Dual Downhole System -DDS

Geotomographie GmbH, Am Tonnenberg 18, 56567 Neuwied (Germany)
Tel.: +49 2631 778135 email: info@geotomographie.de

Content

1. Description

The Dual Downhole System (DDS) is used to receive P- and S-waves in dry and water-filled boreholes in order to determine interval velocities. The DDS consists of two stations, each equipped with tri-axial sensors. The stations are mechanically connected to each other to ensure the alignment of all horizontal sensors. Both stations are coupled to the borehole wall by a pneumatic clamping system (inflatable bladder). Air is supplied to the DDS through an electro-pneumatic hybrid cable with a Kevlar tension string. A magnetic compass shows azimuthal deviation to the North and can be used to get the orientation of the DDS in the borehole. The cable is terminated by a connector to the seismograph.

The Dual Downhole System DDS is a rugged tool with a station length of 620 mm and a diameter of 65 mm diameter usable for seismic borehole measurements in boreholes with a borehole diameter of 75mm up to about 100 m depth. Each station weighs 2.5kg, and 100m cable 14.5kg.

In comparison to a single BGK3 measurement, DDS has the following advantages:

- The same signal at each station
- Interval velocity independent of trigger time
- Cross-correlation traveltime analysis can be used to determine interval velocity

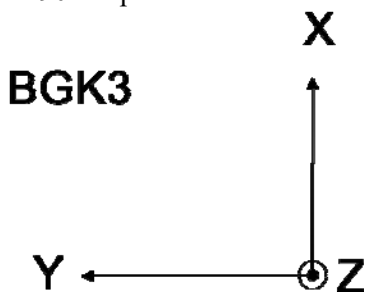
2. Structure of the DDS

2.1. Geophones units

The DDS consists of two BGK3, an upper and a lower unit. In each BGK3 unit, two (H1, H2) and a vertical geophone (V) are placed inside a stainless steel tube and act as a multi-component seismic receiver.

The horizontal components in each BGK3 are placed in 90° steps in a clockwise order.

- **H1:** X (North)- lower unit
- **H2:** Y - lower unit
- **H3**: Z - lower unit



- **H1:** X (North)- lower unit
- **H2:** Y - lower unit
- **H3**: Z - lower unit

The space between the pipe and geophone elements is filled with polyurethane for sealing and to suppress mechanical resonance. The reference direction of the geophone unit is the axis of the H1 element.

The two DDS receivers are usually spaced 1 or 2 m. Don't hesitate to get in touch with us for other distances. Both are connected by an inflexible air pipe to maintain the direction of the H1 components. The lower unit contains a magnetic compass.

Figure 1: Dual Downhole System

A seismic impulse towards the marker line produces a positive rising signal. A test impulse by knocking at about the middle of the geophone unit using a simple ball pointer or pen shows such a signal. All other H-components can be tested in the same way. A small pressure tube inside the geophone unit is led from the quick connector on the probe head to the clamping unit to supply the pneumatic clamping device.

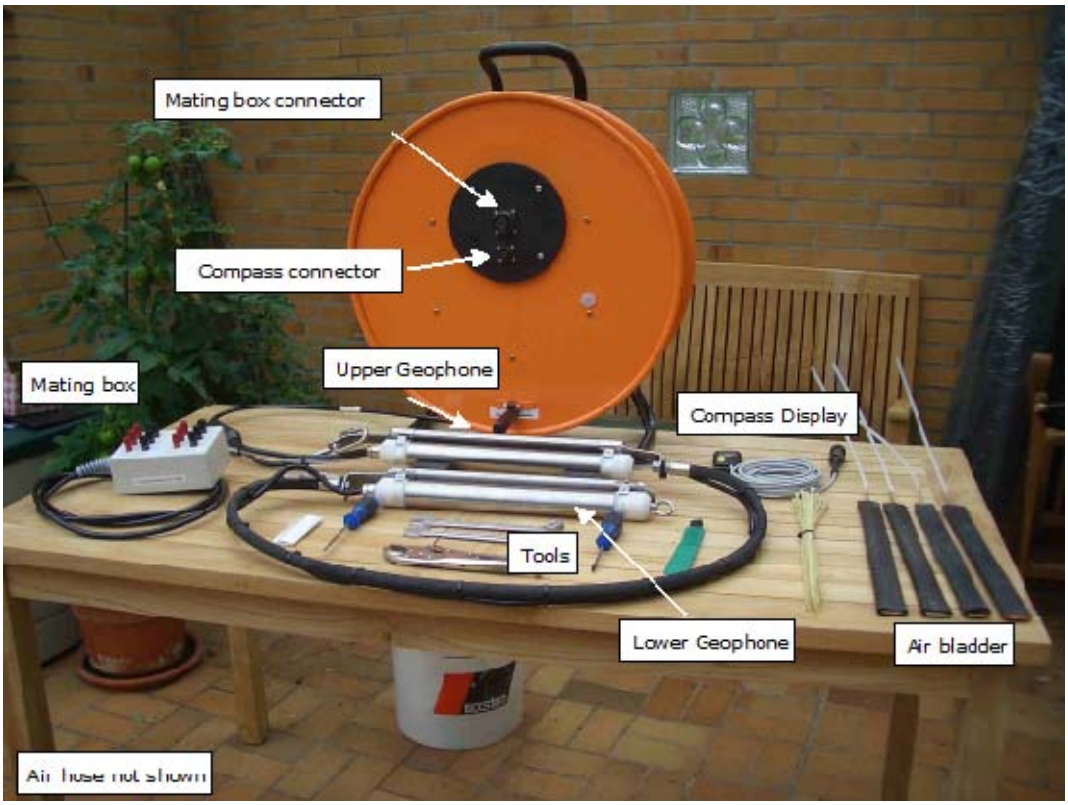


Figure 2: Dual Downhole System

2.2 Geophone wiring

Following channels are active (DDS):

