



# User Guide

## QL40 SFM – Spinner Flow Meter





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# 1 General Information

The QL40 SFM measures impeller rotation caused by fluid flow in the borehole. It uses a magnetically coupled pick-up which drives a low friction, high resolution encoder located inside the lower pressure housing. The encoder produces 256 pulses per shaft rotation. It has quadrature sensing electronics that instantaneously detect flow direction changes.

The probe comes standard with a 3 inch cage and impeller assembly. If a larger cage and impeller assembly are required it can be ordered. The part number for a 4 inch cage and impeller assembly is a Q40SFM-1200. This assembly includes the 4 inch cage pieces and entire impeller assembly to be attached to the bottom of the QL40-SFM probe in place of the 3 inch version supplied with the probe.

The QL40 SFM is a bottom sub, and can be combined with other logging tools in the QL (Quick Link) product line or operated as a standalone tool. Weight bars with centralizers are recommended to improve log response and repeatability in large boreholes or low flow environments.

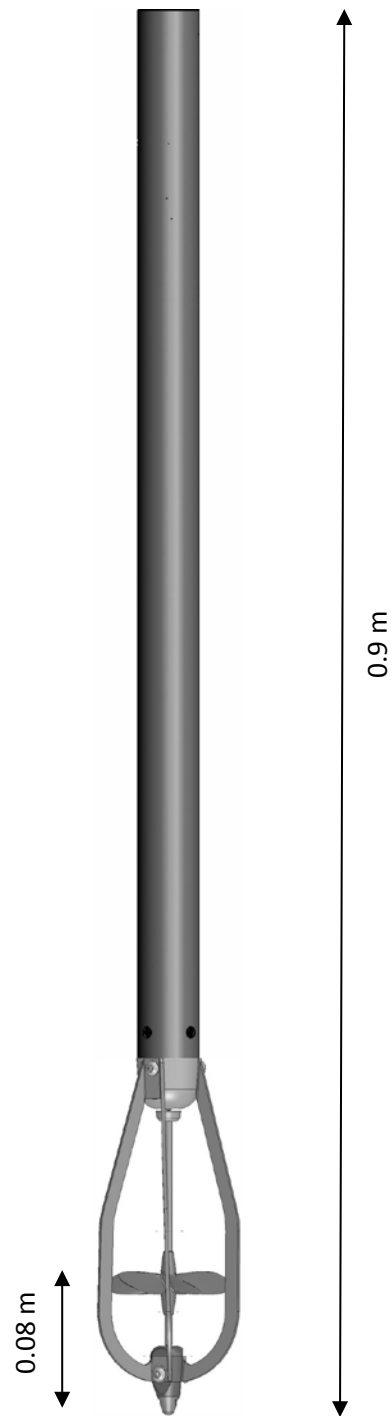
## ➤ Applications

- Pumping flow profiles in screened or perforated cased holes
- Identification of hydrostratigraphic units
- Confirmation of predicted transmissive zones in open hole

## ➤ Operating conditions

- Open or cased borehole
- Water filled
- Centralization recommended

## 1.1 Dimensions



**Figure 1-1** QL40 SFM dimensions with a 3" impeller cage

## 1.2 Technical Specifications

### Tool

Diameter:	Max 40mm (1.57") excluding cage
Standard impeller cage:	76.2mm (3.0")
Bigger impeller cage:	101.6mm (4.0")
Length:	0.9m (35.4")
Measurement point:	0.08m up from bottom of impeller cage
Weight:	3.2kg (7lbs)
Max. Temp:	70°C (158°F)
Max.Pressure:	200bar (2900psi)

### Cable:

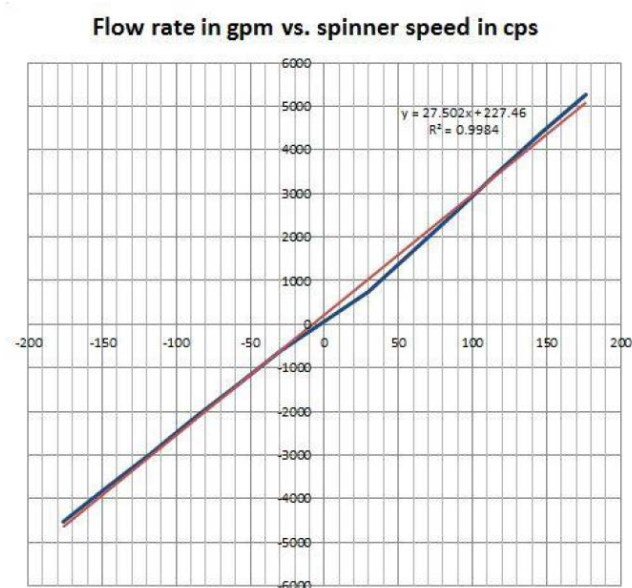
Cable type:	Mono, Coaxial, 4 or 7 conductor
Digital data transmission:	Up to 500 Kbits per second depending on wireline
Compatibility:	ALTlogger – BBOX – Matrix

### Measurements:

Range:	Pickup sensor 3000 RPM Max
Accuracy:	Better than 1%
Resolution:	256 pulses per revolution
Output:	Counts Per second (cps)

