

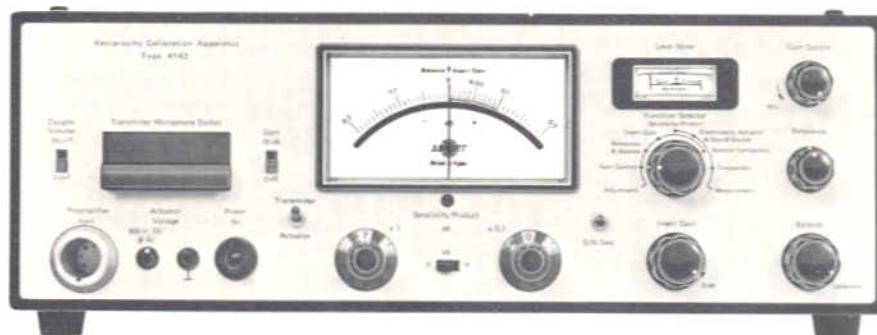
Measuring Microphones, Studio Microphones, Hydrophones and Accessory Equipment

type 4143

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 $\pm 0,05$ 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 cm³ and 20 cm³ couplers supplied
- 1 cm³ coupler supplied for measurement of equivalent microphone volume and front volume of adaptors
- Accessories for electrostatic actuator calibration of 1", 1/2", 1/4" and 1/8" condenser microphones included

Reciprocity Calibration Apparatus



- Capillary tubes supplied for static pressure equalization and hydrogen filling of couplers
- One 1" B & K Condenser Microphone Cartridge Type 4160 and one 1" Insert Voltage Preamplifier Type 2627 included

USES:

- Precision reciprocity calibration of 1" standard microphones in accordance with IEC Recommendations 327 and 402
- Precision comparison calibration of 1" and 1/2" condenser microphones
- Reciprocity and comparison calibration of accelerometers
- Microphone frequency response measurements by the electrostatic actuator method
- Reference sound source
- Comparator

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 fulfils 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 640A.

The 4143 is a versatile instrument which in addition to reciprocity calibration of 1" condenser microphones can be used in a variety of other applications such as: Comparison calibration of 1" and 1/2" condenser microphones, measurement of frequency response of 1",

1/2", 1/4" and 1/8" 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 reference sound source and comparator.

Calibration Principles

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

Reciprocity calibration applies for both 1" condenser microphones and accelerometers, comparison calibration for 1" and 1/2" condenser microphones and accelerometers and electrostatic actuator calibration for 1", 1/2", 1/4" and 1/8" 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 1" 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 4143.

Three 1" microphones are used when making reciprocity calibra-

tions with the 4143. The basic measurement performed is the Measurement 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, a coupler. See Fig.1. The current through the transmitter microphone is found by measuring the voltage (U_1) across a reference capacitor ($C_{ref.}$) in series with the transmitter (Dr. Kjerbye Nielsen's Method), which means that the frequency does not enter the calculations directly. These voltages are then fed to a built-in ratio-voltmeter (Fig.1) 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 in turn to each other and measuring, three sensitivity product values dB_{12} , dB_{13} and dB_{23} are obtained. dB_{12} is the sensitivity product value obtained with microphone 1 as transmitter and microphone 2 as receiver etc.

