**Slim Telemetry Module**

The telemetry module is the uppermost tool in the stack. Its main function is to collect and combine digital data from all the other tools and to transmit this in a digital form via the logging wireline to the surface acquisition system. It also provides control functions and tool power to the other logging tools. The tool includes natural-gamma, CCL, mud-resistivity and borehole-tilt measurements.

**Principle of data communications:**
All tools in the stack communicate with the telemetry module over common internal RS485 data buses. The telemetry module organises this data and transmits it to the surface digitally using a high-speed proprietary RG protocol. Data is acquired on a depth basis with a sample interval that can be selected to optimise measurement resolution and/or logging speed.

### Features
- Bi-directional digital transmission.
- Compatible with industry-standard 5/16” or larger diameter cable.

### Measurement
- Natural Gamma
- Casing-collar locator (CCL)
- Mud resistivity
- Borehole inclination

### Applications
- Natural gamma
- Lithology indication
- Shale measurement
- Bed boundary/bed thickness measurement
- Correlation between logs and wells
- Mud resistivity
- Correction of resistivity/conductivity logs
- Casing collar locator
- Location of casing shoe
- Depth correlation between logs
- Borehole tilt
- QA of borehole construction
- Bed thickness correction

### Operating Conditions
- Borehole type: 4” to 12” open hole

### Specifications
- Diameter: 63mm (2.5”)
- Length: 2.93m (115”)
- Weight: 35kg (77lb)
- Max. temperature: 125°C
- Max. pressure: 88MPa (12,500psi)

### Sales Information
- **Probe:**
  - I015464  Telemetry
    - Includes gamma, CCL, mud-resistivity, tilt

- **Accessories**
  - I015464  Natural gamma check blanket
  - I004127  Make-up plate
  - I004128  Assembly wrench

sales@geologging.com  www.geologging.com
**Slim Litho-Density Module**

The litho-density tool combines a borehole-corrected bulk density measurement with a photoelectric lithology log (Pe). A radioactive source and detectors are mounted in an articulated skid maintained in contact with the borehole wall by a powered backup arm. The arm also doubles as a caliper measurement. The tool may be combined with compensated neutron, focused induction and sonic measurements in a classic ‘quad combo’ configuration.

**Principle of measurement:**
Gamma radiation from a $^{137}$Cs source is Compton scattered by the formation and detected by two scintillation detectors. The relative intensities of the radiation at each detector provide a measurement of formation bulk density. The photoelectric measurement is derived from the ratio of the gamma intensities in high and low energy windows at the short-spaced detector. The Pe measurement depends on the atomic number of the formation and is a good lithology indicator. Both density and Pe measurements are influenced by the borehole environment. These effects are minimised by corrections calculated by extensive Monte Carlo modelling and benchmarked to standards at the Callisto facility in Leicestershire, UK.

**Features**
- Drift eliminated by digital circuitry and active calibration loops based on internal reference sources
- Well characterised tool response based on computer calculations
- Tungsten carbide coated wear plate on skid can be replaced in the field
- High-resolution measurement. Maximum data sampling rate is 1cm (0.4”)

**Measurements**
- Bulk density ($\rho_B$)
- Correction indicator (delta-$\rho$)
- Photoelectric effect (Pe)
- Stabilisation loop indicator

**Applications**
- Matrix Identification
- Formation fluid analysis
- Porosity

**Operating Conditions**
- Borehole type: 4” to 12” open hole

**Specifications**
- Diameter: 63mm (2.5”)
- Length: 3.23m (127”)
- Weight: 60kg (132lb)
- Max. temperature: 125°C
- Max. pressure: 86MPa (12,500psi)
- Density range: 1.1 to 2.95g/cc
- Pe range: 1 to 10 Barns
- Caliper range: 75mm (3”) – 400mm (12”)

**Sales Information**
- **Probe:**
  - I003937 Litho-density probe
- **Accessories:**
  - I013961 18.5GBs $^{137}$Cs source
  - I004126 Source holder
  - I004125 Source transport pig
  - I004123 Source handling tool set
  - I004129 Density/ Pe calibrator
  - I004131 Caliper calibrator
The dual neutron module provides an environmentally compensated porosity log in mud-filled open holes. The tool design has been optimised to provide good performance at acceptable logging speeds while still using a relatively small 92GBq $^{241}$Am-Be source. It is combinable with the litho-density, dual induction/dual laterolog and sonic tools to provide the standard 'quad-combo' measurements in a single run.

