Product Data

Condenser Microphone — Type 4179
Microphone Preamplifier — Type 2660

System for very-low-level sound measurements

USES:

0 Hearing research

0 Monitoring of very low background noise levels

0 Sound power measurement of very-low-level sources

0 Distanced measurement of very-low-level compressor, fan or motor noise where close measurements are impaired by wind-induced noise

FEATURES:

0 Very low inherent noise floor of -2,5dB (A) . (-7 to -16dB in the '/s-octave bands 20 Hz to 20 kHz)

0 High sensitivity: 1 V/Pa

0 Frequency response in accordance with IEC 651, Type 1

0 Microphone individually calibrated

0 Well-defined operating characteristics

Condenser Microphone Type 4179 and Microphone Preamplifier Type 2660 constitute a unique system for measuring sound pressures well below the nominal 0dB re 20 μPa reference level for acoustic measurements. The 1/3-octave bandwidth inherent noise floor of the complete system at 1 kHz is typically -16dB.

The frequency response of the combined microphone and preamplifier system ranges from 7Hz to 12,5 kHz +2, -3dB and is in accordance with IEC 651, Type 1 requirements. High sensitivity, low inherent noise and well-defined operating characteristics, make the system suitable for a wide range of applications: from laboratory hearing research and quality assurance measurements in anechoic chambers, to industrial measurements of very low-level machine noise.

Condenser Microphone Type 4179 is supplied with a calibration chart which includes individually measured frequency responses, sensitivity and inherent noise.

Brüel & Kjær has developed the 1" Condenser Microphone Type 4179 and Microphone Preamplifier Type 2660 system for measuring ultra-low sound pressure levels. High-quality, conventional 1" condenser microphones, such as B&K Types 4144 and 4145, and half-inch diameter Types 4165 and 4166, provide for the majority of noise measurements to IEC, IS0 and ANSI standards. However, for measurements around the 20 μPa reference pressure, a very low noise floor in the 1/3-octave bands between 20Hz and 20 kHz is needed. The microphone and preamplifier system, with a noise floor of typically -2,5dB(A), provides for this area without compromising the useful frequency range and omnidirectivity of a microphone intended for precision measurements. With narrow-band analysis, the noise floor falls to approximately -16dB for 1/3-octave bandwidth at 1 kHz, and -34dB for 3,16Hz bandwidth at 1 kHz. The system is thus well-suited to both laboratory and industrial applications ranging from hearing research to the measurement of very-low-level machine noise.

System Description

Introduction

The system for very low-level sound measurements comprises Type 4179, the Type 2660 and a 1/2" to 1" Adaptor DB0375. Type 2660 is presented in a mahogany case designed with space for the Type 4179 and adaptor, so that the system may be stored together (see main picture). Type 4179, also has its own mahogany case (which fits in the larger case) for seperate storage when required. The microphone is supplied with its own calibration chart, and a plastic cover for protecting the diaphragm from dust when the microphone is not in use.

Microphone Preamplifier Type 2660, while designed especially for use with Type 4179, may also be used with other microphones. It has a function selector which is set to "4179 +20dB" for Type 4179, and either "Lin. 0dB" or "Lin. +20dB" for other condenser microphones. Fig. 1 shows the settings in a simplified block diagram of Type 2660. It accepts l/2" microphones directly and 1" types via the supplied adaptor DB0375. Adaptors are also available for fitting 1/4" and l/8" diameter microphones*.

