

**Robertson Geo** is the preferred choice for the provision of borehole data for water well exploration, evaluation and maintenance. Its data wireline technologies and service is consistently delivering data and interpretation for projects in varied and challenging global locations.



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Unlocking Your GeoData

# Water & Environmental

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## Borehole logging SUBSURFACE CHARACTERISATION AND DATA ACQUISITION

Groundwater exploration  
Water well evaluation  
Well performance and sustainability monitoring  
Hydrology and contamination monitoring  
Dam site investigation

*International concerns over environmental issues such as pollution and its policing recognise Robertson Geo groundwater data provision and monitoring as an increasingly important activity for the identification of Hydrology and Contaminant issues.*

# Water & Environmental

Robertson Geo is the market leader and globally the largest supplier of slimhole wireline logging instrumentation systems with its comprehensive offer of geophysical probes and supporting surface equipment purpose designed and built in-house.



*Images are representational  
and not necessarily to scale  
- see specifications on  
pages 6 through 19*

Impeller Flowmeter Probe

Electric Log Probe

Fluid/Gas Sampler Probe

Heat-Pulse Flowmeter Probe

Dual Induction Probe

With many years of international experience and after evaluating thousands of wells often in difficult and challenging environments and locations, Robertson Geo logging technologies has a results proven record for delivering quality data for the exploration, characterisation, performance and environmental monitoring of groundwater wells.



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## Groundwater wells

Borehole logging is proven to be the most cost effective methodology of characterising the construction, performance and sustainability of water wells.

Geophysical logging provides subsurface data not only at the initial drilling procedures but also for the essential monitoring of well performance identifying problems before they become costly failures.

Robertson Geo wireline logging equipment is portable and easy to use providing real time evaluation data and interpretation at the well location. Its proven technology is in use worldwide by water drillers, hydrologists, environmental consultants and agencies, the military and research universities.

Robertson Geo technologies deliver reliable, calibrated quality data for exploration, to locate water tables or perched water bodies, to characterise aquifers and aquitards, to establish potential water yields and for evaluation of new water wells to check the grout integrity behind the casing, to measure borehole depth, dimensions and verticality and to provide permanent records for monitoring studies.

## Environment

Regular well maintenance is essential to check for productivity, leaks, obstructions, casing corrosion and grout degradation and with ever increasing international concerns and policing relating to environmental issues, the use of Robertson Geo data acquisition technology is increasingly important for identifying and monitoring hydrology and contamination issues.

## Logging services

Robertson Geo engineers are experienced, highly trained and can be deployed to any global location.

The complete catalogue of equipment is available on a service basis operated by these field crews. They are capable of prolonged logging services with minimum outside support and are expert in data processing and interpretation.

These are very cost effective contracting services in circumstances where projects do not justify purchasing equipment and the necessary back up facilities.

## Equipment supply

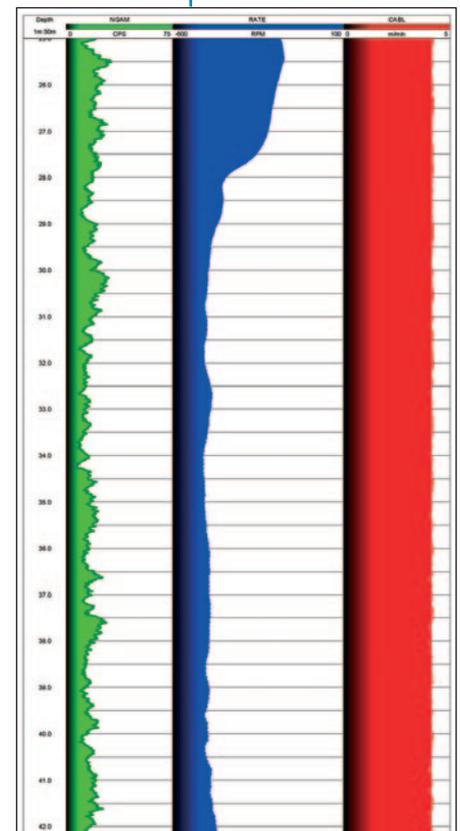
All Robertson Geo probes are fully tested and calibrated at the Deganwy facility prior to dispatch, eliminating testing time on site and ensuring the probes are fully operational prior to downhole use.

Depending on customer needs operational and customised training can be provided; this for winch use, probe deployment, logging techniques, data capture and equipment maintenance and troubleshooting.

## Equipment rental

Robertson Geo equipment is available to rent with a minimum rental period of 3 days in the USA or 15 days elsewhere. Full systems (including winches) or individual probes can be rented as required with borehole and classroom based training made available for rental customers.

In-house data management and log processing services are available for rental equipment clients, at an additional cost.



*Example of data created by the Impeller Flowmeter probe.*

*Further data examples are shown with each specification page for probes and where applicable surface equipment on pages 6 through 19.*

Robertson Geo is the only logging services provider with a QMS certified to ISO 9001, comprehensively calibrating all of its logging systems and uniquely using an on-site borehole for testing at its Deganwy test well and calibration facility.

## Probes

**Electric Log:** the classic water-well combination probe combining shallow, medium and deep penetrating resistivity measurements with Self-Potential (SP). *See page 6*

**Temperature Conductivity:** provides a continuous depth-based measurement of fluid temperature and conductivity. A natural gamma detector is included for correlation purposes. *See page 7*

**Dual Focussed Induction:** provides two simultaneous conductivity logs, corresponding to “medium” and “deep” radii of investigation into the formation. *See page 8*

**3-Arm Caliper:** provides a single continuous log of borehole diameter as recorded by three mechanically coupled arms in contact with the borehole wall. *See page 9*

**Impeller Flowmeter:** provides a continuous log of vertical fluid velocity within a borehole. *See page 10*

**Fluid/Gas Sampler:** probes are used to recover discrete samples of well fluid at a particular depth and return it uncontaminated to the surface. *See page 11*

**Heat-Pulse Flowmeter:** used to detect low vertical flows within a borehole below the threshold limits of conventional impeller tools. *See page 12*

**Dual Neutron:** the probe of choice for quantitative formation fluid studies providing a calibrated borehole compensated porosity measurement. *See page 13*

**Formation Density:** uses dual shielded detectors to provide a borehole compensated density measurement with good bed-boundary resolution. *See page 14*

**Borehole Geometry:** consists of a 4-arm caliper combined with a verticality measurement. The probe can replace the standard 3-arm caliper with advantage where the borehole cross-section departs from circular and where directional information is required for well completion studies and formation stress analysis. *See page 15*

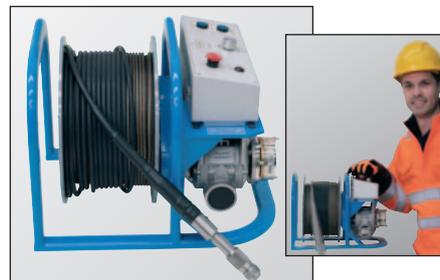
**Full Waveform Sonic:** provides high quality formation acoustic velocity data. Options are available for display of full waveform data and cement bond data (CBL) in cased boreholes. *See page 16*

## Surface equipment

**Micrologger2:** surface interface system for handling logging data acquisition, which supports all Robertson Geo probes, including acoustic and imaging tools. *See page 17*



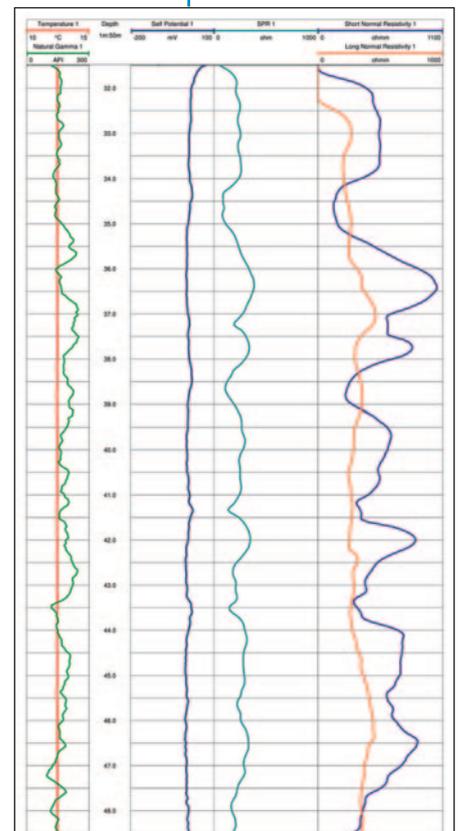
**Winlogger:** MS Windows based operating system for the Micrologger2, provides field acquisition capability. In-house processing, interpretation and reporting is undertaken. *See page 17*



**Winches:** Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

- Mini Winch
- 500m Winch
- 600m Winch
- 1000m/2000m Winch
- 2000m Marine Winch
- 3000m Winch

*See pages 18-19*



*Example of data created by the Electric Log probe.*

*Further data examples are shown with each specification page for probes and where applicable surface equipment on pages 6 through 19.*



# Water & Environmental Applications

Representative examples to show **Essential**, **Intermediate** and **Advanced** systems as a benchmark for identifying the level of data and interpretation required for individual locations and characteristics.

