Geovista Sonde Operations Manual

DLL3 Resistivity Sonde

DLL3 Logging Operations

The DLL3 Sonde

The DLL3 sonde measures formation resistivity using a set of electrodes designed to allow for both a Deep and a Shallow investigation capability. This is in contrast with the simple LL3 sonde which has only a Deep investigation capability. Like the LL3 and the ELOG sondes, the DLL3 sonde requires the use of an isolating bridle.
The DLL3 is a superior alternative to the traditional Normal Resistivity sonde. It offers the advantage of deeper penetration (particularly in conductive mud) and better vertical resolution – See fig.1. below.

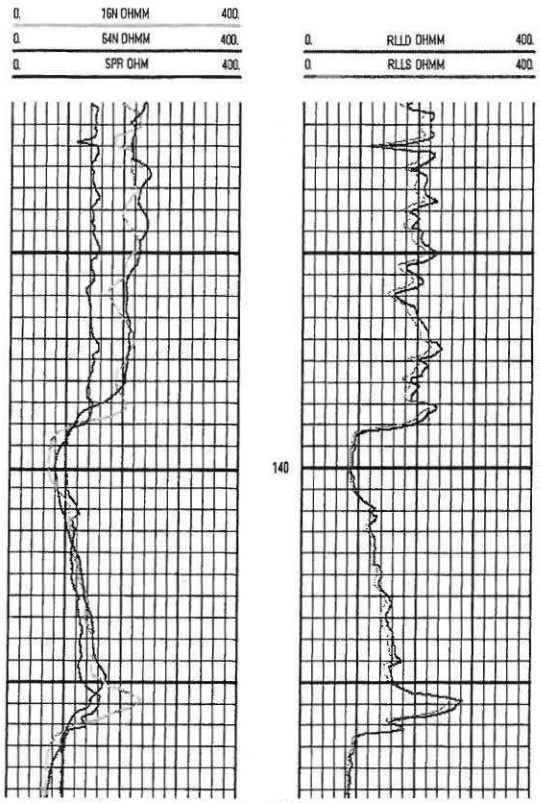


Fig.1. *DLL3 and Normal Resistivity Comparison*

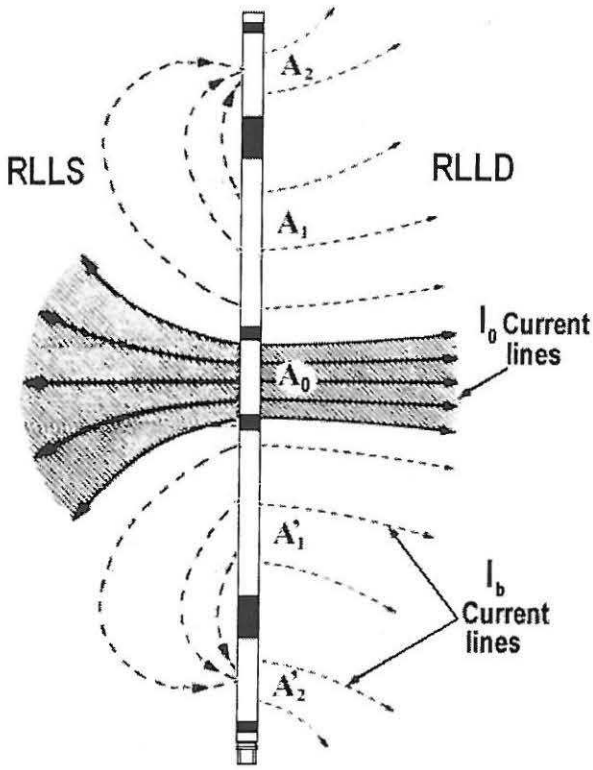


Fig.2. *The Dual Guard Log Sonde*

Principle

The Dual Guard Sonde works on a principle that is similar to the simple LL3 Guard sonde. A measure current I_0 is sent from a central electrode A_0 to a remote return (the cable armour beyond the isolating bridle). This current is focussed by means of a *Bucking* current I_b which flows from the Guard Electrodes pairs which are connected together. The potential of the Guard Electrode pairs is held equal to the potential of the measure electrode A_0. This turns the sonde into an equipotential surface forcing current I_0 to flow out perpendicularly as a disc with an initial thickness equal to the measure electrode A_0.

In contrast to the simple LL3 sonde, the Dual Guard sonde has four Guard Electrodes A_1, A_1' and A_2, A_2'. Shallow LLS and Deep LLD Resistivity are measured by

changing the guard electrode length and the return of the bucking current.
LLS uses A_1 and A_1' electrodes as guards with bucking current returning to A_2 and A_2' Electrodes. LLD uses both A_1 and A_2 and A_1' & A_2' as guards with bucking current returning to cable armour (See fig.2.).
The sonde measures current I_0 and the potential V_0 (with respect to the bridle electrode). The ratio of these measurements is computed to generate the resistivity seen by the measure electrode

Recommended mnemonic: *DLL3*

Sonde Dimensions:

Sonde length	2.27 metres
Sonde diameter	38 millimetres
Sonde weight	7.5 Kg

Output User Data:

Channel #	Depth Offset	Recommended Mnemonic	Recommended Unit
#1	116 cm	RLLS	OHMM
#2	116cm	RLLD	OHMM

ANTARES
UMWELT- u. GEOTECHNIK

Digital
SPECTRAL GAMMA RAY INSTRUMENT
Type 1428

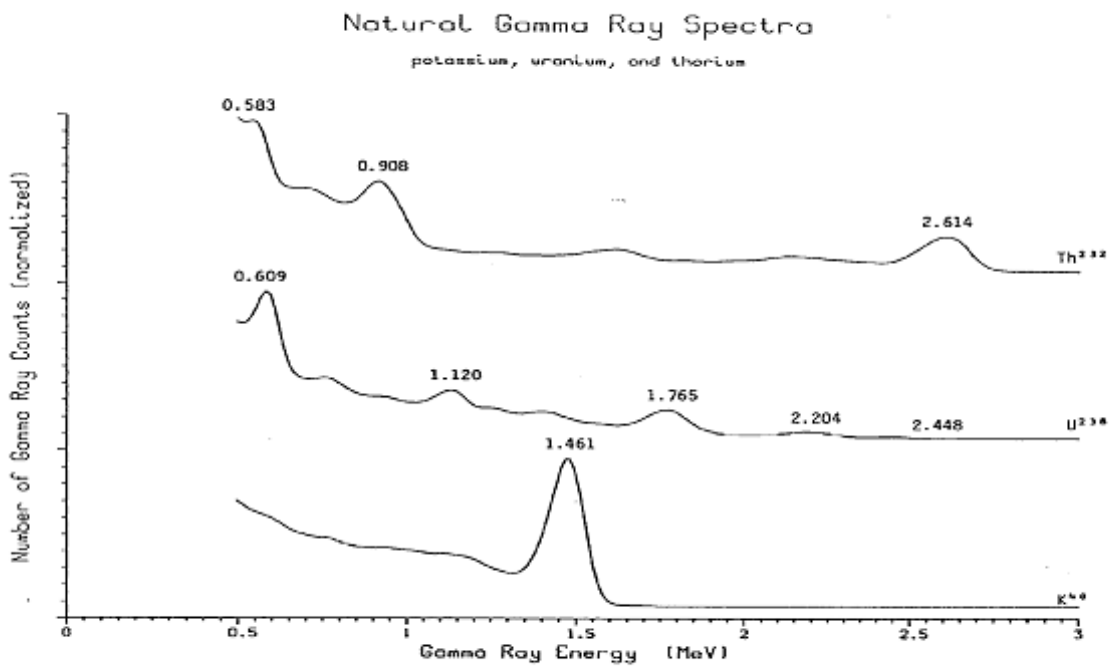
May 2003

A. INTRODUCTION

Natural gamma radiation exists everywhere on the earth. Certain radioactive elements as well as groups of elements, that are found in the formations of the earth's crust, are the cause of the radiation. This content of these radioactive components is strongly dependent on the lithology; therefore, it is possible to use a Gamma Ray log to determine the lithology and to recognize the respective geology.

The digital ANTARES Spectrum Gamma Ray instrument is a borehole logging instrument for recording of the natural gamma radiation. For this purpose, a scintillation counter converts the arriving gamma rays in light flashes. The intensity of these flashes corresponds to the energy of the striking gamma rays; the frequency of the flashes in turn indicates the intensity of the radiation.

The light flashes are converted into electrical pulses inside a photo-multiplier tube. The pulses are forwarded to the electronics. The amplitude of the pulses is digitized and divided up into 256 'channels.' After every data request from the surface system, the 256 channels are transferred to the acquisition equipment via the logging cable, together with the time passed since the last data request. This so resembled gamma energy spectrum is transferred to the logging PC where it is decomposed into its basic components. Now it is possible to quantitatively determine the amount of ^{232}thorium, ^{238}uranium and ^{40}potassium. The typical shape of the individual spectra is shown in the illustration below.



