

# User Guide

## QL40 FTC and 40FTC Fluid Temperature and Conductivity Probe





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## 1 General Information

The QL40 FTC and 40FTC logging tools provide borehole temperature and fluid conductivity measurements. In comparison with tools from competitors, the QL40-FTC / 40FTC is capable of recording a wide range of conductivity from fresh to highly saturated water.

The borehole fluid temperature measurement is helpful to detect anomalies caused by events such as fluid flow into or out of the borehole. It is also used to normalize the conductivity measurement which is temperature dependent and so allowing comparisons between boreholes.

The borehole fluid conductivity is directly proportional to the concentration of dissolved minerals. It is generally used in hydrogeology to determine the concentration of dissolved ions in the aquifers and to locate the fluid flows occurring in the borehole.

The QL40 FTC 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 stand alone tool. The 40FTC is the standalone - non stackable – version. The tools are fully downhole digital and operate with the ALTLogger and Matrix logging systems. They can be run on any standard wireline (mono, 4 or 7 conductor, coax).

### 1.1 Dimensions



**Figure 1-1** QL40 FTC Dimensions (bottom sub)



## 1.2 Technical Specification

### Tool

Diameter: Max 40mm (1.57")  
Length: 0.78m (30.7")

### Measurement point:

Temperature: 0.09m up from bottom  
Conductivity: 0.063m up from bottom  
Weight: 3.35kg (7.2lbs)  
Operating Temp.: 0 - 70°C (32 - 158°F)  
Max. Pressure: 200bar (2900psi)

### Cable:

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

### Temperature measurement:

Range: -20 to 80°C  
Accuracy: < 1%  
Resolution: 0.004°C

### Conductivity measurement:

Range: 5µS/cm to 2.5 x 10<sup>5</sup> µS/cm  
Accuracy: 1% (500 – 2.5 x 10<sup>5</sup> µS/cm)

### Power:

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



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## 2 Measurement Principle

The FTC probe measures simultaneously borehole fluid temperature and conductivity.

### 2.1 Temperature

Borehole temperature is measured with a sensor based on a fast response semiconductor device whose output current changes proportionally to absolute temperature. The temperature sensor is located in a stinger at the top of the sensor body in the center of the three exit ports where the borehole fluid returns to the well bore.

### 2.2 Fluid Conductivity

Borehole fluid conductivity is measured using a seven electrode mirrored Wenner array. The conductivity array is an internal cylindrical array open at the bottom of the probe. Borehole fluid passes by the array as the probe is lowered in the hole. The array is completely shielded from the outside borehole, so that only fluid conductivity is measured. The following table provides an overview of typical water categories and associated conductivities.

Drinking water	Up to 500 uS/cm
Fresh water rivers	30 – 500 uS/cm
Marginal river water	500 – 1500 uS/cm
Brakish water	1500 – 5000 uS/cm
Industrial waters	100 – 10000 uS/cm
Sea water	50000 - ... uS/cm

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**Note:** Logging in downward direction may result in a better flow of the fluid through the sensor cell!

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## 3 Notes on QL tool assembly

The following explanations are only valid for the QL40 FTC tool. 40FTC 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 FTC is a bottom sub.

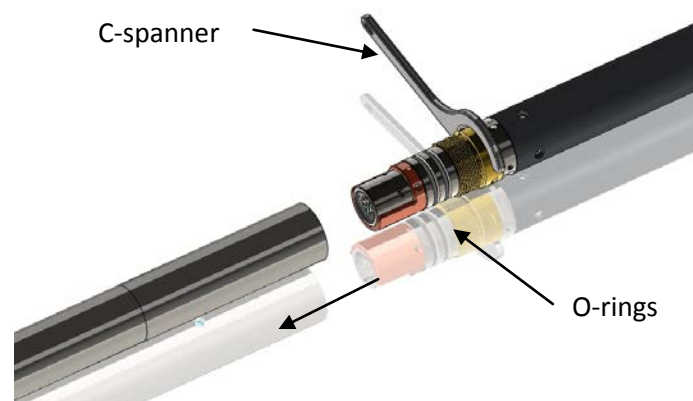
### Bottom Sub definition

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.

