type 4143

Reciprocity Calibration Apparatus

USES:

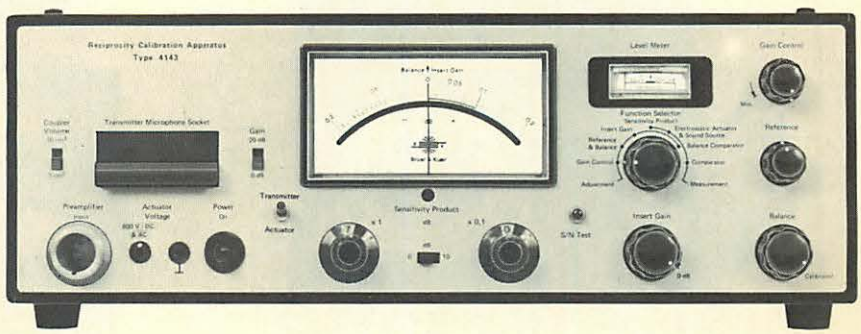
- Precision reciprocity calibration of one-inch standard microphones in accordance with IEC Recommendations 327 and 402
- Precision comparison calibration of one- and half-inch condenser microphones
- Reciprocity and comparison calibration of accelerometers
- Microphone frequency response measurements by the electrostatic actuator method
- Reference sound source
- Comparator

FEATURES:

- Reciprocity and comparison calibration frequency range from 20 Hz to 20 kHz
- Microphone calibration range from – 23 dB to – 40 dB re 1 V/Pa
- Overall microphone reciprocity calibration accuracy according to IEC Recommendation 327 estimated to approximately ± 0,05 dB
- Ground shield in accordance with IEC Recommendations 327 and 402 and ANSI S1.10-1966
- Provision for insert voltage calibration and electrostatic actuator calibration
- Delivered with individual calibration chart
- Fast and easy to use
- Built-in 200 V precision polarization voltage
- Built-in ratio-voltmeter and high precision attenuator
- Built-in high-pass filters and provision for connection of external filters and attenuators
- IEC standardized 3,4 cm^3 and 20 cm^3 couplers supplied
- 1 cm^3 coupler supplied for measurement of equivalent microphone volume and front volume of adaptors
- Accessories for electrostatic actuator calibration of one-, half-, quarter-, and eighth-inch condenser microphones
- Capillary tubes supplied for static pressure equalization and hydrogen filling of couplers
- One-inch B&K Condenser Microphone Cartridge Type 4160 and half-inch Insert Voltage Preamplifier Type 2645 included

A high precision laboratory instrument for the reciprocity calibration of one-inch condenser microphones to IEC R 327. Delivered with all necessary accessories, including individually calibrated couplers, a Microphone Preamplifier Type 2645 (with insert voltage facility) and a one-inch Condenser Microphone Type 4160.

The instrument can also be used for comparison calibration of one-inch and half-inch microphones, equivalent volume measurement, frequency response measurement using the electrostatic actuator method, reciprocity and comparison calibration of accelerometers and precision comparison of AC electrical signals.



Introduction

The Reciprocity Calibration Apparatus Type 4143 is a fast and easily operated high precision and high stability laboratory instrument designed primarily for precision calibration of condenser microphones by means of the reciprocity method.

It fulfills the requirements of IEC Recommendation 327 "Precision method for pressure calibration of one-inch standard condenser microphones by the reciprocity technique" and the requirements of IEC Recommendation 402 "Simplified method for pressure calibration of one-inch condenser microphones by the reciprocity technique".

The apparatus is primarily intended for calibration of B&K Condenser Microphones, but can also be used to calibrate other condenser microphones provided they have similar physical dimensions (ANSI S1.12-1967, Type L) e.g. Western Electric WE 640 A.

The Type 4143 is a versatile instrument which in addition to reciprocity calibration of one-inch condenser microphones can be used in a variety of other applications such as: Comparison calibration of one- and half-inch condenser microphones, measurement of frequency response of one-, half-, quarter- and eighth-inch condenser microphones by the electrostatic actuator method; measurement of front volume of adaptors and equivalent volume of microphones; reciprocity and comparison calibration of accelerometers. It may also be used as a reference sound source and comparator.

Calibration Principles

The Type 4143 can be used for three different types of calibration: Reciprocity calibration, comparison calibration and electrostatic actuator calibration.

Reciprocity calibration applies for both one-inch condenser microphones and accelerometers; comparison calibration for one- and half-inch condenser microphones and accelerometers; and electrostatic actuator calibration for one-, half-, quarter- and eighth-inch condenser microphones.

In the following section, microphone reciprocity calibration is described. The other types of calibration are described in sections ELECTROSTATIC ACTUATORS and EXAMPLES OF USE.

Reciprocity Calibration of One-inch Condenser Microphones

The normally tedious and time consuming procedure for the reciprocity calibration of microphones has been made much easier and more accurate with the introduction of the Type 4143.

Three one-inch microphones are used when making reciprocity calibrations with the Type 4143. The basic measurement performed is that of U/I where U is the open circuit voltage from the receiver microphone and I is the current through the transmitter microphone, when both are acoustically coupled to each other via a closed air volume, such as a coupler (Fig. 1). The current through the transmitter microphone is found by measuring the voltage (U_I) across a reference capacitor (C_{ref}) in series with the transmitter (Dr. Kjerbye Nielsen's Method). This means that the frequency does not enter the calculations directly. These voltages are then fed to a built-in ra-