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

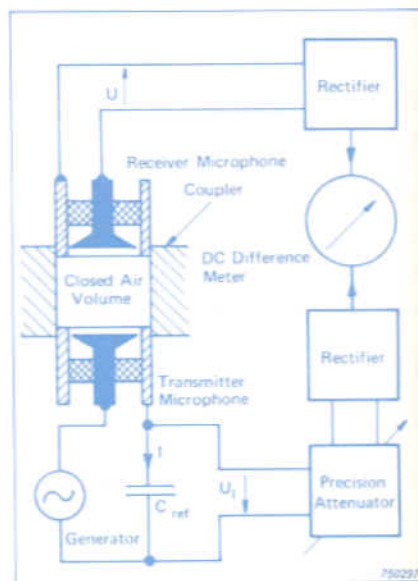


Fig.1. Principle of microphone reciprocity calibration with 4143

$$M_{p1} = dB_{ref} - 1/2 (dB_{12} + dB_{13} - dB_{23})$$

$$M_{p2} = dB_{ref} - 1/2 (dB_{12} + dB_{23} - dB_{13})$$

$$M_{p3} = dB_{ref} - 1/2 (dB_{23} + dB_{13} - dB_{12})$$

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

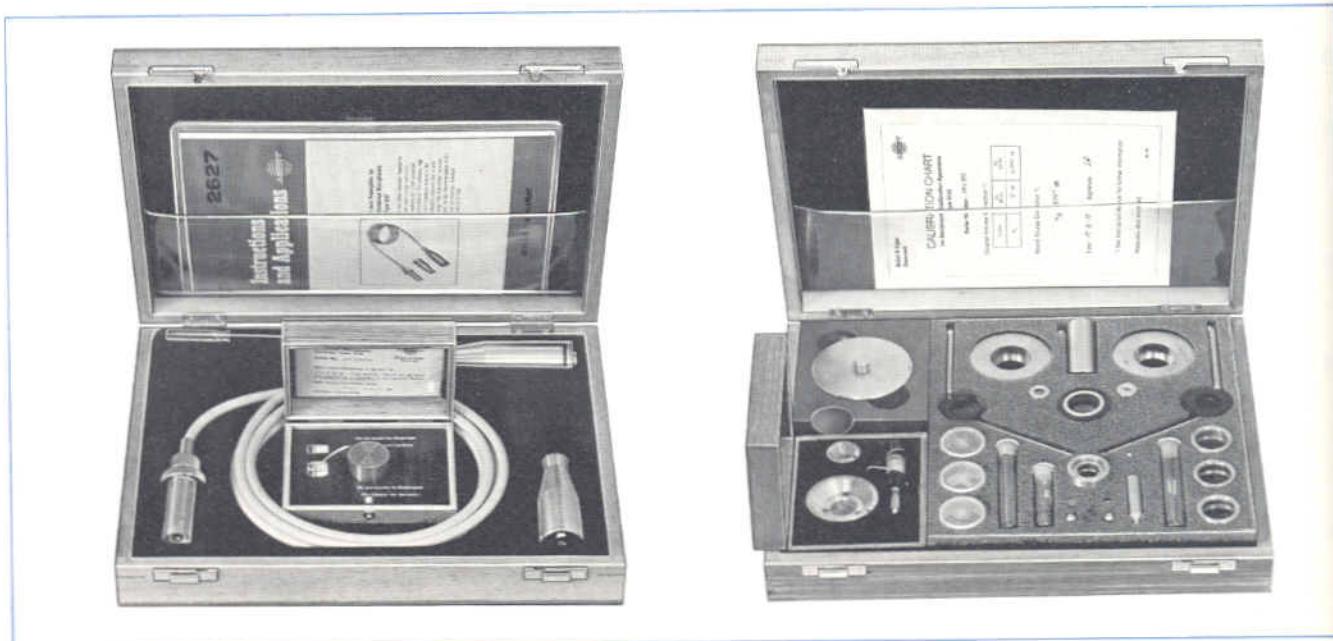


Fig.2. Accessories supplied with 4143

The dB_{ref} shall 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 Preamp

Type 2627 and the 1" Condenser Microphone Cartridge Type 4160, which is equivalent to the Western Electric WE 640A, see separate product data sheets.

