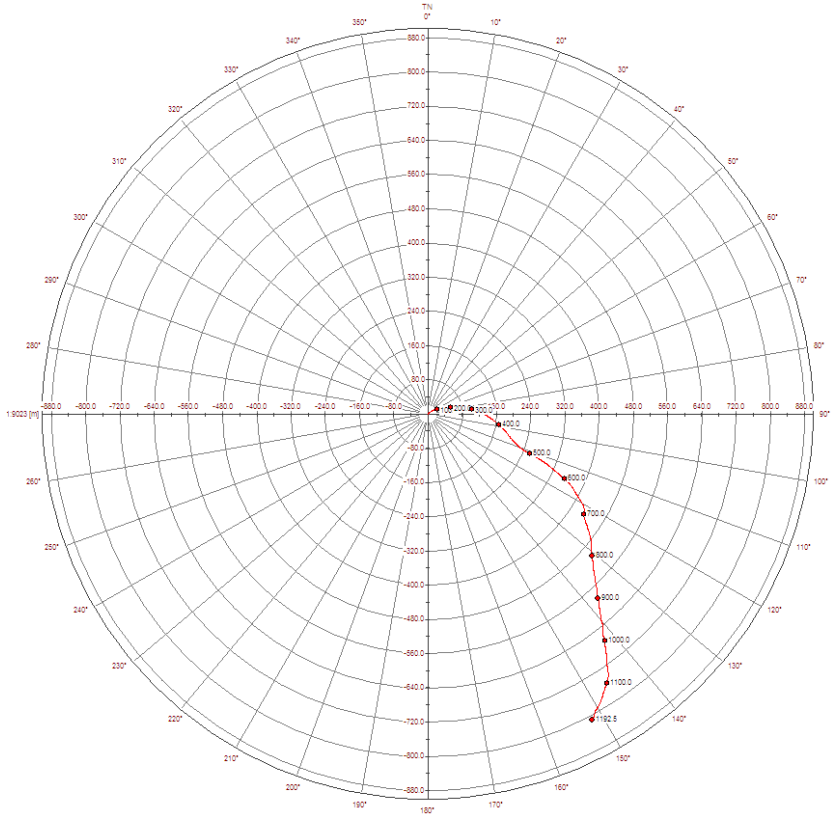

User Guide

QL40 DEV – Borehole Deviation Probe

MOUNT SOPRIS INSTRUMENTS

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1 General Information

1.1 Overview

The QL40 DEV Borehole Deviation Probe measures the borehole's azimuth, tilt and trajectometry using a three axis magnetometer and three accelerometers. These parameters are calculated in real time using the quantities measured by the probe.
This QL40 Dev middle sub has its own Telemetry board, Power supply element and A/D converter allowing the tool to be operated as a stand-alone probe (tool top and bottom plug necessary) or in combination with other subs of the QL family.

1.2 Dimensions

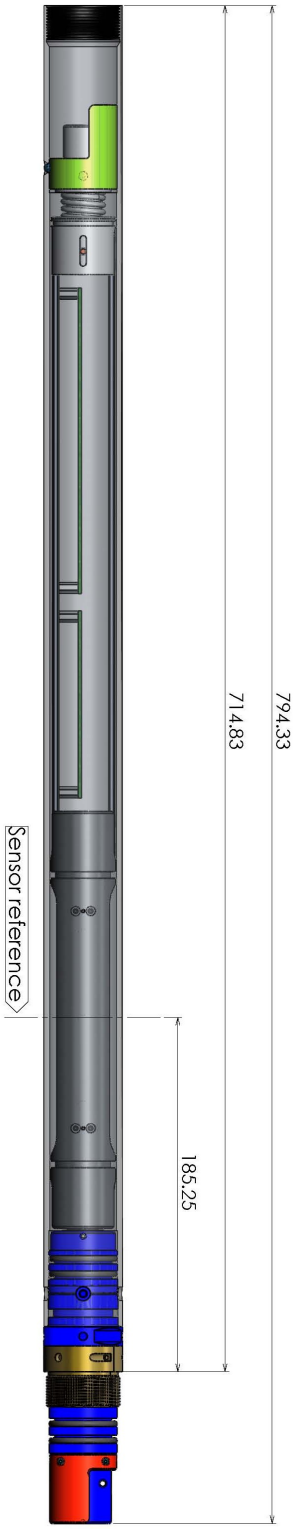

Figure 1-1 *QL40 DEV Dimensions*

1.3 Technical Specification

Tool

Diameter:	40mm
Length:	0.715m
Measurement point:	0.185m (from bottom join)
Weight:	3.4 kgs
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:	ALTLogger family – MATRIX