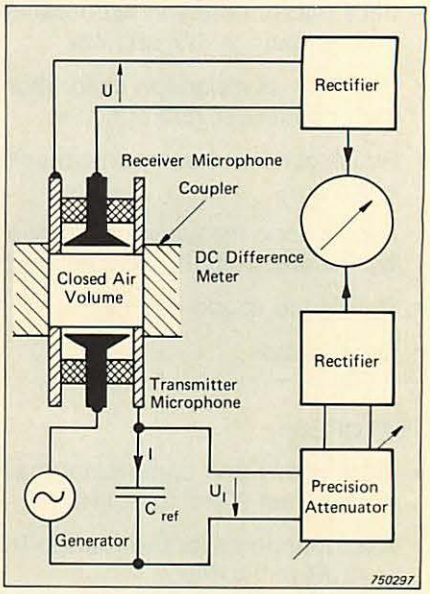


Fig. 1. Principle of microphone reciprocity calibration with Type 4143

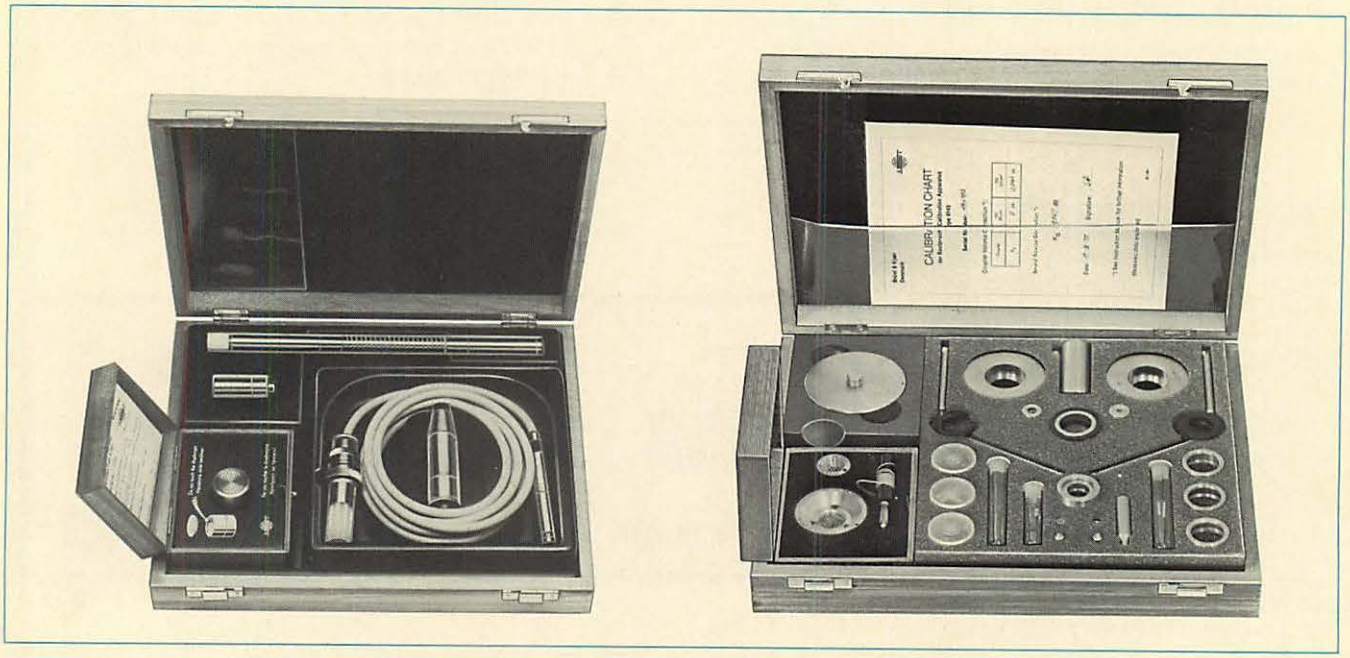


Fig. 2. Accessories supplied with the Reciprocity Calibration Apparatus Type 4143

tio-voltmeter on which the difference in dB between the two voltages can be read off directly, after a few preliminary adjustments. By coupling the three microphones to each other in turn, three sensitivity product values dB_{12}, dB_{13} and dB_{23} are obtained. The sensitivity product dB_{12} is the value obtained with microphone 1 as transmitter and microphone 2 as receiver etc.

The pressure sensitivity M_p of the microphones in dB re 1 V/Pa, can then be calculated from the following equations:

$$M_{p1} = dB_{ref} - \tfrac{1}{2}(dB_{12} + dB_{13} - dB_{23})$$
$$M_{p2} = dB_{ref} - \tfrac{1}{2}(dB_{12} + dB_{23} - dB_{13})$$
$$M_{p3} = dB_{ref} - \tfrac{1}{2}(dB_{23} + dB_{13} - dB_{12})$$

The dB_{ref} value is determined by the reference capacitor and the coupler used. In the case of the Type 4143 the dB_{ref} value is – 23 dB re 1 V/Pa.

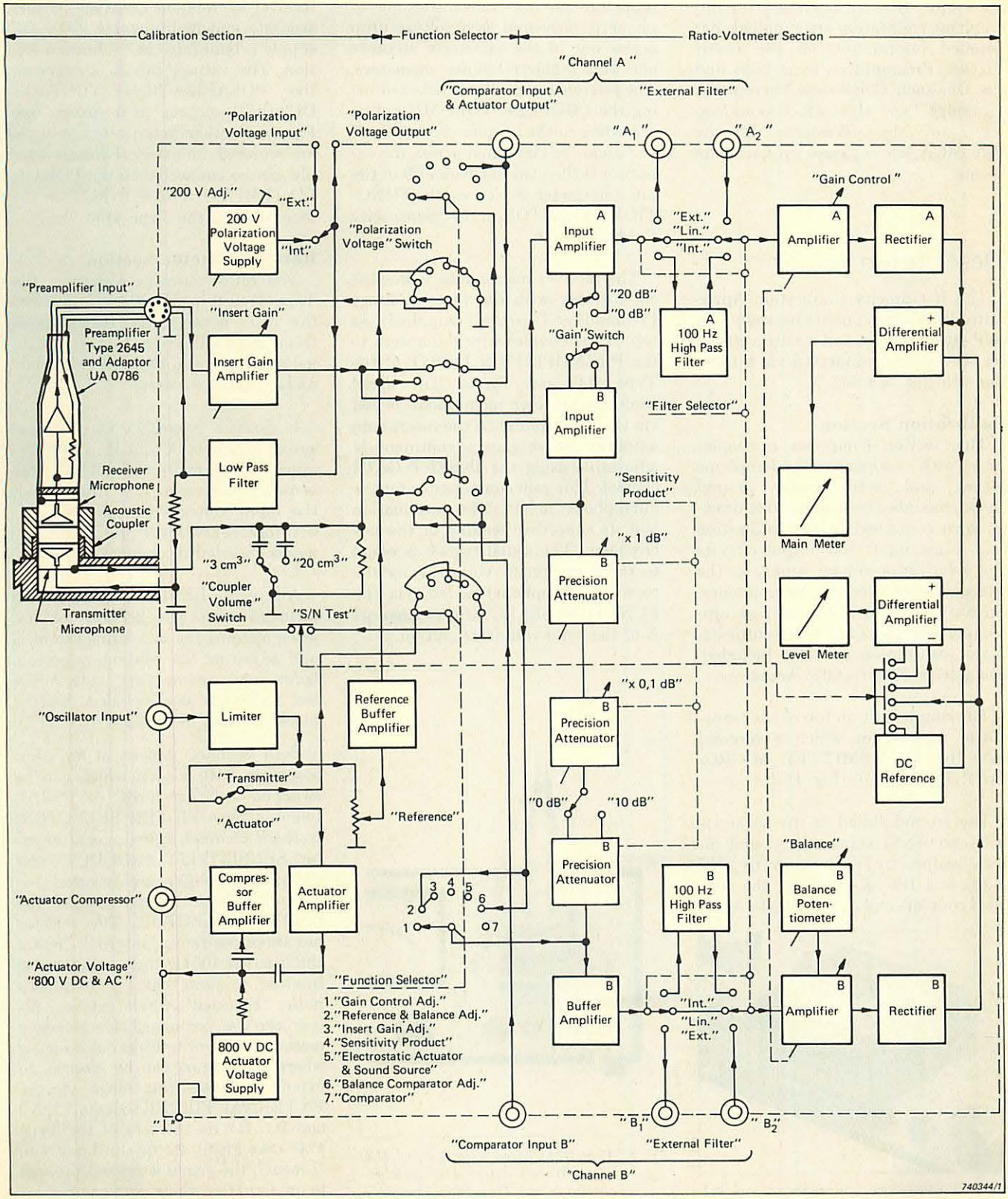


Fig. 3. Simplified block diagram of the Reciprocity Calibration Apparatus Type 4143

