

# User Guide

## QL40 GRA - Natural Gamma Ray Probe





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# 1 General Information

The QL40-GRA probe measures the amount of gamma radiations occurring naturally within the formations crossed by a borehole.

A scintillation Sodium Iodide crystal is used to detect the gamma rays. Gamma rays are produced mainly by isotopes of potassium, thorium, uranium and their decay products. The gamma ray log is widely used in the mining and oil industry for the identification of lithology, correlation between boreholes and clay content analyses.

The tool is supplied as an inline 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 stand alone tool.

The QL40-GRA operates with the ALTLogger and Matrix logging systems and can be run on any standard wireline (mono, 4 or 7 conductor, coax).

### 1.1 Dimensions

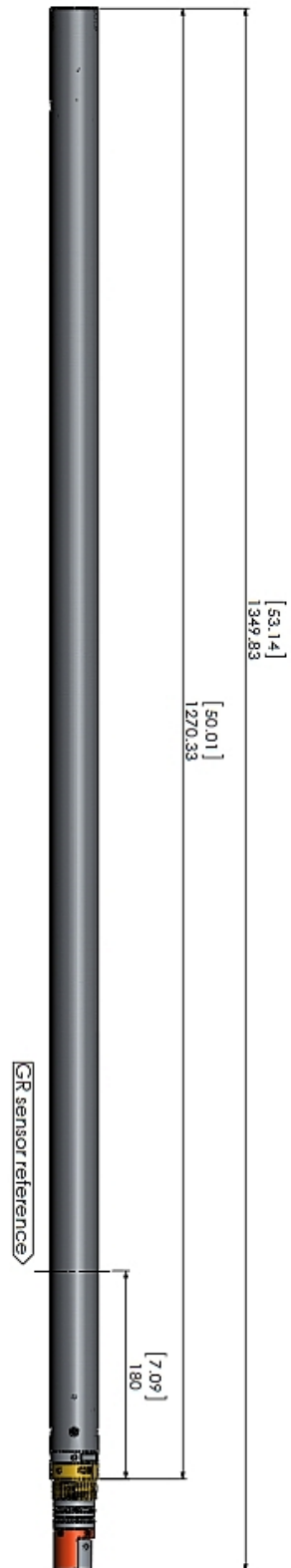


Figure 1-1 QL40-GRA Dimensions Technical Specification

**Tool**

Diameter: 42.3 mm (1.66")  
Length: 1.27 m (50.01" )  
Measurement point: 0.18 m (7.1") from bottom connector

Weight: 4.67 kg (10.3 lbs)  
Min. Temp.: 0 °C (32 °F)  
Max. Temp.: 70 °C (158 °F)  
Max.Pressure: 200 bar (2900 psi)

**Cable:**

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

**Sensors:**

Nal(Tl) crystal 2.22 cm x 7.62 cm (0.875" x 3.00")