Orientation sensor:

Sensor:	APS544
Location:	Middle point of sensor located at 18.5 cm from tool bottom
Orientation:	3 axis magnetometer, 3 accelerometers
Inclination accuracy:	0.5 degree
Azimuth accuracy:	1.2 degree

2 Measurement Principle

The probe measures the magnetic field and acceleration in three different directions that is along the 3 axes of a right handed Cartesian coordinate system. The X-axis is parallel to the tool axis and points towards the bottom of the tool while the Y - and the Z- axis are perpendicular to the tool axis. A mark on the tool housing – an engraved “Y” – indicates the direction of the Y-axis (looking at the mark means looking down the direction of the positive y -axis). Figure 2-1 provides a sketch of the axis orientation.

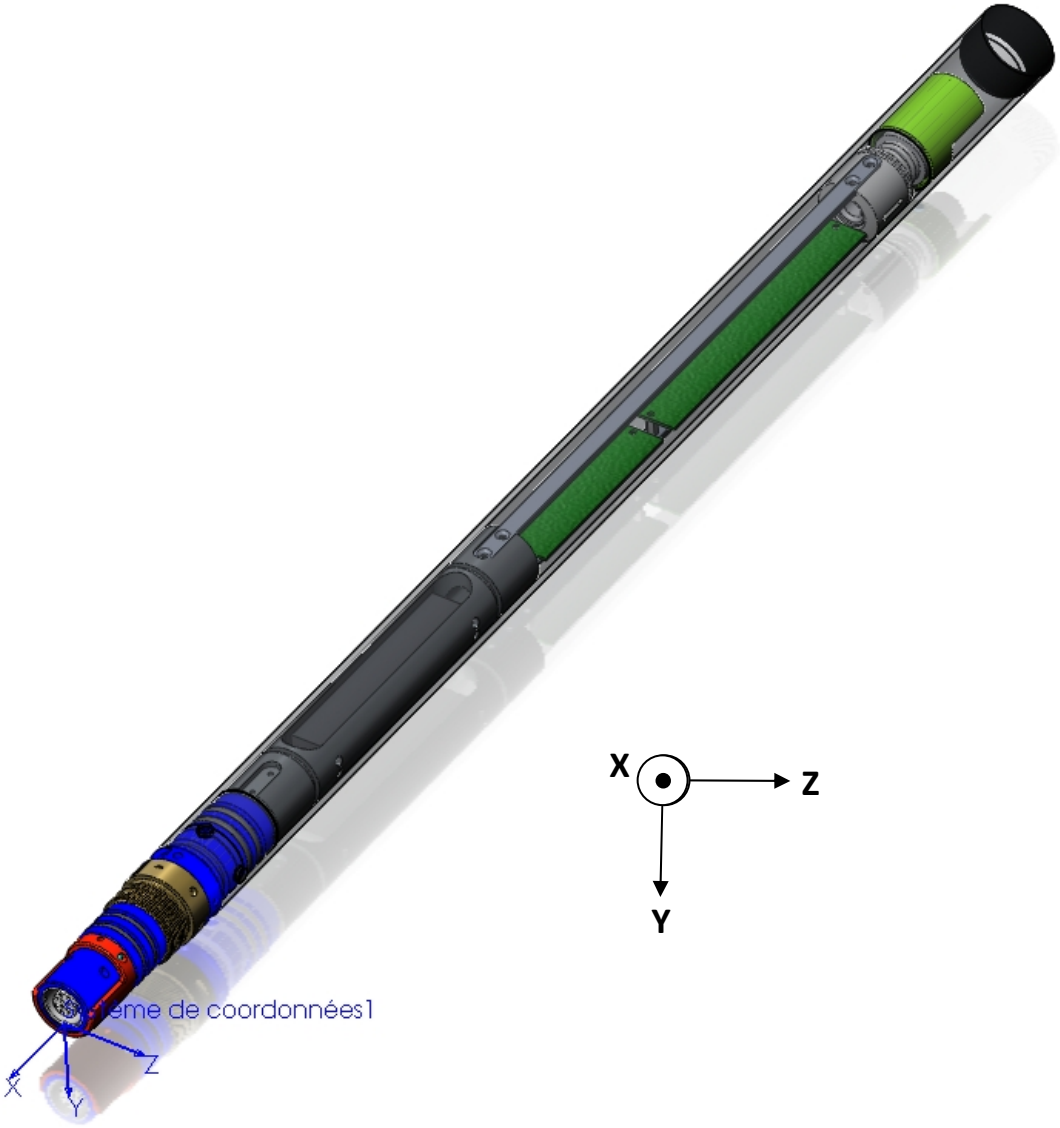

Figure 2-1 *QL40 DEV Reference Axis System*

3 Notes on QL tool assembly

QL stands for **Q**uick **L**ink 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.

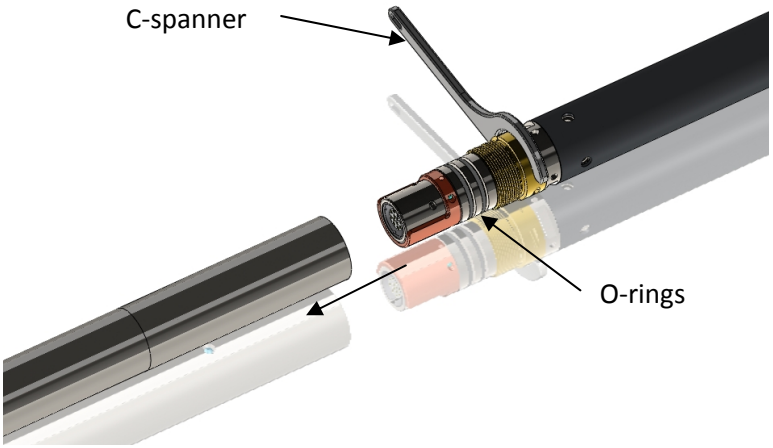

Figure 3-1 *C-spanner and O-rings of QL connection*

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

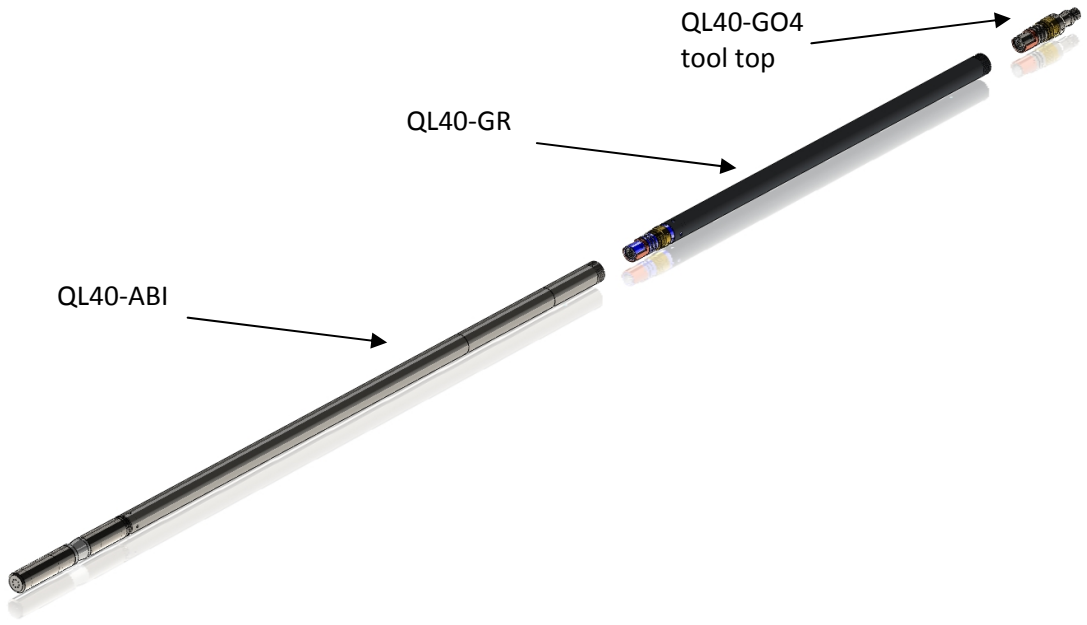

Figure 3-2 *Tool stack example*

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.