Robertson Geo support teams are always available for further information and discussion when considering system applications at [support@robertson-geo.com](mailto:support@robertson-geo.com)

## Essential

- Micrologger2
- Winch (Mini)
- Electric Log Probe
- Temperature Conductivity Probe  
*and/or*
- Dual Focussed Induction Probe

## Intermediate

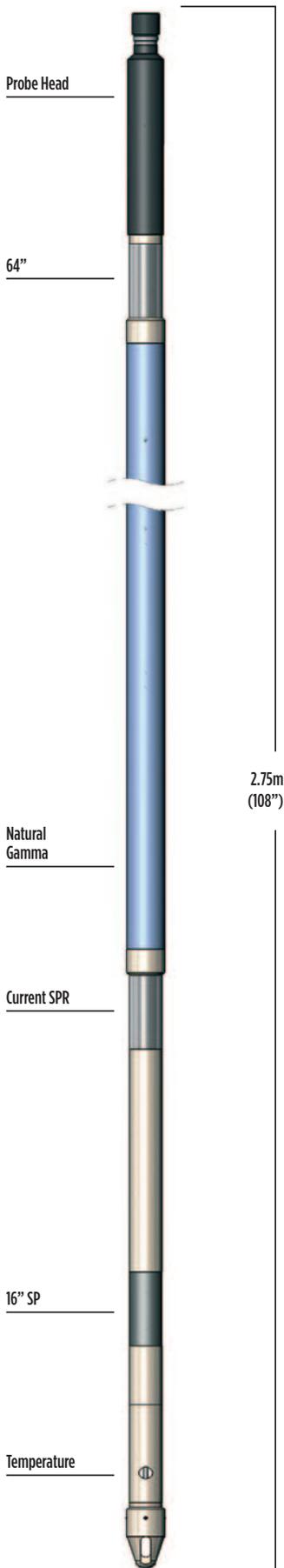
- Micrologger2
- Winch (Mini/500m)
- Electric Log Probe
- Temperature Conductivity Probe  
*and/or*
- Dual Focussed Induction Probe
- Full Waveform Sonic Probe
- 3-Arm Caliper Probe
- Impeller Flowmeter
- Water Sampler Probe

## Advanced

- Micrologger2
- Winch (Mini/500m/600m)
- Electric Log Probe
- Borehole Geometry Probe
- Temperature Conductivity Probe  
*and/or*
- Dual Focussed Induction Probe
- Full Waveform Sonic Probe
- Impeller Flowmeter or Heat-Pulse Flowmeter
- Water Sampler Probe
- Dual Neutron Probe
- Formation Density Probe

See probe and surface equipment specifications pages 6 through 19

# Electric Log



Electric Log Probe

The classic water-well combination probe combining shallow, medium and deep penetrating resistivity measurements with Self-Potential (SP).

**Principle of Measurement:**

A low-frequency bi-directional electric current from a source electrode on the probe returns through the formation to the cable armour above an insulated bridle. Potentials due to this current flow are measured on various sense electrodes on the probe with respect to a voltage reference 'fish' normally located at the surface. These measurements are converted to apparent formation resistivities within the probe and transmitted to the surface.

**SPECIFICATION:**

**Features**

- Digital down-hole measurement avoids errors due to cable effects
- Constant-power down-hole current source

**Measurements**

- 16" Normal resistivity
- 64" Normal resistivity
- Single-point resistance
- Self-Potential (SP)
- Natural-gamma
- Fluid Temperature
- Optional 8" and 32" Normal resistivity

**Applications**

- Water
- Determination of water quality
- Indication of permeable zones and porosity
- Minerals/Engineering
- Bed-boundary positions
- Strata correlation between boreholes
- Fracturing Indication

**Operating Conditions**

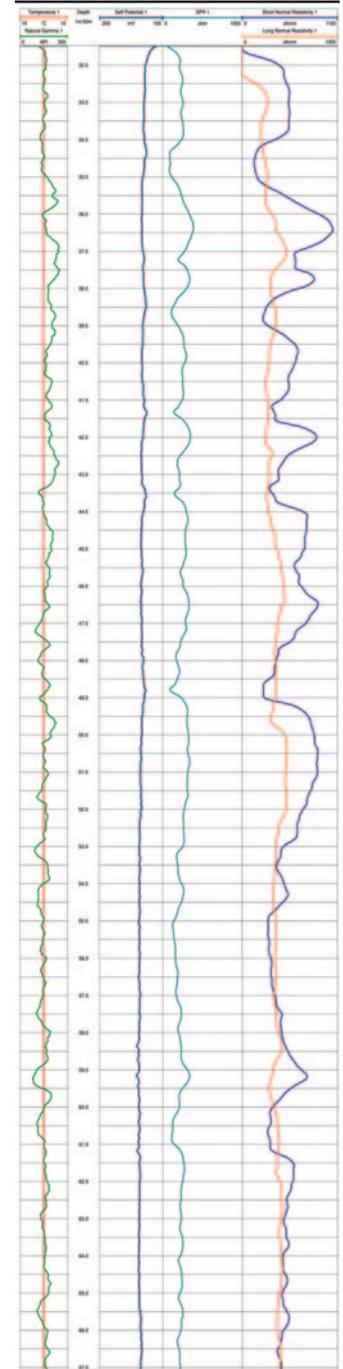
- Borehole type: open-hole, water-filled
- Recommended Logging Speed: 4m per min

**Specifications**

- Diameter: 45mm
- Length: 2.75m or 3.16m (with 8" and 32" option)
- Weight: 11kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Resistivity range: 1 to 10,000 ohm-m

**Part Numbers**

- 1002072 Electric Log probe with natural gamma and temperature
- 1002111 - including 8" and 32" normal resistivity



Example of logging data

# Temperature Conductivity



This probe combination provides a continuous, depth-based measurement of fluid temperature and conductivity.

Both parameters can be output in absolute and in differential forms. A natural gamma detector is included for correlation purposes.

**Principle of Measurement:**

The temperature and conductivity sensors are located in an insulated housing at the base of the probe. During logging, borehole fluid flows freely through ports on the side and base of this housing and over the sensors. The log is recorded downwards while running into the hole to minimise fluid disturbance.