### 3.1 QL40 stack assembly

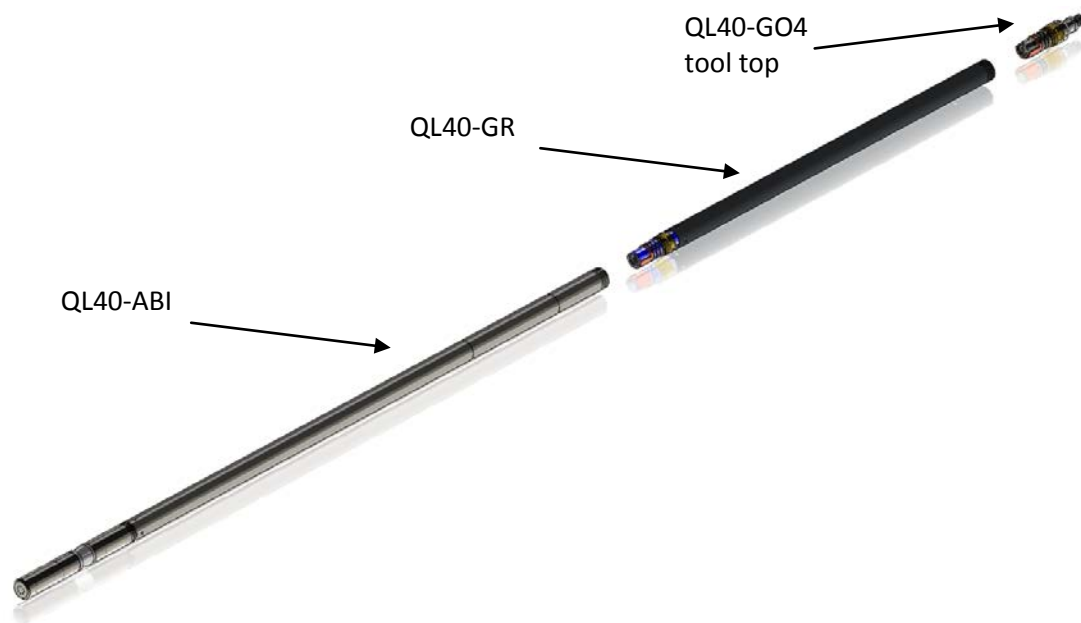
QL40 tool stacks are terminated by either a QL40 bottom sub or a QL40 bottom plug. At the top of the stack a QL40 tool top is required to connect the tool string to the cable head. Several tool tops are already available, special ones can be made on request.

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.



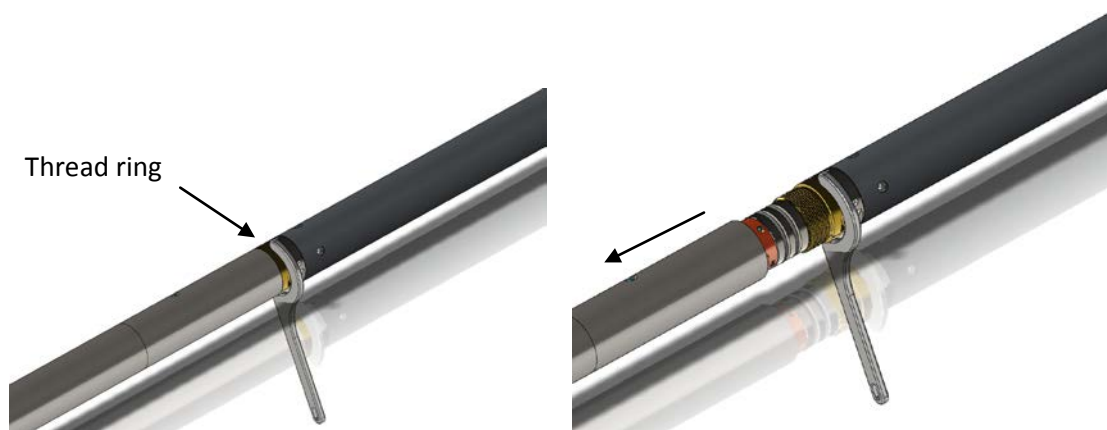
*Figure 3-1 C-spanner and O-rings of QL connection*

