation. This enables our engineers to optimise designs for maximum reliability by identifying and consequently removing internal resonances.

Following verification of the mathematical model, prototypes are produced for initial review by our customers and for extensive in-house testing against relevant environment and operating specifications.

Quality Management

Brüel & Kjær operates AS/EN9100 and ISO 9001:2000 quality management systems to provide the organisational structure, policies, procedures, processes and resources needed to ensure quality and safety of products. This demonstrates our organisations ability to meet the strict requirements and needs of our customers.

Production Processes

Production processes optimised to produce quality products for these tough aerospace applications are paramount. Clean-room production, extended accelerometer burn in, component process optimisation to withstand high g effects, annealing processes to remove residual strains, electron-beam welding and multi-axis CNC machines to ensure tight manufacturing specifications, are all processes used in the production of Brüel & Kjær accelerometers.

World-wide Support and Service

Brüel & Kjær is a global company. With more than 90 sales offices in 55 countries supported by a team of application specialists at our Headquarters in Denmark, we have the largest sound and vibration sales network in the world. With eight accredited calibration centres worldwide, and 500 employees working within local sales, service and support, we provide you with immediate customer support no matter where you are.

Calibration Laboratories

Our calibration laboratories are accredited in many regions, fulfilling the requirements of ISO A2LA and other standards, in accordance with the quality standard for laboratories – ISO 17025. Brüel & Kjær offers a comprehensive range of calibration services to meet national and international requirements – traceable to national institutes (DPLA, NIST, NPL, PTB).

Brüel & Kjær Heritage

Brüel & Kjær is no newcomer to innovative accelerometer design. Back in 1943, the company founder, Dr. Per V. Brüel, developed the world's first commercial piezoelectric accelerometer, made from Rochelle salt crystals. Since those early days, Brüel & Kjær has been at the forefront of transducer technology. The DeltaShear, OrthoShear and ThetaShear piezoelectric designs, on which many of the world's present-day accelerometers are based, were all invented by Brüel & Kjær, and the IEEE1451 TEDS standard that adds plug and play capabilities to analog transducers was driven by Brüel & Kjær.

Transducers have been, and will remain, a core part of our business.


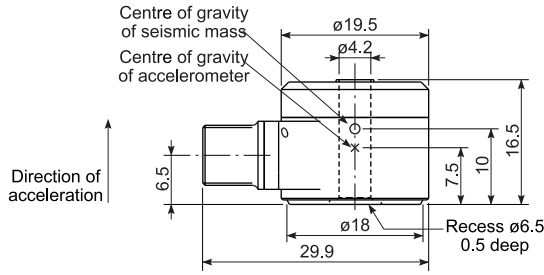

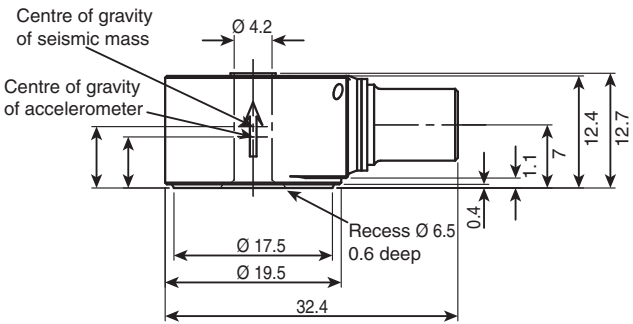
Industrial Accelerometers

All Brüel & Kjær industrial accelerometers are hermetically sealed to protect against environmental contamination. They are based on Shear piezoelectric designs to provide the combination of enhanced performance characteristics with better size-to-weight ratio, and environmental stability. We guarantee long-term reliable sourcing of materials.

HUMS Accelerometers

Table 1 shows a selection of Brüel & Kjær's industrial HUMS and engine monitoring accelerometers.

