

TECHNICAL DOCUMENTATION

BHTV42/BHTV42G ACOUSTIC IMAGING PROBE

PART 1: PROBE INFORMATION & USE

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IMPORTANT SAFETY INFORMATION



This probe is powered by a supply voltage of up to 110 Vdc supplied by the EMINDLOGGER surface module. To avoid the risk of electric shock, the operator should verify that the probe power supply is switched off before connecting the probe to the logging cable, or before disconnecting the probe after use.



Maintenance of this equipment should only be carried out by competent personnel. If the probe is powered on with the outer housing removed, voltages of up to 1000 Vdc may be present on exposed contacts.

This equipment should always be operated in line with the recommendations contained in this document. Use of this equipment outside recommended limits may present a safety risk.

INTRODUCTION

This documentation presents the principal features of the BHTV42 and BHTV42G acoustic imaging probe and explains its operation with the EMINDLOGGER acquisition module and BHTV software package. For more detailed information concerning the BHTV acquisition software, please consult the BHTV Software Reference Manual.

PROBE APPLICATIONS

The probe provides orientated acoustic image data of the borehole wall used for:

- determination of geological formation dip angles and dip directions
- fracture analysis (frequency, degree of opening, fracture dip angles and dip directions)
- lithological characterisation (hardness, grain size ...) and clay content (with optional natural gamma detector)
- assisting with core sample orientation
- steel or PVC casing surface inspection

DATA EXAMPLES

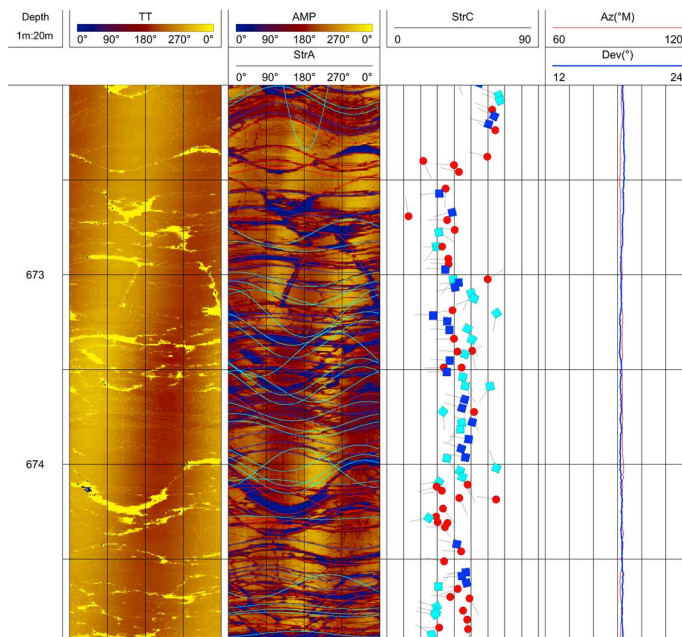


Figure 1: BHTV data with structural geological interpretation

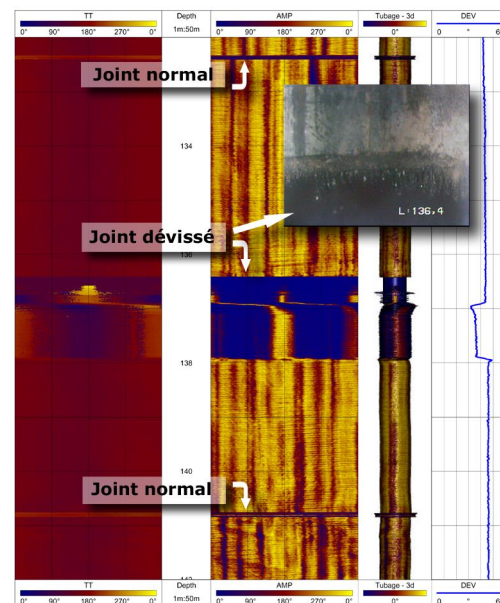


Figure 2: BHTV data from a casing inspection

PROBE DESCRIPTION & SPECIFICATIONS



The **BHTV42** acoustic televiewer tool employ a rotating transducer mounted at the lower extremity of the tool to send a highly focussed ultrasonic pulse radially outwards towards the borehole wall up to 360 times per revolution, the amplitude and travel time of which are measured on its return to the probe after reflection at the borehole wall. This information, combined with the data given by the tool's onboard orientation system, provides an extremely detailed and orientated acoustic image of the borehole wall.

As an option, the standard **BHTV42** probe can be supplied with a natural gamma detector to provide additional lithological information or for horizon correlation purposes.