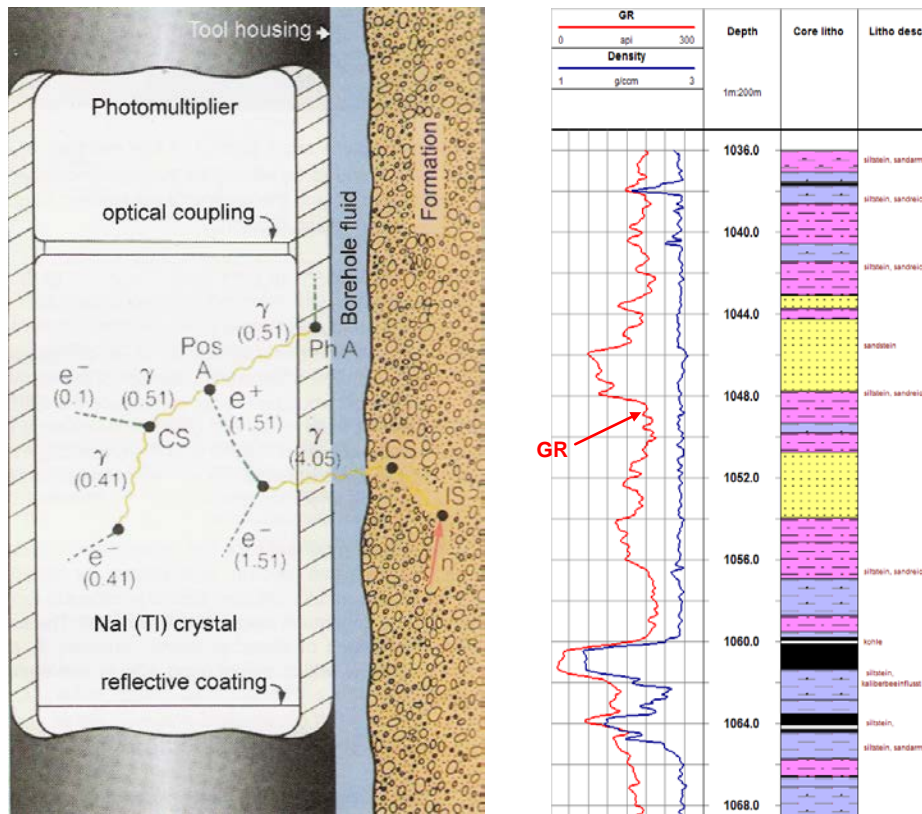
**Power:**

DC voltage at probe top: Min 80 VDC  
Max 160 VDC  
Nominal 120 VDC  
Current: Nominal 25 mA



## 2 Measurement Principle

The QL40-GRA tool is equipped with a scintillation Thallium doped Sodium Iodide crystal - NaI(Tl), which, when hit by gamma rays, emits pulses of light. These pulses of light are amplified by a photo multiplier tube and are then converted into electrical pulses (Figure 2-1). The number of pulses are counted, digitized and transmitted up the wireline to the surface acquisition system.



**Figure 2-1** Measurement principle (left, O.&L. Serra, 2004) and typical GR responses and data display (right)



## 3 Notes on QL tool assembly

**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.

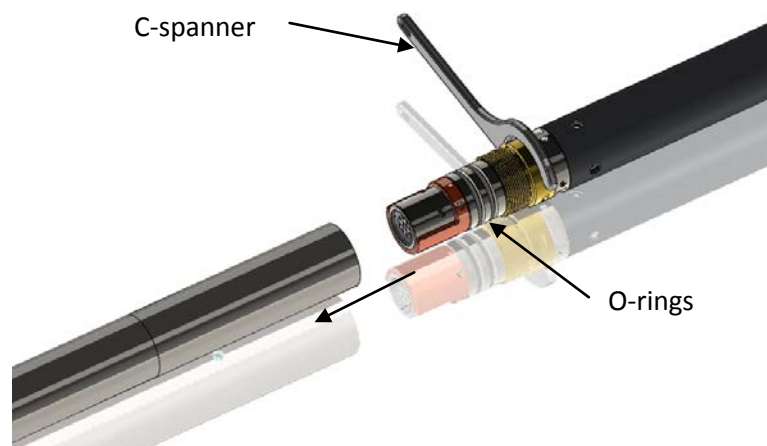
### Mid Sub

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

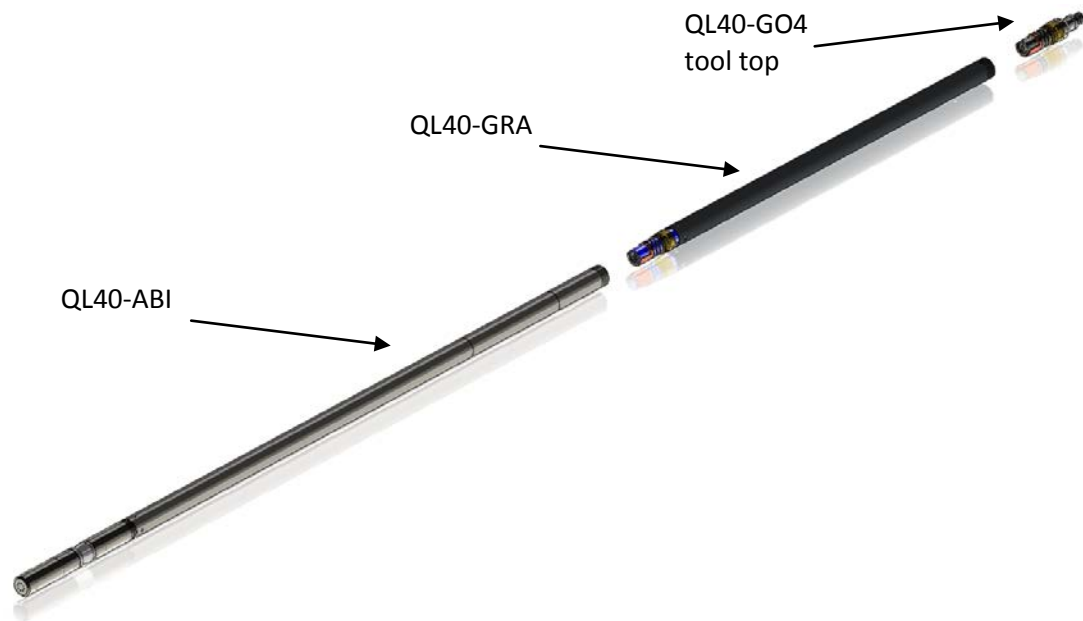
QL40 tool stacks are terminated by either a QL40 bottom sub or a QL40 bottom plug. At the top of the stack a QL40 tool top is required to connect the tool string to the cable head. Several tool tops are already available, special ones can be made on request.

