40LGR-1000
LITHOLOGY GAMMA
RESISTANCE PROBE

Mount Sopris Instrument Co., Inc.
Golden, CO U. S. A.
April 11, 2013

Table of Contents

General Information

Overview

The 40LGR-1000 Lithology Gamma, Resistance probe is a combination probe providing natural gamma, spontaneous potential (SP), and single point resistance (SPR), measurements. The gamma portion of the measurement is done so in a digital manner in which the data from the probe is sent up the wire line by means of a modem. This modem once properly setup will aid the user in data detection from the probe and not require the setting of discriminators as with pulse type transmission probes. The operator will need to acquire the gamma and resistance measurements in two separate runs, meaning one trip in and out of the bore hole. The gamma log is made in one direction in the borehole and the S.P. and SPR is made in the other direction of the borehole. The SP and SPR logs are made with the Matrix logging unit sending out a current generator signal down the cable line to an electrode on the probe and the return of this current generator is at the surface called Mud Plug or Mud Fish. The 40LGR probe is a stand-alone probe and can be run on a Matrix achieving both Gamma and the Resistance logs.

The SP and SPR measurements must be run in open (uncased), fluid filled, boreholes to obtain reasonable data. The natural gamma may be run in any borehole conditions within specifications.

Probe Layout and General Connections

Connectors for the tool are as follows. The probe top described below is a Mount Sopris standard single conductor probe top. No other variations of probe tops exist so if a different cable head is used then the user must obtain an adapter or cross-over to attach another manufactures style of cable head to the Mount Sopris single conductor probe top.

PROBE TOP CONNECTOR:

Looking down into the probe top of the 40LGR you will see a brass pin or plunger. This plunger is a new design that unlike past Mount Sopris single conductor probes is now sealed from the borehole environment. If the O-rings on the cable head were to be breeched by pressure and fluid from the borehole this added feature will keep the internal electronics dry in the event of a pressure failure at the probe top and cable head connection.

Connection	Signal
Brass Center Pin	Power to tool and data to and from probe
Body of Probe Top	Armor connection, power return or electrical ground for probe
Electrode 25.4mm Exposed	Down Hole Electrode for Resistance and Spontaneous Potential

Layout for the tool is as follows starting at the bottom of the tool. The bottom of the housing of the probe has a bull nose isolation dampener on it. Internally inside the housing is the scintillation crystal and photo multiplier tube, detector or PMT. Above the detector assembly is the electronic section for the Gamma and Telemetry/Power supply section. This is all followed by the passive circuitry to steer the SP and SPR signals for resistance measurements. The internal electronics are then attached to the bottom of the probe top assembly that houses the SPR electrode and cable head connection.

Theory of Operation

SINGLE POINT RESISTANCE

The single point resistance measurement is made by passing an AC current between a surface electrode or (mud plug), and the probe electrode. The probe electrode is located just below the probe top and should be the only piece of metal exposed on the probe during the logging process. The Matrix electronics will read the varying AC signal between these two electrodes and produces a voltage measured by the Matrix Logger. Then by use of Ohms law the tool file calculates the resistance between them.

Ohms law: $r = E / I$

r = resistance in ohms;
E = potential in volts;
I = current in amperes.

The SPR measurement is the sum of cable resistance, and the resistance based on the composition of the medium, the cross sectional area and length of the path through the medium. Therefore the single point resistance log is not quantitative.

SPONTANEOUS POTENTIAL

The spontaneous potential, also known as self-potential or SP uses the same electrodes as the SPR measurement. This natural potential, which originates from electrochemical differences between borehole and formation fluid, or electro-kinetic "streaming" is measured by the surface electronics. The circuit measures a small DC voltage, typically in the mV range between the surface electrode and the probe electrode. This potential may be positive or negative with respect to the surface electrode.

GAMMA

The natural gamma measurement is made by the use of a Sodium Iodide crystal, which when struck by a gamma ray emits a pulse of light. This pulse of light is then amplified by a photo multiplier tube, which outputs a current pulse. These pulses are then detected, shaped and sent to a DSP where they are counted, sent to the modem and the digital data is transmitted up the cable line. The center of the Sodium Iodide crystal is approximately .165 meters from the bottom of the probe towards the probe top. The approximate location of the gamma detector is referenced by a band of colored tape on the Heat Shrink protective tubing on the housing of the probe. The user must maintain this band of tape, or marker, as it may tend to degrade with repeated use of the tool in the borehole environment.

