Technical Documentation

Calibration Exciter Types 4294 and 4294-002

User Manual



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User Manual

From serial no. 2863100

Safety Considerations

This apparatus has been designed and tested in accordance with IEC 61010-1 and EN 61010-1Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use. This manual contains information and warnings which must be followed to ensure safe operation and to retain the apparatus in safe condition. Special note should be made of the following:

Safety Symbols



The apparatus will be marked with this symbol when it is important that you refer to the associated warning statements given in the manual.



Protective Earth Terminal 🔏 Haz

Hazardous Voltage

Explosion Hazard

The equipment is not designed to be used in potentially explosive environments. It should not be operated in the presence of flammable liquids or gases.

Warnings

- Switch off all power to equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment.
- Whenever it is likely that the correct function or operating safety of the apparatus has been impaired, it must be made inoperative and be secured against unintended operation.
- Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service personnel.



- Do not dispose of electronic equipment or batteries as unsorted municipal waste
- It is your responsibility to contribute to a clean and healthy environment by using the appropriate local return and collection systems
- Hazardous substances in electronic equipment or batteries may have detrimental effects on the environment and human health
- The symbol shown to the left indicates that separate collection systems must be used for any discarded equipment or batteries marked with that symbol
- Waste electrical and electronic equipment or batteries may be returned to your local Brüel & Kjær representative or to Brüel & Kjær Headquarters for disposal

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Introduction

USES

- Precise field calibration of vibration transducers
- · Rapid calibration and checking of vibration transducer sensitivity
- Quick, easy field calibration of vibration measurement and recording systems

FEATURES

- Small, lightweight, and battery-driven
- Leather case for impact protection
- Designed for everyday use in harsh environments
- Acceleration, velocity and displacement calibration
- High-precision, crystal-controlled servo operating at 159.15 Hz (1000 rad s^{-1})
- Drop- and environment-tested according to IEC 60068
- Splash-proof according to IP 54 (IEC 60529)

Description

Type 4294 enables accurate adjustment of measuring instrumentation at a standard acceleration level of 10 ms^{-2} (0 – 70 gram load). The reference signal can also be used for velocity and displacement calibration at 10 mms⁻¹ and 10 μ m, respectively.

Type 4294-002 enables accurate adjustment of measuring instrumentation at a standard acceleration level of 3.16 ms^{-2} (0 – 200 gram load). The reference signal can also be used for velocity and displacement calibration at 3.16 mms^{-1} and $3.16 \mu\text{m}$, respectively.

The calibrator contains an electromagnetic exciter driven by a crystal oscillator at a frequency of 159.15 Hz (1000 rad s⁻¹). A small accelerometer on the underside of the vibration table provides servo feedback to maintain a constant, accurate vibration level independent of the mass of the transducer under test (maximum 70 gram for Type 4294 and 200 gram for Type 4294-002).

Fig. 1.1 Calibration Exciter Type 4294 in its leather case



To prevent overload, power to the calibrator is automatically disconnected if a transducer mass above 70 gram for Type 4294 or 200 gram for Type 4294-002 is mounted on the exciter's vibration table.

Use of the calibrator is straightforward. You can attach a transducer to the vibration table using (see Fig. 2.2):

- 10 32 UNF Steel Stud YQ-2962
- 10 g Mounting Disc DB-2996 (supplied) for transducers:
 - with 3 mm threads
 - fitted with Mounting Magnet UA-0642
 - mounted with beeswax

Note:

Mounting using adhesive is not recommended.

To switch the calibrator on, press the small button on the side of its housing.

After system adjustment, turn the calibrator off by pressing the button again.

To prolong the battery life, the exciter automatically switches off after approximately 100 seconds.

Operation

2.1 Environment and Handling

Calibration Exciter Type 4294 is designed for use in environments at temperatures within the range -10 to $+55^{\circ}C$ (+14 to $+131^{\circ}F$) and with relative humidity up to 90% RH ($30^{\circ}C$ ($86^{\circ}F$), non-condensing). Whenever possible, the exciter should be used in its leather case (see Fig. 1.1) to protect it from mechanical damage and contamination from grease or dirt.