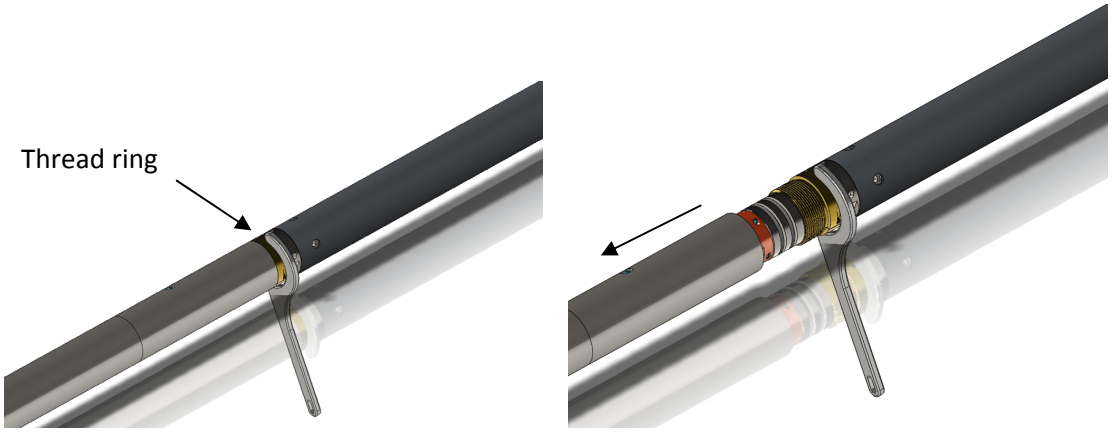

Figure 3-3 *Unscrewing the thread ring and removing the bottom sub*

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.

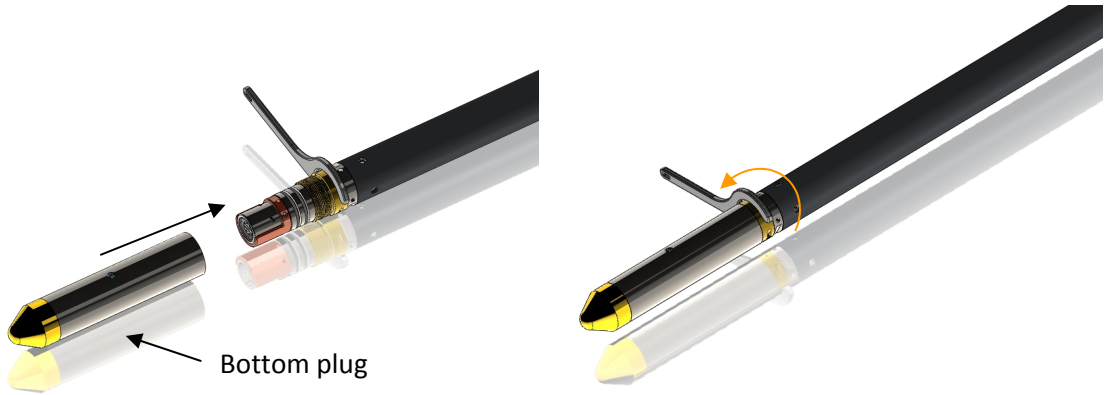

Figure 3-4 *Attaching the QL40-Plug*

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

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

4 Operating Procedure

Note: Parts of the topics discussed in these sections below assume that the user is familiar with the 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.

4.1 Quick Start

1. Connect the QL40 DEV to your wireline and start the data acquisition software.

2. Select the relevant QL40 DEV tool from the drop down list (Figure 4-1) 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).

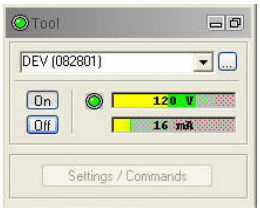

Figure 4-1 *Tool panel*

3. In the **Tool** panel switch on the tool (click the **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 tool configuration file. The configuration returned by the tool is also checked during this procedure. (Setup tool communication as explained in chapter **4.2** if error message is displayed.)

4. In the **Acquisition** panel (Figure 4-2) select the sampling mode (depth or time). Click on **Settings** and specify the corresponding sampling rate. Switch on the sampling (click the **ON** button).

