

# Measuring Microphones, Studio Microphones, Hydrophones and Accessory Equipment

Types 4129, 4155 and 4176

## Prepolarized Condenser Microphone Cartridges

### FEATURES:

#### Type 4129

- Free-field frequency response from 6,5 Hz to 8 kHz  $\pm 2$  dB
- Dynamic range from 13,5 dB(A) noise floor to 142 dB (3% distortion limit)

#### Type 4155

- Free-field frequency response from 4 Hz to 16 kHz  $\pm 2$  dB
- Dynamic range from 14,5 dB(A) noise floor to 146 dB (3% distortion limit)

#### Type 4176

- Free-field frequency response from 6,5 Hz to 12,5 kHz  $\pm 2$  dB
- Dynamic range from 13,5 dB(A) noise floor to 142 dB (3% distortion limit)

#### Common

- Sensitivity 50 mV/Pa (-26 dB re 1 V/Pa)

Prepolarized Condenser Microphones Types 4129, 4155 and 4176 are high-quality,  $\frac{1}{2}$ " diameter, free-field microphones which complement the existing range of externally polarized B & K Condenser Microphones for accurate and reliable sound measurements. The microphones utilize a fixed charge-carrying polymer layer which eliminates the need for an external polarization voltage.

Type 4129 is intended for use in noise measurement systems fulfilling IEC 651, Type 2 and ANSI S1.4-1971, Type 2\* (the latter when fitted with the Random Incidence Corrector DZ 9566 supplied). It is acoustically equivalent to the externally polarized Microphone 4130, although of higher sensitivity. Type 4129 is used with Integrating Sound Level Meters Types 2225 and 2226.

Type 4155 is a precision measurement microphone which is acoustically equivalent to the externally polarized  $\frac{1}{2}$ " Condenser Microphone Type 4165 and is intended for sound measure-

- No external polarization voltage required
- Artificially aged for long term stability
- Very wide operating temperature range
- Low ambient temperature coefficient
- Well defined operating characteristics
- Supplied with individual calibration chart
- Robust construction
- High resistance to humidity

### USES:

- In noise measurement systems to:
  - IEC 651, Type 1 (Types 4155 and 4176)
  - IEC 651, Type 2 (Type 4129)
  - ANSI S1.4-1971, Type 1\* (Type 4176 with Random Incidence Corrector DZ 9566 supplied)
  - ANSI S1.4-1971, Type 2\* (Type 4129 with Random Incidence Corrector DZ 9566 supplied)



ments in accordance with IEC 651, Type 1. Type 4155 is fitted to Precision Integrating Sound Level Meters Types 2230 and 2233 which fulfil the requirements of IEC Draft Proposal for Integrating Sound Level Meters Type 1 (Peak), IEC 651 Type 1 (Impulse) and ANSI S1.4-1971 Type 1\*. These portable instruments offer measurement of a wide range of parameters and have provision for connection of Octave Filter Set Type 1624 and  $\frac{1}{3}$  -  $\frac{1}{1}$  Octave Filter Set Type 1625.

Type 4176 is a precision measurement microphone and is primarily intended for use with B & K Precision Integrating Sound Level Meters

Types 2221/22 (fulfilling IEC Draft Proposal for Integrating Sound Level Meters Type 1P and relevant sections of IEC 651, Type 1) and Precision Sound Level Meter Type 2232 (IEC 651, Type 1). When fitted with the Random Incidence Corrector DZ 9566 supplied, ANSI S1.4-1971, Type 1\* is fulfilled.

From the users viewpoint there are two potentially important advantages which can be gained by dispensing with the external polarization voltage. Firstly, there is a saving in power consumption and space, desirable in portable instruments. Secondly, the reliability of the associated preamplifier is improved in humid and polluted at-

\* and proposed revision of this standard

mospheres. Together with the robust construction of the microphones, these factors make the Prepolarized Condenser Microphone particularly suitable for field measurements, both outdoors and in industrial environments.

## General Description

### Construction

The method of construction of the Microphones results in reliable transducers of high sensitivity and low temperature dependence. During manufacture, the cartridges are artificially aged at a high temperature to ensure good long term stability. Static pressure equalization between the internal cavity and the atmosphere takes place at the rear of the cartridge via a vent whose size determines the lower limiting frequency. Rear venting permits the use of a Dehumidifier for operation in especially humid environments.



Fig. 2. 1/2" Microphones Types 4129, 4176 and Random Incidence Corrector DZ 9566



Fig. 3. 1/2" Microphone Type 4155 with protection grid removed. The diaphragm is flat and practically flush with the housing. This allows frequency response calibration to be performed using the Electrostatic Actuator UA 0033



Fig. 1. Precision Sound Level Meter Type 2232; Integrating Sound Level Meters Types 2225/26; Precision Integrating Sound Level Meters Types 2221/22, 2230/33; and Filter Sets Types 1624 (1/1 octave) and 1625 (1/3 - 1/1 octave)

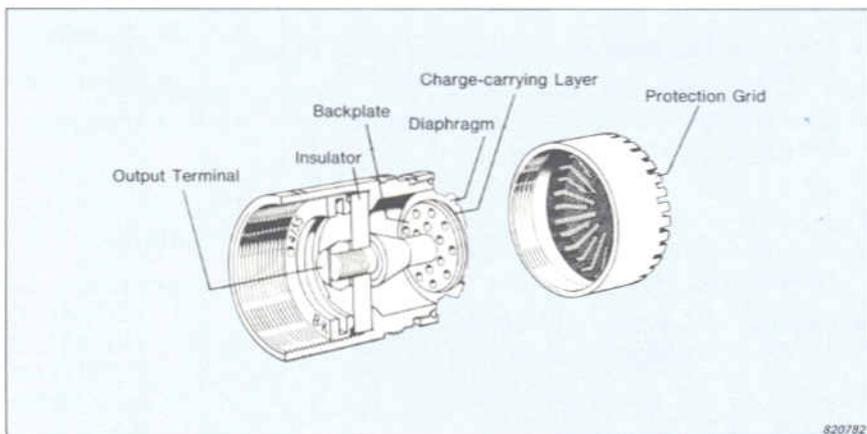


Fig. 4. Sectional view of Prepolarized Condenser Microphone Type 4155

Types 4129 and 4176, shown in Fig. 2., are of similar basic construction. The cartridge is polarized by a fixed charge-carrying layer which is deposited on the microphone backplate. This layer is negatively charged, resulting in a positively increasing output voltage for a positively going incident sound pressure at low frequencies. The nickel diaphragm is coated with an extremely thin polymer film which adds little overall mass, but affords good protection