Table 1 A selection of Brüel & Kjær's industrial HUMS and engine monitoring accelerometers

Type 4511-001	
Uses <ul style="list-style-type: none"> • Flight-test applications • Measurements in harsh environment • In Health Usage Monitoring Systems • Measurement on gearboxes 	Features <ul style="list-style-type: none"> • Case insulated and internally shielded • High frequency (15 kHz) • High temperature (150°C) • EMI and radiation resistant • Ease of installation – centre bolt (360° orientation) design • Flight certified (for specific helicopters)
 <p>050016/2</p>	 <p>Centre of gravity of seismic mass Centre of gravity of accelerometer Direction of acceleration All dimensions in millimetres</p> <p>040288</p>
Type 4511-006	
Uses <ul style="list-style-type: none"> • Flight-test applications • Measurements in harsh environment • In Health Usage Monitoring Systems • Measurement on gearboxes 	Features <ul style="list-style-type: none"> • Case insulated and internally shielded • High frequency (25 kHz) • High temperature (150°C) • EMI and radiation resistant • Ease of installation – centre bolt (360° orientation) design • Flight certified (for specific helicopters)
 <p>130215/1</p>	 <p>Centre of gravity of seismic mass Centre of gravity of accelerometer All dimensions in millimetres</p> <p>140047</p>

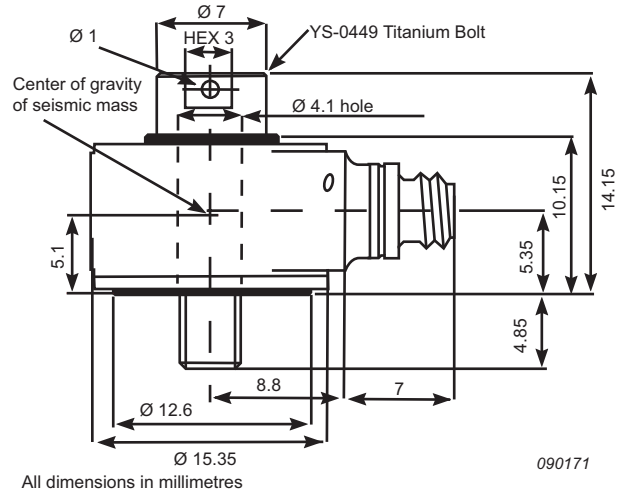
Type 4523

Uses

- Flight-test applications
- Measurements in harsh environment
- In Health Usage Monitoring Systems
- Measurement on gearboxes

Features

- Isolated mounting surfaces
- High frequency (13 kHz)
- High temperature (150°C)
- EMI resistant
- Ease of installation – centre bolt (360° orientation) design
- Flight certified (for specific helicopters)



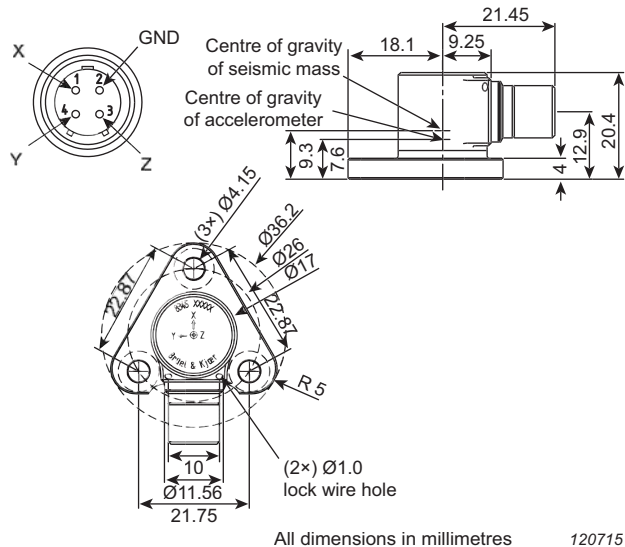
Type 8345

Uses

- Measurements in harsh environment
- Triaxial measurements
- Permanently installed machine condition monitoring
- In Health Usage Monitoring Systems