5. Press the **Record** button in the **Acquisition** panel (Figure 4-2), specify a file name and start the logging.

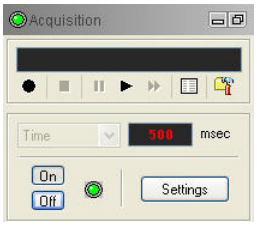

Figure 4-2 *Acquisition panel*

6. During logging observe the controls in the **Telemetry** panel (Figure 4-3):
   - Status must be valid (green light);
   - Bandwidth usage in green range;
   - Memory buffer should be 0%;
   - Number of **Data** increases and number of **Error**s negligible.

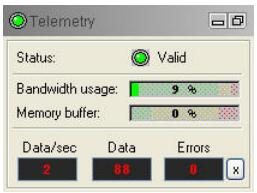

Figure 4-3 *Telemetry panel*

7. To end the logging procedure press the **Stop** button in the **Acquisition** panel and turn off the sampling (click **OFF** button).

8. In the **Tool** panel power off the tool.

4.2 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 (Figure 4-3) of the dashboard click on **Settings** to display the **Configure Tool Telemetry** dialog box (Figure 4-4).
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.

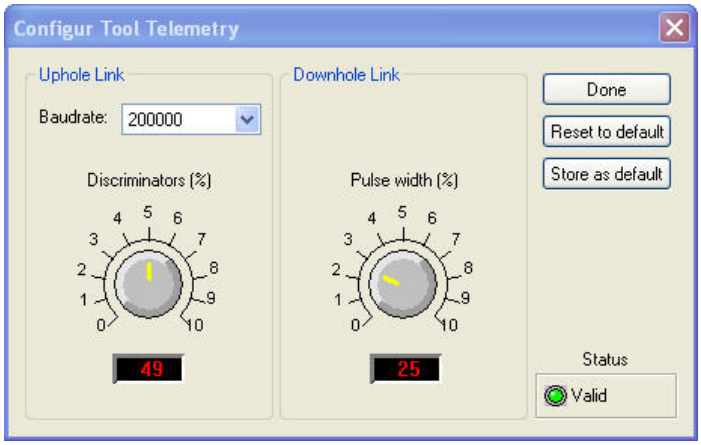

Figure 4-4 *Tool communication settings*

4.3 Tool Communication with MATRIX

The tool telemetry can be configured through the **Telemetry** panel of the data acquisition software's dashboard. By clicking on **Settings**, the operator has access to the **Configure ALT Telemetry** dialog box (Figure 4-5) 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 **lin**ear / **log**arithmic 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 4-5) 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.

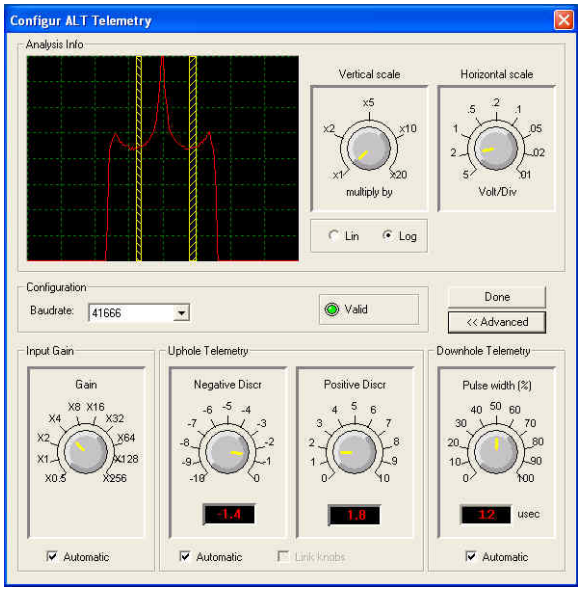

***Figure 4-5** Matrix telemetry settings*

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.

4.4 Configuring Tool Parameters

The QL40-DEV tool does not have any configuration options.

