

User Guide

QL40 ABI (2G) – VLB: Acoustic Imager for Very Large Borehole



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1 General Information

The QL40-ABI2G-VLB acoustic televiewer is specially designed to assess the integrity of large diameter wells. The tool implements the latest hardware/firmware generation to perform casing thickness measurement, corrosion evaluation and cement bond mapping in one run. The tool benefits from the new 2G telemetry protocol optimizing the logging speed on long single or multi-conductor wirelines when used in conjunction with the latest generation of ALT acquisition systems (OPAL-SCOUT).

The acoustic borehole imager records both 360°unwrapped and 3D images of the borehole wall.

The tool emits an ultrasonic beam towards the formation or casing and records the amplitude and the travel time of the reflected signal. The amplitude record is representative of the impedance contrast between the borehole wall and fluid. It gives a detailed image of the borehole wall. The travel time is used to determine accurate borehole diameter data, which makes the tool ideal for casing inspection and borehole deformation description -stress field analysis.

In addition new sophisticated algorithms compute the thickness of the casing and the cement distribution behind a steel casing (CADI). The CADI (Casing Amplitude Decay Index) represents a qualitative index related to the cement bonding.

A built in high precision orientation package incorporating a 3 axis fluxgate magnetometer and 3 accelerometers allows orientation of the images to a global reference and determination of the borehole's azimuth¹ and inclination.

The tool is supplied as a bottom sub of the Quick Link (QL) product line and can be combined with other QL40 tools to form a tool string or it can be run as a standalone tool.

Applications

- Well integrity
- Steel casing thickness
- Corrosion evaluation
- Cement bond mapping - Qualitative cement bond analysis
- Open Hole - structural analysis

¹ Only applicable in Open Hole

1.1 Dimensions

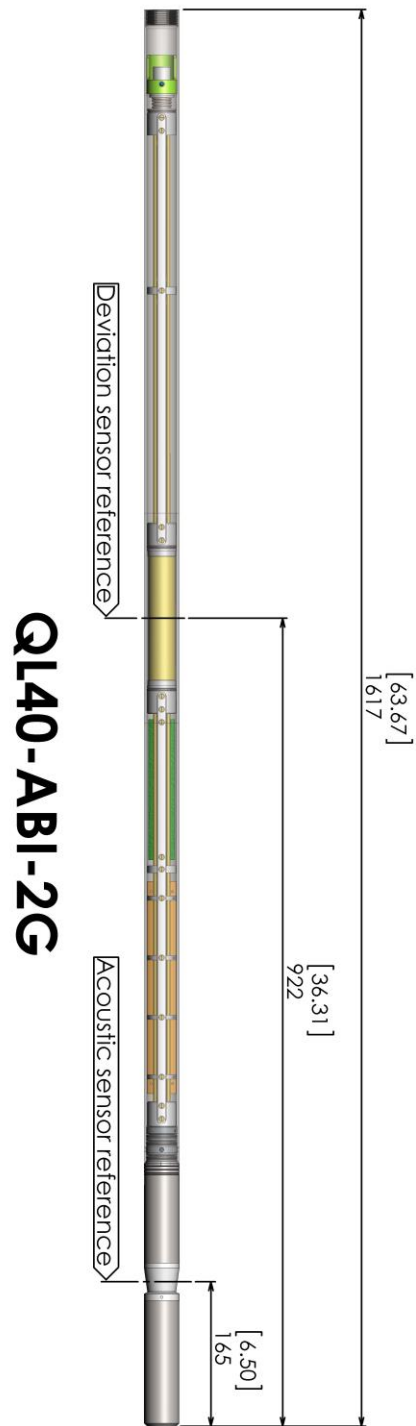


Figure 1-1 QL40-ABI-2G-VLB dimensions

1.2 Technical Specification

Tool

Diameter:	40mm
Length:	1.62m (63")
Measurement point:	0.165m (from probe bottom)
Weight:	6.7 kg (14 .7 lbs)
Max. Temp:	70°C
Max.Pressure:	200bar

Cable:

Cable type:	Mono, Coaxial, 4 or 7 conductor
Digital data transmission:	Up to 500 Kbits per second depending on wireline
Compatibility:	Scout – Opal – ALTlogger - BBOX - Matrix

Acoustic sensor:



Figure 1-2 Acoustic head

Acoustic sensor:	Fixed transducer and rotating focusing mirror
Measurement range ² :	Open Hole Mode 2.5" – 20" (64mm-500mm) Cased Hole Mode 10" – 30" (254mm-760mm)
Focusing:	Collimated acoustic beam
Frequency:	1.2 Mhz
Ultrasonic waveform sampling rate:	200ns – 800 μs full scale
Acoustic beam width:	1.5 mm (at focal point)
Rotation speed:	Up to 20 revolutions per second – automatic

² Diameter range of the hole in which the measurement is possible (depends on borehole conditions).

Azimuthal resolution:	<i>Open Hole Mode</i> 72, 144, 216 and 288 ppt - operator defined <i>Cased Hole Mode</i> 72 ppt
Caliper resolution:	0.16mm (0.006")
Orientation sensor:	
Sensor:	APS544
Location:	Middle point of sensor located at 0.92m from tool bottom
Orientation:	3 axis fluxgate magnetometer, 3 accelerometers
Inclination accuracy:	0.5 degree
Azimuth accuracy:	1.2 degree

Software requirements:

LoggerSuite:	12.1 or later
WellCAD	5.1 or later

Logger Firmware requirements:

Matrix:	113 – 117 - 100
Jazz – BBOX:	108
Scout:	Min. 209
Opal:	Min. 209

2 Measurement Principle

An understanding of the basic principles of operation of the televiwer is essential for successful use of the tool. The ABI produces images of the borehole wall which are based on the amplitude and time of travel of an ultrasonic beam reflected from the formation wall. The ultrasonic energy wave is generated by a specially designed piezoelectric ceramic crystal and has a frequency of around 1.2MHz. On triggering, an acoustic energy wave is emitted by the transducer and travels through the acoustic head and borehole fluid until it reaches the interface between the borehole fluid and the borehole wall. Here a part of the beam energy is reflected back to the sensor, the remainder continuing on into the formation medium at a changed velocity (Figure 2-1). By careful time sequencing the piezoelectric transducer acts as both transmitter of the ultrasonic pulse and receiver of the reflected wave. The travel time for the energy wave is the period between transmission of the source energy pulse and the return of the reflected wave measured at the point of maximum wave amplitude. The magnitude of the wave energy is measured in dB, a unit less ratio of the detected echo wave amplitude divided by the amplitude of the transmitted wave.

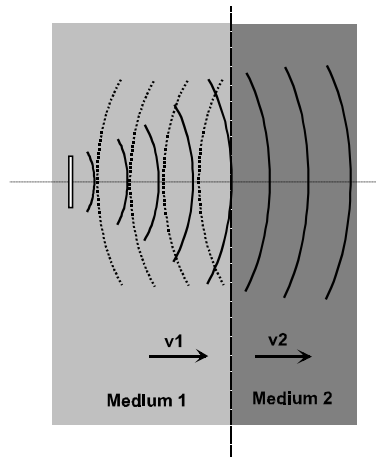


Figure 2-1 Wave propagation

2.1 Reflection coefficient

The strength of the reflected signal depends principally on the impedance contrast between the borehole fluid and the formation (Figure 2-1).

The reflection coefficient r is given by the following equation:

$$r = (\rho_b v_b - \rho_m v_m) / (\rho_b v_b + \rho_m v_m)$$

where ρ_b = density of formation
 ρ_m = density of borehole fluid
 v_b = velocity of sound of formation
 v_m = velocity of sound of borehole fluid

The larger the reflection coefficient is the greater is the signal reflection and thus the ability to detect the signal. From the equation above it may be seen that when the properties of the borehole fluid and borehole wall are similar, i.e. $\rho_b v_b \approx \rho_m v_m$, the reflection coefficient r approaches zero and there is negligible reflection. In this situation determination of the true reflected wave is made more difficult.

2.2 Acoustic head operation

The acoustic wave is generated by applying a high voltage pulse across the two faces of a piezo ceramic disc. The applied voltage causes deformation within the crystal structure, either an expansion or contraction depending on the polarity of the applied voltage, with a resultant energy wave emitted normal to the free surface. It has been shown that the beam generated by this process has a maximum energy at a distance of twice the diameter of the disc and that after this point the beam tends to diverge. In order to optimize the beam energy at the point of investigation the ALT televiewer head has been designed as illustrated below (Figure 2-2).

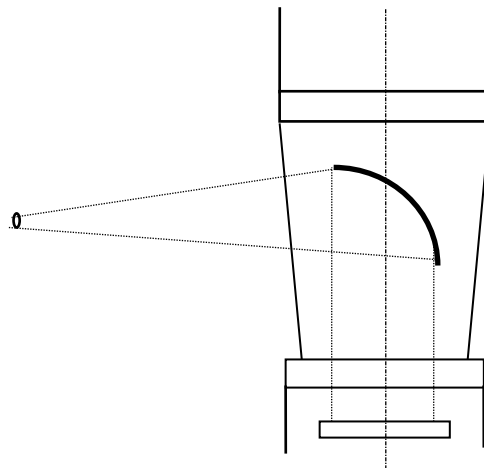


Figure 2-2 Focussing arrangement

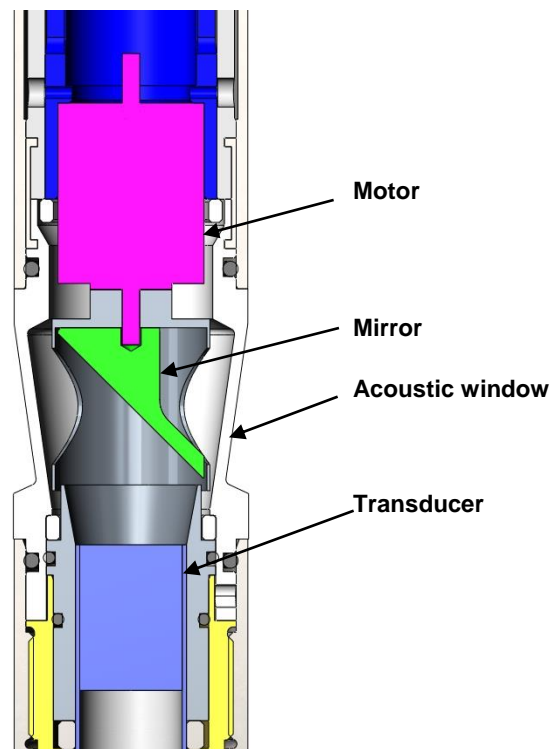


Figure 2-3 QL40 ABI acoustic head architecture

The acoustic wave propagates along the axis of the tool body and is then reflected perpendicular to this axis by a special reflector that focuses the beam to a high-energy point of +/- 1.5 mm diameter. The radial distance of the focal point from the axis of the tool is determined by the focal length of the mirror, +/- 75mm (for an acoustic head with a 6" focusing mirror).

The frequency of the transmitted wave is determined amongst other factors such as ceramic composition by the diameter of the piezo transducer, a smaller diameter giving a higher frequency. The ALT televiewer operates around 1.2MHz.

The reflector is mounted on the drive shaft of a stepper motor. This enables the position of measurement to be rotated through 360°. Sampling rates of 72, 144, 216 and 288 measured points per revolution are available, thus at maximum resolution a near continuous image of the borehole wall is made. The higher sampling rate can be used for better resolution in larger diameter boreholes but is less useful in small diameters due to overlap of the sampling points.

3 Notes on QL tool assembly

The following explanations are only valid for the QL40 ABI tool versions. ABI40 “standalone” users can skip this chapter.

QL stands for **Quick Link** and describes an innovative connection between logging tools (subs) allowing to build custom tool stacks. QL40 describes a specific family of logging tools. Each sub is equipped with its own Telemetry board, Power supply element and A/D converter allowing an operation as stand-alone tool or as a stack in combination with other subs of the QL product family.

The QL40 probe line deals with two types of subs - Bottom Subs and Mid Subs.

Bottom Sub

A bottom sub is a tool that must have one or more sensors located at the bottom. It can be operated in combination with other QL subs connected to the top but it is not possible to connect another sub below. When used in stand-alone mode the bottom sub only needs a QL40 tool top adaptor, which fits the cable head.

Mid Sub

A mid sub is a tool that can be integrated anywhere within a stack of tools. When used at the bottom of a tool string a QL40 bottom plug must be used to terminate the string. If the mid sub is used as a stand-alone tool it needs a QL40 bottom plug at the lower end and a QL40 tool top adaptor at the top.

3.1 QL40 stack assembly

QL40 tool stacks are terminated by either a QL40 bottom sub or a QL40 bottom plug. At the top of the stack a QL40 tool top is required to connect the tool string to the cable head. Several tool tops are already available, special ones can be made on request.

To assemble and disassemble the subs the C-spanner delivered with the tool must be used (Figure 3-1). It is recommended that before each assembly the integrity of the O-rings (AS216 Viton shore 75) is verified. Prime the O-rings with the silicon grease that was supplied with the subs.

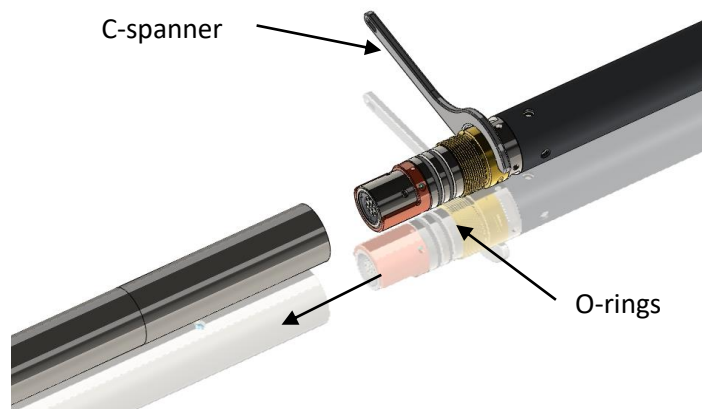


Figure 3-1 C-spanner and O-rings of QL connection

The following example of a QL40-ABI, QL40-GAM and QL40-GO4 (Figure 3-2) describes how to replace the QL40-ABI with a QL40-Plug in order to run the QL40-GAM sub stand-alone.

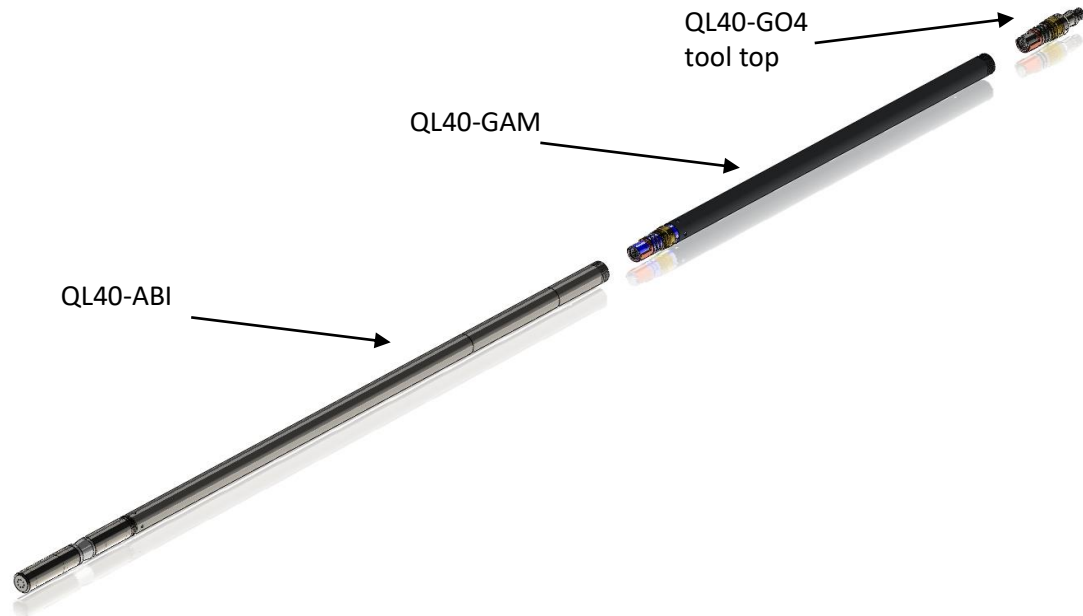


Figure 3-2 Tool stack example

To remove the QL40-ABI bottom sub attach the C-spanner to the thread ring as shown in Figure 3-3, unscrew the thread ring and remove the QL40-ABI bottom sub.

