PRODUCT DATA

PULSE™ Vibration Check Systems for Aircraft Engines — Types 3647-A, 3647-B including PULSE Standard Configuration 3560-B-T57

To ensure the maintenance of helicopter engines and to optimise the up-time of the aircraft, Brüel & Kjær has developed a system for the field verification on the ground of specific engines based on PULSE Type 3560-B hardware and dedicated software. Vibration measurements are made according to the procedures specified by the engine manufacturer.

USES AND FEATURES

USES

- Vibration checks can be performed on specific aircraft engines according to the manufacturer's specifications

FEATURES

- Verifies the vibration levels with reference to two tachometer signals, one from the gas generator and one from the power turbine (also known as the free turbine) of the engine
- Simplified user interface
- Alarm if level limitations are exceeded
- Alarm if low level occurs (<1 mm/s)
- Automatic storage of results in database
- Contour plot (frequency, speed, level) to aid fault diagnosis
- System can be extended to allow advanced analysis of vibration signals and/or measure static droop
- Mains, aircraft and battery operation
- Automatic recognition of accelerometer and sensitivity by means of TEDS

BENEFITS

- Report produced immediately
- Only one run-up for all measurements to be measured

Photograph courtesy of AgustaWestland Helicopters

Brüel & Kjær

Description

Fig. 1 *Type 3647 is a portable system consisting of a basic system and an engine-specific system*

Vibration Check System for Aircraft Engines Type 3647-A consists of a PULSE bundle, Type 3560-B-T57 with hardware and software, a portable PC, a two-channel galvanic isolator for the tachometer signals, an accelerometer with a high-temperature cable with integrated charge converter/filter and TEDS (Type 8324-G) and a water- and shockproof case. Type 3647-B is the same as Type 3647-A, but does not contain Charge Accelerometer Type 8324-G.

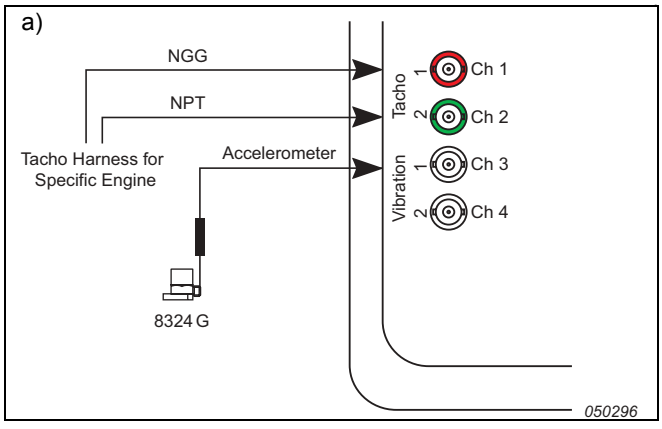
To use Type 3647-A or B to measure on a specific engine, the user must first supply Brüel & Kjær with the engine specifications necessary for an engine-specific project to be written.[1)]

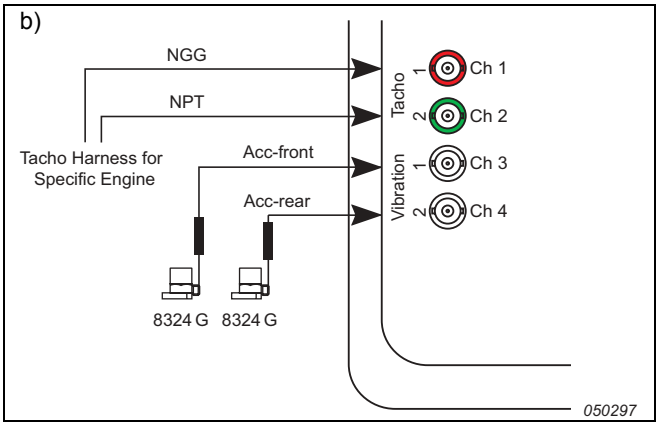
The system is installed in a weather- and shockproof carrying case. Engine-specific cables are stored in a robust shoulder-bag clearly labelled with the relevant engine type (Fig. 2).