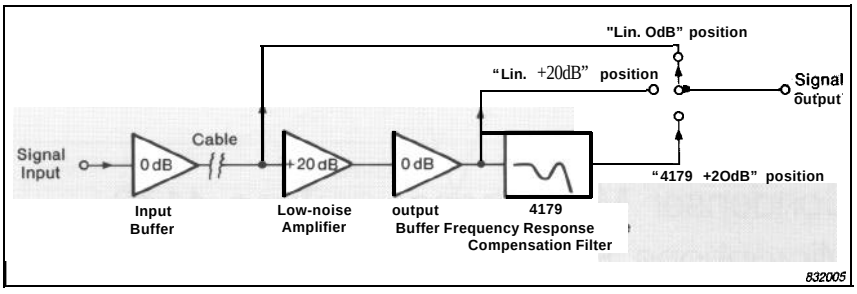

Fig. 1. Simplified block diagram of Type 2660, showing the signal path in each of the three operation modes

Type 2660 may be connected to the range of B&K Frequency Analyzers and Measuring Amplifiers via their 7-pin preamplifier input socket. The necessary preamplifier voltages for the power supply, heater supply and microphone polarization are provided via this socket (see Specifications). Adaptor JE0002 is available for connection to the deeper preamplifier input socket of earlier B&K instruments.

Frequency Response — Individual Calibration

The very low inherent noise of Type 4179 is achieved by reducing the acoustic resistance of the diaphragm damping system. This reduction causes a resonance peak in the frequency response (at approximately 7 kHz) because the diaphragm resonance is underdamped. To compensate for this, the Preamplifier Type 2660, has a special filter built-in for use with the 4179. The filter produces a linear frequency response for the complete system (within ± 2dB from 10Hz to 10kHz).

*For details of use of the 2660 with microphones other than Type 4179, see separate Product Data for Microphone Preamplifiers Types 2633, 2639, 2645 and 2660

Inherent Noise of Condenser Microphone Systems

In acoustic circuits, as in electrical networks, thermal noise arises as a result of damping mechanisms, or resistances. These result in an effective equivalent noise pressure given by the equation:

$$\overline{p^2} = \int_{f_1}^{f_2} 4KTR\,df$$

where $\overline{p^2}$ is the mean value of the squared equivalent noise pressure, K is Boltzmann's constant, T is the absolute temperature, R is the acoustic resistance and the definite integral is evaluated over frequency limits f_1 and f_2.

Condenser microphones have two internal sources of noise: the damping mechanism behind the diaphragm, R_1, and the acoustic resistance of the pressure equalization vent, R_2. Externally, the acoustic impedance, Z_a, loading the diaphragm on the outside, has a real part, R_a, which also produces thermal noise. A corresponding loading impedance exists at the outside of the pressure equalization vent, but the effect is very small and can be neglected. The most serious noise generator is the dominant acoustic impedance associated with the diaphragm damping system, R_1. The inherent noise of the transducer can thus be minimized by reducing R_1.

This approach has been adopted in the design of B&K Condenser Microphone Type 4179. A damping resistance approximately forty times lower than that of conventional 1" microphones has been achieved with a corresponding reduction in noise of 16dB. Since it is not possible to reduce the diaphragm mass and stiffness proportionally, the cartridge frequency response is changed significantly; the primary resonance of the diaphragm system is underdamped causing a peak at the diaphram resonance of 7 kHz. To compensate for this, the Preamplifier Type 2660, has a special filter built-in for use with the 4179. The filter produces a linear frequency response for the complete system (within ± 2dB from 10Hz to 10kHz).

