

# Microphones, Hydrophones and Preamplifiers

types 8100, 8101, 8103 and 8104

## Hydrophones

### FEATURES:

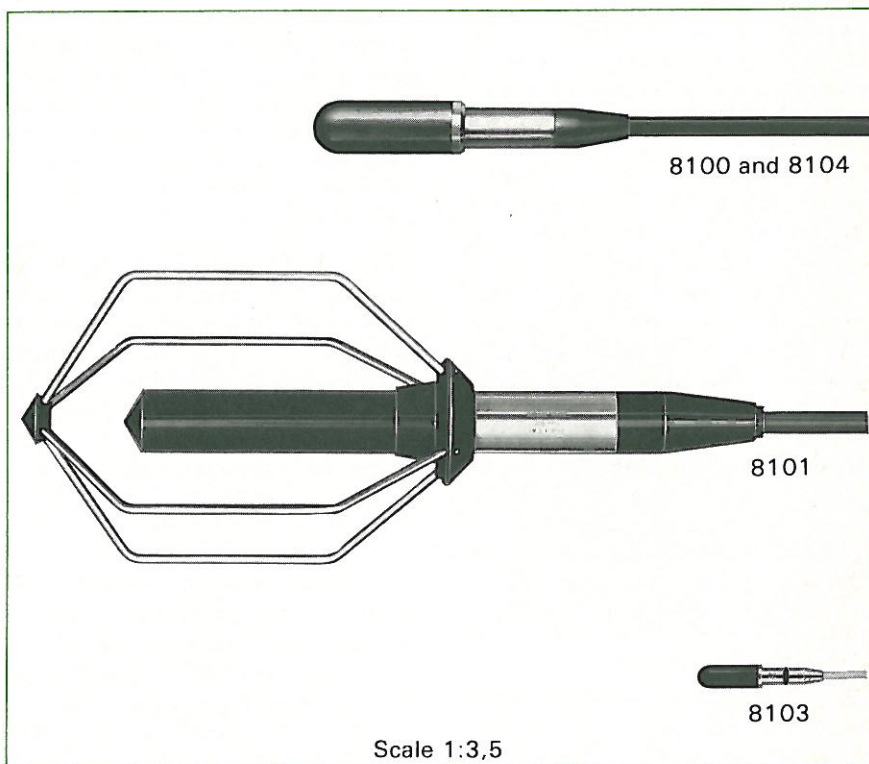
- Frequency ranges from 0,1 Hz to 200 kHz
- Individually calibrated
- Flat frequency response over wide range
- Omnidirectional over wide frequency range
- Receiving-sensitivity calibration traceable to NBS
- Working pressure up to 40 ato (400 m (1300 ft) ocean depth)
- Shielded-element construction
- Monel-metal body and exposed parts for corrosion resistance
- Absolutely waterproof synthetic-rubber moulded construction

### ADDITIONAL FEATURES 8100 and 8104:

- Working temperature  $-40^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$
- Usable as underwater acoustic transmitter
- Low-noise low-capacitance integral cable to MIL-C-915A

### ADDITIONAL FEATURES 8101:

- Built-in solid state preamplifier
- Provision for insert-voltage calibration
- Inherent noise level well below sea-state zero and close to Wenz's lowest ambient



- Working temperature  $-10^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$
- Protective cage included
- Low-noise low-capacitance cable to MIL-C-915A
- Electrostatic shield

### ADDITIONAL FEATURES 8103:

- Very wide frequency range 0,1 Hz to 200 kHz
- Very small size ( $50 \times 9,5$  mm)
- $-3$  dB limit in air at 15 kHz
- Double-shielded low-noise integral cable
- Working temperature  $-40^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$

### USES:

- Waterborne-sound measurements
- Calibration reference standard
- Ultrasonic measurements in liquids
- Investigation of marine-animal noise
- Laboratory and industrial measurements in liquids and gases
- Sound measurements in water tanks
- Underwater projectors (8100, 8103 and 8104)
- Educational experiments
- Noise measurements in humid and polluted atmospheres

The Brüel & Kjær range of waterborne-sound transducers consists of the following:

The **Standard Measuring Hydrophones Types 8100 and 8104** are wide-range waterborne-sound transducers for making absolute sound measurements over the frequency range 0,1 Hz to 125 kHz with a receiving sensitivity of  $-205$  dB re  $1$  V/ $\mu$ Pa. Each type can also be used as a sound transmitter (projector) which makes them ideal for calibration purposes either by the reciprocity method or by the calibrated-projector method.

