

BRÜEL & KJÆR® Transducers

Hydrophone Types 8103, 8104, 8105 and 8106

Brüel & Kjær hydrophones are transducers for measuring waterborne sound. The four hydrophones are:

- Miniature Hydrophone Type 8103
- Calibration Standard Hydrophone Type 8104
- Spherical Hydrophone Type 8105
- Low-noise Hydrophone Type 8106

Each hydrophone:

- Is individually calibrated
- Has a flat frequency response
- Is omnidirectional over a wide frequency range
- Is absolutely waterproof
- Has a high resistance to corrosion
- Is manufactured using lead-free nitrile butadiene rubber
- Has shielded-element construction



Hydrophone Overview

Fig. 1

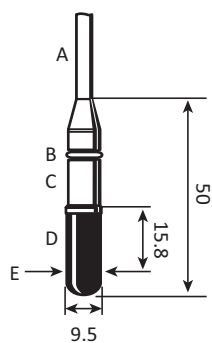
A: Integral low-noise, double-shielded cable

B: Mounting seal

C: Supporting body: CuNi

D: Lead free, nitrile butadiene rubber

E: Acoustic centre



All dimensions in mm

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Miniature Hydrophone Type 8103

A small transducer with a high sensitivity relative to its size and good all-round characteristics; applicable to laboratory, industrial and educational use. Its high-frequency response is valuable when measuring pressure-distribution patterns in ultrasonic-cleaning baths, for example.

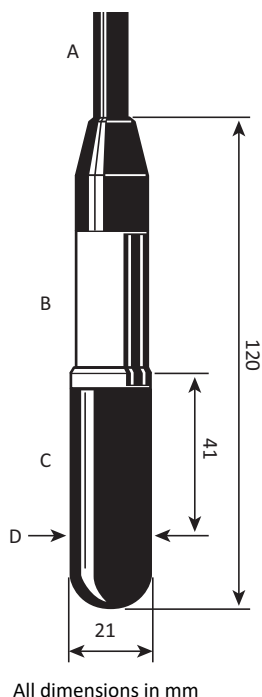
Uses

- Cavitation measurements
- Ultrasonic measurements in liquids
- Acoustic investigation of marine animals
- Laboratory and industrial measurements in liquids and gases
- Noise measurements in humid and polluted atmospheres

Features

- Frequency range: 0.1 Hz to 180 kHz
- Receiving sensitivity: -211 dB re 1 V/ μ Pa
- Very small size (50 \times 9.5 mm)
- -3 dB limit in air at 15 kHz
- Integral cable ending with 10-32 UNF connector (male), length from 1 to 400 m (3.3 to 1312 ft)

Fig. 2
A: Integral low-noise cable
B: CuNi supporting body
C: Lead free, nitrile butadiene rubber
D: Acoustic centre



All dimensions in mm

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Calibration Standard Hydrophone Type 8104

A wide-range standard measuring transducer that can also be used as a sound transmitter (projector), which makes it ideal for calibration purposes by reciprocity, calibrated-projector and comparison methods.

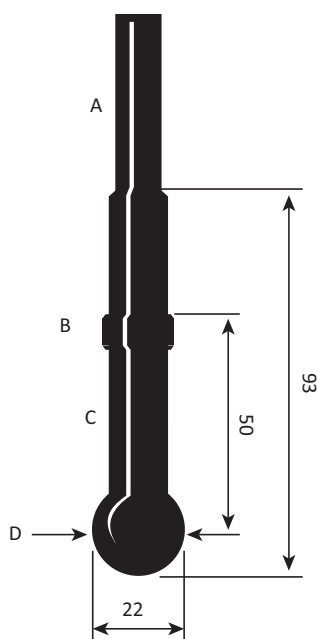
Uses

- Calibration reference standard
- Underwater projector
- Ultrasonic measurements in liquids
- Laboratory and industrial measurements in liquids and gases
- Noise measurements in humid and polluted atmospheres

Features

- Frequency range: 0.1 Hz to 120 kHz
- Receiving sensitivity: -205 dB re 1 V/ μ Pa
- Integral cable ending with BNC connector, length from 10 to 200 m (32.8 to 656 ft)
- Integral cable ending with submersible connector, length 10 m (32.8 ft)

Fig. 3
A: Integral low-noise cable
B: Positioning belt
C: Lead free, nitrile butadiene rubber
D: Acoustic centre



All dimensions in mm

170190/1

Spherical Hydrophone Type 8105

A small, spherical transducer with rugged construction, capable of withstanding pressures of up to 9.8 MPa (100 atm; 1000 m (3250 ft) ocean depth). This hydrophone has excellent directional characteristics: at 100 kHz, it is omnidirectional over 360° in the xy (radial) plane and 270° in the xz (axial) plane.

