

# User Guide

## QL40-TGU – Triple Gamma Probe





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## 1 General Information

The QL40-TGU modified triple gamma probe measures natural gamma radiation using two different types of detectors.

The probe's most sensitive detector is a photo multiplier tube and 0.5"x1.5" NaI crystal assembly. Two Geiger Mueller (G-M) tubes are installed in the probe above the NaI detector. These G-M tubes have been used successfully to determine ore grade in very high concentrations of U<sub>3</sub>O<sub>8</sub>. The count rate output of the G-M tube pair is about 0.5% of the NaI detector.

By utilizing two detector types with varying sensitivities, the QL40-TGU can be used in exploration and production projects with a wide variation in ore grade. Accurate concentrations can be measured in uranium ore grades ranging from less than 0.1% to as high as 20% U<sub>3</sub>O<sub>8</sub>. Data is logged from all three detectors on a single pass in the hole. The data is digitized in the probe and sent to the surface using the TelePSU modem/power supply.

Because gamma rays can travel such distances through rock, the spatial resolution of the method is affected. Boundaries between widely differing natural gamma ray emitters can tend to be somewhat "smeared" in the gamma ray log results. Moreover, because the emission of gamma rays is a physical process with natural statistical variability, gamma response has a temporal variation. In logging, this effect is minimized by averaging response over a fixed time interval.

The QL40-TGU operates with Matrix, Scout-Pro, and Opal logging systems and can be run on any standard wireline (mono, 4 or 7 conductor, coax).