A high-temperature variant, the **BHTV42-HT**, can operate at up to 125°C / 257°F.

Specifications

- ✓ Diameter: 42 mm / 1.65 "
- ✓ Length: 2100 mm / 82.7 "
- ✓ Weight: 8 kg / 17.6 lbs
- ✓ Max. operating Temp: 70°C (standard), 125°C (HT)
- ✓ Max. operating Pressure: 200 bar / 2900 psi
- ✓ Recommended max.cable length: 2000 m with 3/16" 4Go cable
1000 m with 1/10" monocable
- ✓ Housing type: Titanium & non-magnetic brass

Data / sensor parameters

- ✓ Max.communication speed: 312.5 Kbit/sec.
- ✓ Transducer: 1" focussed piezo-composite and rotating mirror
- ✓ Signal frequency: 1.5 MHz
- ✓ Acoustic beam angle: 3°(3dB) conical
- ✓ Amplification: 0 to 60dB in 1dB steps/AGC
- ✓ Horizontal resolution: 90, 120, 180 or 360 pixels defined by logging speed (2.4 m/min if resol.is 2 mm)
- ✓ Vertical resolution: (2.4 m/min if resol.is 2 mm)
- ✓ Orientation sensor: triple magnetometers / accelerometers
- ✓ Orientation precision: ± 0,5° inclination, ±1° azimuth

Accessories / options

- ✓ Natural gamma detector: ø25 x 50 mm NaI(Tl) crystal
- ✓ Non-magnetic centralisers
- ✓ Sinkers weight
- ✓ Image reference calibrator

Borehole conditions

- ✓ Fluid-filled open borehole: water or light bentonite mud
- ✓ Probe must be centralised
- ✓ Recommended diam. range: 75 to 300 mm / 3 to 12"

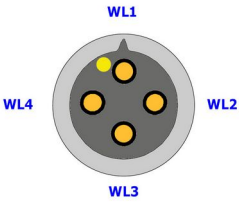
PROBE DATA PARAMETERS AND MEASURE POINTS

The measure point offsets indicated in the table below are measured from the bottom of the sonde.

SEQUENCE NUMBER	PARAMETER DESCRIPTION	PARAMETER MNEMONIC	DATA UNIT	OFFSET (cm)
1	Record depth	DPTH	mm	0
2	Log time	TIME	ms	0
3	Image shift angle	SHAN	0.1°	0
4	Acoustic blanking period	BLNK	*100ns	0
5	Peak detect period	PEAK	*100ns	0
6	Acoustic signal gain	GAIN	dB	0
7	Resolution	RESO		0
8	Head step	STEP		0
9	Baud rate divisor	BAUD		0
10	Communication pulse width	PULS	*100ns	0
11	Reserved parameter	-	-	-
12	X-axis magnetometer value	HX	*100μT	151
13	X-axis accelerometer value	GX	mg	151
14	Y-axis magnetometer value	HY	*100μT	151
15	Y-axis accelerometer value	GY	mg	151
16	Z-axis magnetometer value	HZ	*100μT	151
17	Z-axis accelerometer value	GZ	mg	151
18	Natural gamma counts ¹	NGAM	counts	189
19	Natural gamma timer value ²	GCLK	ms	189
20	Transducer temperature	TTEM	°C	0
21	Probe electronics temperature	PTEM	°C	0
22	Acoustic data (Travel Time, Amplitude)	SCAN	-	17
23	Data validity checksum	CSUM	-	0

PROBE CONNECTION CONFIGURATIONS

The probe can be operated in monocable or four conductor modes (as selected from the BHTV acquisition software).

 Pin configuration (looking into probe top from above)	WL n°	MONOCABLE MODE	FOUR CONDUCTOR MODE
	1	Probe power and data up/down	Uphole data (probe to surface)
	2	Not connected	Downhole data (surface to probe)
	3	Not connected	Not connected
	4	Not connected	Probe power

The yellow dot identifies WL1 which **must be positioned next to the alignment keyway for correct operation.**

- 1 Parameter only available if optional detector is installed
 2 See 1 above

OPERATING PRINCIPLES

The means by which the principle data parameters provided by the probe are obtained are described below.

ACOUSTIC TRAVEL TIME AND AMPLITUDE DATA

A rotating transducer located at the bottom of the probe sends an ultrasonic pulse (1.5 MHz) toward the borehole wall. After reflection from the borehole wall, the returning signal is analysed in the probe and the travel time and amplitude of the strongest reflection are recorded. To optimise the recording in terms of resolution and borehole diameter, the number of pulses per rotation can be selected by the user (90, 120, 180, 360) as well as the time period over which the reflected signal is analysed. The resulting travel time and amplitude values are presented in the form of two images. These images are generally presented orientated with respect to either the earth's magnetic North (when the borehole is vertical or slightly inclined) or the borehole high-side (when borehole inclination exceeds 30° from the vertical).

