

Operation and Maintenance Instructions Borehole Hydrophone String BHC- Type 5



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1. Introduction

A hydrophone string is a series of hydrophones attached to a cable which can be lowered into the water-filled borehole. The hydrophones are designed to detect seismic signals generated by various sources, such as SBS42 or a sledgehammer. Hydrophone strings in water-filled boreholes can provide valuable information about the subsurface environment and help improve the understanding of the natural processes beneath the Earth's surface.

The BHC5 hydrophone string is used to receive P-waves in water-filled boreholes. The BHC5 consists of a downhole cable containing a high-tensile Kevlar tension string and several molded hydrophones at pre-determined intervals. Each hydrophone consists of a sensor with a pre-amplifier board. The electronic boards are powered from the surface by a bank of AA rechargeable battery cells. The BHC5 amplifier boards are equipped with an internal test function to allow a quality check anytime. The test function outputs a synthetic signal on each channel, allowing the amplification factors to be evaluated. The cable is terminated with a connector to the seismograph.

The BHC-5 is a string of 24 (or less) small-diameter hydrophones with an integrated pre-amplifier designed for tomographic seismic surveys in boreholes of approximately 50 mm (2") diameter or larger. The standard BHC-5 has a hydrophone spacing of 1m and can be operated from the standard depth of 123 m to several hundred meter.

2. Description of the equipment

1.1 Borehole cable equipment

A robust seismic cable with 24 pairs of wires and a PUR (polyurethane) mantle is used for the hydrophone section and the following lead-in cable. The cable is spooled on a cable drum. The cable is marked every two meters for depth measurement.

Depth reference (=0m) is at the lowest hydrophone.

The cable end splits into a connector to the seismograph and a connector to the battery box (see Figure 1).

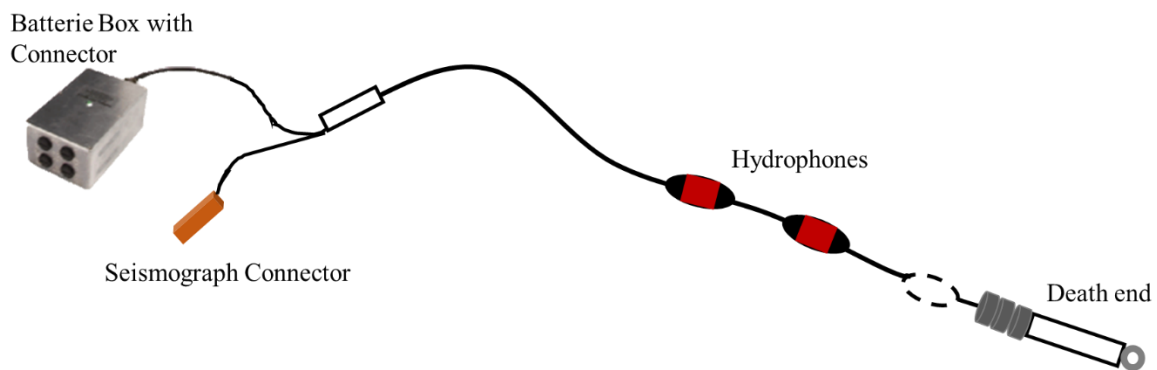


Figure 1: Schematic diagram of the BHC5

- **Connect the battery box to the string before connecting it to the seismograph.**
- **Disconnect from the seismograph before disconnecting from the battery box.**

Additional parts supplied with the string are

Spooler device to unspool cable on the drum





Clamping device to hold the cable on top of the borehole



Battery box with self-test function

The borehole cable and hydrophones are coiled onto a simple drum. The cable can be easily uncoiled using the cable spooler (see Figure 2). The cable can be clamped to the top of the housing. Please use the supplied clamping device (see Figure 3). Handle the cable carefully, and do not pull the cable over sharp edges.