**Principle of Measurement**
The dual neutron measurement uses two 3He proportional detectors and a side-door-entry sealed neutron source. Fast neutrons emitted by the source are scattered and slowed down by light elements (principally hydrogen) in the formation. The ratio of the neutron flux reaching the detectors depends on the formation hydrogen index/formation porosity. Neutron porosity measurements are affected by the borehole environment. These effects are compensated in software by algorithms calculated by Monte Carlo modelling and benchmarked to standards at the Callisto facility in Leicestershire, UK.

**Features**
- Well characterised tool response based on computer calculations for limestone, sandstone and dolomite.
- Fully digital telemetry combines with density, induction and other logging probes.
- Low-activity source requirements for safe handling and cost reduction.
- High-resolution measurement.
- Maximum data sampling rate is 1cm (0.4`).

**Measurements**
- Porosity (phi)
- Ratio long/short (NRA)
- Raw long and short-spacing counts

**Applications**
- Porosity evaluation
- Lithology identification (in conjunction with other logs)
- Detection of gas or light hydrocarbons
- Correlation between logs

**Operating Conditions**
- Borehole type: 4" to 12" mud-filled open or cased boreholes.

**Specifications**
- Diameter: 63mm (2.5`)
- Length: 2.07m (81`)
- Weight: 27kg (59lb)
- Max. temperature: 125°C
- Max. pressure: 86MPa (12,500psi)
- Porosity range: -15% to +60% limestone

**Sales information**
- Probe: I003942 Dual neutron probe
- Accessories:
  - I013962 92 GBq $^{241}$Am-Be source
  - I004124 Source holder
  - I004122 Source transport pig
  - I004123 Source handling tool set
  - I004137 Field check jig
  - I004132 Bow spring

sales@geologging.com  www.geologging.com
The dual induction probe provides conductivity logs with deep and medium depths of investigation. The tool uses an ‘array’ technique where multiple sets of in-phase and out-of-phase receiver responses are processed and summed to emulate the vertical and radial responses of classic 6FF40 ILD and ILM logs. The tool may be combined with other measurements and is always run at the base of the stack. The probe includes a fast-response platinum resistance thermometer for measurement of external borehole temperature.

**Principle of measurement:**
An oscillating high-frequency magnetic field created by a transmitter coil within the probe induces an alternating electrical current within the surrounding conductive formation. This current, in turn, induces voltages within multiple receiver coils in the probe proportional to formation conductivity. The transmitter-receiver spacings determine the depth of investigation of the measurements.

**Features**
- Multiple coil ‘array’ measurement using computer processing to synthesize tool responses
- Internal temperature compensation for low drift
- Oil-filled and pressure-balanced mandrel
- Fully digital telemetry combines with density, neutron and other logging probes
- High-resolution measurement.
- Maximum data sampling rate is 1 cm (0.4’
- Includes external temperature measurement

**Measurements**
- Deep conductivity (ILD)
- Medium conductivity (ILM)
- Raw conductivity channels
- Temperature and differential temperature

**Applications**
- Hydrocarbon saturation
- Porosity
- Lithology (in conjunction with other logs)
- Correlation between wells

**Operating Conditions**
- Borehole type: 4” to 12” mud or air-filled open hole

**Specifications**
- Diameter: 63 mm (2.5”)
- Length: 4.01 m (159”)
- Weight: 31 kg (68 lb)
- Max. temperature: 125°C
- Max. pressure: 86 MPa (12,500 psi)
- Resistivity range: 0 to 200 ohm-m
- Depth of investigation: ILD 60” ILM 30”

**Sales Information**
- Probe: 1003947 Dual induction probe with temperature
- Accessories: 1004133 Calibration loop
- 1004134 Fin stand-off (set of two)
**Slim Dual Laterolog Tool**

The RG dual laterolog provides deep and medium penetrating resistivity measurements using a classic laterolog-9 electrode configuration. It is the preferred alternative to the array induction probe in saline drilling muds.