4.5 Recorded Parameters and Browsers

4.5.1 Recorded parameters

The following data channels will be recorded by the tool:

Azimuth	Azimuth from Magnetic North - deg
Tilt	Inclination from verticality - deg
MRoll	Tool relative bearing calculated from magnetometers - deg
Roll	Tool relative bearing calculated from accelerometers - deg
MagField	Total Magnetic field strength at measurement point - µT
Grav	Absolute value of the earth gravity - g
TDev	Temperature at deviation sensor - °C
Voltage	Deviation sensor voltage - V
MX	Magnetometer X-component - µT
MY	Magnetometer Y-component - µT
MZ	Magnetometer Z-component - µT
AX	Accelerometer X-component - g
AY	Accelerometer Y-component - g
AZ	Accelerometer Z-component - g
Temperature	Temperature (CPU) - °C
Time	Sampling time - s

4.5.2 MChNum Browser Window

Figure 4-6 and Figure 4-7 show typical examples of the numerical values displayed in the MChNum browser window during logging.

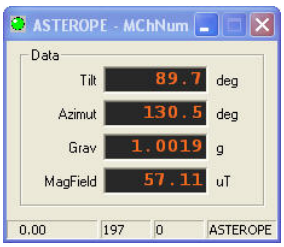

Figure 4-6 *Multi Channel Browser for Numerical Data (MChNum)*

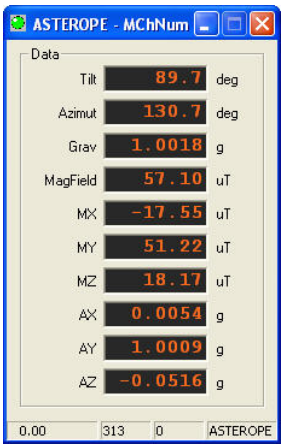

Figure 4-7 *Multi Channel Browser for Numerical Data (MChNum)*

4.5.3 MCHCurve Browser Window

The MChCurve browser displays in real time the recorded parameters by means of curves. The user is allowed to modify the curve presentation by double clicking on the log title (colours, column position, scale, filter,gridding,….)

Figure 4-8 *QL40 DEV MCHCurve Browser Window*

Vertical scales and grids:

Depth mode display and pre-defined depth scales

Operator defined depth scales, interval spacings and settings

Time mode display

Vertical grid settings

Horizontal grid settings

5 Performance Check & Calibration

5.1 Testing the Deviation System

The QL40 DEV deviation system is factory calibrated and does not require further calibration.

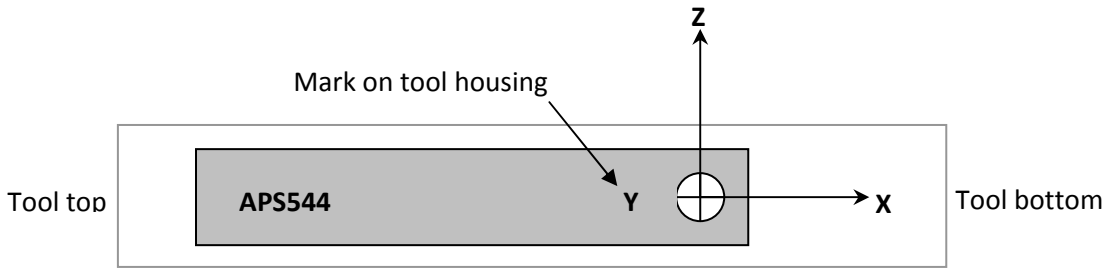

Figure 5-1 *Deviation sensor reference axis system*

The functionality test described hereafter has to be executed to check that the tool is giving the correct deviation outputs:
To check Roll and Tilt outputs, place the probe on a flat surface with the Y mark engraved on the tool housing pointing up (Y axis of the coordinate system is pointing down, Figure 5-1).
Verify that the Roll and Tilt outputs are as follows:
Roll = 90° ± 0.5°
Tilt = 90° ± 0.5°
Next, roll the probe counterclockwise (looking towards the tool bottom) about its X axis in increments of 90° and verify that for each position the roll angle increments in succession to 0°, 270° and 180° while the tilt remains 90° ± 0.5°.
To verify inclination at 0° and 90°, position the probe so that the X axis is pointing down (0° inclination) and horizontal (90°).
To verify azimuth accuracy, a good compass and an area free from magnetic materials should be used. Use a compass to orient the probe horizontal and North and verify that the azimuth reading is 0° ± 1°. Repeat the procedure for East, South and West directions.