BOREHOLE INCLINATION AND AZIMUTH

The BHTV42 probe incorporates an orientation sensor based on tri-axial accelerometer and magnetometer detectors. This data allows the spatial orientation of the probe in terms of inclination and azimuth to be determined.

NATURAL GAMMA (OPTION)

The naturally occurring radioactivity generated by rock formations is in the main caused by the presence of potassium, uranium or thorium. The gamma radiation emitted by these elements is detected by means of a sodium iodide scintillation crystal. Incident gamma rays generate light flashes in the crystal material that are subsequently captured and transformed into electrical pulses by a photomultiplier tube. These pulses are counted by the probe electronics and sent to the surface together with the timing information required to calculate a counts-per-second value.

PROBE CALIBRATION AND/OR VALIDATION

ACOUSTIC TRAVEL TIME AND AMPLITUDE DATA

In respect of the acoustic data, the only parameter that can be user-calibrated is the marker angle reference value. This requires a specific accessory (part n° 51106) and the procedure is explained in the BHTV software reference document (page 29). With normal use this parameter should not change over time. A calibration should be carried out if for any reason the probe is disassembled and rebuilt. During this procedure, the acoustic signal travel time and signal amplitude can be checked and compared with previous values to ensure that probe performance is stable over time.

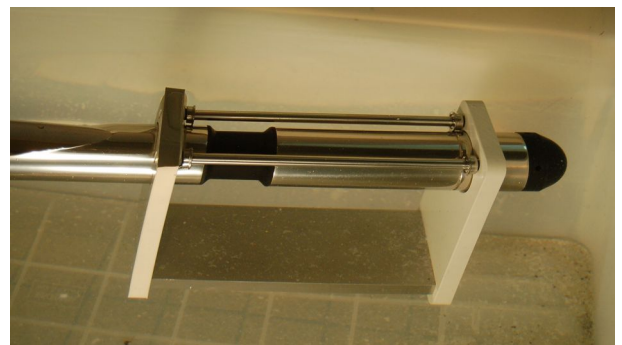


Figure 3: BHTV reference angle calibrator positioned on the probe during a check procedure

BOREHOLE INCLINATION AND AZIMUTH

The probe's on-board orientation sensor can not be calibrated by the user.

The sensor's performance can be checked periodically by setting up the probe in a known orientation (as given by a compass and/or inclinometer) in a location free of any possible magnetic influences and comparing the probe data with the reference values. If the probe values are not within normal limits ($\pm 0.5^\circ$ for inclination, $\pm 1^\circ$ for azimuth), please contact us for assistance.

NATURAL GAMMA (OPTION)

Ongoing detector performance can be monitored periodically either with a check source or calibrator accessory, or by running the probe in a test borehole and comparing the probe output with the values recorded on previous occasions.

The BHTV software incorporates a sensitivity coefficient that can, for example, be adjusted to compensate for the normal gradual loss of sensitivity that will occur over the lifetime of the probe (see BHTV software reference document page 9 for more information). In this case, the coefficient corresponds to the ratio of the initial cps value (i.e. the value obtained at probe delivery) to the new value obtained from the calibrator or borehole test.

Another use of the coefficient is to apply a cps to standard unit (e.g. API) conversion factor. This factor can be determined by running the probe in a test borehole where a reference log in calibrated standard units is available.

A gamma detector check jig/calibrator can be ordered from us either at the time of probe purchase or at a later date as an accessory (part n° 57110).



Figure 4: Gamma detector check jig/calibrator

Under normal circumstances, detector sensitivity loss should not exceed 5 to 10% annually according to probe use intensity. A sudden or excessive reduction in detector sensitivity should be investigated.

PROBE MAINTENANCE

The maintenance procedures necessary to keep the probe in its best operating condition are described in this section.

ACOUSTIC TRAVEL TIME AND AMPLITUDE DATA

The lowermost part of the probe below the acoustic window contains the pressure compensation system that ensures that the ultrasonic transducer is in equilibrium pressure-wise with the borehole environment. Over time, deposits and drilling mud residue entering this part of the probe through the compensation ports can build up, eventually solidify and impair the correct functioning of the compensation piston.

To avoid operating issues, the pressure compensation section of the probe should be cleaned periodically. According to probe use intensity and operating conditions, this may need to be done e.g. monthly or bi-monthly.