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.



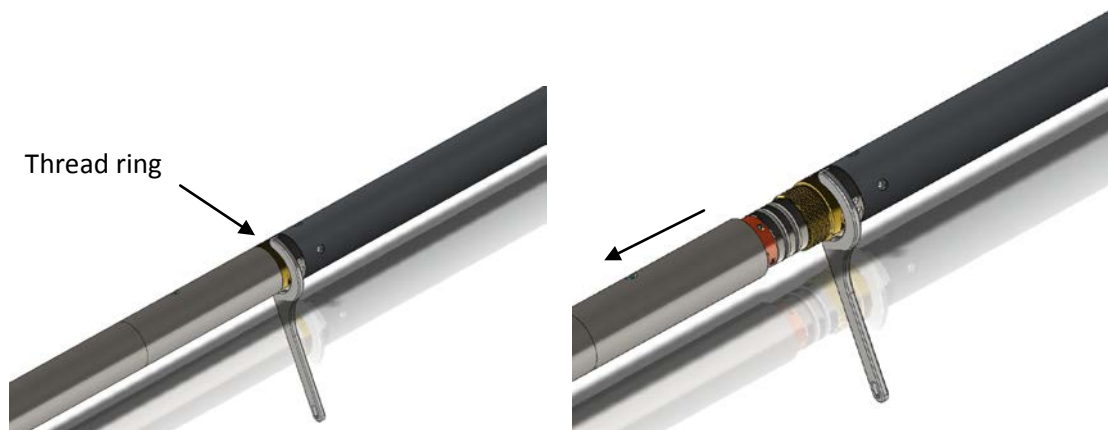
**Figure 3-1** C-spanner and O-rings of QL connection

The following example of a QL40-ABI, QL40-GRA 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-GRA can now be run stand-alone (Figure 3-5).



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



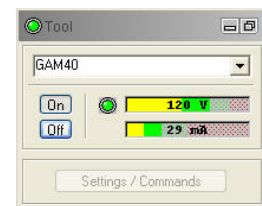
## 4 Operating Procedure

**Note:** Parts of the topics discussed in the 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.

### 4.1 Quick Start

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

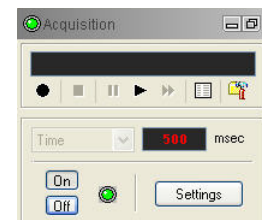
2. Select the relevant QL40-GRA tool from the drop down list (Figure 4-1) in the software's **Tool** panel (if your tool is not listed check that your tool configurations file is stored in the designated folder on your computer).



**Figure 4-1** Tool panel

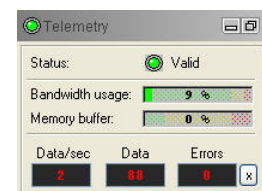
3. In the **Tool** panel switch on the tool (click **On** button) and verify that the power indicator shows a valid (green) level. The system goes through a short initialization sequence which sets the default parameters and communication settings held in the tool configuration file. The configuration 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. On the **Tool** panel (Figure 4-1) click the **Settings / Commands** button to configure your tool (see chapter 4.5 for details).