The dB_{ref} should be corrected for static pressure, temperature, heat conduction etc. according to IEC R 327 before calculating the absolute pressure sensitivity of the microphones.

Except for the signal generator and instruments for the determination of static pressure and temperature, all accessories (Fig. 2), necessary for microphone calibration are supplied. For detailed information on the Insert Voltage Preamplifier Type 2645 and the One-inch Condenser Microphone Cartridge Type 4160, which is equivalent to the Western Electric WE 640 A, see separate product data sheets.

Description

The Reciprocity Calibration Apparatus Type 4143 consists basically of a calibration section and a ratio-voltmeter section interconnected via a function selector. See Fig. 3.

Calibration Section

This section comprises a coupler base with transmitter microphone socket and standardized ground shield, mounted in a retractable drawer. Also contained in the calibration section are input and output circuits and polarization voltage supply for the transmitter and receiver microphones. An 800 V DC polarization voltage supply and amplifiers for electrostatic actuator calibration are also included. See section Electrostatic Actuators.

The couplers fit on top of the transmitter microphone which is screwed onto the TRANSMITTER MICROPHONE SOCKET (Fig. 4).

The ground shield in the socket is IEC and ANSI standardized and allows reciprocity calibration to IEC R 327 and IEC R 402 using the supplied couplers and calibration to ANSI S1.10-1966, if suitable couplers are made.

Fig. 4. Transmitter microphone socket with standardized ground shield

The transmitter microphone is excited from an external generator, for instance a Type 1027, via the TRANSMITTER/ACTUATOR switch and a limiter circuit which prevents overloading of the microphone. The current through the transmitter microphone is measured as a voltage drop across one of the extremely accurate and very stable reference capacitors. The reference capacitor is selected using the COUPLER VOLUME switch according to the coupler used ("3 cm^3" or "20 cm^3"). The signal across the capacitor is then fed to Channel B of the ratio-voltmeter section via the FUNCTION SELECTOR in the "Sensitivity Product" mode.

The receiver microphone is mounted, together with the Insert Voltage Preamplifier Type 2645 (supplied), on top of the coupler which connects to the PREAMPLIFIER INPUT of the Type 4143, (see Fig. 5). The signal from the receiver microphone is fed via the preamplifier to the insert gain amplifier whose gain is continuously adjustable using the INSERT GAIN control. This gain compensates for the microphone preamplifier attenuation and its capacitive loading of the microphone. The signal (which is equal to the open circuit voltage from the receiver microphone) is fed, via the FUNCTION SELECTOR, to Channel A of the ratio-voltmeter section.

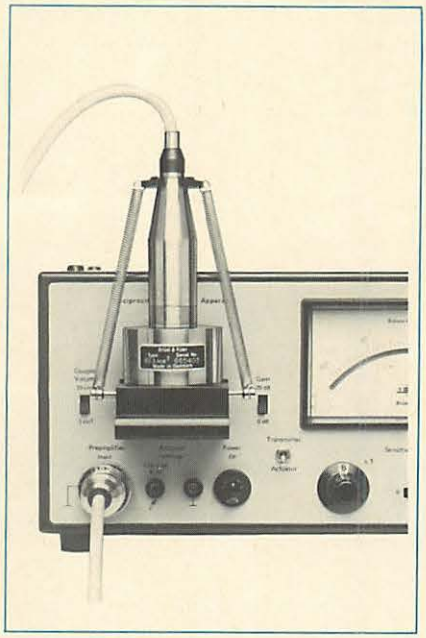


Fig. 5. Type 4143 fitted with 3,4 cm^3 IEC Plane Wave Coupler, One-inch microphone and Type 2645 Preamplifier

A reference signal for adjustment of the insert gain amplifier is obtained from the external oscillator via the REFERENCE potentiometer and the reference buffer amplifier, with the FUNCTION SELECTOR in the "Insert Gain Adj." mode.

For polarizing the transmitter and receiver microphone cartridges, a very accurate and highly stable 200 V DC supply is built into the calibration section. The voltage can be checked at the POLARIZATION VOLTAGE OUTPUT on the rear panel (see Fig. 6). If other polarization voltages are required, an external voltage supply can be connected to the POLARIZATION VOLTAGE INPUT on the rear panel of the Type 4143.

Ratio-Voltmeter Section

The ratio-voltmeter section of the Type 4143 is used either to measure the ratio between the two voltages from the calibration section, or to measure the ratio between two externally applied voltages.

It consists essentially of two measuring channels, A and B, which terminate at the main meter. This meter is used to determine the ratio between the input voltages (sensitivity product) together with the precision attenuators inserted in channel B.

A separate LEVEL METER is also included with this section for use when aligning the measuring channels and adjusting the calibration section before measurements are made. A S/N test facility is also included. See the block diagram in Fig.3.

Both channels consist of an input amplifier, with a gain which can be switched to either "0 dB" or "20 dB", followed by a FILTER SELECTOR. In the B-channel, a precision attenuator, SENSITIVITY PRODUCT , and a buffer amplifier are inserted between the input amplifier and the FILTER SELECTOR. The selector has three positions: "Internal", where the internal 100 Hz high pass filter is inserted to filter out low frequency noise; "External", where external filters can be connected for selective measurements or to filter out noise, or where attenuators can be inserted to extend the measuring range, via the EXTERNAL FILTER sockets A 1, A 2 and B 1, B 2 on the rear of the Type 4143 (See Fig.6). In the third position, "Linear", the signal is passed through to an amplifier whose gain can be varied continuously over a 23 dB range,

using the GAIN CONTROL knob. The BALANCE potentiometer in the B-channel, which provides a ± 1 dB adjustment range, is used to balance the gain of the B-channel to the same value as that of the A-channel. Further, the signal is fed to a rectifier and then to the differential amplifier which terminates both channels in the main meter.