All detected gamma rays which exceed a certain energy are counted for the sum-gamma ray curve. The actual measured value is the number of pulses per second. To determine this value, all counts available since the previous data request and the time elapsed is transferred as digital signal via the logging cable.

Digital transfers make the undistorted transfer of large data quantities possible over big distances (logging cable).

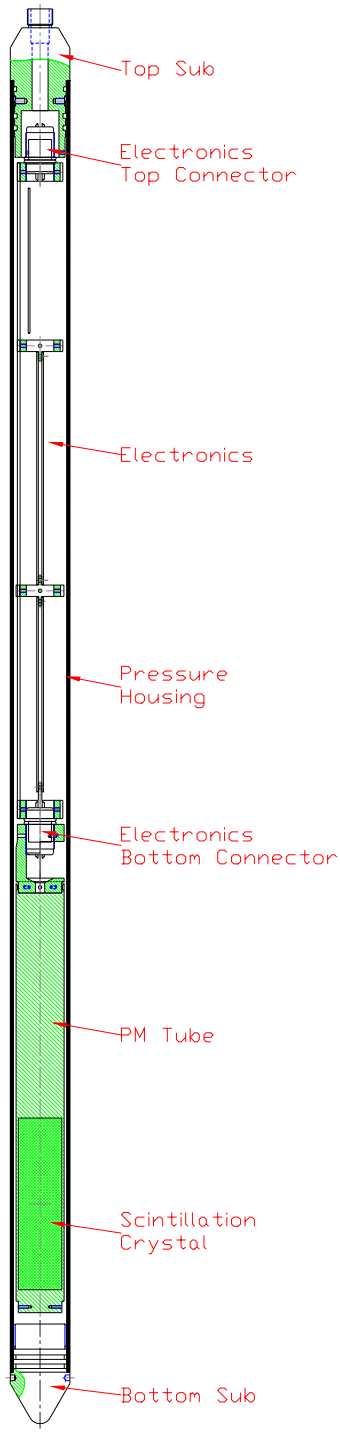
C. TECHNICAL DATA

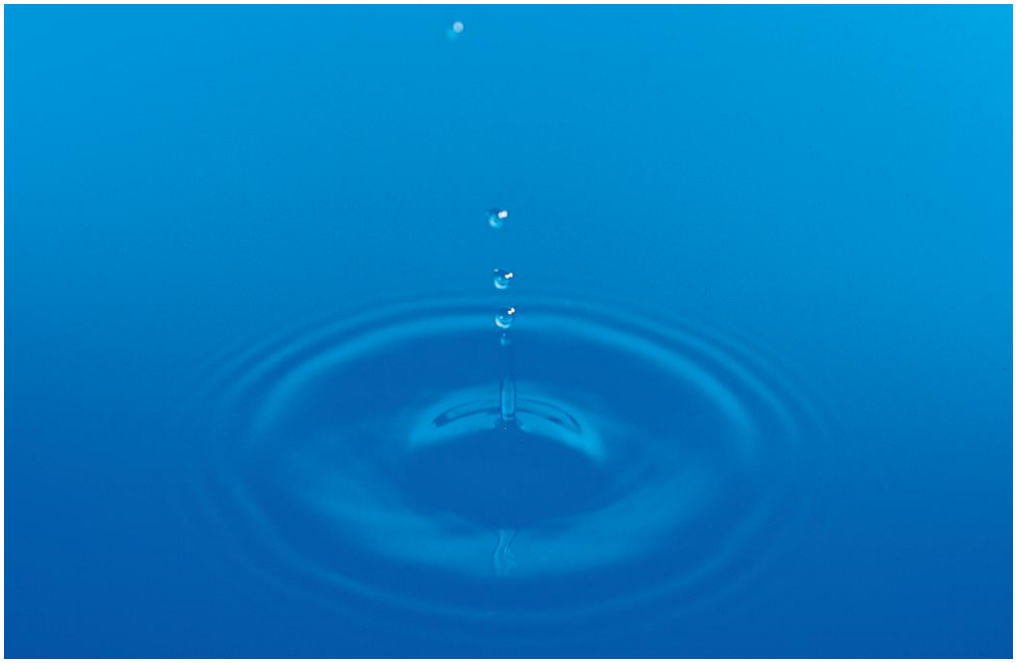
1. General Data

Instrument Power Supply:	90 V-150 V DC, approximately 35-30 MA,
Detector size:	38 mm diameters x 150 mm length
Detector Material:	BGO
Mass:	10 kg
Diameters:	52 mm
Length:	1.235 m
Measure Point:	0.147 m from the lower end of the pressure housing
Instrument Data	256 spectrum channels (pulses since last request) Total Gamma Ray (pulses since last request) Time since last data request Cable head voltage Electronics temperature

2. Pin-Out (ANTARES Configuration)

Top connector (GO4):	Contact 1	Power supply+ and Data
	Housing	Power supply- and Data





User Guide

QL40 OCEAN – Multi Parameter Water Quality Probe

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1.2 Dimensions

Figure 1-1 *QL40 OCEAN probe overview*

1.3 Technical Specification

Tool

Diameter:	40mm
Length:	1.41m
Measurement point:	0.15m (from bottom)
Weight:	5.45 kgs
Max. Temp:	50°C
Max.Pressure:	150bar

Cable:

Cable type:	Mono, 4 or 7 conductor (for multi conductor only 1 line used)
Digital data transmission:	Up to 500 Kbits per second depending on wireline
Compatibility:	ALTLogger – ABOX – Matrix

Sensors:

The standard probe can be equipped with sensors to measure the following parameters:

Parameter	Range	Accuracy	Resolution	Time cst
Pressure	0.. 1000 dbar	0.05 %F.S.	0.0015% F.S.	50 ms
Temperature	-1.. +50°C	0.005 °C	0.001 °C	50 ms
Conductivity				
Salt water	0..70 mS/cm	0.007 mS/cm	0.01 mS/cm	50 ms
Fresh water	0.. 7000 µS/cm	5 µS/cm	0.1 µS/cm	50 ms
Oxygen	0.. 50 ppm	0.1 ppm	0.01 ppm	3s
	0..500 %sat.	0.2 1%sat.	0.02 0.1 %sat.	3s
pH	0.. 14 pH	0.01 pH	0.001 pH	3s
Redox	+/- 1000mV	1 mV	0.1 mV	3s

Table 1 *Parameters recorded with the standard configuration of the sensor unit*

Optional sensors are available:

Parameter	Range	Accuracy	Resolution	Time cst
Pressure	0.. 6000 dbar	0.01 %F.S.	0.002% F.S.	50 ms
Ammonia	0.. 100 mg/l-N		0.1 mV	
Nitrate	0.. 100 mg/l-N		0.1 mV	
Chloride	0.5.. 18000 mg/l-N		0.1 mV	

Table 2 *Parameters recorded with the extended configuration of the sensor unit*

2 Measurement Principle

The bottom section of the probe is 43mm in diameter and contains the Idronaut sensors and electronics.

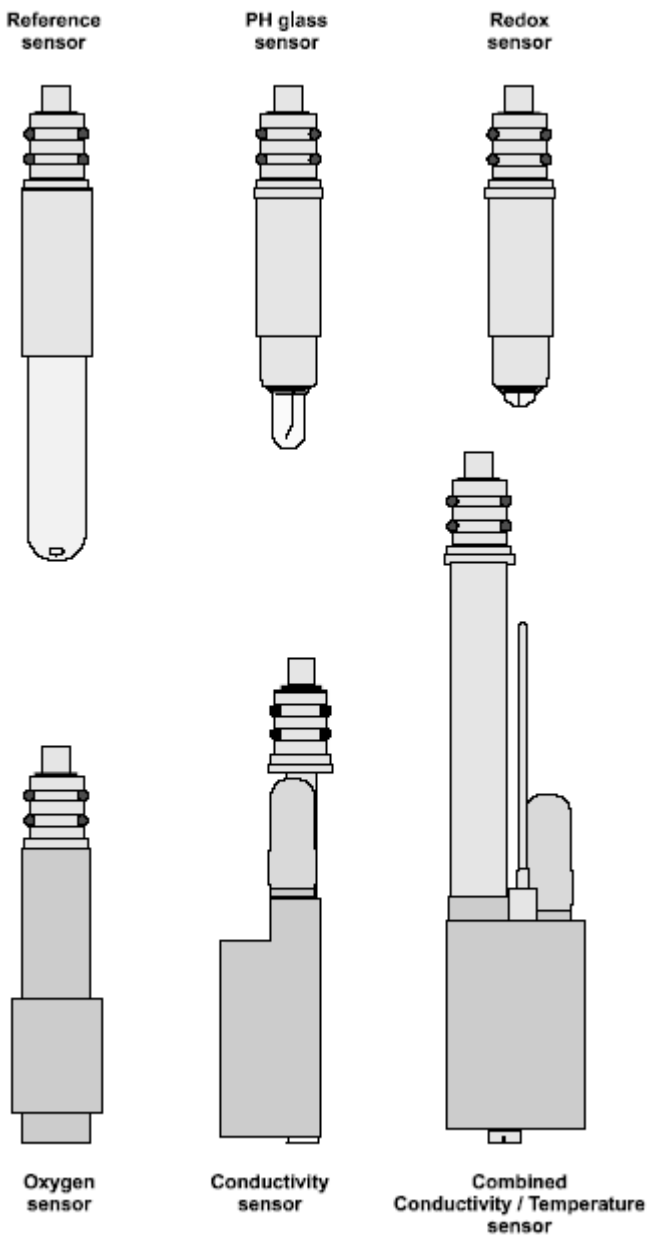


Figure 2-1 *Sensor view*

Pressure

A high quality pressure sensor is integrated. It is centrally mounted on the probe base and is capable of generating a linear signal output.