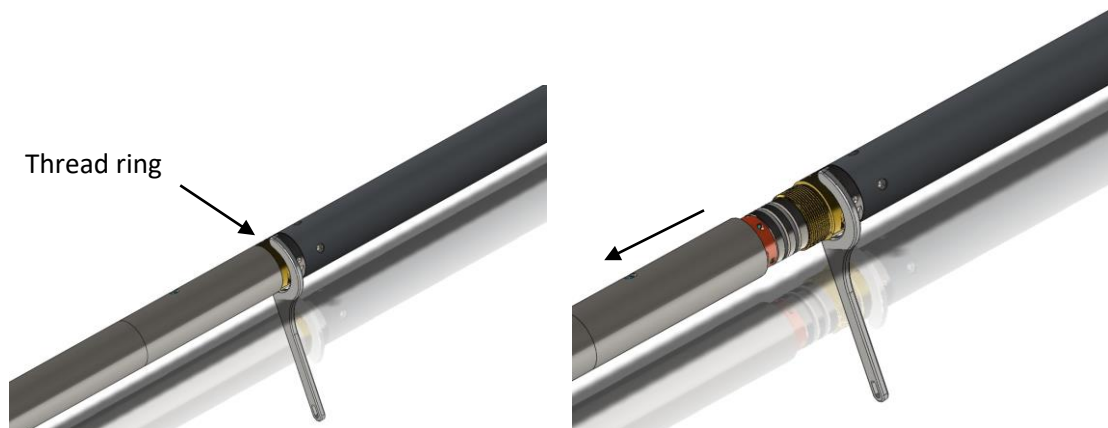


Figure 3-3 Unscrewing the thread ring and removing the bottom sub

After checking the O-ring integrity slip the QL40-Plug over the exposed QL connector (Figure 3-4) attach the C-spanner and screw the thread ring until the plug fits tight.



Figure 3-4 Attaching the QL40-Plug

The QL40-GAM can now be run stand-alone (Figure 3-5).



Figure 3-5 QL40-GAM mid sub with tool top and bottom plug

4 Operating Procedure

4.1 Preliminary note

Acoustic televiewer image quality is highly dependent upon tool centralisation.

One set of centralizers is supplied with the QL40-ABI-2G-VLB and is suitable for cased hole inspection. The standard assembly comprises upper and lower mounting rings with two sets of blades for respectively 10" to 18" and 18" to 27" casing sizes. The following points relating to the use of centralisers should be considered:

The centralisers should be fitted before mating the tool with the wireline cable head and should always be fitted from the cable head end to avoid damaging the acoustic window.

Refer to the schematic below for the centralizer assembly.

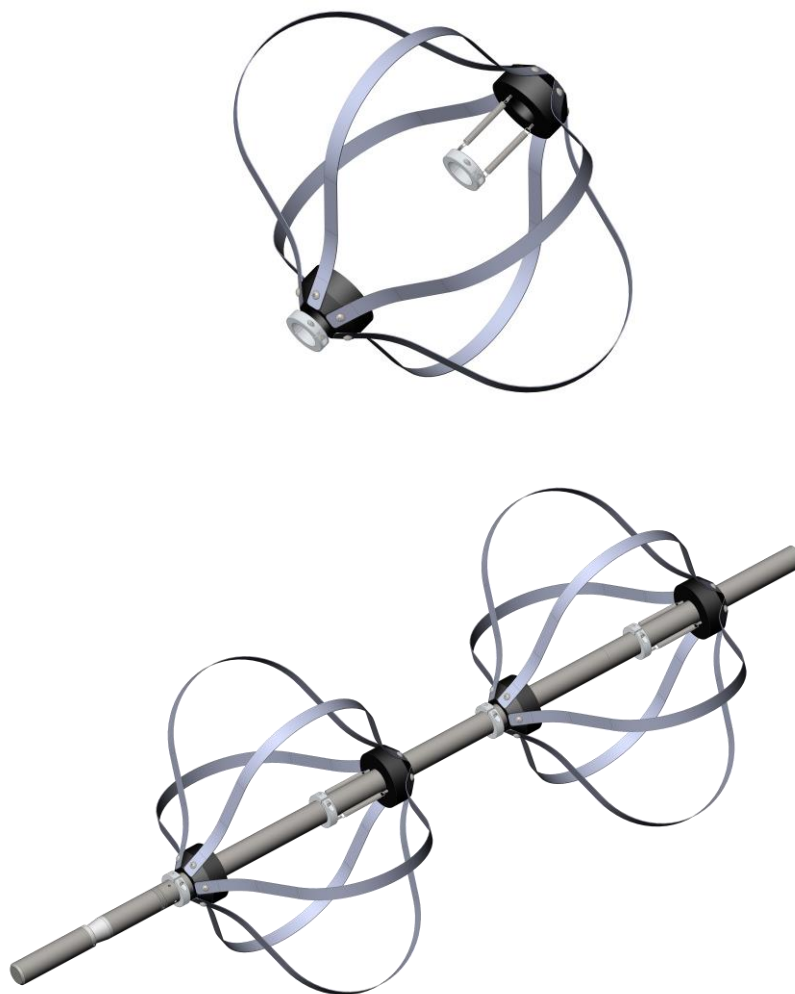


Figure 4-1 QL40-ABI-2G-VLB with mounted centralizers.

4.2 Quick Start

Note: Parts of the topics discussed in these sections below assume that the user is familiar with the data acquisition software. Refer to the corresponding operator manuals for more details. Information about assembly and configuration of tool stacks can be found in the same manuals.

1. Connect the tool to your wireline and start the data acquisition software.

2. Select your predefined winch configuration from the **Winch** panel and pick the relevant QL40-ABI-2G-VLB tool from the drop down list (Figure 4-2) in the software's **Tool** panel (if your tool is not listed check that your tool configuration file is stored in the designated folder on your computer).



Figure 4-2 Tool panel

3. In the **Tool** panel switch on the tool (click **On** button) and verify that the power indicator shows a valid (green) level. The system goes through a short initialization sequence which sets the default parameters and communication settings held in the winch data base. The configuration returned by the tool is also checked during this procedure. (Setup tool communication as explained in chapter 4.5 if error message is displayed.)
4. On the **Tool** panel (Figure 4-2) click the **Settings / Commands** button to configure your tool for open hole/cased hole logging (see chapter 4.3 and 4.4 for details).

5. In the **Acquisition** panel (Figure 4-3) select the sampling mode ("depth" recommended). Click on **Settings** and specify the corresponding sampling rate. Switch on the sampling (click the **ON** button).



Figure 4-3 Acquisition panel

7. During logging observe the controls in the **Telemetry** panel:

- Status must be valid (green light);
- Bandwidth usage in green range;
- Memory buffer should be 0%;
- Number of **Data** increases and number of **Errors** negligible.
- Verify motor status (synchronization) in MChNum browser is valid.
- Do not log too fast! The **Data/sec** parameter must not exceed the speed of the motor rotating the mirror. Check against the **MotSpeed** displayed in the MChNum window.

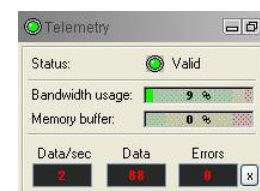
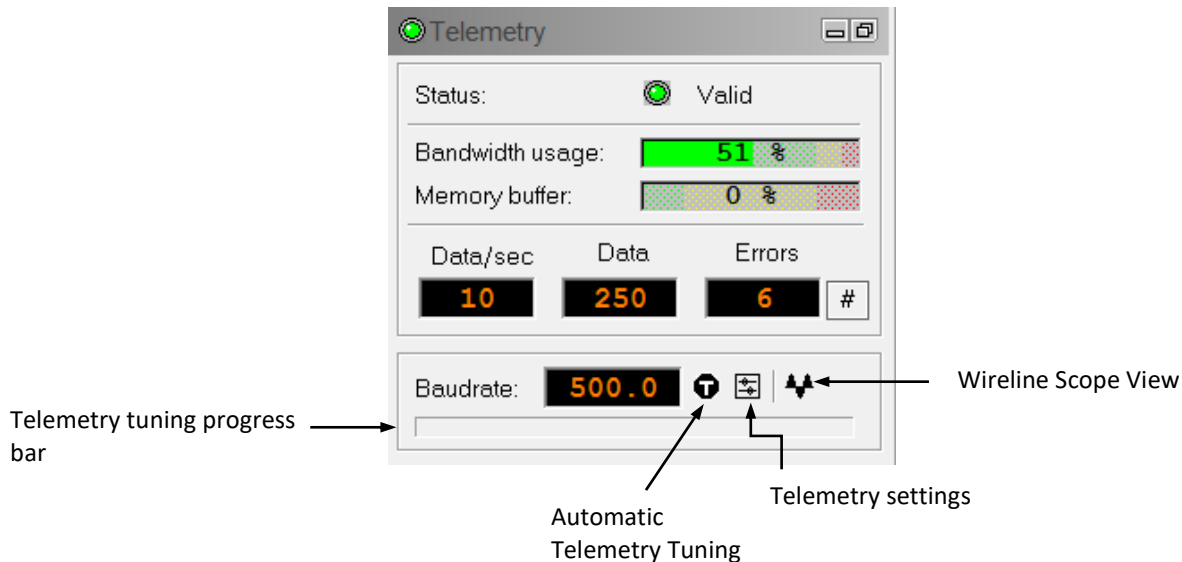


Figure 4-4 Telemetry panel

8. To end the logging procedure press the **Stop** button in the **Acquisition** panel and turn off the sampling (click **OFF** button).
9. In the **Tool** panel power off the tool.

4.3 Tool Communication with OPAL/SCOUT (ALT MODEM)


The telemetry provided through the **OPAL-SCOUT** systems implementing the **ALT MODEM** controls and configures **AUTOMATICALLY** the telemetry settings for any wireline. In case communication status is not valid the user has different options to adjust manually the telemetry settings from the telemetry panel of the dashboard:



Baud rate:

Indicates the default baud rate or optimal baud rate in kbps found by the system for the selected winch/telemetry scheme

Automatic Telemetry Tuning:

The Tune button  resets the telemetry tuning automatically. This process defines:

- the optimum baud rate for the winch configuration selected
- a transfer function and a filter to re-construct at the surface the shape of the pulse trains distorted by the wireline.

A **progress bar** at the bottom of the telemetry window shows the progression of the telemetry tuning. At the end of the process the baud rate display is refreshed with the optimal baud rate value.

Refer to **Appendix** at the end of this manual for more information on the **advanced telemetry settings**.

4.4 Tool Communication with ALT Logger

The telemetry provided through the ALTLogger is self-tuning. In case communication status is not valid the user can manually adjust the settings. In the **Telemetry** panel of the dashboard click on **Settings** to display the **Configure Tool Telemetry** dialog box (Figure 4-5). A procedure to achieve valid communication is given below:

- Change the **Baudrate** to 41666 kbps.

- Verify that the **Downhole Pulse width** knob is set on 20 (default value). This value is the preferred one and is suitable for a wide range of wirelines. For long wireline (over 2000m), increasing the pulse width could help to stabilize the communication. The reverse for short wireline (less than 500m).
- Set the **Uphole** discriminators in the middle of the range for which the communication status stays valid.
- Increase the **Baudrate**, check the communication status stays valid and the **Bandwidth usage** (in **Telemetry** panel of the dashboard) is below the critical level.
- When **Uphole** discriminators are properly set, store the new configuration as default. The tool should go through the initialisation sequence the next time it is turned on.

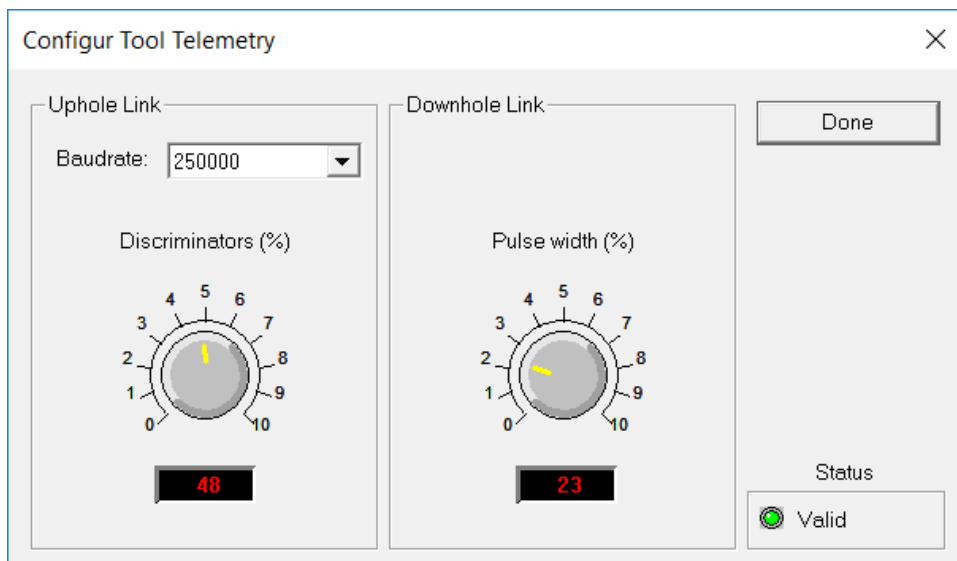


Figure 4-5 Tool communication settings

4.5 Tool Communication with MATRIX

The tool telemetry can be configured through the **Telemetry** panel of the Matrix dashboard. By clicking on **Settings**, the operator has access to the **Configure ALT Telemetry** dialog box (Figure 4-6) providing various controls to adjust the telemetry settings and monitor its current status.

The **Analysis View** displays the current discriminator levels (vertical yellow lines) and a histogram of the up-hole data signal. The scales of the **Analysis View** can be adjusted using the **Vertical Scale** and **Horizontal Scale** knobs and the **linear / logarithmic** scale buttons. The status of the configuration should be flagged as Valid (indicated by the LED being green). In any other case (LED red) the telemetry should be adjusted (we assume a pulse signal is displayed in the analysis view). Click on the **Advanced** button to display additional controls to tune the telemetry.

The Automatic settings option is the preferred mode and should allow the telemetry to be configured for a wide range of wirelines without operator input. For wirelines with a more limited bandwidth, the operator might need to turn off the automatic mode and adjust the telemetry settings manually.

For each wireline configuration, the discriminators (vertical yellow lines) for the **positive** and **negative** pulses must be adjusted in order to obtain a valid communication status (see

Figure 4-6) for an example of a suitable discriminator position). There is also the option to alter the **baudrate** in order to optimize the logging speed. The input **gain** can be increased (long wirelines) or decreased (short wirelines) in order to set up the discriminator levels correctly.

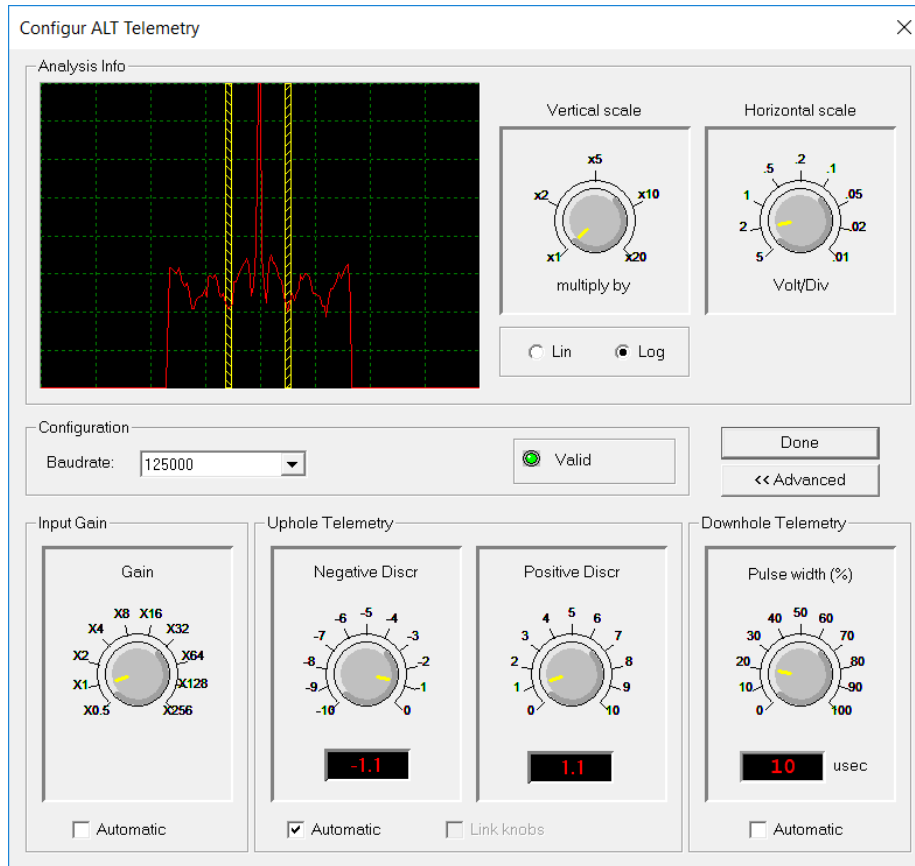


Figure 4-6 Matrix telemetry settings

Once the telemetry is correctly set, store the new settings as default. The tool should go through the initialization sequence in “Valid” status the next time the power is turned on.