The main meter is a mirrored-scale, moving coil meter. The large scale is graduated from − 0,2 dB to + 0,2 dB and the range from 0 dB to + 0,1 dB is graduated in 0,005 dB divisions. It is used to determine the ratio between the input voltages of the voltmeter together with the precision attenuators SENSITIVITY PRODUCT in the B-channel. The attenuator is switchable in steps of 10 dB, 1 dB and 0,1 dB with an accuracy of ± 0,005 dB in the range 20 Hz to 10 kHz, and ± 0,02 dB in the range from 20 Hz to 20 kHz.

Instrument Calibration

In order to measure correctly, the apparatus should be calibrated. For this purpose, adjustment facilities are built into the Type 4143. The calibration is performed with an external signal applied to the OSCILLATOR INPUT and the FUNCTION SELECTOR switched to the following modes:

1. "Gain Control Adj." in which the gain of both channels of the ratio-voltmeter are adjusted simultaneously by means of the GAIN CONTROL knob using the built-in LEVEL METER as indicator.
2. "Reference & Balance Adj." where the reference voltage in the calibration section is adjusted, by means of the REFERENCE potentiometer, until the pointer of the LEVEL METER is centred. The gain of channel B is balanced to the same value as channel A, by means of the BALANCE potentiometer, when the pointer of the main meter is centred.
3. "Insert Gain Adj.". In this mode the attenuation of the receiver microphone preamplifier (Type 2645) and its capacitive loading of the microphone are compensated for by adjusting the INSERT GAIN control until the main meter is centred.

As an additional feature, a signal-to-noise ratio test can be performed to determine whether the electrical noise, the ambient acoustical noise, and the vibration levels in the coupler are sufficiently low for a reciprocity calibration to be performed with the selected sound pressure. The test is carried out by simply pushing the S/N TEST button and reading the LEVEL METER.

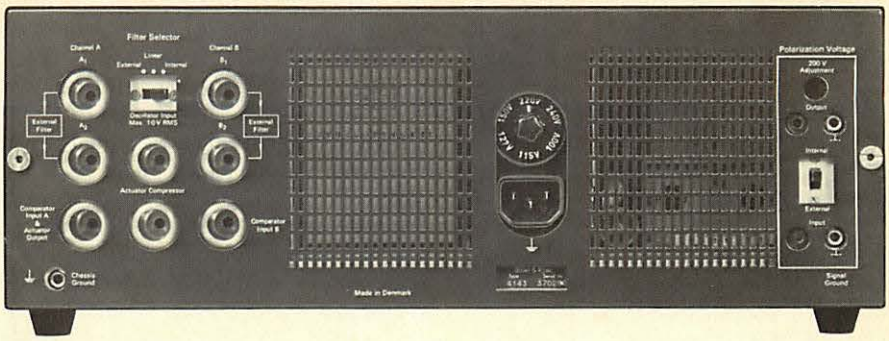


Fig. 6. Rear view of the Type 4143

Measurement

The measurement of the ratios (dB_{12}, dB_{13} and dB_{23}) between the input voltages of the voltmeter is carried out by setting the pointer of the main meter in the 0 to + 0,1 dB range by means of the precision attenuator. The ratio is then determined by adding together the setting of the attenuator and the reading on the meter.

Accuracy and Reproduceability of Calibration

The Type 4143 fulfils the IEC Recommendation 327. For a One-inch B&K Condenser Microphone such as the Type 4160, the over-all accuracy of reciprocity calibration is, according to IEC R327, estimated to be approximately ± 0,05 dB at low and middle frequencies, decreasing to about ± 0,1 dB at 10 kHz.

The reproduceability is typically ± 0,02 dB for a one-inch microphone such as B&K Type 4160 which is included with the instrument.

Couplers and Adaptors

Three couplers with accessories are supplied with the Type 4143:

1. A 20 cm^3 coupler (DB 1388), which is in accordance with IEC R327 and IEC R402. The approximate cavity volume is 18,6 m^3 (excluding front and equivalent volumes of the microphones). The individual volume of the coupler and its correction factor are stated in the calibration chart which is included. The coupler can be used up to 2,8 kHz when filled with air and up to 10 kHz when filled with hydrogen.

2. A 3,4 cm^3 coupler (DB 1392) which is in accordance with IEC R327 and IEC R402 with an approximate cavity volume of 2,0 cm^3 (excluding front and equivalent volumes of the microphones). The individual volume and its correction factor is stated in the calibration chart. The coupler can be used up to 10 kHz when filled with air and up to 20 kHz when filled with hydrogen.

3. A 1 cm^3 coupler (DP 0099) and a 1,4 cm^3 Volume Expansion Ring (YO 1804) (supplied together as

Fig. 7. Couplers for Type 4143: 1,4 cm^3 Volume Expansion Ring YO 1804, 1 cm^3 Coupler DP 0099, 3,4 cm^3 IEC Coupler DB 1392 and 20 cm^3 Coupler DB 1388

DB 1433) for measurement of front and equivalent volume of microphones. The approximate volume of the DP 0099 is 1,0 cm^3 and the volume added by the YO 1804 is 1,4 cm^3. The individual volumes may be found in the calibration chart.

The couplers have provision for use of capillary tubes and because of the different wall thickness of the couplers, two sets of capillary tubes (UA 0465 and UA 0467) are provided. They have a colour coding which correspond to colour marks on the couplers. If the capillary tubes are not used, the holes in the couplers can be closed by means of the colour coded steel plugs supplied as set UA 0462.

The following Adaptors are supplied with the apparatus:

1. A set, DB 1774, consisting of 3 Coupler Adaptor Rings DB 0111, numbered 1, 2 and 3. These screw onto the one-inch microphones in place of the protection grid to adapt the microphone cartridges to the IEC couplers. In the Type 4160 the Adaptor Ring is an integral part of the microphone.

2. Adaptor DB 0225, which dimensionally transforms half-inch microphones to one-inch microphones. Adaptors DB 0264 and DB 0900 which transform quarter- and eighth-inch microphones into half-inch microphones.

3. A Coupler Adaptor Ring (DB 0111), which screws onto Adaptor DB 0225 to adapt this to the IEC couplers.

Calibration chart

A calibration chart (BC 0091) is supplied with the Type 4143 giving the individually measured geometrical coupler cavity volumes, volume correction factors, and a sound source correction factor. Also supplied are copies of the two IEC standards, IEC R327 and IEC R402, dealing with reciprocity calibration of one-inch condenser microphones, containing tabulated correction factors for wave motion and heat conduction.