Uses

- Ultrasonic measurements in liquids
- Laboratory and industrial measurements in liquids and gases
- Underwater projector
- Noise measurements in humid and polluted atmospheres

Features

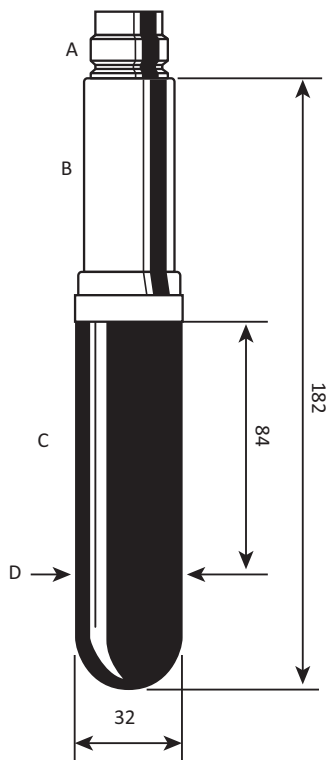
- Frequency range: 0.1 Hz to 160 kHz
- Receiving sensitivity: -205 dB re 1 V/ μ Pa
- Spherical
- Omnidirectional over full frequency range
- Completely encased in rubber
- -3 dB limit in air at 7 kHz
- Can sustain a hydrostatic pressure of 9.8 MPa (approximately corresponds to a 1000 m column of water)
- Integral cable ending with BNC connector, length from 10 to 200 m (32.8 to 656 ft)
- Integral cable ending with submersible connector, length 10 m (32.8 ft)

Fig. 4
A: Waterproof connector

B: Aluminium-bronze
($\text{CuAl}_{10}\text{Ni}_5\text{Fe}_4$) supporting
body

C: Lead free, nitrile
butadiene rubber

D: Acoustic centre



All dimensions in mm

170191/1

Low-noise Hydrophone Type 8106

A wide-range, general-purpose transducer capable of withstanding high static pressure, the operational upper limit being 9.8 MPa (100 atm; 1000 m (3250 ft) ocean depth). An integrated watertight connector enables disconnection of the cable, making replacement and storage very easy.

Built-in Preamplifier

A high-quality, thick-film, low-noise, 10 dB built-in preamplifier provides signal conditioning for transmission over long underwater cables. The preamplifier features a 7 Hz high-pass filter and an insert-voltage calibration facility, but does not allow the hydrophone to be used as a projector.

Uses

- Measurement of weak, underwater signals

Features

- Frequency range: 3 Hz to 80 kHz
- Receiving sensitivity: $-173\text{ dB re } 1\text{ V}/\mu\text{Pa}$
- Durable construction
- Equivalent noise level well below sea-state zero
- Can sustain a hydrostatic pressure of 9.8 MPa (corresponding to approximately 1000 m water column)

Construction

Brüel & Kjær hydrophones are piezoelectric transducers. The ceramic piezoelectric sensing element and its internal supporting structure are permanently bonded into sound-transparent, lead-free, nitrile butadiene rubber.

Internal Support

Support structures are made from metal alloys that are extremely resistant to corrosion in virtually all hostile environments, and have very good anti-fouling properties when immersed in seawater. Note that Type 8105 is completely covered in nitrile butadiene rubber, leaving no metal components exposed.

The internal support is mechanically and electrically isolated from the metal housing, being coupled only by synthetic rubber. This provides vibration isolation of the sensing element. Except for Type 8106, the hydrophones are equipped with an integral cable, the shield of which is connected to the internal support/housing, thus providing electrical shielding for the sensing element.

High Electromagnetic Interference

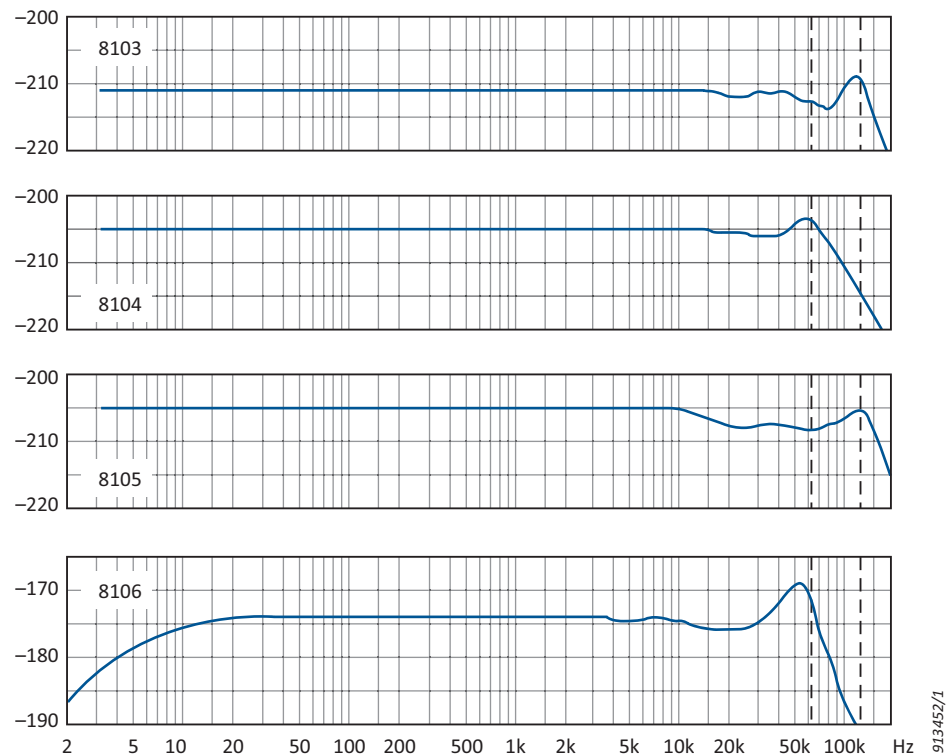
The support body of Type 8103 is connected internally to the outer shield of the integral cable which is connected to the inner shield of the terminating plug end of the cable. For instances of high electromagnetic interference, a metal screen can be clamped onto the metal support body.