Fig. 2 *Carrying case and shoulder bag*

Fig. 3 *Charge Accelerometer Type 8324-G with calibration chart and accessories*

Fig. 4 *Cabling for (a) single- and (b) dual-accelerometer systems*





1)**Note:** This does not apply to Turbomeca engines, which have their own hardware and engine-specific systems

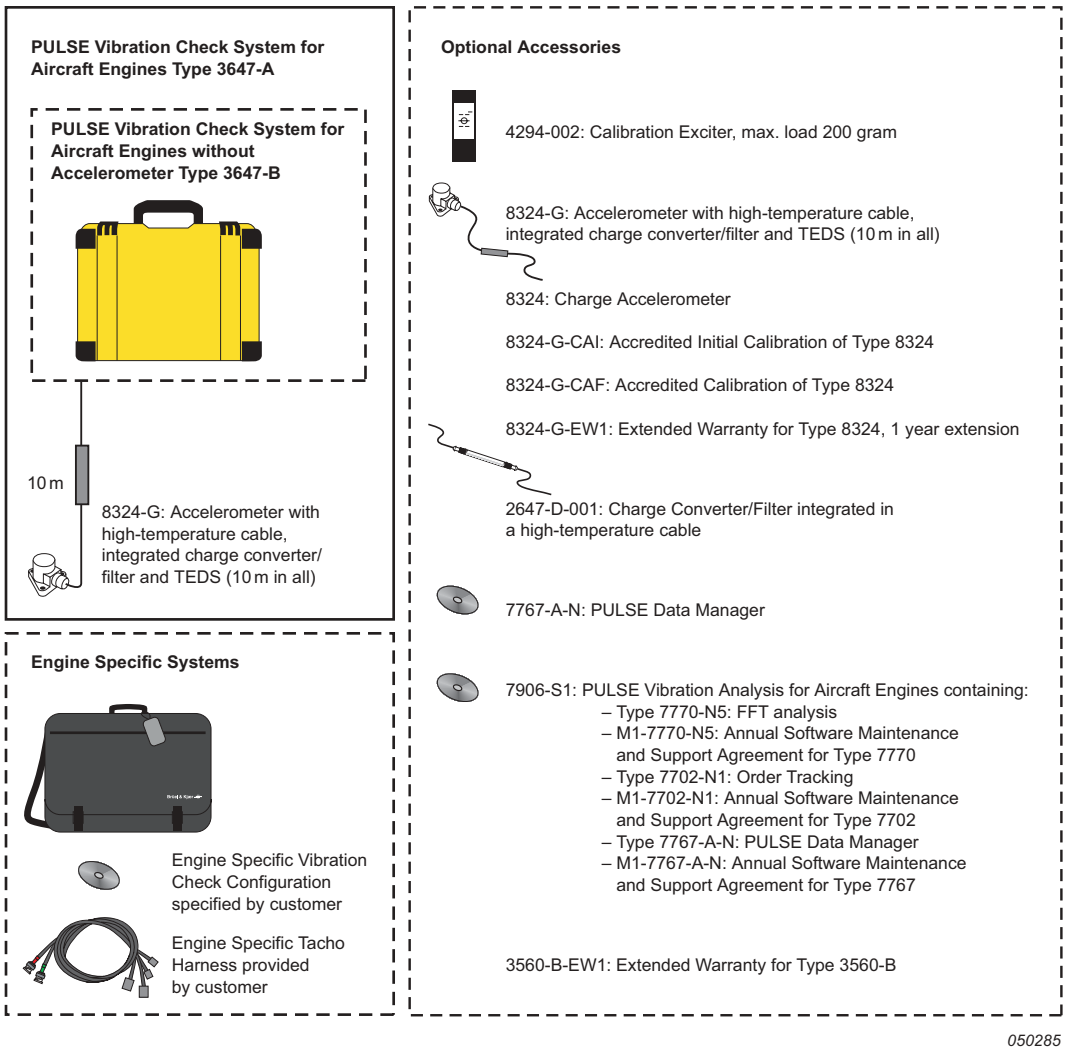


Fig. 5
System summary for Types 3647-A and 3647-B

The necessary Charge Accelerometer Type 8324 is included in the high-temperature cable, charge converter and TEDS unit (Fig. 3). Users who already possess a Charge Accelerometer Type 8324 can send the accelerometer to Brüel & Kjær for calibration with the required cable, or purchase a TEDS Editor Kit and read the data into the TEDS unit themselves. Systems for other helicopter engines are under preparation.

The simple user interface leads the technician from the identification of the engine, to the monitoring of the signals and finally to comparison with threshold levels (the verification). The signal is stored in a database and service report is produced where the results are clearly indicated as “Passed” or “Limit Exceeded” (Fig. 9).