Temperature

The temperature sensor consists of a platinum resistance thermometer (Pt 100) fitted on a stainless steel housing. The sensor has a very low time response (50ms) and a high stability reading with ageing.

Conductivity

The conductivity sensor is a flow through cell with 7 platinum ring electrodes. The cell is mounted on a special cylindrical plastic body that guarantees thermic insulation and is filled with silicone oil. A rubber bellow is also integrated to achieve pressure compensation (for the 7000 dbar conductivity sensor version).

Oxygen sensor

The oxygen sensor is a polarographic type and consists of 2 half cells, the anode and the cathode. The anode is a silver tube that encircles a glass body where a platinum wire, the cathode, is sealed. The cathode ends at the tip of the sensor where the glass body is rounded. A special cap with a gas-permeable replaceable membrane screws onto the sensor. The inside of the cap is filled with an electrolyte which allows the measuring current to flow between the anode and the cathode. The anode acts as a reference cell, providing a constant potential with respect to the cathode.

The cathode, where oxygen is consumed or reduced, is separated from the sensor to be analysed by a thin layer of electrolyte and a special composite membrane.

Reference and pH sensors

The reference sensor is a Silver/Silver Chloride cell in a saturated potassium chloride solid gel. The contact with the solution to measure is made by means of a small hole drilled in the glass tip. The body of the reference sensor is made of stainless steel. The glass tip of the sensor is covered with a soft silicone rubber protective cap filled with a special solution. **This cap must be removed before using the probe.**

The pH sensor has a Titanium body and a pH sensitive glass tip. During storage, the glass tip is fitted with a plastic cap filled with a pH7 buffer solution to prevent any dehydration. **This cap must be removed before using the probe.**

Redox sensor

The redox sensor measures the oxydation reduction potential of the redox couples present in the medium. The sensor itself consists of a platinum wire that ends at the tip of the sensor where the glass body is rounded.

BSS-02B

Borehole Magnetic Susceptibility Sonde

Innovation in Magnetic Measuring Instruments

Bartington® Instruments

BSS-02B Borehole Magnetic Susceptibility Sonde

The BSS-02B is a borehole probe for measurement of magnetic susceptibility from 10^{-5} to 10^{-1} cgs. It is calibrated for 50mm diameter boreholes up to +90°C, and is able to operate at depths of up to 6000 metres over a temperature range of ambient to +120°C. The sonde can resolve strata as thin as 25mm, and will display a double response for layers thinner than 20mm.

The sonde comprises two sections: an aluminium alloy cylindrical enclosure containing electronic circuitry, and a high strength, non-magnetic enclosure in which the detector is located. The electronics enclosure must be surrounded by a pressure enclosure; this is usually provided by the client, to fit the rest of their system.

The sonde operates from an unregulated 15V nominal supply. It provides an output in the form of a three-wire CMOS serial interface (for integration into the client's data acquisition system), and a single wire pulse rate output for use with rate meters and counters.

Features

- Wide measuring range: 10^{-5} to 10^{-1} cgs
- Low operating frequency: 1.36kHz
- Good vertical resolution: 25mm with dual coil system
- Operates to pressures of 10000 psi maximum
- Operates to temperatures of 120°C: calibrated to 90°C
- Fast: logs at up to 21 readings per second
- High spatial resolution: will resolve strata down to 25mm
- Low temperature induced drift: <20 x 10^{-5} cgs over the calibrated temperature range ambient to 90°C.

Typical applications

- Mineral prospecting, including discrimination of kimberlites, iron ore and uranium ore
- Stratigraphic correlation
- Delineation of alteration fronts
- Delineation of strata of economic interest and evaluation of the ore's grade

BSS-02B Specifications

Performance		
Max operating pressure	10,000 psi	
Maximum stratigraphic (spatial resolution) Note: below 20mm a small double response will be recorded.	25mm F.W.H.M. (Full-Width-Half-Maximum)	
Calibration	Calibrated to read directly 1 x 10^{-5} cgs units in a 50mm borehole	
Diameter effect (relative to 25mm layer normalised to a 50mm diameter borehole)		
Borehole ø(mm) 70 80 100	Response centralised 0.75 0.275 0.09	Response decentralised 0.725 0.5 0.45
Temperature induced drift Baseline Scaling	 <20 x 10^{-5} cgs from 20°C to 90°C <1.0% full scale	
Max operating temperature	120°C	
Pressure induced baseline drift	Typ. -5.5 x 10^{-5} cgs	
Sensing coil type Overall length Separation Diameter Distance from nose to centre of detection	Focused dual coil 97mm 27mm 35mm 190mm	
Principle of operation discrimination:	AC induction by frequency	
Operating frequency	1.36 kHz	
Power supply rejection ratio	Not measurable	

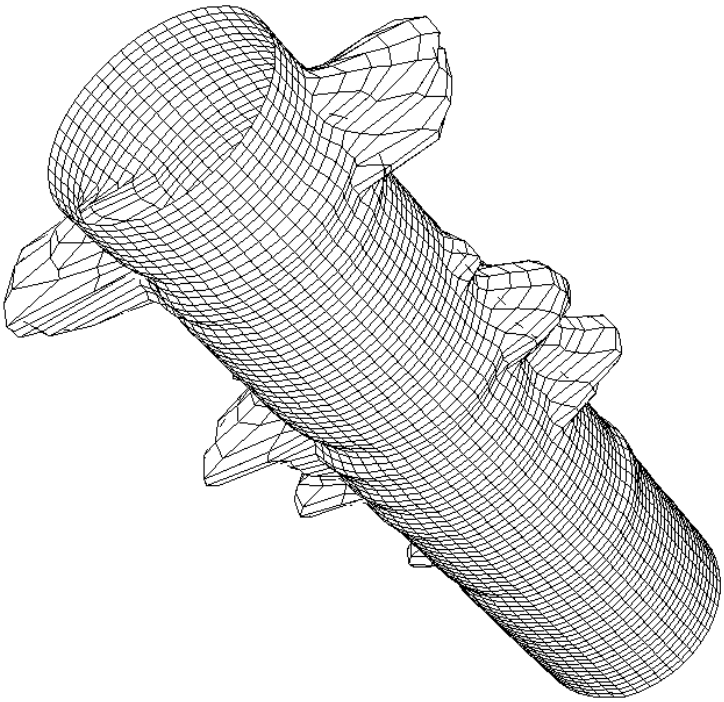
Mechanical	
Construction - Non-magnetic enclosure - Pressure barrel	PEEK enclosure Supplied by user
Overall length of sonde (mm)	720 (-1=735)
Weight in air (g)	815
Seals - Pressure barrel to mid-adaptor - Mid-adaptor to PEEK barrel - PEEK barrel to nose	2 Viton "O" rings BS 216 1 Viton "O" ring BS 126 "O" ring BS 126
Mating threads - BSS02B-1* - BSS02B-2 - BSS02B-3	1.375[INCH]-18 WHIT FORM 1.375[INCH]-12UNF-3A 1.375[INCH]-16UN
Pressure compensation	Piston
Volume of silicone oil	155ml

Note: the sensor coil is housed in a pressure compensated, thin walled cylinder to achieve optimum magnetic coupling to the borehole wall. This cylinder is sufficiently robust for down-hole operation but can be damaged if it is subjected to excessive shock through dropping or strain through bending.

* BSS-02B-1 is chamfered to provide a smooth step down to a Ø38mm outer pipe.