4.6 Configuring Tool Parameters

The **Configure ABI Tool Parameters** dialog box (Figure 4-7) can be accessed by clicking on the **Settings / Command** button on the dashboard's **Tool** panel or by clicking on the tool's bitmap located in the **Tool Stack Manager** window.

4.6.1 Operating Modes

Three operating modes are possible for recording acoustic images with the QL40-ABI2G-VLB:

- Open hole mode
- Behind PVC mode
- Cased hole mode

4.6.1.1.1 Open hole mode

This record mode is used in open-hole conditions or to record the inner face of a casing.

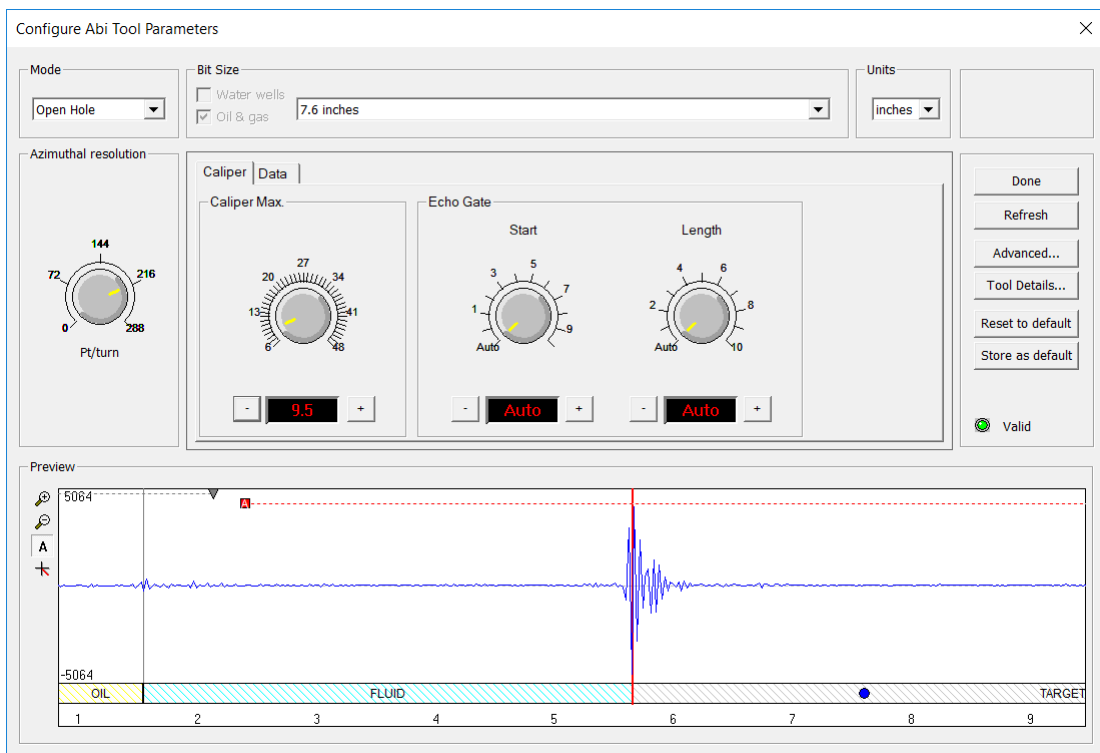


Figure 4-7 Example of tool settings – Open hole mode

When selecting a predefined bit size from the **“Bit Size”** dropdown list, the system configures automatically the most suitable tool settings – azimuthal resolution, caliper max, echo gates - for the selected bit size or borehole nominal diameter.

Note that the User always has the choice to modify the tool settings as per his or her own requirements.

Imperial or **metric** units can be used for displaying the wave form preview and for configuring the caliper/echo gate settings.

Selecting the **“Open Hole”** mode gives access to two page tabs – **Caliper** and **Data** - for configuring the record:

Caliper tab:

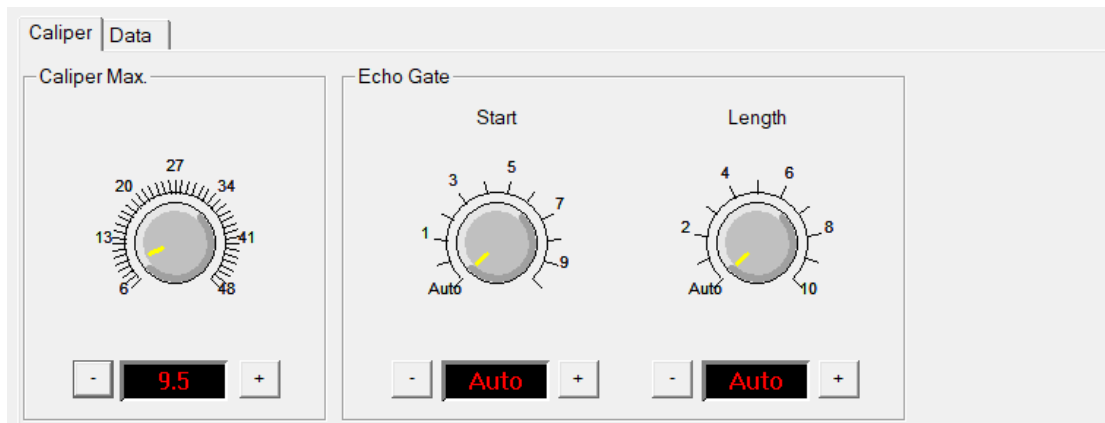


Figure 4-8 Caliper and Echo Gate settings

In the **Caliper** page, the **Caliper Max.** knob (Figure 4-8) controls the extension of the real time preview of the ultrasonic waveform. It must be adjusted for the borehole diameter to investigate to allow detection and recording of the main echo.

Echo Gate settings are set in the “Auto” mode by default. If required, User can define a **“Start”** gate and specify the **“Length”** interval for recording the reflected echo. The tool firmware will pick up the strongest amplitude in the signal train within the Echo Gate and records amplitude and travel time of the borehole echo.

Note that the **Echo Gate** settings can also be adjusted interactively in the waveform preview.

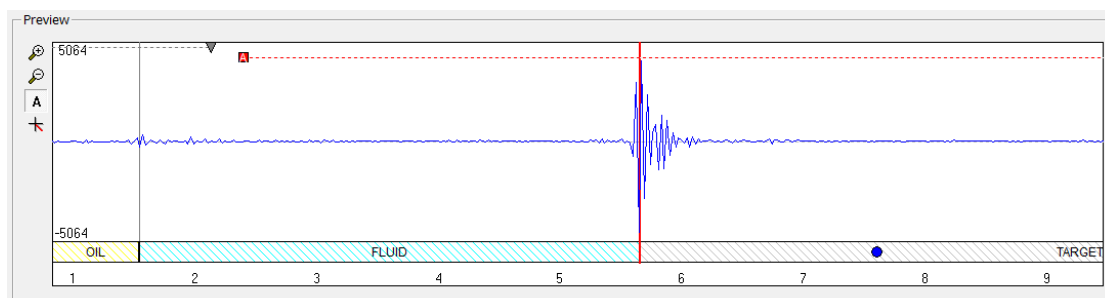




Figure 4-9 Waveform preview - Echo gate Automatic setting

For the open hole mode, the waveform preview allows the user to adjust the limits of two gates – the **Acoustic Window gate** and the **Echo Gate**. The Acoustic Window is represented by a grey dashed line while the Echo Gate is shown as red dashed line.

The Acoustic Gate allows determination of the tool’s acoustic window reflection time.

The **Echo Gate “Start”** limit can be determined automatically or adjusted interactively in the preview. Square and triangle symbols indicate whether the limit of the **“Start”** gate is automatically set (square symbol - ) or if the user can adjust the limit with the mouse cursor (triangle - ) .

Three modes are supported to set the **Start** time of the Echo Gate - To toggle from one mode to another right click on the square or triangle symbol.

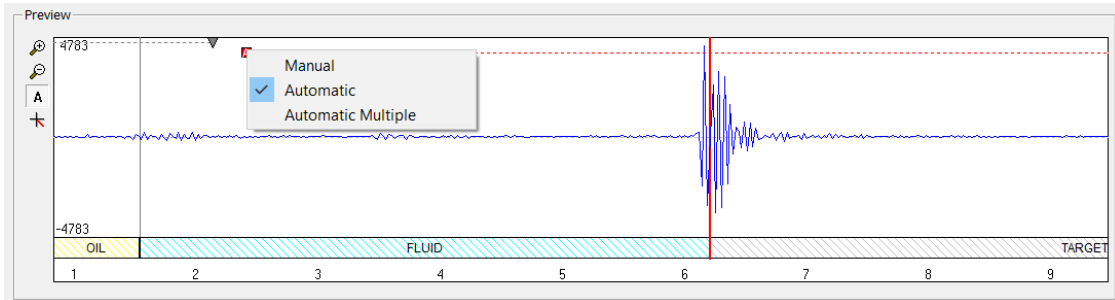


Figure 4-10 Toggling between Echo Gate detection modes

- **Automatic:** the system will automatically detect and record the highest amplitude occurring after the Acoustic Window Gate and the upper limit of the Echo Gate (Figure 4-11). Automatic is the recommended setting.

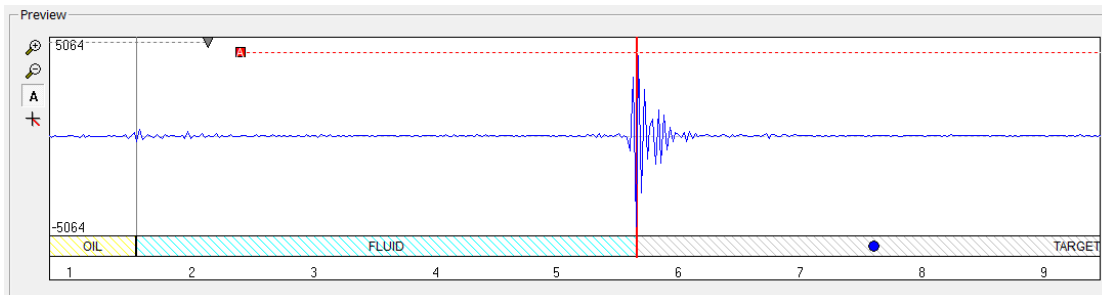


Figure 4-11 Start gate set in automatic mode

- **Automatic Multiple:** the system will automatically adjust the start time of the Echo Gate so that the first multiple of the Acoustic Window reflection is skipped. This setting is useful for large diameter boreholes when the amplitude of the first multiple of the Acoustic Window reflection is higher and arrives earlier than the echo from the borehole wall (Figure 4-12).

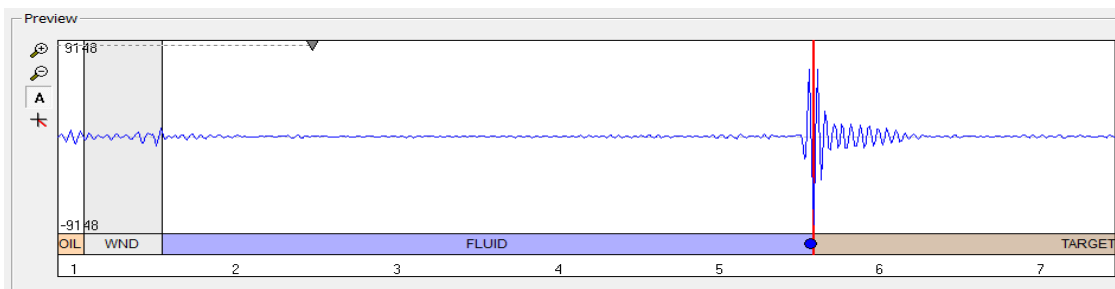


Figure 4-12 Start gate set in automatic multiple mode

- **Manual:** Manual adjustment of the Echo Gate start time is useful to exclude noise with amplitudes higher than the formation signal (e.g. exclude the reflection from the inside of a PVC casing) – (Figure 4-13).

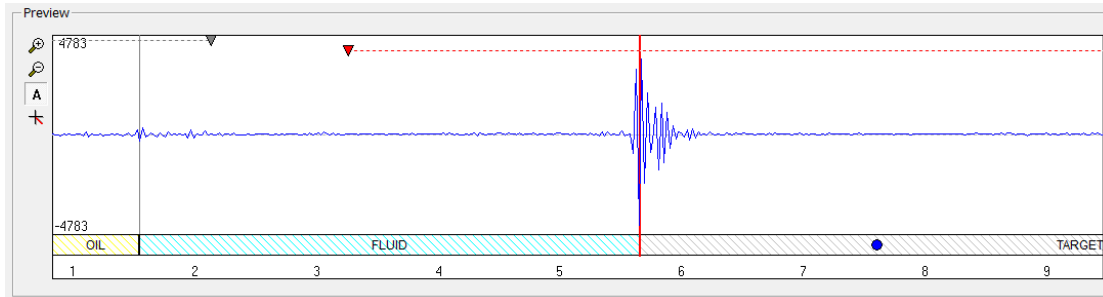


Figure 4-13 Start gate set in manual mode

Interactive adjustment in the waveform preview of the Echo Gate **Length** is also possible. It could be useful when multiple reflections with large amplitudes arrives towards the end of the gate period (e.g. exclude Acoustic Window reflection multiples when logging in soft formations).

To toggle the Echo Gate **Length** from the automatic to the manual mode, place your cursor at the right end of the red dashed line to display the double arrows symbol. Drag then the length limit to the desired position on the wave form preview.

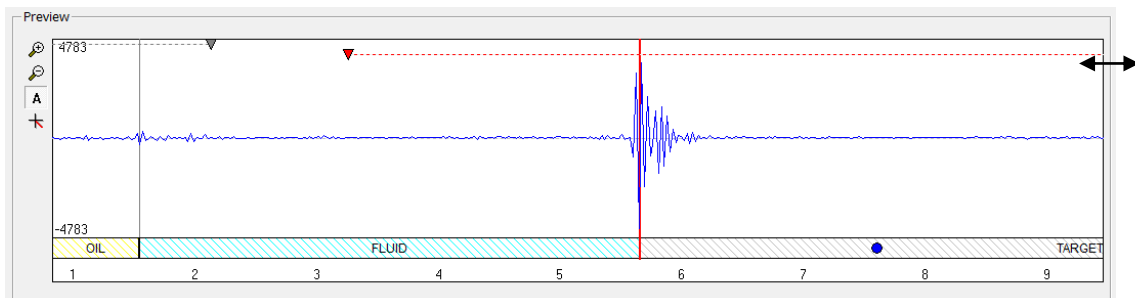


Figure 4-14 Toggling the Echo Gate Length between automatic and manual mode

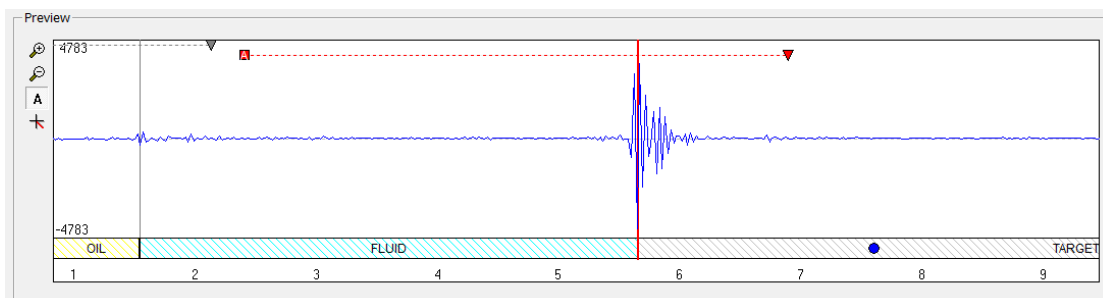


Figure 4-15 Echo Gate Length set in manual mode

To toggle the Echo Gate **Length** from manual to automatic mode, right click on the corresponding triangle symbol.