Fig. 9. Electrostatic Actuators UA 0023 and UA 0033 as supplied with Type 4143

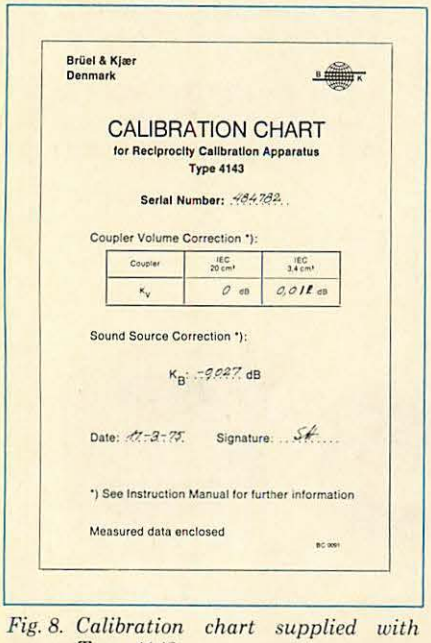
Electrostatic Actuators

The Electrostatic Actuators are intended for determination of the Actuator frequency response of B & K Condenser Microphone (or any type of condenser microphone having similar dimensions) and of complete sound measuring systems.

Two actuators are supplied with the Type 4143:UA 0023, for calibration of one-inch microphones (except Type 4160) and UA 0033, for half-, quarter- and eighth-inch microphones. See Fig.9.

The actuators consist of a perforated plate which is mounted in close proximity to the microphone (Fig.10). When a suitable DC polarization voltage and an AC signal are applied to the plate, the pressure produced by the electrical field will set the diaphragm into a motion equivalent to that caused by a sound pressure wave.

The polarization voltage required by the actuators is supplied from an 800 V DC supply in the calibration section of the Type 4143, via the ACTUATOR VOLTAGE output. The necessary AC signal (max. 10 V RMS input signal) is obtained from an external oscillator and fed via a limiter circuit, 20 dB amplifier and the TRANSMITTER/ACTUATOR switch to the ACTUATOR VOLTAGE output. In order to keep the signal voltage constant during calibration, a compressor voltage is available at the ACTUATOR COMPRESSOR output. This is used together with the compressor facility of B & K Generators.



Brüel & Kjær
Denmark

CALIBRATION CHART
for Reciprocity Calibration Apparatus
Type 4143

Serial Number: 484782

Coupler Volume Correction *):

Coupler	IEC 20 cm³	IEC 3,4 cm³
K_V	0 dB	0,01 dB

Sound Source Correction *):

K_B: -.0027 dB

Date: 11-3-75 Signature: SK

*) See Instruction Manual for further information

Measured data enclosed

BC 0091

Fig. 8. Calibration chart supplied with Type 4143

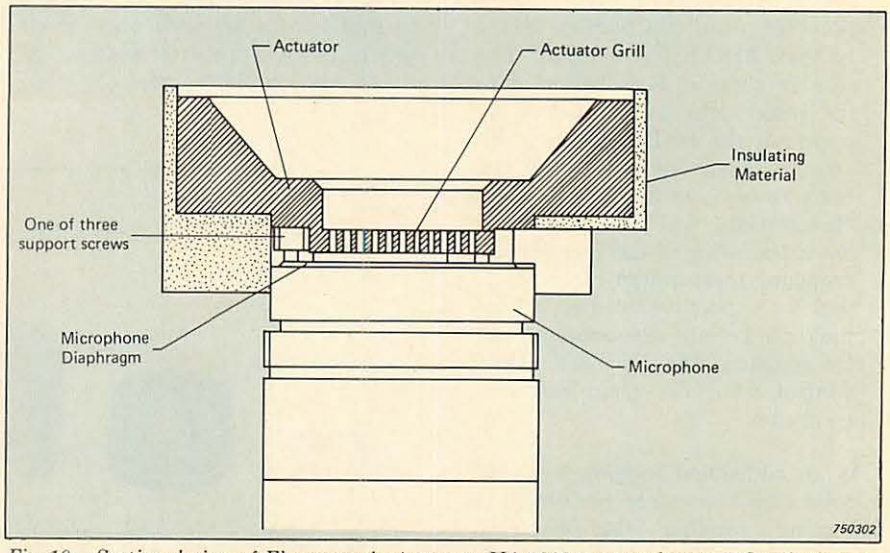


Fig. 10. Sectional view of Electrostatic Actuator UA 0023 mounted onto a One-inch condenser microphone

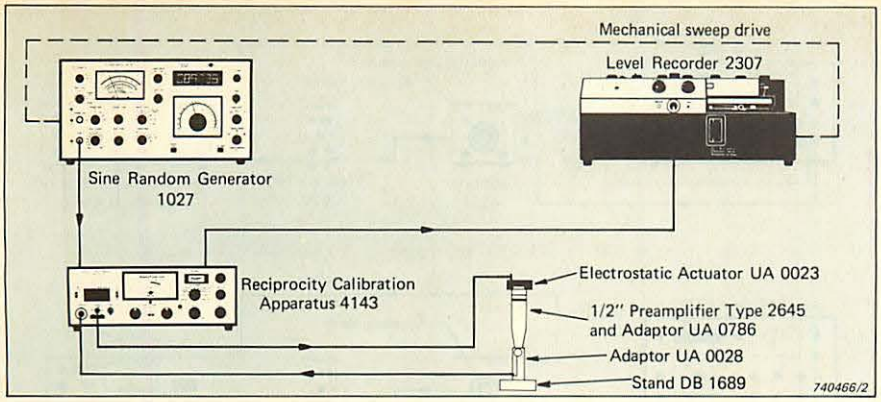


Fig. 11. Set-up for automatic recording of the response of a condenser microphone to an Electrostatic Actuator

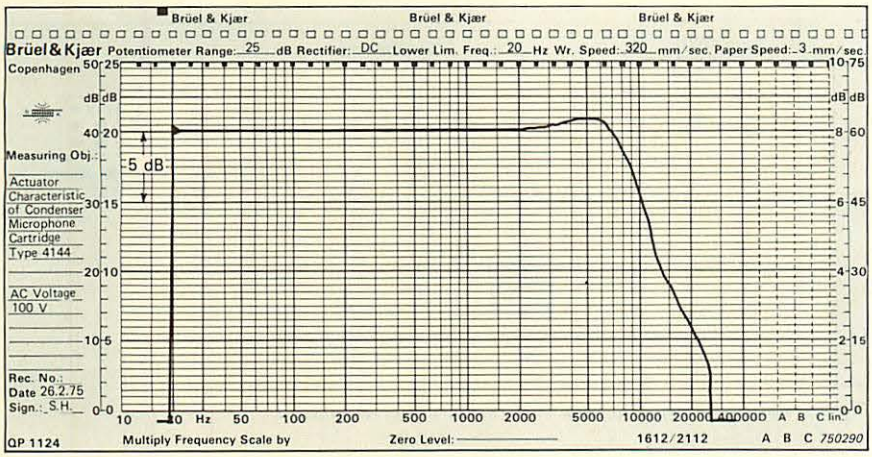


Fig. 12. Microphone frequency characteristic recorded by means of the set-up shown in Fig. 11

An actuator calibration is performed by connecting an oscillator to the OSCILLATOR INPUT and the Actuator to the ACTUATOR VOLTAGE output and sweeping the oscillator through the desired frequency range, thereby obtaining the actuator characteristic of the microphone via the ACTUATOR OUTPUT. By connecting a Level Recorder Type 2307 to the ACTUATOR OUTPUT and sweeping the oscillator by means of the Recorder, an automatic recording of the microphone's response is readily obtained. See Figs. 11 and 12.