Individual Calibration

Each Brüel & Kjær hydrophone is submitted to an extensive ageing and temperature stabilizing procedure before being individually calibrated. Individual calibration data and frequency response curves are supplied with each hydrophone. The receiving sensitivity calibration of the hydrophones is traceable to international standards.

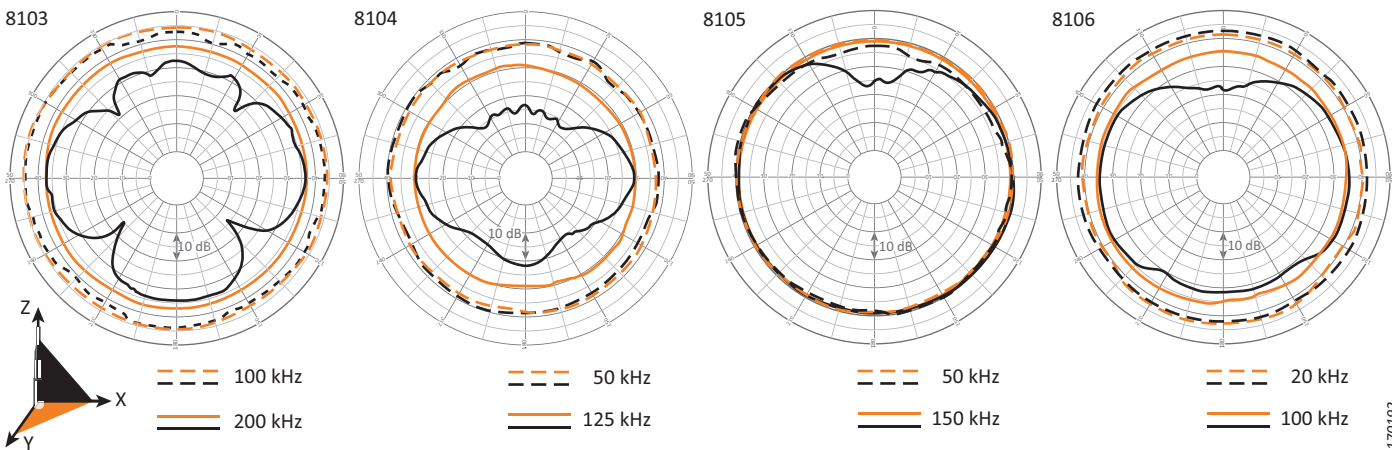
Typical frequency responses of the hydrophones are shown in Fig. 5. These are measured in a water tank in free-field conditions achieved by means of pulse techniques using a Brüel & Kjær PULSE™ LabShop-based calibration system.

Fig. 5
Typical receiving
frequency characteristics
(dB re 1 V/ μ Pa)



The hydrophones have very good omnidirectional characteristics. Typical directivity patterns of the hydrophones in water are shown in Fig. 6. These polar directivity patterns were measured in free-field conditions achieved by means of gating techniques in a water tank. This method requires a standard hydrophone as a projector and the unknown hydrophone as the receiver whose polar directivity pattern is to be determined.