5. 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).



**Figure 4-2** Acquisition panel

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



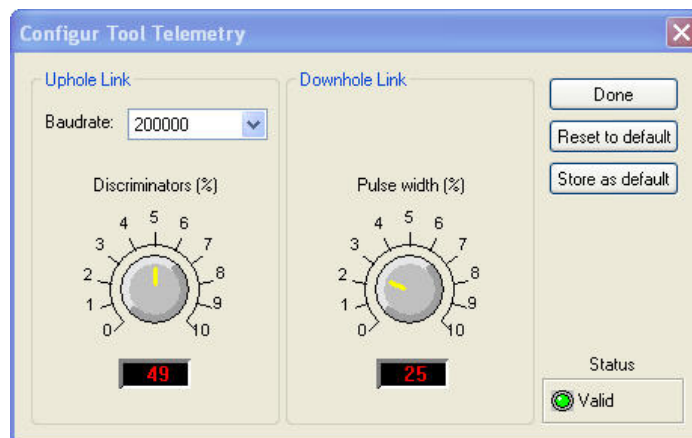
**Figure 4-3** Telemetry panel

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.

## 4.2 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 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*

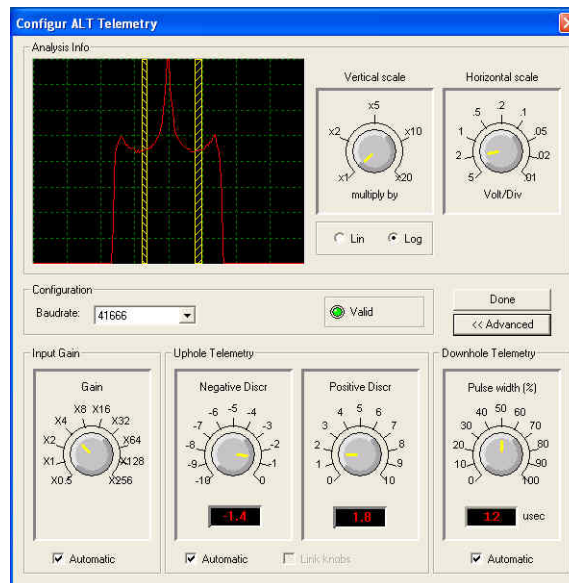
## 4.3 Tool Communication with MATRIX

The tool telemetry can be configured through the **Telemetry** panel of the Matrix 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 **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 4-5) 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-GRA does not have any configuration options.

## 4.5 Recorded Parameters, Processors and Browsers

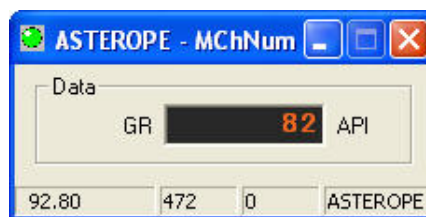
### 4.5.1 Recorded parameters

The following data channels are recorded by the QL40-GRA tool.

Time	Sampling time in seconds
TCPU	Temperature at CPU board in °C
EHT	High tension at photo multiplier in V
COUNT	Raw gamma ray counts
GR	Gamma ray in counts per second [cps] or calibrated unit

### 4.5.2 MChNum Browser

Figure 4-6 shows a typical example of the numerical values displayed in the MChNum browser window during operation.

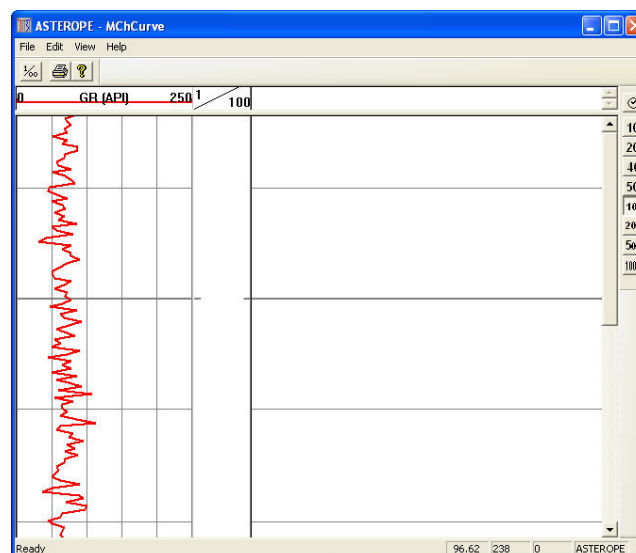


*Figure 4-6 MChNum Browser during operation*

### 4.5.3 MChCurve Browser Window

The MChCurve browser displays the recorded parameters by means of curves in real time (Figure 4-7).