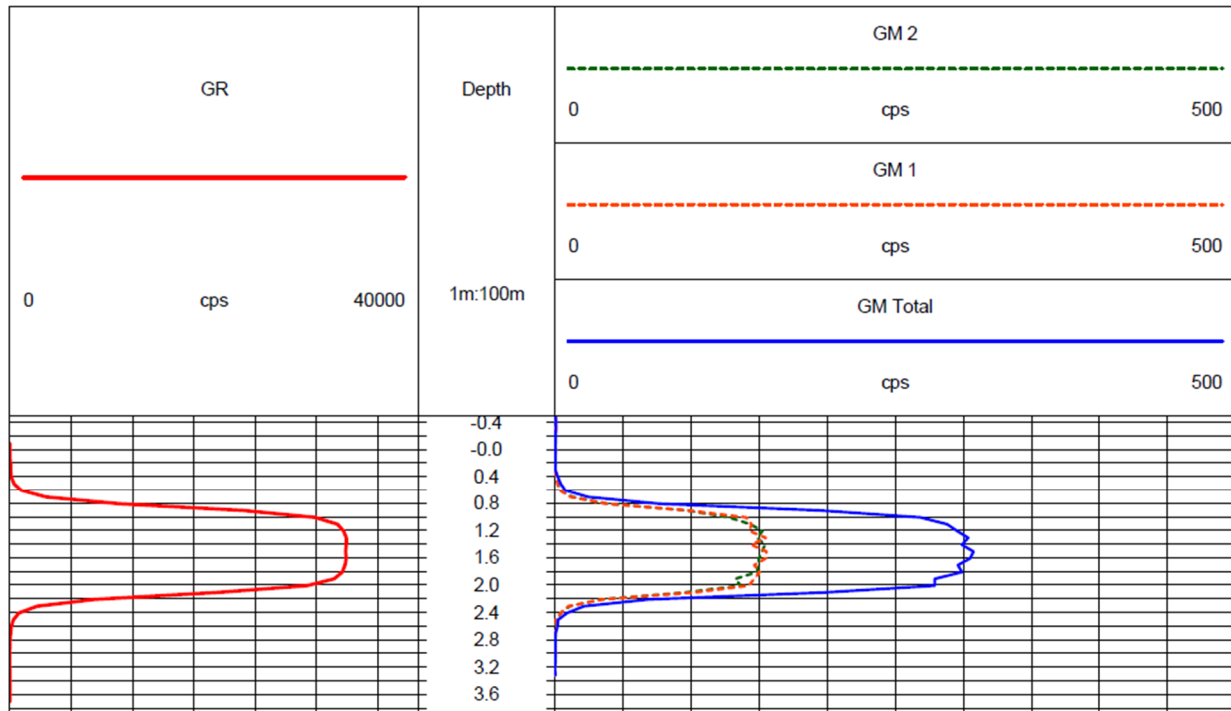


Figure 1.1: Sample data from a QL40-TGU

### 1.1 Dimensions

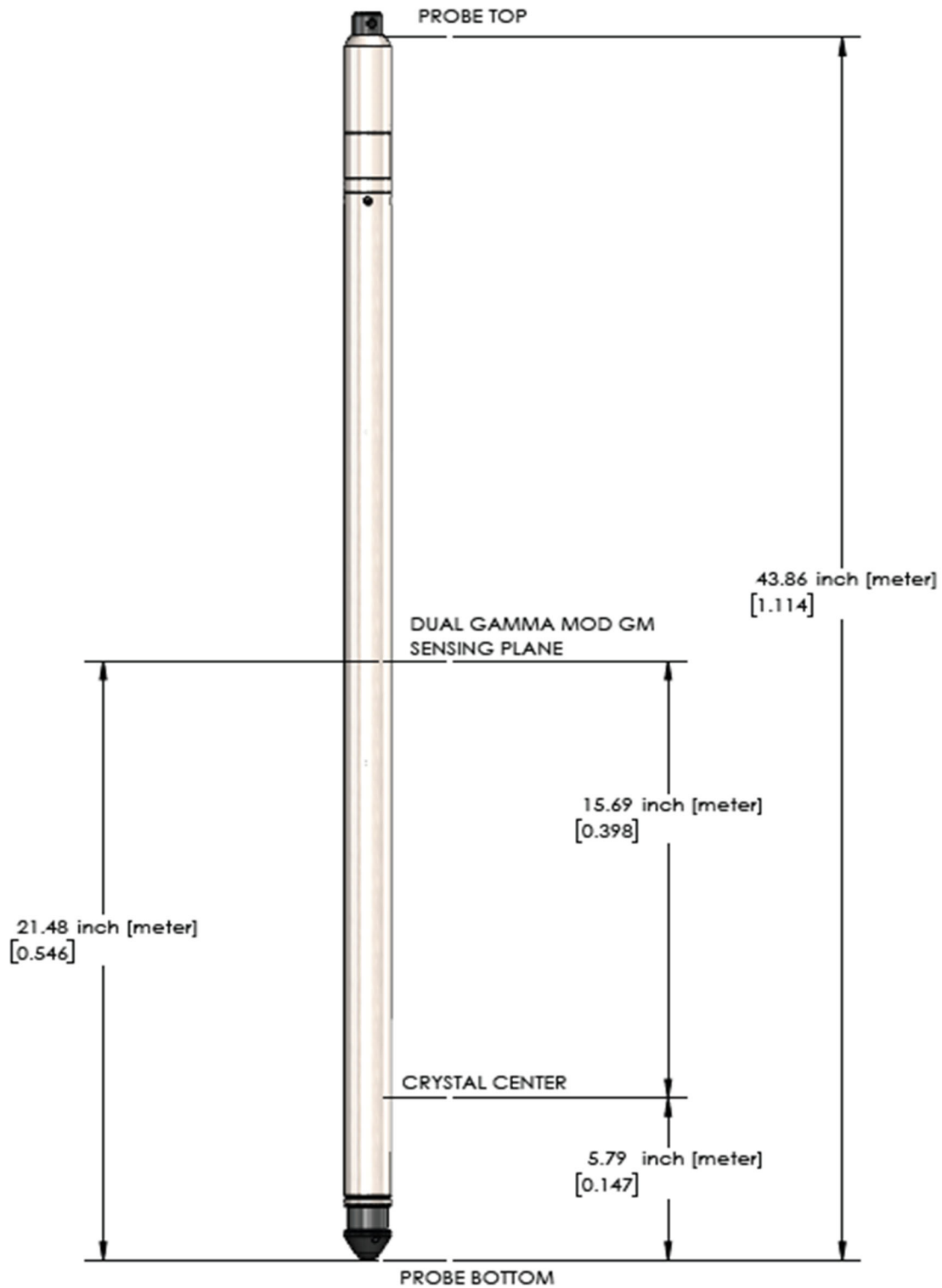


Figure 1-2: 40TGU Dimensions

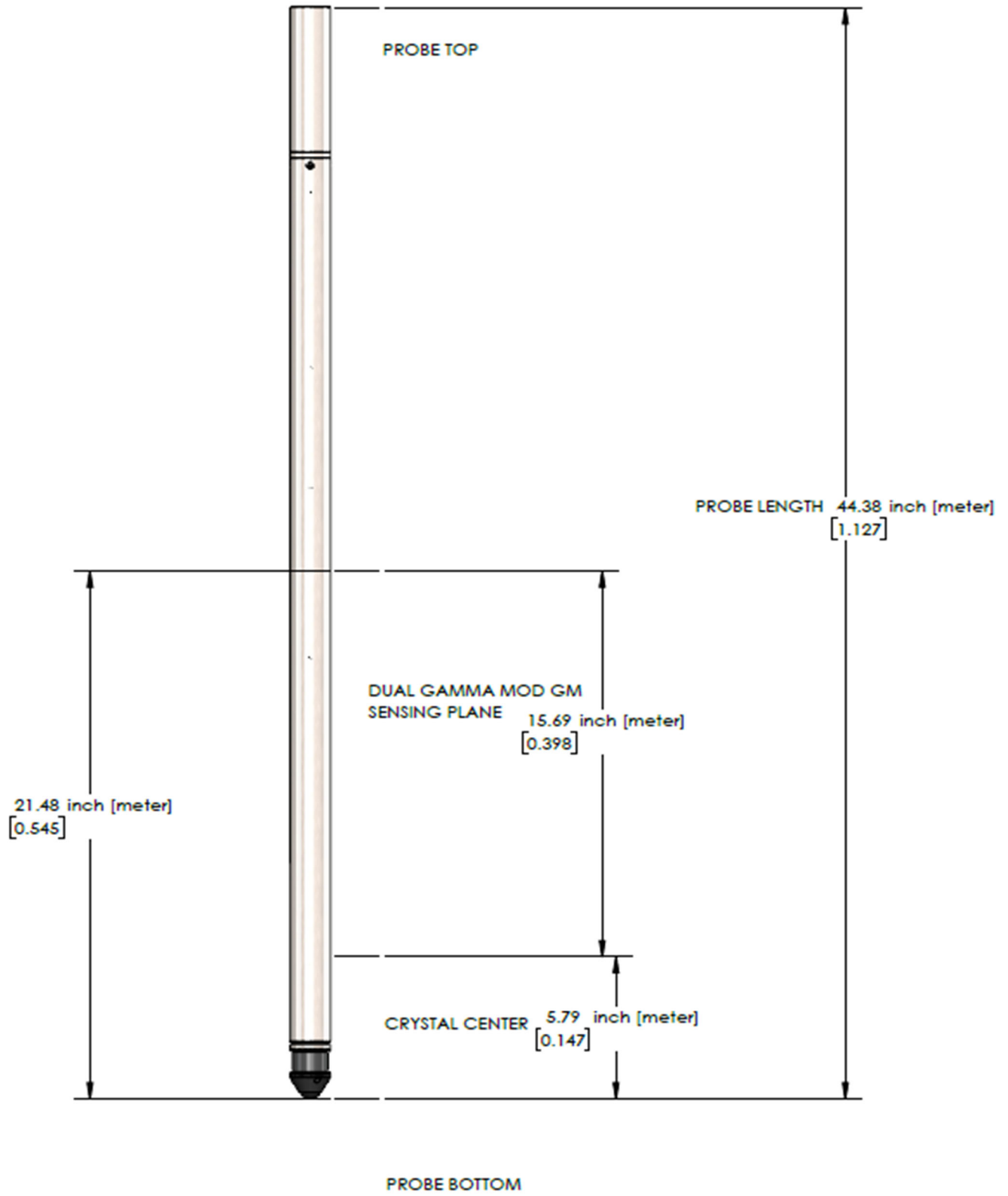


Figure 1-3: QL40-TGU Dimensions

## 1.2 Technical Specifications

<b>Dimensions</b>	
Length (40TGU)	1.114 m (43.86")
Length (QL40-TGU)	1.127 m (44.38")
Measurement Point (NaI)	0.147 m (5.79") from bottom of probe
Measurement Point (G-M)	0.546 m (21.48") from bottom of probe
Diameter	42.3 mm (1.66")
Detector: NaI(Tl) crystal	1.27 cm x 3.81 cm (0.5" x 1.5")
Detector: Geiger-Muller Tubes (G-M)	(2) x 34.3 mm x 7.9 mm (1.35" x 0.31")
<b>Properties</b>	
Weight	5 kg (11.0 lbs)
<b>Maximum Operating Conditions</b>	
Maximum Temperature	70 °C (158 °F)
Minimum Temperature	0 °C (32 °F)
Maximum Pressure	200 bar (2900 psi)
<b>Compatibility</b>	
Wireline	Mono, Coaxial, 4-Conductor, and 7-Conductor
Acquisition System	Matrix, Scout, and Opal
<b>Power</b>	
DC voltage at probe top	Minimum: 100 VDC, Maximum: 160 VDC
Current	Nominal 120 VDC, Nominal 25 mA