Features

- Ruggedized connector
- Isosceles triangle footprint to avoid misalignment



Type 8347-C

Uses

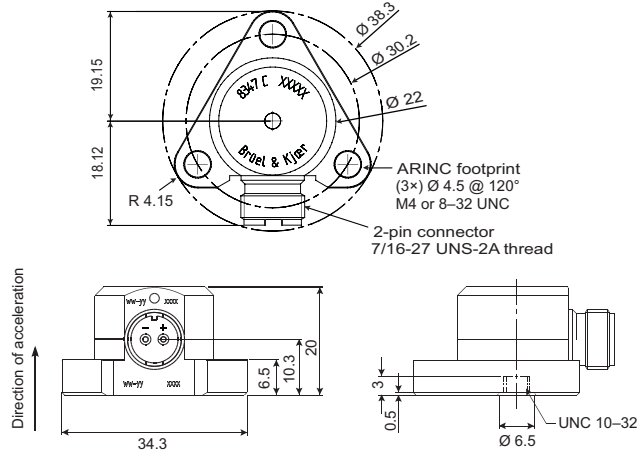
- Measurements in harsh environment
- Measurements on engines and industrial gas turbines
- Measurements on turbo pumps
- Measurements in nuclear power plants
- High-temperature and cryogenic applications
- In Health Usage Monitoring Systems

Features

- Wide temperature range -196°C to $+482^{\circ}\text{C}$
- High resistance to radiation
- Usable frequency range up to 12.8 kHz
- Low sensitivity to EMI
- Transverse resonance frequency 17 kHz
- Industry standard ARINC footprint



120026/2



ALL dimensions in millimeters

120250/2

Individual Accelerometer Calibration Charts

Every accelerometer produced at Brüel & Kjær undergoes the strictest production and quality control processes to ensure reliability, and also to maintain the smallest of spread amongst devices of the same type. The accelerometers are then individually calibrated to provide accurate data on several parameters, and this means that each accelerometer comes complete with an individual calibration chart containing extensive calibration information. Calibration charts include data on sensitivity, measurement range, frequency response, electrical parameters, dimensions, weight and a comprehensive collection of environmental specs.

The amplitude and phase frequency response are measured with a full 1600-point resolution – providing a complete response characterisation, showing the true response of the individual units over the frequency range.

An example of a Calibration Chart for the Type 4511-001 is shown in Fig. 1.

Fig. 1. Calibration chart for Type 4511-001

Calibration Chart for DeltaTron® Accelerometer Type 4511-001

Serial No.: 30220



Reference Sensitivity ¹⁾ at 159.2 Hz ($\omega = 1000 \text{ s}^{-1}$), 20 ms^{-2} RMS, 4 mA supply current and 24.5 °C: 0.9995 mV/ ms^{-2} (9.802 mV/g)

Frequency Range: Amplitude ($\pm 10\%$): 1 Hz to 15 kHz
Phase ($\pm 5^\circ$): 2 Hz to 10 kHz

Mounted Resonance Frequency: 43 kHz

Transverse Sensitivity: < 5% re Reference Sensitivity
Maximum (at 30 Hz, 100 ms^{-2}):

Calculated values for TEDS ³⁾: Resonance frequency: 48.4 kHz
Quality factor @ f_{res} : 27.9
Amplitude slope: -2.5 %/decade
High pass cut-off frequency: 0.089 Hz
Low pass cut-off frequency: 2000 kHz

Measuring Range: $\pm 5000 \text{ ms}^{-2}$ peak ($\pm 500 \text{ g}$ peak)

Polarity of the electrical signal is positive for an acceleration in the direction of the arrow on the drawing.