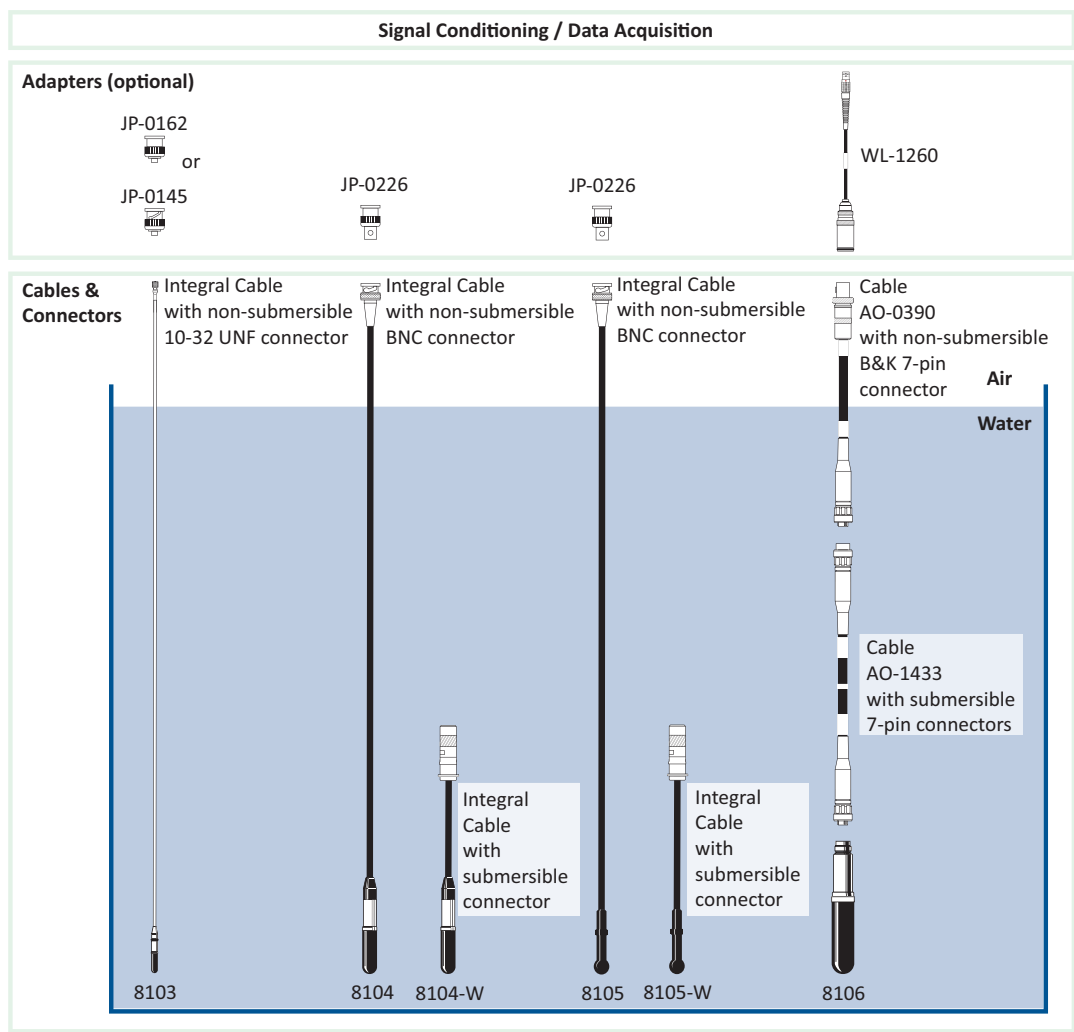
Fig. 6 Typical directivity patterns



Brüel & Kjær hydrophone cables have good electrical shielding. This enables the hydrophones to be used in both air and water, where the electrical potential of the water is different from the ground potential, as well as in cases of high electromagnetic interference*.

All hydrophone connectors are dry-mate connectors, some of which are submersible. Dry-mate connectors cannot be connected/disconnected while under water.

Fig. 7
Hydrophone cables and connectors in air and water



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* In cases of high electromagnetic interference, a metal screen can be clamped onto the metal support body of Type 8103.

Type 8103, 8104 and 8105 Cables

Types 8103, 8104 and 8105 have integral cables that terminate with non-submersible connectors. The length of the cable is specified when ordering; if unspecified, the minimum length is the default length.

Table 1
Minimum and maximum lengths of the integral cable for Types 8103, 8104 and 8105

TYPE NUMBER	RAW CABLE	CABLE LENGTH	
		MINIMUM	MAXIMUM
8103	AC-0043	1 m (3.3 ft)	400 m (1312 ft)
8104	AC-0034	10 m (32.8 ft)	200 m (656 ft)
8105			

Types 8104 and 8105 are also available as custom orders (Types 8104-W and 8105-W variants) with 10 m integral cables that terminate with submersible connectors.

The raw cables used are either waterproof or water-blocking:

- Waterproof: Watertight
- Water-blocking: Watertight and can completely withstand water pressure

Type 8103 Cable

The raw cable, AC-0043, is waterproof but not water-blocking. It is a double-shielded cable that terminates with a coaxial 10–32 UNF plug (male connector).

The depth up to which Type 8103 can be used is limited to the maximum length of its integral cable.

Types 8104 and 8105 Cable

The raw cable, AC-0034, fulfils MIL-C-915, and is a water-blocking cable that terminates with a BNC plug.

The maximum length of the integral cable of is 200 m (656 ft), but the hydrophones can be used at depths greater than that. To use Types 8104 and 8105 at depths greater than the maximum length of the integral cable, you must replace the BNC connector on the integral cable with two submersible connectors*:

- JP-0415: submersible plug that mates with JJ-0415
- JJ-0415: submersible socket that mates with JP-0415

Attaching JP-0415 to the integral cable and then connecting it to JJ-0415 allows you to use the following submersible extension cables:

- AO-1431: underwater cable with two submersible connectors
- AO-1432: wet-to-dry cable with one submersible connector

This cable/connector configuration extends the ranges for the Type 8104 hydrophone to depths up to 400 m (1312 ft) and for Type 8105 up to 1000 m (3250 ft).

Type 8106's Four-core Cable

Low-noise Hydrophone Type 8106 has a submersible connector that is an integrated part of the hydrophone's bronze body support.