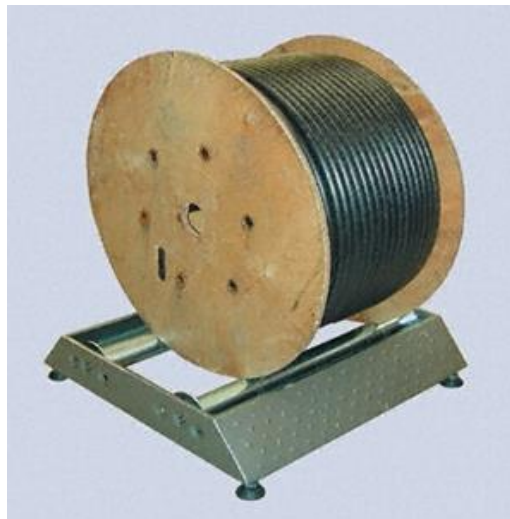


Figure 2: Cable spooler



Figure 3: Clamping device

1.2 Hydrophones

Hydrophone sensors of type SQ54 or AQ2000 are used. Each hydrophone consists of a piezoelectric pressure sensor, a low noise pre-amplifier, and a line driver for two-conductor signal transmission. The current consumption of a single hydrophone is about 5 mA and about 120 mA for 24 hydrophones.

A pre-amplification of 4 x is pre-set. All hydrophone connections of the borehole cable junctions are entirely embedded in the PU compound.

1.3 Battery box and self-test function

The pre-amplifier requires power from the surface. A battery box is supplied, which can be connected to the hydrophone cable (see Figure 4). Fully charged batteries will provide approximately **10 hours of operation.**

You can use rechargeable batteries or standard AA batteries. The batteries should be inserted with the correct polarity (polarity is shown on a diagram outside the battery box).



Figure 4: Power supply box

The battery box and connectors are **not waterproof.** Prevent water from entering the connectors or box.



Figure 5: Changing batteries



Figure 6: Connection to box

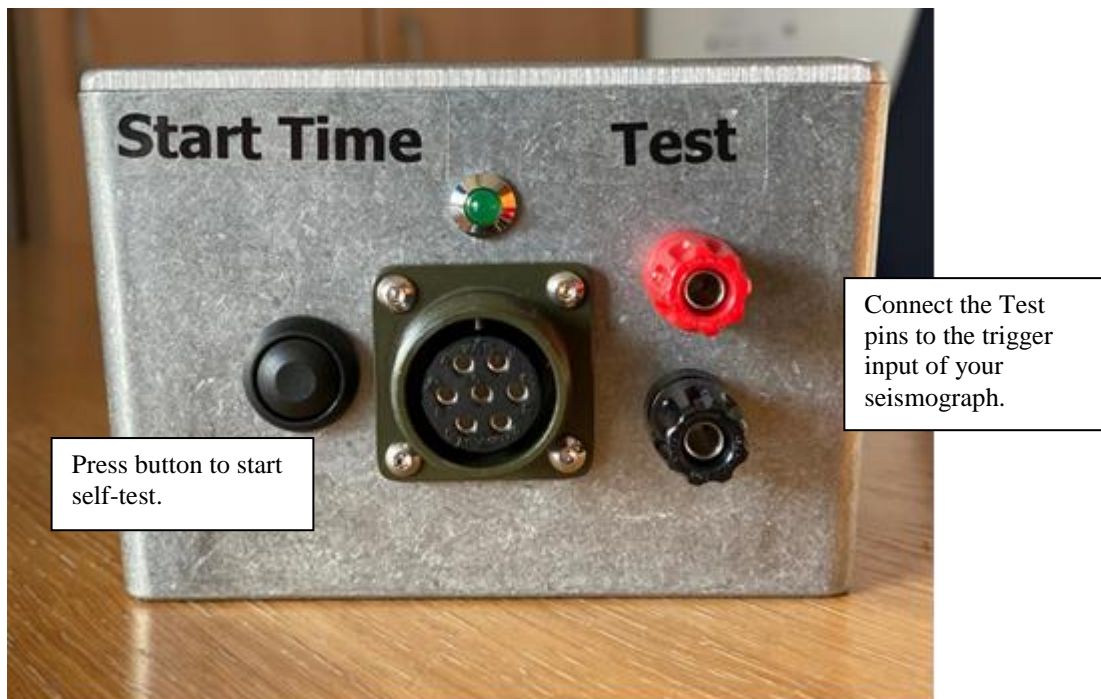


Figure 7: Controls at the battery box

- A self-test function is provided to check the operational status and amplification of the amplifiers. To perform the self-test, a seismograph must be connected to the string.
- Use the two (**red/black**) banana plugs and connect a trigger line to your seismograph. Once the seismograph is ready and the hydrophone string is connected, press the 'Start Time' button to start the self-test.
- The internal self-test generates a 1 kHz test signal. Set a sample rate of at least 8 kHz or higher on the seismograph and a recording time of at least 250 ms.
- To start, press the button on the battery inlet side of the battery box and record. To analyse the data, you can use software supplied by Geotomographie GmbH (please get in touch with us).