**Principle of measurement:**

An alternating current from a centre electrode A0 passes through the formation and returns to a surface fish (deep resistivity) or to electrodes A2 and A2’ on the probe (shallow resistivity). A bucking current flowing from the guard-electrode pair A1 and A1’ is controlled to maintain the monitor electrode pairs M1M2 and M1’M2’ at the same potential. These equipotential surfaces constrain the measure current path to a disc of thickness 2ft.

---

**Features**

- Down-hole digital control of current sequence for deep and shallow measurements
- Focused measurement gives high vertical resolution
- Constant power drive for wide dynamic range
- Voltage reference and SP measurement from electrode on rigid bridle
- Stackable with RG slim oilfield tool range

**Measurements**

- Deep focused resistivity (LLD)
- Shallow focused resistivity (LLS)
- Groningen SP

**Applications**

- Invasion profile
- Fluid Saturation
- Permeability indication

**Operating Conditions**

- Borehole type: Open-hole, mud filled 4” – 12”

**Specifications**

- Diameter: 63mm (2.5”)
- Total length: 9.04m (357”) (in 3 sections)
- Max section length: 3.37m (133”)
- Weight: 102kg (225lb)
- Max. temperature: 125°C
- Max. pressure: 86MPa (12,500psi)
- Range: 0.1 to 40,000ohm-m
- Accuracy: 5% at 1000ohm-m
- Resolution: 1% measured value

**Sales Information**

- Probe: I0013886 Dual laterolog probe
- Accessories:
  - I0015009 Solid bridle with reference electrode
  - I0013888 Field test box with leads and clamps
  - I0015341 Centraliser (2 required)
**Slim Micro-Resistivity Module**

The micro-resistivity module provides a high-vertical-resolution micro-focused resistivity measurement within the flushed zone. The measurement electrodes are mounted on a flexible pad which is maintained in contact with the borehole wall by a motor-driven back-up/caliper arm. The measurement pad is interchangeable to give either micro-focused resistivity or micro-normal/micro-lateral electrode geometries. The tool is stackable with all other RG slim oilfield probes. When combined with the dual laterolog it replaces the lower guard electrode.

**Principle of measurement:**

**Micro-focused resistivity**

A central current-injection electrode is surrounded by 3 concentric ring electrodes in a circular LL-7 configuration. The measure current is focused into a narrow beam which penetrates the mud-cake to give a resistivity measurement in the flushed zone (Rxo) beyond.

**Micro-normal/micro-lateral**

Three in-line button electrodes, 1” apart, are configured to provide simultaneous 2” micro-normal and 1.5” micro-lateral measurements. Separation of the two measurement values due to their different depths of investigation gives an indication of mud-cake thickness.

---

**Features**

- High-vertical-resolution resistivity
- Robust back-up arm ensures good pad contact
- Pad interchangeable in field
- Fully stackable with other RG oilfield probes

**Measurement**

- Resistivity of invaded zone (Rxo)
- Borehole diameter

**Applications**

- Determination of moveable hydrocarbons
- Correction of Rt for invasion
- Indication of permeability
- Precise location of bed boundaries

**Operating Conditions**

- Borehole type: 4” to 12” open hole

---

**Specifications**

- Diameter (over pad): 97mm (3.9”)
- Length: 3.53m (139”)
- Weight: 56kg (123lb)
- Max. temperature: 125°C
- Max. pressure: 86MPa (12,500psi)
- Range: 0.2 – 2000ohm-m (micro-focused resistivity)
- Caliper range: 96mm (3.9”) – 400mm (12”)