To carry out the cleaning, the black plastic nose-cone needs to be unscrewed from the lower probe housing. Use e.g. an appropriately-sized hex key inserted through the compensation ports to unscrew the nose cone.



While doing this, it is extremely important that the lower housing itself is not allowed to turn with respect to the acoustic window. Otherwise the transducer section can be seriously damaged.



Figure 5: Remove only the probe nose cone to clean the piston

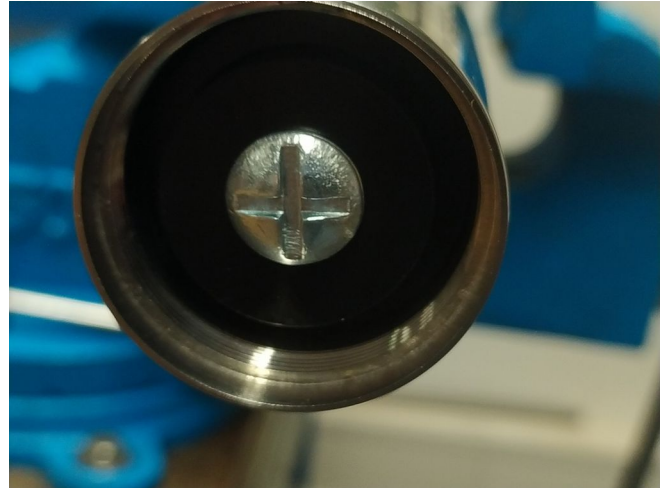


Figure 6: Clean the space around the piston with clean water

Once the nose cone has been removed, rinse the interior space between the piston assembly and the housing with clean, fresh water until the outflowing water runs clean and no further debris is apparent. **Be sure not to unscrew the compensation piston itself during this procedure.**

Once the compensation system has been cleaned, replace the nose-cone on the lower housing. **Again, while doing this, it is extremely important that the housing itself is not allowed to turn with respect to the acoustic window.**

NATURAL GAMMA (OPTION)

Periodically check the gamma ray response in cps using a test source or by running the probe in a reference borehole. It is normal for the probe response to deteriorate slightly over time, particularly if the probe is subjected to heavy use. A significant (> 10%) or sudden loss of response should be investigated.

PROBE OPERATION

SETTING UP/CONNECTIONS/STARTING THE SYSTEM



- Set up the winch and position the pulley over the borehole, either using the support legs or by hanging it from a suitable cable on the drilling machine (if present). If the pulley is to be used for depth measurement, connect it to the winch with the appropriate cable. Connect the winch to its power source **after checking that speed and direction controls are set so that the winch will not start unexpectedly.**
- Connect the eMindLogger module to the winch (MIL-19 cable) and to the logging PC or laptop with an appropriate USB cable. Connect the eMindLogger module to an appropriate source of power (220Vac mains power using the supplied transformer, or to a suitable 12Vdc supply eg. car battery).
- Start the PC or laptop, power on the eMindLogger module and double-click on the BHTV program icon to start the software :



PREPARATIONS FOR RECORDING A LOG

- Check in the BHTV program depth display that the depth increments in the correct direction when turning the pulley (positive depth increase = downwards).
- Fix centralisers to the probe and connect the probe to the logging cable taking care to align the cable-head correctly with respect to the probe.
- Unwind sufficient cable from the winch, then place the probe in the borehole taking care to avoid striking the probe against the drilling machine, tripod or surface casing.
- Using the winch, align the probe with the chosen depth reference (the alignment point on the probe corresponds to the bottom edge of the cable-head locking collar).
- If the currently configured probe is not the correct one, select the probe to be used from the probe

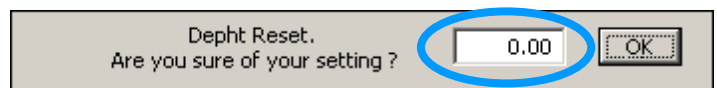


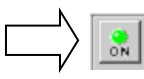
selection menu accessed by clicking on the  icon and then selecting the **Probe** tab in the **Logger**

Setup dialogue box :

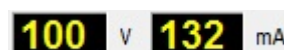


- Click on the  icon located in the top left corner of the program window. Enter the depth offset between the reference used to align the probe and the depth datum to be used for logging. If the probe alignment level is **above** the logging depth datum enter a **negative** value. If the probe alignment level is **below** the logging depth datum enter a positive **value**.



- Check that the probe is connected** and power it onprobe by clicking on the icon :  → 

The sonde voltage and current consumption are then displayed in the program window.