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

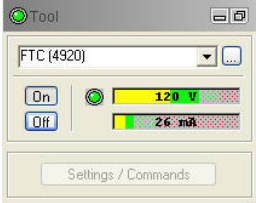




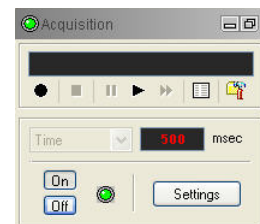
## 4 Operating Procedure

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

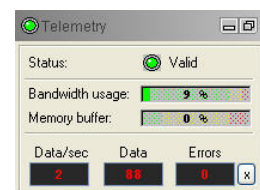
### 4.1 Quick Start

1. Connect the tool to your wireline and start the data acquisition software.
2. Select the relevant FTC tool from the drop down list (Figure 4-1) in the software's **Tool** panel. *If your tool is not listed check that the tool configuration files (.sub and .stack files) are properly installed. Tool configuration files may be found on the installation or separate CDROM. The files should be installed using LoggerSettings.exe utility program supplied with the software installation. See LoggerSettings.doc for detailed instructions.*


**Figure 4-1** Tool panel
3. Once the tool is properly positioned to the depth reference level, click the button in the upper right of the Depth panel and press "Zero Tool".
4. 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.)
5. On the **Tool** panel (Figure 4-1) click the **Settings / Commands** button to configure your tool (see chapter 4.5 for details).
6. 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).
7. Press the **Record** button in the **Acquisition** panel (Figure 4-2), specify a file name and start the logging.
8. 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 4-2** Acquisition panel



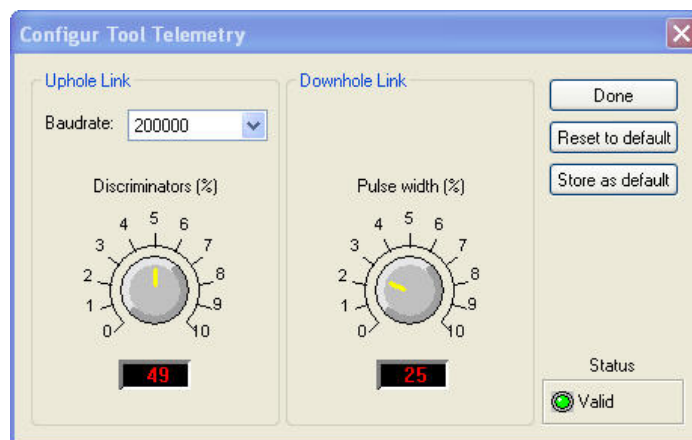
**Figure 4-3** Telemetry panel

9. To end the logging procedure press the **Stop** button in the **Acquisition** panel and turn off the sampling (click **OFF** button).
10. 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

