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High Build Rate Logging While Drilling System (HbuildLWD) & Near-bit Azimuth Gamma Ray (NGR/AP600)

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High Build Rate Logging While Drilling System (HbuildLWD)

High Build Rate Logging While Drilling System (HbuildLWD)

① Bi-directional Communication & Power System While Drilling-High Build Rate(BCP-B)

②Pressure and Caliper Unit (PCD)

③Resistivity-High Build Rate (EPR-B)

④Azimuth & Inclination and Gamma Unit (MWD-B)

⑤ Rotary Steerable Unit (RSU)

⑥Azimuthal Resistivity Drilling (ARD)(Optional)

⑦Caliper Corrected Neutron Porosity (CCN)(Optional)

⑧Rotary Azimuthal Density (RAD) (Optional)

⑨Near-bit Azimuth Gamma Ray (NGR/AP600)

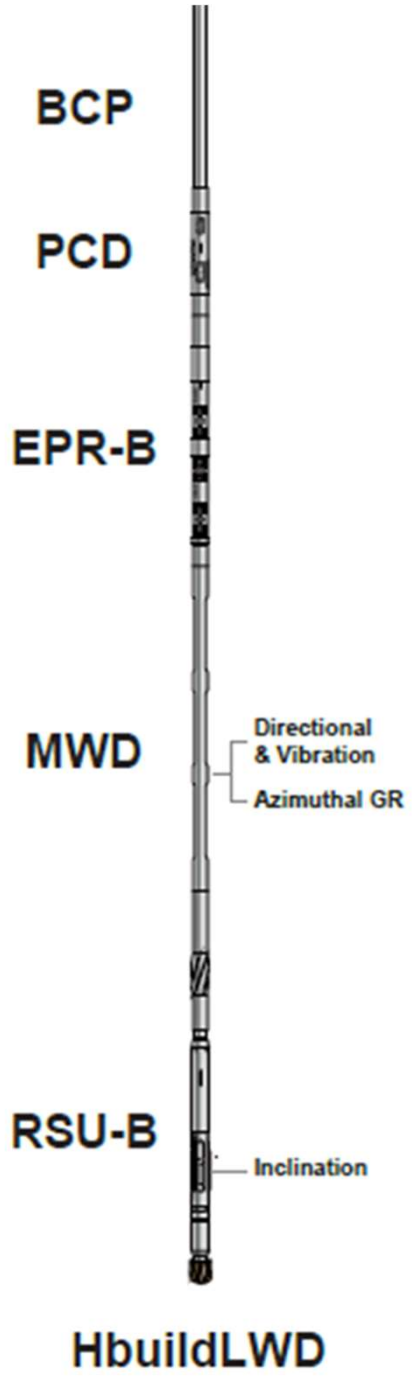
•Continuously rotating steering

•Improve borehole cleanliness

•Improve drilling time and save costs

•Avoid stuck

•High build rate: 15°/100 ft. (15°/30 m)



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High Build Rate Logging While Drilling System (HbuildLWD)

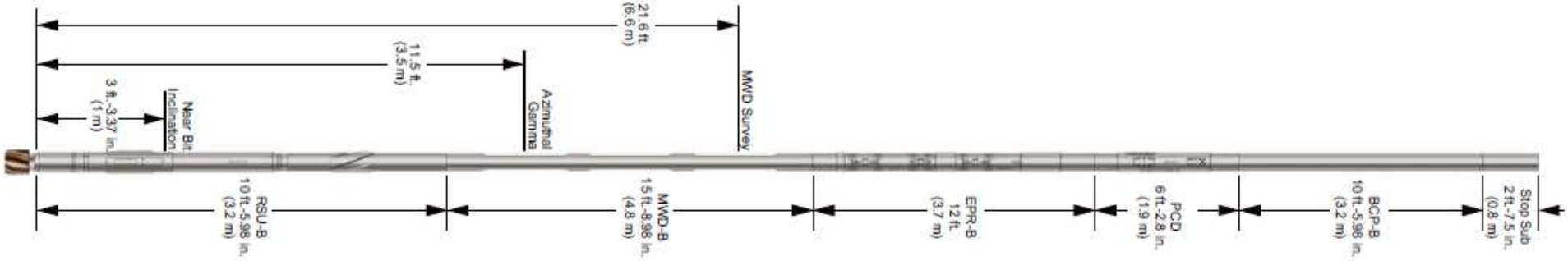
Advantages of High-Build Rate Logging-While-Drilling System (HbuildLWD):

1. High Build Rate: 4.75 in. instrument build rate is 10°/30 m, 6.75 in. instrument build rate is 15°/30 m, 9.5 in. instrument build rate is 6.5°/30 m.
2. The instrument adopts embedded mode, with different sizes of azimuth unit, resistivity and azimuth gamma unit (4.75 in., 6.75 in. and 9.5 in.) instruments are interchangeable, saving cost.
3. The independent pressure caliper unit (PCD) can measure the caliper in real time, monitor the bottom hole pressure, and ensure the safety of operation.