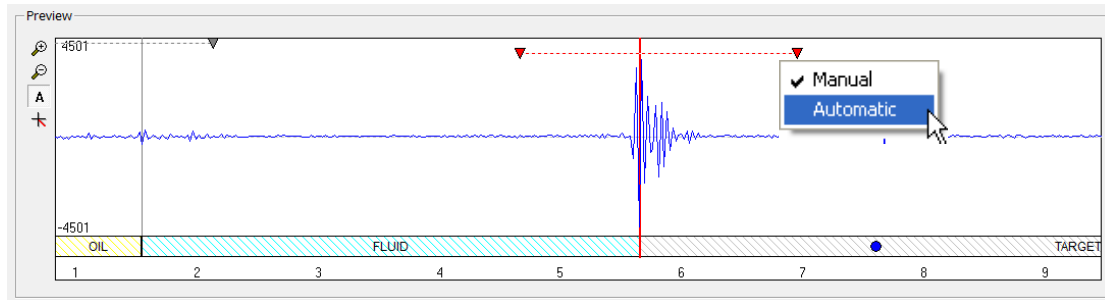


Figure 4-16 Toggling the Echo Length setting from manual to automatic

Data tab:

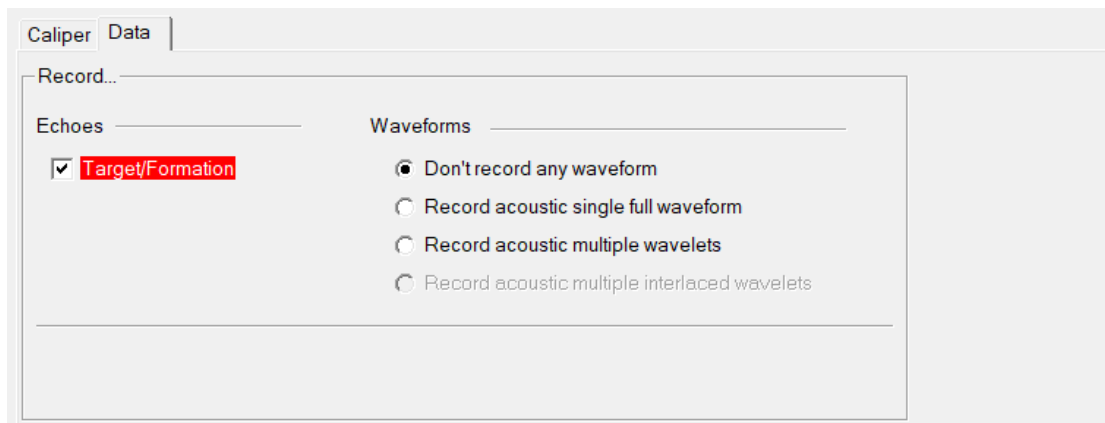


Figure 4-17 Data record options for the Open hole mode

The **“Target/Formation”** record option **must always be checked**. If unchecked, no acoustic image will be recorded.

For diagnostic purposes or advanced processing, the **“Waveforms”** record option can be activated.

- The **“Record acoustic single full waveform”** option records the complete ultrasonic waveform shown in the preview window in a single and predefined direction.
- The **“Record acoustic multiple wavelets”** option records the echo wavelets reflected on the borehole wall. The system records a maximum of 36 wavelets over the borehole circumference on each acoustic trace.

Note that recording the ultrasonic waveforms and wavelets will affect the telemetry performance and will slow down the logging speed significantly.

4.6.1.1.2 Behind PVC Mode

The “**Behind PVC**” mode is used in PVC cased boreholes. The main purpose is to log the borehole wall image located behind a PVC casing.

The algorithms implemented in the tool firmware detect and record all existing echoes on the ultrasonic waveforms. The detected echoes are then sorted and interpreted as either a reflection from the casing or from the borehole wall (Figure 4-18).

Remember that for this application, the PVC casing must be properly centred in the borehole and the tool correctly centralised in the casing to obtain satisfactory results.

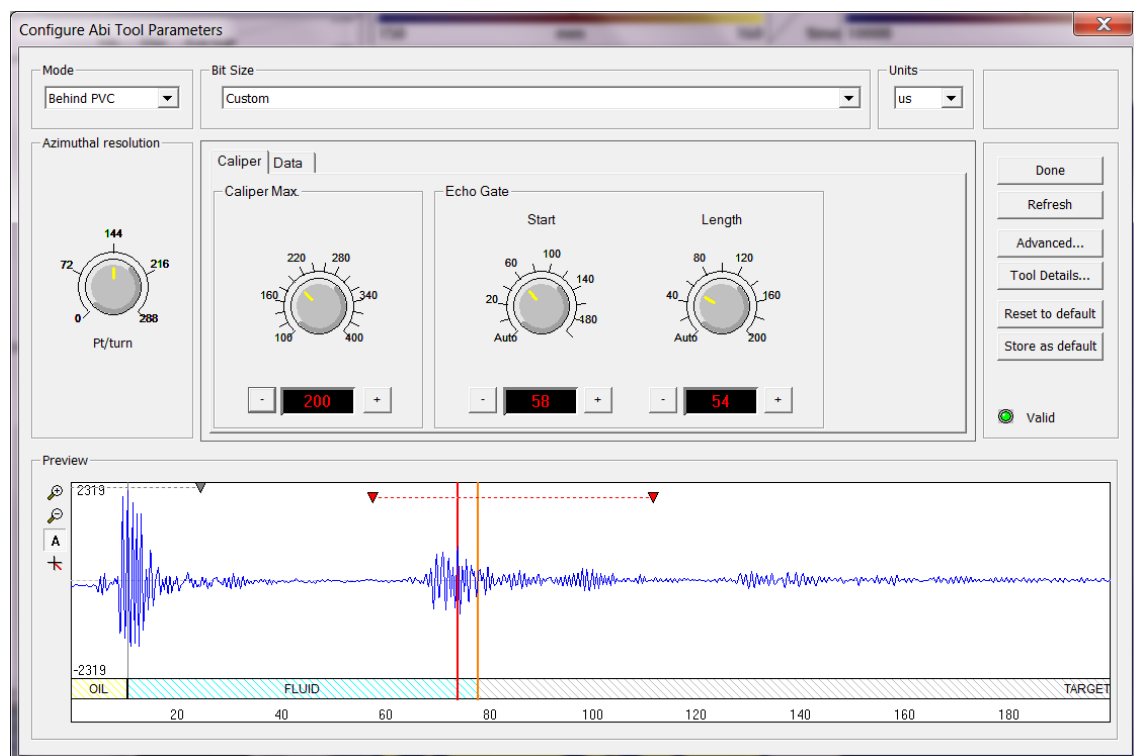


Figure 4-18 Behind PVC settings – automatic settings

Selecting the “**Behind PVC**” mode gives access to two page tabs – **Caliper** and **Data** - for configuring the record:

Caliper tab:

The caliper settings described in section 4.5.1.1 are applicable for the “Behind PVC” mode.

In principle two major echoes are detected on the waveform preview. The first one is the reflected echo from the inner side of the casing. It is highlighted by the red vertical line. The second reflected echo, corresponding to the borehole wall, is highlighted by the orange vertical line.

Data tab:

Figure 4-19 Data record options for the Behind PVC mode

By default, the system records both the PVC and the Target/Formation images.

The **“Target/Formation”** record option **must always be checked**. If unchecked, no acoustic image from the borehole wall will be recorded.

The option is given to the user whether or not to record the image of the inner face of the PVC casing.

Recording the PVC image might be interesting to check the casing integrity or for looking at eventual encrustations.

For diagnostic purposes or advanced processing, the **“Waveforms”** record option can be activated.

Note that recording the ultrasonic waveforms and wavelets will affect the telemetry performance and will slow down the logging speed significantly.

4.6.1.1.3 Cased hole mode

This acquisition mode is used to perform casing thickness measurements and corrosion evaluation in steel casings.

The operator can select from a dropdown list the nominal specifications of the casing under investigation (Figure 4-20). Two casing tables are available. One for “Water Wells” application and a second one for “Oil & Gas” applications. The user has the option to display one of the two or both casing tables in the dropdown list by checking the corresponding boxes.

When selecting a predefined **“Casing size”**, the system configures automatically the most suitable tool settings – azimuthal resolution, caliper max, echo gate, thickness, echo gate length - for the casing external diameter and weight chosen.

The User is also given the choice of customizing his or her own settings manually by adjusting the different knobs or interactively in the waveform preview window as described in a previous chapter.

Imperial or **metric units** can be used for displaying the wave form preview and for configuring the caliper - thickness settings.

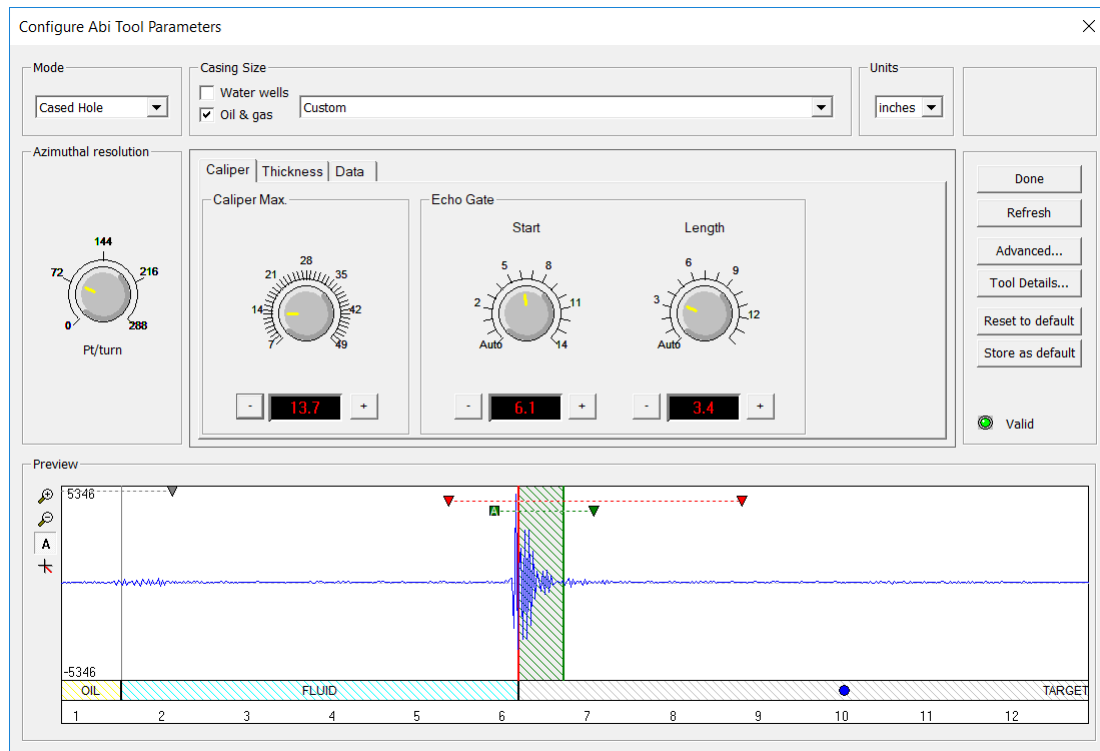


Figure 4-20 Example of Cased hole settings

Caliper tab:

The caliper settings described in section 4.5.1.1 are applicable for the “Cased hole” mode. Caliper settings must be adjusted for recording the echo reflected on the inner face of the steel casing.

Thickness tab:

From the thickness tab, the operator has the option to edit the internal (Low) and external (High) casing thickness dimensions manually for the record. The Echo gate Length can be adjusted from this window or interactively from the wave form preview.

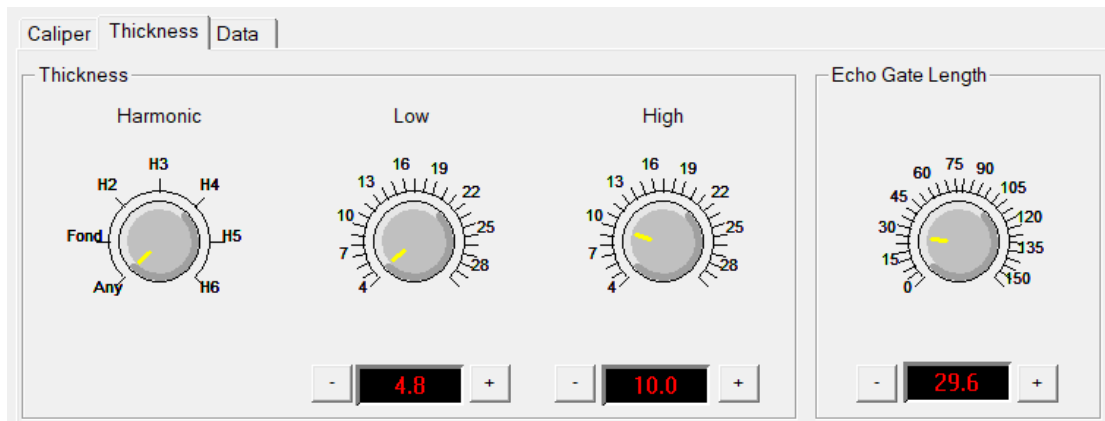


Figure 4-21 Thickness and Echo Gate Length settings

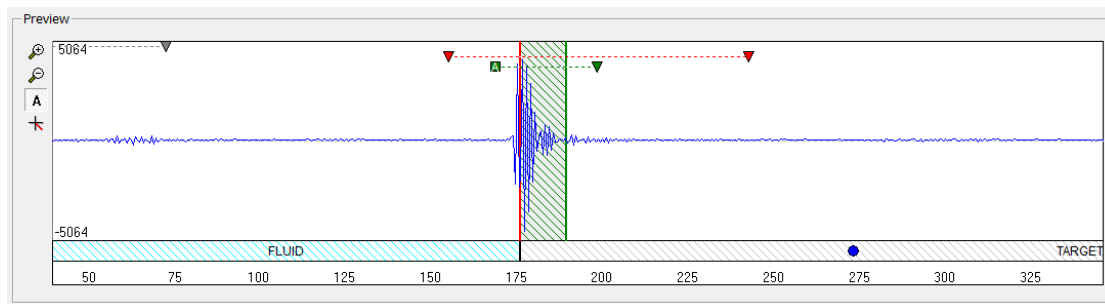


Figure 4-22 Waveform preview – Thickness Echo Gate

For cased hole application, in addition to the Acoustic Window and Echo Gates, a third gate - the **Thickness Echo Gate** (green dashed line – Figure 4-22) - is available for which only the end limit is user adjustable. Reduction of the gate length may be necessary if the ringing signal from the casing is superimposed by noise (e.g. multiples of the inner reflection) towards the end of the gate period.

The greyed - green hatched interval overlapping the recorded echo on the wave form preview is representing the casing thickness measured by the system for this specific ultrasonic trace and orientation.

The **“Harmonic”** knob controls the signal harmonic on which the processing algorithms will be applied. By default the **“Harmonic”** knob must stay on **“Any”**. Other **“Harmonic”** options are applicable for advanced users or developers only.

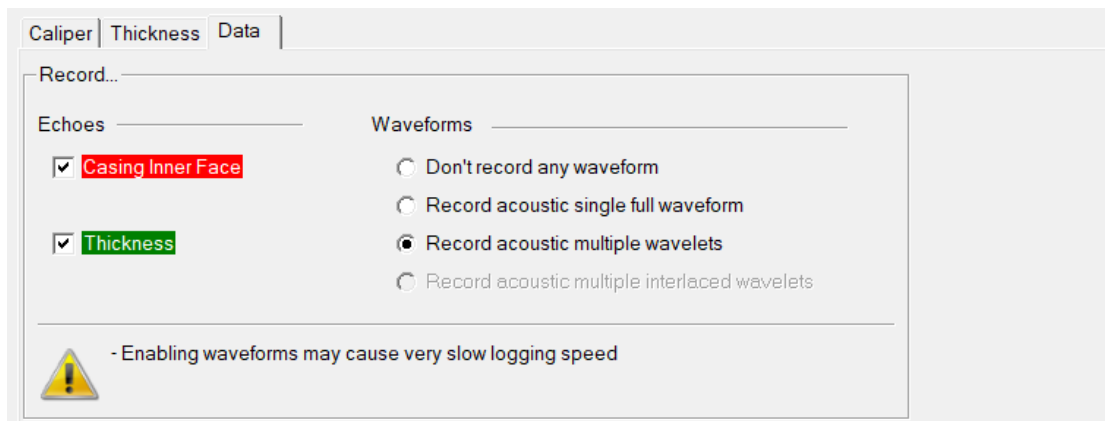
Data tab:

Figure 4-23 Data record options for the Cased hole mode

The option is given to the user whether or not to record the image of the inner face of the steel casing.