Lower Geophone

Channel 1	Geophone H1(X)	Contact 1 Signal +
		Contact 2 Signal -
Channel 2	Geophone H2 (Y)	Contact 3 Signal +
		Contact 4 Signal -
Channel 3	Geophone V	Contact 5 Signal +
		Contact 6 Signal –

Upper Geophone

Channel 4	Geophone H1 (X)	Contact 7 Signal +
		Contact 8 Signal -
Channel 5	Geophone H2 (Y)	Contact 9 Signal +
		Contact 10 Signal -
Channel 6	Geophone V	Contact 11 Signal +
		Contact 12 Signal –

2.3 Pneumatic clamping unit

The pneumatic clamping unit is used to anchor the geophone inside the borehole for seismic recording. It consists of a plastic tube with several holes and a rubber hose. It is screwed to the geophone unit and shielded by a stainless steel tube with a window of approximately 180°.

When air is injected into the clamping unit, the rubber housing expands in the direction opposite to the reference direction. After reaching the borehole wall, the geophone probe is pressed against the wall. By further increasing the pressure, the probe can be anchored in the borehole for seismic recording. If the rubber hose is damaged, the clamping unit can be replaced as described in Chapter 4 Maintenance.

2.4 Compass unit

The central part of the compass unit is a two-component magnetometer sensor placed in a non-magnetic housing. The compass unit is mechanically connected to the geophone unit by the housing tube of the clamping unit.

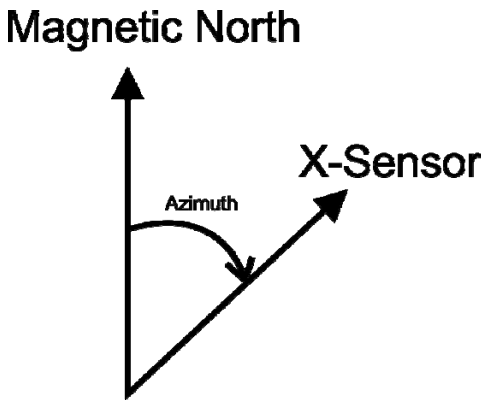


Figure 2: Schematic sketch showing angle measure

The angle between the magnetic North and the direction of the H1 component can be correctly measured and is displayed on the surface unit.

The electrical connection is via a cable connector housed in the plastic tube of the clamp unit. Two pairs of borehole cable wires connect both sensor components to the surface display box.

The resolution and accuracy of the compass readings are ± 2.5°. A display at the drum shows the measured magnetic azimuth of the downhole sensor.

2.5 Drum Instrumentation

The air pressure can be checked using the pressure gauge (see Figure 3).

Figure 3: Connectors on orange drum

- The OPEN valve (turn counter-clockwise) allows air to be supplied.
- The CLOSE valve (clockwise) allows the air to be released and the pressure to be maintained for Clamping.
- **RELEASE allows the air to be released while the pump is connected.**

The air pump connection is supplied with a special adapter. The outer ring must be pulled back to release the pump from the "AIR IN" socket. The pump can be permanently connected and doesn't need to be disconnected to release the air.

There are several other connectors mounted on the black plastic disk (see Figure 4)

Figure 4: Connectors on black plastic disc

USB:

- USB Interface to read magnetic azimuth using PC

ON/OFF:

- Switch on/off display

CHARGER:

- Adapter to charge internal batteries for compass

LIGHT:

- Press shortly once and the display will be illuminated (30sec)
- Press longer; illumination is forever (press again illumination stops)

RESET/CAL

- Press shortly compass is reset (resets basic values)
- Press longer (~ 2 sec) hard iron calibration is made. Hold BGK vertical and turn twice within the calibration time (20sec) for calibration.

3. Operation

3.1 Preparation

3.1.1 Clamping Steps

The maximum diameter of the borehole for anchoring the geophone is approximately 90 mm (without extension).

Please follow these steps to clamp the borehole geophone to the borehole wall:

Air in for Clamping	• Lower the geophone to the desired depth • Connect the air pump to the valve • Apply pressure and lift the cable slightly up and down • Stop applying pressure when BGK starts to clamp (lifting up and down is no longer possible) • Gently close the valve (turn to the right) • The geophone is now fixed. Slightly lower the cable by 5-10 cm and clamp it with the clamping device. This will release the tension in the cable.
Air out for release	• Disconnect the air pump from the valve • Open the valve (turn to the left) and release the pressure until the geophone is released. • Move the geophone to the next position

Apply gentle pressure to the system. Stop immediately if the system clamps. Check pressure frequently to see if the system is still clamped.

3.1.2 Cable Handling

To ensure a quality measurement, please note the following when handling the cable

- Please unwind the cable before starting the measurement, i.e., if you have a 30m cable, unwind the whole 30m.
- Place the cable in loops and avoid kinking the cable.

3.2 Measurement

3.2.1 Magnetic Compass

Please switch off the compass during seismic data acquisition!

3.2.2 Moving the Borehole Geophone

- The cable is clamped in place!
- Disconnect the air pump from the valve
- Open the valve (turn to the left) and release the pressure until the geophone is released.
- Move the geophone to the next position

4. Maintenance

4.1 Exchange of the clamping unit DDS

Unscrew the screws at upper and lower packer

Disconnect air pipe at moulding.
Remove air bladder.
Place new air bladder.
Cut new air pipe to appropriate length.
Re-connect