PRODUCT DATA

Vibration Transducer Calibration System — Type 3629

Vibration Transducer Calibration System Type 3629 is an easy-to-use, automatic calibration system that provides traceable calibration of a wide range of transducers.

The hardware for the basic system consists of a Portable PULSE™ front-end, which provides the necessary inputs and generator output, a power amplifier and a shaker.

USES AND FEATURES

USES

- Fast and accurate magnitude and phase calibration of vibration transducers
- Comparison calibration according to ISO 16063–21
- Primary magnitude and phase calibration (optional) according to ISO 16063–11
- Fast and accurate gain and phase calibration of preamplifiers
- Generation of complete certificates in Microsoft® Word according to ISO 17025
- Supervision of measuring instrumentation according to ISO 9000
- Quality assurance of sensors in manufacturing or use

FEATURES

- Very low expanded calibration uncertainty
- Automated calibration provides ease of use yet fault-proof results
- Frequency range 0.1 Hz to 25 kHz (optionally 100 kHz), depending on shaker and reference
- Calibrates practically all transducer types: charge, DeltaTron® (constant current IEPE), piezoresistive, variable capacitance, voltage, servo and electrodynamic
- Calibrates voltage and charge conditioners (using reference capacitor), (optional)
- Automated system calibration
- Choice of random or sine excitation
- User-defined test frequencies and levels depending on shaker and reference transducer
- Based on proven Brüel & Kjær PULSE™ Multi-analyzer technology
- Primary calibration according to ISO 16063–11 method 3 using commercial laser interferometer (optional, requires Type 5309 software)
- Brüel & Kjær back-up including staff training and system maintenance (optional)
- Typical calibration accuracy 10 – 2000 Hz: 0.7%; 2 – 5 kHz: 1.1%; 5 – 7 kHz: 1.2%; 7 – 10 kHz: 1.8% (one point reference calibration and including influence from the transducer to be calibrated)
- Software control by Vibration Transducer Calibration Software Type 5308
- Comprehensive database
- Customer database for handling of data and inventory following ISO 17025
- Tabular and graphical calibration results with flexible scaling
- Selection between SI or imperial units (g, in, in/s)

Brüel & Kjær

System Description

Vibration Transducer Calibration System Type 3629 is an easy-to-use, automatic calibration system that provides traceable calibration of a wide range of transducers.

The hardware for the basic system shown in Fig. 1 consists of a Portable PULSE front-end, which provides the necessary inputs and generator output, a power amplifier and a shaker. The front-end is connected via Ethernet to a standard PC (desktop or laptop). Furthermore, a Reference and a Working Standard transducer are required, with suitable preamplifiers if they are not DeltaTron transducers (transducers with constant current supply) or voltage output types. The standard reference transducer used in the mid-frequency range is Type 8305-001 with Charge to DeltaTron Converter Type 2647.

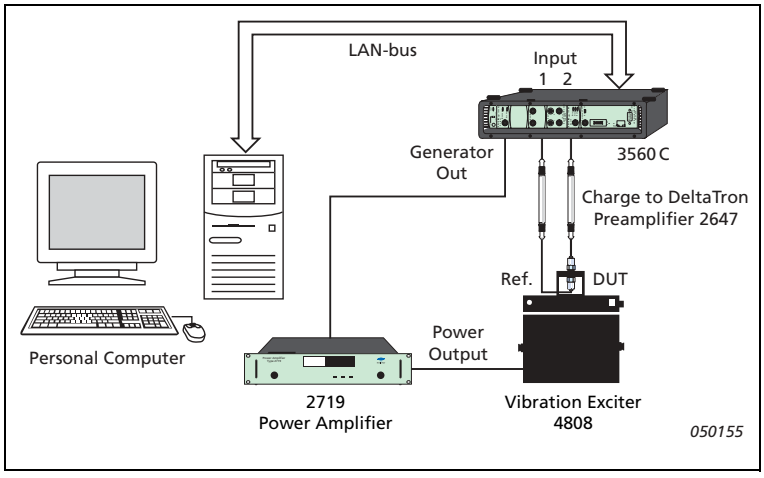

Fig. 1
Configuration of the Vibration Transducer Calibration System Type 3629 and computer

The system normally uses two vibration exciters. Type 4808 covers the frequency range 3 Hz to 6.4 kHz and can take heavy loads (up to at least 500 grams), while Type 4809 covers 10 Hz to 12.8 kHz for small transducers up to about 100 grams. A fixture is mounted on top of Type 4808 to give maximum mounting flexibility, and this houses the Working Standard Accelerometer (Type 4371). The Standard Reference Accelerometer (Type 8305-001) or the DUT is mounted on top of the fixture. No fixture is used with Type 4809, the Working Standard (Type 8305) being mounted directly onto the exciter table and the Standard Reference or the DUT being mounted on top of the Working Standard.