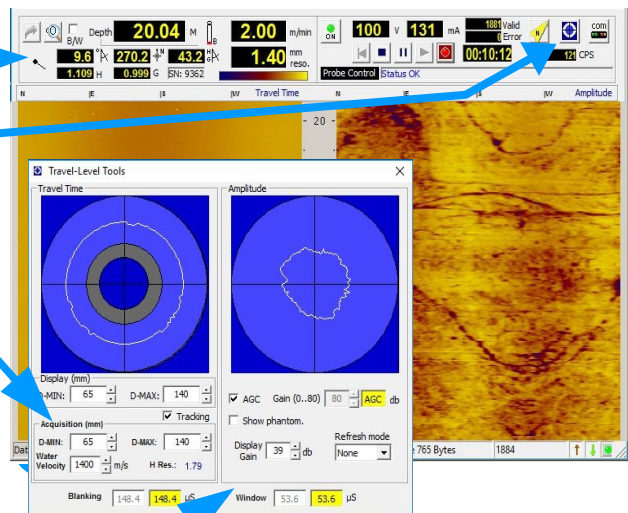


- Check that valid data is being obtained :
- Lower probe in the borehole to the log starting depth.



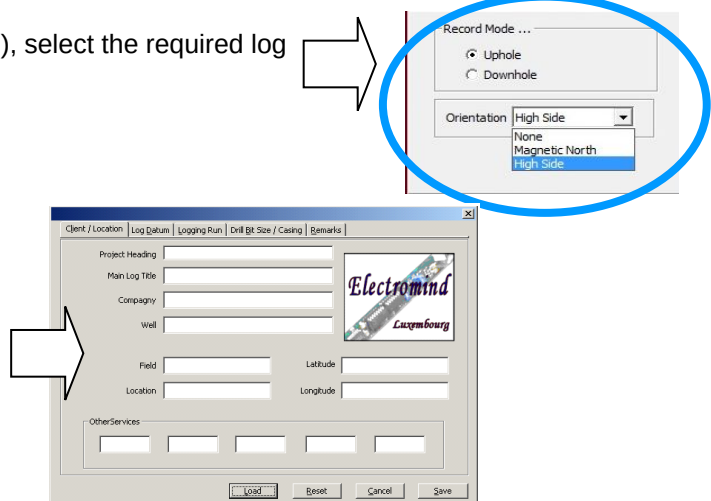
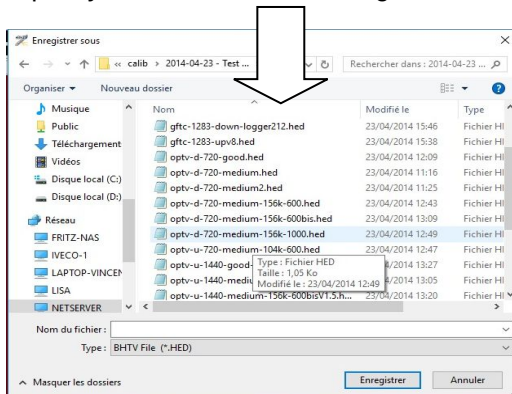
- Note that travel time and amplitude images will only be obtained once the ultrasonic transducer is immersed in the borehole fluid.**

- The probe orientation and image resolution are displayed below the depth/speed panel :
- If necessary, adjust the acquisition parameters by clicking here :
- Set the travel time window parameters by changing the D-MIN and D-MAX values according to the borehole size :
- Apply automatic gain or a fixed gain value (AGC recommended) and change the display gain value if the image is too dark or light using the controls in the right hand part of the dialogue box :

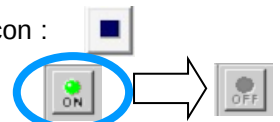


LOG RECORDING & REPLAY

- Click on the record button  or navigate to **File, New log** to begin a recording.
- Confirm the type of log (uphole or downhole), select the required log orientation mode and click on **OK**.
- Specify a file name in the dialog box.



- If you wish to complete the information in the log header dialog, enter the relevant data in the form, then click on **Save**, if not then click directly on **Cancel**.
- Start the winch and check that the data status remains valid. The image data will appear on the screen and the viewer windows – the recommended logging speed is between 1.5 and 2.5 metres/minute and should be adjusted according to the required image resolution.
- When the probe arrives at the log end depth, stop the recording by clicking on the icon :
- Switch off sonde power by clicking on the icon **before disconnecting the probe** :
- To replay the log for QC purposes, click on **File, Open** then select the required file. Use the replay control buttons to start, pause and halt the data replay :
- If required, click on **File, Export** to generate a LAS format file or a re-sampled raw data file for later processing.



For additional information, consult the BHTV software manual delivered with your system