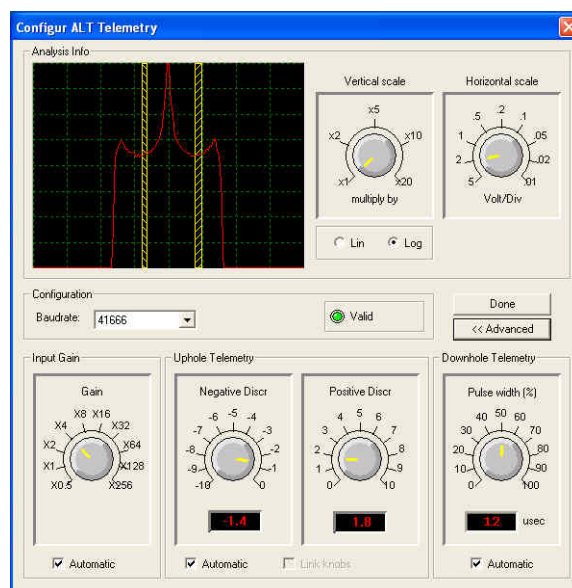
The tool telemetry can be configured through the **Telemetry** panel of the Matrix dashboard. By clicking on **Settings**, the operator has access to the **Configure ALT Telemetry** dialog box (Figure 4-5) providing various controls to adjust the telemetry settings and monitor its current status.

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 FTC probe 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 FTC tool.

VInj	<i>For internal use only</i>
IInj	<i>For internal use only</i>
DV1	<i>For internal use only</i>
DV2	<i>For internal use only</i>
Temp	Fluid temperature in °C
Cond	Measured fluid conductivity at temperature Temp

### 4.5.2 MChNum Browser

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

Temp	Fluid temperature in °C
Cond	Measured fluid conductivity
Cond25C	Fluid conductivity corrected to 25 °C (Temperature corr. Factor: 2 %/°C)

As mentioned before, conductivity measurements are temperature dependent. The degree to which temperature affects conductivity varies from solution to solution and can be calculated using the following formula:

$$\text{Cond}_{T_{\text{cal}}} = \text{Cond} / (1 + \alpha * (T - T_{\text{cal}}))$$

where

$\text{Cond}_{T_{\text{cal}}}$  = conductivity at reference temperature,

$T_{\text{cal}}$  = reference temperature (e.g. 25°C),

Cond = measured conductivity,

T = measured temperature,

alpha = correction factor.

The Cond25C channel is calculated with an alpha of 2% per °C, which corresponds approximately to NaCl solutions at 25 °C

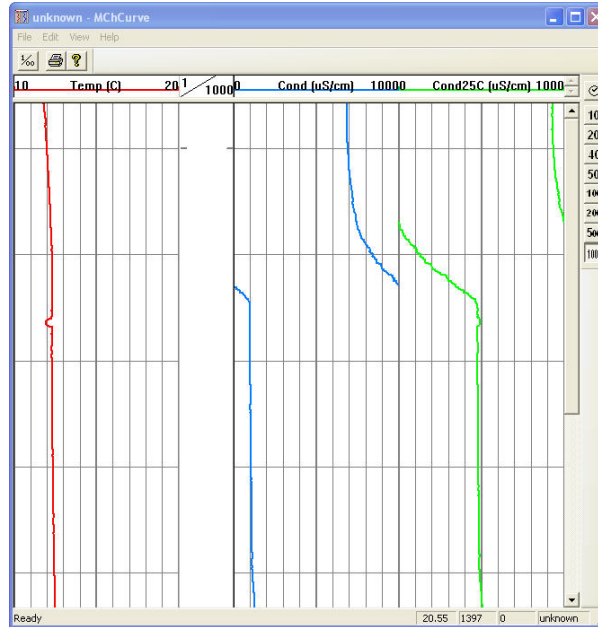


**Figure 4-6** MChNum Browser during operation

### 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, grids,.....)



**Figure 4-7** MChCurve Browser Window



## 5 Performance Check & Calibration

Calibrations are performed at the factory and ensure stable readings for a long period of time. However, good practice requires regular validation of the measurements. This can be achieved by comparison of tool readings and measurements made with a conductivity-meter in solutions of known conductivity. Solutions should be constantly stirred during the procedure (mainly for high conductivity measurements, above 10000 uS/cm) and measurements should be made for a sufficiently long time.