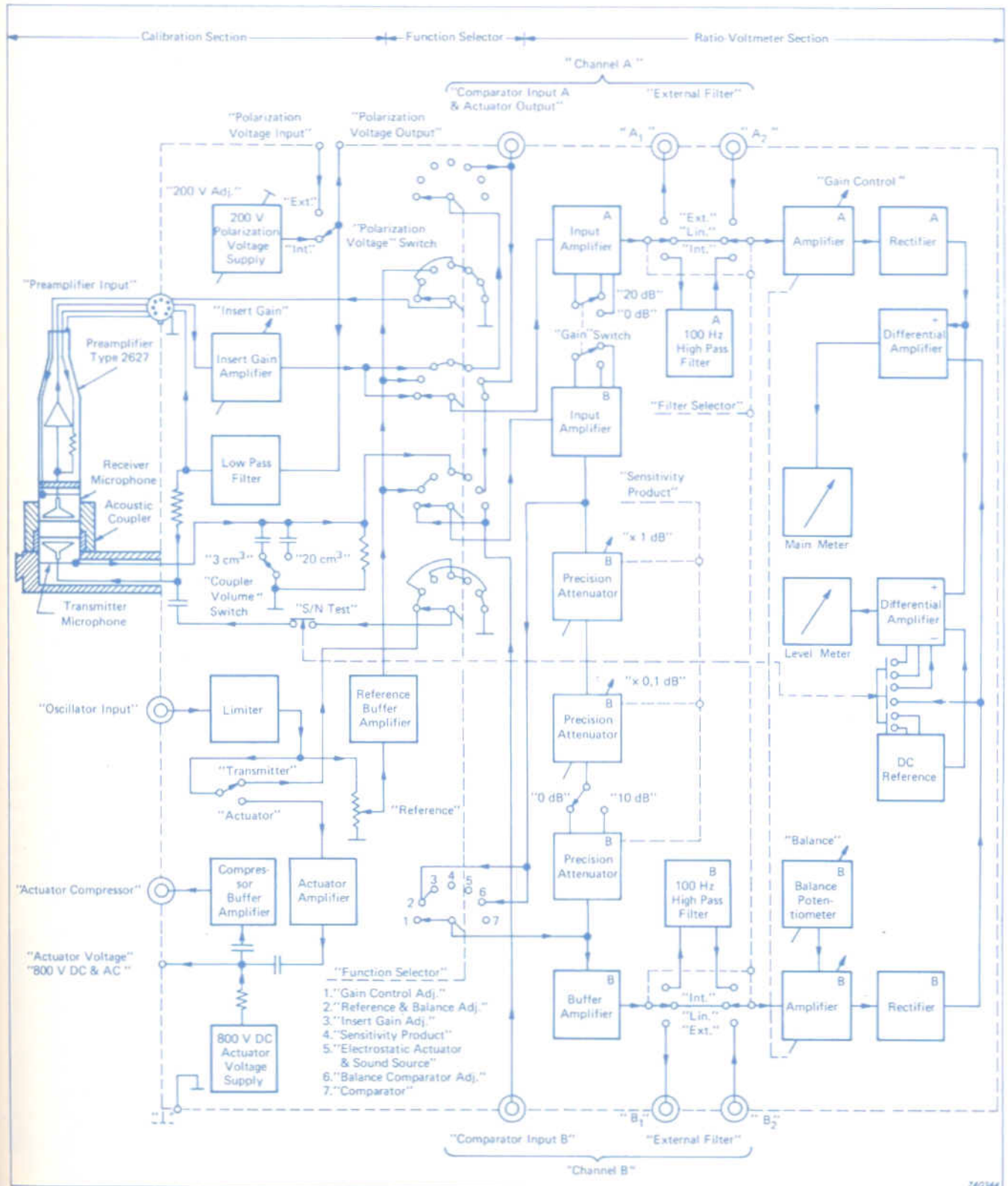


Fig.3. Simplified block diagram of Type 4143

Description

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

Calibration Section

This section contains a coupler base with a transmitter microphone socket with standardized ground shield, all 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 800V DC polarization voltage supply and amplifiers for electrostatic actuator calibration are also included. See section Electrostatic Actuators.



Fig. 4. Transmitter microphone socket with standardized ground shield



Fig. 5. Type 4143 fitted with 1" microphones, preamplifier and 3.4 cm³ IEC plane wave coupler

The couplers mount on the top of the transmitter microphone which is screwed onto the TRANSMITTER MICROPHONE SOCKET. See 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 with the couplers supplied, and calibration to ANSI S1.10-1966, if suitable couplers are made.

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 overload 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, which is chosen with the COUPLER VOLUME switch in accordance with the coupler used ("3 cm³" or "20 cm³"). The signal across this 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 onto the top of the coupler together with the Insert Voltage Preamplifier Type 2627 (supplied) which connects to the PREAMPLIFIER INPUT of the 4143. See Fig. 5. From the preamplifier the signal from the receiver microphone is fed to the insert gain amplifier whose gain is continuously adjustable with the INSERT GAIN control and compensates for the microphone preamplifier attenuation and its capacitive loading of the microphone. Via the FUNCTION SELECTOR, the signal which is equal to the open circuit

voltage from the receiver microphone is fed to Channel A of the ratio-voltmeter section.

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 200V DC voltage supply is built into the calibration section. The voltage can be checked at the POLARIZATION VOLTAGE OUTPUT at the rear of the apparatus. See Fig. 6. If other polarization voltages are required an external voltage supply can be connected to the POLARIZATION VOLTAGE INPUT at the rear of the 4143.