During calibration, the microphone and its preamplifier are placed on the Stand DB 1689 using Adaptor UA 0028, both of which are supplied with the Type 4143. See Fig. 13.

The Actuators are adjusted during manufacture so that with the 800 V DC polarization voltage supplied by the Type 4143 and a signal voltage of 30 V RMS (3 V RMS input signal) applied between the Actuator and the microphone diaphragm, a pressure of about 1 Pa acts upon the diaphragm.

Electrostatic actuator calibration can be performed in the frequency range 2 Hz to 200 kHz using the Type 4143 and a suitable generator, for instance a Type 1027. A maximum sound pressure level of approximately 104 dB can be obtained with an AC input signal to the Type 4143 of 10 V RMS.

If only the AC signal is applied to the Actuator (800 V DC omitted) an equivalent sound pressure at twice the frequency of the AC signal will act on the microphone diaphragm. This may be used to extend the measurement frequency range to twice that of the generator. However, with an AC voltage of 100 V RMS (available from earlier B&K Generators), the equivalent sound pressure level is only about 72 to 84 dB, which might be insufficient in noisy places.

Examples of Use

The Reciprocity Calibration Apparatus is an extremely versatile instrument. Apart from being used in its main applications for reciprocity calibration or electrostatic actuator calibration of microphones, the Type 4143 can also be used in several other applications such as:

Measurement of Front and Equivalent Volume of Microphones

This measurement is performed with the Type 4143 in the "Sensitivity Product" mode. The measurements apply for one- and half-inch microphones and can be carried out at frequencies up to approximately 500 Hz. Three microphones are used, mounted two at a time in the 1 cm^3 Coupler (DP 0099) and three sets of measurements are made in the same way as in reciprocity calibration. Each set consists of a measurement of the sensitivity product with and without the Volume Expansion Ring YO 1804 mounted inside the Coupler. From the six results obtained, the front and equivalent vol-

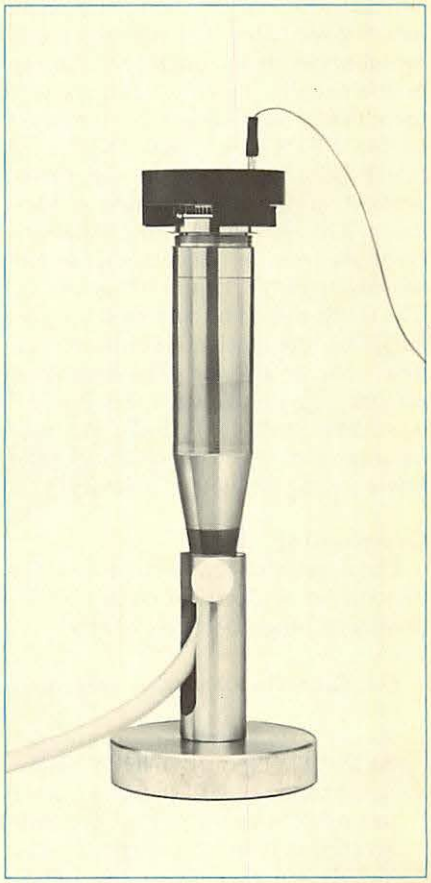


Fig. 13. Calibration of One-inch Condenser Microphone mounted with Electrostatic Actuator UA 0023 and Preamplifier placed in Adaptor UA 0028 and on stand DB 1689

ume of each of the three microphones can be calculated.

Reference Sound Source

The Type 4143 can, together with the supplied Condenser Microphone Type 4160, and a generator, for instance a Type 1023, be used as a stable and accurate sound source for fast calibration of microphones, sound level meters, analysing systems etc.

The sound pressure will depend upon the coupler used and the oscillator voltage chosen. With voltages between 1 V and 10 V RMS, the SPL in the 3,4 cm^3 coupler will be between approximately 75 and 95 dB and in the 20 cm^3 coupler between approximately 60 and 80 dB.

Precision Comparison Calibration of the One and Half-inch Condenser Microphones

This type of calibration can be performed in conjunction with the supplied Microphones Type 4160, which is used as a reference microphone. The Type 4160 is mounted onto the TRANSMITTER MICROPHONE SOCKET, together with one of the supplied IEC couplers and fed from an external oscillator. The microphone to be calibrated is mounted into the top of the coupler, together with its preamplifier, whose output is connected to the PREAMPLIFIER INPUT of the Type 4143. Then the sensitivity product of the microphones is measured. The sensitivity of the other microphone can be calculated, as the sensitivity of the Type 4160 is known. The result should be corrected for preamplifier attenuation, equivalent volume, coupler size etc. The estimated accuracy obtainable with this method is approximately ± 0,15 dB, not taking into account the uncertainty of the reference microphone sensitivity.

Comparator

The Apparatus may also be used for comparison of electrical signals in the frequency range 20 Hz to 20 kHz.

The Type 4143 is used in two ways:

1. As a ratio-voltmeter, where the SENSITIVITY PRODUCT attenuator together with the main meter are used to measure the level difference between two signals. The signals are applied to the COMPARATOR inputs A and B on the rear panel of the Type 4143.