### Power:

DC voltage at probe top:	Min 80 VDC Max 160 VDC Nominal 120 VDC
Current:	Nominal 38mA



**Figure 1-2** Typical flow response curve for up and down runs in 6" casing



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## 2 Measurement Principle

Borehole flow measurements are made either in a trolling mode or a static mode depending upon flow rates and desired pump configurations. The probe is capable of determining the direction of flow based upon the direction of the spinning motion of the impeller. The impeller assembly uses a point and cup system much the same as a jeweled bearing to reduce friction and allow for smooth spinning of the impeller assembly. These bearings are made from a hard material and should last for many runs in boreholes given the impeller assembly is properly set up. Proper adjustment of the impeller is required for the smoothest operation of the impeller. A discussion of this set up will be covered in this manual in the Installation section.

### ➤ Principle

A buoyant impeller mounted on a hollow stainless steel shaft is suspended between two precision ground ceramic bearings. A balanced transfer bulkhead fitted with magnets couples motion and direction from the impeller through a sealed sensor body inside the probe. A low friction high resolution encoder detects this information and transfers it digitally to a counter circuit that sends the information by wireline modem to the surface.



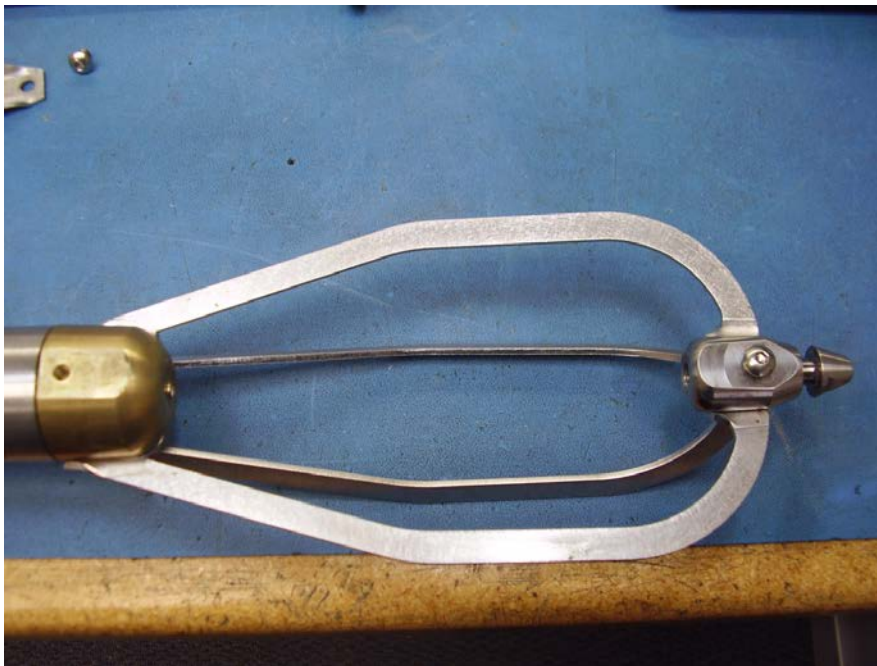
### 3 Installation of the impeller and cage assembly

**Installation tools required:** 3mm allen wrench, flat blade screw driver, small crescent wrench

This section covers instructions on how to properly install the impeller and cage assemblies supported by the Q40SFM Spinner Flow Meter. Failure to read and or follow these instructions may result in damage to the impeller assembly and rendering the probe non operational. Take the time to read and understand this portion of the document so the sensitivity of the impeller assemblies can be properly set and optimum performance from the probe be realized. The Q40SFM comes standard with the 3" cage and associated impeller assembly. An optional 4" cage and impeller assembly can or may be purchased. One or both assemblies will be located in the small box provided with the probe in the shipping case.

To begin remove the probe from the case and the desired cage assembly you wish to log with. This can be either the 3" or the 4" cage version. If purchased with both cage options the probe will be delivered with a smaller and larger impeller assembly. The probe was designed to be run with the smaller impeller inside the 3" cage and the larger impeller to be run inside the 4" cage.

Find the lower Cage Tip and (3) of the same size Impeller Cage pieces. Attach the Cage Tip with only two of the Impeller Cage pieces to the brass main body of the lower portion of the probe as shown below.



**Figure 3-1** Cage tip mounted with two of the impeller cage pieces

Tighten the screws down but do not fully tighten them until the impeller and final cage piece have been installed. Remove the cone piece from the Cage Tip and set aside.