Ratio-Voltmeter Section

This section of the 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 into 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 measuring. A S/N

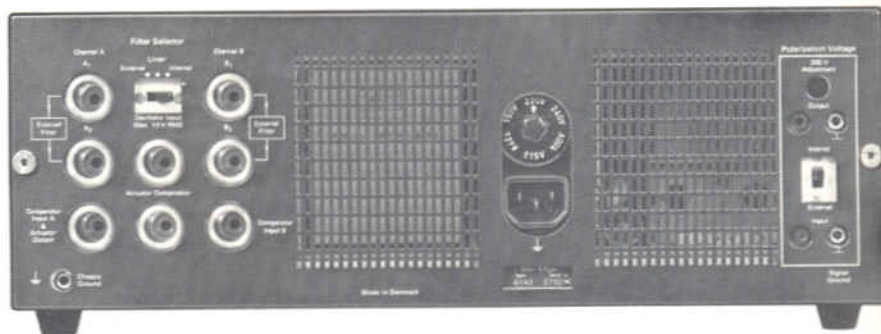


Fig. 6. Rear view of Type 4143

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 "0dB" or "20dB", followed by the 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 100Hz 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 A1, A2 and B1, B2 on the rear of the 4143 (See Fig.6) and "Linear", where the signal is passed through to an amplifier whose gain is continuously variable with the GAIN CONTROL knob over a 23 dB range. 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 into 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 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 $\pm 0,005$ dB in the range 20 Hz to 10 kHz, and $\pm 0,02$ 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 4143. The calibration is performed with an external signal applied to the OSCILLATOR INPUT and the FUNCTION SELECTOR switched to the 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 with 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 centered, and 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 centered.
3. "Insert Gain Adj.". In this mode, the attenuation of the receiver microphone preamplifier (Type 2627) and its capacitive loading of the microphone are compensated for by adjusting the INSERT GAIN control until the main meter pointer is centered.

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

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 the setting of the attenuator and the reading on the meter.

Accuracy and Reproducibility of Calibration

The 4143 fulfils the IEC Recommendation 327. For a 1" 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 $\pm 0,05$ dB at low and middle frequencies, decreasing to about $\pm 0,1$ dB at 10 kHz.

The reproducibility is typically $\pm 0,02$ dB for a 1" microphone such as B & K Type 4160 which is included with the instrument.

Couplers and Adaptors

Three couplers with accessories are supplied with the 4143:

1. A 20 cm³ Coupler, DB 1388, which is in accordance with IEC R327 and IEC R402. The approximate cavity volume is 18,6 cm³ (excluding front and equivalent volumes of the microphones). The individual volume of the coupler and its correction factor can be found from the calibration chart 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 cm³ Coupler, DB 1392, which is in accordance with IEC R327 and IEC R402 with an approximate cavity volume of 2,0 cm³ (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.



Fig. 7. Couplers for 4143: 1,4 cm³ Volume Expansion Ring YO 1804, 1 cm³ Coupler DP 0099, 3,4 cm³ IEC Coupler DB 1392 and 20 cm³ Coupler DB 1388

3. A 1 cm³ Coupler, DP 0099, and a 1.4 cm³ Volume Expansion Ring, YO 1804, (both supplied as DB 1433) for measurement of front and equivalent volume of microphones. The approximate volume of the DP 0099 is 1.0 cm³ and the volume added by the YO 1804 is 1.4 cm³. 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 thicknesses 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 in a set as UA 0462.

The following Adaptors are supplied with the apparatus:

1. DB 1774, a set of three Coupler Adaptor Rings, numbered 1, 2

and 3, which screw onto the 1" microphones instead 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 1/2" microphones to 1" microphones. Adaptors DB 0264 and DB 0900 which transform 1/4" and 1/8" microphones into 1/2" microphones.

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

Calibration chart

A calibration chart, BC 0091, is supplied with the 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

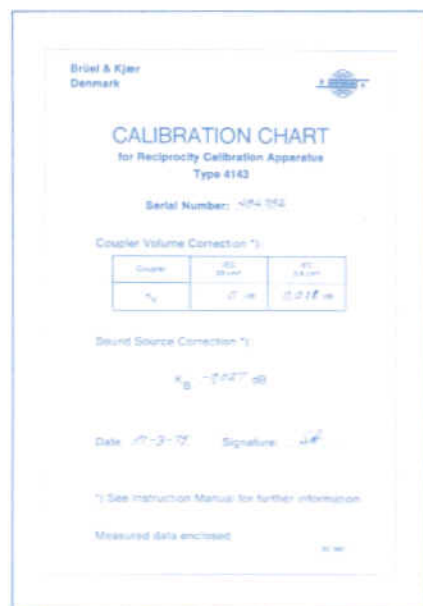


Fig.8. Calibration chart supplied with 4143

R 327 and IEC R 402, dealing with reciprocity calibration of 1" condenser microphones, containing tabulated correction factors for wave motion and heat conduction.

Electrostatic Actuators

The electrostatic actuators are intended for determination of the pressure frequency response of B & K condenser microphones, or any type of condenser microphone having similar dimensions, and of complete sound measuring systems.