5.2 Rolling Test – Azimuth And Tilt Check

Azimuth and tilt can 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 ±2.5° and a deviation of the tilt less than the limit ±0.5°.

6 Maintenance

6.1 Upgrading firmware

In accordance with the ALT policy of continuous development the tool has been designed to allow firmware upgrades.

Firmware upgrade procedure is as follows:

1. Checking the communication is valid.
2. Upgrading firmware

6.1.1 Checking the communication

- Connect the tool to your acquisition system.
- Start the data acquisition software.
- In the **Tool** panel select the appropriate tool and turn the power on.
- In the **Communication** panel, select **Settings**. Check **baud rate** is set to **41666** and **communication status** is **valid** (Figure 6-1 or Figure 6-2).

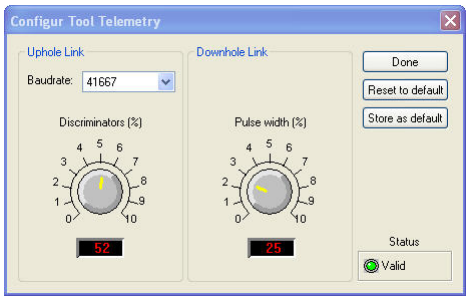

Figure 6-1 *Tool communication settings - ALTLog*

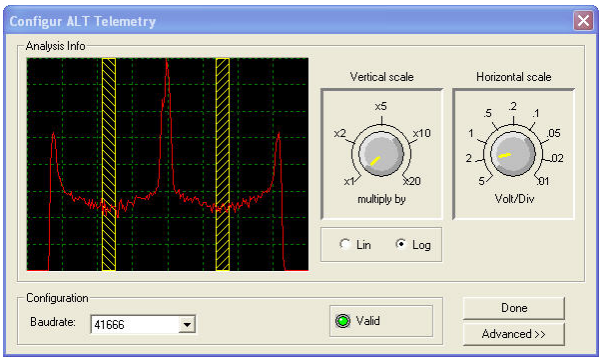

Figure 6-2 *Tool communication settings - Matrix*

Warning: The telemetry must be tuned properly. Bad communication may abort the upgrade of the firmware!

6.1.2 Upgrading the firmware

Check that the communication status is valid. **Right Click** on the tool preview in the **ToolStack Manager** view and select **Upgrade Firmware** from the context menu (Figure 6-3).