### Prepare to Calibrate:

1. Assemble the tool and connect to the wireline.
2. In the **Tool Panel**:  
Select the proper tool/stack;  
Turn the tool power **On**;
3. In the **Acquisition Panel** select **Time** and turn it **On**.
4. 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).
5. Select **Calibration Settings** (see Figure 5-2).

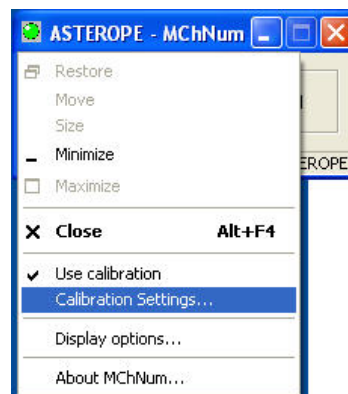


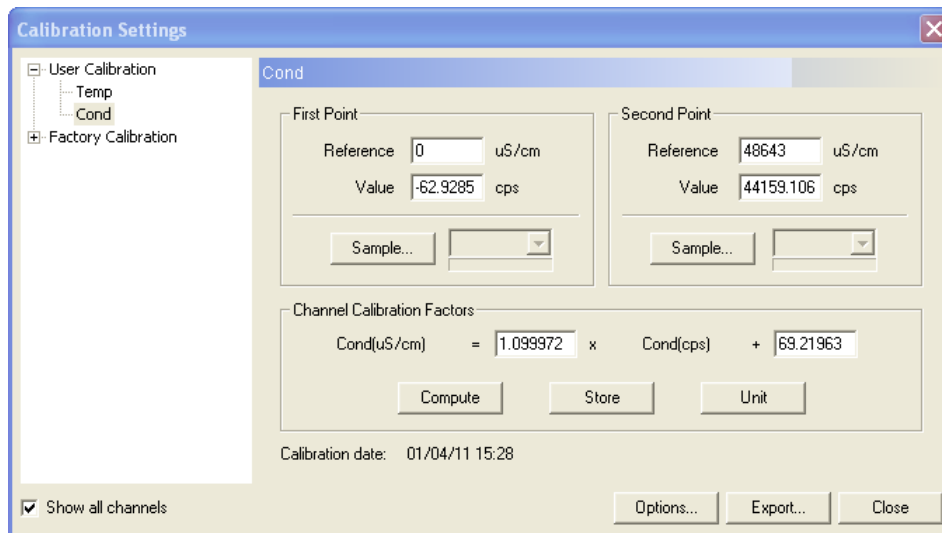
Figure 5-1 MChNum context menu

### 5.1.1 Conductivity

#### Calibration Settings

1. Place the sensor body in the reference solution. Ensure the reference solution is above the three exit holes on the probe. In the **First Point Reference edit box of the Calibration Settings dialog box** (Figure 5-2) enter the ***non-compensated*** low calibration value read from the conductivity-meter. If necessary change the units by clicking on the **Unit** button.
2. Click **Sample**. When the average sampling is complete the value read from the tool will be displayed in the **First Point Value** box. (The number of samples taken can be changed under **Options**.)
3. Place the sub into a high value reference solution.

4. In the **Second Point Reference** enter the ***non-compensated*** high calibration value as read from the conductivity-meter.
5. Click **Sample**. When the average sampling is complete the value read from the tool will be displayed in the **Second Point Value** box.
6. Click **Compute** to determine the calibration coefficients.
7. Click **Store** to update the sub file with the new calibration settings.
8. Click **Close** to leave the calibration settings.