Vibration Transducer Calibration Software Type 5308 runs on the PC with no external processing, which means that software performance increases in line with general PC development. The operating system can be Microsoft® Windows® 2000 or XP, giving familiar user interfaces. Data are displayed on screen in graphical and tabular form. Data and results are stored on the hard disk of the computer, and ISO 17025 compatible certificates can be printed out. A Microsoft® Access database, which is accessed transparently by the Type 5308 control software, is used for the storage and organisation of data. Microsoft® Word is used for the generation of certificates, making modifications easy and permitting printing on most printers.

You do not need to be proficient in Access, nor do you need to be familiar with Windows® to operate the software – only rudimentary computer proficiency is required for certain system-management operations, such as backing up system and data files. Furthermore, different user-levels giving access to different menus are included for maximum security.

The PULSE front-end is calibrated using a high-precision voltmeter and correction factors are stored in the database for subsequent use. For automated calibration of the PULSE front-end, an Agilent® 3458A DMM is needed together with an IEEE 488.2 interface for the PC.

Due to this extended calibration of the PULSE front-end, an extremely low system transfer uncertainty (typically 0.1% for $k = 2$) can be obtained. To this, the reference calibration uncertainty has to be added, for example, 0.5%, giving 0.51% total expanded uncertainty (for $k = 2$) but without influence factors on the transducers.

Type 3629 calibrates practically all transducer types: charge, DeltaTron (constant current supplied transducers), piezoresistive, variable capacitance, voltage, servo and electrodynamic (for example, velocity pick-ups). For piezoresistive and other bridge-type transducers, a Differential Amplifier Type 2697 (optional) is used for powering and conditioning through the preamplifier input socket on PULSE. Type 2697 can also be used for powering variable capacitance and other transducers. Type 3629 performs comparison calibration according to ISO 16063–21.

The portable PULSE analyzer measures the FFT autospectra and cross-spectra between the transducer signals and calculates the frequency response function. This removes nearly all influence from distortion and noise outside the single FFT band in which the measurement is made. Very narrow bandwidths are used for the low-frequency measurements to minimise noise. For highest measurement speed, random excitation is used, while sine excitation is used mainly to concentrate the energy for low-frequency calibrations and to satisfy special requirements.

The Type 3629 system consist of standard Brüel & Kjær instruments, but is capable of using other components like shakers, conditioners and references.

Back-to-back Calibration by Substitution

The sensitivities of two accelerometers can be compared by using random excitation and the FFT analysis capability of PULSE to measure the ratio of their outputs. By supplying the output from the Standard Reference Accelerometer to Input 1, and the output from the DUT to Input 2, the sensitivity of the DUT can be displayed as the frequency response function (magnitude and phase).

In practice, accuracy and ease of use can be improved by employing the back-to-back calibration method, using the well-established calibration by substitution technique.

This involves making two measurements. Initially, the transfer function between the Working Standard Accelerometer and the Standard Reference Accelerometer is measured and stored for subsequent use over a specified time. (This can be considered as an extended transfer calibration.) Then the transfer function between the DUT and the Working Standard is measured. The resulting frequency response is calculated using the reference spectrum and finally the result is stored. The Working Standard remains fixed to the exciter head.

The method offers the following advantages:

- Fast calibrations by simultaneous calibration over a wide frequency range by random excitation
- Cancellation of systematic errors contributed by the electronics
- Coverage of all frequencies in the range catching all glitches
- Single sine excitation can be used during DUT measurements without the need for new transfer calibration

To further improve the accuracy of the system, an automated calibration of all ranges in level and frequencies of the PULSE front-end is performed using a high precision voltmeter. This can be repeated as needed provided an IEEE 488.2 type bus and an Agilent® 3458A are available. The data are stored and subsequently used for corrections.

The accuracy of the FFT-calibration technique, using the substitution method, and correction after calibration with the high-precision voltmeter is extremely high. The method produces results having the following typical uncertainties: 5 – 2000 Hz: 0.8%; 2 – 7 kHz: 1.2%; 7 – 10 kHz: 1.8% (one point reference calibration and including the influence of the properties of the transducer to be calibrated).

Flexibility

Depending on the system configuration, Type 3629 can perform either comparison or (optionally) absolute calibrations on a wide variety of transducers. Calibrations based on the comparison method determine DUT characteristics by comparison to a reference transducer traceable to a Primary Laboratory. Absolute calibrations (requiring Type 5309 software and high-frequency input modules) are performed using a laser interferometer with quadrature output and a routine to convert these outputs to the absolute displacement value as a function of time, so measurements are based on the absolute parameters of time and the wavelength of light from a helium-neon laser following ISO 16063−11 method 3 (called sine-approximation).