The **General Purpose Hydrophone Type 8101** is a wide-range waterborne-sound transducer for making absolute sound measurements over the frequency range 1 Hz to 125 kHz with a receiving sensitivity of  $-184$  dB re  $1$  V/ $\mu$ Pa. A built-in high-quality low-noise FET preamplifier acts as an impedance converter to provide a non-inverted signal suitable for transmission over long underwater cables. The built-in preamplifier of the 8101 features an insert-voltage calibration facility, but does not allow the hydrophone to be used as a projector.

The **Miniature Hydrophone Type 8103** is a small-size high-sensitivity waterborne-sound transducer for making absolute sound measurements over the frequency range 0,1 Hz to 200 kHz with a receiving sensitivity of  $-211$  dB re  $1$  V/ $\mu$ Pa. It has a high sensitivity relative to its size and good all-round characteristics which make it generally applicable to laboratory, industrial and educational use. The 8103's high-frequency response will be specially valuable when making acoustic investigations on marine animals, and for example in the measurement of the pressure-distribution patterns in ultrasonic-cleaning baths.

The four B & K hydrophones are piezoelectric transducers, i. e., they use piezoelectric ceramics as sensing elements. The piezoelectric sensing element and its internal supporting structure are permanently bonded into a sound-transparent polychloroprene-rubber boot. The support body of the hydrophone is made of Monel metal (Ni-Cu-Al-Fe

alloy), which has extremely high corrosion resistance to virtually all hostile environments, and very good antifouling properties when immersed in seawater.

The internal support, made in brass, is mechanically and electrically isolated from the monel housing, (the internal support and the monel housing of the 8103 are electrically connected at the plug end of the cable), coupled only through the synthetic rubber, thus providing vibration isolation of the sensing element. The hydrophones are fitted with an integral cable, the shield of which is connected to the internal support, thus providing electrical shielding for the sensing element.

The Hydrophone Type 8100 is equipped with an integral 6 m low-noise cable and waterproof extension connector. A 1,2 m termination cable with waterproof connector on one end and a B & K JP 0106 standard plug on the other end is included. The cable used is of the highest quality and conforms to the MIL-C-915A standard.

The Hydrophone Type 8104 is identical to the 8100 except that it has a 10 m integral cable terminated with a B & K JP 0106 plug, and no accessories are supplied. It is thus not possible to insert waterproof extension cables.

The Hydrophone Type 8101 is equipped with a 6 m waterblocked-to-MIL-C-915A-standard low-noise cable fitted with a waterproof connector. A 1,2 m termination cable is included, fitted with a waterproof connector at one end and a B & K JP 0701 7 pin standard plug on the other end, suitable for direct connection to the PREAMP. socket of the B & K range of measuring amplifiers, spectrometers and frequency analyzers.

Extension cables are available with moulded waterproof connectors for the 8100 and 8101.

The Miniature Hydrophone Type 8103 is fitted with a 6 m integral double-shielded cable terminated with a B & K miniature plug JP 0056 and in cases of high electromagnetic interferences, a metal screen can be clamped onto the

Monel support. This support is connected internally to the outer shield of the cable which is connected to the inner shield of the terminating plug end of the cable. When this connection has to be broken to isolate the fluid surrounding the hydrophone from the signal ground, the 8103 should be used with a transformer-coupled output preamplifier such as the Type 2626.

These special measures have been taken to obtain good electrical shielding enabling the use of the hydrophones in air, and in water tanks where the electrical potential of the water is different from the ground potential, as well as in cases of high electromagnetic interference.

A schematic drawing, showing the principle of construction of a piezoelectric hydrophone, is shown in Fig.1.

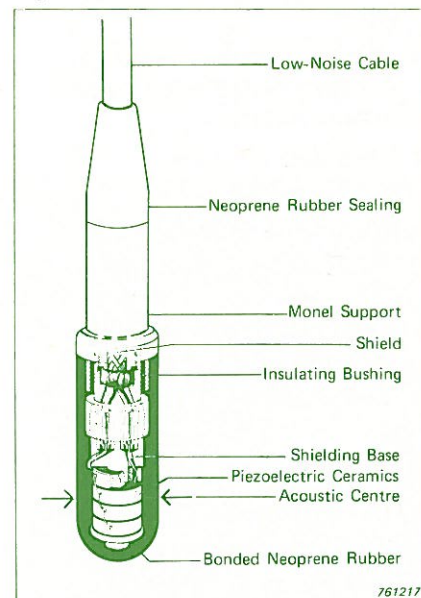


Fig.1. Schematic drawing of hydrophone construction

The typical frequency responses of the hydrophones are shown in Fig.2. These are measured in free-field conditions achieved by means of pulse technique using a Type 4440 in a reflective water tank.