against corrosion. Both Types are fitted with a non-removable protection grid which is internally fitted with a

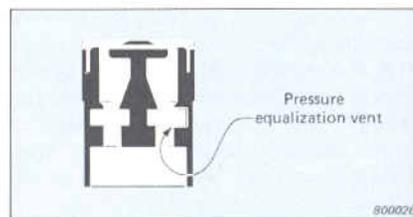


Fig. 5. Rear vented microphone cartridge



Fig. 6. Microphone and Preamplifier combinations

gauze filter to prevent dust and particle penetration to the diaphragm. The protection grid fitted to Type 4129 is finished in a wear resistant, matt black chrome. For use under diffuse field conditions, the Microphones are supplied with a Random Incidence Corrector DZ 9566 (Fig. 2.) which is fitted over the normal protection grid.

A sectional view of Type 4155 is shown in Fig. 4. The backplate, which carries the negatively charged pre-polarized layer, and the main body housing are made of Monel, a corrosion resistant high nickel alloy, while the diaphragm is pure nickel and is coated with a protective quartz film. The insulator is silicone treated synthetic sapphire to ensure good electrical insulation and long-term dimensional stability. The Microphone is delivered with a removable protection grid which is fitted with an internal gauze filter.

### Preamplifiers

The Microphones are designed to be used with a preamplifier, such as 1/2" Preamplifier Type 2619, which acts as an impedance converter and onto which the Microphones may be fitted directly (Fig. 6). Type 2619 employs a field effect transistor to achieve high input impedance with low inherent noise. The Preamplifier has a nominal gain of -0.06 dB and is powered from a 120 V DC supply, for example by direct connection to the seven-pin preamplifier input socket on B & K measuring amplifiers and analyzers. When using Pre-polarized Condenser Microphones with a preamplifier and power supply normally used to supply 200 or 28 V microphone polarization, it is essential to ensure that the polarization voltage is grounded (see sections "Power Supplies" and "Notes on Practical Use"). Further information concerning the characteristics of the Preamplifier can be found in the separate Product Data sheet for the 2619, which is available on request.

### Microphone/Preamplifier Assembly Response

All data given for the Microphones in this data sheet are open circuit, which means that the cartridge looks into an infinitely high impedance. In practice, however, the Microphones are used with a preamplifier which influences the response of the assembly. The size of this influence depends on the preamplifier input capacitance, the capacitance of the Microphone (and adaptor, if used), the load due to extension cables used between the assembly and associated analysis equipment, and the attenuation of the preamplifier itself. The overall response

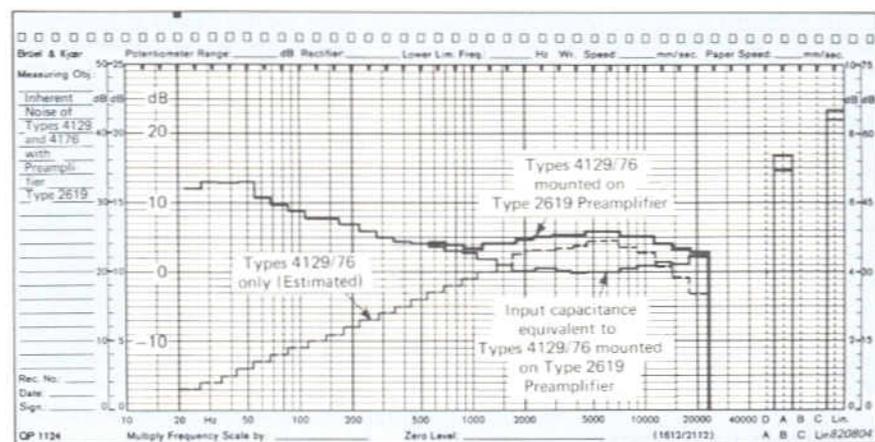
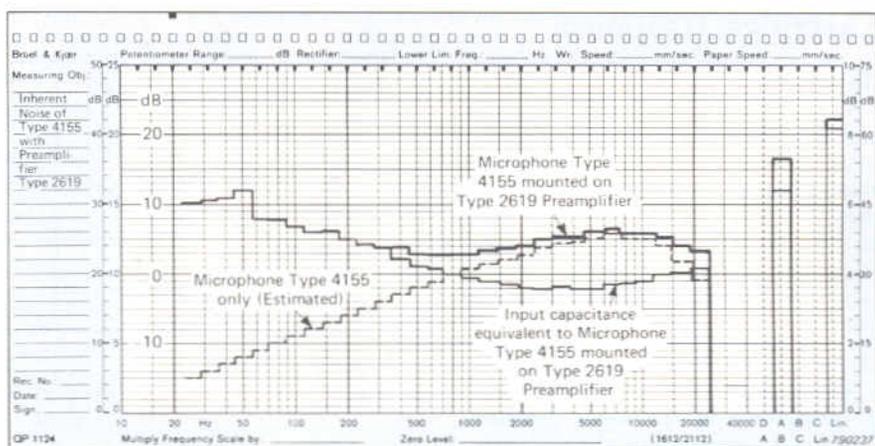