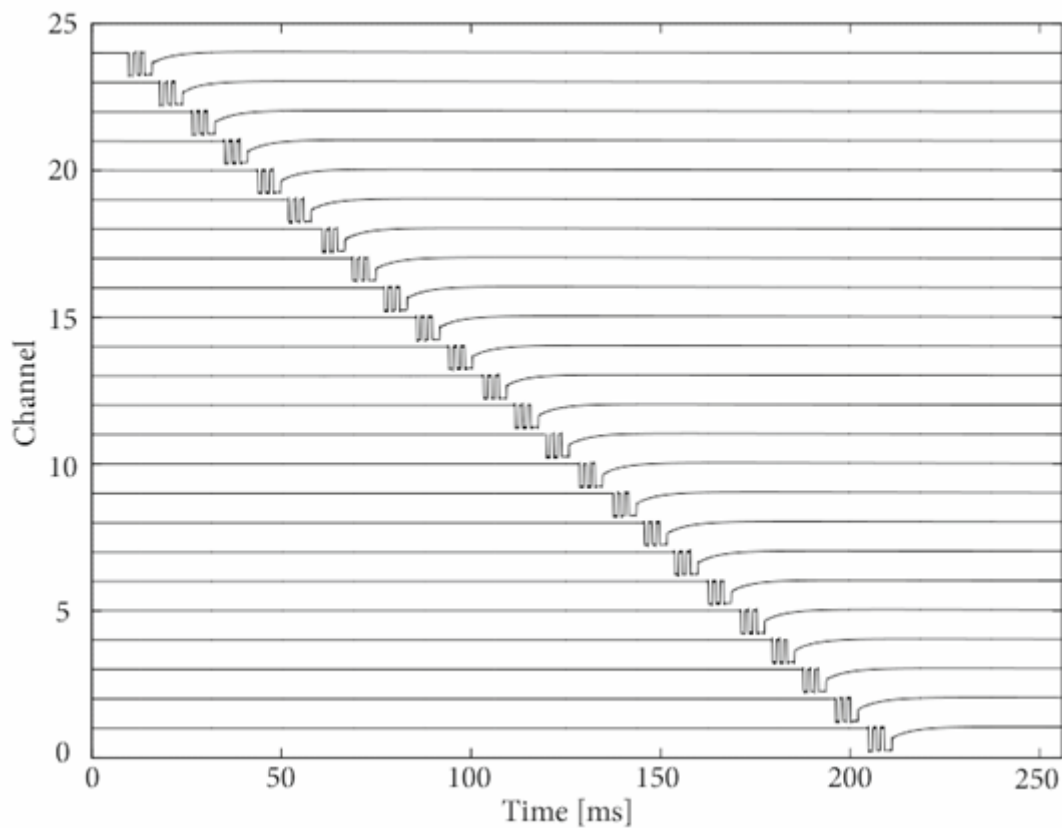


Figure 8: Self-test record

3. Operation

Lower the hydrophone cable to the desired depth and clamp it in place. It is absolutely necessary to follow the correct sequence when connecting the battery box and the Seismograph.

Connect	1) Connect to the battery box 2) Connect to Seismograph
Disconnect	1) Disconnect from Seismograph 2) Disconnect from the battery box

Regarding the use of the geophone string, the following should be noticed:

- **Watch the tension of the string as it is lowered.**
- **Ensure that the cable runs smoothly. Check frequently that the cable can be lifted.**
- **Do not pull or lower the cable over sharp edges. If the cable mantle is damaged, water may enter, and sooner or later, the string will stop working.**
- **Do not cut the cable.**