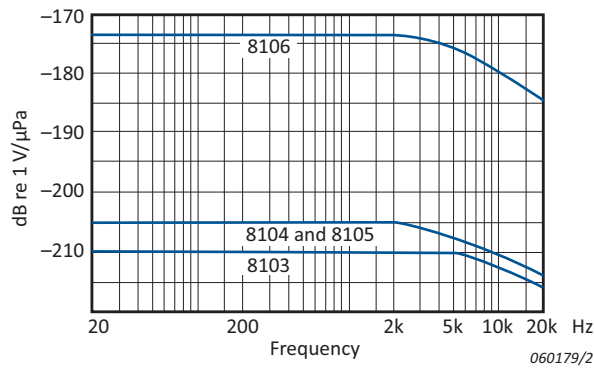
There are two cables that can be used with Type 8106:

- AO-1433: underwater cable with two submersible connectors
- AO-0390: wet-to-dry cable with one submersible connector

Raw cable, AC-0101, a screened, 4-core cable with reinforcement, is used in both of these cables. The raw cable can tolerate high loads: 1300 N in service, with a breaking load of 2600 N. This makes the cable strong enough to be self-supporting for measurements at ocean depths of 1000 m (3250 ft). Despite the strength of the cables, it is always recommended to use some form of cable strain release whenever it is exposed to dynamic movements.

* Variants of Types 8104 and 8105 that come pre-assembled with other types of connectors, such as wet mate-ables or submersibles, are custom orders.

Fig. 8
Typical receiving characteristics in air: Types 8103, 8104, 8105 and 8106 in the xy plane



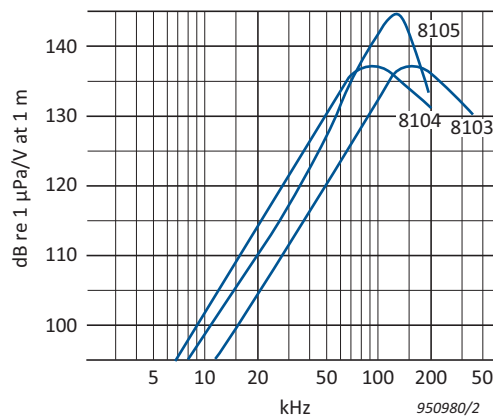
Hydrophones are particularly useful for measurements under extreme environmental conditions such as very high humidity, very high temperature, or polluted atmospheres – conditions that could damage ordinary microphones or affect their performance.

Hydrophones may also be used for measurement of extremely high sound pressure levels.

Please note that Type 8103 is quite sensitive to acceleration, up to 115 dB/ms^{-2} when vibrated axially and up to 128 dB/ms^{-2} when vibrated perpendicular to the hydrophone axis. As always for hydrophones the dB reference pressure is $1 \mu\text{Pa}$.

Use as Projectors

Fig. 9
Typical transmitting response to voltage of Types 8103, 8104 and 8105



Hydrophone Types 8103, 8104 and 8105 can be used as sound transmitters (projectors), for both measurement and reciprocity calibration. Just as the piezoelectric effect produces an electrical output from mechanical excitation, applying alternating voltage to the transducer will produce mechanical excitation in the piezoelectric element.

Transmitting responses to applied voltage in water are shown in Fig. 9. Note the 12 dB/octave slope which is typical for piezoelectric hydrophones driven with constant voltage input.

Signal Conditioning and Data Acquisition

Signal Conditioning

In some cases, it is necessary to route the high-impedance output signals through a signal conditioning amplifier. Although the international standards call for calibration of the hydrophones' voltage sensitivity (using a voltage amplifier), it is often more practical to use a charge amplifier, which will result in a charge sensitivity independent of the actual cable length.

Type 8106

The built-in preamplifier provides an output signal that does not require further conditioning.

Types 8103 – 8105

While the entire Brüel & Kjær range of accelerometer preamplifiers is suitable, the NEXUS™ range of conditioning amplifiers (product data: [BP 1702](#)) is recommended because it features a sensitivity adjustment (for convenient output values: 0.1 or 1 V/unit), have a wide frequency range and have adjustable low- and high-pass filters.

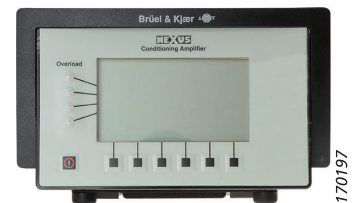
Connecting a Charge Output

If you want to connect a charge output (for example, output from Types 8103, 8104 and 8105) to CCLD input, you can use Charge to CCLD Converter Type 2647 (product data: [BP 1874](#)).

Discontinued Brüel & Kjær Signal Conditioners

The following signal conditioners are no longer manufactured but can be used:

- Conditioning Amplifier Type 2635, requires a cable terminating with a proprietary connector, referred to as a B&K 7-pin connector such as Cable AO-0390
- Measuring Amplifier Type 2525, requires a BNC to TNC adapter such as Adapter JP-0226



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Data Acquisition

The recommended data acquisition for hydrophones is LAN-XI 1-ch. Input + 1-ch. Output Module Type 3161 (product data: [BP 2215](#)). The module's input and output channels have a frequency range of DC to 204.8 kHz.

Connecting the Measurement Chain

Fig. 11 provides an overview of the cable options for connecting your hydrophone to the recommended signal conditioning and data acquisition hardware. Depending on the signal conditioning and/or data acquisition hardware, you may need an adapter to convert connectors from one type to another. Note that the adapters are non-submersible.