Electrical	
Power requirements	+14 to +18Vd.c.at 32mA
Input connection	300mm of 6-core PTFE coated leads
Connector type	None
Interface	Three-wire 5V CMOS serial interface and single wire pulse rate output, all ESD protected
Pulse Rate Output	
A pulse of approximately 50µs width is output at a rate which is proportional to the current measurement. Refresh time is 47.5ms but will extend by 0.2ms for every 1000 units of measurement. Maximum output is 16000cps.	
Digital Data Output	
The /Ready signal goes low for a period of 10ms when the conversion has been completed and bit 24 (MSB) is present on the SDO Line. The minimum repetition period of /Ready is 47.5ms in air but will extend by 0.2ms for every 1000 units of measurement. Each low to high transition of Clock In will cause the next bit to be placed on the SDO line. Data can be conveniently clocked into the external interface on high to low transitions of Clock In. Minimum clock pulse width is 0.5µs. Data are presented as 24 bits with the MSB first.	
Calibration	
The system is scaled to a change of one least significant bit = 1 x 10^{-5} cgs units. (One measurement unit.) A residual value of circa 1000 accommodates negative values and ageing effects. Departure from linear response will be:	
Range x 10^{-5} cgs 1-1000 1000-10,000 10,000-100,000	**Error %** 0 to -0.9 -0.9 to -9.0 -9.0 to –50
To calculate true value of K: K x 10^{-5} cgs = $(R + R^2 / 10^5)$ x 10^{-5} cgs where R is the measured value.	

Calibration block	
Dimensions of cylinder	Overall diameter 110mm Length 100mm
Bore	44mm
Weight	1.13kg
Calibration value	(as marked)
Temperature coefficient	+0.05% / °C
Note: To simulate groundwater effects the calibrator should be grounded via hand contact. This will depress the measured value by approximately -15 x 10^{-5} cgs.	



User Guide

QL40 CAL – 3 Arm Caliper

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1.1 Dimensions

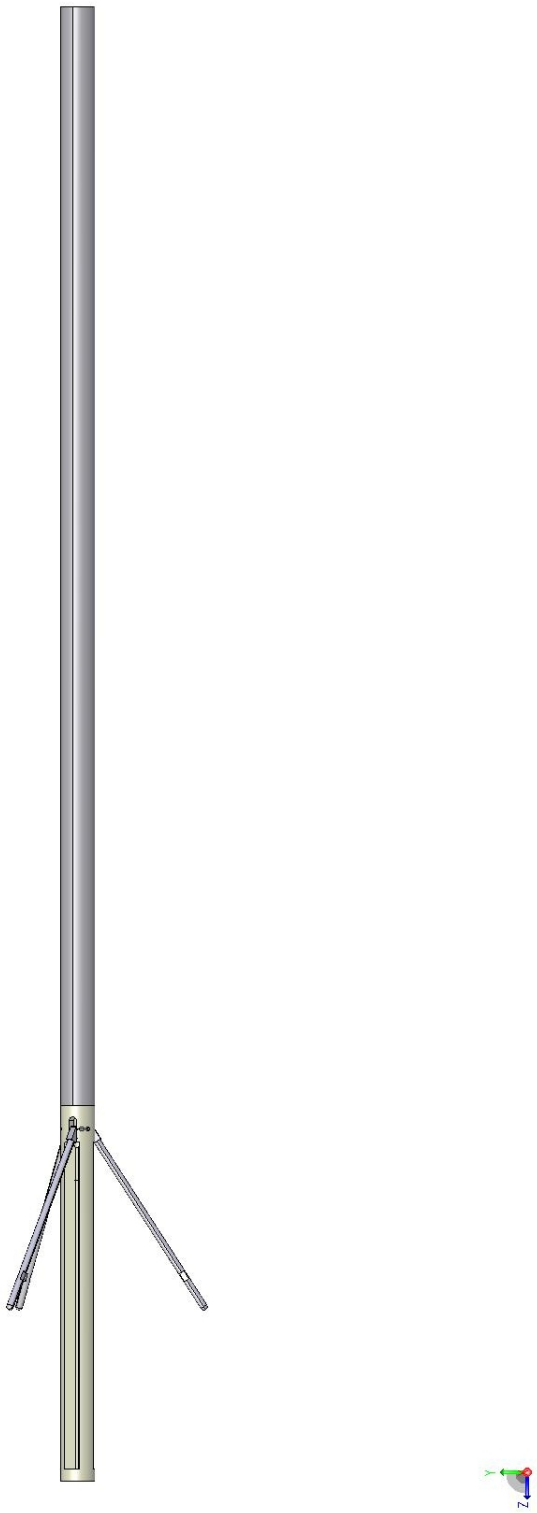


Figure 1-1 *QL40 CAL Dimensions*

1.2 Technical Specification

Tool

Diameter:	Max 42.3mm (1.67”)
Length:	1.785m (70.28”)
Measurement point:	0.2m up from bottom of locking ring at the tip of the closed, short caliper arms
Weight:	10kg (22lbs)
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

Measurement:

Standard arms:	57.2mm to 406mm 2.25” to 16”
Extended arms:	300mm to 736mm 12” to 30”

Power:

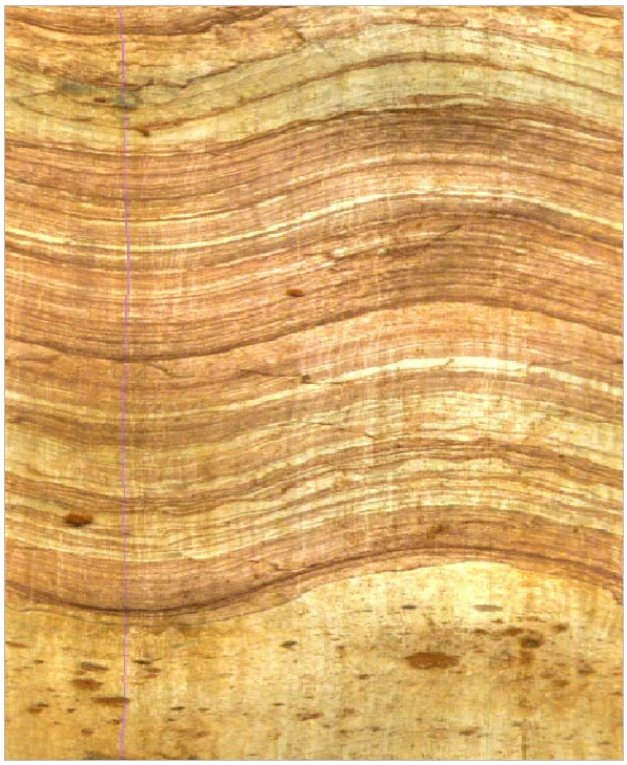
DC voltage at probe top:	Min 80 VDC Max 160 VDC Nominal 120 VDC
Current:	Nominal 25mA

Figure 1-2 *QL40 CAL 3-arm caliper probe*

2 Measurement Principle

The caliper measurement is made with three arms attached to a mechanical assembly which drives a linear potentiometer. The DC output voltage from the wiper of the potentiometer is converted to a frequency linearly related to the borehole diameter. The 3 Arm Caliper data can be scaled and calibrated in inches or in centimeters.
Opening and closing of the caliper arms is surface controlled from the LoggerSuite application allowing the probe to be run into the borehole with the arms closed. Once positioned at the bottom of the borehole, and caliper arms opened, the spring-loaded arms respond to borehole diameter variations as the probe is moved up the borehole.

The QL40 CAL is supplied with two sets of arms. The standard arms are suitable for a borehole diameter ranging from 57 mm to 406 mm. The extension arms are suitable for borehole diameters up to 736mm. The caliper arms can be unscrewed from their short pivot arms and may be replaced with ones of different length. The hardened arm wear tips can be unscrewed and are easily replaced.



User Guide

QL40 OBI and **OBI40** Optical Borehole Imager

Advanced Logic Technology

1.1 Dimensions

Figure 1-1 *QL40 OBI and OBI40 overview*

1.2 Technical Specification

Tool

Diameter:	Max 42mm (1.65”)	
Length:	QL40 OBI:	1.228m (48.35”)
	OBI40:	1.577m (62.06”)
Sensor position::	40mm (1.57”) from the bottom	
Measurement range:	0.05m (2”) to 0.53m (21”) depending on water and borehole conditions	
Weight:	QL40 OBI:	4.9kg (11 lbs)
	OBI40:	5.9kg (13 lbs)
Max. Temp:	50°C (122°F)	
Max.Pressure:	200bar	

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
Software requirements:	Min. LoggerSuite 11.0 and WellCAD 4.3 build 2319

Optical Sensors

Camera:	DSP based digital CCD Camera
Azimuthal resolution:	User defined 90, 180, 360 or 720 pixels over 360°
Vertical resolution:	User defined (function of encoder resolution) depth and time sampling modes available
Color resolution:	24 bit RGB values
White balance:	Automatic or user adjustable
Aperture & Shutter:	Automatic or user adjustable
Special functions:	Triangular RGB diagram for colour calibration, gamma correction, sharpness

Orientation Sensor

Sensor:	APS544
Location:	QL40 OBI: Middle point of sensor located at 0.97m OBI40: Middle point of sensor located at 1.284m from tool bottom
Orientation:	3 axis magnetometer, 3 accelerometers
Inclination accuracy:	+/- 0.5 degree
Azimuth accuracy:	+/- 1.2 degree

2 Measurement Principle

The OBI incorporates a high resolution, high sensitivity CCD digital camera with matching Pentax optics. The CCD camera, located above a conical mirror, captures the reflection of the borehole wall. The light source is provided by a light ring assembly located in the optical head (Figure 2-1).