Two actuators are supplied with the 4143: UA 0023, for calibration

of 1" microphones (except 4160) and UA 0033, for 1/2", 1/4" and 1/8" microphones. See Fig.9.

The actuators consist of a perforated plate which is mounted in close proximity to the diaphragm of the microphone. See Fig.10. When a suitable DC polarization voltage and an AC signal is 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.

The polarization voltage required by the actuators is supplied from an 800V DC supply in the calibration section of the 4143, via the ACTUATOR VOLTAGE output. The neces-



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

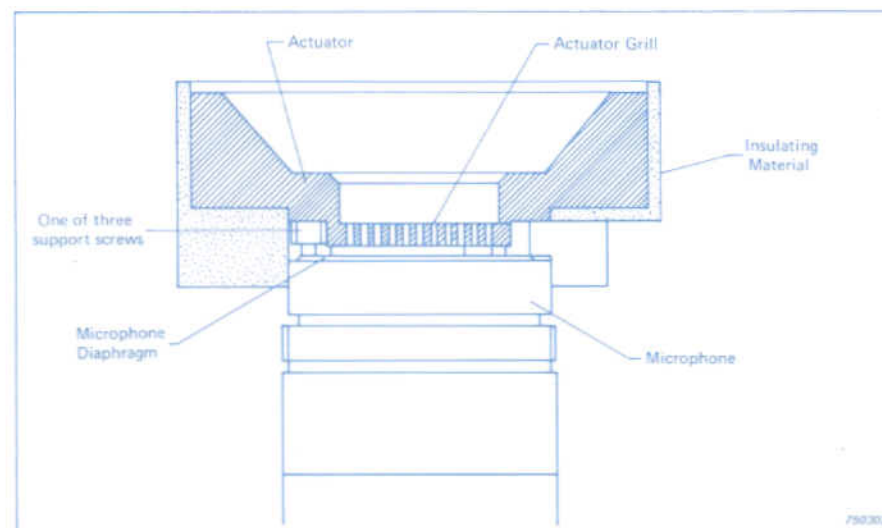


Fig.10. Sectional view of Electrostatic Actuator UA 0023 mounted onto a 1" condenser microphone

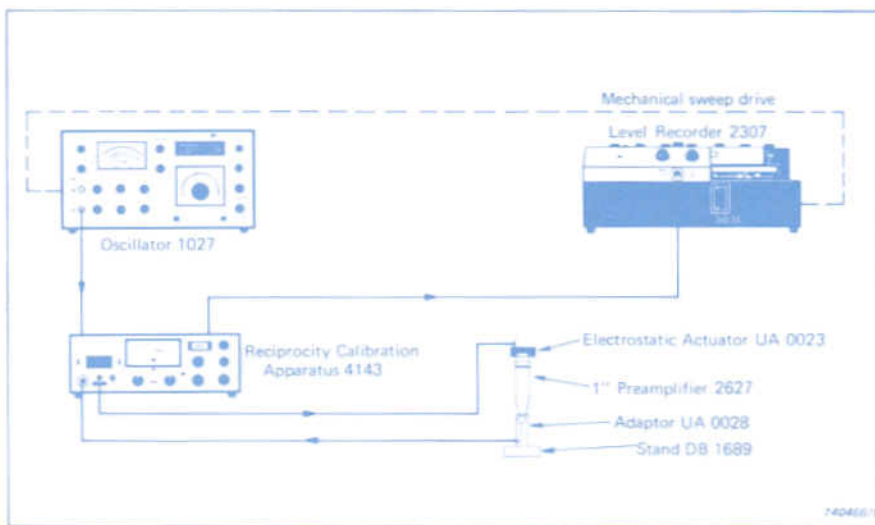


Fig. 11. Set-up for automatic recording of the response of a condenser microphone to an electrostatic actuator



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

sary AC signal (Max. 10V RMS input signal) is obtained from an external oscillator and fed via a limiter circuit, a 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 to be used together with the compressor facility of B & K Generators.

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 is placed on the Stand DB 1689 by means of the Adaptor UA 0028 which are both supplied with the 4143. See Fig. 13.

The actuators are adjusted during manufacture so that with the DC polarisation voltage of 800V DC supplied by the 4143 and a signal volt-

age 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.

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

If only the AC signal is applied to the actuator (800V 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 100V 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.



Fig. 13. 1" Condenser Microphone mounted with Electrostatic Actuator UA 0023 and preamplifier placed in Adaptor UA 0028 and on Stand DB 1689 for calibration

Examples of Use

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

Measurement of Front and Equivalent Volume of Microphones

This measurement is performed with the 4143 in the "Sensitivity Product" mode. The measurements apply for 1" and 1/2" 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 cm³ 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 DB 1433 mounted inside the coupler. From the six dB values obtained, the front and equivalent volume of each of the three microphones can be calculated.