Fig. 7. 1/3 octave noise spectra for Types 4129, 4155 and 4176 using Preamplifier Type 2619. Noise spectra for the cartridges alone were calculated using measured data

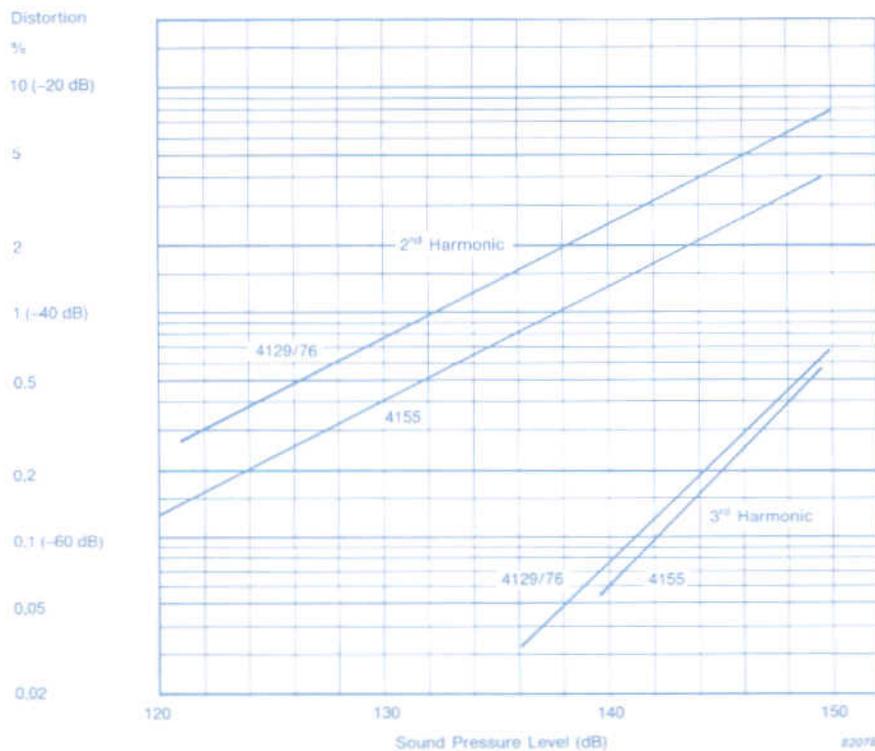


Fig. 8. Distortion characteristics of the Microphones at high sound pressure levels

of the assembly is found by adding the open circuit response for the Microphones to the response of the pre-

amplifiers, given in the respective data sheets.

# Cartridge Response

## General

The Cartridges have wide dynamic and frequency ranges and high sensitivity and stability. The operating characteristics are well defined and all three Microphones are delivered with an individual calibration chart. The Type 4155 calibration chart also contains an individual frequency response curve.

## Dynamic Range

The dynamic range of a microphone is determined at the lower pressure limit by a combination of the microphone inherent noise and preamplifier noise for a given frequency bandwidth, and at the high pressure limit by distortion (general taken at 3%). Below approximately 1 kHz the preamplifier noise is dominant, while above 1 kHz the inherent noise of the cartridge dominates.  $1/3$  octave noise spectra for the Microphones are shown in Fig. 7. The distortion characteristics of the Microphones at high sound pressure levels are given in Fig. 8. The dynamic ranges of the Microphone/Preamplifier combinations are shown in Fig. 9.

## Free-Field Corrections

The free-field corrections, which represent the change in sound pressure caused by diffraction of sound waves around the microphone because of its own presence in the sound field, only become significant when the wavelength is comparable with the external dimensions of the microphone, i.e. at higher frequencies. The free-field correction curves for angles of incidence at  $30^\circ$  intervals are given in Fig. 10. The addition of these values for the stated angles to the electrostatic actuator response gives the free-field frequency response at that angle. The random response (the response of the microphone to sound equally incident from all angles) is obtained by a weighted summation of the responses at various angles and is also shown in Fig. 10.

## Frequency Response

All three B & K Prepolarized Condenser Microphones are free-field microphones, i.e. they are designed so that the damping of the high frequency response is such that when the  $0^\circ$  incidence, free-field correction is added to the pressure response characteristic, the resulting free-field response is frequency independent to the highest possible frequency. The  $0^\circ$  incidence frequency responses of the Microphones are thus made as wide and flat as possible. Typical  $0^\circ$  incidence free-field and random incidence fre-

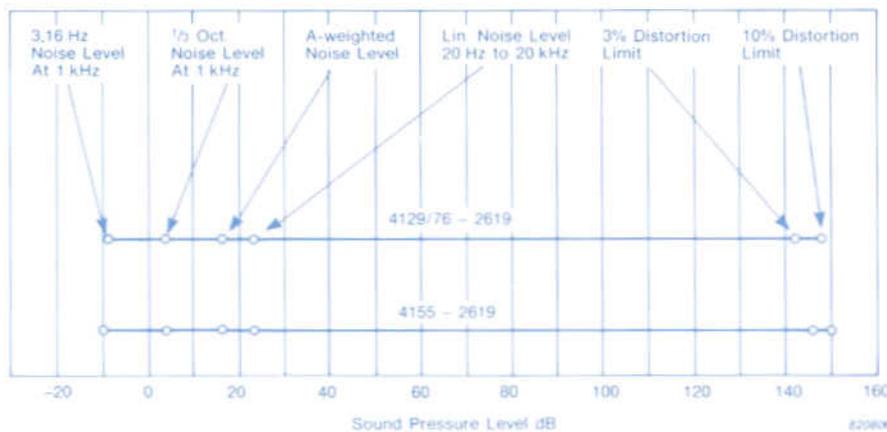


Fig. 9. Dynamic ranges of the Microphone/Preamplifier combinations. The upper limit is given for two degrees of distortion, while typical lower limits are given for various bandwidths of the measuring equipment. The limits for 3,16 Hz and  $1/3$  octave bandwidths are valid at 1 kHz only