Inside the Cage Tip is an adjustable screw that will tighten and loosen the impeller axle assembly into the bearings. The picture below shows the cup the impeller axle bearing will

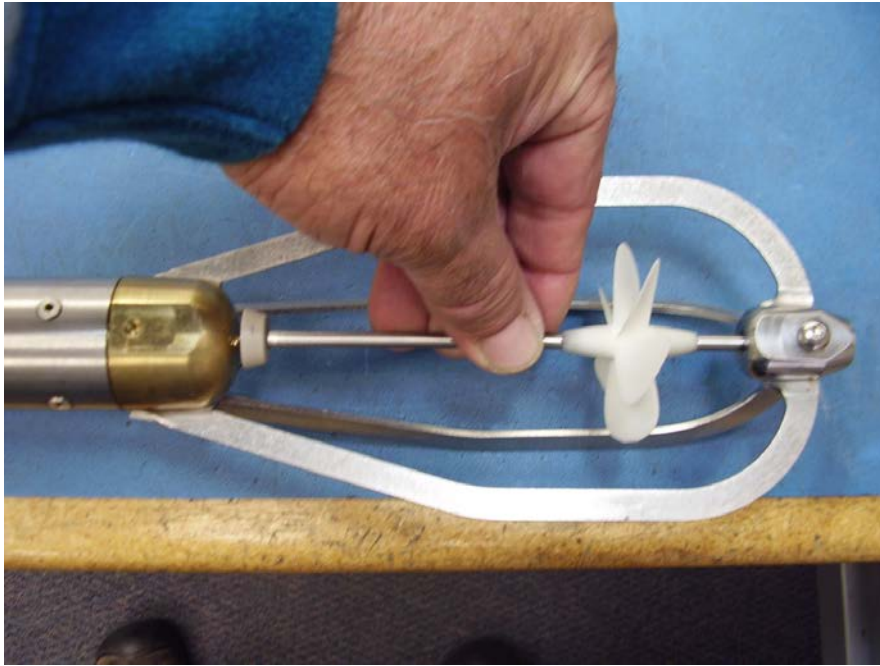
ride in. The other end of the brass portion of the probe also has one of these cups for the axle to ride in but it is not adjustable but fixed in place.



**Figure 3-2** Cup detailed picture of the cup for the impeller axle bearing

You will need a small flat blade screw driver to make the required adjustments to the screw inside the Cage Tip when mounting the axle of the impeller assembly. Take the screw driver and back the screw inside the Cage Tip out some so you can insert the entire axle into the cage and probe assembly .

You will not want to force in any way when inserting this axle and impeller assembly. Make certain there is plenty of room by adjusting the screw in the Cage Tip if needed. The points on the Axle Tips are rugged but if forced can be broken off or damaged. You should be able to move the axle assembly inside the cage back and forth with ease at this point. Installation of the axle assembly is such that the impeller end is closer to the bottom of the probe and the axle end with the small disk at one end goes closer towards the brass end of the main probe body as shown on the next picture.



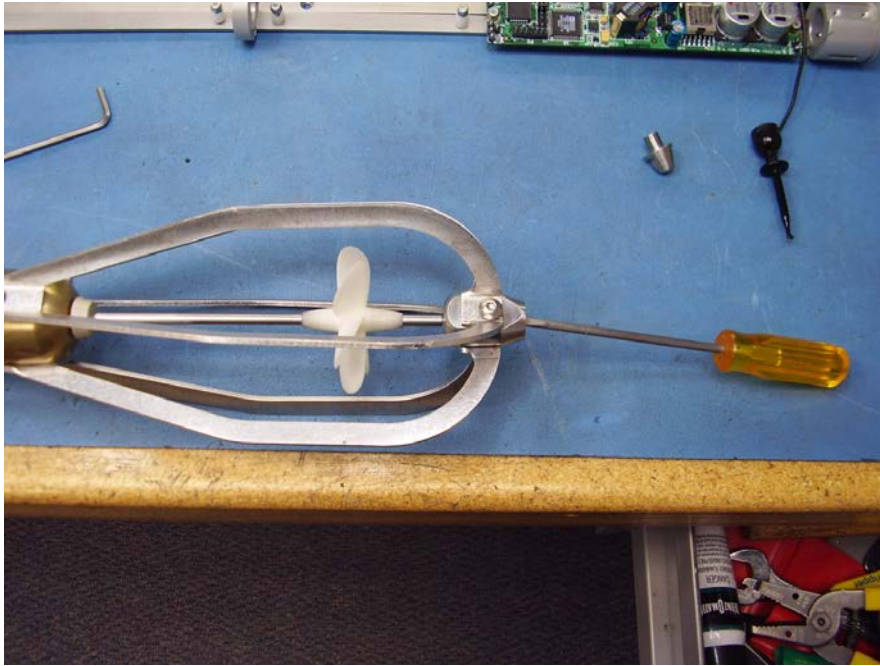
*Figure 3-3 Mounting the axle of the impeller assembly*

Locate the tip of the Axle inside the lower cup in the adjustment screw you will be adjusting in the Cage Tip and begin to turn the screw inward to push the entire assembly towards the cup located in the brass section of the probe. Watch carefully that you are in fact inserting the point of the axle into the actual cup and not off to the side while adjusting the screw. Once the screw is adjusted to where the axle is supported in the cups stop adjusting.

**DO NOT adjust the screw so tight that it can smash or damage the ends of the axle or the cup bearings.**

Final setting of this adjustment must not be done until the cage is fully assembled and tightened as it may change overall setting for the axle adjustment screw.