**SPECIFICATION:**

**Features**

- Stable, high-quality, semiconductor temperature sensor
- Graphite conductivity electrodes resist corrosion and are easily cleaned

**Measurements**

- Fluid temperature/differential temperature
- Fluid conductivity/differential conductivity
- Natural Gamma

**Applications**

**Water**

- Fluid salinity
- Location of zones of different water quality
- Water-well monitoring
- Identification of zones of in-flow/out-flow
- Temperature gradient
- Water-level determination
- Location of grout behind casing
- Temperature compensation of other logs

**Operating Conditions**

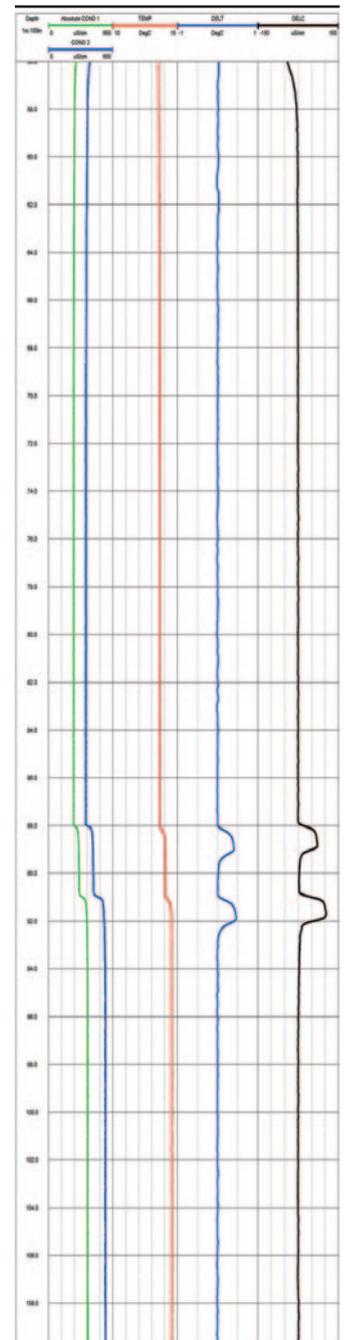
- Borehole type: open/cased holes, water-filled
- Recommended Logging Speed: 5m/min

**Specifications**

- Diameter: 38mm
- Length: 1.69m
- Weight: 4.5kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Temp. range: 0-70°C (extended ranges available)
- Conductivity range: 50 to 50,000  $\mu\text{S} / \text{cm}$

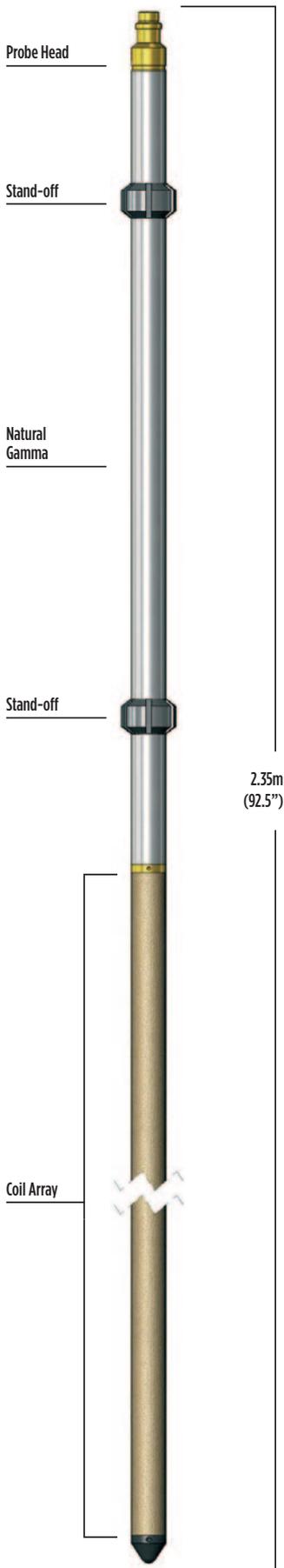
**Part Numbers**

- 1002055 Temperature Conductivity probe with gamma



Example of logging data

# Dual Focussed Induction | Ultra-Slim Induction



Dual Focussed Induction Probe

The Dual Focussed Induction probe provides two simultaneous conductivity logs, corresponding to “medium” and “deep” radii of investigation into the formation.

The two depths of penetration are useful in porous, permeable formations where displacement of formation fluids by drilling mud creates an “invasion zone” with different electrical properties. The 1” focussed induction probe produces a single medium penetration conductivity log. It finds particular application in small-diameter dry or plastic-lined boreholes used for mineral exploration and for conductivity/resistivity in dry holes.

### Principle of Measurement:

An oscillating high-frequency magnetic field from a transmitter coil within the probe induces an alternating electrical current within the surrounding conductive formation. This current, in turn, induces voltages within receiver coils proportional to the formation conductivity. The transmitter-receiver spacings determine the depth of investigation of the measurements. Additional focussing coils minimise the contribution of the borehole signal.

## SPECIFICATION:

### Features

- Formation conductivity measurement in wet/dry boreholes or through plastic casing
- Separate deep and medium penetrating measurements give information on invaded zone
- Focussed measurements for minimum borehole signal PSD (phase-sensitive detector) discriminates between magnetic susceptibility and conductivity signals

### Measurements

- Deep formation conductivity
- Medium formation conductivity
- Natural Gamma

### Applications

#### Water

- Indicator of permeable zones and porosity
- Formation water salinity
- Long-term well monitoring

#### Mineral/Engineering

- Ore identification and quality
- Correlation

#### Other

- Indication of hydrocarbons

### Operating Conditions

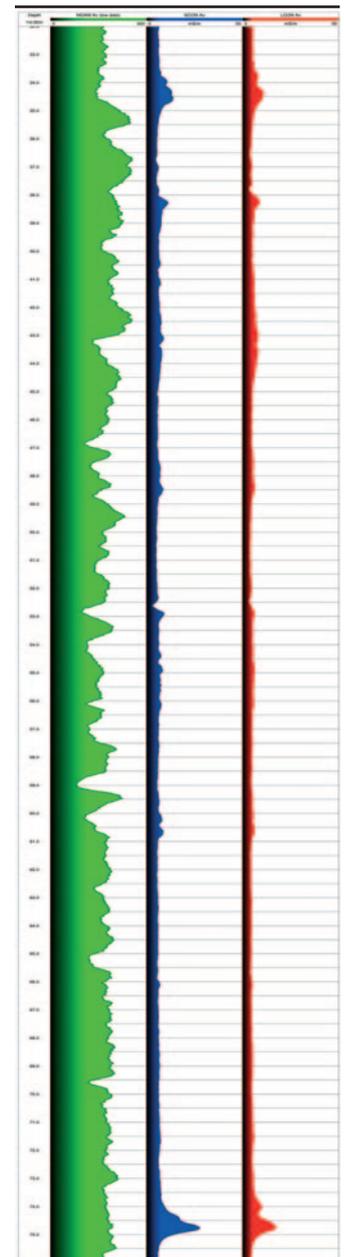
- Borehole type: open/plastic or grp cased, air/water-filled
- Recommended Logging Speed: 5m/min

### Specifications

- Diameter: 38mm/25mm
- Length: 2.35m/1.95m
- Weight: 6kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Number of coils: Dual Induction 7, Ultra-slim 4
- TX-RX spacings: ILM 50cm (20”), ILD 81cm (32”)
- Conductivity range: 3 to 3300mS/m

### Part Numbers

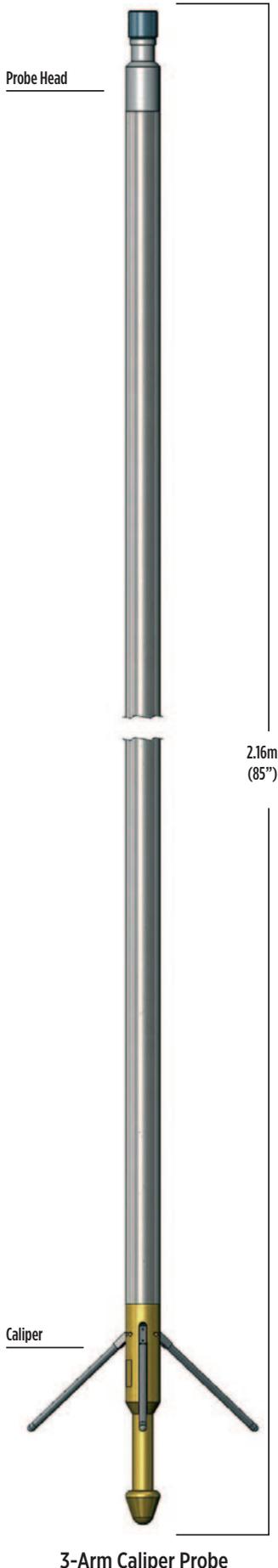
- 1002087 Dual Focussed Induction probe with natural gamma
- 1002091 Ultra-Slim Induction probe with natural gamma



Example of logging data

# 3-Arm Caliper

710mm, 1000mm and 1500mm ranges



The 3-Arm Caliper probe provides a single continuous log of borehole diameter as recorded by three mechanically coupled arms in contact with the borehole wall.