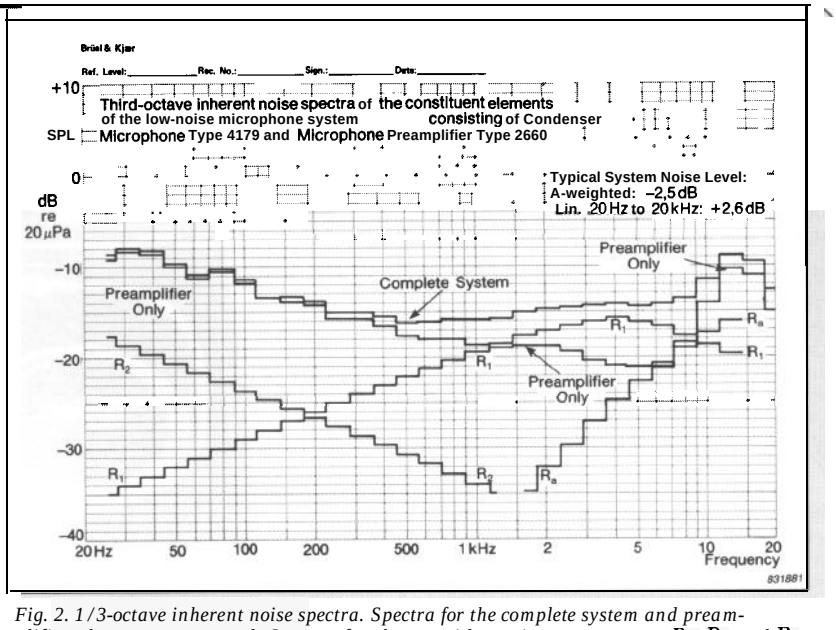

Fig. 2. 1/3-octave inherent noise spectra. Spectra for the complete system and preamplifier alone are measured. Spectra for the cartridge noise generators R_1, R_2 and R_a have been calculated

Third-octave noise spectra of the elements comprising the system are shown in Fig. 2. The spectra for the preamplifier alone and the complete system are measured spectra, while those for the individual noise generators of the cartridge are calculated. With the large reduction in R_1, the real part of the external ioad impedance R_a becomes a relatively significant noise generator at high frequencies. The inherent noise of the system is typically -2,5 dB(A).

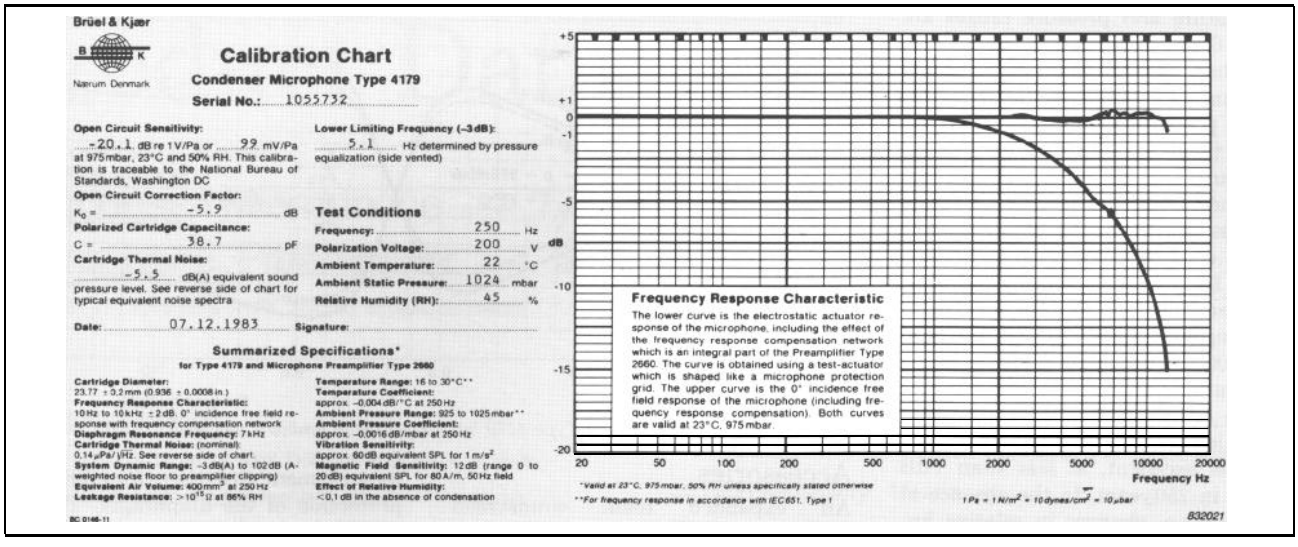

Fig. 3 Calibration chart supplied with Type 4179

sate for the resonance peak, a filter is built into Type 2660, so that the complete system has a linear 0° incidence free-field response. The system can thus be used in accordance with IEC 651, Type 1, for the angles of incidence specified in the standard (0° to 30° and 0" to 90°).