## 2 Measurement Principal

The QL40-TGU Triple-gamma tool is equipped with a Thallium doped Sodium Iodide scintillation 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.

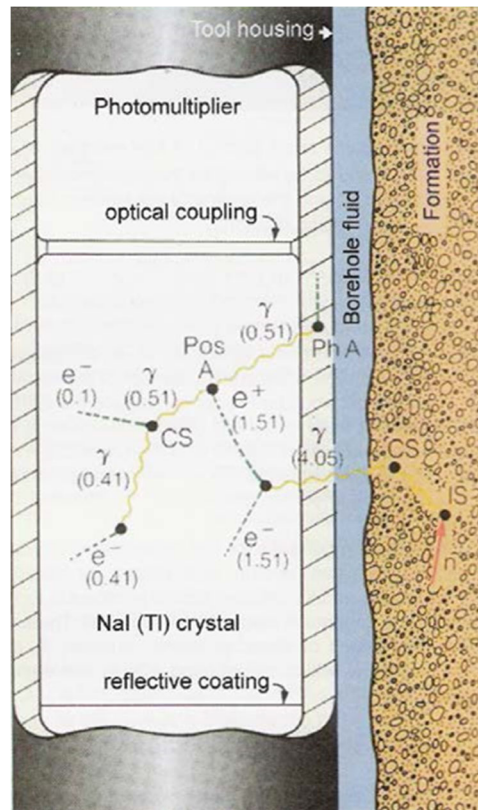


Figure 2-1: Measurement principle (left, O.&L. Serra, 2004)

The QL40-TGU tool is additionally equipped with two gaseous ionization detectors, Geiger-Muller tubes (G-M), that utilize the Townsend Avalanche phenomenon to discriminate individual incident radiation events. Incident gamma radiation passes through the walls of the G-M tube, producing secondary electrons via the photoelectric effect. Alternatively, the inert fill gas molecules can be directly ionized by the incident radiation as well. The freed electrons are accelerated towards the anode where they collide with additional molecules causing additional ionizations. The cascading ionization produces a direct electrical signal without the need of signal amplification (Figure 2-2). The number of pulses is counted, converted digitally, and transmitted up the wireline to the surface logger.