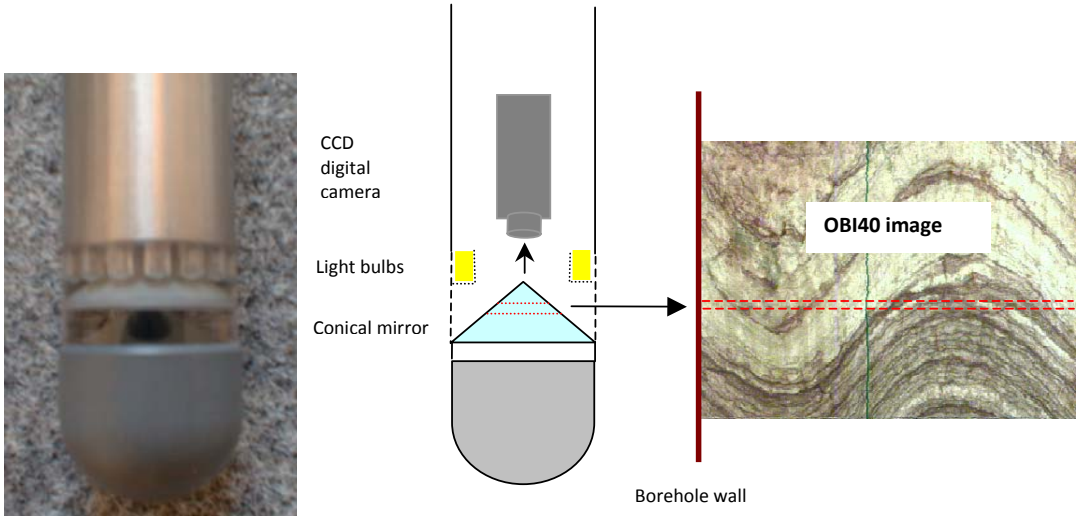
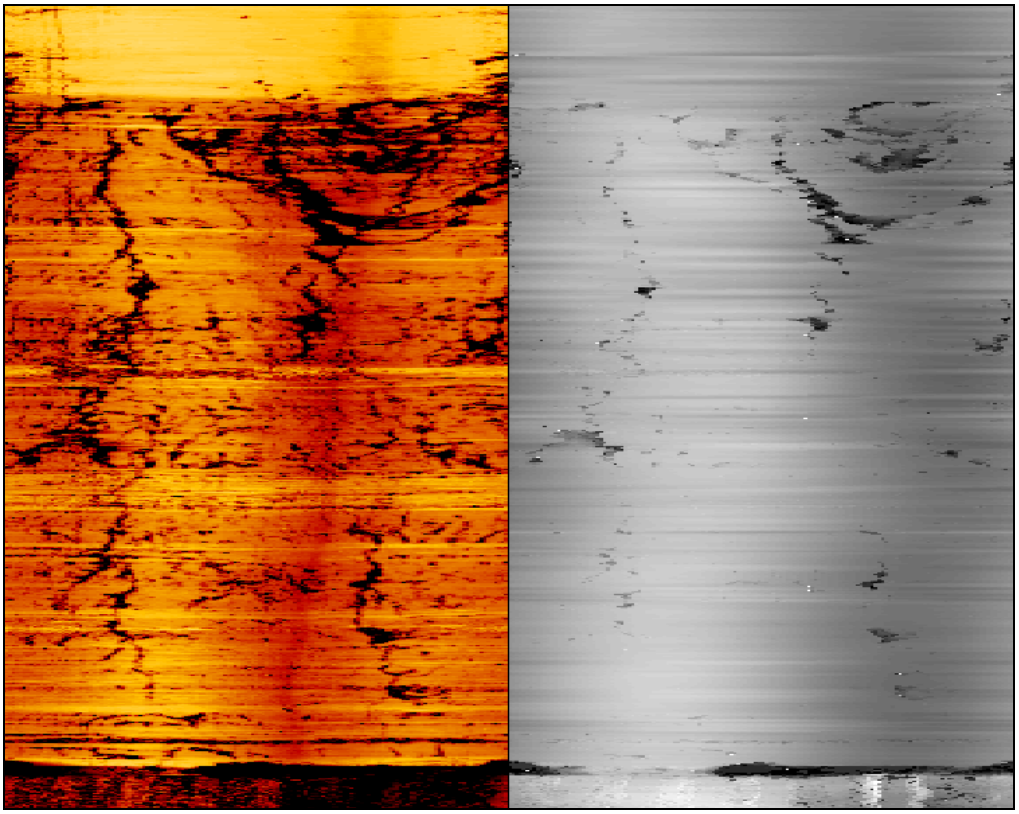


Figure 2-1 *Optical assembly*

The camera CCD sensor consists of an array of light sensors, each representing one pixel of the complete image. Due to manufacturing limitations individual sensors have a slightly different response and calibration factor. To produce a coherent image the camera processing system checks all the pixels and compensates for variations (white balance). The displayed log image is derived from a single annulus extracted from the total pixel array (Figure 2-1). Azimuthal resolutions available are 720, 360, 180 and 90 points per recorded circle.
By using processed camera data in combination with deviation sensor data, the tool can generate an unwrapped 360° oriented image.



User Guide

QL40 ABI and **ABI40** Acoustical Borehole Imager

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1.2 Dimensions

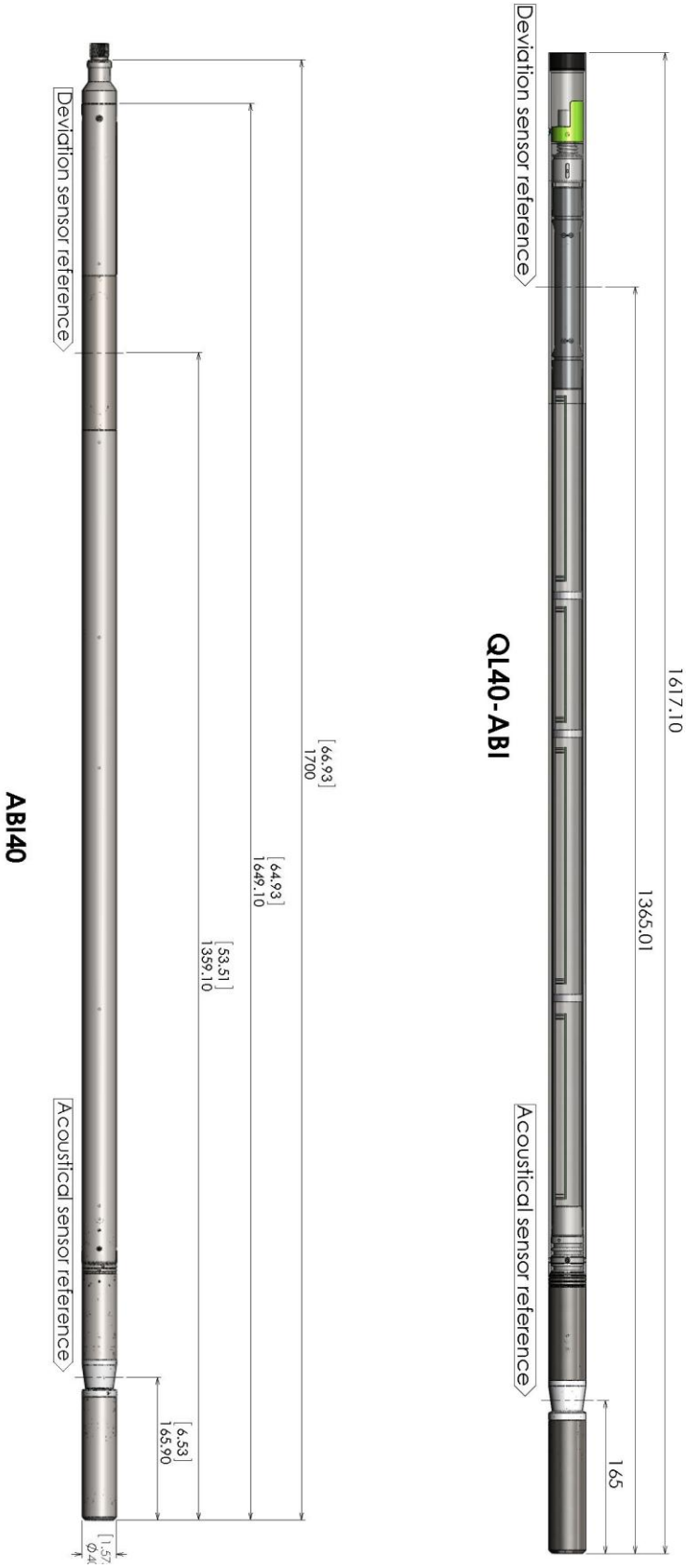


Figure 1-1 *ABI40 and QL40-ABI dimensions*

1.3 Technical Specification

Tool

Diameter:	40mm	
Length:	QL40 ABI:	1.61m (63”)
	ABI40:	1.70m (66”)
Measurement point:	0.165m (from probe bottom)	
Weight:	QL40 ABI:	6.7 kg (14 .7 lbs)
	ABI40:	7.0 kg (15.4 lbs)
Max. Temp:	70°C	
Max.Pressure:	200bar	