Each B & K hydrophone is submitted to an extensive ageing and temperature stabilizing procedure before being individually calibrated. Their individual calibration data and frequency response curves are supplied. The receiving sensitivity calibration of the B & K Hydrophones is traceable to NBS.

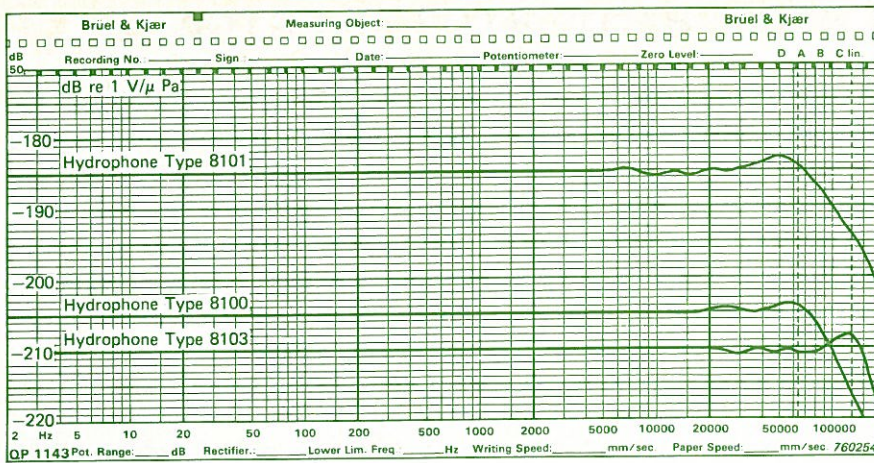


Fig.2. Typical receiving frequency characteristics of the Hydrophones Types 8100, 8101, 8103, and 8104

The hydrophones have very good omnidirectional characteristics. The typical directivity patterns of the hydrophones in water are shown in Fig.3. Again, these polar directivity patterns have been measured in free-field conditions achieved by means of gating techniques in a reflective water tank.