2.2 Battery Installation and Replacement

For powering Type 4294, a long-life alkaline battery QB-0016 (IEC Type 6LR61) is recommended. The battery fits into the battery holder, which is accessible after unscrewing the base of the calibrator (see Fig. 2.1). To prevent damage, take care not to cross the screw thread on reassembly.

To maximise battery life, Type 4294 automatically switches off after approximately 100 s. Using Battery QB-0016, approximately 200 calibrations, each of approximately 100 s, are possible. After this, the operating period rapidly decreases, indicating that the battery needs to be replaced. However, the exciter can be used until its battery is fully depleted without influencing the accuracy of the reference level generated.

Fig.2.1 9 V battery installed in the calibrator



2.3 Mounting a Transducer

Types 4294 and 4294-002 are designed for use with Brüel & Kjær Accelerometers with maximum weights of 70 and 200 grams, respectively. The accelerometers can be mounted with "finger-tight" mounting torque (~0.3 Nm, max. 0.5 Nm) directly onto the vibration table using a 10-32 UNF steel stud YQ-2962, or mounted with the aid of Mounting Disc DB-2996 for transducers weighing less than 10 grams. Different mounting options are illustrated in Fig.2.2.

Caution:

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If the specified torque is exceeded, be sure to apply a similar counter-torque to the armature in order to protect the vibration table from damage

The mounting disc lets you attach accelerometers in several ways. Small transducers fitted with 3 mm threads can be attached using 3 mm Steel Stud YQ-2007. Alternatively, a Mounting Magnet UA-0642 or Beeswax YJ-0216 can be used to attach transducers to the mounting disc.





2.4 Basic System Calibration

The following procedure can be used for quick, accurate adjustment and calibration of vibration measurement systems for a reference acceleration level of $10 \text{ ms}^{-2} \text{ RMS}/14.14 \text{ ms}^{-2}$ peak for Type 4294 (3.16 ms⁻² RMS/4.47 ms⁻² peak for Type 4294-002). Calibration using reference values of velocity or displacement is also possible, as mentioned in step 6).

- 1) Attach the system transducer to the vibration table (finger-tight is sufficient) of the calibrator using either a 10–32 UNF Stud YQ-2962 of Mounting Disc DB-2996. See section 2.3.
- 2) Connect the transducer to the vibration measurement system using a suitable low-noise cable, for example, that supplied with the transducer. Where a preamplifier with adjustable sensitivity conditioning is employed, the accelerometer sensitivity specified on the calibration chart should be entered prior to setting the measuring range of the read-out instrument.
- 3) Switch on the preamplifier and indicating instrument and select the acceleration mode and the highest indicating range on the appropriate instruments.
- 4) Press the button on the side of the calibrator to vibrate the transducer. The transducer is now subjected to a sinusoidal acceleration of 10 ms^{-2} RMS ±3% (4294-002: 3.16 ms⁻² RMS ±3%) at a frequency of 159.15 Hz (that is, $\omega = 1000 \text{ rad s}^{-1}$).
- 5) Switch the range controls of the preamplifier and/or indicating instrument to obtain an onscale meter indication without the overload lamps of the instruments lighting.

The indicating instrument should now indicate a reference acceleration level of 10 ms^{-2} RMS (4294-002: 3.16 ms⁻² RMS). If not, adjust the sensitivity potentiometer of one of the instruments until the correct reference level is indicated. Once correctly set, avoid further adjustment of the sensitivity potentiometer, as the calibration will be lost.

Note: If an indicating instrument with peak indicating mode is employed, then it should be adjusted to indicate a reference level of 14.14 ms^{-2} peak (4294-002: 4.47 ms⁻² peak).