Important information: The Crystal detector and the Photo Multiplier Tube are both very fragile items. Care has been taken to design into the probe as much shock and vibration prevention to the detector assembly as reasonably possible. Care should be taken when transporting or shipping this probe. The Crystal assembly is fragile and can be destroyed rendering the probe inoperable. The Crystal and PMT are the most expensive items to replace in the probe. It is suggested that the user transport and or ship the probe in a suitable shipping case protecting the probe detector from damage as much as possible. The cost of a good shipping case will be much less expensive than the cost to replace a broken Crystal and PMT detector assembly. The use of a round PVC tube to ship this probe in is the absolute worst type of shipping container one could use for this probe. It is almost guaranteed if the 40LGR is shipped in a PVC tube that the detector assembly will be ruined and need to be replaced.

Specifications: 40LGR-1000

Power Requirements

Gamma Section:

Volts DC	120V DC at the probe top at the center pin Return or GND at the Armor or body connection
Current DC	Nominal 40mA

SP and SPR

AC Current Generator	Not to exceed 16VAC, low current type under 100mA

Tool Output

Digital Modem; ALT telemetry

Gamma Detector

NaI (tl) 22.22mm dia. X 76.2mm long

Gamma Detector location

From Bottom of probe, .165 meters.

Measurement Range

0-100K CPS Gamma, Accuracy 1% FS, Resolution 0.02% FS
± 1500 mV SP, Accuracy 1% FS, Resolution 0.02% FS
0-5000 Ohms SPR, Accuracy 1% FS, Resolution 0.02% FS

Operating temperature range

0 to 70 degrees C

Pressure rating

200bar

Dimensions

Length	1.11 meters	
Diameter	40mm	(41 to 43mm with neoprene heat shrink and PVC electrical tape)
Weight	4.7 kg	

Installation

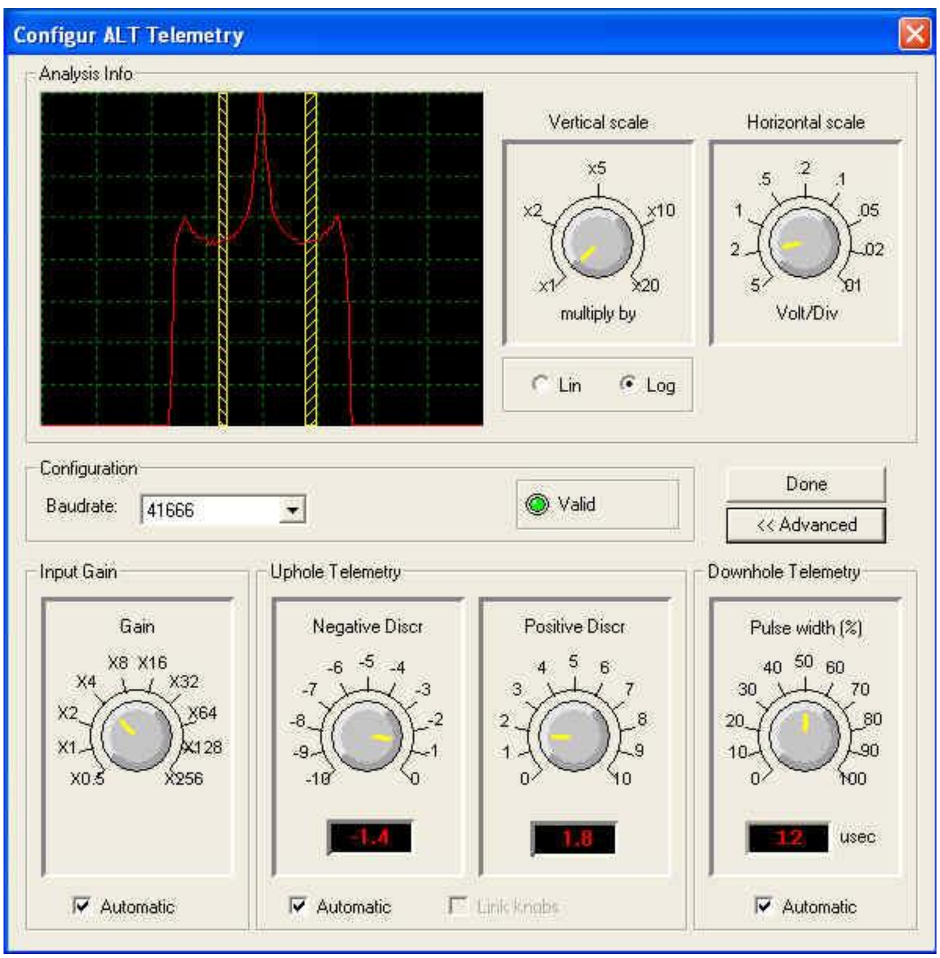
Installing the 40LGR-1000 - Gamma

In order to operate the probe it must be connected directly to a Mount Sopris Single conductor cablehead. Remove the probe-top thread protector from the top sub then thread the probe onto the cablehead. Inspect the o-rings on the cablehead for cuts or abrasions before each use to ensure an adequate seal. See the logging software operating instructions to configure and to log this tool.