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Type 8103

- JP-0145: 10–32 UNF coaxial socket (female connector) to BNC plug
- JP-0162: 10–32 UNF coaxial socket to TNC plug

Types 8104 and 8105

These hydrophones can connect directly to LAN-XI data acquisition module Type 3161. With NEXUS signal conditioners use:

- JP-0226: BNC socket to TNC plug

Type 8106

- WL-1260: B&K 7-pin* socket to 7-pin LEMO plug

Fig. 10

Left:
7-pin B&K plug

Right:
7-pin LEMO plug

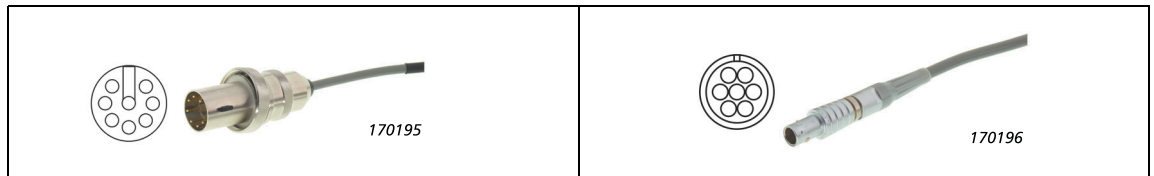
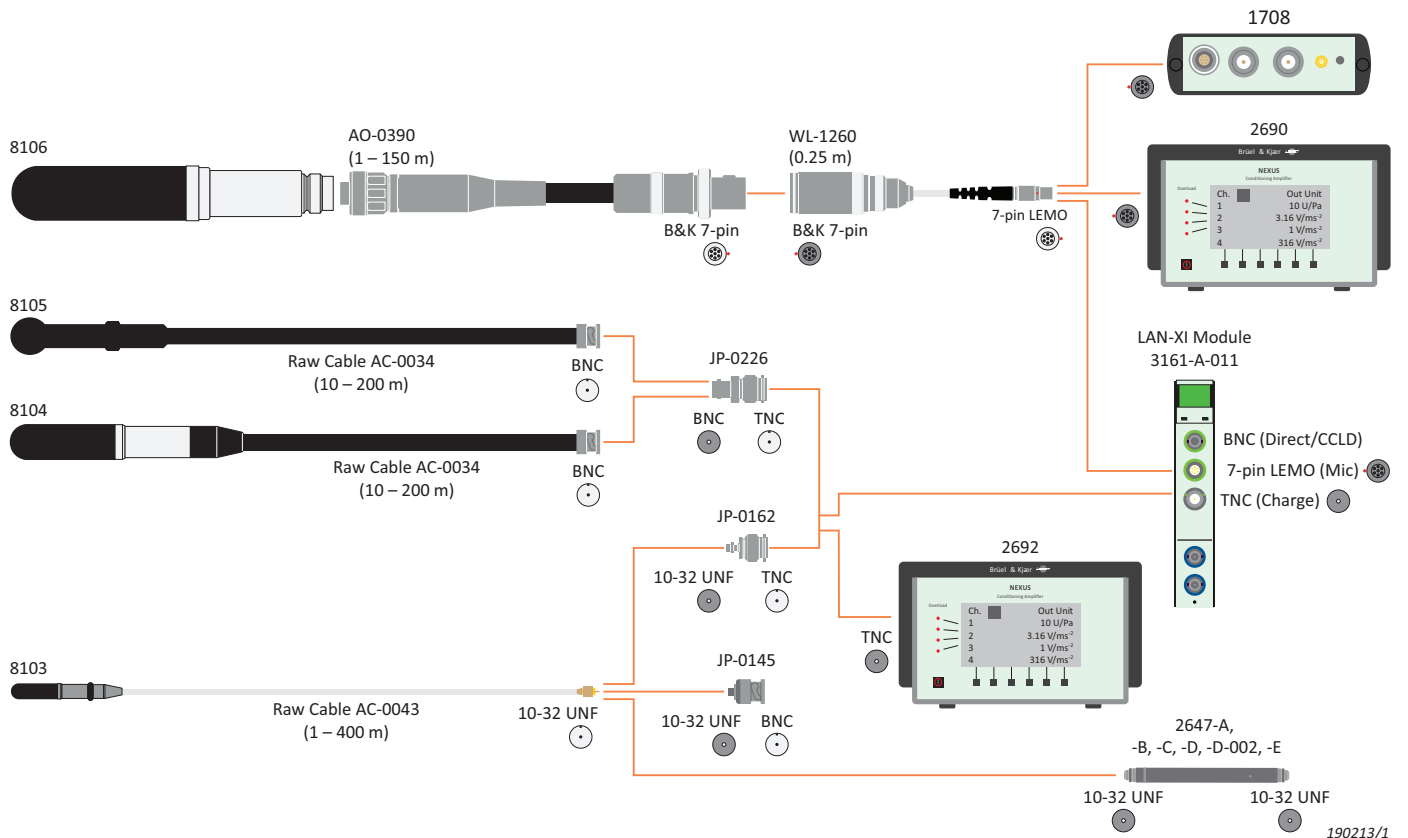


Fig. 11 Measurement chain connections

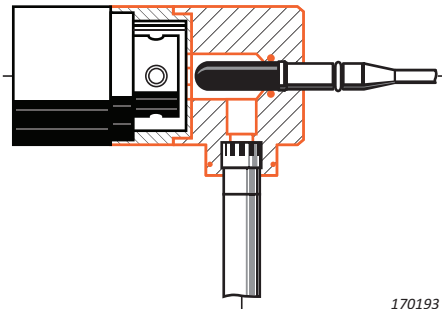


* Proprietary connector used in older Brüel & Kjær hardware: Conditioning Amplifier Type 2635 and Measuring Amplifier Type 2636

Fig. 12
Illustration of Type 8103
mounted in its coupler
(UA-0548). A half-inch
microphone monitors the
sound pressure level
produced in the coupler

Hydrophone Calibrator Type 4229
At low frequencies, the sensitivity of a hydrophone is the same in air as in water, and the calibration can be checked using Hydrophone Calibrator Type 4229 (product data: [BP 1024](#)). The calibrator includes couplers for Types 8103, 8104 and 8105 and a barometer giving the atmospheric pressure correction in dB. A coupler for Type 8106 is available separately.