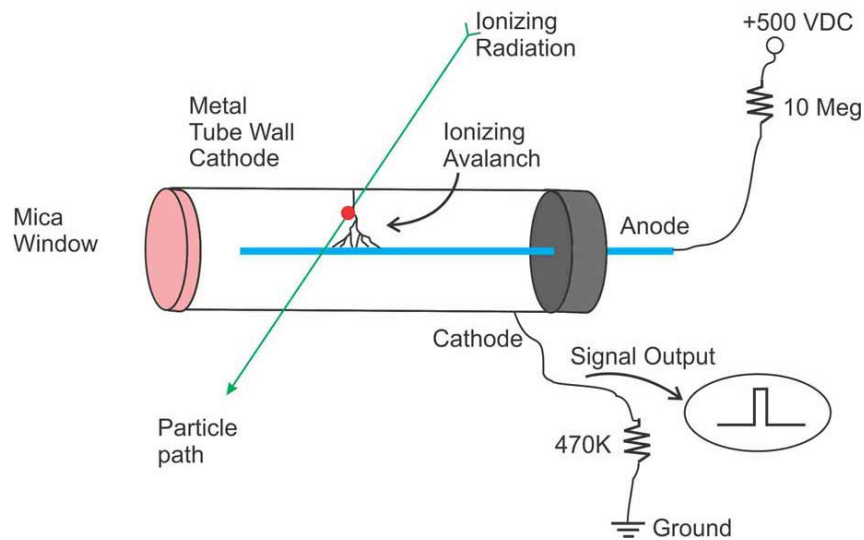


Figure 2-2: Example of a Geiger Muller Tube (Ghuge et al., 2016)

### 3 Notes on QL Stack 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.

#### **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 is verified. Prime the O-rings with the silicon grease that was supplied with the subs.

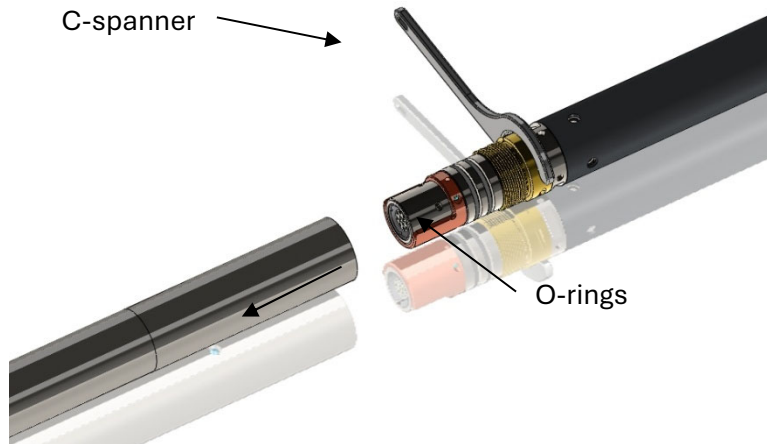


Figure 3-1: C-spanner and O-rings of QL connection

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.

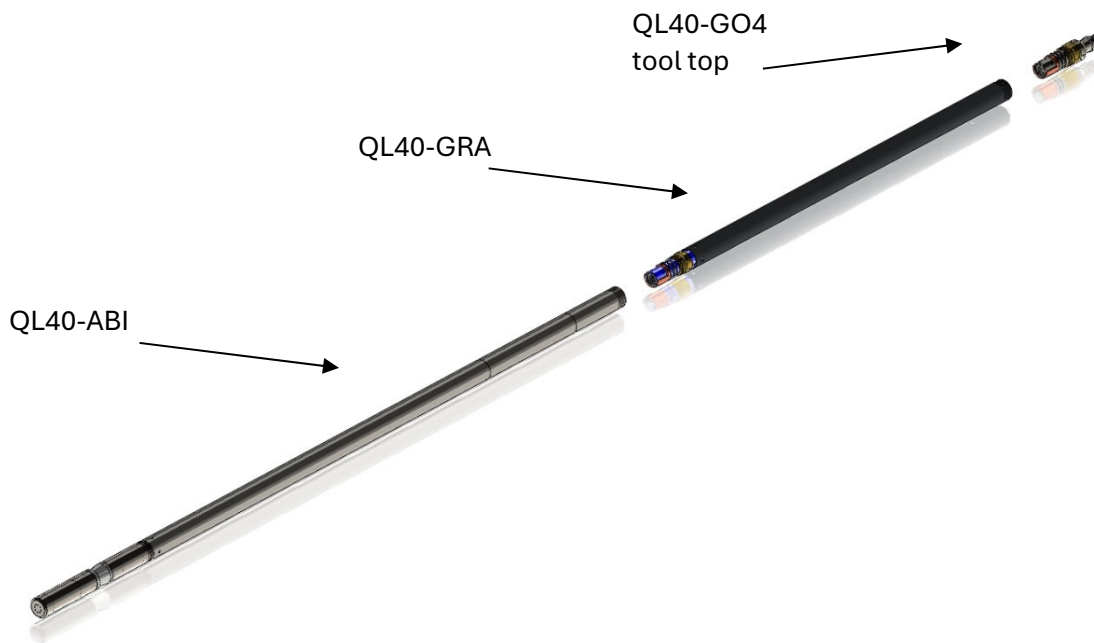


Figure 3-2: Tool stack example

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.