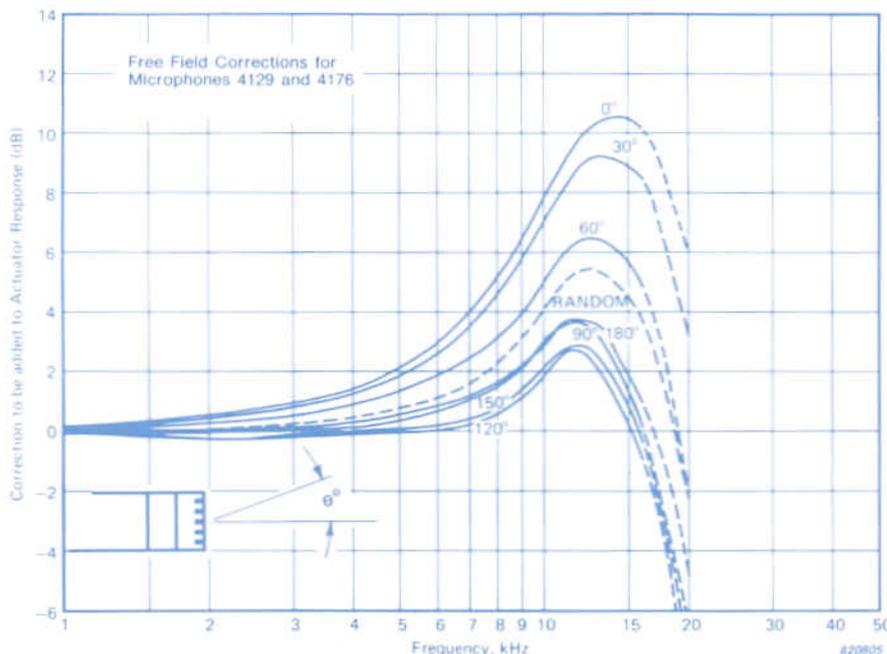
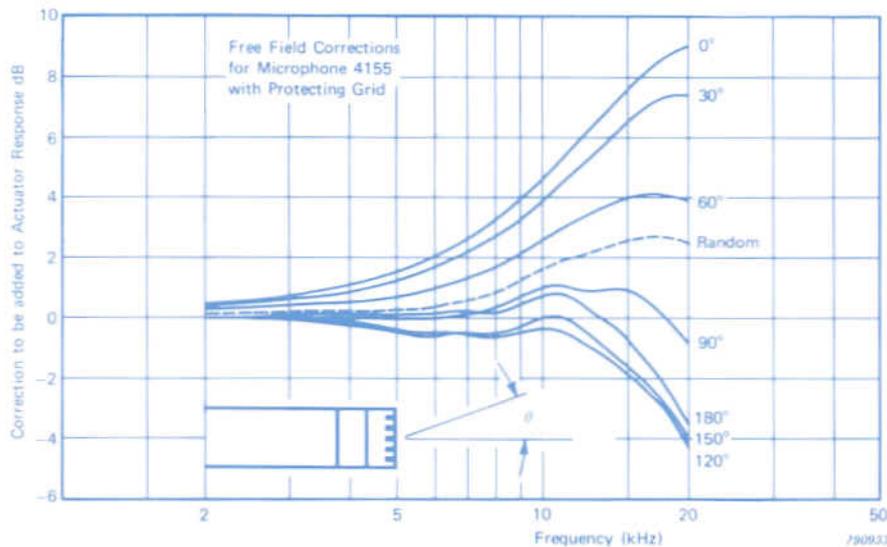


Fig. 10. Free-field correction curves for the Microphones

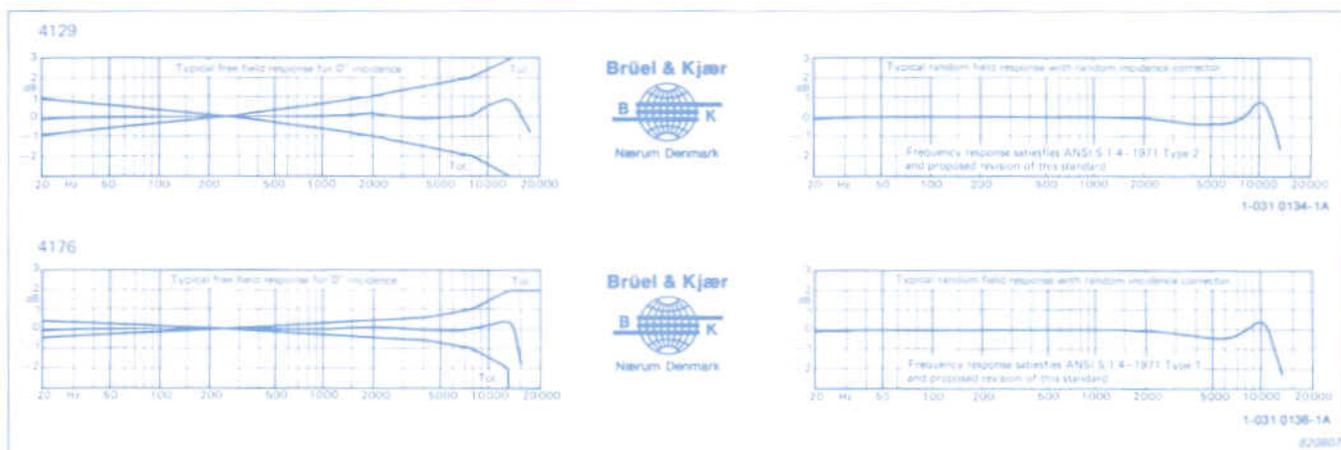


Fig. 11. Typical frequency response curves for Types 4129 and 4176 as shown on the reverse side of the calibration charts supplied with the Microphones

quency responses for Types 4129 and 4176 are shown in Fig. 11. The frequency response of Type 4155 is shown in Fig. 12.