Vibration Transducer Calibration System Type 3629 can operate from 0.1 Hz to 25 000 Hz, (to 100 kHz with high-frequency module Type 3110), although the actual frequencies are determined by the capabilities of the shaker and transducers used. Where signal conditioning is needed (for example, for piezoelectric transducers), the software is able to measure and store the frequency response characteristics of the conditioners, and then compensate for these characteristics during operation. Similarly, the controller is designed to characterise and drive virtually any vibration source, and to use any reference transducer, using a conditioner as necessary. Frequency response characteristics of exciter, amplifier, conditioner and reference transducer are stored in the Microsoft® Access database, minimising calibration uncertainties and calibration time by correcting for such characteristics.

Verification

To ensure high calibration accuracy, special attention has been paid to system and standard verifications. The system verification involves a series of measurements to validate the stability. The computer then calculates the mean value and standard deviation at a particular frequency, and compares them with preset tolerances.

The standard verification ensures that Standard Reference Accelerometer and the Working Standard are within the tolerance for valid calibration measurements. The ratio of the measured outputs from the Reference and Working standards is compared to the ratio of the sensitivities found from the original measurements. The calibration system must pass the verification tests before a valid calibration can be performed. A calibration certificate, including the graphs of the sensitivity magnitude and phase response of the accelerometer, is generated automatically. All the information required by ISO 17023 is included. Microsoft® Word templates with keywords are used providing easy change of the format and text in the certificate.

The Database

Vibration Transducer Calibration Software Type 5308 features a comprehensive database in which all pertinent data for users' vibration transducers can be made available. By simply selecting a particular transducer for calibration, the database automatically sets the nominal sensitivity, frequency range and tolerance limits for the calibration measurement.

The user can produce a certificate of the calibration result, and all data can be stored in the database.

Type 5308 is a user-friendly program minimising the required number of manual operations, making transducer calibration an automated and simple procedure. The database contains all the necessary data required for calibration. The data is recalled and used to set measurement parameters in the calibration program, and is used to prompt the user to select the correct instruments.

The procedures contain all the relevant data for calibration of each transducer type. To initiate a calibration, the user selects the transducer type and procedure name or the serial number of known transducers. The computer then recalls the associated procedure and selects either

accelerometer charge or voltage or velocity pick-up calibration. It sets the required frequency range for the calibration and prompts the user to use the correct conditioners.

The database contains a history of calibrations for each transducer.

All the relevant data for the defined references and other instruments are also stored in the database. When a system calibration or a conditioner calibration is made, the data are stored and afterwards used to correct the measured results. Historical data are kept in the database.

Specifications – Vibration Transducer Calibration System Type 3629

Principle of Calibration: Improved FFT Method (Calibration by Substitution)

INPUTS
Charge: 0.004 to 400 pC/ms^{-2} (0.04 to 4000 pC/g) (at 10 ms^{-2})
Voltage: 0.004 to 400 mV/ms^{-2} (0.04 to 4000 mV/g) (at 10 ms^{-2})
Velocity: 0.4 to 99 mV/mms^{-1} (10 to 2500 mV/in/s)
Noise (Device Under Test Channel):
Charge Input <10^{-4} pC/Hz$^{0.5}$ (above 10 Hz) with Type 2647

INPUT IMPEDANCE
Voltage: 1 MΩ
Velocity: 1 MΩ

FREQUENCY RANGE
Accelerometers: 3 Hz to 12.8 kHz
Velocity Pick-ups: 3 Hz to 6.4 kHz

MAX. TRANSDUCER WEIGHT
3 Hz to 6.4 kHz: > 500 grams
10 Hz to 12.8 kHz (on Type 4809): > 60 grams

CALIBRATION ACCURACY
Typical estimated absolute errors (using k = 2 and including temperature and transverse sensitivity effects) for charge calibration of transducers having sensitivities within the range 0.1 to 12 pC/ms^{-2} and using a one frequency 0.5% uncertainty reference calibration are as follows:
3 – 10 Hz: 1.0%
10 – 2000 Hz: 0.7%
2 – 5 kHz: 1.1%
5 – 7 kHz: 1.2%
7 – 10 kHz: 1.8%

Additional points of calibration and calibration of the reference with lower uncertainty reduces the uncertainties. With some of the best available reference calibrations and assuming ideal DUT the uncertainties becomes (best attainable system values):
160 Hz: 0.35%
10 – 2000 Hz: 0.4%
2 – 4 kHz: 0.6%
4 – 10 kHz: 0.7%.
A comprehensive error analysis is included in the instruction manual