An example of the calibration chart for the 4179 is shown in Fig.3. The lower curve is the electrostatic actuator response. The upper curve is the 0° incidence free-field response which is obtained by adding the 0° incidence free-field correction to the actuator response. Both curves include the effect of the compensation filter built into the 2660. The calibration chart also includes individually measured values of sensitivity, inherent noise and other relevant data for the 4179.

Free-field correction curves for the 4179 are given in Fig.4. These show the pressure increase caused by the presence of the microphone itself in the sound field. The free-field response at a specified angle of incidence can then be obtained by adding the relevant free-field correction to the actuator response. The microphone is sensitive to objects placed close to it*.

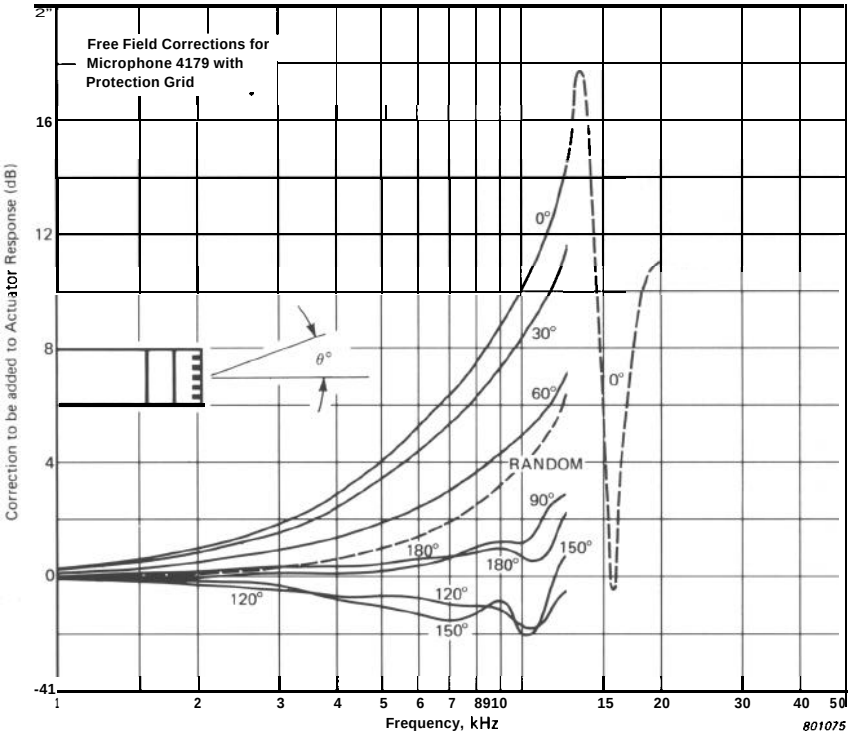

Fig. 4. Free-field correction curves for Microphone Type 4179

Upper Limit	<3% distortion	102dB
Lower Limit	Lin. 20 Hz to 20 kHz	+2,6 dB
	A-weighted Level	–2,5 dB
	1/3 octave at 1 kHz	–16 dB
	3,16 Hz at 1 kHz	-34dB

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Table 1. Dynamic range of the assembly

Dynamic Range

The dynamic range of the assembly is shown in Table 1. The lower limits indicate the system noise floor for different bandwidths of the associated measurement equipment. Note that the lower limits for l/s-octave and 3,16Hz bandwidths are valid at 1 kHz only. (Third-octave spectra are shown in Fig.2.) The upper limit indicates the 3% distortion limit.