At this time you will want to install the final or third piece of the cage you will be running the probe with. Tighten all screws on cage pieces down at both ends. With the three cage pieces firmly attached you can now adjust and tune the impeller adjustment screw in the Cage Tip for optimum operating tension. The proper amount of screw adjustment will result in the impeller being able to move freely but not be so loose that it will come out of the two end cups. A small amount of movement back and forth, between the cups is okay. This adjustment will take some feeling to get use to but the idea is to allow it to float with as little friction inside the cups as possible but not be so tight that it inhibits free movement of the impeller and axle assembly. By simply blowing on the impeller or spinning the axle with your finger tip you can tell if the proper setting and adjustment of the lower screw is correct.



**Figure 3-4** Fine tuning the installation of the impeller

Install the lower cone onto the Cage Tip and the probe is ready to have a probe top installed. Place the probe in a vertical position and again blow on the impeller and or check the operation of the impeller assembly in this position. The cages for the Q40SFM are rugged enough for what would be considered normal spinner boreholes but not so rugged that they can encounter objects and or blockage in the borehole. Any damage to the cage by running at fast rates into the borehole and hitting something or forcing it past an obstruction in the borehole may result in damage to the cage and improper adjustment changes to the impeller axle setting.



**Figure 3-5** Installation of the lower cone and final check

## 4 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.

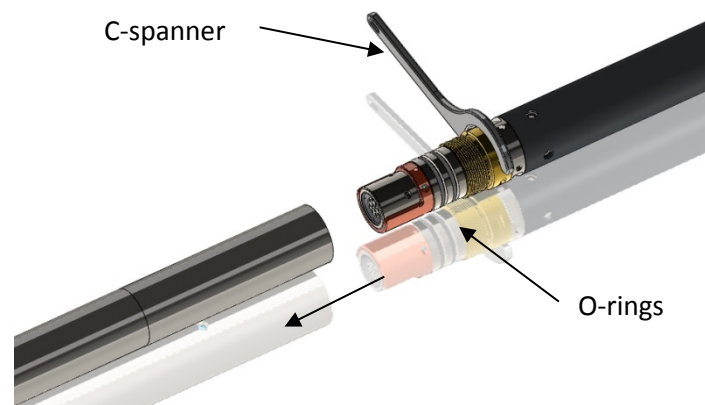
### Mid Sub

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.

### 4.1 QL40 stack assembly

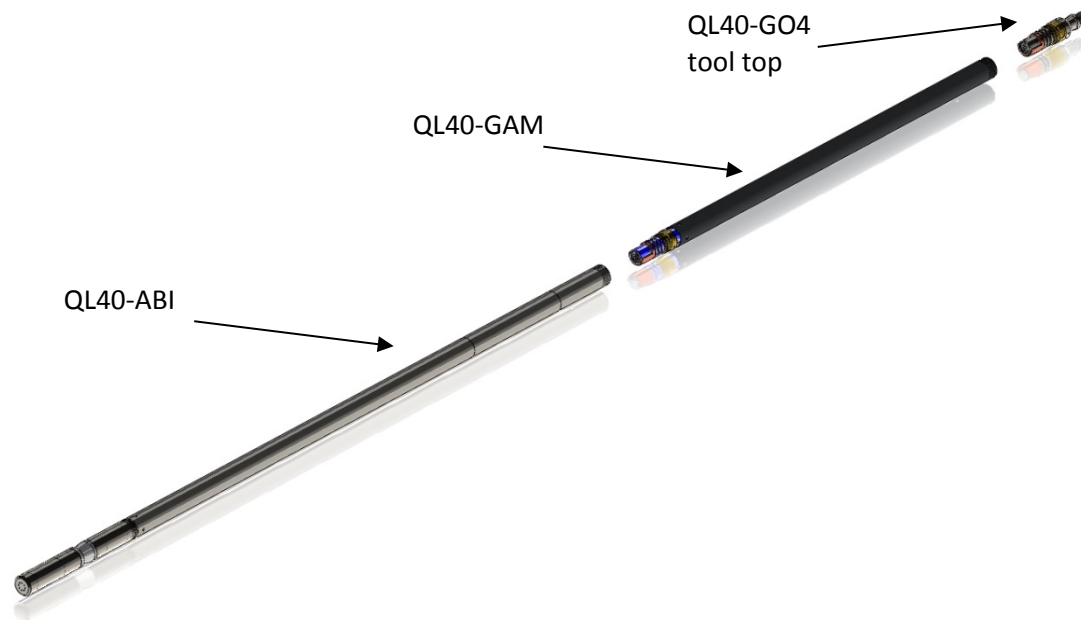
QL40 tool stacks are terminated by either a QL40 bottom sub or a QL40 bottom plug. At the top of the stack a QL40 tool top is required to connect the tool string to the cable head. Several tool tops are already available, special ones can be made on request.