**Figure 5-2** Calibration Settings dialog box (Conductivity page)

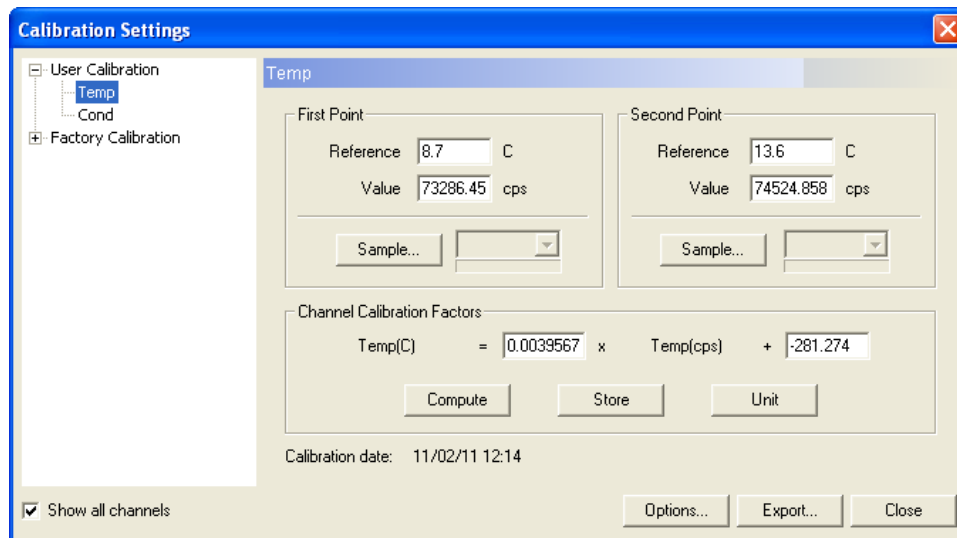
On the **Browsers & processors** panel click **Close All** then **Start All** to refresh the other Browsers and Processors. This must be done as they only read the calibration constants from the configuration file when they start.

### 5.1.2 Temperature

The tool is using a measurement circuit that measures the temperature to a very high accuracy that most of common thermometers can not measure. Therefore the factory calibration should be kept. However, if it is necessary to recalibrate the tool the 2 points calibration can be achieved from the dedicated page of the calibration dialog box (Figure 5-3) in a similar manner as the conductivity calibration described above.

It is unlikely that any problems will occur with the temperature measurement. If a problem occurs, it is recommended to return the probe.





**Figure 5-3** Calibration Settings dialog box (Temperature page)



## 6 Maintenance

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

### 6.1 Fluid Resistivity Cell Maintenance

Wash the cell with clean tap water and scrub the surface of the ring assembly with a bottle brush or a similar tool to remove any surface contaminants. Be careful not to damage the Temperature stinger located at the top of the cell. Mild soap and water may help remove oil, grease or other contaminants. Ensure you rinse the sensors carefully after using soap.

### 6.2 Upgrading firmware

In accordance with the ALT policy of continuous development the FTC has been designed to allow firmware upgrades. The current version of firmware installed in a tool may be verified in the **Tool Details** window opened from the **Tool Settings** dialogue box.

Firmware upgrade procedure is as follows:

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

#### 6.2.1 Checking the communication

1. Connect the FTC tool to your acquisition system.
2. Start ALTLog/Matrix software.
3. In the **Tool** panel select the appropriate tool and turn the power on.