The user is allowed to modify the curve presentation by double clicking on the log title (colours, column position, scale, filter, gridding,...)



*Figure 4-7 QL40-GRA MChCurve Browser Window*

## 5 Performance Check & Calibration

Calibrations are performed at the factory and require a basic knowledge and understanding of the tool. Performance checks for the gamma measurement can be made on the surface before logging. With the tool powered on and viewing data on the computer screen a small source of natural gamma radiation can be placed in close proximity to the detector area about 16.5 cm above the bottom of the probe. An increase in gamma counts will then be observed in the MChNum and MChCurve window if the tool is working properly. The only sensible calibration can be carried out for the GR sensor.

### Prepare to Calibrate:

1. Assemble the tool sub(s) and connect to the wireline.
2. In the **Tool Panel**:  
Select the proper tool/stack;  
Turn tool power **On**;  
Click Tool Panel **Settings / Commands** button.  
In the **Acquisition Panel** select **Time** and turn it **On**.
3. Click the Green LED at the top left corner of the MChNum Browser window or right click the top pane to display the MChNum context menu (Figure 5-1).
4. Select **Calibration Settings**.

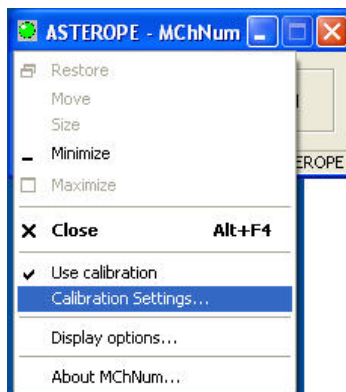
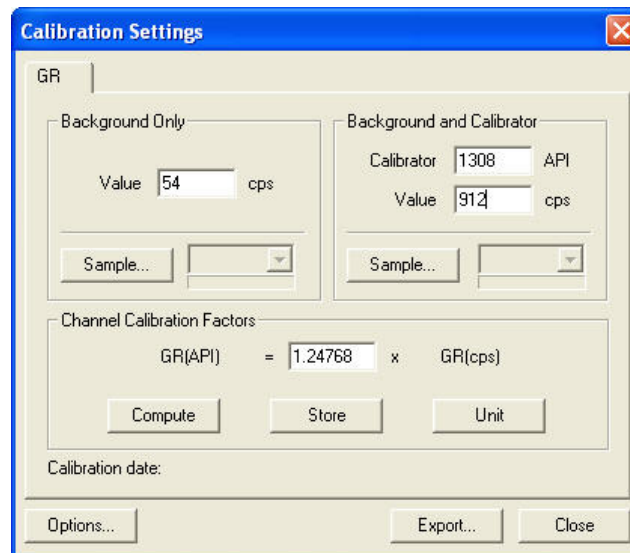


Figure 5-1 MChNum context menu

### Calibration Settings

1. In order to measure the background radiation, place the tool away from any radioactive material at least 1.5m above the ground or, if available, place the tool in a water tank.
2. In the **Tool Panel**:  
Select the proper tool/stack;  
Turn tool power **On**;
3. In the **Calibration Settings** dialog box (Figure 5-2) click on **Sample** in the **Background Only** section and wait until an average value has been determined. The corresponding **Value** will be updated automatically. (The number of samples taken can be changed under **Options**.)