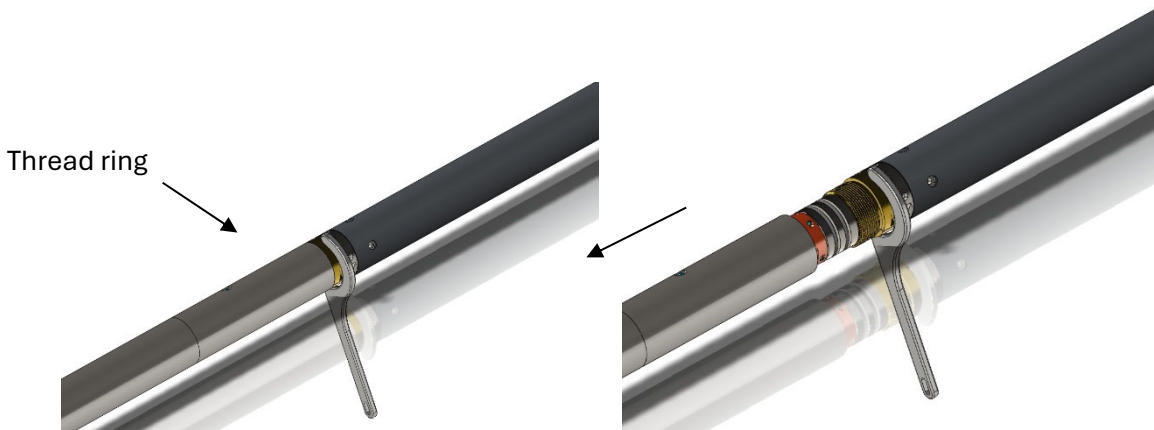


Figure 3-3: Unscrewing the thread ring

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

- Connect the tool to your wireline and start the data acquisition software.
- Select the relevant TGU 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).
- 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.
- On the **Tool** panel (Figure 4-1) click the **Settings / Commands** button to configure your tool.
- Zero the tool at the surface by positioning the connection between the cable head and the tool top/bridle at your reference point (ground surface). When the tool is in position go to **Depth** panel and select the box in the upper right corner (Figure 4-2).
- A new dialog box will appear (Figure 4-3) and you can select **Zero Tool**.

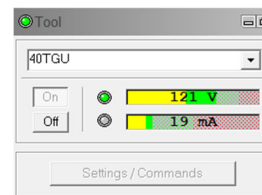


Figure 4-1: Tool Panel



Figure 4-2: Depth Panel



Figure 4-3: Expanded Depth Panel

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

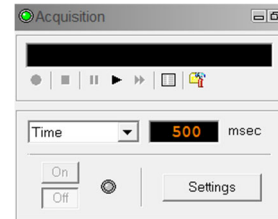


Figure 4-4: Acquisition Panel

- Press the **Record** button in the **Acquisition** panel (Figure 4-4), specify a file name and start the logging.
- During logging observe the controls in the **Telemetry** panel (Figure 4-5):
  - 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.

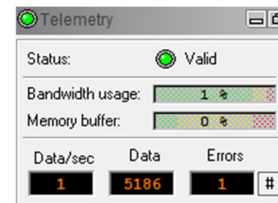


Figure 4-5: Telemetry Panel

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

## 4.2 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.

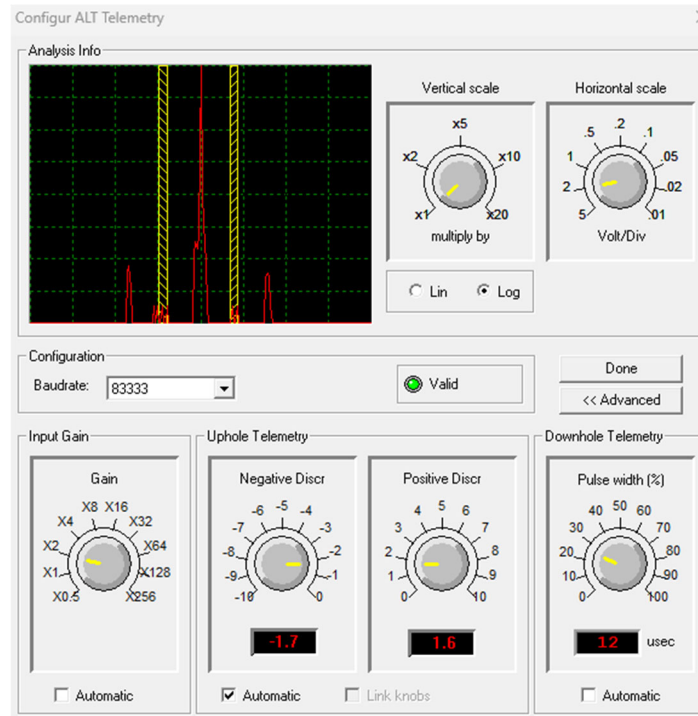


Figure 4-6: Matrix Telemetry Settings

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.

### 4.3 Tool Communication with Scout-Pro / Opal

The telemetry provided through the Scout-Pro / Opal 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 4-7). A procedure to achieve valid communication is given below:

- Change the **Baudrate** to 41666 bps.
- Turn off “Enable auto-detection at startup”.
- 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 initialization sequence the next time it is turned on.
- Save your changes before exiting settings window.