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

Acoustic sensor:

Figure 1-2 *Acoustic head*

Acoustic sensor:	Fixed transducer and rotating focusing mirror
Measurement range[1]:	2.5” – 20” (64mm-500mm)
Focusing diameter[2]:	6” (152mm)
Frequency:	1.2 Mhz
Acoustic beam width:	1.5 mm (at focal point)
Rotation speed:	Up to 12 revolutions per second - automatic
Azimuthal resolution:	72, 144, 288 operator defined
Caliper resolution:	0.08mm

Orientation sensor:

Sensor:	APS544
Location:	Middle point of sensor located at 1.365 m from tool bottom
Orientation:	3 axis magnetometer, 3 accelerometers
Inclination accuracy:	0.5 degree
Azimuth accuracy:	1.2 degree

[1] Diameter range of the hole in which the measurement is possible (depends on borehole conditions).
[2] Diameter of the hole where the focusing of the acoustical beam is optimum.

2 Measurement Principle

An understanding of the basic principles of operation of the televiewer is essential for successful use of the tool. The ABI produces images of the borehole wall which are based on the amplitude and time of travel of an ultrasonic beam reflected from the formation wall. The ultrasonic energy wave is generated by a specially designed piezoelectric ceramic crystal and has a frequency of around 1.2MHz. On triggering, an acoustic energy wave is emitted by the transducer and travels through the acoustic head and borehole fluid until it reaches the interface between the borehole fluid and the borehole wall. Here a part of the beam energy is reflected back to the sensor, the remainder continuing on into the formation medium at a changed velocity (Figure 2-1). By careful time sequencing the piezoelectric transducer acts as both transmitter of the ultrasonic pulse and receiver of the reflected wave. The travel time for the energy wave is the period between transmission of the source energy pulse and the return of the reflected wave measured at the point of maximum wave amplitude. The magnitude of the wave energy is measured in dB, a unit less ratio of the detected echo wave amplitude divided by the amplitude of the transmitted wave.

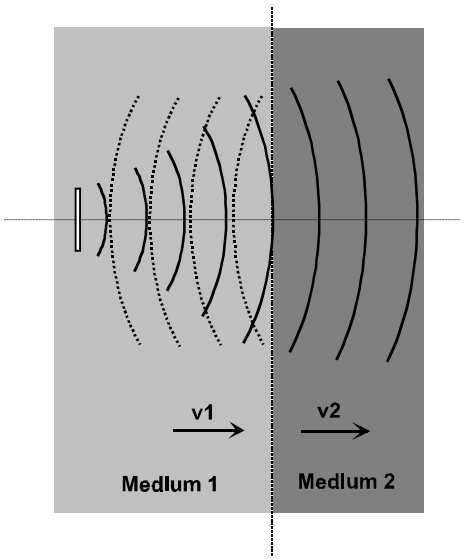


Figure 2-1 *Wave propagation*

2.1 Reflection coefficient

The strength of the reflected signal depends principally on the impedance contrast between the borehole fluid and the formation (Figure 2-1).
The reflection coefficient *r* is given by the following equation:
$r = (\rho_b v_b - \rho_m v_m) / (\rho_b v_b + \rho_m v_m)$

where ρ_b = density of formation
ρ_m = density of borehole fluid
v_b = velocity of sound of formation
v_m = velocity of sound of borehole fluid

The larger the reflection coefficient is the greater is the signal reflection and thus the ability to detect the signal. From the equation above it may be seen that when the properties of the borehole fluid and borehole wall are similar, i.e. $\rho_b v_b \approx \rho_m v_m$, the reflection coefficient *r* approaches zero and there is negligible reflection. In this situation determination of the true reflected wave is made more difficult.

2.2 Acoustic head operation

The acoustic wave is generated by applying a high voltage pulse across the two faces of a piezo ceramic disc. The applied voltage causes deformation within the crystal structure, either an expansion or contraction depending on the polarity of the applied voltage, with a resultant energy wave emitted normal to the free surface. It has been shown that the beam generated by this process has a maximum energy at a distance of twice the diameter of the disc and that after this point the beam tends to diverge. In order to optimize the beam energy at the point of investigation the ALT televiewer head has been designed as illustrated below (Figure 2-2).

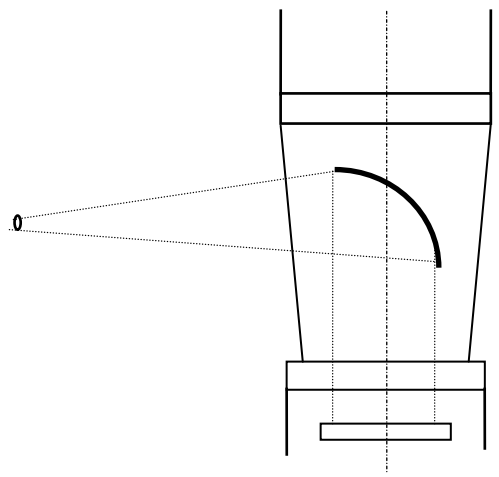


Figure 2-2 *Focussing arrangement*

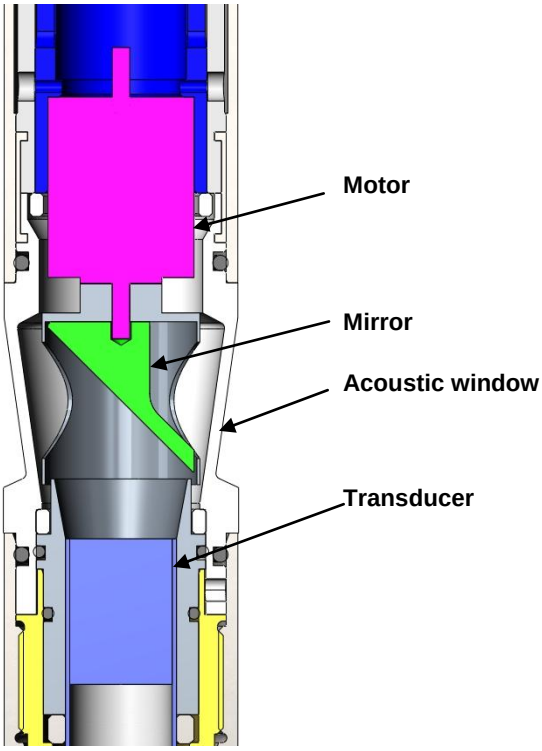
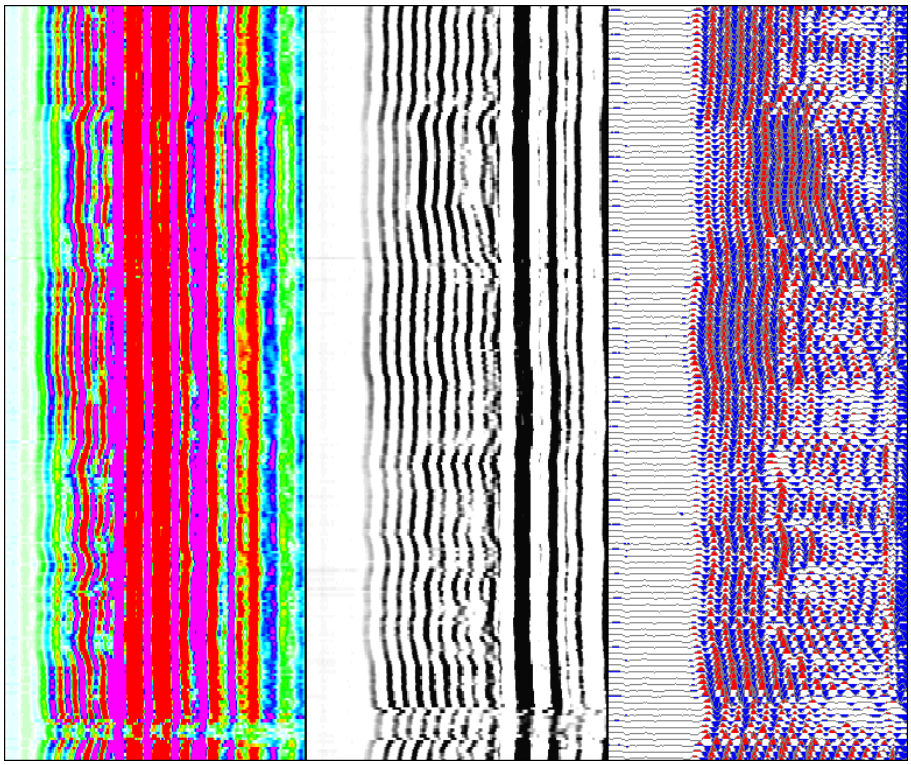