710mm, 1000mm and 1500mm range calipers are available to suit a range of well diameters. The caliper is a useful first log to determine the borehole conditions before running more costly probes or those containing radioactive sources.

### Principle of Measurement:

Opening and closing of the motor-driver caliper arms is by surface command, allowing the probe to run into the borehole with the arms retracted. Once opened, the spring-loaded arms respond to borehole diameter variations as the probe is raised up the borehole.

## SPECIFICATION:

### Features

- Small diameter for slim-hole operation
- Extension arms supplied as standard for 38mm version
- Optional natural-gamma measurement
- Optional casing collar locator

### Measurements

- CCL (optional)
- Borehole volume (derived)
- Natural Gamma (optional)
- Borehole volume

### Applications

- Minerals/Water/Engineering
- Location of borehole collapse or obstructions
- Cement volume calculations for grouting
- Identification of hard and soft lithology
- Location of cracks, fissures, caving, faulting, casing breaks
- Correction of other logs affected by borehole diameter

### Operating Conditions

- Borehole type: open/cased; water/air-filled
- Centralisation: recommended in large holes
- Centralisation: recommended in inclined holes
- Recommended Logging Speed: 5m/min

### Specifications

- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa

### 3-Arm Caliper (710mm range)

- Diameter: 38mm
- Length: 2.18m-2.68m (depending on CCL and extended arms)
- Weight: 7.5kg
- Range: 40-300mm and 40-710mm

### 3-Arm Caliper (1000mm range)

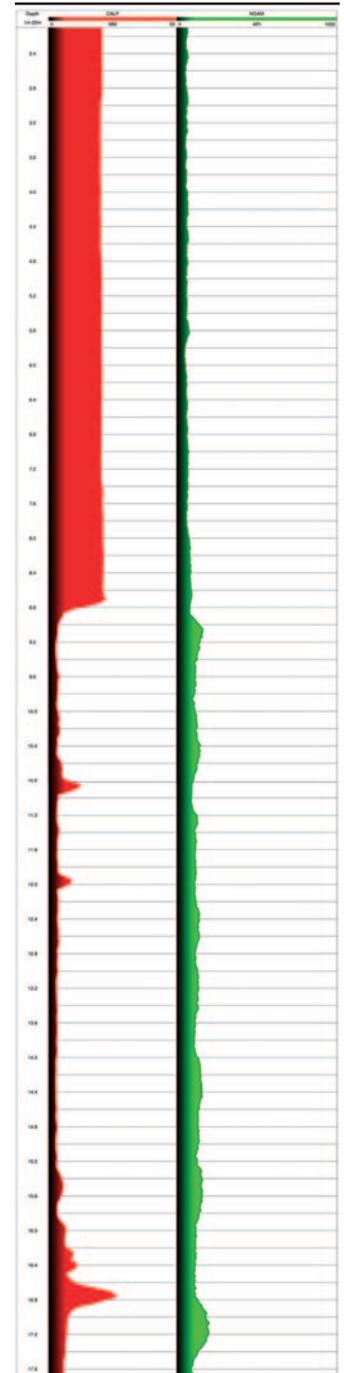
- Diameter: 60mm
- Length: 2.83m
- Weight: 15kg
- Range: 65-1000mm

### 3-Arm Caliper (1500mm range)

- Diameter: 80mm
- Length: 3.14m
- Weight: 17.5kg
- Range: 100 - 1600mm

### Part Numbers

- 1002035 3-Arm Caliper (710mm range) with arm extension kit and calibrator
- 1002037 - including natural gamma
- 1002041 3-Arm Caliper (1000mm range) with calibrator
- 1002052 3-Arm Caliper (1500mm range)



Example of logging data

# Impeller Flowmeter



Impeller Flowmeter Probe

Impellers can detect differential flow rates as low as 1.0m/min.

Logging at a range of speeds allows detection of flow of any rate (although for high precision in low flow rates use of the Heat-Pulse Flowmeter is advised).

**Principle of Measurement:**

The probes are equipped with lightweight helical impellers mounted on double sapphire bearings. The impellers contain magnets which actuate Hall-effect switches within the probe to detect impeller rotation. Separate log channels record the time of rotation according to fast and slow timebases for improved resolution at high and low flow rates. Uphole and downhole rotations are distinguished within the probe.

**SPECIFICATION:**

**Features**

- Jewelled bearings for minimum friction
- Low-drag sensors
- Choice of head diameters
- Cable-speed readout

**Measurements**

- Flow
- Cable velocity
- Optional natural gamma

**Applications**

**Water**

- Flow measurement within a water well
- Location of permeable zones
- Casing leak detection

**Operating Conditions**

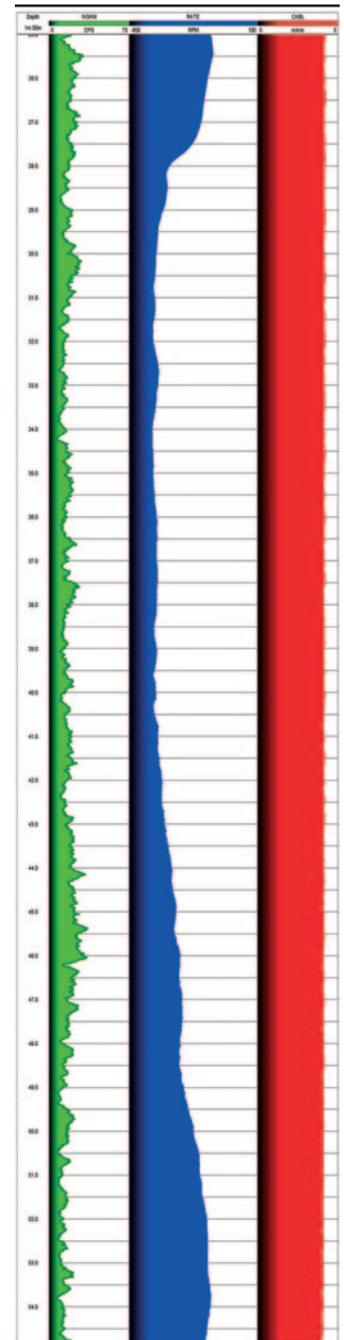
- Borehole type: open/cased, water-filled
- Centralisation: required
- Recommended Logging Speed: Multiple passes, varied speeds 2-7 m/min

**Specifications**

- Diameter: 45mm, 70mm
- Length: 1.53m
- Weight: 4.0kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa

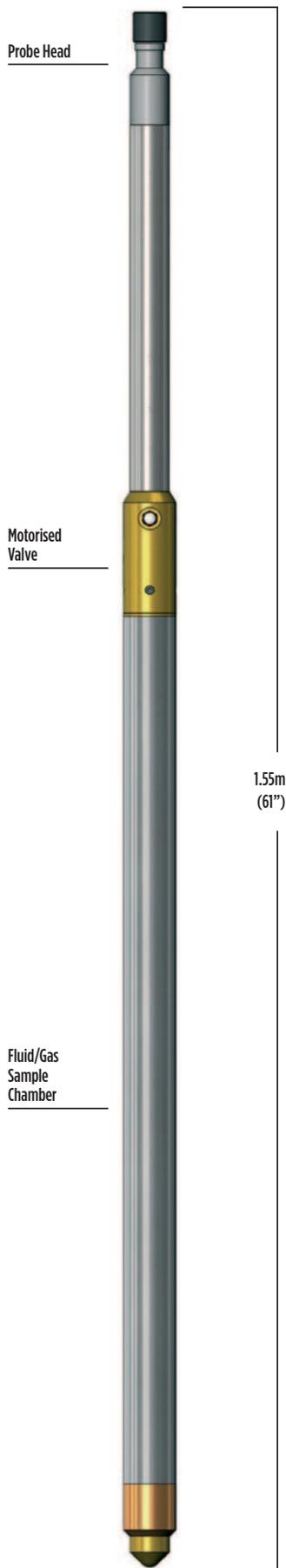
**Part Numbers**

- 1002122 Impeller Flowmeter 45mm
- 1002115 Impeller Flowmeter 70mm



Example of logging data

# Fluid/Gas Sampler



Fluid and Gas Sampler probes are used to take a discrete sample of well fluid at a particular depth and to return it uncontaminated to the surface.