The report can be sent directly to the engine manufacturer. With the PULSE Data Manager Type 7767 option, a copy of the time signal can accompany the report. Further analysis can be performed by using PULSE products. Type 7906-S1 Vibration Analysis for Aircraft Engines (requires Type 7795-N) is a suite of three products that enables up to four channels of FFT and order analysis and access to PULSE Data Manager.

Fig. 6
An example of the result of a 70 second run-up on a helicopter engine
Upper left: Level of 1st order vibration using a tacho from the generator
Lower left: Level of first order vibration using a tacho from the turbine
Upper right: Tachometer profiles.
Lower right: Control and status window

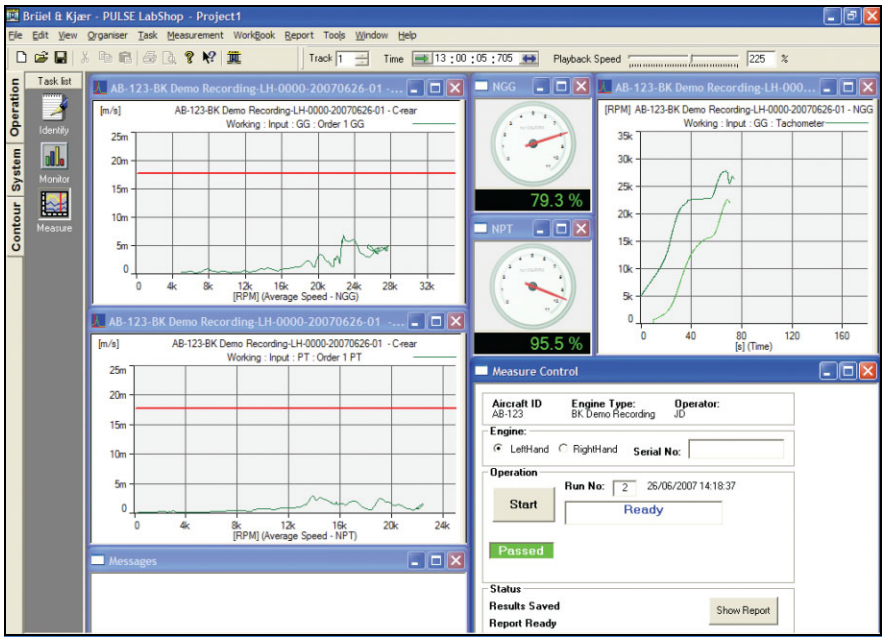


Fig. 7
Identification screen: system setup (left), instructions (right)

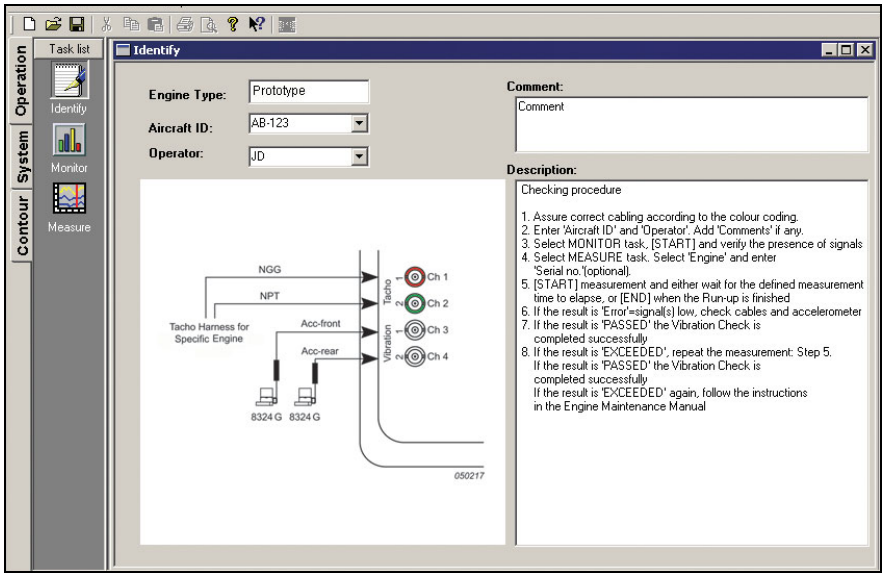


Fig. 8
Order plots for 1st order vibration signals using a tacho from the generator (upper plot) and a tacho from the turbine (lower plot)