Traceable Calibration
The sound pressure level in the coupler volume can be monitored with a half-inch microphone (see Fig. 12), enabling the calibration to be traceable to international standards.



Compliance with Standards

CE	The CE-mark indicates compliance with EMC Directive 2014/30/EU.
Safety	EN/IEC 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use
EMC Emission	EN/IEC 61000-6-3: Generic emission standard for residential, commercial and light industrial environments CISPR 32: Radio disturbance characteristics of information technology equipment. Class B. FCC Rules, Part 15: Complies with the limits for a Class B digital device
EMC Immunity	EN/IEC 61000-6-1: Generic standards – Immunity for residential, commercial and light industrial environments EN/IEC 61000-6-2: Generic standards – Immunity for industrial environments EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements Note: The above is only guaranteed using accessories listed in this document. Note 2: Susceptibility when exposed to levels specified in EN 61000-6-1.
Temperature	IEC 60068-2-1 & IEC 60068-2-2: Environmental Testing. Cold and Dry Heat Ambient Operating Temperature: – 10 to +50 °C (14 to 122 °F) Storage Temperature: – 25 to +70 °C (– 13 to +158 °F)
Humidity	IEC 60068-2-78: Damp Heat: 93% RH (non-condensing at 40 °C (104 °F))
Mechanical	Non-operating: IEC 60068-2-6: Vibration: 0.3 mm, 20 m/s ² , 10 – 500 Hz IEC 60068-2-27: Shock: 1000 m/s ² IEC 60068-2-29: Bump: 1000 bumps at 400 m/s ²
Enclosure	IEC 60529: Protection provided by enclosures: IP 68

Unless otherwise stated, all values are valid at 23 °C (73 °F) and (where applicable) with standard length integral cable.

	TYPE 8103	TYPE 8104	TYPE 8105	TYPE 8106
Sensitivity*	–211 dB re 1 V/μPa ±2 dB	–205 dB re 1 V/μPa ±3 dB	–205 dB re 1 V/μPa ±2 dB	–173 dB re 1 V/μPa ±3 dB
Nominal Voltage Sensitivity	29 μV/Pa	56 μV/Pa		2.24 mV/Pa
Nominal Charge Sensitivity*	0.1 pC/Pa	0.44 pC/Pa	0.41 pC/Pa	N/A
Capacitance* (incl. standard cable)	3700 pF	7800 pF	7250 pF	N/A
Frequency Response* (re 250 Hz) Specification is valid with integral cable length up to: • 100 m (382 ft) for Types 8103 and 8104 • 25 m (82 ft) for Type 8105	0.1 Hz to 20 kHz +1/–1.5 dB 0.1 Hz to 100 kHz +1.5/–6.0 dB 0.1 Hz to 180 kHz +3.5/–12.5 dB	0.1 Hz to 10 kHz ±1.5 dB 0.1 Hz to 80 kHz ±4.0 dB 0.1 Hz to 120 kHz +4/–12.0 dB	0.1 Hz to 100 kHz +1/–6.5 dB 0.1 Hz to 160 kHz +3.5/–10.0 dB	10 Hz to 10 kHz +1/–3.0 dB 7 Hz to 30 kHz +1/–6.0 dB 3 Hz to 80 kHz +6/–10.0 dB
Horizontal Directivity† (radial, xy plane)	±2 dB at 100 kHz			±2 dB at 20 kHz
Vertical Directivity (axial, xz plane)	±4 dB at 100 kHz	±2 dB at 50 kHz	±2 dB over 270° at 80 kHz ±2.5 dB at 100 kHz	±3 dB at 20 kHz
Leakage Resistance* (at 20 °C)	>2500 MΩ			
Operating Temperature Range: Short-term (≤1 hr continuous operation) Continuous	–30 to +120 °C –30 to +80 °C			– –10 to +60 °C
Sensitivity Change with Temperature: Charge Voltage	0 to +0.03 dB/°C 0 to –0.03 dB/°C	0 to +0.03 dB/°C 0 to –0.04 dB/°C	0 to +0.03 dB/°C 0 to –0.03 dB/°C	– 0 to +0.01 dB/°C
Max. Operating Static Pressure	252 dB = 4×10^6 Pa = 40 atm = 400 m ocean depth		260 dB = 9.8×10^6 Pa = 100 atm = 1000 m ocean depth	
Sensitivity Change with Static Pressure	0 to -3×10^{-7} dB/Pa (0 to –0.03 dB/atm)			0 to 1×10^{-7} dB/Pa 0 to 0.01 dB/atm
Allowable Total Radiation Dose	5×10^7 Rad.			
Dimensions: Length Body Diameter	50 mm (1.97 in) 9.5 mm (0.37 in)	120 mm (4.73 in) 21 mm (0.83 in)	93 mm (3.66 in) 22 mm (0.87 in)	182 mm (7.17 in) 32 mm (1.26 in)
Weight (including integral cable)	170 g (0.37 lb)	1.6 kg (3.5 lb)		382 g (0.84 lb)
Integral Cable Standard Length	Waterproof low-noise double-shielded 6 m (19.69 ft)	Waterblocked low-noise shielded cable fulfilling MIL-C-915 10 m (32.8 ft)		–
Connector	Standard miniature coaxial plug	BNC plug		Proprietary 7-pin