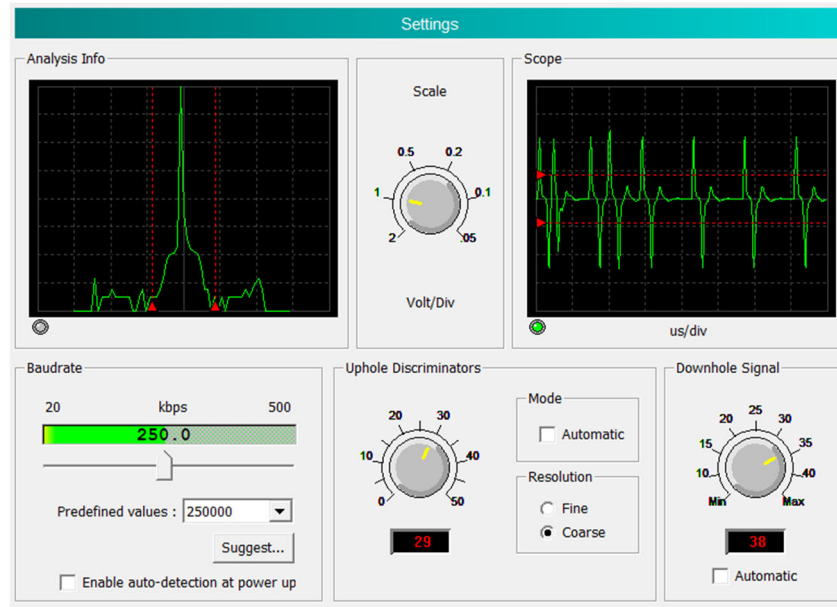


Figure 4-7: ALT Logger Telemetry Settings

## 4.4 Recorded Parameters, Processors, and Browsers

### 4.4.1 Recorded Parameters

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

Parameter	Description
Time	Sampling time in seconds
TCPU	Temperature of CPU board in °C
EHT PMT	High tension at photo multiplier in V
EHT GM Tubes	High tension at GM tubes in V
Count PMT	Raw gamma ray counts of NaI Crystal
Count GM1*	Raw gamma ray counts of GM Tube 1
Count GM2*	Raw gamma ray counts of GM Tube 2
GR	Gamma ray in counts per second [cps] or calibrated unit for NaI Crystal
GM1*	Gamma ray in counts per second [cps] for GM Tube 1
GM2*	Gamma ray in counts per second [cps] for GM Tube 2
GM Total*	Sum of gamma ray in counts per second [cps] for GM Tube 1 and 2

**\*Note:** In early versions of the 40TGU, GM channels were referenced as ZP (i.e. ZP1320 1, ZP1320 2, ZP total) due to the sensor type.

#### 4.4.2 MChNum Browser

Figure 4-8 shows a typical example of the numerical values displayed in the MChNum browser window during operation.

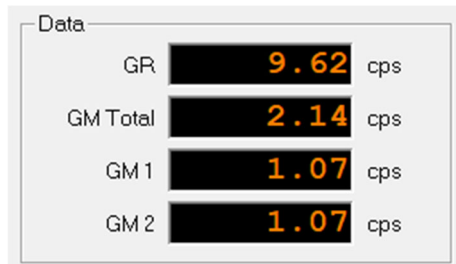


Figure 4-8: MchNum Browser during operation

#### 4.4.3 MChCurve Browser Window

The MChCurve browser displays the recorded parameters by means of curves in real time (Figure 4-9).

The user is allowed to modify the curve presentation by double clicking on the log title (colors, column position, scale, filter, gridding,....) or through the view tab (Figure 4-0).