When used with Type 4179, the maximum input voltage of the 2660 is 0,25V RMS which corresponds to a maximum SPL of 102dB re 20 μPa (105dB peak). Since the system frequency response is limited above 14 kHz, the effect of capacitive loading on the preamplifier output due to extension cables can be neglected. The maximum output current of the preamplifier should not be exceeded, as the signal will be distorted.

Environmental Considerations

For frequency response in accordance with IEC 651, Type 1 the ambient

* Electrostatic actuator calibration using UA 0023 is not possible. Random Incidence corrector and nose cones impair the frequency response of the microphone

temperature and pressure ranges are from 16 to 30°C and from 925 to 1025 mbar, respectively. Fig. 5 shows the change in sensitivity for temperature or pressure variations over these ranges. (Ambient temperature or pressure variations cause a shift in the resonance frequency of the cartridge and thus affect the frequency response of the combined system). With extended frequency response tolerances, the operating temperature and pressure ranges are from -10 to +50°C and from 800 to 1040mbar. The operating temperature range of the preamplifier is from -20 to +60°C.

The long-term stability of the cartridge is excellent, at less than 1dB change in 250 years. In the absence of condensation, changes in relative humidity affect the cartridge sensitivity by less than 0,ldB.

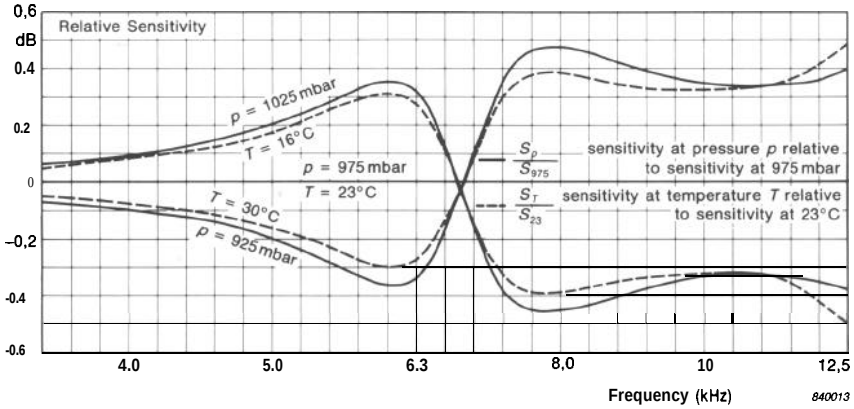


Fig. 5. Relative sensitivity of Type 4179 for variations in ambient temperature and pressure

Accessories

An expanded foam windscreen UA0207 is available for use outdoors or in very dusty environments. This windscreen may also be used in other measurement situations for additional protection of the diaphragm. The effect of the windscreen on the frequency response of the microphone is small, within ±1 dB up to 10 kHz.

Specifications 4179, 2660

Note: Data given here refer to use of Type 2660 with Type 4179. For details of use with other condenser microphones, please refer to the separate Product Data available for Types 2633, 2639, 2645 and 2660.

Cartridge data valid at 23°C. 975 mbar, 50% RH unless specifically stated otherwise.

FREQUENCY RESPONSE*:
In accordance with IEC 651, Type 1:
14Hz to 4kHz ±1 dB**
10 Hz to 10 kHz ± 2 dB**
7 Hz to 12,5 kHz + 2, -3dB"
Cartridge Lower Limiting Frequency*:
-3dB point at 5 to 7 Hz, determined by pressure equalization system (side vented)

SENSITIVITY:
System: nominally 1 V/Pa (0 dB re 1 V/Pa)
Cartridge*: nominally 100 mV/Pa at 250 Hz (-20dB re 1 V/Pa)
Preamplifier Gain: 20dB ±0,1dB