The well defined, lower limiting frequency of the Microphones is obtained by careful design and adjustment of the equalization vent size.

### Individual Calibration

The calibration chart which is delivered with each microphone cartridge contains all the parameters required for correct use of the microphone. Type 4155 is, in addition, supplied with individual frequency response curves as shown in Fig. 12. The pressure response is obtained using the electrostatic actuator method, and the 0° incidence free-field response is obtained by adding the 0° incidence free-field correction to this pressure (actuator) response.

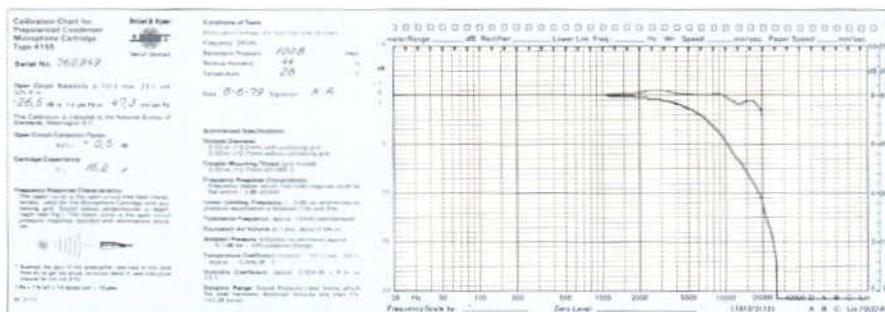


Fig. 12. Individual calibration chart delivered with Type 4155

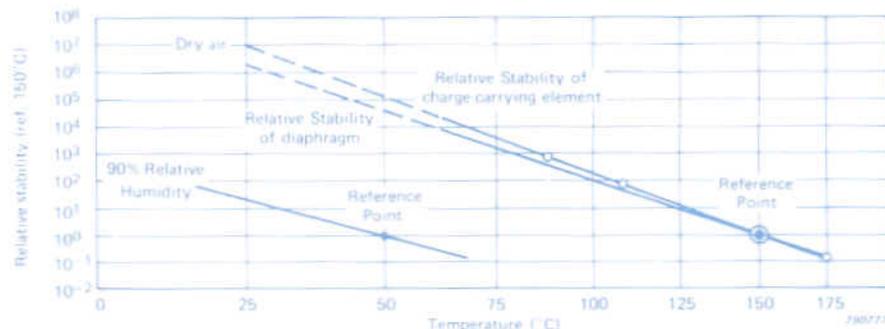


Fig. 13. Relative stability of the Microphones

## Long Term Stability

### Temperature Effects

The sensitivity of a microphone changes slowly but permanently over a long period of time for two reasons. Firstly, relaxation of the diaphragm tension gives rise to an increase in sensitivity. This process is influenced by the external environment, e.g. temperature. Secondly, loss of charge from the charge-carrying (electret) material results in a decrease in sensitivity. The two processes tend to work in opposition, but normally the effect of decreased diaphragm tension is dominant. The combined rate of sensitiv-

ity change is greater at higher temperatures and is normally specified for comparison purposes at a temperature of 150 °C. For Type 4155 this stability coefficient is better than 1 dB for 40 minutes. The long term stability is highly temperature dependent and improves markedly as the temperature decreases. Extrapolating the stability - temperature curve to normal room temperatures gives a stability of approximately 1 dB in 400 years. This excellent stability is obtained by arti-

ficially ageing the microphone during manufacture.

### Humidity Effects

High humidity, like high temperature, causes a slow but permanent loss of sensitivity due to loss of charge in the charge-carrying material. This effect is minimized by artificially ageing the Microphones in a humid environment. The long-term stability of the Microphones in humid environments is also shown in Fig. 13.

## Short Term (Environmental Stability)

### Temperature Effects

Ambient temperature variations cause a reversible change in sensitivity

(Fig. 14). This is due to the differential expansion of the various components of the microphone which results

in small changes in the backplate-diaphragm distance and the diaphragm tension. Careful thermal matching of

the microphone materials have kept this effect to a minimum.

The frequency response also changes with temperature, as shown in Fig. 15 for Type 4155. This is partly due to the differential expansion mentioned above, and partly due to a change in damping, especially in the region of the diaphragm resonance, brought about by temperature dependent changes in the viscosity of the air.

### Humidity Effects

Type 4155 exhibits a reversible, short term sensitivity change which is dependent on humidity (Fig. 16). However, for measurements in any given location, this effect is unlikely to be of significance. The effect is due to moisture absorption by the protective quartz coating on the Type 4155 diaphragm.

## Use with Other B & K Instruments and Accessories

A number of instruments are available for optimum utilization of the Microphones. Some of these are mentioned in this section and further details can be obtained from individual data sheets and the B & K publication "Condenser Microphones and Microphone Preamplifiers". This book gives an extensive discussion of construction, parameters, calibration, wind-screening, environmental effects and accessories.

### Calibration Equipment Types 4220, 4230 and UA 0033

For accurate calibration of a complete sound measuring system including the microphone, either in the laboratory or in the field, the Pistonphone Type 4220 or the Sound Level Calibrator Type 4230 can be used (Fig. 17). Both calibrators are battery operated and easy to use.

The Pistonphone produces a nominal sound pressure level of 124 dB ( $\pm 0.2$  dB) at 250 Hz and 1013 mbar. The factory calibration chart supplied is accurate to  $\pm 0.15$  dB and the high stability of the Type 4220 makes it suitable for laboratory use.