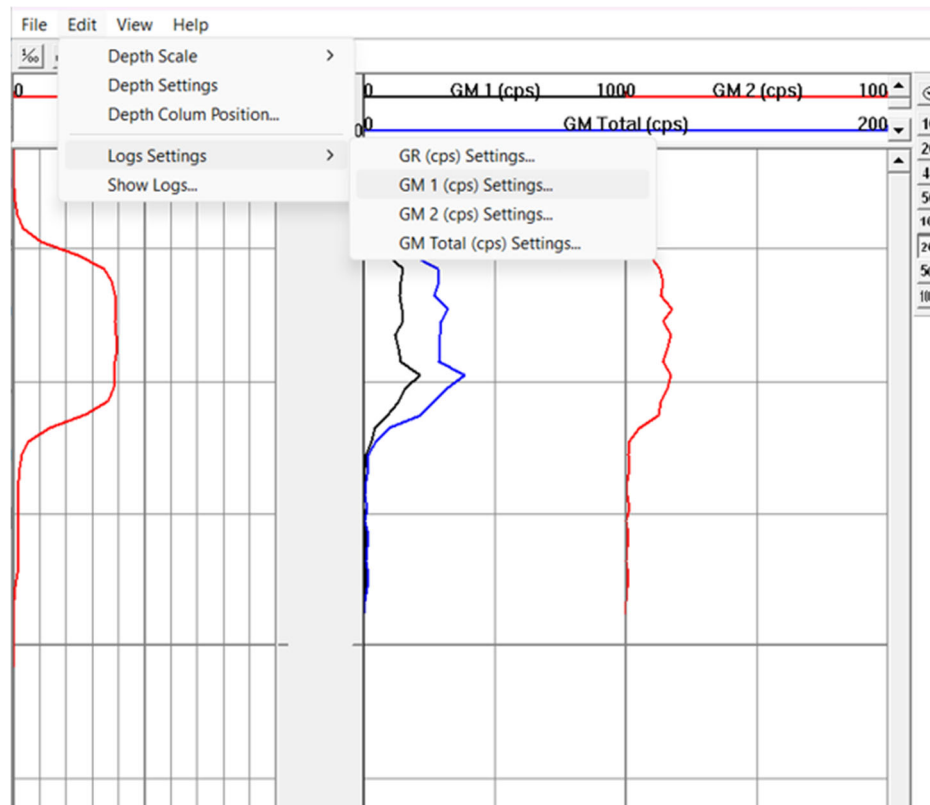


Figure 4-9: Changing presentation in MchCurve

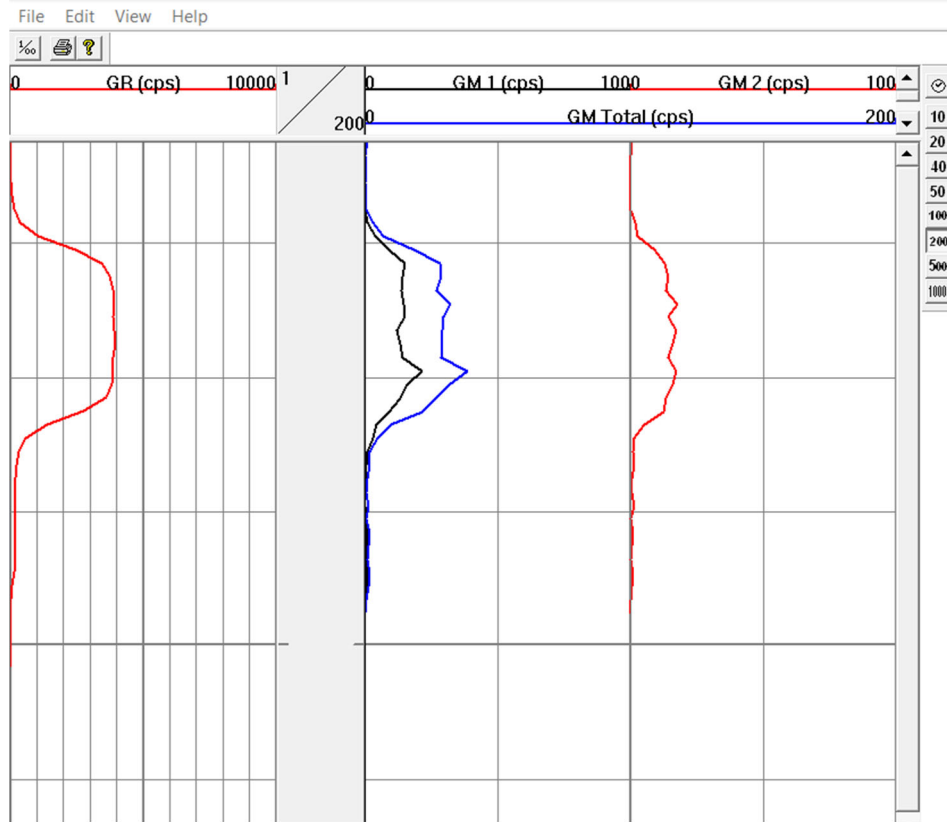


Figure 4-10: MchCurve Browser during operation

## 5 Performance Checks

Calibrations are performed at the factory and require a basic knowledge and understanding of the tool. Performance checks for the gamma measurement for both detectors can be made on the surface before logging. With the tool powered on, place small source of natural gamma radiation near the detector area, about 0.147 m (5.8 in) above the bottom of the probe and is marked with red tape. For the GM tubes, repeat the process at 0.546 m (21.48”) from the bottom of the tool. The gamma counts in the MChNum and MChCurve window should increase if the tool is working properly. Additionally, checking the high voltage channel (EHT) in MchNum can give indications of tool performance.

### Performance check:

1. In the **Tool Panel**: Select the proper tool/stack; Turn tool power **On**;
2. Navigate to the **MChNum** browser and right click on the top of the window to display the dropdown. Select **Display options** (Figure 5-1).

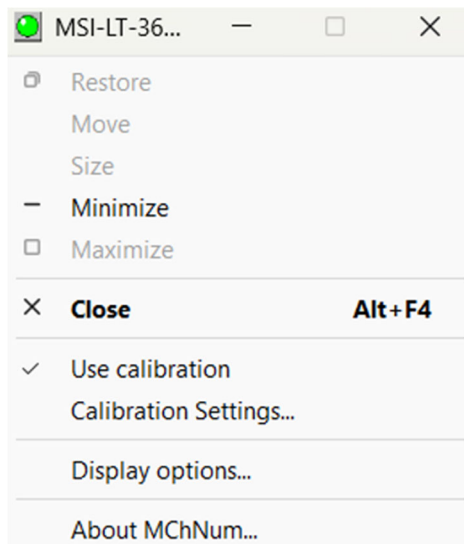


Figure 5-1: MChNum Dropdown Menu

3. Select the high voltage channel(s) (EHT) to be moved into MChNum browser by highlighting the desired channel and using the arrow key (>) to make the channel active (Figure 5-2).