Reference Sound Source

The 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 cm³ coupler will be between approximately 75 and 95 dB and in the 20 cm³ coupler between approximately 60 and 80 dB.

Precision Comparison Calibration of 1" and 1/2" Condenser Microphones

This type of calibration can be performed in conjunction with the supplied Microphone Type 4160 used as reference microphone. The 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 cali-

brated is mounted into the top of the coupler together with its preamplifier whose output is connected to the PREAMPLIFIER INPUT of the 4143. Then the sensitivity product of the microphones is measured and knowing the sensitivity of the 4160, the sensitivity of the other microphone can be calculated. The result shall be corrected for preamplifier attenuation, equivalent volume, coupler size etc. The estimated accuracy obtainable with this method is approximately $\pm 0,15$ 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 4143 is used in two ways:

1. As 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 of the 4143.

2. As zero indicator, where the 4143 indicates equality of two signals. The signals are applied to the 4143 via the COMPARATOR inputs A & B or the EXTERNAL FILTER inputs A₂ and B₂. See Figs.3 and 6.

Accelerometer Calibration

The comparator facility of the 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 4143 together with the Accelerometer Calibrator Type 4291 (see Fig.14). Two transducers are required and the calibration principle is based on the recip-

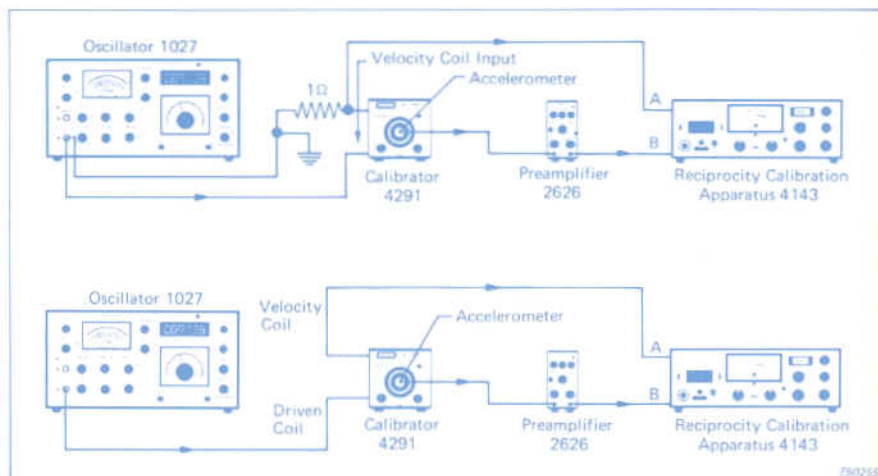


Fig.14. Set-up for reciprocity calibration of accelerometers

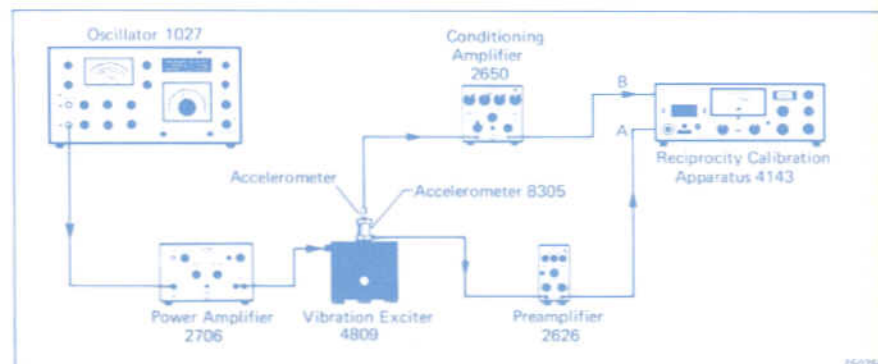


Fig.15. Set-up for back-to-back calibration of accelerometers

rocal performance of one of them. One is the accelerometer to be calibrated and the other, the reciprocal transducer, is the Velocity Coil of the 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 $\pm 0,5\%$.

In the back-to-back comparison calibration (see Fig.15), the accelerometer to be calibrated is vibrated on the Vibration Exciter Type 4809 together with a reference accelerometer, for instance the 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 4143. This measurement

can be performed with a resolution of approximately 0,02%. Then, knowing the sensitivity of the reference accelerometer, it is very easy to calculate the sensitivity of the unknown. The Type 8305 and Type 2626 is available as Calibration Set Type 3506, where both instruments have been calibrated together to eliminate cumulative errors.