A recording of the casing inner face image is required for further internal caliper processing and for casing thickness/corrosion evaluation.

For diagnostic purposes or advanced processing, the **“Waveforms”** record option can be activated.

- The **“Record acoustic single full waveform”** option records the complete ultrasonic waveform shown in the preview window in a single and predefined direction.
- The **“Record acoustic multiple wavelets”** option records the echo wavelets reflected on the borehole wall. The system records a maximum of 36 wavelets over the borehole circumference for each acoustic trace. ***It is strongly recommended to activate this option as it allows post-processing of the thickness data using dedicated software.***³

Note that recording the ultrasonic waveforms and wavelets will affect the telemetry performance and will slow down the logging speed significantly.

4.6.2 Azimuthal resolution

The azimuthal resolution allows the operator to choose the number of points sampled per revolution of the focusing mirror. Sampling rates of 72, 144, 216 and 288 measured points per revolution are available.

³ Currently data post-processing can only be performed by ALT trained personnel

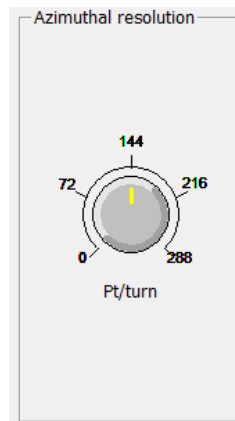






Figure 4-24 choice of azimuthal resolutions

The higher sampling rate can be used for better resolution in larger diameter boreholes but it might be less useful in small diameter hole as it would cause an overlap of sample points. The speed of rotation of the focusing mirror is directly linked to the azimuthal resolution and echo mode chosen.

4.6.3 Additional notes on the waveform preview

Beside the interactive settings of the echo gates, the waveform preview is offering other tools to enhance the display of the ultrasonic trace:

-  Zoom in the vertical scale of the echo amplitude
-  Zoom out the vertical scale of the echo amplitude
-  Set the vertical scale automatically with the best fit for the echo display
-  Display the wave azimuth control knob and scan option

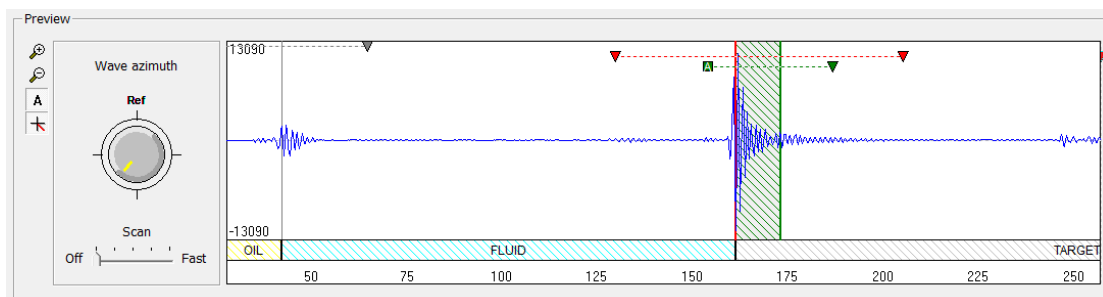


Figure 4-25 Display of the wave azimuth control knob and scan option

The **Wave Azimuth** knob in the full waveform preview box (Figure 4-25) allows one to display the ultrasonic wave train in a preferential direction other than the reference position of the mirror.

The preview of the full waveform of the received signal is generated at the position indicated by the **Wave Azimuth** control knob. By turning the control knob, a different position relative to the tool internal reference side can be chosen.

To turn on an **automatic scan** move the slider bar handle from the **Off** position towards **Fast**. In that case the azimuthal scan position will continuously change with the azimuthal step increasing if the slider position is set towards **Fast**.

4.6.4 Advanced Settings

By clicking on **Advanced** in the “Tool Parameters” dialog box (Figure 4-26) the operator can edit the “Fluid and Casing velocity” constants to convert the acoustic travel time from μsec to metric or imperial units. The default values are 1480 m/s for the fluid velocity and 5850 m/s for the steel velocity.

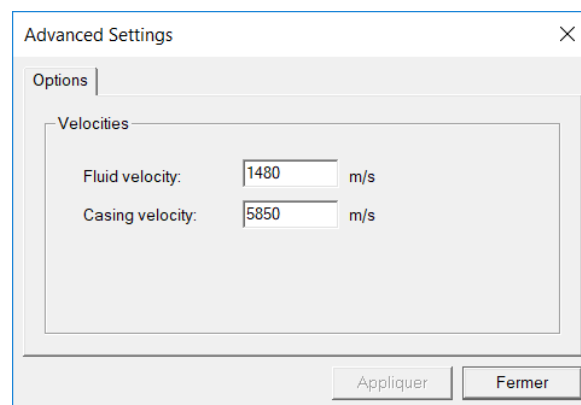


Figure 4-26 Advanced settings

4.6.5 Tool details

By clicking on the **Tool Details** button in the **Configure ABI Tool Parameters** dialog box four tabs (Figures 4-27 to 4-30) become available summarizing tool serial number, acoustic head details, deviation sensor model and analog front end. If necessary, newer tool firmware versions can be uploaded. The upgrade procedure will be explained in a later chapter.

Note: All the information displayed in the following dialog boxes can't be edited

Details

Tool | Acoustic Head | Deviation Device | Analog Front End

Tool details

Model: 1.50

Serial: 0 [Upgrade]

Firmware: 1.7

Acoustic modes

- Open Hole
- Cased Hole (behind casing)
- Cased Hole (casing thickness)

Fermer

Figure 4-27 Tool details

Details

Tool | Acoustic Head | Deviation Device | Analog Front End

Details

Serial number: 172210

Focus: 6 inches

Marker position: 357.5 degree

Fermer

Figure 4-28 Acoustic head details

Details

Tool | Acoustic Head | Deviation Device | Analog Front End

Details

Serial number: 13820

Model: APS

Firmware: 4.30

Fermer

Figure 4-29 Deviation sensor details

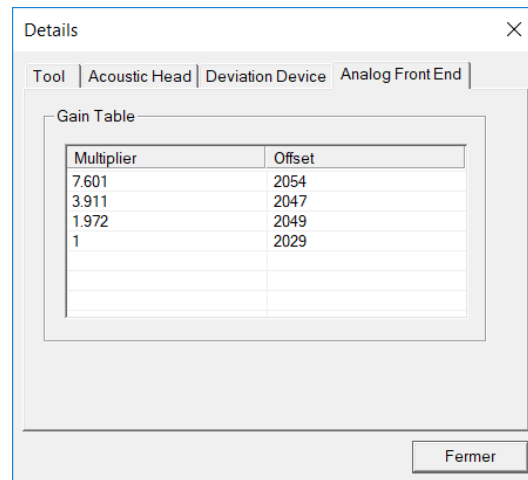


Figure 4-30 Analog Front End

4.7 Recorded Parameters and Browsers

4.7.1 Recorded parameters

The following data channels are recorded by the tool:

TravelTime (1 st echo):	Two Way Traveltime 1 st echo - μ sec
Amplitude (1 st echo):	Amplitude 1 st echo (NM = North Magnetic, HS = High Side)
TravelTime2 (2 nd echo):	Two Way Traveltime 2 nd echo - μ sec
Amplitude2 (2 nd echo):	Amplitude 2 nd echo (NM = North Magnetic, HS = High Side)
ThicknessTTime:	Two Way Traveltime within casing - μ sec
CADI:	Casing Amplitude Decay Index
Azimuth:	Azimuth from Magnetic North – deg
Tilt:	Inclination from verticality – deg
Roll:	Tool relative bearing calculated from accelerometers - deg
Mroll:	Tool relative bearing calculated from magnetometers – deg
Magn.Field:	Magnetic field surrounding the borehole - μ T
Gravity:	Absolute value of the Earth gravity – g
Orientation:	Orientation diagnostic code
WndTime:	Two way traveltime of acoustic window reflection – μ sec
WndAmpl:	Amplitude of acoustic window reflection
System Status	General system diagnostic code
VTool:	Tool head voltage - V
V12:	Internal tool voltage - V
RTHead :	Temperature sensor resistance - ohms
TCPU :	CPU temperature - $^{\circ}$ C
T APS:	Temperature inside the deviation sensor - $^{\circ}$ C
T Head :	Acoustic head internal temperature - $^{\circ}$ C
MotSpeed:	Motor - Speed of rotation – rps
Motor:	Diagnostic code
Motor Period:	Time for a single revolution – sec

4.7.2 MChNum Browser Window

Figure 4-31 shows a typical example of the numerical values displayed in the MChNum browser window during logging.

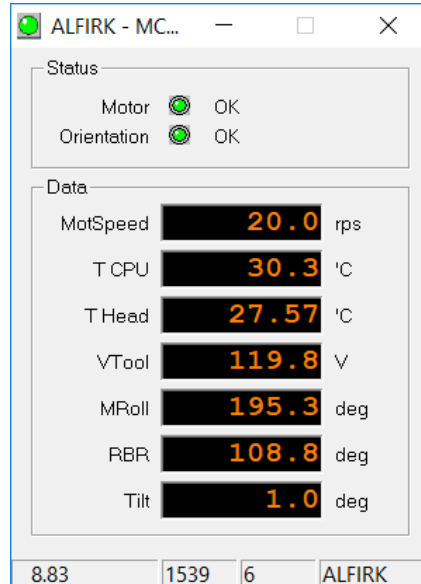


Figure 4-31 MChNum browser display

MotSpeed:	Motor - Speed of rotation – rps
T CPU:	CPU temperature - °C
T Head:	Acoustic head internal temperature - °C
VTool:	Tool head voltage - V
MRoll:	Tool relative bearing calculated from magnetometers – deg
RBR:	Tool relative bearing calculated from accelerometers - deg
Tilt:	Inclination from verticality – deg

To display additional parameters in the MChNum browser right click on the MChNum browser title and select **Display Options** to add/remove channels and Led status.

4.7.3 Surface Image Browser Window (AbiSurfacelmg)

The system returns an unwrapped image of the borehole wall based on the caliper and amplitude values of the recorded acoustic signal (Figure 4-32). The left column shows the caliper image and the right column the amplitude image.

These images consist of a succession of variable density colors. By double clicking on the log titles Minimum and Maximum scale values may be adjusted to enhance the log appearance.

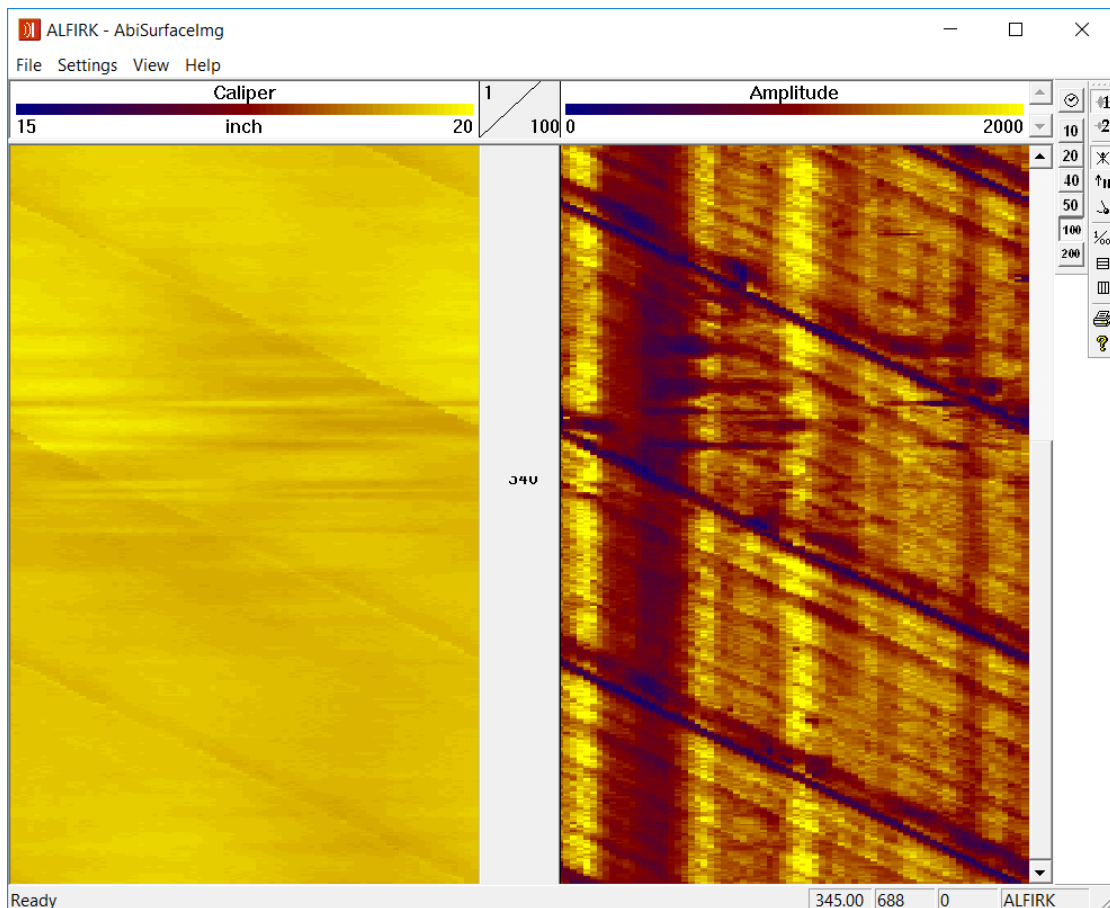


Figure 4-32 ABI Surface Image browser window

Note that the displayed units for the caliper log can be converted to either metric or imperial units via the menu bar's **Settings** option or by double clicking on the log title.

Echo selection :






-  Echo1 is displayed (borehole wall or inner side of the casing)
-  Display Echo2 (borehole wall behind a PVC casing)

Image orientation:

-  Image is non-oriented
-  Orient image to magnetic North
-  Orient image to High Side of the tool

There are two modes of tool data orientation: orientation to High Side and orientation to North. Orientation to High Side is used in inclined boreholes when magnetometers data are unavailable (for example in a cased hole).

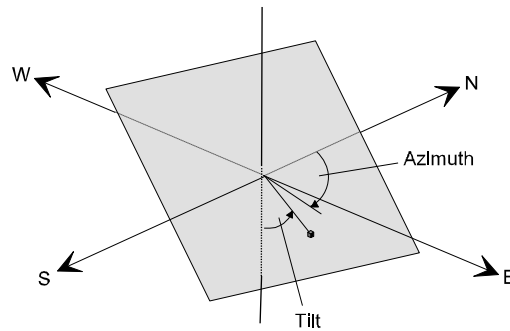


Figure 4-33 Orientation to Magnetic North

Vertical scales and grids:

- 10 Depth mode display and pre-defined depth scales
- 20
- 40
- 50
- 1/100 Operator defined depth scales, interval spacings and settings
- Time mode display

4.7.4 CADI Image Browser Window (AbiCadimg)

In Cased Hole Mode, the CADI browser displays on the left column an unwrapped color coded image of the casing *thickness* processed by the system (Figure 4-34).

The CADI image log displayed on the right of the window represents a *qualitative index related to the cement bonding*. A high CADI indicates a good cementation, a low CADI indicates a poor cementation. CADI stands for Cementation Attenuation Decay Index. As CADI is a non-calibrated qualitative index, it needs to be interpreted by the user in a semi-qualitative way similar to conventional CBL.