Operating Procedure

Operation

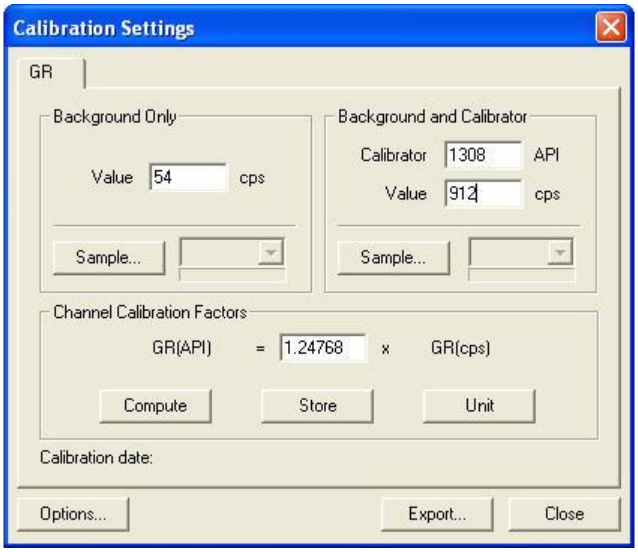
To use the 40LGR-1000 Gamma probe with the MATRIX logging system, make sure the correct Stand Alone sub files are installed in the C:\Logger\Tools\QL Stand Alone directory. The files are most easily installed using **LoggerSettings.exe** utility program supplied with the software installation. 40XXX sub files may be found on the installation CD, separate CD or memory stick. In the case of the Matrix logger, the power settings are set to default values used for all probes equipped with the QL TelePSU down-hole power supply. Different wirelines may require some adjustment to the telemetry. These settings are accessed by pressing the Settings button in the Telemetry section of the Matrix dashboard. The user may also view the pulse stream on the cable line by pressing on the Scope button. To change telemetry settings, press the properties button after the Modem Settings window appears. The user can observe the discriminator settings and make changes as necessary using the "Advanced Settings" button in the Telemetry window on the dashboard. The two discriminator bars should be placed in the middle of the displayed troughs, as shown in the following figure. When correct discriminator settings are made, SAVE the configuration, naming it as to describe the wire line configuration and the settings will be recorded for future use. In general the "factory" settings will not need adjustment. In the event of counts rates higher than 10K cps for gamma it is suggested once tuning is done to turn off all auto settings and save the tool file as is for the given length of cable. There is no need to run this probe at baud rates any higher than 41666. The tool does not produce enough data to benefit from running it at a higher baud rates and will likely cause you problems with communications and errors.



Performance Checks and Calibrations

Gamma

Calibrations are typically not need for bulk gamma counting and the probe will be reading raw counts as they are seen by the crystal detector. In the event the user feels the tool needs to be calibrated it is advisable to speak with a representative of Mount Sopris. 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. An increase in gamma counts will then be observed on the computer screen if the tool is working properly. API and uranium K factor calibrations are available for this sub. Contact the factory for details.



Calibration Settings dialog box for 40LGR Gamma Tool

In general the calibration procedure is based on a linear regression between two reference points, such as background radiation and radiation emitted by a calibration standard for a natural gamma ray tool.

With the tool turned on and exposed only to background radiation, press the Background Only Sample… button.

When background sampling is complete place the tool in the calibration fixture at a set distance or at maximum counts whatever the fixture requires. Press the Background and Calibrator Sample… button.

To check the Electrode of the tool for connection place an Ohmmeter set to read ohms on the center conductor of the probe top. Place the other meter lead on the electrode. The meter should read approximately 620 ohms.

SP and SPR

The use of a 4RSP-1000 calibration box offers the calibration points for the resistance and spontaneous potential measurements the probe can perform. Connection from the calibration box is between the electrode of the probe and the MudPlug attached to the Matrix Logger

Resistivity circuit

Resistor values are 1% rated at 50 watts.
Range selection 0, 2, 5, 10, 20, 50, 100, 500, and 1000 ohms

SP circuit

-1000 mV DC through 0 to 1000 mV DC.
Range selection 0, -2, -5, -10, -20, -50, -100, -500, and –1000 milli-volts DC
Range selection 0, 2, 5, 10, 20, 50, 100, 500, and 1000 milli-volts DC

Preventative Maintenance

The 40LGR-1000 Lithology Gamma requires little maintenance other than washing the probe off after each use. ***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 repaired.*** Inspecting o-rings of the cable head occasionally and keeping the threads clean, will minimize problems in the future. The heart of the gamma section is the photo multiplier tube and the sodium iodide crystal. Both units are very fragile and can be damaged if the probe is dropped or sees very abrupt shock. Take great care while handling or packing the probe for transportation.