The Sound Level Calibrator Type 4230 produces a nominal sound pressure level of 94 dB at 1000 Hz and is calibrated with an accuracy of 0.3 dB. It is especially suitable for field use with A-weighted Sound Level Meters which have no applied weighting at 1 kHz.

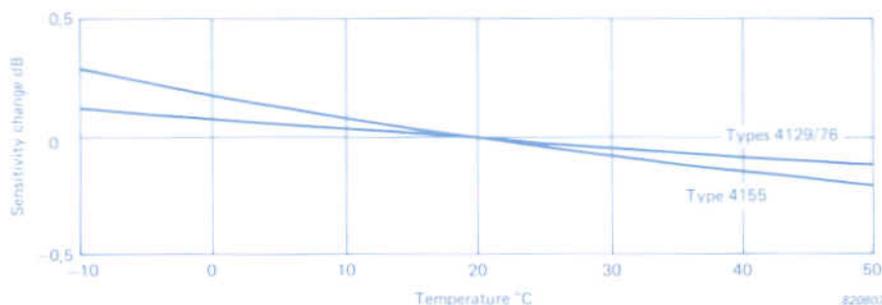


Fig. 14. Typical effect of temperature on sensitivity of Microphone Type 4155

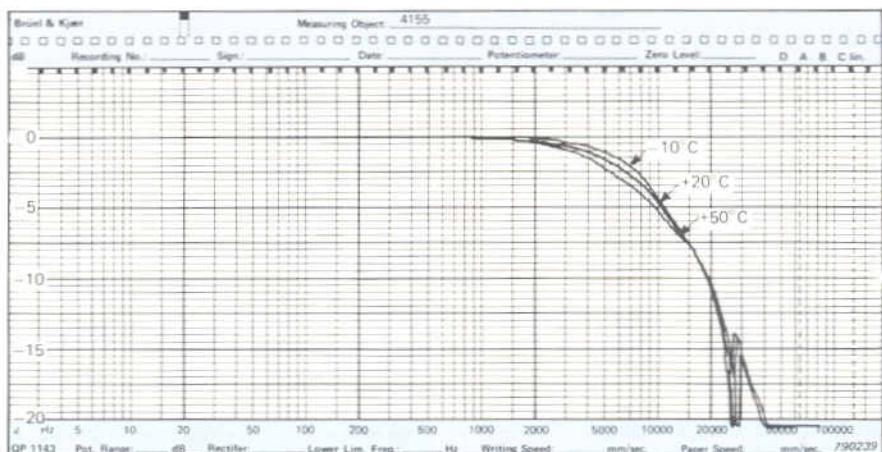


Fig. 15. Effect of temperature on the pressure response of Type 4155

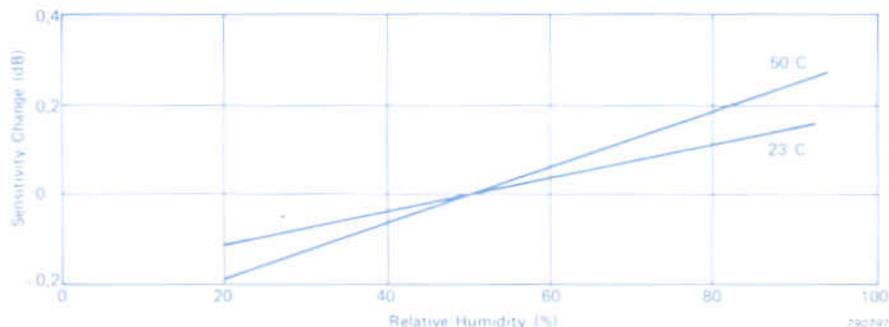


Fig. 16. Short-term reversible effect of humidity on Type 4155



Fig. 17. Pistonphone Type 4220 and Sound Level Calibrator Type 4230



Fig. 18. Microphone Accessories

The 1/2" Electrostatic Actuator UA 0033 can be used, with suitable equipment, for frequency response calibration of Type 4155.

### Windscreens, Turbulence Screen and Nose Cone

A range of windscreens is available for reduction of wind-induced noise when measurements are made outdoors. Windscreen UA 0570 is a foam windscreen with anti-bird spikes intended for use with permanent outdoor installations. Windscreens UA 0237 (90 mm diameter) and UA 0459 (65 mm diameter) are spherical foam windscreens for use in shorter-term outdoor applications. They are available in sets of six under order numbers UA 0254 and UA 0469 respectively. Nose Cone UA 0386 is available for use with Type 4155 at higher wind velocities. The Turbulence Screen UA 0436 is designed to attenuate turbulence noise when measuring in wind tunnels, air ducts, etc. These accessories are shown in Fig. 18. Note that the Nose Cone and Turbulence Screen are only applicable to Type 4155.

### Dehumidifier UA 0308

Designed to fit between the microphone cartridge and the preamplifier, the Dehumidifier UA 0308 (Fig. 19) contains a silica gel which effectively dries the air inside the cartridge for use in especially humid environments. A small window in the body of the Dehumidifier allows the moisture content of the silica gel to be checked. The gel changes colour from blue (dry state) to red (saturated) and may be dried out by heating at relatively low temperatures (approximately 100 °C)



Fig. 19. Dehumidifier UA 0308

### Power Supplies

Although no external polarization voltage is required by the Microphones, a power supply is necessary for the preamplifier.