Specifications 4143

MICROPHONE CALIBRATION CIRCUIT AND COUPLERS																													
<p>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</p> <p>Accuracy of Reciprocity Calibration: For a 1" condenser microphone, such as Type 4160, the over-all accuracy is approximately $\pm 0,05$ dB at low and middle frequencies, decreasing to about $\pm 0,1$ dB at 10 kHz</p> <p>Reproduceability of Reciprocity Calibration: Typically $\pm 0,02$ dB for a 1" microphone such as B & K Type 4160</p> <p>Frequency Range of Couplers: 3,4 cm³ coupler DB 1392</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 50%;">Filled with</th> <th style="width: 50%;">Max. Frequency</th> </tr> </thead> <tbody> <tr> <td>Air</td> <td>10 kHz</td> </tr> <tr> <td>Hydrogen</td> <td>20 kHz</td> </tr> </tbody> </table>	Filled with	Max. Frequency	Air	10 kHz	Hydrogen	20 kHz	<p style="text-align: center;">20 cm³ coupler DB 1388</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr> <th style="width: 50%;">Filled with</th> <th style="width: 50%;">Max. Frequency</th> </tr> </thead> <tbody> <tr> <td>Air</td> <td>1 kHz (2,8 kHz*)</td> </tr> <tr> <td>Hydrogen</td> <td>3,5 kHz (10 kHz*)</td> </tr> </tbody> </table> <p style="text-align: center; font-size: small;">* with wavemotion correction</p> <p>Capillary Tubes: Correction for 2 capillary tubes at 250 Hz:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr> <th style="width: 30%;">Coupler Volume</th> <th style="width: 35%;">3,4 cm³</th> <th style="width: 35%;">20 cm³</th> </tr> </thead> <tbody> <tr> <td>Air</td> <td>-0,031 dB</td> <td>-0,0053 dB</td> </tr> <tr> <td>Hydrogen</td> <td>-0,008 dB</td> <td>-0,0018 dB</td> </tr> </tbody> </table> <p style="text-align: center; font-size: small;">Length: 50 mm \pm 0,1 mm Inner Diameter: 0,335 mm \pm 0,02 mm</p> <p>Polarization Voltage: 200 V DC Long term stability: Approximately $\pm 0,05\%/1000$ h Adjustment range: ± 5 V with a resolution of 0,02% Output Impedance: 30 kΩ (rear panel output)</p>	Filled with	Max. Frequency	Air	1 kHz (2,8 kHz*)	Hydrogen	3,5 kHz (10 kHz*)	Coupler Volume	3,4 cm ³	20 cm ³	Air	-0,031 dB	-0,0053 dB	Hydrogen	-0,008 dB	-0,0018 dB	<p>Preamplifier Input: B & K standard 7-pin input socket</p> <p>OSCILLATOR INPUT (TRANSMITTER/ACTUATOR switch in "Transmitter" mode) Input Impedance: 20 kΩ Maximum Input Voltage: 40 V_{pp} (14 V RMS)</p> <p>Limiters: Clipping Limit: 14 V RMS (40 V_{pp}) Maximum Current: 100 mA peak</p> <p>INSERT GAIN Adjustment Range: 0 to + 2 dB Calibrated: 0 dB \pm 0,003 dB</p> <p>Reference Capacitors: (The reference capacitors are individually adjusted with a dummy microphone mounted on the 4143 and include circuit and stray capacitance)</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 60%;">"Coupler Volume" Switch</th> <th style="width: 40%;">Reference Capacitor</th> </tr> </thead> <tbody> <tr> <td>"3 cm³"</td> <td>4,7456 nF</td> </tr> <tr> <td>"20 cm³"</td> <td>27,9545</td> </tr> </tbody> </table>	"Coupler Volume" Switch	Reference Capacitor	"3 cm ³ "	4,7456 nF	"20 cm ³ "	27,9545
Filled with	Max. Frequency																												
Air	10 kHz																												
Hydrogen	20 kHz																												
Filled with	Max. Frequency																												
Air	1 kHz (2,8 kHz*)																												
Hydrogen	3,5 kHz (10 kHz*)																												
Coupler Volume	3,4 cm ³	20 cm ³																											
Air	-0,031 dB	-0,0053 dB																											
Hydrogen	-0,008 dB	-0,0018 dB																											
"Coupler Volume" Switch	Reference Capacitor																												
"3 cm ³ "	4,7456 nF																												
"20 cm ³ "	27,9545																												
ELECTROSTATIC ACTUATORS																													
<p>Frequency Range: (with compressor regulation)</p> <p>50 V RMS: actuator signal voltage 20 Hz to 12,5 kHz \pm 0,05 dB 10 Hz to 25 kHz \pm 0,10 dB 5 Hz to 50 kHz \pm 0,20 dB 5 Hz to 100 kHz \pm 0,30 dB 2 Hz to 200 kHz \pm 0,60 dB</p> <p>100 V RMS: actuator signal voltage 20 Hz to 12,5 kHz \pm 0,10 dB 10 Hz to 25 kHz \pm 0,20 dB 5 Hz to 50 kHz \pm 0,40 dB 5 Hz to 100 kHz \pm 0,60 dB 2 Hz to 200 kHz \pm 1,0 dB</p>	<p>Equivalent Sound Pressure Level: Maximum 104 dB SPL (10 V RMS input voltage to 4143 and 800 V DC polarization voltage)</p> <p>Polarization Voltage: 800 V DC Adjustment Range: ± 50 V</p> <p>OSCILLATOR INPUT: (TRANSMITTER/ACTUATOR switch in "Actuator" mode) Input Impedance: 3 kΩ Maximum Input Voltage: 10 V RMS (14 V_p)</p>	<p>ACTUATOR COMPRESSOR output: Output Impedance: < 1 Ω Maximum Capacitive Load: 200 pF Compressor Voltage: -6 dB below OSCILLATOR INPUT voltage</p> <p>ACTUATOR OUTPUT: Output Impedance: 1 kΩ</p> <p>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</p>																											