### Principle of Measurement:

**Fluid Sampler:** The Fluid Sampler includes a chamber incorporating motor-actuated valves at the top and base. While the probe is being lowered into the borehole, the valves are held open, allowing well fluid to flow freely through the chamber. At the desired depth, the motor is activated under surface control, closing the valves to seal the chamber and contents ready for retrieval.

**Gas Sampler:** The Gas Sampler is designed to retrieve uncontaminated samples of well fluids comprising or containing gas whilst maintaining the original well pressure. The probes contain a sealed sample chamber with a moveable piston and motor-actuated valve. Prior to logging, the piston is withdrawn manually and locked into position, leaving a partial vacuum within the sample chamber. For sampling, the valve is opened under surface control, allowing the well fluid to enter the chamber. The valve is then closed, enclosing the sample under ambient pressure. At the surface, the fluid can be transferred while still under pressure to a suitable container for analysis.

## SPECIFICATION:

### Features

- Simple, motor-operated actuation
- Fluid sample chamber easily cleaned
- Fluid/gas sample retained at borehole pressure

### Applications

- Fluid**
- Sampling well fluid at depth for surface analysis
- Groundwater and water well studies

### Operating Conditions

- Borehole type: open/cased, water-filled
- Recommended Logging Speed: Static sampling

### Specifications

#### Fluid Sampler

<b>Volume: 0.25L</b>	Diameter: 38mm	Length: 0.96m	Weight: 5kg
<b>Volume: 0.5L</b>	Diameter: 38mm	Length: 1.27m	Weight: 5kg
<b>Volume: 1.0L</b>	Diameter: 38mm	Length: 1.88m	Weight: 5kg
<b>Volume: 1.25L</b>	Diameter: 38mm	Length: 2.19m	Weight: 5kg
Temperature:	0-70°C (extended ranges available)		
Max. pressure:	20MPa		

#### Gas Sampler

<b>Volume: 0.5L</b>	Diameter: 51mm	Length: 1.18m	Weight: 10kg
<b>Volume: 1.0L</b>	Diameter: 51mm	Length: 1.55m	Weight: 10kg
Temperature:	0-70°C (extended ranges available)		
Max. pressure:	20MPa		

### Part Numbers

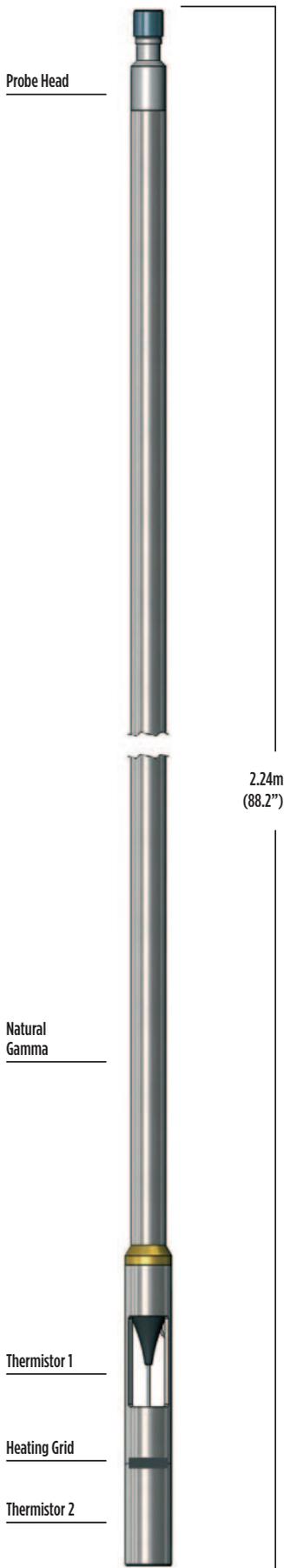
1002198	Fluid Sampler probe 1li
1002206	Gas Sampler probe 1li



Mechanical valve assembly where the sample is extracted

Fluid/Gas Sampler Probe

# Heat-Pulse Flowmeter



The Heat-Pulse Flowmeter probe is used to detect low vertical flows within a borehole below the threshold limits of conventional impeller tools.

The probe is designed for stationary measurements only. Normal logging practice involves measurements at a series of depths across the zone of interest.

## Principle of Measurement:

The probe contains a horizontal wire-grid heating element and thermistors located above and below it. Apertures in the tool permit the free flow of well fluid through the assembly. Pulses of electric current are applied to the heating grid under surface command, warming fluid in the vicinity of the grid. The warm fluid front migrates towards the thermistors where it is detected. Depending on the direction of flow, either upper or lower thermistor detects the warm fluid front first. The time taken to reach the detector gives an indication of flow rate.

## SPECIFICATION:

### Features

- Detection of very low vertical flow rates
- Auto-null command cancels tool offsets prior to each measurement

### Measurements

- Up/down flow

### Applications

#### Water

- Location of permeable zones in water wells
- Casing leak detection

### Operating Conditions

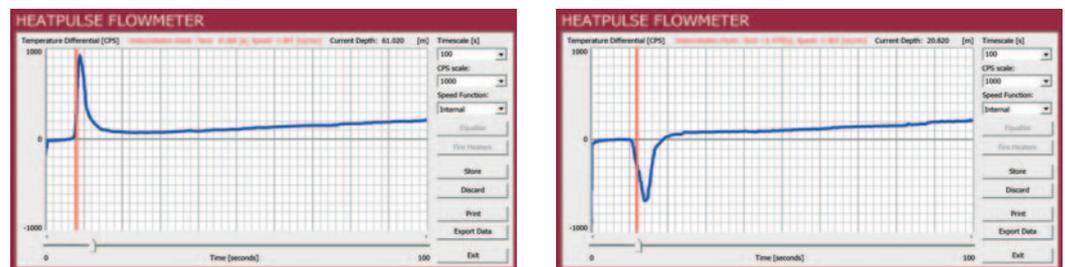
- Borehole type: open/cased hole, water-filled
- Centralisation: required
- Recommended Logging Speed: static measurements

### Specifications

- Diameter: 51mm
- Length: 2.24m
- Weight: 8.0kg
- Temperature: 0-50°C
- Max. pressure: 20MPa
- Measurement range: 0.1 to 3m/min

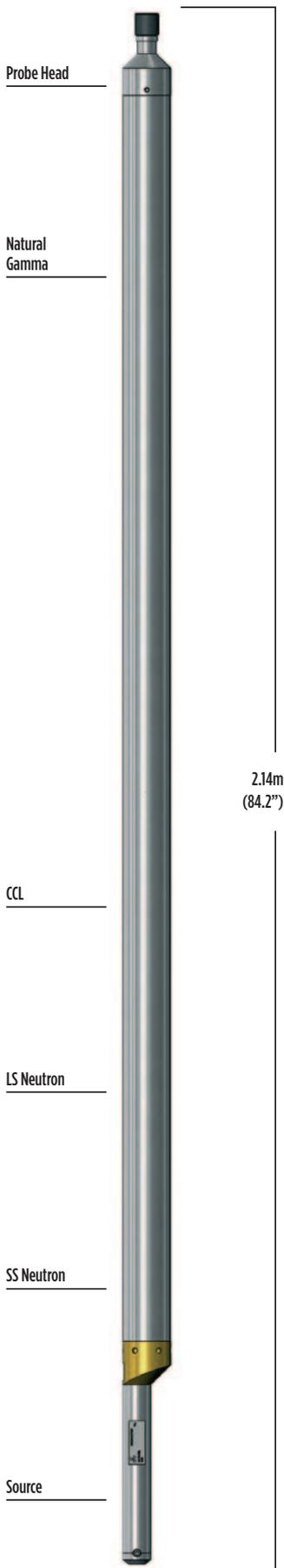
### Part Numbers

- 1002119 Heat-Pulse Flowmeter probe



Examples of logging data

# Dual Neutron



Dual Neutron Probe

The Dual Neutron probe provides a calibrated borehole-compensated neutron porosity measurement in mud-filled open holes.

It is the probe of choice for quantitative formation-fluid studies.

A single-detector neutron probe is also available for qualitative porosity logging under most borehole conditions including through steel or plastic casing and drill-pipe.