Preamplifier Type 2619 requires a 150 V (2 mA) supply which is available by direct connection to the seven-pin preamplifier input socket on the

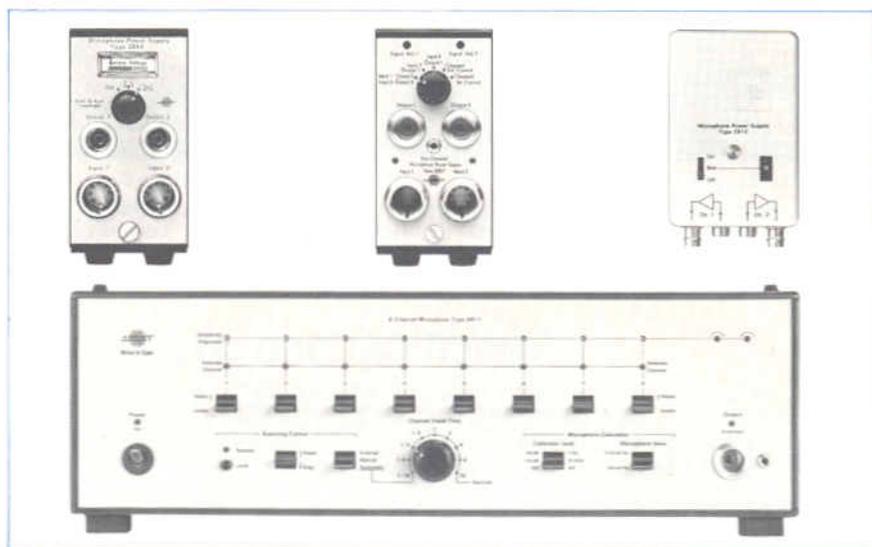


Fig. 20. Power Supplies Types 2804, 2807, 2810 and Eight Channel Multiplexer Type 2811

B & K range of measuring amplifiers and frequency analyzers. For other applications or operation with other equipment, the assembly may be powered from the Two Channel Microphone Power Supplies Type 2804 and 2807. Type 2619 may also be powered from a 28 V (0.5 mA) supply with modified specifications.

Type 2804 is powered from internal batteries and is therefore especially suitable for field measurements.

Eight Channel Multiplexer Type 2811 can supply the necessary powering voltages for up to eight microphone/preamplifier assemblies. Manual, automatic or external remote scanning can be selected.

**Note** that when using a Pre-polarized Condenser Microphone, it is essential that the preamplifier connection which would normally supply the microphone polarization voltage is grounded. This is to ensure that the polarization voltage is equal to zero and is not able to float. Removing the lead from the source is not sufficient; it must be grounded at the supply (see Fig. 21).

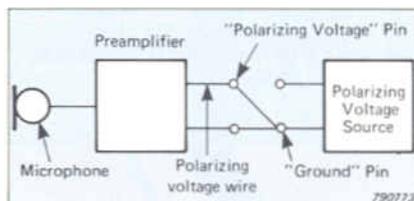


Fig. 21. Diagram of preamplifier showing correct connection for using Pre-polarized Condenser Microphone Cartridges

### Notes on Practical Use

Many of the Measuring Amplifiers and Analyzers available from Brüel & Kjær allow 0, 28 or 200 V polarization to be selected. In order to ensure a zero polarization voltage when using power supplies which do not have this facility, the following procedures are necessary:

When using the Microphone Preamplifier Type 2642 (described in sepa-

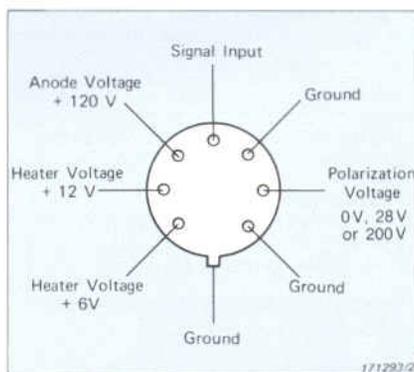


Fig. 22. View of the standard B & K seven-pin plug. Soldering side of plug shown

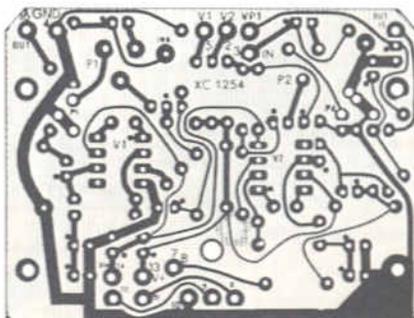


Fig. 23. Circuit board of Microphone Power Supply Type 2810

rate data sheet) and Adaptor JP 0713 combination, the connection to pin 2 (yellow wire) of the five-pin socket of the JP 0713 must be removed and replaced by a direct connection from pin 2 to either of the "Ground" pins of the seven-pin plug. See Fig. 22.

When using Preamplifier Type 2619, the wire from the pin labelled

"Polarization Voltage" in Fig. 22, should be unsoldered and resoldered to either of the "Ground" pins.

When using Microphone Power Supply Type 2810, remove the cover and unscrew the single countersunk screw in the square support post to allow removal of the amplifier from the case. On the circuit board, unsol-

der the wire from the terminal labelled "VP1" and resolder it to the terminal labelled "GND", shown in Fig. 23.

Other instruments which are to be used with Pre-polarized Condenser Microphones should be returned to the supplier to make the necessary adjustments.