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



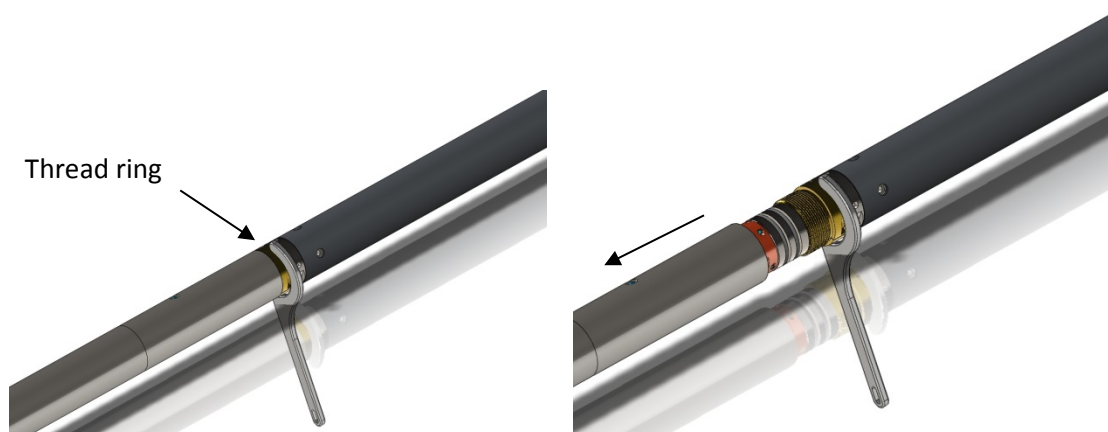
**Figure 3-1** C-spanner and O-rings of QL connection

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



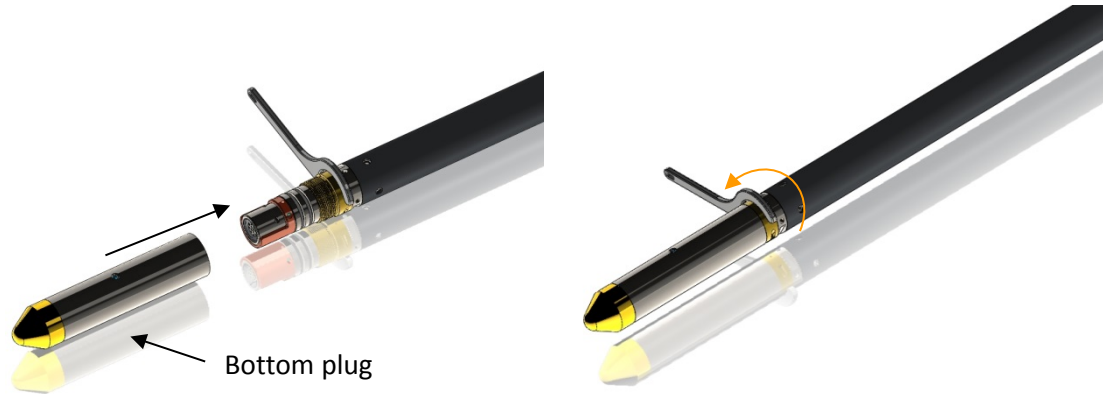
**Figure 3-2** Tool stack example

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



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

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



**Figure 3-4** Attaching the QL40-Plug

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



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



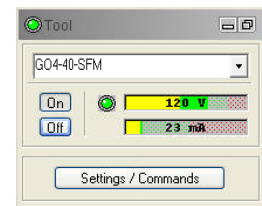
## 5 Operating Procedure

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

### 5.1 Quick Start

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

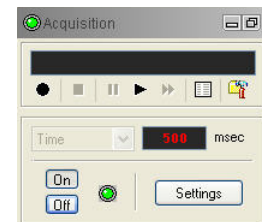
2. Select the relevant QL40 SFM tool/stack from the drop down list (Figure 5-1) in the software's **Tool** panel (if your tool is not listed check that your tool configuration file is stored in the designated folder on your computer using the *LoggerSettings* application).



**Figure 5-1** 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 5.2 if an error message is displayed.)

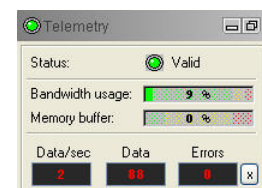
4. In the **Acquisition** panel (Figure 5-2) select the sampling mode (depth or time). Click on **Settings** and specify the corresponding sampling rate. Switch on the sampling (click the **ON** button).



**Figure 5-2** Acquisition panel

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

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



**Figure 5-3** Telemetry panel

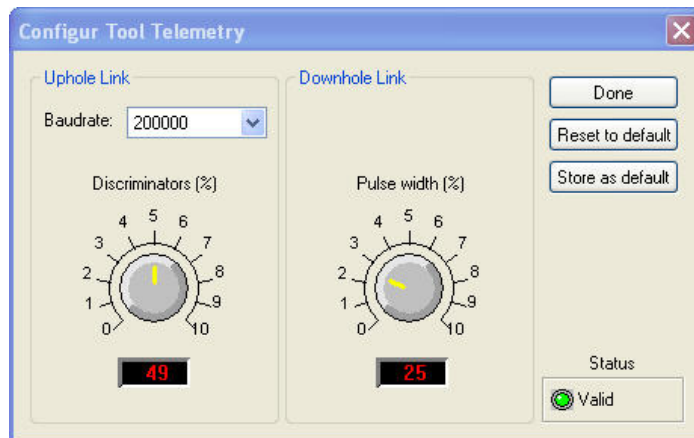
7. To end the logging procedure press the **Stop** button in the **Acquisition** panel and turn off the sampling (click **OFF** button).
8. In the **Tool** panel power off the tool.