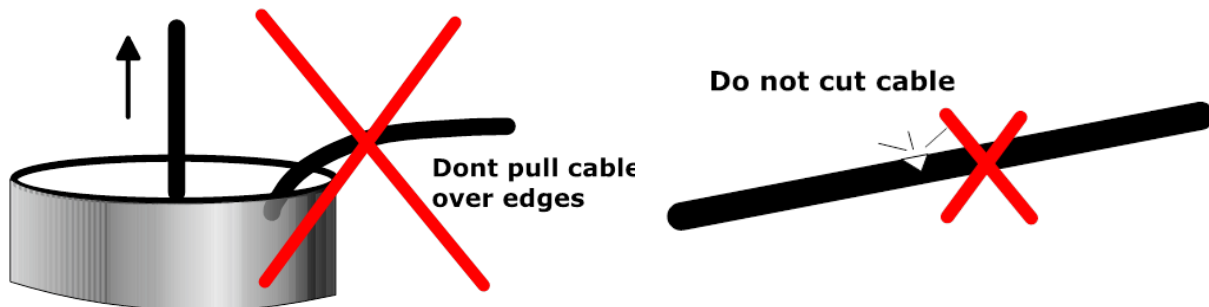


Figure 9: Cable handling instructions

4. Technical data

4.1 Hydrophone specifications

Voltage sensitivity (individual phones):	-201.0 ± 1.0 dBV re 1 mPa @ 20°C, 8.4 V/mbar
Charge sensitivity:	40 nC/bar
Capacitance:	4.5 nF ± 10% @ 20°C
Capacitance variation with temperature:	0.4% increase per °C
Capacitance variation with pressure:	8% loss per 1,000 m (3,300 ft)
Operating depth:	down to 2,000 m
Frequency response:	flat from 1 Hz to 10,000 Hz
Acceleration sensitivity:	< 0.2 mbar/g when properly mounted
Diameter:	13.5 mm (0.5")
Length:	46.0 mm (1.8")
Electrical leads:	two, 28 AWG stranded,
Electrical insulation:	> 500 mW
Water-blocked leads:	yes

4.2. Cable specifications

- Main cable with 25 X 2 X 28 AWG, Cores twisted in pairs & 4 X 2 X 24 AWG:
- Elements laid up together in concentric layers around LPC fiber strength member of 500 Kg breaking strength
- Hydrolysis UV resistant matt PUR outer sheath, nominal thickness 2,80 mm
- Nominal overall diameter 13,50 +/- 0,5mm
- Weight in air nom. : 200 kg/km
- Weight in freshwater nom. : 57 kg/km

5. Maintenance

- Before and after a survey, visually inspect the BHC equipment for visible damage.
- Charge the batteries after long periods of use or storage.
- Exercise care when transporting and handling the hydrophone string; it is a sensitive tool.

6. Accessories

The cable can be equipped with towing points. Towing points can be used to fix the cable to a boat railing while moving along the sea. Towing points are to protect the cable mantle from uncontrolled fixation.

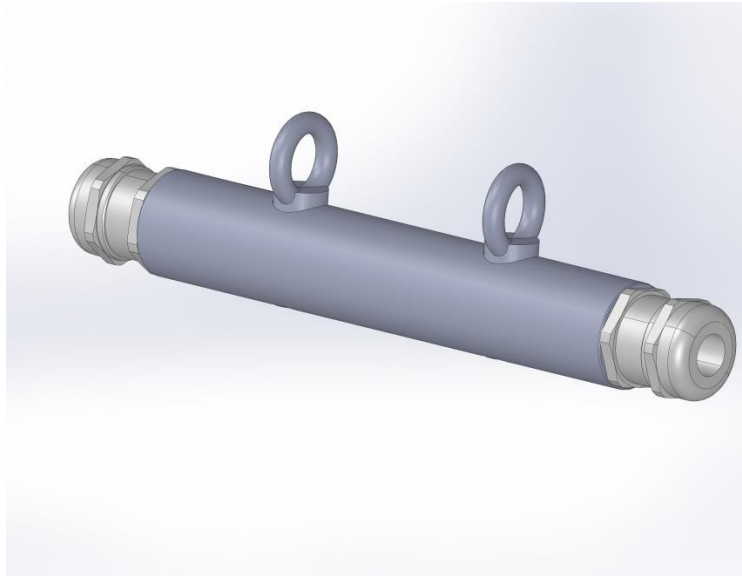


Figure 10: Towing point