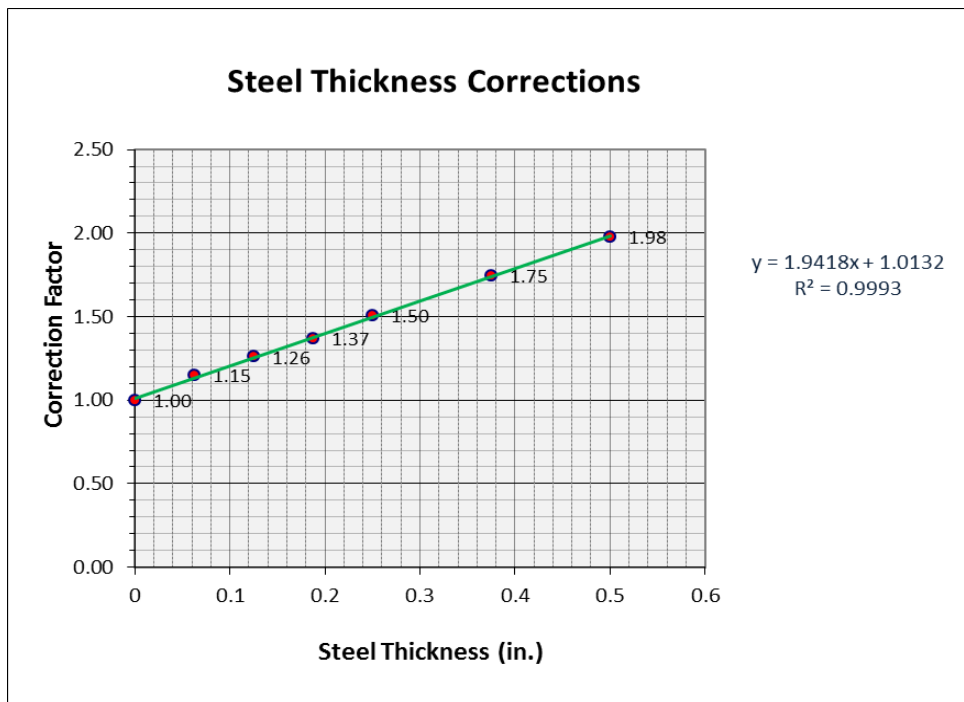
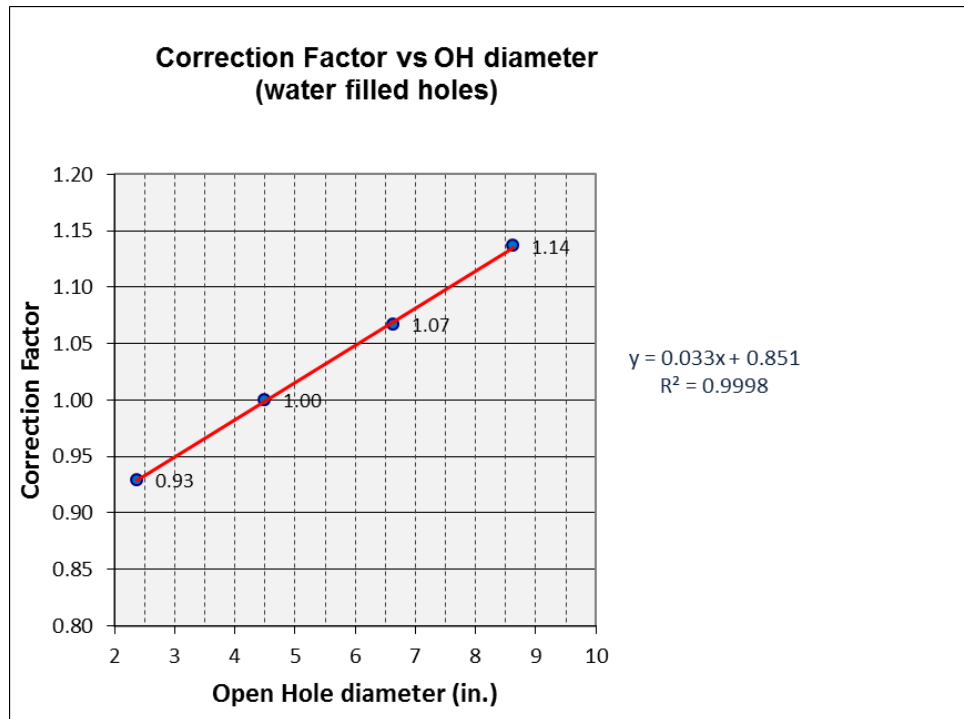
**Figure 5-2** Calibration Settings dialog box

4. Place the calibrator on top of the sensor or lower the tool into the test pit.
5. Enter the known source strength into the **Calibrator** edit box. If necessary change the units by clicking on the **Unit** button.
6. Click on **Sample** in the **Background and Calibrator** section to determine an average value. The corresponding **Value** will be updated automatically. Click on **Compute** in order to compute the calibration factor.
7. **Store** the new calibration settings in the sub file by clicking on the corresponding button.