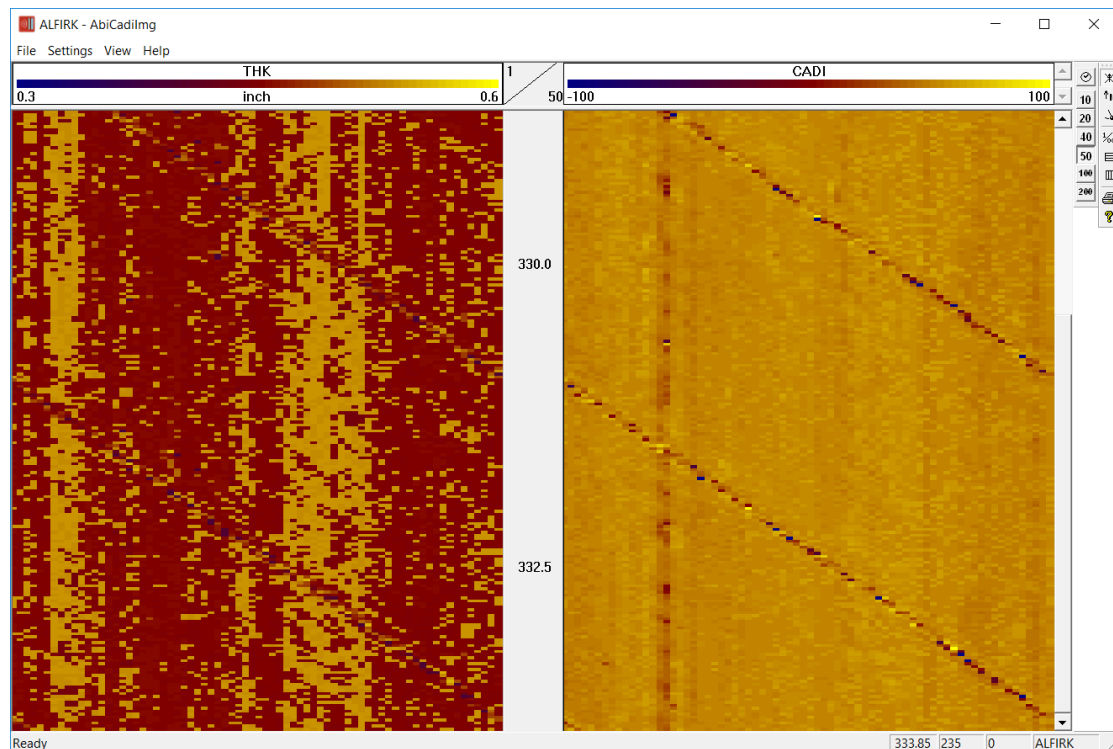


Figure 4-34 QL40ABI2G-VLB Thickness Image

As for the Surface image browser, scales and units of the displayed parameters can be adjusted by double clicking on the log title or from the **Settings** option of the menu bar.

4.7.5 Caliper Browser Window (AbiCaliper)

Caliper browser - Open Hole Mode


The Open Hole caliper view (Figure 4-35) shows in real-time a cross-section of the acoustic caliper. Scaling, concentric gridding and displayed units are adjustable from the tool bar “Settings” option.

The black circle shows the external limit of the acoustic window.

The red circle is the cross section of the acoustic caliper corresponding to the main reflector detected by the system (borehole wall or inner surface of a casing).

As for the image browsers, the caliper view can be oriented to Magnetic North, High side or displayed without orientation.

During the acquisition, it is possible to centralize the caliper cross section to remove the effect of decentralization of the tool in the borehole.

Clicking the symbol  can do this.

Statistical caliper figures (Min, Max, Average) are displayed on the left side of the dialog box.

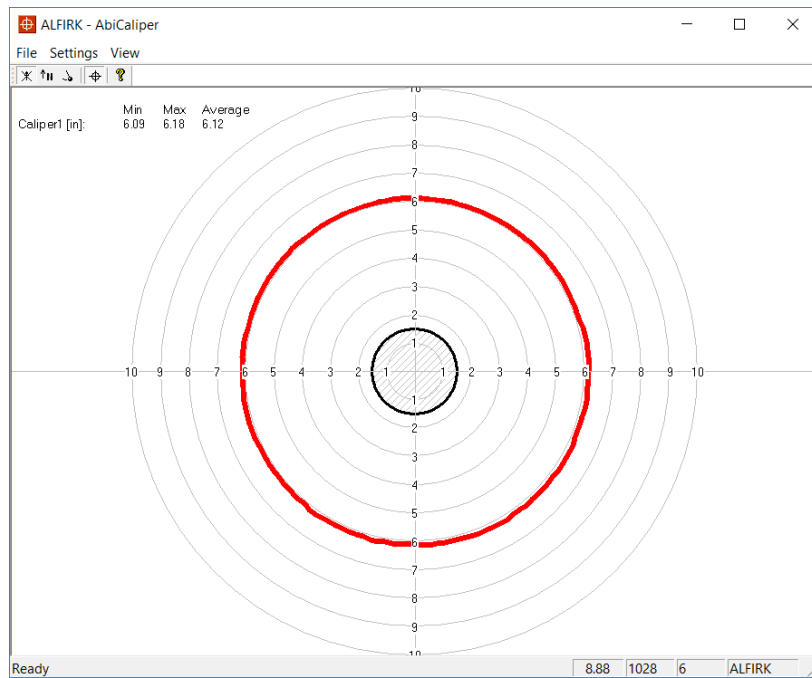


Figure 4-35 ABI Caliper – Open Hole Mode

Caliper browser - Cased Hole Mode

Cross sections of both of the inner (red circle) and outer (green circle) surface of the casing are shown in this browser (Figure 4-36), giving a good visualization of the casing thickness in real-time. Orientation, scaling, concentric gridding and displayed units are adjustable from the menu bar's **Settings** option.

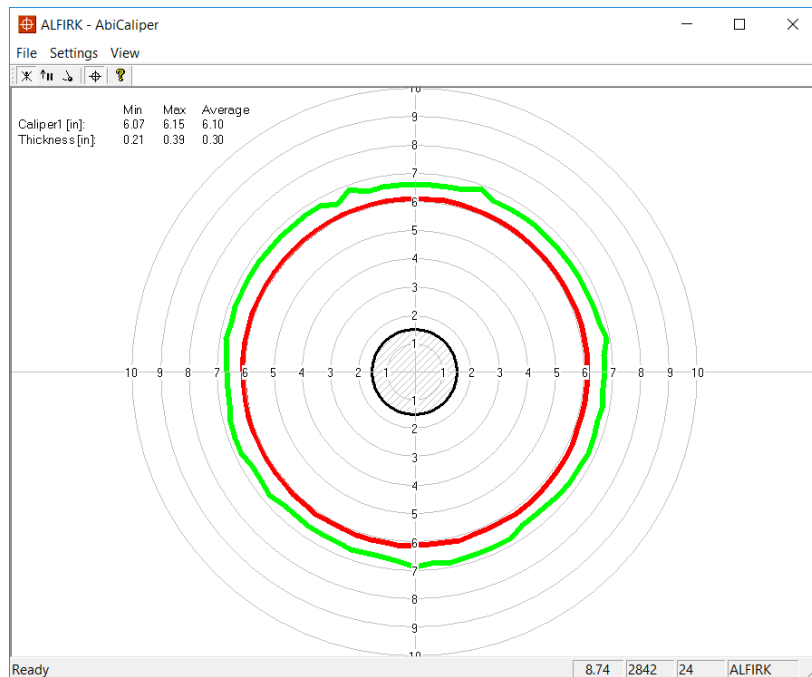


Figure 4-36 ABI Caliper – Cased Hole Mode

5 Performance Check & Calibration

5.1 Mirror rotation

Direction of motor rotation is **clockwise viewed from top of tool** (Figure 5-1):

Placing 2 fingers⁴ on the acoustic window may check mirror rotation. In time mode, record the 2 finger traces shown⁵ on the Abi surface browser. Remove your right finger from the acoustic window; the corresponding right finger trace on the Abi surface image should disappear.

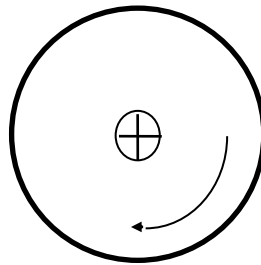


Figure 5-1 Direction of mirror rotation

5.2 Functionality test of the deviation system

5.2.1 Functionality test

The ABI's deviation system is factory calibrated and does not require further calibration. The functionality tests subsequently described have to be done to check that the tool is giving the correct deviation outputs:

To verify inclination at 0° and 90°, position the probe vertical (acoustic head pointing down) for 0° inclination and horizontal for 90° inclination. Note that uphole measurement is possible with the APS544 deviation system as it includes 3 accelerometers. In uphole, the inclination will be between 90° and 180° (probe vertical, acoustic head pointing up).

To verify azimuth accuracy, a good compass and an area free of magnetic materials must be used. Use a compass to orient North with the probe horizontal and verify that the azimuth reading is $0^\circ \pm 1^\circ$. Repeat the procedure for East, South and West directions.

5.2.2 Rolling test – azimuth and tilt check

Azimuth and tilt could be tested by rotating the tool about its long axis while maintaining both a constant inclination to the vertical, say 15°, and a fixed azimuth. The data imported into WellCAD should show a deviation of the azimuth less than the limit of $\pm 1.5^\circ$ and a deviation of the tilt less than the limit $\pm 0.5^\circ$.

⁴ Wet your fingers first for a better coupling

⁵ Adjust the amplitude scale to enhance the finger traces

6 Maintenance

Warning: Removing the electronic chassis from pressure housing without prior consultation with ALT will void the tool warranty.

The ABI televiewer is a delicate instrument and should be treated with care at all times. Excessive shock or extreme temperatures should be avoided and the tool should always be transported in its transport case or a similarly cushioned enclosure. Never support the tool on the acoustic head. Experience shows that with attention to these points the QL40 ABI will give several years fault free operation.

The ABI televiewer separates into four basic parts

- The tool top adaptor
- The pressure housing
- The electronic chassis
- The acoustic head.

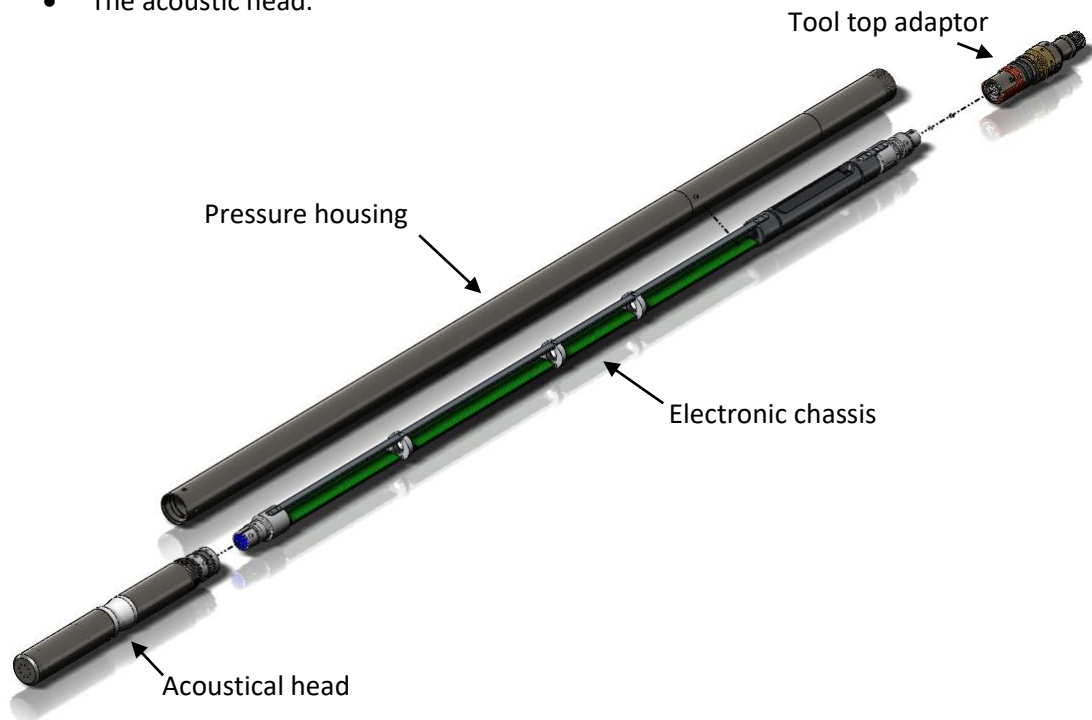


Figure 6-1 ABI and tool top, exploded view

Should it become necessary to open the tool, the tool parts must be separated in the following sequence:

1. Remove the tool top adapter
2. Remove the acoustic head
3. Remove the pressure housing

Disassembly of the electronic chassis from the pressure housing should never be attempted in the field.

6.1 Tool Top Adapter

The tool top adapter provides the connection between wireline cable head and chassis electronics and can be provided to suit 7 conductors, 4 conductors, mono or special wireline configurations. The adapter is fixed by the means of a threaded ring screwed in the pressure housing. To remove the tool top adapter, use the correct C spanners provided with the tool - see picture below (Figure 6-2).

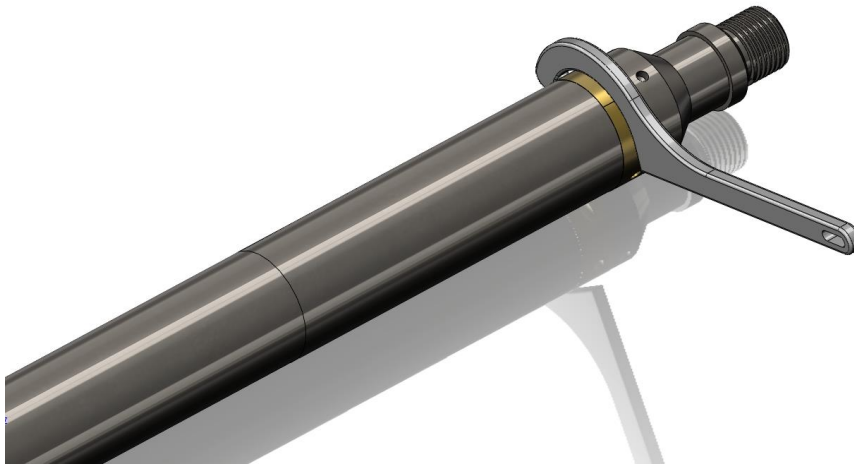


Figure 6-2 Removing the tool top

The wireline cable head socket and tool top adapter connector pins should be checked for cleanliness before each use of the tool. The pin inserts, whether 4 or 7 pin, have a locating mark indicating WL1 or A that should line up with the slot mating with the cable head.

Check O-Ring seals and apply silicon grease before re-assembly. Silicon grease of a similar type to RS Components Ref 494-124 is suitable for this and other O-Ring seals.

(Rem: O-Ring reference for tool top and for the quick link 40 is AS215 26,57 x 3,53 Viton Shore 75)



Figure 6-3 QL40-GO4 Tool top adaptor



Figure 6-4 QL40-G07 tool top adaptor



Figure 6-5 QL40-G01 tool top adaptor

6.2 Acoustic head

Warning: The televiewer acoustic head is extremely delicate and must be treated gently at all times. Any laterally applied force on the end of the head is liable to cause damage!

The acoustic head is attached to the electronic chassis of the sonde by three 2.5mm hex set screws. To remove the entire televiewer head the tool top and pressure housing must first be removed as described below. Slacken off the fixing screws and slide the televiewer head off the connector. The connector has a keyway to locate the head with the correct orientation.

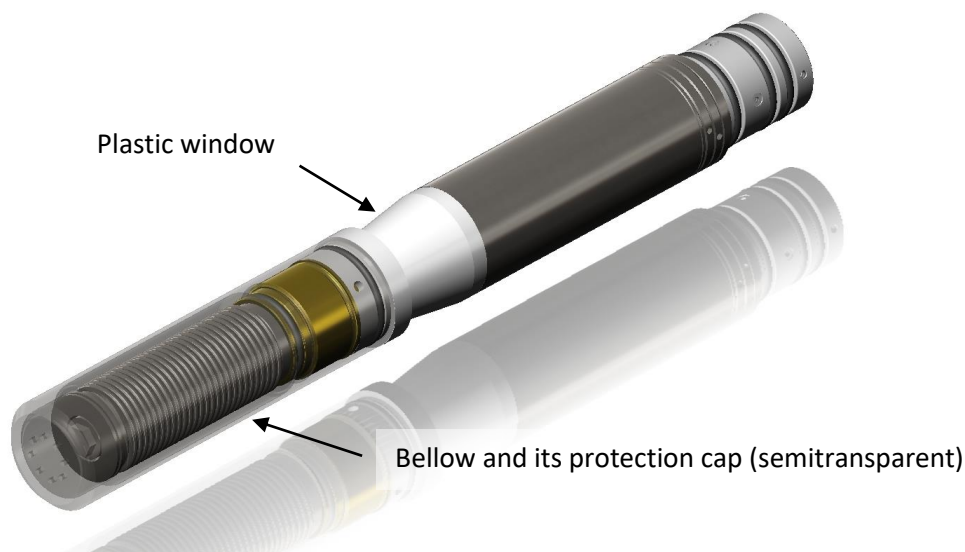


Figure 6-6 Acoustical head

Re-assembly is the same procedure in reverse order, but taking care not to force the head on to the connector. This will result in bent or broken connector pins! Check all “O” ring seals (Orings AS215, 26.57x3.53, viton, shore 75) and apply silicon grease to them.