**Principle of Measurement:**

The Dual Neutron measurement uses two <sup>3</sup>He proportional detectors and a detachable, sealed <sup>241</sup>Am-Be neutron source. Fast neutrons emitted by the source are scattered and slowed to thermal levels, principally by hydrogen in the formation. The ratio of the neutron flux reaching the near and far detectors depends on the hydrogen index and porosity. Use of dual detectors and a ratio method provides a porosity measurement compensated for borehole diameter but not independent of it.

**SPECIFICATION:**

**Features**

- Real-time porosity measurement
- Compensation for borehole diameter

**Measurements**

- Compensated porosity
- Neutron (raw counts)
- Natural gamma
- Option: Casing-collar locator (CCL)

**Applications**

**Minerals / Water / Engineering**

- Lithology identification
- Location of aquifer and aquitard
- Fracture analysis in coals
- Correlation between open and cased-hole logs
- Strata correlation between wells

**Operating Conditions**

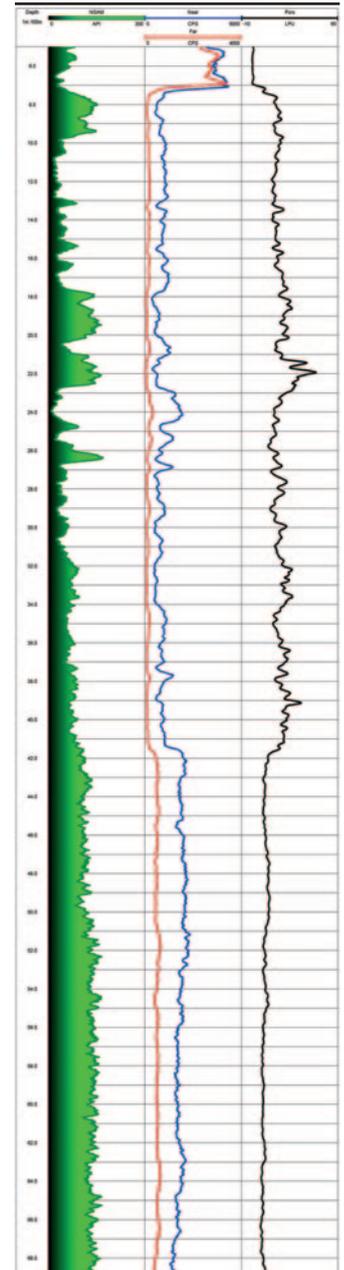
- Borehole type: open/cased, water-filled
- Centralisation: ex-centralised with bowspring
- Recommended Logging Speed: 4m/min

**Specifications**

- Diameter: 65mm
- Length: 2.14m
- Weight: 19.5kg
- Temperature: 0-70°C (0-125°C optional)
- Max. pressure: 20MPa
- Range: 15 to 45% Limestone Porosity Units (LPU)

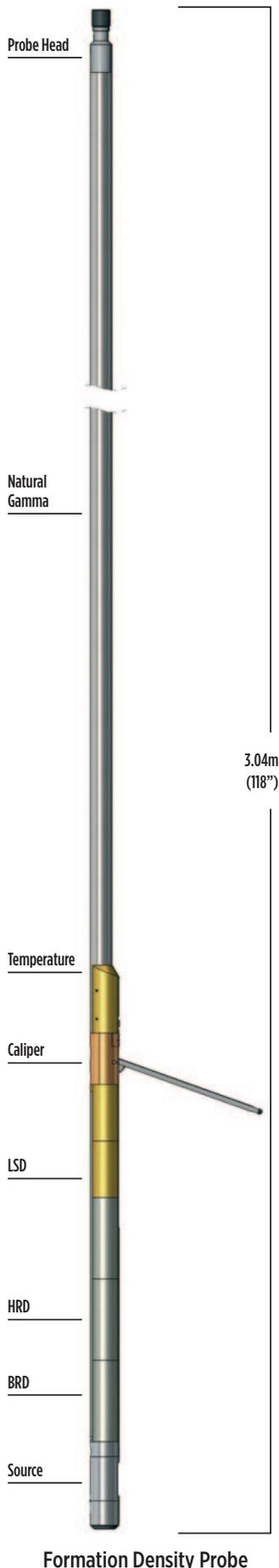
**Part Numbers**

- 1002029 Dual Neutron probe with natural gamma
- 1002030 - includes CCL



Example of logging data

# Formation Density, Density Guardlog & Iron Ore Density



The Formation Density probe uses dual shielded detectors to provide a borehole-compensated density measurement with good bed-boundary resolution.

The Density Guardlog probe offers an additional LL3 focussed electrical measurement with good vertical resolution and depth of investigation. The Iron Ore Density probe includes extra collimation, different source-detector spacings and a higher activity source to extend the density range to 5g/cc for iron ore logging.

## Principle of Measurement:

The probes contain a detachable <sup>137</sup>Cs gamma source and two scintillation gamma detectors. The active windows of the source and detectors are maintained in contact with the borehole wall by a motorised caliper arm. Gamma radiation back-scattered by the formation (Compton effect) reaches the detectors where the relative count rates provide a measure of formation density.

## SPECIFICATION:

### Features

- Compensated density output in engineering units (g/cc)
- Short-spacing detector for high vertical resolution
- Tungsten shielding reduces borehole effects
- Standard calibration blocks for field or base use

### Measurements

- Bulk density
- High-resolution density (HRD)
- Natural gamma
- Caliper
- Options: Guard resistivity, Bed-resolution density (BRD), Temperature
- Dual calibrated density channels
- Fluid Temperature

### Applications

#### Minerals:

- Density and porosity
- Lithology
- Bed thickness and boundary location
- Coal ash and moisture content

#### Engineering:

- Rock strength and elasticity parameters (with sonic log)
- Detection of weathered or fractured zones

#### Water:

- Location of aquifer and aquitard
- Detection of cavities and missing cement

### Operating Conditions

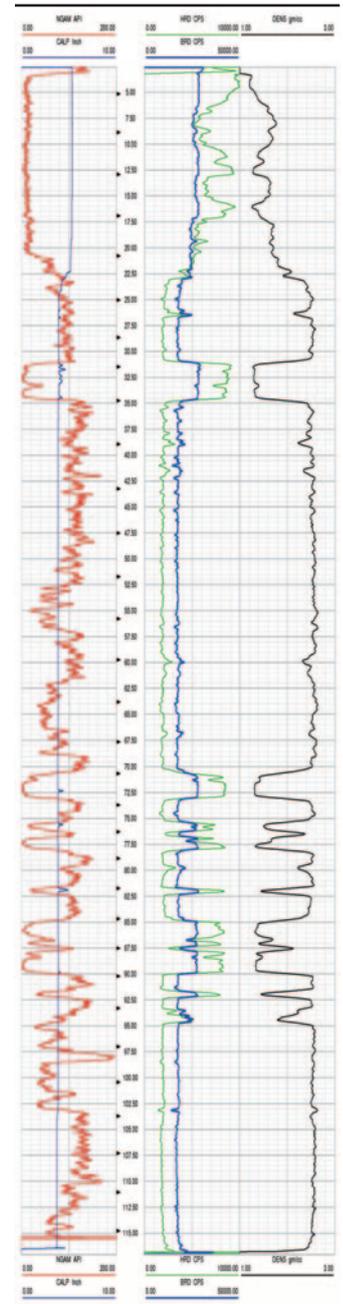
- Borehole type: All, including air filled (qualitative measurement only)
- Recommended Logging Speed: 4m/min

### Specifications

- Diameter: 51mm
- Length: Formation Density 3.04m / Density Guardlog 2.89m
- Weight: 21kg (Density Guardlog 28.5kg)
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Density range: 1.1 to 2.95g/cc (Formation Density and Density Guardlog probes)  
1.5 to 5.0g/cc (Iron Ore Density probe)
- Caliper range: 50mm to 300mm
- Resistivity range: 1-10000 ohm-m

### Part Numbers

- I002013 Formation Density probe
- I002016 – includes BRD and temperature
- I014720 Density Guardlog probe with BRD
- I018309 Iron Ore Density probe



Example of logging data

# Borehole Geometry



Borehole Geometry Probe

The Borehole Geometry probe consists of a 4-arm caliper combined with a verticality measurement.