On the **Browsers & processors** panel click **Close All** then **Start All** to refresh the other Browsers and Processors. This must be done as they only read the calibration constants from the sub file once when they start.

## 6 Correction charts

Use correction charts for correcting field data with model data, which is logged in a 4<sup>1/2</sup>" diameter borehole filled with water. Multiply the raw cps value (or API value when calibrated) by the correction factor.





## 7 Maintenance

### 7.1 Upgrading firmware

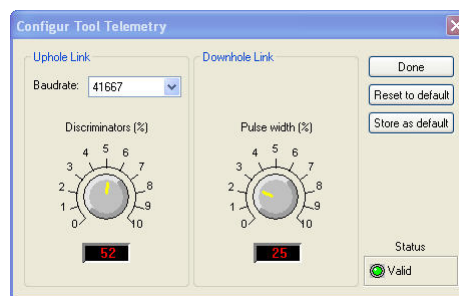
In accordance with the ALT policy of continuous development the tool has been designed to allow firmware upgrades.

Firmware upgrade procedure is as follows:

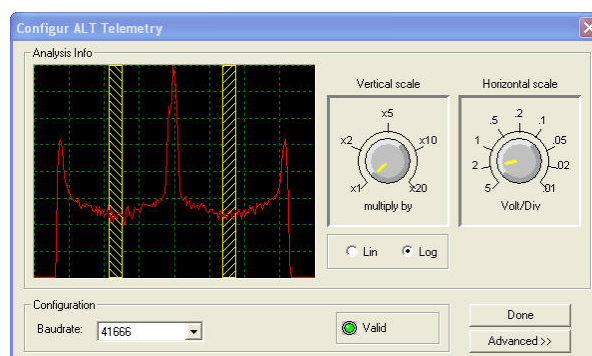
1. Checking the communication is valid.
2. Upgrading firmware

#### 7.1.1 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

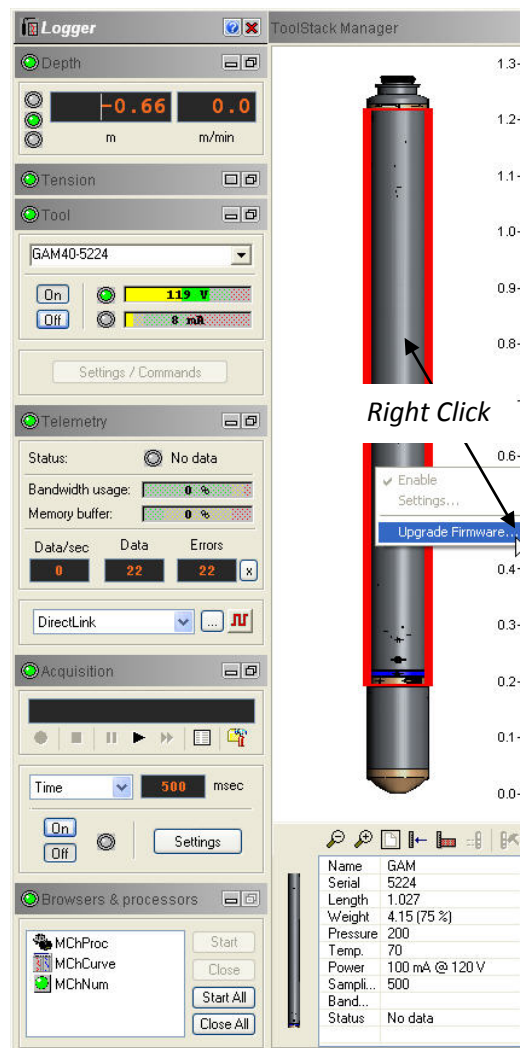
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**Warning: The telemetry must be tuned properly. Bad communication may abort the upgrade of the firmware!**

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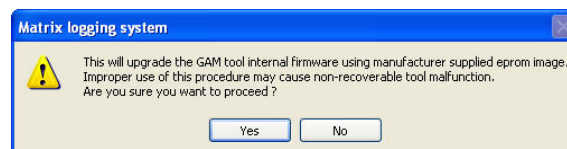
### 7.1.2 Upgrading the firmware

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).