Ordering Information

Type 3629 A (Frequency range 3 Hz to 6.4 kHz)
includes the following:

Type 3560 C-T01	PULSE Sound & Vibration Analyzer (2 In/2 Out)
Type 5308	Vibration Transducer Calibration Software
2 × Type 2647	Charge to DeltaTron® Converter
2 × JP 0145	Input Adaptor, BNC to 10–32 UNF microdot socket
Type 8305-001	Standard Reference Accelerometer, with Cable and Primary calibration at 160 Hz
Type 4371	Accelerometer 1 pC/ms^{-2}, with Cable
2 × AO 0038	Accelerometer Cable, 10–32 UNF, 1.2 m
Type 2719	Power Amplifier 180 VA
Type 4808	Small Vibration Exciter
WA 0567	Calibration Fixture
WH 2651	Special Selection of Type 4808
Type 7202-A-GB	Dell™ Standard Tower PC
UL 0217-GB	Dell 19″ Standard Monitor
UL 0207-GB	Microsoft® Office XP Professional GB OEM/without manuals
3629-CTI	Type 3629 system, Traceable Initial Calibration

Type 3629 B (Frequency range 10 Hz to 12.8 kHz)
includes the following:

Type 3560 C-T01	PULSE Sound & Vibration Analyzer (2 In/2 Out)
Type 5308	Vibration Transducer Calibration Software
2 × Type 2647	Charge to DeltaTron® Converter
2 × JP 0145	Input Adaptor, BNC to 10–32 UNF microdot socket
Type 8305-001	Standard Reference Accelerometer, with Cable and Primary calibration at 160 Hz
Type 8305	Standard Reference Accelerometer, with Cable and Primary calibration at 160 Hz (Working Standard)
2 × AO 0038	Accelerometer Cable, 10–32 UNF, 1.2 m
Type 2719	Power Amplifier 180 VA
Type 4809	Small Vibration Exciter
Type 7202-A-GB	Dell™ Standard Tower PC
UL 0217-GB	Dell 19″ Standard Monitor
UL 0207-GB	Microsoft® Office XP Professional GB OEM/without manuals
3629-CTI	Type 3629 system, Traceable Initial Calibration

Type 3629 C (Frequency range 3 Hz to 12.8 kHz)
includes the following:

Type 3560 C-T01	PULSE Sound & Vibration Analyzer (2 In/2 Out)
Type 5308	Vibration Transducer Calibration Software
2 × Type 2647	Charge to DeltaTron® Converter
2 × JP 0145	Input Adaptor, BNC to 10–32 UNF microdot socket
Type 8305-001	Standard Reference Accelerometer, with Cable and Primary calibration at 160 Hz
Type 4371	Accelerometer 1 pC/ms^{-2}, with Cable
2 × AO 0038	Accelerometer Cable, 10–32 UNF, 1.2 m
Type 2719	Power Amplifier 180 VA
Type 4808	Small Vibration Exciter
WA 0567	Calibration Fixture
WH 2651	Special Selection of Type 4808
Type 4809	Small Vibration Exciter
Type 8305	Standard Reference Accelerometer, with Cable and Primary calibration at 160 Hz (Working Standard)
Type 7202-A-GB	Dell™ Standard Tower PC
UL 0217-GB	Dell 19″ Standard Monitor
UL 0207-GB	Microsoft® Office XP Professional GB OEM/without manuals
3629-CTI	Type 3629 system, Traceable Initial Calibration

ACCESSORIES INCLUDED
All necessary cables.
System test data on PC

ACCESSORIES AVAILABLE

Type 2697	Differential Amplifier for bridge type transducers and for powering variable capacitance and other transducers
110684	1 nF Precision Adaptor for calibration of charge conditioners
WA 0506	Vibration Exciter Support Stand for Types 4808 and 4809
WA 0507	Granite Block for WA 0506
WA 0523	Carriage for WA 0506
WQ 2347	Longstroke Vibration Exciter (0.1 to 200 Hz)
WQ 2464	National Instruments IEEE–488.2 GPIB interface (available from Brüel & Kjær)
WS 3104	Top-plate for fixture. Different versions with other mounting hole patterns available

BP 1975 – 13 05/03

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 5188-8166 · Canada (+1) 514 695-8225
China (+86) 10 680 29906 · Czech Republic (+420) 2 6702 1100 · Finland (+358) 9-521 300 · 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 · 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 47 11 4 53 · Singapore (+65) 377 4512
Slovak Republic (+421) 2 5443 0701 · Spain (+34) 91 659 0820 · Sweden (+46) 8 449 8600
Switzerland (+41) 44 880 7035 · 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