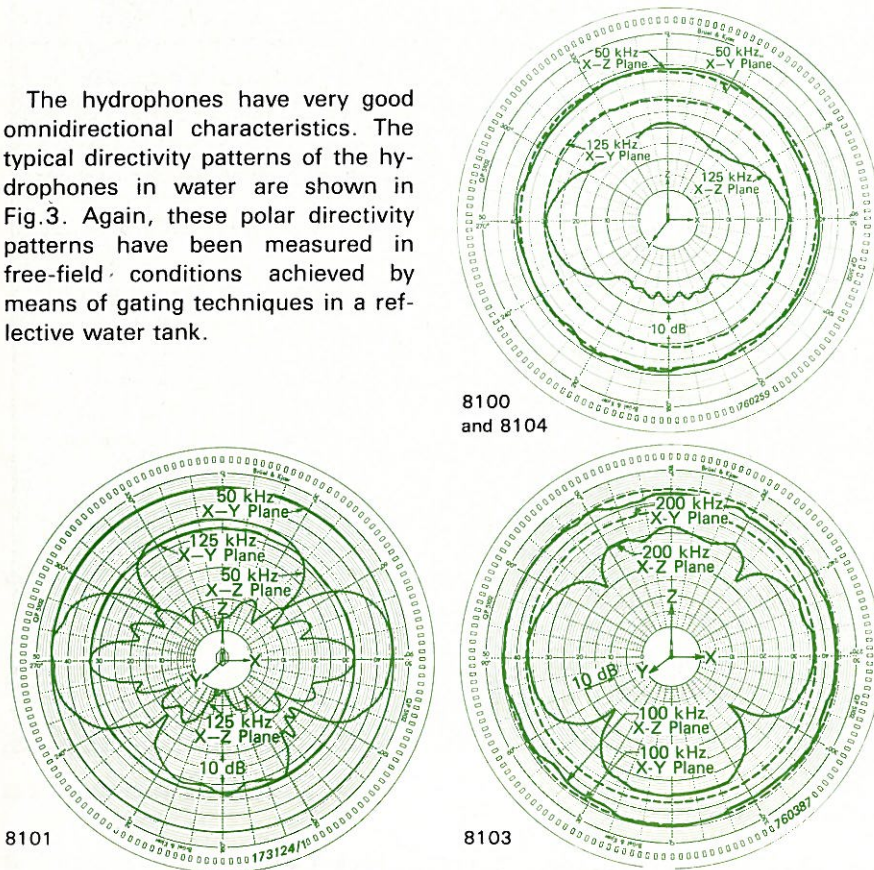


Fig.3. Typical directivity patterns of the Hydrophones Types 8100, 8101, 8103, and 8104

The piezoelectric effect of the sensing element is reversible, i. e., mechanical excitation causes an electrical output, and conversely, an applied alternating voltage causes corresponding mechanical excitation. Therefore the Hydrophones Types 8100, 8103, and 8104 (but not the Hydrophone Type 8101 because of its built-in preamplifier), can be used as sound transmitters (projectors), both for measurement and reciprocity calibration. The transmitting responses to voltage for the Hydrophones Types 8100,

8103, and 8104 in water are shown in Fig.4. Note the 12 dB/octave slope of the transmitting response to voltage which is typical for piezoelectric hydrophones.

Before onward transmission to the measuring instrumentation the high-impedance output signal from the Hydrophones Types 8100, 8103, and 8104 should be routed through a signal-conditioning amplifier. Although the entire B & K range of accelerometer preamplifiers is suitable, the use of the Condi-

tioning Amplifiers Types 2626, 2628, 2635 and 2650 is particularly recommended. These preamplifiers feature a dial-in sensitivity adjustment to give convenient output values, for example 0,1 or 1 V/Unit, and have a wide frequency range, and adjustable low-pass and high-pass filters. Note that the 2635 is portable, being battery powered. For technical details of these preamplifiers, the reader is referred to their respective product data sheets.

The Hydrophone Type 8101 features a built-in solid-state preamplifier which acts as an impedance converter. The output signal does not require further conditioning, and by means of the connection cable AO 0111, the 8101 can be directly plugged into the Preamplifier socket of the B & K range of measuring amplifiers, frequency analyzers and real-time analyzers.

When hydrophones are used as sound transmitters (projectors), the driving signal requires power amplification. The B & K Power Amplifier Type 2713 has been especially designed for driving the Hydrophones Types 8100, 8103, and 8104 used as projectors, but is also useful for driving other highly reactive loads. The 2713 is a low-noise 100VA power amplifier with a frequency range extending from 10 Hz up to 200 kHz, and a gain continuously adjustable between 0 and 60 dB over six 10 dB ranges. It also features selectable maximum output voltage limits as well as extensive protective functions to prevent damage both to the amplifier and the the transducer.