## 5.2 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 **Error! Reference source not found.**).

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 5-4 Tool communication settings*

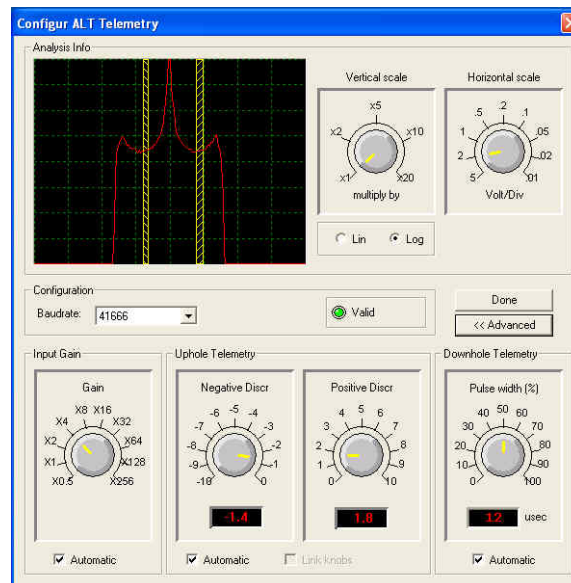
## 5.3 Tool Communication with MATRIX

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 3-5) 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 5-5** 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.

## 5.4 Recorded Parameters, Processors and Browsers

### 5.4.1 Recorded parameters

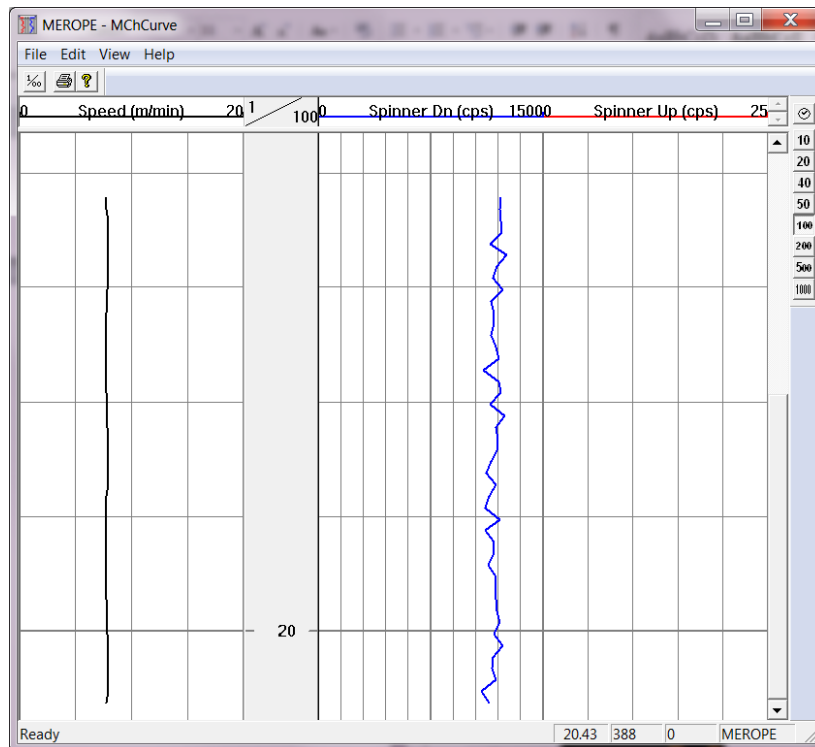
The following data channels are recorded by the QL40 SFM tool.

<i>Temperature</i>	<i>Temperature recorded on CPU board in °C</i>
<i>Time</i>	<i>Sampling time in seconds</i>
<i>Count Up</i>	<i>Spinner counts in up direction</i>
<i>Count Dn</i>	<i>Spinner counts in down direction</i>
<b>Spinner Up</b>	<b>Spinner count rate in up direction (cps)</b>
<b>Spinner Dn</b>	<b>Spinner count rate in down direction (cps)</b>
<b>Speed</b>	<b>Logging speed in m/min</b>

### 5.4.2 MChCurve Browser

The MChCurve browser displays the recorded parameters by means of curves in real time (Figure 5-6).

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



**Figure 5-6** MChCurve browser window displaying Spinner and Speed curves

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

#### Vertical scales and grids:

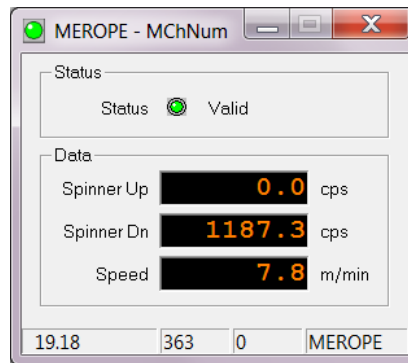
- 10 Depth mode display and pre-defined depth scales
- 20
- 40
- 50
- 1/100 Operator defined depth scales, interval spacing and settings
- Time mode display

### 5.4.2 MChNum Browser

Figure 5-7 shows a typical example of the numerical values displayed in the MChNum browser.