The probe can replace the 3-Arm Caliper (710mm range) with advantage where the borehole cross-section departs from circular and where directional information is required for well-completion studies and formation stress analysis. The top section can be logged as a standard verticality.

**Principle of Measurement:**

The XY caliper provides continuous measurements of borehole diameter from two independent pairs of linked arms. The verticality section includes a triaxial magnetometer and three accelerometers. Data from these are combined by a downhole microprocessor to provide real-time, continuous logs of probe orientation and borehole inclination and direction.

**SPECIFICATION:**

**Features**

- Sensitive X-Y caliper
- Continuous orientation log for all borehole inclinations

**Measurements**

- X and Y calipers
- Borehole deviation and drift
- Borehole volume (derived)
- True vertical depth (TVD)
- Natural gamma

**Applications**

- Water/minerals/engineering
- Borehole diameter in two axes
- Borehole break-out for stress analysis
- Cracks, fissures and casing defects

**Operating Conditions**

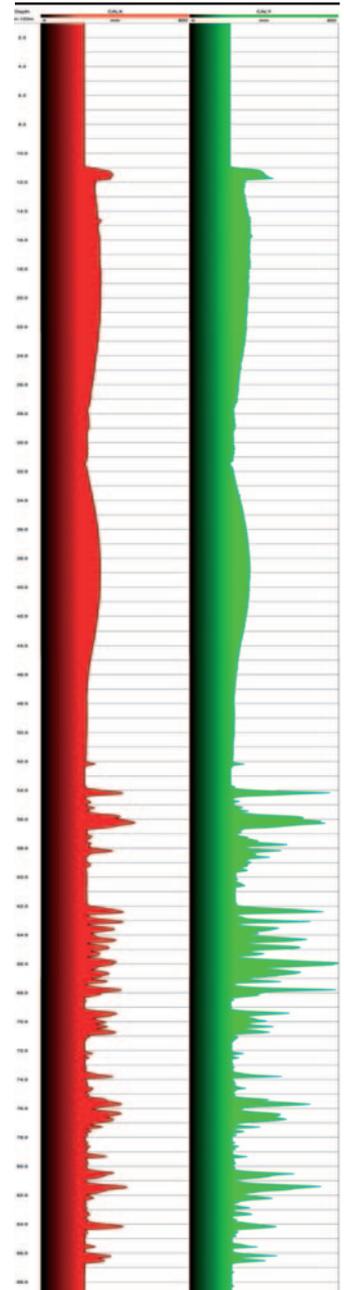
- Borehole type: open/cased, water/air-filled
- Centralisation: recommended, non-magnetic centralisers required
- Recommended Logging Speed: 5m/min

**Specifications**

- Diameter: 60mm
- Length: 3.54m (in two sections) or 1.81m
- Weight: 19.5kg complete (5.5kg for top section)
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Caliper range: 75mm to 700mm

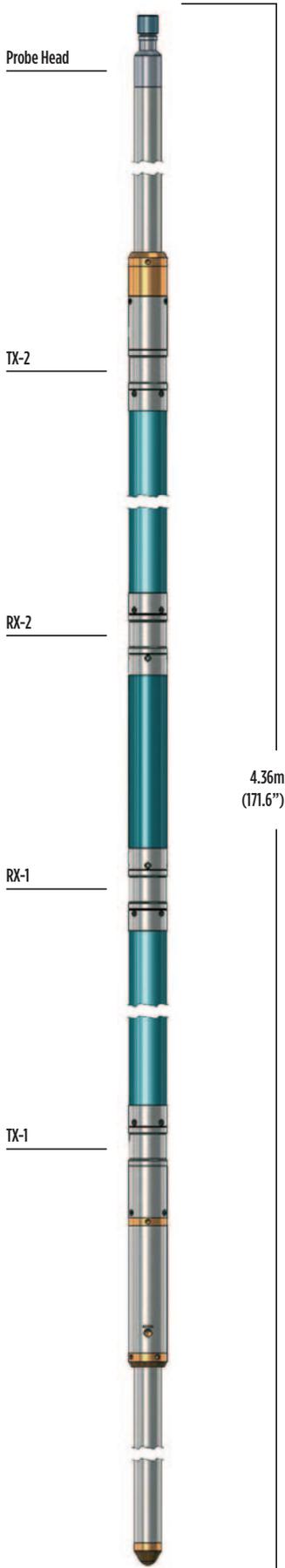
**Part Numbers**

- 1002044 Borehole Geometry probe with natural gamma



Example of logging data

# Full Waveform Sonic



Full Waveform Sonic Probe

The Full Waveform Sonic probe uses a dual-transmitter dual-receiver array to provide high quality formation acoustic-velocity data.

Options are available for display of full-waveform data and cement-bond data (CBL) in cased boreholes.

### Principle of Measurement:

A piezoelectric transmitter stimulated by a high-voltage pulse radiates a high-frequency acoustic wavelet. This is coupled via the borehole fluid and formation to each receiver. An accurate quartz clock measures the first arrival transit time. The first arrival in open hole corresponds to the p-wave path in the formation.

**Full Waveform Sonic mode:** Two pairs of transmitters and receivers are used to allow cancellation of the borehole fluid path and determination of formation velocity (slowness). The full sonic waveform from both receivers is displayed as a variable-density log (VDL) or waveform ('wiggles') trace.

**Cement Bond Log (CBL) mode:** The probe records the amplitude and arrival time of the first casing arrival at the near receiver and full sonic waveforms from both receivers.

## SPECIFICATION:

### Features

- Down-hole digitisation of waveform data
- Compensation for poor centralisation or casing
- Variable density log (VDL) or wavelet ('wiggles') display

### Measurements

- Formation velocity (slowness)
- Shear (S) velocity (where shear wave exists)
- Full waveform Time of first arrival ( $\Delta t$ )
- Amplitude of first arrival (CBL)
- Integrated transit time
- Natural Gamma optional

### Applications

#### Water / Minerals / Engineering

- Porosity
- Rock strength and elasticity (with density log)
- Correction of seismic velocity
- Fracture and permeability indication in hard rock
- Location of poor or missing cement behind casing

### Operating Conditions

#### Borehole type:

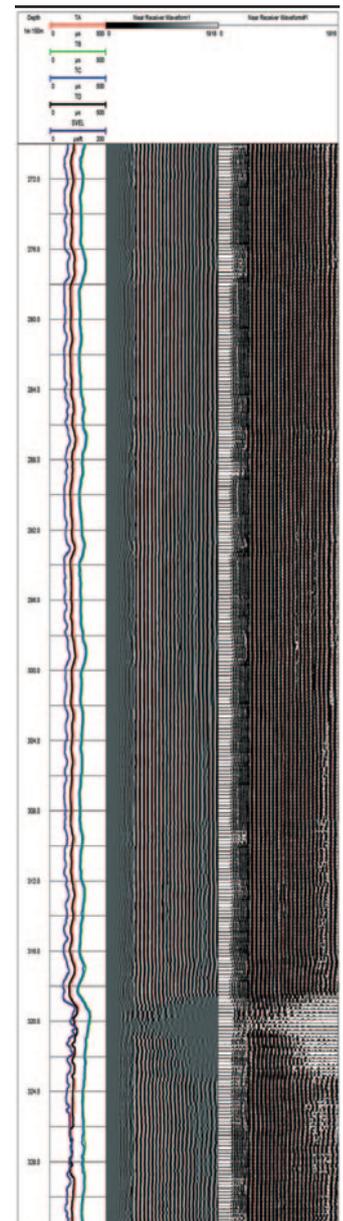
- Sonic: open-hole, water-filled
- CBL: cased-hole, water-filled
- Centralisation: required
- Recommended Logging Speed: 4m/min

### Specifications

- Diameter: 60mm
- Length: 4.36m (4.78m with gamma)
- Weight: 30kg (33kg with gamma)
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa

### Part Numbers

- 1002128 Full Waveform Sonic probe with CBL



Example of logging data



# Mini Winch | 500m Winch | 600m Winch

Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

Each winch is precision engineered for reliable use in the most challenging field applications. The winches are fully compatible with the Micrologger2 surface system and the full range of Robertson Geo probes, for depths of up to 3,000m.