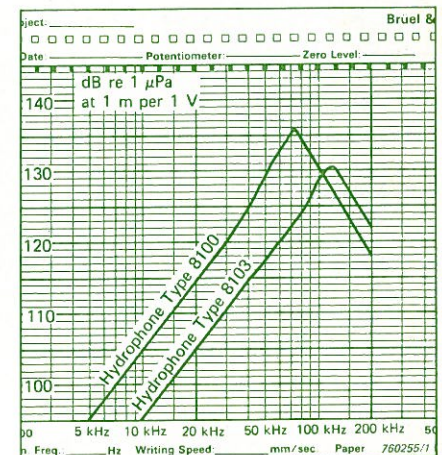


Fig.4. Typical transmitting response to voltage of Types 8100, 8103, and 8104

# Specifications 8100, 8101, 8103 and 8104

Type	8100 and 8104	8101	8103
Voltage sensitivity: (with integral cable)	56 $\mu\text{V}/\text{Pa}^*$ (-205 dB re 1 V/ $\mu\text{Pa}$ )	630 $\mu\text{V}/\text{Pa}^*$ (-184 dB re 1 V/ $\mu\text{Pa}$ )	30 $\mu\text{V}/\text{Pa}^*$ (-211 dB re 1 V/ $\mu\text{Pa}$ )
Charge sensitivity:	$42 \times 10^{-8}$ pC/ $\mu\text{Pa}^*$	—	$10^{-7}$ pC/ $\mu\text{Pa}^*$
Capacitance: (with integral cable)	8100: 7500 pF 8104: 7800 pF	—	3300 pF
Frequency range: ( $\pm 2$ dB) (-10 dB)	$\geq 0,1$ Hz to 80 kHz $\geq 0,1$ Hz to 125 kHz	$\geq 1$ Hz to 80 kHz $\geq 1$ Hz to 125 kHz	$\geq 0,1$ Hz to 125 kHz $\geq 0,1$ Hz to 200 kHz
Horizontal directivity:● (at 100 kHz)	$\pm 2$ dB (typical)	$\pm 2$ dB (typical)	$\pm 2$ dB (typical)
Vertical directivity:●	$\pm 2$ dB (typical) at 50 kHz	$\pm 2$ dB (typical) at 15 kHz	$\pm 4$ dB (typical) at 100 kHz
Leakage resistance: (at 20°C)	2500 M $\Omega$	—	2500 M $\Omega$
Operating temperature range:	-40°C to +120°C (-40°F to +248°F)	-10°C to +65°C (+14°F to +149°F)	-40°C to +120°C (-40°F to +248°F)
Sensitivity change with temperature: Charge: Voltage:	$\leq +0,03$ dB/°C (+0,017 dB/°F) $\leq -0,04$ dB/°C (-0,022 dB/°F)	— $\leq -0,04$ dB/°C (-0,022 dB/°F)	$\leq +0,03$ dB/°C (+0,017 dB/°F) $\leq -0,03$ dB/°C (-0,017 dB/°F)
Max. operating static pressure:	$4 \times 10^6$ Pa = 40 ato = 400 m ocean depth		
Sensitivity change with static pressure:	$-3 \times 10^{-7}$ dB/Pa (-0,03 dB/ato)		
Allowable Total Radiation Dose:	$5 \times 10^7$ Rad.		
Dimensions: Length: Body dia: Width across the cage:	120 mm (4,73 in) 21 mm (0,83 in)	248 mm (9,76 in) 24 mm (0,95 in) 132 mm (5,21 in)	50 mm (1,97 in) 9,5 mm (0,37 in)
Weight: (Including integral cable)	8100: 1,3 kg (2,9 lb) 8104: 1,6 kg (3,5 lb)	2,5 kg (5,5 lb)	170 g (0,37 lb)
Integral cable:	6 m waterblocked low-noise shielded cable to MIL-C-915A with waterproof connectors $\Delta$		6 m low noise double shielded teflon cable with standard miniature coaxial plug
Accessories included:	Individual calibration chart and calibration data (all hydrophones) Mahogany case (except 8104)		
	1,2 m termination cable AO 0100++ with B & K standard plug (except 8104)	1,2 m termination cable AO 0111++ with B & K standard 7-pin plug. Protective cage (removable)	
Accessories available:	Standard extension cables fitted with waterproof connectors: 10 m AO 0104++ 30 m AO 0105+ 100 m AO 0106+ } except 8104	Standard extension cables fitted with waterproof connectors: 10 m AO 0112++ 30 m AO 0113+ 100 m AO 0114+	
	Other lengths of cable to special order		

\* Nominal value, each hydrophone is supplied with its own calibration data

● See polar directivity diagrams given in Fig.3

$\Delta$  10 m waterblocked low-noise shielded cable to MIL-C-915 A with B & K standard plug for 8104

+ Waterproof cable

++ Waterblocked cable to MIL C 915 A

## Specifications Built-in Preamplifier 8101

<p><b>Gain:</b> 0 dB</p> <p><b>Frequency Range:</b> &lt; 0,5 Hz to 300 kHz</p> <p><b>Input Impedance:</b> 1000 M<math>\Omega</math> // 10 pF</p> <p><b>Maximum Input Signal:</b> With 12 V supply: 2,5 V RMS (~3850 Pa) With 24 V supply: 5,0 V RMS</p>	<p><b>Inherent Noise:</b></p> <p style="text-align: right; font-size: small;">173008/1</p>	<p><b>Maximum Output Signal:</b> With 12 V supply: 2,5 V RMS or 10 mA With 24 V supply: 5,0 V RMS or 20 mA</p> <p><b>Output Impedance:</b> &lt; 50 <math>\Omega</math></p> <p><b>Power Requirement:</b> + 12 to + 24 V DC, 12 to 24 mA</p>
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