The acoustic head needs to be properly maintained to give the best image results.

Note the following points:

- Check that there are no air bubbles visible in the acoustic window. Air can separate out of the oil filling the head, notably after airfreight at low pressure, and can also work its way out of the inner parts of the motor. The presence of air in the head is indicated by a spotty image or streaking. These effects may come and go as the orientation of the tool is changed.
- Check that there is not excessive lateral movement on the end of the head. The bellows cap must be screwed up against the acoustic window but not excessively tight.
- If the acoustic signal is lost, check for isolation between pins A&B in the acoustic head. The most common reason for loss of signal is the cutting of the signal coax to the transducer in the head. This happens when the window is rotated relative to the head body. Check with a gentle twisting motion that the window does not rotate more than a degree or two relative to the tool body.

- At very low temperatures the oil in the acoustic head becomes viscous and this may prevent the mirror from rotating. In this case keep the tool and head warm before use.

6.2.1 Cleaning the acoustic head bottom section

The bottom section of the televiewer assembly houses a pressure compensating bellows that must be free to move. For this reason the bellows cover is removable to allow cleaning of the exterior of the bellows. The interior of the bellows and main body of the televiewer head is oil filled. Both, the end of the bellows cover and its side wall, have holes to allow pressure equalization, and these holes must be kept clear. The bellows cover is threaded at the top end and held by a screw thread on the main body below the nylon window. The cover should only be **hand tightened**.

Keep the bellows section clean. This will prevent the deterioration of glue seals and the bellows itself. Grit lodged in the folds of the bellows can cause perforation if left over a period of time.

When removing the cover, it is important to **hold the nylon mirror section only**, which is locked integrally with the main tool, while unscrewing the cover. Wrenches must **NOT** be used (Figure 6-7 and Figure 6-8).

Warning: Any Rotation of the nylon section relative to the main tool pressure housing will result in damage to the head and probable tool failure.

The necessity for cleaning will depend on the borehole fluid and borehole conditions. The bellows should only be cleaned when the sonde was used in heavily contaminated fluids, i.e. heavy muds or sediments, or when the fluid is known to be corrosive. In this case it is important to clean deposits off the bellows where it is glued to the flanges at either end. The bellows wall is thin and can become perforated if allowed to corrode.

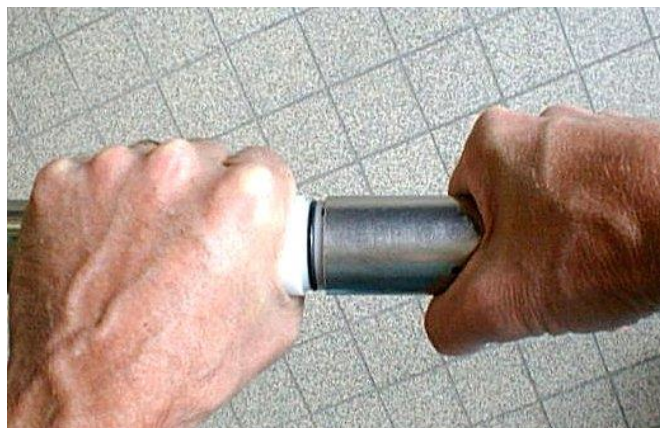


Figure 6-7 Unscrewing the bellows cover



Figure 6-8 Bellows cover removed

6.3 Pressure Housing

The main pressure housing is locked on to the televiewer head by four 2.5mm hex cap screws. After removal of the tool top, the pressure housing can be removed after undoing these screws. When separating the two parts, place the tool on suitable stands, grip the pressure housing with one hand and the acoustic head close to the joint with the other and apply a straight pull. During re-assembly extreme care should be taken not to over tighten the fixing screws which may shear off if overloaded!

The outside of the pressure housing is marked with a Y symbol to indicate the position of the Y axis vertical and upward. The purpose of this is to simplify tool checking.

When re-assembling the pressure housing make sure that the reference mark is correctly aligned with the upper side of the deviation sensor.

7 Troubleshooting

Observation	To Do
<i>Tool not listed in Tool panel drop down list.</i>	<ul style="list-style-type: none"> - Do you have a configuration file? - Has the configuration file been copied into the ../Tools folder (refer to MATRIX or ALTLog manual about details of the directory structure)?
<i>Tool configuration error message when powering on the tool.</i>	<ul style="list-style-type: none"> - Check all connections. - Adjust the telemetry settings for your wireline configuration (see chapter 4.3 or 4.4) and store the new settings as default. Apply the appropriate tool settings for your logging run (see chapter 4.5).
<i>Tool panel - No current.</i>	<ul style="list-style-type: none"> - Verify that the wireline armour is connected to the logging system. Test your interface cable between winch and data acquisition system. - Verify cable head integrity. - Verify voltage output at the cable head (it should be 120V).
<i>Tool panel - Too much current (red area).</i>	<p>! Immediately switch off the tool !</p> <ul style="list-style-type: none"> - Possible short-circuit (voltage down, current up): Check for water ingress and cable head integrity - wireline continuity. - Verify the interface cable between winch slip ring and data acquisition system is not loose at the connectors. Check for possible source of a short-circuit. - If the above shows no issues, use test cable provided by ALT to verify tool functionality. - If the problem still occurs, please contact service centre.
<i>Telemetry panel - status shows red.</i>	<ul style="list-style-type: none"> - Verify the telemetry settings for your wireline configuration (see chapter 4.3 or 4.4). - If problem cannot be resolved contact support@alt.lu .
<i>Telemetry panel - memory buffer shows 100%.</i>	<ul style="list-style-type: none"> - Indicates that the systems internal memory buffer is full. PC can't receive incoming data streams fast enough. Ensure your PC has enough resources available.
<i>Telemetry panel – bandwidth usage shows 100%. (Overrun error message.)</i>	<ul style="list-style-type: none"> - Set the baudrate to highest value allowed by your wireline configuration. - Reduce logging speed, decrease azimuthal resolution and/or increase vertical sample step.
<i>Telemetry panel - large number of errors.</i>	<ul style="list-style-type: none"> - Verify the telemetry settings for your wireline configuration (see chapter 4.3 or 4.4). - Check bandwidth usage and telemetry error status.

Observation	To Do
<p><i>Permanent No Sync message and red led status in MChNum browser.</i></p> <p><i>Motor stalled and increase of current drawn by the tool.</i></p>	<p>! Immediately switch off the tool !</p> <p>- Stepper motor and mirror synchronization issue. Contact ALT for Acoustic Head service.</p>
<p><i>WellCADimport : acoustic images not imported</i></p>	<p>- Check your WellCAD version (please refer to 1.3 Technical Specifications chapter).</p>
<p><i>WellCAD import : Magnetic North and High Side orientation options not available</i></p>	<p>- Check your WellCAD version (please refer to 1.3 Technical Specifications chapter).</p>

8 Notes on Data Processing

The processing of data acquired with the QL40 ABI and the ABI 40 tools is usually performed using the WellCAD software. We would like to refer the user to the WellCAD user guides for a detailed description of the software's functionality. In particular *Book 3 - Image & Structure Module* should be of help when processing image data.

The following paragraphs will focus on three processes to process traveltime data for which the input of correct units and parameters is crucial in order to obtain accurate results.

8.1 Estimation of Fluid Velocity

The procedure described below outlines the estimation of the borehole fluid velocity which can be used as input for the computation of caliper data described hereafter.

1. From the **Process > Image Module > Image Logs** menu in WellCAD select the **Estimate Fluid Velocity** entry. The corresponding options dialog box will open (Figure 8-1).

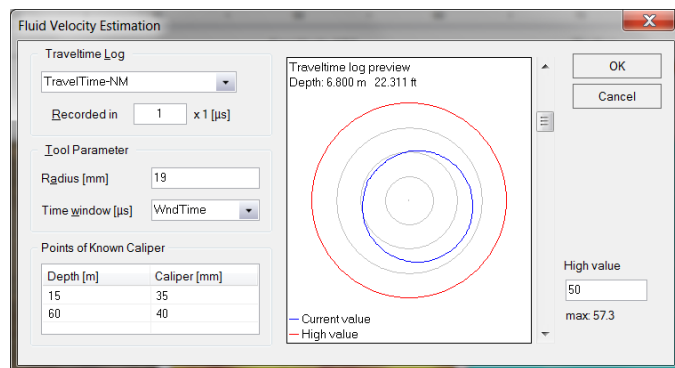
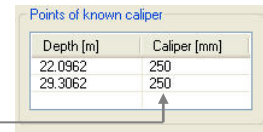


Figure 8-1 Fluid velocity estimation dialog box

2. Select the TravelTime log from the corresponding drop down list in the dialog box.
3. Set the unit the traveltime has been recorded in. For the QL40 ABI or ABI40 tool this manual refers to the unit is 1 μs . (Older tools measured in 0.1 μs . You can find out by double left clicking on the log title of the TravelTime log. The unit should show μs . If no unit is shown the measurement was made on 0.1 μs .)
4. Enter the radius of the acoustic head at the measurement point into the corresponding edit box. For the ABI tools described here a value of 19 mm is appropriate
5. Select the Time window channel *WndTime* which contains the traveltimes from transducer to the acoustic head window and back (has been recorded by your tool along with the other measurements).
6. Use the scroll bar next to the preview of the cross sections generated from the traveltime data and find a depth at which the caliper of the pipe or borehole is known and best reflected by the measurement (for example the nominal internal diameter of casing or the bit size).

- Right click into **Points of known caliper** list and add a new row for a reference point. The depth value will automatically set to the depth of the preview. Enter the known caliper value in [mm].



Depth [m]	Caliper [mm]
22.0962	250
29.3062	250

- Try to set a least a reference point at or near the top and base of the well. Click **OK** when finished. A new log containing the estimated velocity profile will be created.

8.2 Computation of Caliper Data

The following steps summarize the steps to compute radius and caliper data from the acoustic traveltime recorded with your ABI tool:

- Select the **Calculate Caliper** process from the **Process > Image Module > Image Logs** menu. The options dialog box (Figure 8-2) will open.

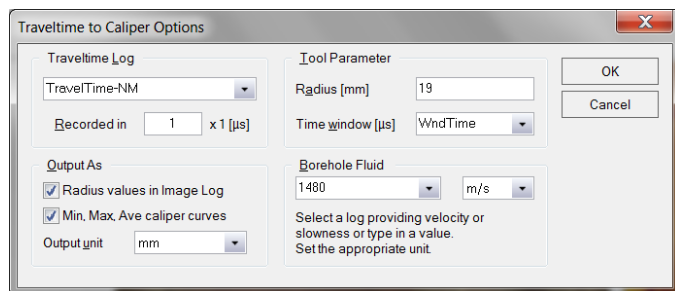
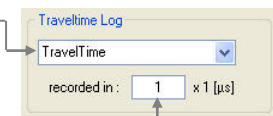
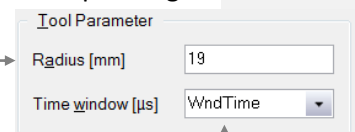


Figure 8-2 Traveltime to caliper conversion dialog box

- Select the TravelTime log from the corresponding drop down list in the dialog box.
- Set the unit the traveltime has been recorded in. For the QL40 ABI or ABI40 tools [that](#) this manual refers to the unit must be set to 1 μs . (Older tools measured in 0.1 μs . You can find out by double left clicking on the log title of the TravelTime log. The unit should show μs . If no unit is shown the measurement was made on 0.1 μs .)

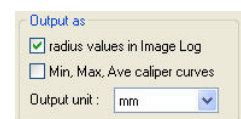
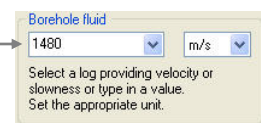


- Enter the radius of the acoustic head at the measurement point into the corresponding edit box. For the ABI tools described here a value of 19 mm is appropriate.



- Select the Time window channel *WndTime* which contains the traveltimes from transducer to the acoustic head window and back (has been recorded by your tool along with the other measurements).

- If you estimated a fluid velocity as described in the paragraph above or have measured values, extend the drop down list and select the corresponding log. You can also enter a textbook value manually. Ensure the correct unit has been selected.



- Select the output options and unit. You can create a new Image Log containing a radius value for each traveltime measurement. In addition you can create **Min, Max and Average** caliper curves.
- Click on **OK** to close the dialog box and start the computation.

8.3 Calculation of Casing Thickness

If you made measurements in cased hole mode you will get a log containing the traveltime within the steel casing (thickness travel time). The procedure described below summarizes the conversion of the thickness traveltime into a true thickness value.

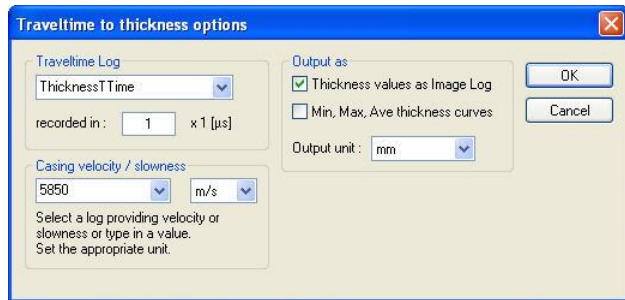


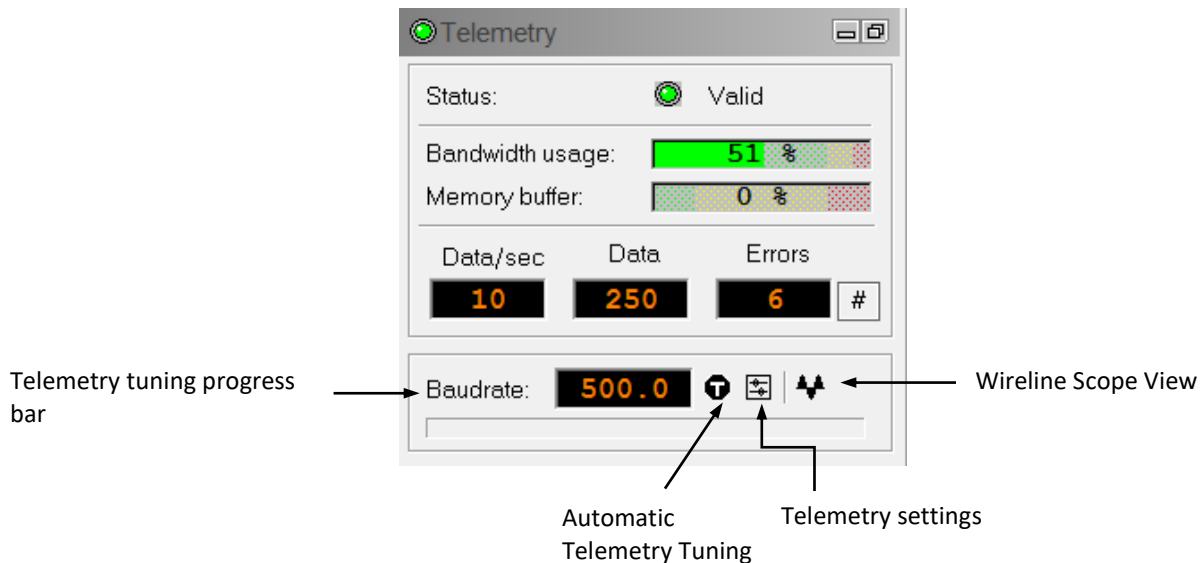
Figure 8-3 Traveltime to casing thickness conversion dialog box

- From the **Process > Image Module > Image Logs** menu in WellCAD select the Calculate Thickness... entry. The corresponding options dialog box will open (Figure 8-3).
- Select the ThicknessTTime log from the corresponding drop down list in the dialog box.
- Set the unit **in which** the thickness traveltime has been recorded **in**. For the QL40 ABI or ABI40 tools **that** this manual refers to the unit must be set to 1 μ s. (Older tools measured in 0.01 μ s. You can find out by double left clicking on the log title of the ThicknessTTime log. The unit should show μ s. If no unit is shown the measurement was made on 0.01 μ s.)
- Enter the velocity of sound in steel into the corresponding edit box. A typical value for steel is 5850 m/s. If you have a velocity profile available in a log extend the drop down list and select the corresponding channel.
- Choose the output option and unit. The thickness values can be given as a Image Log with on thickness value for each traveltime thickness measurement and as curve of the minimum, maximum and average thickness determined.
- Click on **OK** to close the dialog box and start the computation.