Spinner Up  
Spinner Dn  
Speed

Spinner count rate in up direction (cps)  
Spinner count rate in down direction (cps)  
Logging speed in m/min



**Figure 5-7** MChNum browser window during logging



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## 6 Maintenance

### 6.1 Preventive maintenance

The QL40 series tools require some maintenance. Make sure the threads on the brass nut on the toll joints are free of sand mud or other dirt. A thin layer of anti-seize is recommended. When disassembling the sub string dry the joint as it is separated to prevent fluid from entering the sub top and getting into the Lemo electrical connector inside.

Before probe is removed from cable head it is good to wash the probe off after each use if at all possible. Wash the probe with clean tap water and remove any sediments or grime that may have lodged itself where the impeller bearings are located. Mild soap and water may help remove oil, grease or other contaminants. You may scrub the surface of the housing with a brush or something similar to remove any surface contaminants. Be careful not to damage the impeller blades as they are fragile.

Inspect O-rings occasionally when breaking tool joint apart and keep the threads on both ends of the probe clean, to minimize problems in the future.

**Never take the probe apart. This probe is very difficult to disassemble and requires special steps to be taken in order to gain access to the inside of the probe without damaging the electronics. If you have read this after attempting to disassemble the probe chances are the probe has experienced damage and will need to be sent to the factory to be repaired.**

#### **Tools required:**

1.5mm Allen wrench  
2 ea 40-42mm spanner wrench  
Paper towels or clean rags

#### **Replacement Parts:**

ALT26005, Large Threaded Ring, Qty 2  
28-174-995 M2x8 SHCS, Qty 2

#### **Disassembly:**

Unscrew and remove the two M2x8 socket head cap screws and separate the two halves. Four guide pins align the two ring halves and tend to hold them together after the screws are removed.

To pry the halves apart you can use a pair of spanner wrenches inserted into the wrench holes on opposite sides of the ring mating surfaces to pull them apart slightly.

*Do this carefully to prevent bending the guide pins.*



**Figure 6-1** Disassembly of the threaded ring

Place something small in the opening and move the spanners to the other side and pry it open slightly.  
This should be enough to release the two rings as below.



**Figure 6-2** Halves rings when pulled apart

## 6.2 Upgrading firmware

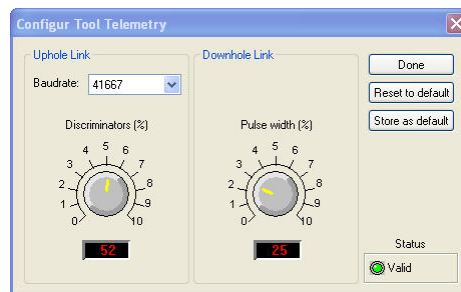
In accordance with the ALT policy of continuous development the tool has been designed to allow firmware upgrades.

Firmware upgrade procedure is as follows:

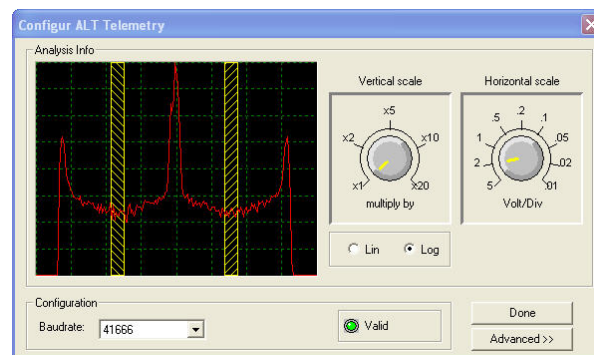
1. Checking the communication is valid.
2. Upgrading firmware

### 6.2.1 Checking the communication

1. Connect the tool to your acquisition system.
2. Start ALTLog/Matrix software.
3. In the **Tool** panel select the appropriate tool and turn on the power.
4. In the **Communication** panel, select **Settings**. Check **baud rate** is set to **41666** and **communication status** is **valid** (Figure 6-3 or Figure 6-4).