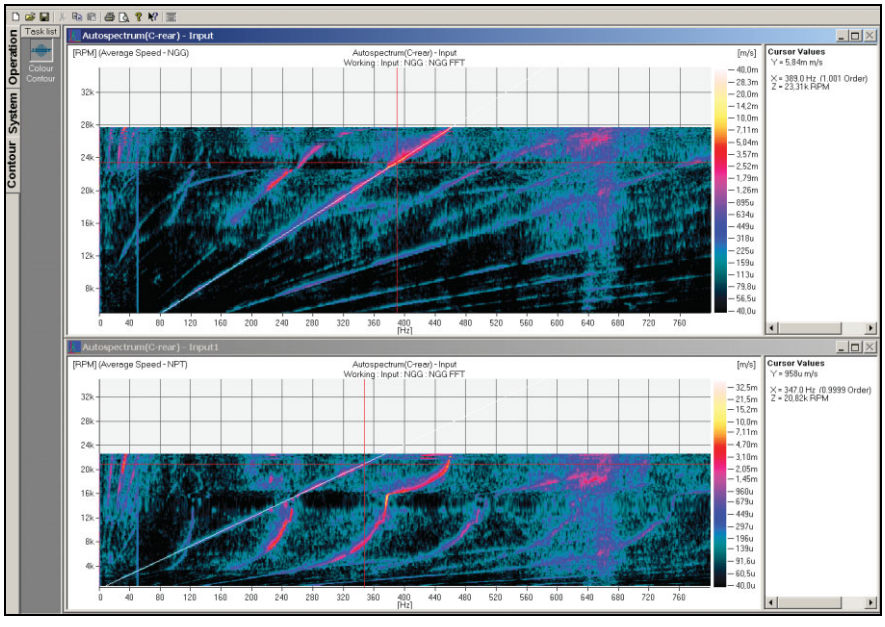
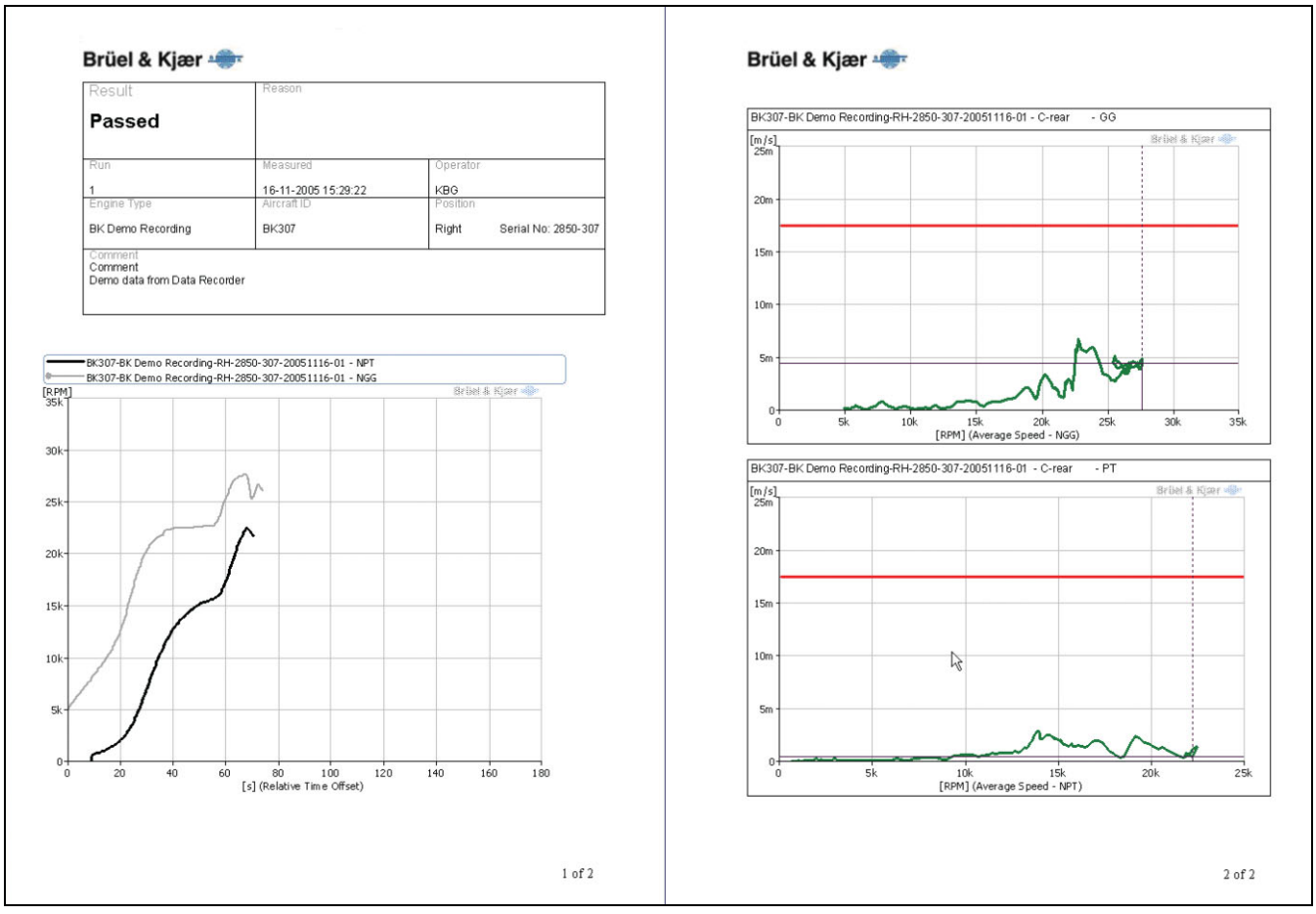