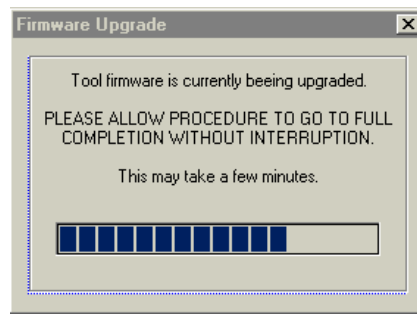
**Figure 6-3** Right Click into ToolStack manager view

- 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

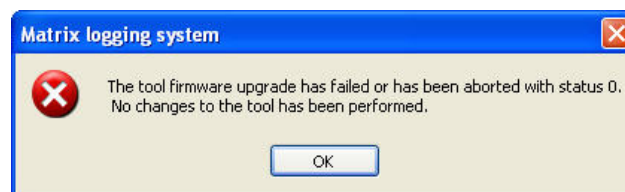
- Once the upgrade has been successfully completed (Figure 6-6), click on **OK** to turn the tool off.



**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

## 7.2 General Tool Maintenance

The QL40-GRA tool should require no maintenance other than a few salient points.

- Keep the probe and the tool top/bottom connectors clean.
- When the probe is transported, it needs to be contained in a vibration damped container to minimize stress on the sensors.
- The probe top/bottom connector should be periodically cleaned with oil free contact cleaning solvent.



## 8 Troubleshooting

Observation	To Do
<i>Tool not listed in Tool panel drop down list.</i>	<ul style="list-style-type: none"> <li>- Do you have a configuration file?</li> <li>- Has the configuration file been imported using the Logger Settings application (refer to the corresponding manual)?</li> <li>- Did you configure a stack for your tool (at least top, tool body and bottom plug)?</li> </ul>
<i>Tool configuration error message when powering on the tool.</i>	<ul style="list-style-type: none"> <li>- Check all connections.</li> <li>- Adjust the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3) and store the new settings as default. Apply the appropriate tool settings for your logging run (see chapter 4.5).</li> </ul>
<i>Tool panel - No current.</i>	<ul style="list-style-type: none"> <li>- Verify that the wireline armour is connected to the logging system. Test your interface cable between winch and data acquisition system.</li> <li>- Verify cable head integrity.</li> <li>- Verify voltage output at the cable head (it should be 120V).</li> </ul>
<i>Tool panel - Too much current (red area).</i>	<p><b>! Immediately switch off the tool !</b></p> <ul style="list-style-type: none"> <li>-Possible shortcut (voltage down, current up): Check for water ingress and cable head integrity - wireline continuity.</li> <li>- 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.</li> <li>- If the above shows no issues, use test cable provided by ALT to verify tool functionality.</li> <li>- If the problem still occurs, please contact service centre.</li> </ul>
<i>Telemetry panel - status shows red.</i>	<ul style="list-style-type: none"> <li>- Verify the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3).</li> <li>- If problem cannot be resolved contact support@alt.lu .</li> </ul>
<i>Telemetry panel - memory buffer shows 100%.</i>	<ul style="list-style-type: none"> <li>- 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.</li> </ul>
<i>Telemetry panel – bandwidth usage shows 100%. (Overrun error message.)</i>	<ul style="list-style-type: none"> <li>- Set the baudrate to highest value allowed by your wireline configuration.</li> <li>- Reduce logging speed, decrease azimuthal resolution and/or increase vertical sample step.</li> </ul>
<i>Telemetry panel - large number of errors.</i>	<ul style="list-style-type: none"> <li>- Verify the telemetry settings for your wireline configuration (see chapter 4.2 or 4.3).</li> <li>- Check bandwidth usage and telemetry error status.</li> </ul>



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## **9 Appendix**

### **9.1 Parts list**

Please contact ALT or Mount Sopris for a list of spare parts and items included in the delivery kit.

### **9.2 Technical drawings**

The following technical drawings are available on request:

- 19" Rack connection diagram.
- QL40-GRA Wiring Diagram.



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