INHERENT NOISE:
Cartridge Thermal Noise: 0,14 μPa/√Hz.
A-weighted*: –5,5 dB(A) including R_a**
Lin. 20 Hz to 20 kHz: –3,5 dB including R_a**
Preamplifier Equivalent Input Noise:
Typically 1,1 μV A-weighted with 50 pF connected to preamplifier input
Total System Noise: See Fig.2.
A-weighted: –2,5 dB.
Lin. 20 Hz to 20 kHz: 2,6 dB

PREAMPLIFIER INPUT:
Input Impedance: 36 GΩ‖0,3 pF
Maximum Input Voltage: 0,25 V RMS

PREAMPLIFIER OUTPUT:
Output Impedance: 50 Ω
Maximum Output Voltage: 2,5 V RMS sine (unloaded)

* Individually calibrated

Maximum Output Current: 7mA peak

UPPER LIMIT OF DYNAMIC RANGE:
Cartridge Open Circuit Distortion Limit:
<3% at 100 Hz at 140 dB re 20 μPa.
Safety limit: 154dB peak
Upper Limit of System: 102 dB re 20 μPa

SENSITIVITY TO VIBRATION:
Cartridge: 20 mPa/ms^{-2} or 60dB equivalent SPL at 1 ms^{-2} (f < 1 kHz)
Preamplifier: 400 μV or 46dB equivalent SPL at 1 ms^{-2}

SENSITIVITY TO MAGNETIC FIELDS:
Cartridge: Typically 12 dB (range: 0 to 20dB) equivalent SPL for 50 Hz, 80Alm field
Preamplifier: 4 μV or 6dB equivalent SPL for 50 Hz, 80 A/m field

OPERATING TEMPERATURE RANGE:'
Preamplifier: -20 to +60°C (-4 to +140°F)
Cartridge: +16 to +30°C (+61to +86°F)***
-10 to +50°C (+14 to +122°F) with extended frequency response tolerances
Cartridge Temperature Coefficient: –0,004 dB/°C at 250 Hz, mean for the range -10 to +50°C

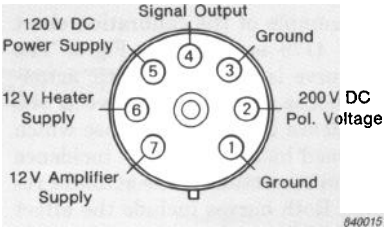
AMBIENT PRESSURE RANGE:
925 to 1025 mbar***
600 to 1040mbar with extended frequency response tolerances
Cartridge Ambient Pressure Coefficient: –0,0016 dB/mbar at 250 Hz

ADDITIONAL CARTRIDGE DATA:
Resonance Frequency: 7 kHz
Polarization Voltage: 200V
Polarized Capacitance*: 40 pF at 250 Hz
Equivalent Air Volume: 400 mm^3 at 250 Hz

**with frequency response compensation network built into Type 2660

Sensitivity To Changes In Relative Humidity: <0,1 dB in the absence of condensation
Long Term Stability: >250 years/dB at 20°C

POWERING: See Figure below



soldering side of plug JP0715 shown

DIMENSIONS:
Cartridge: ø 23,77 × 25mm with protection grid (0 23,77 × 23mm without).
Grid and Preamplifier Mounting Threads: 23,11 – 60 UNS
Preamplifier Input Stage: ø 12,7 x 83mm
Preamplifier Output Stage: 025 x 175mm

ACCESSORIES INCLUDED TYPE 2660:
Coaxial Input Adaptor ..... JJ 2617
½" to 1" Adaptor ..... DB 0375

ACCESSORIES INCLUDED TYPE 4179:
Protective Dust Cap ..... DZ 9025

ACCESSORIES AVAILABLE:
Set of 6 Windscreens UA 0207 . . UA 0253
Measuring Amplifiers ..... Types 2610, 2636
Cables (3, 10, 30 m) AO0027/28/29
Tape Cable .... AR 0001
Adaptor ..... JE 0002

*** for system frequency response in accordance with IEC 651, Type 1

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