## Specifications 4129, 4155, 4176

TYPES 4129 AND 4176:		
<p><b>OPEN CIRCUIT SENSITIVITY AT 250 Hz:</b> 50 mV/Pa (-26 ± 2 dB re 1 V/Pa)</p> <p><b>FREQUENCY RESPONSE:</b> <b>0° Incidence Free-Field Response:</b> Type 4129: 6,5 Hz to 8 kHz (± 2 dB). In accordance with IEC 651, Type 2 Type 4176: 6,5 Hz to 12,5 kHz (± 2 dB). In accordance with IEC 651, Type 1 <b>Random Response:</b> Type 4129: In accordance with ANSI S 1.4 - 1971, Type 2* when fitted with Random Incidence Corrector DZ 9566 Type 4176: In accordance with ANSI S 1.4 - 1971, Type 1* when fitted with Random Incidence Corrector DZ 9566</p> <p><b>LOWER LIMITING FREQUENCY (-3 dB):</b> 0,5 to 5 Hz</p> <p><b>PRESSURE EQUALIZATION TIME CONSTANT:</b> 0,32 to 0,032 s (Back vented)</p> <p><b>DIAPHRAGM RESONANCE FREQUENCY (90° PHASE SHIFT):</b> 12,5 kHz</p> <p><b>CAPACITANCE AT 250 Hz:</b> 12,5 pF</p>	<p><b>THERMAL NOISE:</b> 1,1 μPa/√Hz <b>A-weighted:</b> 13,5 dB <b>Lin.:</b> 14,5 dB</p> <p><b>UPPER LIMIT OF DYNAMIC RANGE:</b> 142 dB (3% distortion limit)</p> <p><b>SAFETY LIMIT:</b> 156 dB (peak)</p> <p><b>EQUIVALENT AIR VOLUME:</b> 50 mm<sup>3</sup></p> <p><b>OPERATING TEMPERATURE RANGE:</b> up to +100 °C (+212 °F) up to +70 °C (+158 °F) when fitted with Random Incidence Corrector DZ 9566</p> <p><b>AMBIENT TEMPERATURE COEFFICIENT:</b> -0,004 dB/°C Mean for the range -10 °C to +50 °C</p> <p><b>LONG TERM STABILITY AT 20 °C:</b> &gt;250 years/dB</p> <p><b>INFLUENCE OF STATIC PRESSURE:</b> -0,002 dB/mbar</p>	<p><b>INFLUENCE OF 1 m/s<sup>2</sup> AXIAL VIBRATION:</b> Typically 60 dB equivalent SPL</p> <p><b>INFLUENCE OF 80 A/m, 50 Hz MAGNETIC FIELD:</b> Typically 30 dB equivalent SPL</p> <p><b>INFLUENCE OF HUMIDITY:</b> &lt;0,1 dB in the absence of condensation</p> <p><b>DIMENSIONS:</b> <b>Overall Diameter with Protection Grid:</b> 13,2 mm <b>Cartridge Housing Diameter:</b> 12,7 mm <b>Height:</b> 14,9 mm <b>Diameter with Corrector DZ 9566:</b> 14,35 mm <b>Height with Corrector DZ 9566:</b> 16,7 mm</p> <p><b>ACCESSORIES INCLUDED:</b> Random Incidence Corrector ..... DZ 9566</p> <p><b>ACCESSORIES AVAILABLE:</b> Preamplifier ..... Type 2619 Sound Level Calibrator ..... Type 4230 Pistonphone ..... Type 4220 Dehumidifier ..... UA 0308 Six Windscreens (UA 0237) ..... UA 0254 Six Windscreens (UA 0459) ..... UA 0469</p>
TYPE 4155:		
<p><b>OPEN CIRCUIT SENSITIVITY AT 250 Hz:</b> 50 mV/Pa (-26 ± 2 dB re 1 V/Pa)</p> <p><b>FREQUENCY RESPONSE:</b> <b>0° Incidence Free-Field Response:</b> 4 Hz to 16 kHz (± 2 dB) In accordance with IEC 651, Type 1</p> <p><b>LOWER LIMITING FREQUENCY (-3 dB):</b> 1 to 3 Hz</p> <p><b>PRESSURE EQUALIZATION TIME CONSTANT:</b> 0,16 to 0,053 s (Back vented)</p> <p><b>DIAPHRAGM RESONANCE FREQUENCY (90° PHASE SHIFT):</b> 14 kHz</p> <p><b>CAPACITANCE AT 250 Hz:</b> 15 pF</p> <p><b>THERMAL NOISE:</b> 1,2 μPa/√Hz <b>A-weighted:</b> 14,5 dB <b>Lin.:</b> 15,5 dB</p>	<p><b>UPPER LIMIT OF DYNAMIC RANGE:</b> 146 dB (3% distortion limit)</p> <p><b>SAFETY LIMIT:</b> 160 dB (peak)</p> <p><b>EQUIVALENT AIR VOLUME:</b> 40 mm<sup>3</sup></p> <p><b>OPERATING TEMPERATURE RANGE:</b> up to +150 °C (+302 °F)</p> <p><b>AMBIENT TEMPERATURE COEFFICIENT:</b> -0,006 dB/°C Mean for the range -10 °C to +50 °C</p> <p><b>LONG TERM STABILITY AT 20 °C:</b> &gt;400 years/dB</p> <p><b>INFLUENCE OF STATIC PRESSURE:</b> -0,001 dB/mbar</p> <p><b>INFLUENCE OF 1 m/s<sup>2</sup> AXIAL VIBRATION:</b> Typically 60 dB equivalent SPL</p>	<p><b>INFLUENCE OF 80 A/m, 50 Hz MAGNETIC FIELD:</b> Typically 30 dB equivalent SPL</p> <p><b>INFLUENCE OF HUMIDITY:</b> 0,004 dB/%RH</p> <p><b>DIMENSIONS:</b> <b>Diameter with Protection Grid:</b> 13,2 mm <b>Cartridge Housing Diameter:</b> 12,7 mm <b>Height with Protection Grid:</b> 17,3 mm <b>Height without Protection Grid:</b> 16,2 mm</p> <p><b>ACCESSORIES AVAILABLE:</b> Preamplifier ..... Type 2619 Sound Level Calibrator ..... Type 4230 Pistonphone ..... Type 4220 Dehumidifier ..... UA 0308 Turbulence Screen ..... UA 0436 Nose Cone ..... UA 0386 Windscreen ..... UA 0570 Six Windscreens (UA 0237) ..... UA 0254 Six Windscreens (UA 0459) ..... UA 0469</p>

\* and proposed revision of this standard