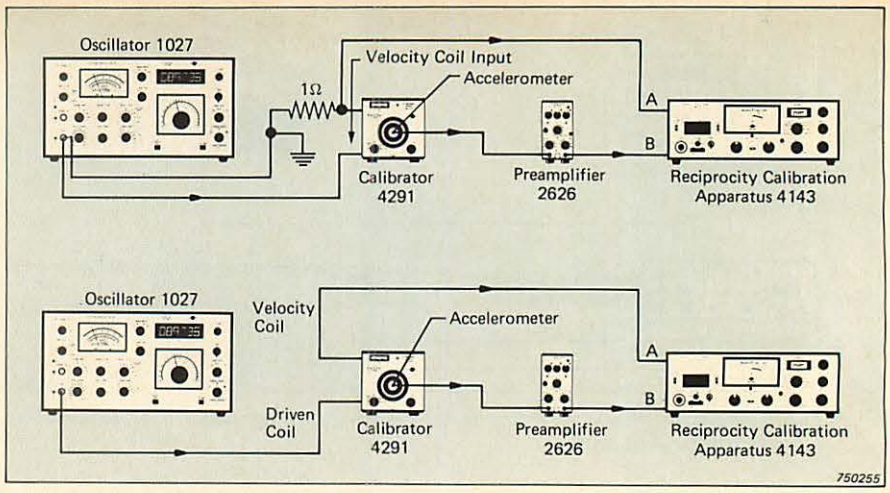


Fig. 14. Set-up for reciprocity calibration of accelerometers

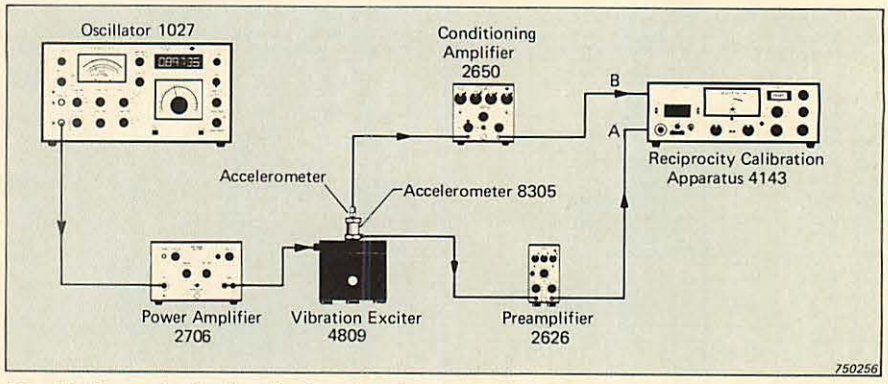


Fig. 15. Set-up for back-to-back calibration of accelerometers

2. As zero indicator, where the Type 4143 indicates equality of two signals. The signals are applied to the Type 4143 via the A and B COMPARATOR inputs, or the EXTERNAL FILTER inputs A_2 and B_2. See Figs. 3 and 6.

Accelerometer Calibration

The comparator facility of the Type 4143 can also be used for accelerometer calibration. Reciprocity calibration as well as back-to-back calibration can be performed with a high degree of accuracy.

Reciprocity calibration is an absolute calibration procedure. It can be performed with the Type 4143 together with Accelerometer Calibrator Type 4291 (see Fig. 14). Two transducers are required and the calibration principle is based on the reciprocal performance of one of them. One is the accelerometer to be calibrated and the other, the reciprocal transducer, is the Velocity Coil of the Type 4291. From two measurements made with each of the set-ups shown in Fig. 14, the sensitivity of the accelerometer to be calibrated can be calculated. The calibration accuracy obtainable with the reciprocity method is estimated to be approximately ± 0,5 %.

In the back-to-back comparison calibration (see Fig. 15), the accelerometer to be calibrated is vibrated on Vibration Exciter Type 4809, together with a reference accelerometer (for example Standard Accelerometer Type 8305, which is calibrated by the laser interference method). The ratio between the output voltages of the accelerometers is measured with the ratio-voltmeter of the Type 4143. This measurement can be performed with a resolution of approximately 0,02 %. Then, knowing the sensitivity of the reference accelerometer, it is easy to calculate the sensitivity of the unknown accelerometer. The Type 8305 and Type 2626 are available as Calibration Set Type 3506, where both instruments have been calibrated together to eliminate cumulative errors.

Specifications Type 4143

MICROPHONE CALIBRATION CIRCUIT AND COUPLERS:

MICROPHONE SENSITIVITY RANGE:
With 3,4 cm³ Coupler DB 1392:
– 23 dB to – 40 dB re 1 V/Pa
With 20 cm³ Coupler DB 1388:
– 23 dB to – 33 dB re 1 V/Pa

RECIPROCITY CALIBRATION:
Accuracy: For a 1″ condenser microphone, such as Type 4160, the overall accuracy is approximately ± 0,05 dB at low and middle frequencies, decreasing to about ± 0,1 dB at 10 kHz
Reproducibility: Typically ± 0,02 dB for a 1″ microphone such as Type 4160

FREQUENCY RANGE OF COUPLERS:

3,4 cm³ coupler DB 1392	
Filled with	Max. Frequency
Air	10 kHz
Hydrogen	20 kHz

T00314GB0

20 cm³ coupler DB 1388	
Filled with	Max. Frequency
Air	1 kHz (2,8 kHz*)
Hydrogen	3,5 kHz (10 kHz*)

* with wave motion correction

T00315GB0

CAPILLARY TUBES:
Correction for 2 capillary tubes at 250 Hz:

Coupler Volume	3,4 cm³	20 cm³
Air	–0,031 dB	–0,0053 dB
Hydrogen	–0,008 dB	–0,0018 dB

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Length: 50 mm ± 0,1 mm
Inside Diameter: 0,335 mm ± 0,02 mm

POLARIZATION VOLTAGE:
200 V DC
Long term stability: Approximately ± 0,05%/1000 h
Adjustment Range: ± 5 V with a resolution of 0,02%
Output Impedance: 30 kΩ (rear panel output)

PREAMPLIFIER INPUT:
B & K standard 7-pin input socket

OSCILLATOR INPUT:
(TRANSMITTER/ACTUATOR switch in "Transmitter" mode)
Input Impedance: 20 kΩ
Maximum Input Voltage: 40 V_{pp} (14 V RMS)

LIMITER:
Clipping Limit: 14 V RMS (40 V_{pp})
Maximum Current: 100 mA peak

INSERT GAIN:
Adjustment Range: 0 to + 2 dB
Calibrated: 0 dB ± 0,003 dB

REFERENCE CAPACITORS:
(The reference capacitors are individually adjusted with a dummy microphone mounted on the Type 4143 and include circuit and stray capacitance)

"Coupler Volume" Switch	Reference Capacitor
"3 cm³"	4,7456 nF
"20 cm³"	27,9545 nF

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ELECTROSTATIC ACTUATORS

FREQUENCY RESPONSE:
(Accuracy of Actuator Voltage re voltage at Actuator Compressor Output [ref. 250 Hz])
Actuator signal voltage: 50 V RMS
20 Hz to 12,5 kHz ± 0,05 dB
10 Hz to 25 kHz ± 0,10 dB
5 Hz to 50 kHz ± 0,20 dB
5 Hz to 100 kHz ± 0,30 dB
2 Hz to 200 kHz ± 0,60 dB
Actuator signal voltage: 100 V RMS
20 Hz to 12,5 kHz ± 0,10 dB
10 Hz to 25 kHz ± 0,20 dB
5 Hz to 50 kHz ± 0,40 dB
5 Hz to 100 kHz ± 0,60 dB
2 Hz to 200 kHz ± 1,00 dB