This calibration is obtained on Brüel & Kjær Calibration System 350197.1

Electrical:

Bias Voltage: at 25 °C and 4 mA: +11 V \pm 0.5 V
at full temperature and current range: +8.5 to 14 V

Power Supply requirements: Constant Current: +2 to +20 mA
Unloaded Supply Voltage: +18 V to +30 V

Output Impedance: < 100 Ω

Start-up time (to final bias $\pm 10\%$): < 2 s

Inherent Noise (RMS): Broadband (1 Hz to 15 kHz): < 10 μV
corresponding to < 0.01 ms^{-2} ($< 1000 \mu\text{g}$)

Spectral: 10 Hz: $1.6 \times 10^{-3} \text{ ms}^{-2}/\sqrt{\text{Hz}}$ ($160 \mu\text{g}/\sqrt{\text{Hz}}$)
100 Hz: $5 \times 10^{-4} \text{ ms}^{-2}/\sqrt{\text{Hz}}$ ($50 \mu\text{g}/\sqrt{\text{Hz}}$)
1000 Hz: $1.6 \times 10^{-4} \text{ ms}^{-2}/\sqrt{\text{Hz}}$ ($16 \mu\text{g}/\sqrt{\text{Hz}}$)

Insulation Resistance (body to mounting surface): > 100 M Ω

Environmental:

Temperature Range: -54 to +150 °C (-65 to +302 °F)

Temperature Coefficient of Sensitivity: 0.09 %/°C

Temp. Transient Sensitivity (3 Hz Low Lim. Freq. (-3 dB, 6 dB/oct)): 1 $\text{ms}^{-2}/^\circ\text{C}$

Magnetic Sensitivity (50 Hz, 0.038 T): 20 ms^{-2}/T

Base Strain Sensitivity (at 250 μm in base plane): 0.01 $\text{ms}^{-2}/\mu\text{m}$

Max. Non-destructive Shock: 50 kms^{-2} peak (5000 g peak)

Humidity: 100 % RH non-condensing

Mechanical:

Case Material: Stainless steel, AISI 316-L

Sensing Element: Piezoelectric, Type PZ 23

Construction: Annular Shear
Case Insulated
Internally Shielded

Sealing class (Helium leak rate): < 10⁻⁶ mBar l/s

Weight: 35 gram (1.23 oz)

Electrical Connector: 3-pin HiRel
All pins insulated from case

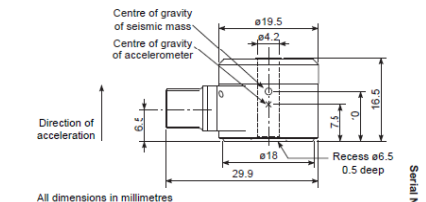


Mounting Hole: Centre hole for M4 bolt

Mounting Thread: 10 - 32 UNF-2B. Depth 3.2 mm

Mounting Surface Flatness: < 3 μm

Mounting Torque: Max. 3.5 Nm (31 lbf-in). Min. 0.5 Nm (4.4 lbf-in)

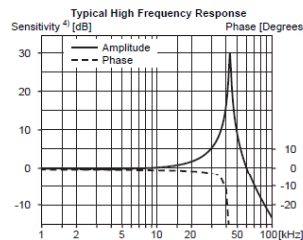
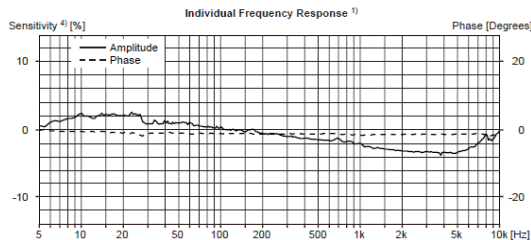


Date: 00 May 2013, 00.47 Operator: JCN

Specifications obtained in accordance with ANSI S2.11-1999 and parts of ISO 5347.

All values are typical at 25 °C (77 °F) unless measurement uncertainty is specified.

BC 0447-11



Specifications, Compliance with Standards and Ordering Information

For specifications, compliance with standards and ordering information, please see the relevant accelerometer Product Data:

- Piezoelectric (CCLD) Accelerometer Type 4511-001 ([BP 2064](#))
- CCLD Accelerometer Type 4511-006 (BP 2477)
- Piezoelectric (CCLD) Accelerometer Type 4523 ([BP 2261](#))
- Triaxial CCLD Accelerometer Type 8345 ([BP 2459](#))
- High-temperature Industrial Charge Accelerometer Type 8347-C ([BP 2431](#))

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