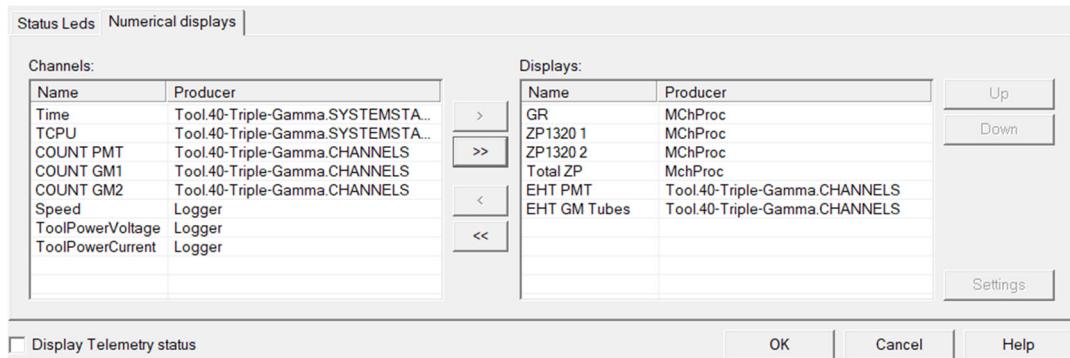


Figure 5-2: Display options in MChNum

4. Confirm that the necessary channels are displayed in MChNum (Figure 5-3).

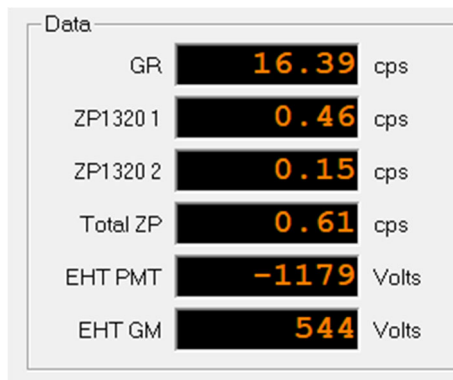


Figure 5-3: Newly displayed parameters

5. Review EHT and CPS channels on respective detectors to confirm functionality.

## 6 Maintenance

### 6.1 Checking 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 **baudrate** is set to **41666** and **communication status** is **valid** (Figure 6-1 or Figure 6-2).

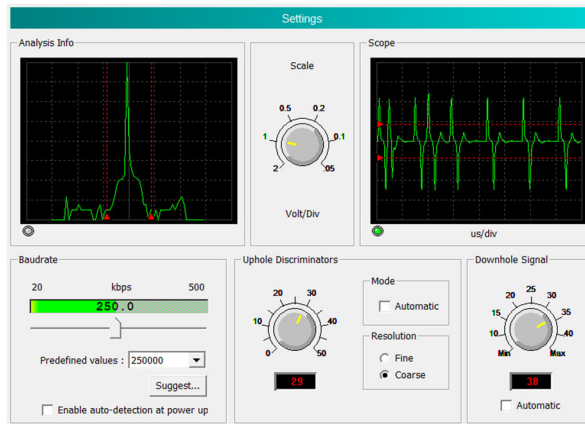


Figure 6-1: Tool communication settings – ALT logger.

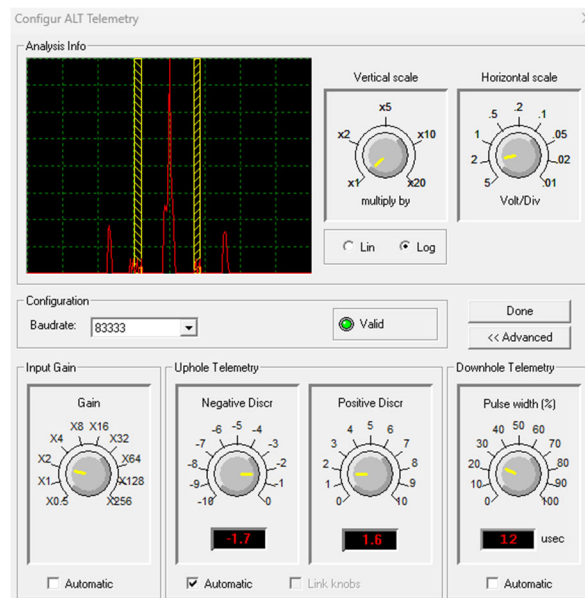


Figure 6-2: Tool communication settings – Matrix.

## 6.2 General Tool Maintenance

The QL40-TGU tool should require no maintenance other 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 detector and photomultiplier tube.
- The probe top connector threads should be periodically cleaned with oil free contact cleaning solvent.
- Ensure sufficient silicone lubricant is applied to QL-40 tool top O-rings.

## 7 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 for your serial number probe?</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) and store the new settings as default. Apply the appropriate tool settings for your logging run.</li> </ul>
<i>Tool panel - No current.</i>	<ul style="list-style-type: none"> <li>- Verify that the wireline and armor are 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 center.</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).</li> <li>- If problem cannot be resolved contact <a href="mailto:support@mountsopris.com">support@mountsopris.com</a></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 PC has enough resources available.</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).</li> <li>- Check bandwidth usage and telemetry error status.</li> </ul>

*MChNum – Zero counts  
per second (GR or GM).*

- Turn on high-voltage channels (See chapter 5).
- Display EHT values (MchNum > Green button > Display Options) for respective sensor make sure value is not 0.
- Contact [tech.support@mountsopris.com](mailto:tech.support@mountsopris.com)

## **8 Appendix**

### **Parts list**

Please contact ALT or Mount Sopris for a list of spare parts and consumables.

### **Technical drawings**

The following technical drawings are available on request:

- Technical drawing pack.