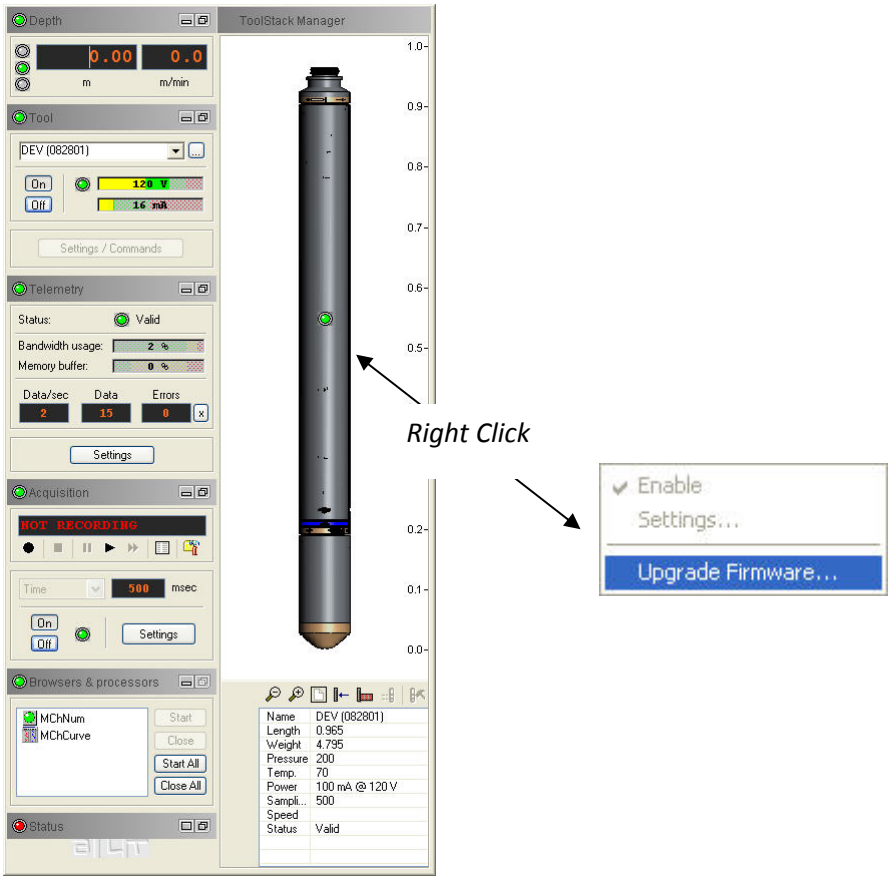

Figure 6-3 *Right Click into ToolStack manager view*

- The following message will appear (Figure 6-4). Click **Yes** to validate your selection.

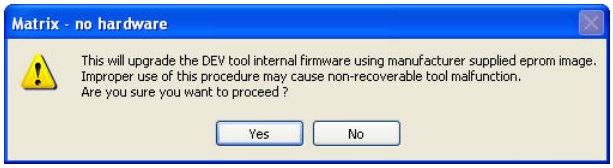

Figure 6-4 *Warning Message during firmware upload*

- Select and open the appropriate **.hex** file provided. The upgrade will start.
- During the upgrade procedure, the following message is displayed:

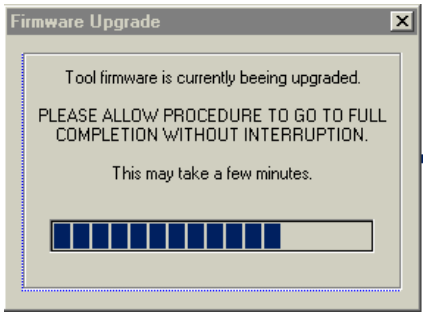

Figure 6-5 *Firmware upgrade progress window*

- Once the upgrade has been successfully completed (Figure 6-6), click on **OK** to turn the tool off.

Figure 6-6 *Successful upgrade*

- Power the tool on to start the upgraded firmware.

Note that the following error message (Figure 6-7) will appear at the end of the procedure when the tool firmware upgrade has failed or has been aborted. Verify the tool communication settings in this case.

Figure 6-7 *Error message*

6.2 General Tool Maintenance

The QL40 Dev should require no maintenance than a few salient points.
Keep the probe and the tool top connector clean.

- When the probe is transported, it needs to be contained in a vibration damped container to minimize stress on the sensor.
- The probe top connector should be periodically cleaned with oil free contact cleaning solvent.
- As mentioned in the operating procedure section, the probe should be kept away from strong magnetic fields, and repeated proximity to material with a high magnetic permeability such as iron and steel.

7 Troubleshooting

Observation	To Do
Tool not listed in Tool panel drop down list.	- Do you have a configuration file? - Has the configuration file been copied into the …/Tools folder (refer to acquisition software manual for details of the directory structure)?
Tool configuration error message when powering on the tool.	- Check all connections. - Adjust the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3) and store the new settings as default.
Tool panel - No current.	- 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).
Tool panel - Too much current (red area).	**! Immediately switch off the tool !** **-**Possible shortcut (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 shortcut. - If the above shows no issues, use test cable to verify tool fu nctionality. - If the problem still occurs, please contact service centre.
Telemetry panel - status shows red.	- Verify the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3).
Telemetry panel - memory buffer shows 100%.	- 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.
Telemetry panel – bandwidth usage shows 100%. *(Overrun error message.)*	- Set the baudrate to highest value allowed by your wireline configuration. - Reduce logging speed, decrease azimuthal resolution and/or increase vertical sample step.
Telemetry panel - large number of errors.	- Verify the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3). - Check bandwidth usage and telemetry error status.

8 Appendix

8.1 Parts list

8.1.1 Tool delivery kit QL40-xxx (ref. 209-016)

Item No.	Qty	Part No.	Description
1	1	210-002	Silicone grease Molykote111
2	2	211-004	C-spanner 40-42 (QL40-43)
3	6	AS215-V-75°	Oring-V 26.57 x 3.53 75°
4	1	210-003	Grease Lubriplate L0034-086

8.2 Technical drawings

The following technical drawings are available on request:

- 19” Rack connection diagram.
- QL40 DEV Wiring Diagram.

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