**Figure 6-3** Tool communication settings - ALTLog



**Figure 6-4** Tool communication settings - Matrix

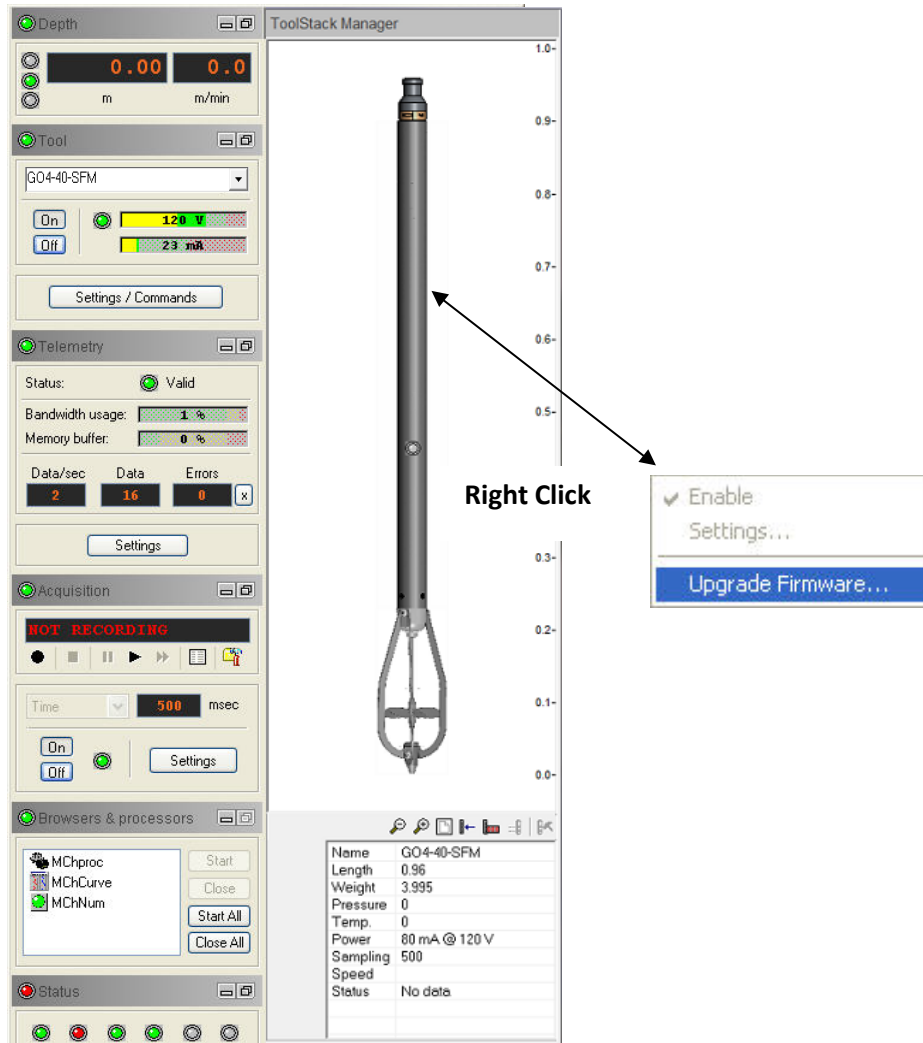
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**Warning: Telemetry must be tuned properly. Bad communication may abort the upgrade of the firmware!**

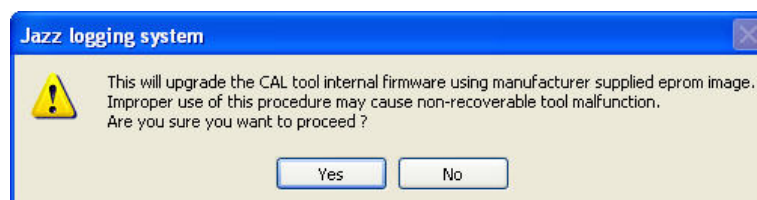
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## 6.2.2 Upgrading the firmware

1. **Right Click** on the tool preview in the **ToolStack Manager** view and select **Upgrade Firmware** from the context menu.

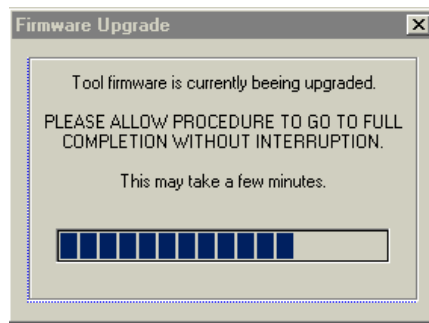


2. The following message will appear (Figure 6-3). Click **Yes** to validate your choice.



*Figure 6-5 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 6-6** Firmware upgrade progress window

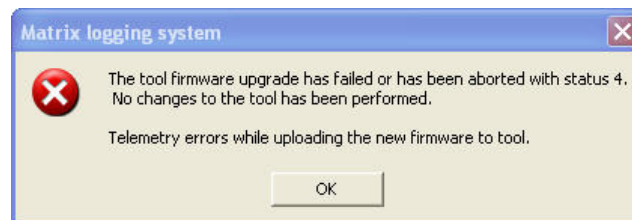
5. Once the upgrade has been successfully completed (Figure 6-5), click on **OK** to turn off the tool.



**Figure 6-7** Successful upgrade

6. Power on the tool to start the upgraded firmware.

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 6-8** Error message



## 7 Troubleshooting

In the event the tool develops a problem, follow the troubleshooting procedure listed below.

**WARNING: NEVER DIS-ASSEMBLE THE PROBE WITHOUT KNOWLEDGE OF PROCEDURE**

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 installed with the LoggerSettings application (refer to LoggerSettings and LoggerSuite manuals for more information)</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 5.2 or 5.3) and store the new settings as default. Apply the appropriate tool settings for your logging run (see chapter 5.4).</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 low, current high): 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 the short circuit.</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 5.2 or 5.3).</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 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 5.2 or 5.3).</li> <li>- Check bandwidth usage and telemetry error status.</li> </ul>



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## 8 Appendix

### 8.1 Parts list

Detailed part numbers and descriptions are available for tool delivery and spare part kits. Please contact [support@alt.lu](mailto:support@alt.lu) or [tech.support@mountsopris.com](mailto:tech.support@mountsopris.com) for further details.

### 8.2 Technical drawings

The following technical drawings are available on request:

- 19" Rack connection diagram.
- Wiring Diagram.



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