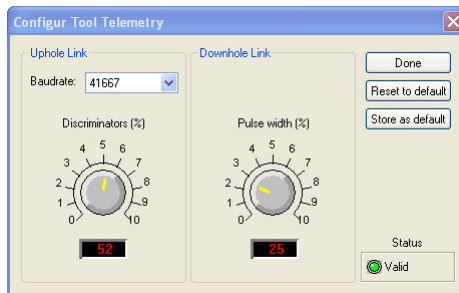


Figure 6-1 Tool communication settings - ALTLog

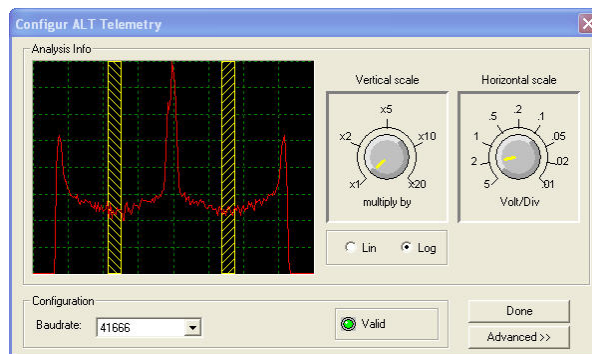


Figure 6-2 Tool communication settings - Matrix

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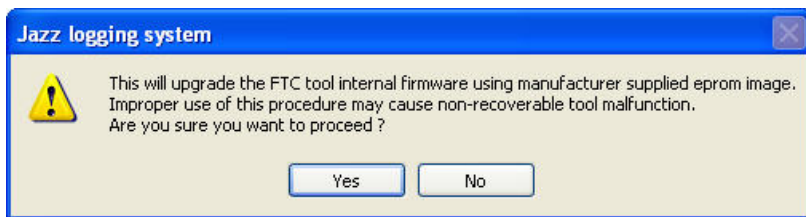
**Warning: The telemetry must be tuned properly. Bad communication may abort the upgrade of the firmware!**

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## 6.2.2 Upgrading the firmware

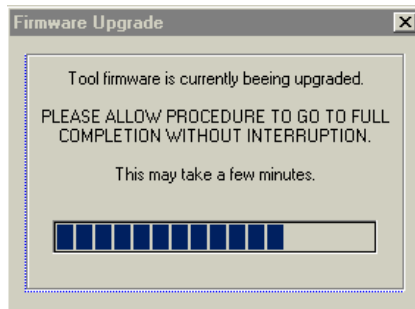
In the **Tool** panel, select **Tool settings/commands**. Check that the communication status is valid.

1. Click on **Tool Details**. Note that the firmware version currently in use is displayed in the firmware box. Click on the **Upgrade** button.
2. The following message will appear (Figure 6-3). Click **Yes** to validate your choice.



*Figure 6-3 Warning Message during firmware upload*

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



*Figure 6-4 Firmware upgrade progress window*

5. Once the upgrade has been successfully completed, click on **OK** to turn off the tool.



*Figure 6-5 Successful upgrade*

6. Power on the tool to start the upgraded firmware. Check in **Tool settings/commands** and **Tool details** that the firmware version has been changed with the new one.

Note that the following error message (Figure 6-6) 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 6-6 Error message*

### 6.3 General Tool Maintenance

The FTC 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.
- Fluid resistivity cell maintenance:

Wash the cell with clean tap water and scrub the surface of the ring assembly with a bottle brush or something similar to remove any surface contaminants. Be careful not to damage the Temperature stinger located at the top of the cell. Mild soap and water may help remove oil, grease or other contaminants.



## 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?</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 probe top and tool body)?</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 the optional ALT/MSI test cable 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 or tech.support@mountsopris.com.</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>





## 8 Appendix

### 8.1 Parts list

#### 8.1.1 Recommended spare parts

Item No.	Qty	ALT Part No.	MSI Part No.	Description
1	1	1673840	-	Molykote111 compound
2	2	55459	-	DIN1810B 40-42 Hook wrench w.pin
3	6	AS215-V-75°	-	O-ring Viton 51414 26.57X3.53 -75°
4	1	L0034-086	-	Grease Lubriplate
5	1	-	504-101-921	1" Bristle brush
6	1	ALT26306	-	QL40 Male plug

#### 8.1.2 Other parts

Item No.	ALT Part No.	MSI Part No.	Description
1	QL40-GO1	17-202-092	QL40-GO1 tool top
2	QL40-GO4	Q40GO4-1000	QL40-GO4 tool top
3	QL40-GO7	17-202-079	QL40-GO7 tool top
4	QL40-MSI1	Q40MS1-1000	QL40-MSI single conductor tool top
5	QL40-BOT	Q40BOT-1000	QL40 bottom plug

### 8.2 Technical drawings

The following technical drawings are available on request:

- QL40 FTC or 40FTC Wiring Diagram.



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