Figure 2-3 *ABI acoustic head architecture*

The acoustic wave propagates along the axis of the tool body and is then reflected perpendicular to this axis by a special reflector that focuses the beam to a high-energy point of +/- 1.5 mm diameter. The radial distance of the focal point from the axis of the tool is determined by the focal length of the mirror, +/- 75mm (for an acoustic head with a 6” focusing mirror).
The frequency of the transmitted wave is determined amongst other factors such as ceramic composition by the diameter of the piezo transducer, a smaller diameter giving a higher frequency. The ALT televiewer operates around 1.2MHz.

The reflector is mounted on the drive shaft of a stepper motor. This enables the position of measurement to be rotated through 360°. Sampling rates of 72, 144 and 288 measured points per revolution are available, thus at maximum resolution a near continuous image of the borehole wall is made. The higher sampling rate can be used for better resolution in larger diameter boreholes but is less useful in small diameters due to overlap of the sampling points.



User Guide

QL40 FWS – Full Waveform Sonic

Advanced Logic Technology

1.1 Dimensions

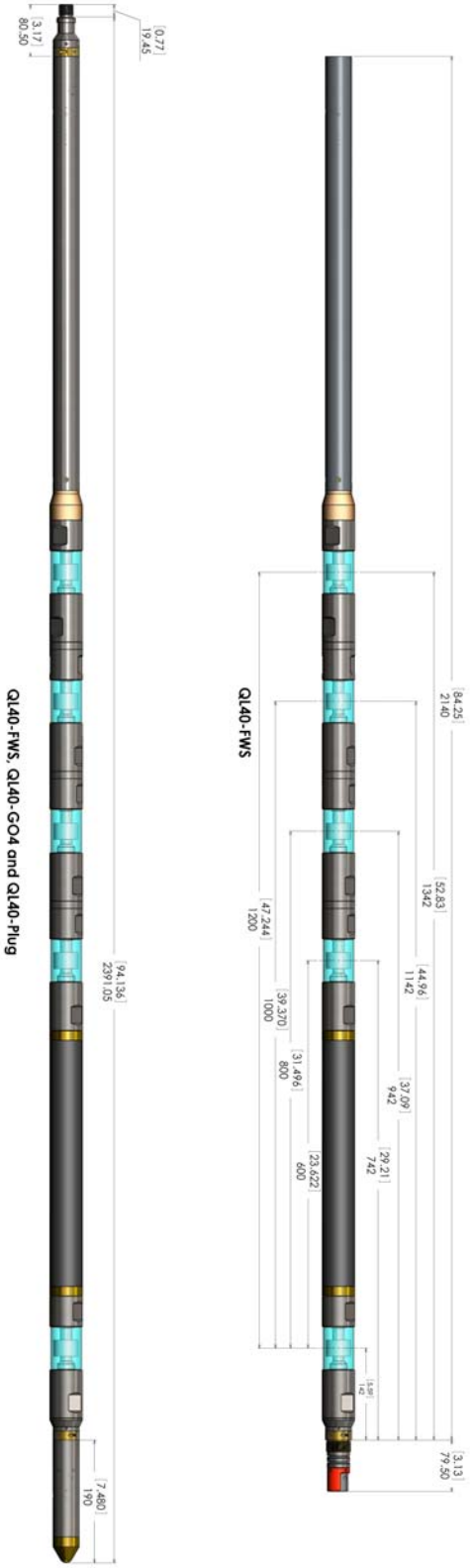


Figure 1-1 *QL40-FWS dimensions*

1.2 Technical Specification

Tool

Diameter:	Max 50mm
Length:	Standard configuration: 1TX – 4RX @ 0.2m RX separation : 2.14m
Weight:	18Kg
Measurement point:	Transmitter location
Max. Temp:	70°C
Max.Pressure:	200bar

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

Sensors:

Transducers:	Ceramic piezoelectric with 6 KHz resonant frequency
Sonic Wave Sampling Rate:	Normal Mode: 4 µs Extended Mode: 20 µs
Sonic Wave Dynamic Range:	16 bits
Sonic Wave Sample Length:	Normal Mode: up to 4 ms Extended Mode: up to 16 ms

2 Measurement Principle

The QL40-FWS tool measures the time it takes for a sound pulse to travel from a piezo electric transmitter to a receiver at a defined distance. Transmitter and receiver are mounted on the same tool. The acoustic pulse generated by the transducer travels through borehole fluid and rock in various different forms while undergoing dispersion and attenuation.
When part of the energy of the emitted sound pulse arrives at a receiver it does so at different time and in the form of different types of waves (**Figure 2-1**).

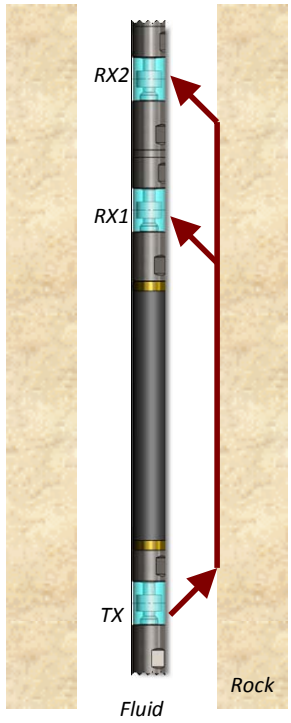


Figure 2-1 *Typical wave path for a 1 transmitter and 2 receiver tool*

Usually it is the compressional wave (P-wave) that travelled through the rock (or pipe) that arrives first followed by shear waves (S-wave), Rayleigh, Stoneley and mud waves. **Figure 2-2** shows a typical sonic trace with received wave forms.

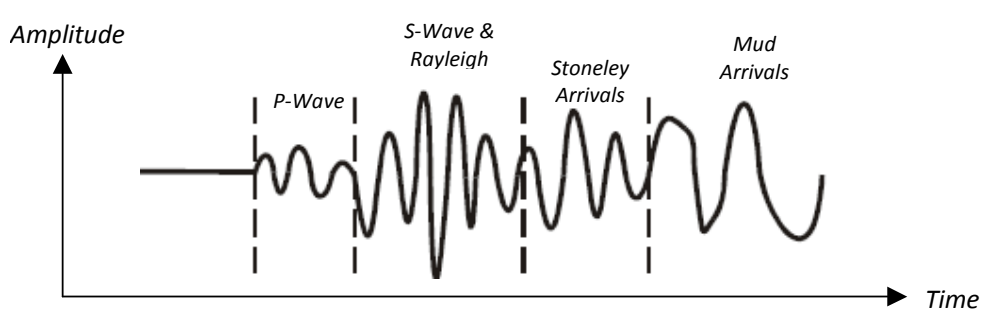


Figure 2-2 *Typical sonic trace with wave form arrivals*

The P-wave is usually the fastest wave but has small amplitudes. The next wave to arrive is the S-wave, which is slower than the P-wave but usually has higher amplitudes. After them come Rayleigh and Stoneley waves, which are associated with energy moving along the borehole wall. The last arrival (mud wave) is a pressure wave that travels through the borehole fluid in the borehole. They can be of high amplitude but always arrive after the two main waves – P- and S-wave.

In cased wells common application of the sonic tool is the measurement of the degree of cementation of steel casing. It is generally called “Cement Bond Logging”.
It is often important to know how much cement is present in the annulus between casing and formation. The sonic tool is used to measure whether there is cement in contact with the outside of the casing and whether that cement is in contact with the formation.
This can be achieved by measuring the amplitude of the first compressional arrival. Just one transmitter and one receiver is needed for this. The amplitude of the first arrival is linked to the amount of cement bonded to the casing. If there is no cement outside the casing, the sonic wave will travel almost entirely along the casing and return to the receiver with a high amplitude. If there is good, solid cement outside the casing, a large proportion of the sonic wave will be refracted into the cement and formation. The amount of energy returning to the receiver will be less and corresponds to a low amplitude of the first compressional arrival.

QL40-SFM
QL40 – Spinner Flow Meter
Probe Sub

Advanced Logic Technology s.à,

Mount Sopris Instrument Co., Inc.