Fig. 9 *Automatically generated report in MIcrosoft® Word*



Static Droop

On engines with mechanical speed governors, it can be necessary to check or adjust the governor for Static Droop (SD) after replacing an engine's Fuel Control Unit (FCU) or at specified operating intervals.

Static Droop is an 'add-on' application to the Vibration Check System to provide a means for measuring Static Droop on specific engines (the user must first supply Brüel & Kjær with engine specific specifications).

The SD measurement is performed by recording Gas Generator rpm (NGG) and the Rotor rpm (NR) derived from the Power Turbine rpm (NPT) at a number of different NGG – typically a minimum of five points between flight-idle and 90%. At the pre-specified NGG, the operator records the NR by clicking the **Add Value** button. The software calculates and displays a curve, an example of which is shown in Fig. 10, where the actual NR is compared with a theoretical tolerance band.

The FCU Slope & Zero screw adjustments required to bring the curve back into tolerance are automatically calculated, and displayed together with an indication of when adjustment limits are exceeded.

Fig. 10
Actual NR plus the theoretical max/min NR limits for a reference NGG

Explanation of Errors and Messages for Aircraft Engine Tests

A collection of different circumstances can cause Messages and Errors to be reported in the Aircraft Engine Test software.

Messages

Messages tell you if the measurement has passed or if the vibration signal exceeded the allowable limits. The possible messages are listed in Table 1.

Table 1
Messages

Signal	Limit Type	Messages
Vib1		PASSED
	1st Order Limit	Vib1, NGG Exceeded
		Vib1, NPT Exceeded
	[Overall Limit]	Vib1, OA Exceeded
[Vib2]		PASSED
	1st Order Limit	Vib2, NGG Exceeded
		Vib2, NPT Exceeded
	[Overall Limit]	Vib2, OA Exceeded

Vib1 and Vib2 are the specific signal names as given by the manufacturer
[in brackets: optional] – only required for certain engines

Errors

Errors tell you that the signal is too low on a channel. This is most likely due to a broken cable, transducer, or hardware. The possible errors are listed in Table 2.

Table 2
Errors

Situation	Error
Signal too low on 1st order of Vibration signal with NGG tacho reference and Signal OK on 1st order of Vibration signal with NPT tacho reference	ERROR on NGG
Signal too low on 1st order of Vibration signal with NPT tacho reference and Signal OK on 1st order of Vibration signal with NGG tacho reference	ERROR on NPT
Signal too low on 1st order of Vibration signal with NGG tacho reference and Signal too low on 1st order of Vibration signal with NPT tacho reference	ERROR on Vib1 or NGG or NPT (Check Signal Monitors to validate source of error)

The errors are calculated using:

$$\frac{\sum_{n=0}^{\text{total}-1} P_n}{\text{total}} \cdot 0.70 < \text{Limit}$$

where P_n is the power spectrum of the 1st Order and "total" is the total number of points in the acquired slice. The formula says that 70% of the slice must be over a predefined "limit"; otherwise an error is given.