---

**Sales Information**

**Probe:**

- I015642 Micro-resistivity probe

**Accessories:**

- I015644 Spare micro-focused resistivity pad
- I015646 Spare micro-normal/micro-lateral pad

---

sales@geologging.com www.geologging.com
O Slim Full-Waveform Sonic Tool

The RG full-waveform sonic provides multi-spacing digital acoustic-velocity (formation-slowness) measurements with high vertical resolution. Full-waveform recording and CBL measurements are also available. The tool can be stacked with other tools in the RG oilfield range.

Principle of measurement:
A piezoelectric transmitter stimulated by a high-voltage pulse radiates a high frequency acoustic wave through the borehole fluid and formation to the receiver array. An accurate quartz clock measures the first-arrival transit time at each receiver.

Compensated sonic mode: Two receivers and two transmitters are used. The probe measures the time of the first compressional arrival at each receiver from each transmitter firing. The data is depth-shifted and processed to remove the influence of the borehole fluid path, tool tilt and caving (depth-derived borehole compensation).

CBL mode: The probe records the 3' first arrival amplitude and 5' full sonic wave train. The attenuation of the first arrival is related to the bond quality and the strength of cement.

> Features
- High-energy transmitters for maximum penetration
- Two monopole receivers and two monopole transmitters
- Depth-deprived borehole compensation for borehole tilt and caving
- Amplitude and waveform data in CBL mode with industry standard 3’ and 5’ spacing’s
- Oil-filled mandrel with pressure compensation

> Operating Conditions
- Sonic: 4” to 12” water-filled open hole
- CBL: 4” to 12” water-filled cased hole
- Centralisation: tool is normally run centralised

> Measurements
- Formation velocity (slowness)
- Tx-Rx spacings: 3ft, 4ft, 5ft, 6ft
- Compensated delta t from each receiver pair
- Cement Bond Log (CBL) amplitude and waveform

> Specifications
- Diameter: 63mm (2.5”)
- Length: 4.45m (17')
- Weight: 51kg (112lb)
- Max. temperature: 125°C
- Max. pressure: 86MPa (12,500psi)
- Range: 40 - 240µS/ft
- Vertical resolution: 1ft or 2ft
- Transmitter(s): 2 piezoelectric
- Receivers: 2 piezoelectric
- Frequency: 20kHz (nominal)

> Applications
- Open Hole
- Lithology
- Porosity
- Rock strength and elasticity
- Fracture indication
- Time to depth correlation for seismic
- Cased Hole
- Location of poor or missing cement behind casing

> Sales Information
- Probe: IO13889 Full-waveform sonic probe
- Accessories: IO14803 6-arm centraliser (2 required)
**Slim Ultrasonic Noise Module**

The noise module detects points of entry of high-pressure gas into an open borehole by listening for an ultrasonic signature.

**Principle of Measurement:**

Sound energy caused by gas entering the borehole is focused by a conical acoustic mirror within the probe onto a microphone. The microphone is tuned to measure the acoustic energy in a frequency band centred at 40kHz, characteristic of entry of high-pressure gas through a narrow orifice.

---

**probe specification**

**Features**
- Dual detectors in a differential configuration to reduce background noise
- High-sensitivity microphones with acoustic focusing
- Fully digital telemetry combines with density, neutron and other logging probes
- Easy field access for replacement of microphones

**Measurements**
- Mean acoustic energy within a fixed passband centred at 40kHz

**Applications**
- Gas detection

**Operating Conditions**
- Dry open hole only

**Specifications**
- Diameter: 63mm (2.5”)
- Length: 1.89m (75”)
- Weight: 27kg (60lb)
- Max. temperature: 125°C
- Max. pressure: Nominal 1MPa. Gas-filled hole only

**Sales Information**
- Probe: 1003952 Ultrasonic noise probe

---

sales@geologging.com  www.geologging.com