EQUIVALENT SOUND PRESSURE LEVEL:
Maximum 104 dB SPL (10 V RMS input voltage to Type 4143 and 800 V DC polarization voltage)

POLARIZATION VOLTAGE:
800 V DC
Adjustment Range: ± 50 V

OSCILLATOR INPUT:
(TRANSMITTER/ACTUATOR switch in "Actuator" mode)
Input Impedance: 3 kΩ
Maximum Input Voltage: 10 V RMS (14 V_p)

ACTUATOR COMPRESSOR OUTPUT:
Output Impedance: < 1 Ω
Maximum Capacitive Load: 200 pF
Compressor Voltage: 6 dB below OSCILLATOR INPUT voltage

ACTUATOR OUTPUT:
Output Impedance: 1 kΩ

ACTUATOR VOLTAGE, 800 V DC & AC Output:
Max. AC Output Voltage: 100 V RMS
Gain: 20 dB
Output Impedance: AC: 20 nF DC: 10 MΩ
Maximum Capacitive Load: 25 pF

SOUND SOURCE

FREQUENCY RANGE:
200 Hz to 1000 Hz (with Condenser Microphone Type 4160)

SOUND PRESSURE LEVEL:
(with Condenser Microphone Type 4160)

Coupler Volume	Sound Pressure Level*	Accuracy**
3,4 cm³	75 dB to 95 dB	± 0,3 dB
20 cm³	60 dB to 80 dB	± 0,2 dB

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* re 2×10^{-5} Pa

**Accuracy does not include accuracy of transmitter microphone sensitivity

RATIO–VOLTMETER SECTION

FREQUENCY RANGE:
(Both Channels) Comparator Inputs A and B: 5 Hz to 50 kHz, ± 0,5 dB

DEVIATION BETWEEN CHANNELS:
± 0,05 dB typical (20 Hz to 20 kHz)

MAXIMUM RATIO BETWEEN INPUT VOLTAGES:
Inputs A and B: 20 dB
Inputs A_2 and B_2: ± 0,2 dB

SENSITIVITY:
Input voltages (Inputs A and B) necessary to centre the pointer of Level Meter

"Gain" Switch position	20 dB		0 dB	
"Gain Control" position	Max.	Min.	Max.	Min.
Input Voltage	2 mV	24 mV	20 mV	240 mV

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Input voltages (Inputs A_2 and B_2) necessary to centre the pointer of Level Meter

GAIN CONTROL position	Max.	Min.
Input Voltage	100 mV	1,4 V

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GAIN CONTROL ADJUSTMENT RANGE:
23 dB

BALANCE ADJUSTMENT RANGE:
± 1 dB

MAIN METER:
Full Scale Deflection: ± 0,2 dB
Accuracy: ± 0,002 dB in the range from 0 to + 0,1 dB

LEVEL METER:
Full Scale Deflection: ± 0,3 dB
Centre Scale Range: ± 0,05 dB

HIGH-PASS FILTERS:
R–C filter with 2 dB attenuation at 100 Hz and 18 dB/octave slope below 100 Hz

EXTERNAL FILTERS:
Output Impedance to External Filters: (Sockets A_1 and B_1) Approx. 1 Ω
Input Impedance from External Filters: (Sockets A_2 and B_2) Approx. 100 MΩ//50 pF

INPUT IMPEDANCE:
(Sockets A and B) Approx.1 GΩ//50 pF

INTERNAL ATTENUATOR:
("Sensitivity Product")
Range: 0 dB to 20 dB. Attenuation variable in steps of 10 dB, 1 dB and 0,1 dB
Accuracy: ± 0,005 dB (20 Hz to 10 kHz), ± 0,02 dB (20 Hz to 20 kHz)

GENERAL

OPERATING CONDITIONS (IEC 68 Part.1):
Temperature Range: 15°C to 35°C (59°F to 95°F)
Humidity Range: 45% to 75% RH
Atmospheric Pressure Range: 860 mbar to 1060 mbar

POWER:
Power Supply: 100, 115, 127, 150, 220 and 240 V AC ± 10%
Power Consumption: Approximately 25 W

CABINET:
Supplied as model A (lightweight metal cabinet), model B (model A in mahogany cabinet) or model C (as A but with flanges for standard 19″ racks)

DIMENSIONS:
(A-cabinet)
Height: 132 mm (5,2 in)
Length: 380 mm (15 in)
Width: 200 mm (7,9 in)

WEIGHT:
(A-cabinet)
7,5 kg (16,5 lb)

ACCESSORIES INCLUDED:
Coaxial Cable ..... AO 0013
Power Cord ..... AN 0010
Test Lead ..... AQ 0100
Standard ..... IEC R 327
Standard ..... IEC R 402
2 Short Connection Plug ..... JP 0149

Mahagany Case ..... KE 0150 contains:
1/2 inch Microphone Preamplifier ... Type 2645
Adaptor for Preamplifier ..... JE 0002
Input Adaptor ..... JJ 2617
Flexible Extension Rod ..... UA 0196
Adaptor ..... UA 0786
Screwdriver ..... QA 0001
1 inch Condenser Microphone Cartridge ..... Type 4160

Microphone Calibration Accessories Set ..... UA 0473 consists of:
Mahogany Case ..... KE 4143
Calibration Chart ..... BC 0091
1 inch Electrostatic Actuator ..... UA 0023
1/2 inch Electrostatic Actuator ..... UA 0033
Cable for Actuators ..... AQ 0102

Microphone Tube-Wrench ..... QA 0076

3,4 cm^3 IEC Coupler ..... DB 1392
Coupler Adapter Ring ..... DB 0111
1/2 to 1 inch Adaptor ..... DB 0225
1/4 to 1/2 inch Adaptor ..... DB 0264
1/8 to 1/4 inch Adaptor ..... DB 0900
3 Dust Caps ..... DZ 9025
1 inch Spring Yoke Assembly ..... UA 0464
1/2 inch Spring Yoke Assembly ..... UA 0463
Adaptor ..... UA 0028
Stand for UA 0028 ..... DB 1689
Set of Capillary Tubes ..... UA 0465
Set of Capillary Tubes ..... UA 0467
Set of Steel Plugs ..... UA 0462
1 inch Isolation Insert Ring ..... DB 0159
1/2 inch Isolation Insert Ring ..... DB 0301
2 Contact Extension Plugs ..... DB 0158
2 Contact Extension Plugs ..... DB 0327
1 cm^3 Coupler[1] ..... DP 0099
1,4 cm^3 Volume Expansion Ring[1] ..... YO 1804
3 Coupler Adaptor Rings[2] ..... DB 0111
Various lamps and fuses

[1] Available as set DB 1433
[2] Available as set DB 1774