There is also a priority that dispatching Errors and Messages must follow:
- If there is an ERROR no Messages may be given
- There may be multiple messages, but only one ERROR at a time
- If PASSED is given, there may be no other messages or ERRORS at the same time

Compliance with Standards – Type 3647

CE, C-Tick	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand.
Safety	EN/IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use. UL 61010B–1: Standard for Safety – Electrical measuring and test equipment.
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	EN/IEC 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments. EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments. EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements. **Note:** The above is only guaranteed using accessories listed in this Product Data.
Temperature	IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat. Operating Temperature: –10 to +50°C (14 to 122°F) Storage Temperature: –25 to +70°C (–13 to 158°F)
Humidity	IEC 60068–2–78: Damp Heat: 93% RH (non-condensing at 40°C (104°F))
Mechanical	Non-operating: IEC 60068–2–6: Vibration: 0.3 mm, 20 ms^{-2}, 10 – 500 Hz IEC 60068–2–27: Shock: 500 ms^{-2} IEC 60068–2–29: Bump: 3000 bumps at: 250 ms^{-2}
Enclosure	IEC 60529: Protection provided by enclosures: IP 67

For environmental specifications and compliance with standards for PCs, see the specifications given by their respective manufacturers.
For PULSE Front-end Type 3560-B, see System Data BU 0228
For Accelerometer Type 8324-G, see Product Data BP 2143

Specifications – PULSE Vibration Check Systems for Aircraft Engines Types 3647-A, 3647-B

Basic System Type 3647-A, 3647-B

WEIGHT
KE-1014 Water- and Shockproof Case:
12 kg (26.5 lb.), without cables

DIMENSIONS
190 × 360 × 450 mm (7.7 × 14.2 × 17.7″)

KE-1013 Shoulder-bag for Cables

Weight: 3 kg (6.6 lb.)

PC Included

DELL™ Latitude® D600 or equivalent

Ordering Information

Basic System Type 3647-A

- Type 3560-B-T57: PULSE vibration check system for aircraft engines, and the necessary software, including:
  - Type 3560-B-020: PULSE B Frame, 2 × QB-0048 Batteries
  - Type 7795-N: PULSE Vibration Check for Aircraft Engines, Node-locked License
  - M1-7795-N: Annual Software Maintenance and Support Agreement for Type 7795-N
- Delivered in a water- and shockproof case containing Type 3560-B-020 Frame, portable PC, two-channel galvanic Isolator for two tachometer signals, powering electronics, etc.
- Type 8324-G: Accelerometer with High-temperature cable, integrated charge converter/filter and TEDS (10 m in all)

Basic System Type 3647-B

As Type 3647-A, but without Type 8324-G

Engine Specific Systems

Please contact Brüel & Kjær in order to specify the engine specific system(s)

Accessories Required for Editing TEDS

- BZ-5294: TEDS Editor software
- BZ-5294-MS5: TEDS Editor Developer's License
- WQ-1320: MicroLAN Adaptor DS 9097U-009
- WL-1363: BNC to MMP-4R Cable for DS 9097

Optional Accessories

- Type 4294-002: Calibration Exciter, max. load 200 gram
- Type 8324-G: Accelerometer with High-temperature cable, integrated charge converter/filter and TEDS (10 m in all)
- Type 8324: Charge Accelerometer
- 8324-G-CAI: Accredited Initial Calibration of Type 8324
- 8324-G-CAF: Accredited Calibration of Type 8324
- 8324-G-EW1: Extended Warranty for Type 8324, 1 year extension
- Type 2647-D-001: Charge Converter/Filter integrated in a high-temperature cable
- Type 7767-A-N: PULSE Data Manager
- Type 7906-S1: PULSE Vibration Analysis for Aircraft Engines comprising:
  - Type 7770-N5: FFT analysis
  - M1-7770-N5: Annual Software Maintenance and Support Agreement for Type 7770
  - Type 7702-N1: Order Tracking
  - M1-7702-N1: Annual Software Maintenance and Support Agreement for Type 7702
  - Type 7767-A-N: PULSE Data Manager
  - M1-7767-A-N: Annual Software Maintenance and Support Agreement for Type 7767
- Type 8604: Static Droop
- 3560-B-EW1: Extended Warranty for Type 3560-B

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) 2 5 443 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

BP 2112 – 13 2007-08 Rosendahls Bogtrykkeri