Advanced Logic Technology s.à, Bâtiment A, route de Niederpallen, L-8506 Redange sur Attert, Grand Duchy of Luxembourg.

Mount Sopris Instruments 4975 E. 41st Ave. Denver CO 80216 USA

December, 2012

QL40-SFM

The QL40-SFM sub provides borehole flow measurements. The QL40-SFM can be operated as a stand-alone probe or can be stacked below another sub on a MATRIX logging system. The QL40-SFM must be the bottom most sub in a stacked string. 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 this 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.

Flow Measurements

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.

QL40 SFM Specifications:

Power Requirements

DC voltage at probe top: MIN. 80VDC MAX. 160VDC Nominal 120VDC
Current 38 mA nominal

Sonde Measurements

Range	Pickup sensor 3000 RPM Max
Accuracy	better than 1%
Resolution	256 ppr
Output Displayed	Counts Per Second

Operating temperature range

32 to 158 degrees F 0 to 80 degrees C

Pressure rating

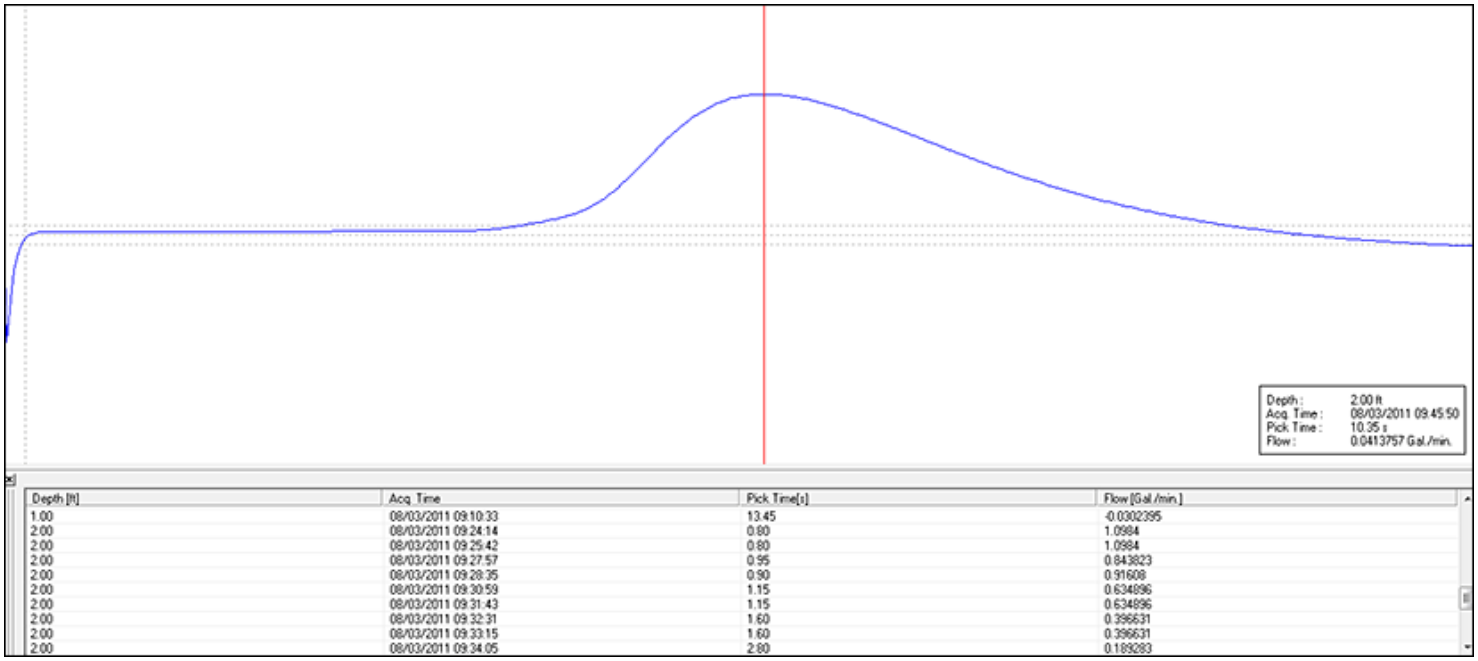
2900 psi 200 bars

Dimensions

Length	35.4 inches	0.9m
Diameter		
Probe Body	1.57 inches	40 mm
3.0” Cage	3.0 inches	76.2mm
4.0” Cage	4.0 inches	101.6mm
Weight	7.2 lbs	3.25 kg

HFP-2293 Heat Pulse Flowmeter

mountsopris.com/items/hfp-2293-heat-pulse-flowmeter/



Depth [ft]	Acq. Time	Pick Time[s]	Flow [Gal./min.]
1.00	08/03/2011 09:10:33	13.45	-0.0302395
2.00	08/03/2011 09:24:14	0.80	1.0984
2.00	08/03/2011 09:25:42	0.80	1.0984
2.00	08/03/2011 09:27:57	0.95	0.843823
2.00	08/03/2011 09:28:35	0.90	0.91608
2.00	08/03/2011 09:30:59	1.15	0.634896
2.00	08/03/2011 09:31:43	1.15	0.634896
2.00	08/03/2011 09:32:31	1.60	0.396631
2.00	08/03/2011 09:33:15	1.60	0.396631
2.00	08/03/2011 09:34:05	2.80	0.189283

Description

The HFP-2293 Heat Pulse Flowmeter is a unique flowmeter tool designed to measure low flow rates in the borehole environment. It will also give the direction of the flow of fluid vertically. To detect these low flow rates, measurements must be made while the probe is stationary at different depths within the borehole. The probe is run standalone.

Matrix Heat software is used with the HFP-2293 and is compatible Matrix Logging Systems. Individual heat-flow waveforms can be saved, and text files with depth and flow rate can be imported into WellCAD for a histogram-type presentation.

Applications

- Measure interval and/or fracture-specific low flow rates
- Identification of hydrostratigraphic units
- Determine transmissivity and hydraulic head
- Confirmation of predicted transmissive zones in open hole

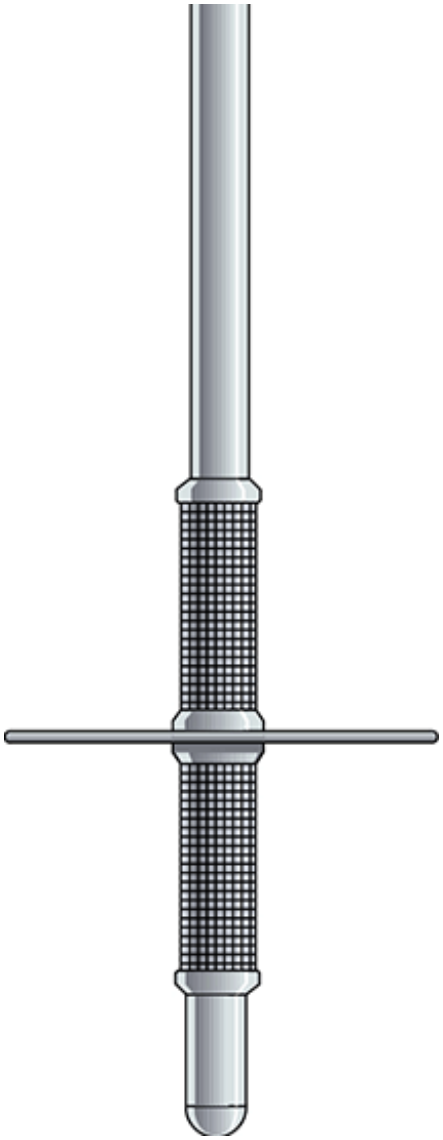
Operating Conditions

Borehole Fluid
[X] Water
[_] Mud

[_] Dry

Casing
[X] Uncased
[X] PVC Borehole
[X] Steel

Centralization
[X] Required
[_] Non-Necessary



Features & Benefits

- Designed by the USGS, industry standard tool for use in very low flow zones.
- Supplied with diverters for 4”, 6” & 8” (100, 150, 200mm) boreholes to provide optimum results in a variety of borehole diameters
- Includes Matrix Heat acquisition (waveform viewing & time picking) and processing software
- Slim, 41 mm diameter. One-person operation.

Specifications – Metric/English

Specification	Metric	Imperial
Diameter	41 mm	1.63″
Length	1.22 m	48″
Weight	5.5 Kg	12 lbs.
Max. Temp.	70ºC	158ºF
Max. Pressure	200 bar	2900 psi

Sensor: Two thermistors
Measuring Range: 0.113 lpm to 3.785 lpm (0.03 gpm to 1.0 gpm)
Measuring Range: 0.046 m/min to 3.962 m/min (0.15 ft/min to 13 ft/min)
Accuracy: 5% midrange to 15% extremes
Resolution: 5%

Documentation

Data Sheet
User Guide
Matrix Heat Software User Guide