Troubleshooting

Problems with the Tool

In the event the tool develops a problem, follow the troubleshooting procedure listed below. ***NEVER DIS-ASSEMBLE THE PROBE WITHOUT KNOWLEDGE OF PROCEDURE***

GAMMA Problems

No counts from the probe.

1. Is the correct probe file being used?
2. Is the logger supplying the correct voltage as specified in this document?
3. When tool power is ON is the probe drawing approx. 40mA in the tool power window.
4. Is the modem tuned properly? Reduce baud rate if using on long cable.
5. Check cable for conductive leakage across the center conductor to ARMOR. (20 Meg MIN.)
6. If no result from the above, consult Mount Sopris.

SP & SPR Problems

Troubles with resistance logs.

1. Is the correct probe file being used?
2. Open Matrix Scope view and verify a sinusoidal waveform. If no wave, issue is with Matrix.
2. Ensure surface electrode is placed in the ground and add some water to this area if possible.
3. Remove the mud plug from the side of the Matrix and with a DVM set to read ohms check the resistance from Pin A to the exposed metal on the MudPlug. The meter should read 0 Ohms.
4. If no response from the above, with the probe removed from the cablehead take a DVM set to read ohms and check the resistance from the center pin in the probe top to the electrode located below the probe top. The meter should read approx. 620 Ohms.
5. While cablehead is disconnected from step 4 check the cable line for leakage from the center conductor to the ARMOR. (20 Meg MIN.)
6. If no result from the above consult Mount Sopris.

Disassembly Instructions

The 40LGR-1000 Gamma Probe should **never be disassembled** unless service is necessary. This can be difficult probe to disassemble, and is highly recommended that any service be performed by Mount Sopris or a qualified technician. There are M4 socket head cap screws located towards the top of the probe where the housing meets the main probe top assembly. This joint is typically hidden under PVC tape. Once these (4) screw have been remove the housing can then be pulled off the main probe top. The electronics are attached to the probe top but it is suggested to NOT rotate the housing while removing the housing from the probe. Use care from this point forward is highly suggested with the fragile PMT and crystal detector inside. Reverse steps to re-assemble.

Schematics

Available upon request

40LGR-1000

Drawing #	500S-2290 5002290.S01	Title: TelePSU
Drawing #	500S-2293 5002293.S01	Title: GenCPU
Drawing #	500S-2283 5002283.S01	Title: QL Gamma
Drawing #	500S-2324 5002324.S01	Title: 40LGR Resistance Schematic
Drawing #	40LGR Wiring Diagram	Title: 40LGR Wiring Diagram

Appendix

Suggested QA Procedure

General notes for Quality Assurance are presented here for users who need to utilize these techniques when collecting data. These users will need to periodically calibrate their equipment using equipment whose calibration is traceable to an approved standard. Details of these calibrations must be recorded.

When an instrument is calibrated, records need to be kept regarding the calibration standard(s) used and what was changed on the instrument to calibrate it. Typically, the corrections made to the instrument involve changing constants that are used to scale the raw instrument reading so that the proper value is reported. The constants must be recorded during a calibration procedure. The Mt. Sopris family of Acquire programs records the calibration constants that were used to acquire the data. This aids the QA process, but does not replace the need for recording these constants at the time of calibration. The reason for this is that the length of time since the last calibration is unknown with only this information.

The device providing the standard must be traceable to an accepted standard. Examples of organizations providing standards for measuring instrumentation are: The U. S. National Bureau of Standards; The American Petroleum Institute; and the American Society for Testing Materials. For example, if the voltmeter or the density standard used for calibration is not traceable to an approved organization, such as those listed above, the calibration should not be considered valid. Records should be kept indicating the last time that standard being used for calibration was calibrated or checked against an approved standard. The QA procedure necessary for some programs mandate that the calibration standards be periodically checked against a standard approved by a proper agency.

A QA procedure may dictate that data taken from a given locale be associated with records indicating the exact time and location that the data was collected. The data itself may have to be collected in a certain format to meet requirements. Often, QA procedure specifies that surveys must be repeated and the data from the successive surveys compared. This technique is used to eliminate poor or invalid data.

Casing and Water Factors for 40LGR-1000