6) For velocity and displacement calibration of the vibration measurement system, the preamplifier/measuring instrument should be equipped with integration networks. The appropriate measurement mode should therefore be selected before switching the calibrator on. The relevant calibration levels are as follows:

Velocity: $10 \text{ mms}^{-1} \text{ RMS}/14.14 \text{ mms}^{-1} \text{ peak } \pm 3\%$ (4294-002: 3.16 mms⁻² RMS/4.47 mms⁻² peak $\pm 3\%$)

Displacement: $10 \ \mu m \ RMS/14.14 \ \mu m \ peak \pm 3\%$ (4294-002: $3.16 \ \mu s^{-2} \ RMS/4.47 \ \mu s^{-2} \ peak \pm 3\%$)





4294 or 4294-0022635DigitalCalibration ExciterCharge AmplifierVoltmeter140096

2.5 Transducer Sensitivity Check

For determination of the actual sensitivity of transducers, calibrated preamplifier and indicating instrumentation are required. Although not intended for absolute sensitivity measurement, the following procedure provides an approximate sensitivity check, sufficient for determining whether a transducer functions correctly and has not been damaged during previous use.

- 1) Attach the system transducer to the vibration table (finger-tight is sufficient) of the calibrator using either a 10–32 UNF Stud YQ-2962 of Mounting Disc DB-2996. See section 2.3.
- 2) Connect the transducer to the vibration measurement system using a suitable low-noise cable, for example, that supplied with the transducer. If a voltage preamplifier is employed, it is important that the particular cable supplied with the transducer is used, otherwise the voltage sensitivity of the transducer will be affected.
- 3) In the case of a vibration meter, RMS indication of acceleration and an appropriate measurement range should be selected. If a conditioning preamplifier featuring direct dialin of charge or voltage sensitivity is employed, the relevant sensitivity specified on the transducer's calibration chart should be entered before setting the range of the calibrated indicating instrumentation.
- 4) Switch on the preamplifier, indicating instrument and calibrator in that order. The transducer is now subjected to a sinusoidal acceleration of 10 ms^{-2} RMS ±3% using Type 4294 or 3.16 ms⁻² RMS ±3% using Type 4294-002.
- 5) A calibrated vibration meter will display the transducer output directly in terms of acceleration, enabling the transducer sensitivity to be determined using:

$$S_c = \frac{A_i \cdot S_0}{A_0}$$

where:

 S_c is the calculated transducer sensitivity in pC/ms⁻² or mV/ms⁻², depending on whether the vibration meter has a voltage or charge preamplifier

 S_0 is the nominal transducer sensitivity for which the vibration meter is calibrated

 A_i is the meter acceleration indication in ms⁻²

 A_0 is the reference acceleration level: $10~{\rm ms}^{-2}$ for Type 4294 or $3.16~{\rm ms}^{-2}$ for Type 4294-002

6) If a calibrated voltmeter together with a fixed sensitivity preamplifier is employed for transducer calibration, the transducer sensitivity may be calculated using:

$$S_c = \frac{V_0}{A_0 \cdot P_s}$$

where:

 S_c is the calculated transducer sensitivity in pC/ms⁻² or mV/ms⁻²

 P_s is the preamplifier sensitivity in mV/pC or mV/mV

 V_0 is the voltage output from the preamplifier measured in millivolts when the accelerometer is vibrated at the reference acceleration

 A_0 is the reference acceleration level: $10~{\rm ms}^{-2}$ for Type 4294 or $3.16~{\rm ms}^{-2}$ for Type 4294 002

- 7) If a calibrated voltmeter and a conditioning amplifier are used to measure the transducer charge sensitivity, then an arbitrary mV/unit out range may be selected on the preamplifier. Multiplication of the mV/unit out setting be the reference acceleration level gives the correct voltmeter reading. It is then a simple step to adjust the transducer sensitivity dials on the conditioning amplifier so that the correct voltage reading is displayed by the voltmeter. The dials on the preamplifier with then indicated the accelerometer sensitivity, S_c .
- 8) Any significant departure of the calculated value of S_c from that shown on the transducer calibration chart is indicative of a faulty transducer.