## Mini Winch

The Robertson Geo Mini Winch is portable, compact and robust. Its basic 'no-frills' design is aimed at long-term reliability under arduous conditions.

### SPECIFICATION:

#### Specifications

Capacity:	175m (575') 4.72, (3/16") cable
Speed:	0 - 17.5m/min (0 - 57ft/min) on full drum (12VDC operation)
Motor:	550W (12 - 24VDC)
Size:	340(w) x 400(l) x 320(h) mm
Weight:	19kg excluding cable

#### Part Numbers

1013754	Mini Winch includes power and data cables
1001117	Mini Winch Tripod with Encoder



## 500m Winch

A robust heavy-duty unit, the 500m Winch can be operated from a vehicle battery and is ideal for heavier probes in shallow boreholes.

### SPECIFICATION:

#### Specifications

Capacity:	530m (1738') 3/16" 4-core cable
Speed:	0 - 13m/min (0 - 43ft/min)
Motor:	180W at 12VDC
Size:	582(w) x 482(l) x 414(h) mm
Weight:	52kg excluding cable

#### Part Numbers

1001019	500m winch including tripod, power and data cable
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## 600m Winch

Of similar basic construction to the 500m winch, the 600m is mains/generator powered.

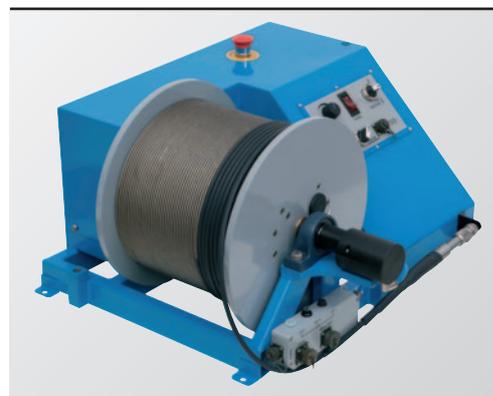
### SPECIFICATION:

#### Specifications

Capacity:	630m (2066') 3/16" 4-core cable
Speed:	0 - 15m/min (0 - 49ft/min)
Motor:	540W at 110/220VAC
Size:	622(w) x 696(l) x 370(h) mm
Weight:	80kg excluding cable

#### Part Numbers

1001043	600m winch including tripod, power and data cable
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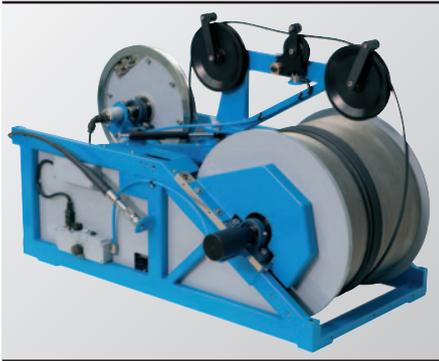
# 1000m/2000m Winch | 3000m Winch 2000m Marine Winch

Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

Each winch is precision engineered for reliable use in the most challenging field applications. The winches are fully compatible with the Micrologger2 surface system and the full range of Robertson Geo probes, for depths of up to 3,000m.

## 1000m/2000m Winch

The standard unit for truck-mounted operations in deep boreholes, the 2000m winch includes an integral depth wheel and an automatic level wind.



### SPECIFICATION:

#### Specifications

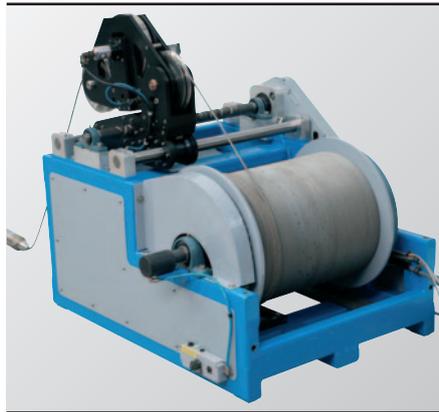
Capacity:	2030m (6658') 3/16" 4-core cable 1030m (3378') 1/4" coaxial cable
Speed:	0 – 30m/min (0 – 99ft/min)
Motor:	2hp (1.5kW) at 110/220VAC
Size:	605(w) x 1060(l) x 735(h) mm
Weight:	142kg excluding cable

#### Part Numbers

1001021	2000m winch for 3/16" 4-core cable includes tripod, power and data cable
1001034	1000m winch for 1/4" coaxial cable includes tripod, power and data cable

## 3000m Winch

A heavy-duty electric draw-works designed for deeper hole and oil/gas investigations. *Please note the pressure limits of standard Robertson Geo slimhole tools.*



### SPECIFICATION:

#### Specifications

Capacity:	3000m (9840') 3/16" cable
Speed:	0.2 – 34m/min rim: 0.5 – 100m/min
Pull:	1,350kgF Rim: 460kgF
Motor:	440VAC 3-Phase 4kVA
Dimensions:	1000(w) x 1100(l) x 900(h) mm
Weight:	415kg excluding cable

#### Part Numbers

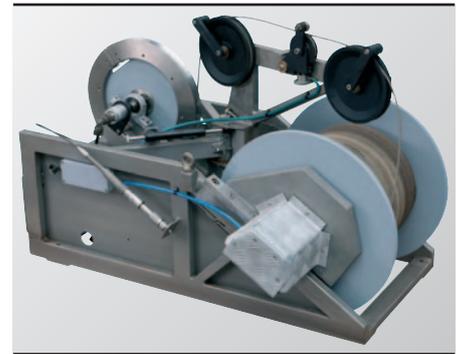
1013866	3000m winch for 3/16" four-core system includes tripod, power and data cable
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## 2000m Marine Winch

Working experience by Robertson Geo offshore logging crews has led to the modification of the 2000m Winch and the introduction of a Marine variation to resist corrosive, saline conditions.

The communications box is waterproofed and filled with silicon to protect the electronics.

Grade 316 stainless steel has been introduced to replace standard steel components. 316 contains the alloy molybdenum, significantly enhancing corrosion resistance, especially for more saline or chloride exposed environments. 316 components include structural frames, depth wheel, panels, spacers, shafts and gears, sprockets and chains.



### SPECIFICATION:

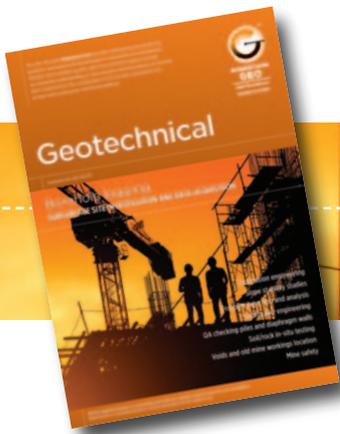
#### Specifications

Capacity:	2030m (6658') 3/16" 4-core cable 1030m (3378') 1/4" coaxial cable
Speed:	0 – 30m/min (0 – 99ft/min)
Motor:	2hp (1.5kW) at 110/220VAC
Size:	605(w) x 1060(l) x 735(h) mm
Weight:	142kg excluding cable

#### Part Numbers

1019167	2000m Marine Winch
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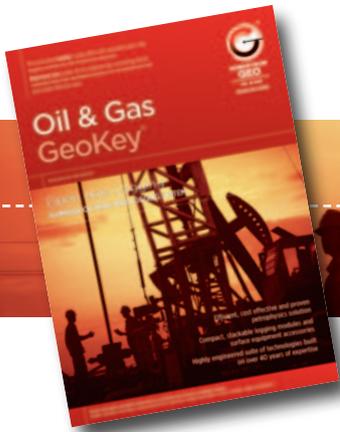
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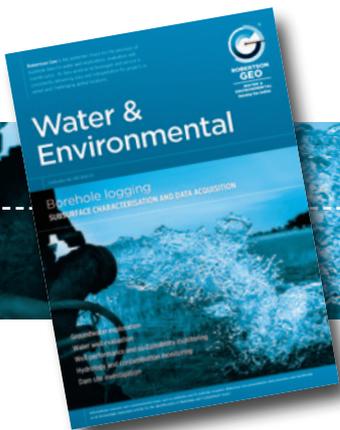
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