SOUND SOURCE

Frequency Range:
(with Condenser Microphone Type 4160)
200 Hz to 1000 Hz

Sound Pressure Level:
(with Condenser Microphone Type 4160)

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

* re 2×10^{-5} Pa

** Accuracy does not include accuracy on 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:
(20 Hz to 20 kHz)
± 0,05 dB (typical)

Maximum Ratio between Input Voltages:
Inputs A and B: 20 dB
Inputs A₂ and B₂: ± 0,2 dB

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

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

Input voltages (Inputs A₂ and B₂) necessary to center the pointer of Level Meter

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

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
Center 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 A₁ and B₁)

Approximately 1 Ω

Input Impedance from External Filters:

(Sockets A₂ and B₂)

Approximately 100 MΩ//50 pF

Input Impedance:

(Sockets A and B)

Approximately 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 R 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 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:

- 1 Coaxial Cable AO 0013
- 1 Power Cord AN 0010
- 1 Test Lead AQ 0100
- 1 Standard IEC R 327
- 1 Standard IEC R 402
- 1 Short Connection Plug JN 0005
- 2 Short Connection Plug JP 0149

1 Mahogany Case KE 0072 containing:

- 1 1" Microphone Preamplifier Type 2627
- 1 Adaptor JJ 2612
- 1 Screwdriver QA 0001
- 1 1" Condenser Microphone Cartridge Type 4160

1 Set of Microphone Calibration Accessories UA 0473 consisting of:

- 1 Mahogany Case KE 4143 containing:
- 1 Calibration Chart BC 0091
- 1 1" Electrostatic Actuator UA 0023

- 1 1/2" Electrostatic Actuator UA 0033
- 1 Microphone Tube-Wrench QA 0076
- 1 20 cm³ IEC Coupler DB 1388
- 1 3,4 cm³ IEC Coupler DB 1392
- 1 Set DB 1433 consisting of one 1 cm³ Coupler DP 0099 and one 1,4 cm³ Volume Expansion Ring YO 1804
- 1 Coupler Adaptor Ring DB 0111
- 1 1/2" — 1" Adaptor DB 0225
- 1 1/4" — 1/2" Adaptor DB 0264
- 1 1/8" — 1/2" Adaptor DB 0900
- 3 Dust Caps DZ 9025
- 1 Set DB 1774 of 3 Coupler Adaptor Rings DB 0111
- 1 1" Spring Yoke Assembly UA 0464
- 1 1/2" Spring Yoke Assembly UA 0463
- 1 Adaptor UA 0028
- 1 Stand for UA 0028, DB 1689
- 1 Set of Capillary Tubes UA 0465
- 1 Set of Capillary Tubes UA 0467
- 1 Set of Steel Plugs UA 0462
- 1 1" Isolation Insert Ring DB 0159
- 1 1/2" Isolation Insert Ring DB 0301
- 2 Contact Extension Plugs DB 0158
- 2 Contact Extension Plugs DB 0327
- Various lamps and fuses