Specifications

3.1 Compliance with Standards

C E 🔕 🕅	The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives RCM mark indicates compliance with applicable ACMA technical standards – that is, for telecommunications, radio communications, EMC and EME 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 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. 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/IEC61000-6-1: 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 the Product Data sheet for Type 4294 and 4294-002 (BP 2101). 	
Temperature	IEC 60068-2-1 & IEC 60068-2-2: Environmental Testing. Cold and Dry Heat. Operating Temperature: 10 to 40°C (50 to 104°F) for 10 ms ⁻² reference within \pm 3% and 3.16 ms ⁻² reference within \pm 3% -10 to +55°C (14 to 131°F) for 10 ms ⁻² reference within \pm 5% and 3.16 ms ⁻² reference within \pm 5% Storage Temperature: -25 to +70°C (-13 to +158°F) IEC 60068-2-14: Change of temperature: -10 to +55°C (2 cycles, 1°C/min.)	
Humidity	IEC 60068-2-78: Damp Heat: 90% RH (non-condensing at 30°C (86°F))	
Mechanical	Non-operating: IEC 60068-2-6: Vibration: 0.3 mm, 20 ms ⁻² , 10-500 Hz IEC 60068-2-27: Shock: 1000 ms ⁻² IEC 60068-2-29: Bump: 1000 bumps at 400 ms ⁻²	
Enclosure	C 60529: Protection provided by enclosures: IP 54	

3.2 Specifications

	4294	4294-002			
Dynamic Characteristics					
Frequency (Hz)	159.15 ± 0.02%				
Acceleration (ms ⁻² (RMS))	10 ± 3%	3.16 ± 3%			
Velocity (mms ⁻¹ (RMS))	10 ± 3%	3.16 ± 3%			
Displacement (µm)	10 ± 3%	3.16 ± 3%			
Transverse Amplitude	< 5% of main axis amplitude				
Distortion	4294:< 2% for 10 to 70 gram load 4294-002: < 2% for 10 to 200 g load 4294 and 4294-002: typical < 7% for 0 to 10 g. Use DB-2996 (10 g) with very light accelerometers to achieve 2% distortion				
Power Requirements					
Built-in Battery	ry One 9 V Alkaline Battery QB- 0016 (IEC type 6LR61)				
Battery Life	Approximately 200 calibrations, each lasting 100 s with automatic switching off at the end of each calibration				
Warm-up Time (Seconds)	< 5				
Signal Duration (Seconds)	103 ± 1 s with automatic stop				
Long-term Stability	Better than 1% per year for acceleration, velocity and displacement; better than 10 ppm per year for frequency				
Physical Characteristics					
Length	From bottom to top of calibrator table: 135 mm (5.3 in) - see Fig.3.1				
Diameter	With case: 46 mm (1.8 in), without case: 43.5 mm (1.7 in)				
Weight	500 g (17.6 oz) including battery and leather case				
Transducer Mounting					
Maximum Load (gram)	70	200			
Mounting Torque (Nm)	ing Torque (Nm) Max. 0.5				
Mounting Thread	10–32 UNF				

3.3 Dimensions

128 mm 5.0 in 43.5 mm 1.7 in 120527/1

Fig. 3.1 Dimensions of Type 4294 without leather case

Fig. 3.2 Main dimensions (mm) of the calibrator's vibration table





Service and Repair

Types 4294 and 4294-002 are designed and constructed to provide many years of reliable operation. However, if a fault occurs that prevents the correct function of the calibrator, then remove its battery to prevent the risk of further damage. For repair, please contact your local Brüel & Kjær representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

Recalibration

Periodic recalibration of Types 4294 and 4294-002 is recommended in order to maintain the high accuracy of the vibration unit, and in order to have proof of traceability. Depending on the application, a recalibration every 1 - 3 years is recommended.



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