* Each hydrophone is supplied with its own calibration data

† See polar directivity given in Fig. 6

Additional Specifications for Type 8106

Max. Output Signal:

• 12 V supply: 3.5 V or 28 mA

• 24 V supply: 7.0 V or 28 mA

Max. Power Output: 50 mW

Output Impedance: <30 Ω

High-pass Filter: –3 dB at 7 Hz (±2 Hz)

DC Ripple Rejection (20 Hz to 20 kHz): 70 dB

Overload Sound Pressure Level:

• 12 V supply: 182 dB re 1 μPa

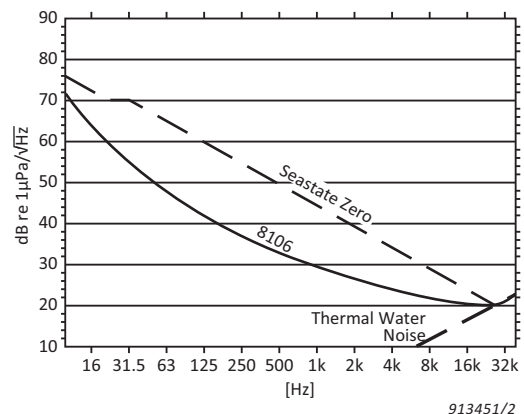
• 24 V supply: 188 dB re 1 μPa

POWER SUPPLY

Supply Voltage: 12 to 24 V DC

Power Consumption: 6 mA without load

Fig. 13 Typical equivalent noise pressure level of Type 8106



Type 8103 Miniature Hydrophone

includes Integral Cable with raw cable AC-0043: low-noise, double-screen (waterproof, not water-blocking) with 10–32 UNF (M) end

Type 8104 Calibration Standard Hydrophone

includes Integral Cable with raw cable AC-0034: water-blocked, MIL–C–915 with BNC end

Type 8105 Spherical Hydrophone

includes Integral Cable with raw cable AC-0034: water-blocked, MIL–C–915 with BNC end

Type 8106 Low-noise Hydrophone

Supported Brüel & Kjær Hardware

ADAPTERS FOR TYPE 8103

JP-0145	Non-submersible Adapter, 10–32 UNF Coaxial (F) to BNC (M)
JP-0162	Non-submersible Adapter, 10–32 UNF Coaxial (F) to TNC (M)
JJ-2617	Non-submersible Adapter, 10–32 UNF Coaxial (F) to half-inch microphone

CABLES AND ADAPTERS FOR TYPES 8104 AND 8105

AO-1431	Submersible Integral Cable with BNC end connector includes:
	• AC-0034: Raw cable (water-blocked, MIL–C–915)
	• JP-0415: 4-pin (M) submersible connector
	• JJ-0415: 4-pin (F) submersible connector

AO-1432	Non-submersible Integral Cable with BNC end connector, includes AC-0034: Raw cable (water-blocked, MIL–C–915)
JP-0226	Non-submersible Adapter, BNC (F) to TNC (M)

CABLES AND ADAPTERS FOR TYPE 8106

AO-1433	Submersible Cable includes:
	• AC-0101: Water-blocked, shielded 4-core cable, reinforced
	• JP-0735: Submersible connector, 7-pin (M)
	• JJ-0738: Submersible connector, 7-pin (F)

AO-0390	Non-submersible Cable includes:
	• AC-0101: Water-blocked, shielded 4-core cable, reinforced
	• JP-0735: Submersible connector, 7-pin (M)
	• JP-0717: Non-submersible connector, B&K 7-pin (M)

WL-1260	B&K 7-pin (F) to 7-pin LEMO (M)
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CALIBRATION

Type 4229*	Hydrophone Calibrator
WA-0658	Type 8106 to Type 4229 Coupler (optional)

SIGNAL CONDITIONING AND DATA ACQUISITION

Type 2647	Charge to CCLD Converter
Type 2690	NEXUS Conditioning Amplifier
Type 2692	NEXUS Charge Conditioning Amplifier
Type 3161	LAN-XI 1-ch. Input + 1-ch. Output Module, 204.8 kHz

Brüel & Kjær Services

SECONDARY CALIBRATION

HYDRO-CFF	Factory Standard Calibration
HYDRO-CVN	Conformance Test with Measurements Report
HYDRO-TCF	Conformance Test with Certificate

* Includes couplers for use with Hydrophone Types 8103, 8104 and 8105