9 Appendix

9.1 Tool Communication with OPAL/SCOUT


The telemetry provided through the OPAL-SCOUT systems implementing the ALT MODEM adapter is self-tuning. In case communication status is not valid the user has different options to adjust manually the telemetry settings from the telemetry panel of the dashboard:



Baud rate:

Indicates the default baud rate or optimal baud rate in kbps found by the system for the selected winch/telemetry scheme

Automatic Telemetry Tuning:

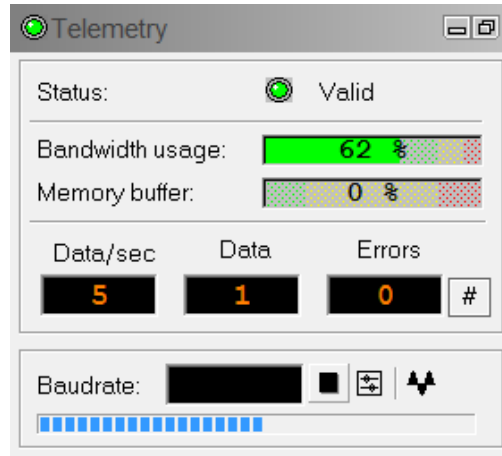
The Tune button  resets the telemetry tuning automatically. This process defines:

- the optimum baud rate for the winch configuration selected
- a transfer function and a filter to re-construct at the surface the shape of the pulse trains distorted by the wireline.⁶ Refer to the **Equalizer** paragraph for more details.


The Automatic Tuning is very useful on wireline over 1000m length to optimize the telemetry performance and logging speed.

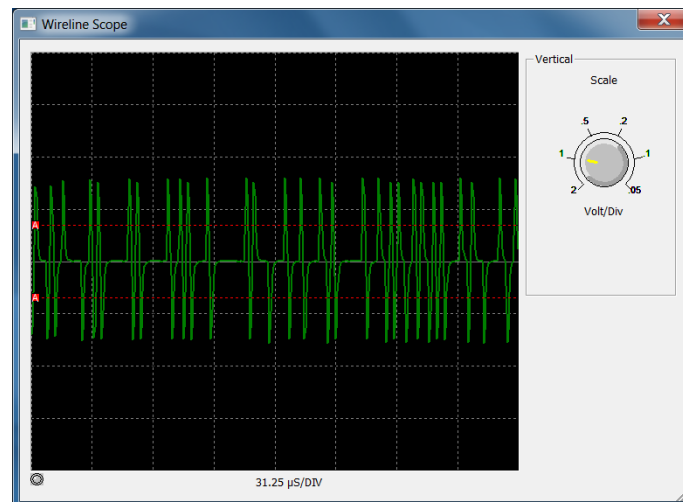
A **progress bar** at the bottom of the telemetry window shows the progression of the telemetry tuning. At the end of the process the baud rate display is refreshed with the optimal baud rate value.

⁶ The transfer function and filter concept are only valid for tools implementing the latest generation of ALT MODEM telemetry board (i.e. QL40-ABI2G, ABI-GR-2G, QL40-OBI2G, OBI-GR-2G, QL43-ABI2G,...)



Scope:

Pressing the scope button  on the **Telemetry Panel** brings up a **Wireline Scope** view (Figure x), which displays the pulse strings transmitted through the wireline and received by the system at the surface.



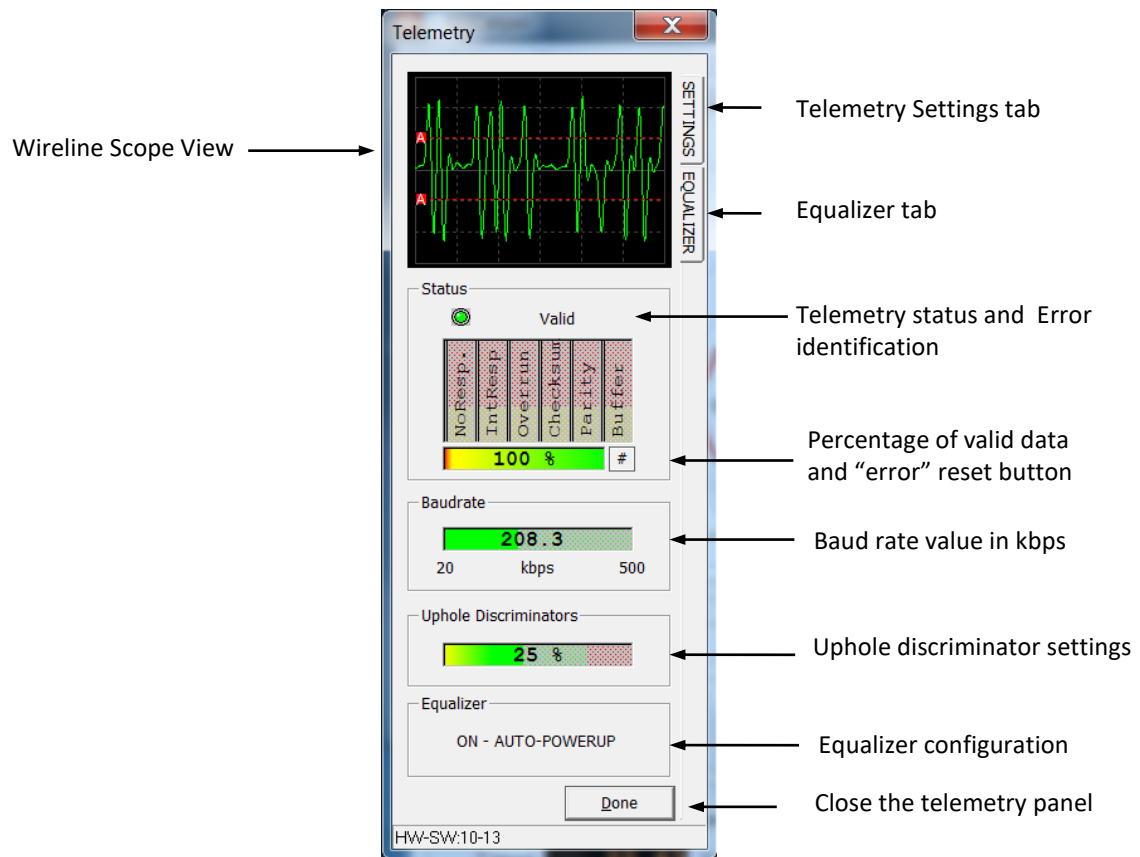
The two red-dashed horizontal lines help to visualize the position of the discriminator levels set for detecting the pulses at the surface. Discriminator levels can be tuned in the **Telemetry Settings** dialog – refer to section 3.6.1 for more information.

The Scale knob can be adjusted to show more or less vertical details. This view has no effect on the communications and is a visual aid only.

Telemetry Settings:

The Telemetry Settings button  opens a **Telemetry** control panel summarizing the telemetry status and configuration.

If the system cannot establish a stable communication with the tool, the **Settings and Equalizer tabs** allow the user to modify the telemetry settings and to apply a telemetry filter (Equalizer option)



Adjusting the Telemetry Settings:

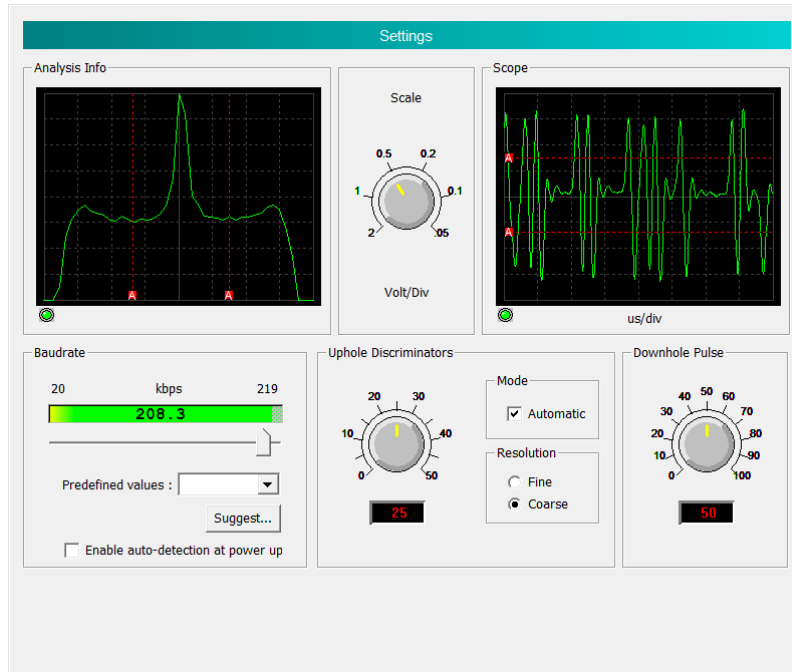
By default the telemetry settings are set to Automatic mode and should stay in this configuration. When more advanced tuning is required (i.e. long wirelines having a limited bandwidth) the manual mode can be activated.

In Automatic mode the uphole discriminators are set automatically to detect the pulse strings.

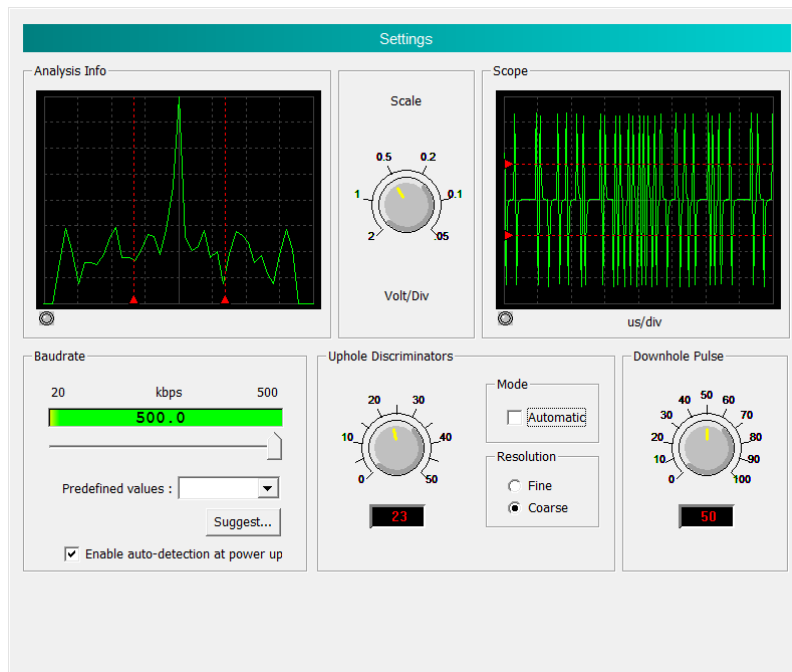
The position of the discriminator levels are visible on the Scope and Analysis views and are represented by two red dashed lines – one for the positive pulses and the other for the negative pulses.

The “A” letter on the red square means that the discriminators are set in automatic mode. The **Scale knob** controls the scale for the Analysis and Scope displays.

Position of the discriminator lines should be set as illustrated below.



When the automatic mode is unchecked the user has the option to adjust manually the uphole discriminators using either the discriminator knob or by moving interactively the red dashed lines in the Analysis and Scope displays. The red triangles located at the extremities of the red dashed lines refer to manual mode. For fine tuning of the discriminators the **Fine resolution** can be chosen.



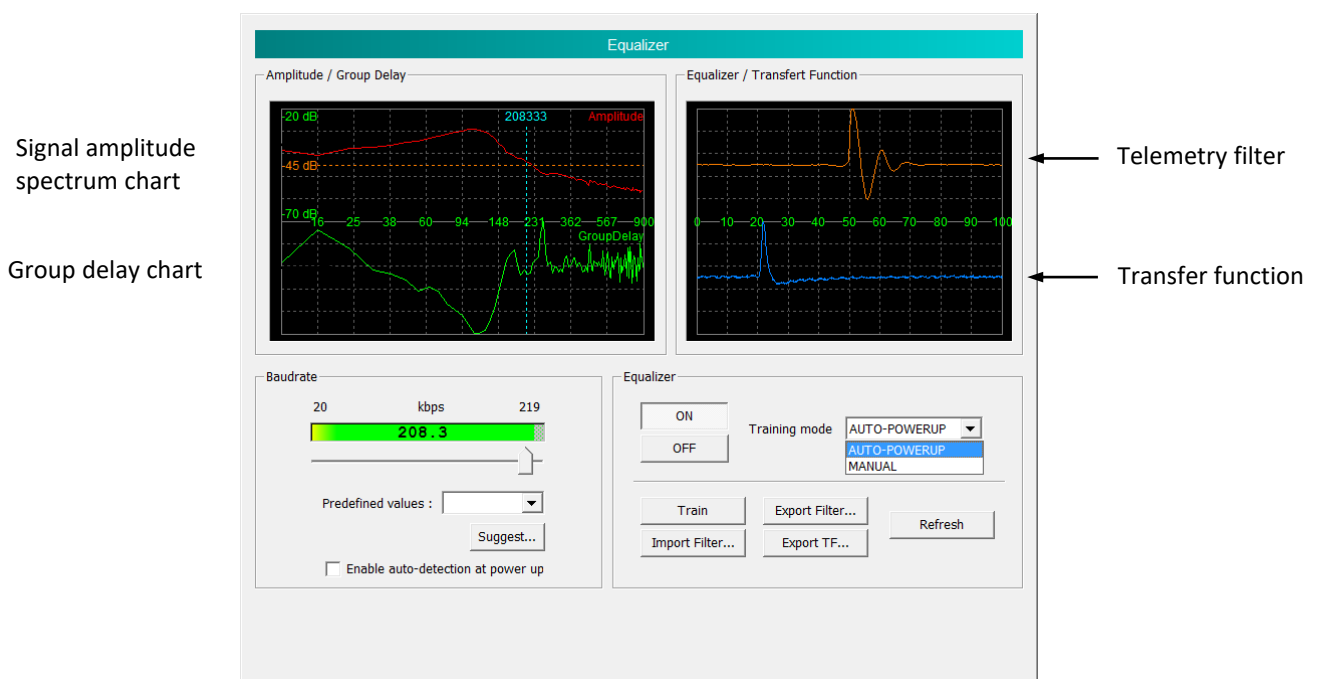
The **Downhole Pulse knob** controls the width of the pulse commands sent to the tool. It is set on 50 as a default value. This value is the preferred one and is suitable for a wide range of wirelines. For a long wireline increasing the pulse width could help to stabilize the communication. The reverse for a short wireline.

The **Baudrate** is generally set to the maximum value for which the communication status stays valid in order to optimize the logging speed for the wireline configuration. The baudrate can be adjusted by moving the cursor below the baudrate bar meter or by selecting a predefined baudrate value from the select box.

When clicking the **Suggest** button the system is searching for the optimum baudrate value and keeps this value for the data transmission.

The **Enable auto-detection at power-up** configures the system such a way that the baudrate is reset to its optimum value each time a tool is powered up.

Applying the Equalizer



The **Equalizer** dialog provides some advanced telemetry settings described hereafter.

- The **Train** button computes the transfer function of a wireline - refer to the blue signal. When clicking on Train the tool sends a pilot pulse frame to the surface. The received signal at the surface is compared with the original pilot pulse frame to measure the distortion of the signal through the wireline. The result of this process is the definition of a transfer function specific to the wireline used.

A filter is then derived from the transfer function - refer to the orange signal. The filter will be applied on the telemetry signal to counteract the distortion of the pulse strings through the wireline.

Applying the filter will thus improve the telemetry performance of the system and logging speed on wirelines with unfavorable band width.

- The **Equalizer ON/OFF** buttons enables or disables the filter. The activation of the equalizer can be configured to **MANUAL** mode or to **AUTO-POWERUP**.

The AUTO-POWERUP feature applies the telemetry filter upon tool power-up.

- The **Export TF** option exports the **Transfer Function** defined by the wireline training process in a ASCII file format
- The **Export Filter** option exports the **Filter** derived from the transfer function in a ASCII format
- The **Import Filter** option loads a saved filter configuration
- The **refresh** button is refreshing the Equalizer/transfer function display

The **Amplitude/Group Delay** charts are mostly used by ALT developers for telemetry signal and performance analysis.

The Equalizer dialog repeats the **Baudrate** settings already discussed in the previous paragraph "Adjusting telemetry settings".

9.2 Parts list

Detailed part numbers and descriptions are available for tool delivery and spare part kits. Please contact support@alt.lu for further details.

9.3 Technical drawings

The following technical drawings are available on request:

- 19" Rack connection diagram.
- Wiring Diagram.

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