4.75 inch Rotary Steering Unit (RSU)

High Build Rate Logging While Drilling System (HbuildLWD) BHA

HbuildLWD the distance of sensor to bit:



Tool OD	4 3/4″	6 3/4″	9 1/2″
Hole Size	5-7/8″～ 6-3/4" (150～172 mm)	8-1/2″～9-7/8 ″ (216-251 mm)	12″～17-1/2 ″ (305-445 mm)
Build Rate	10° /30 m	15° /30 m	6.5° /30 m

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High Build Rate Logging While Drilling System (HbuildLWD) Specification

Tool OD	4 3/4″	6 3/4″	9 1/2″
Length	19.3 m	17.6 m	16.1 m
Weight	1500 kg	1850 kg	6500 kg
Hole OD	5-7/8″～ 6-3/4" (150～172 mm)	8-1/2″～10-5/8 ″ (216-251 mm)	12″～17-1/2 ″ (305-445 mm)
Connections	Up:3 1/2”IF Box Down:3 1/2”Reg Box	Up:4 1/2”IF Box Down:4 1/2”Reg Box	Up:7 5/8” Reg Box Down:7 5/8” Reg Box
Dogleg Severity	Max Rotating 10° /30 m Max Sliding 30° /30 m	Max Rotating 13° /30 m Max Sliding 20° /30 m	Max Rotating 6.5° /30 m Max Sliding 13° /30 m
Mud Flow Range	125～350 GPM	200～900 GPM	300～1600 GPM

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High Build Rate Logging While Drilling System (HbuildLWD) Specification

Maximum Temperature	300° F (150 ° C)
Maximum Pressure	20000 psi (138 MPa)
Sand Content	Maximum volume recommended<1%
Lost Circulation Material	Fine to medium nut plug
Pulsation Dampener	Recommended set to 1/3 stand pipe pressure
Data Acquisition	Mud pulse telemetry to surface and downhole memory
Telemetry Type	Positive pulse
Mud Pumps	Either duplex or triplex
Downhole RPM	± 80% maximum deviation from the mean Operating rpm (e.g., 100 rpm: Operation Range = 20-180 rpm)
Pulser Pressure Drop	Pressure drop dependent upon mud weight, flow rate, MWD tool valve gap, and data transmission rate.
Mud Filter (Uphole)	Most sizes supplied
Full Survey Transmission:	55 seconds from Pumps-On

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High Build Rate Logging While Drilling System (HbuildLWD)

The composition and working principle of the Rotary steering unit (RSU)

The rotating steering unit (RSU) part adopts push-to-type, the shell does not rotate, and the three ribs can be independently controlled. There is a gravity accelerometer in the steering head tool, which can calculate its own well inclination and high side to control the three ribs. The ground sends instructions through mud waves to transmit signals to downhole tools to control the ribs.

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High Build Rate Logging While Drilling System (HbuildLWD)

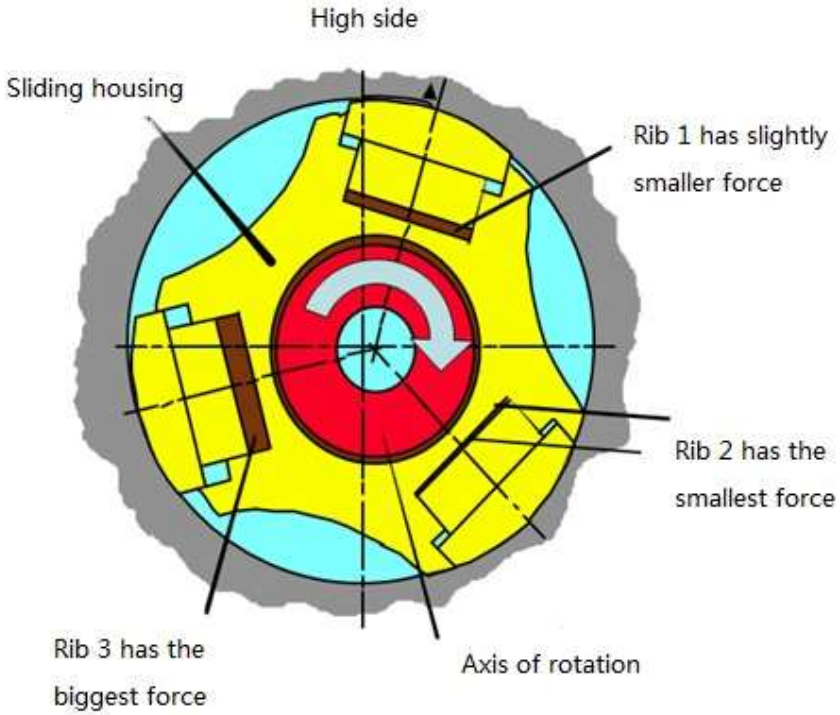
The composition and working principle of the Rotary steering unit (RSU)

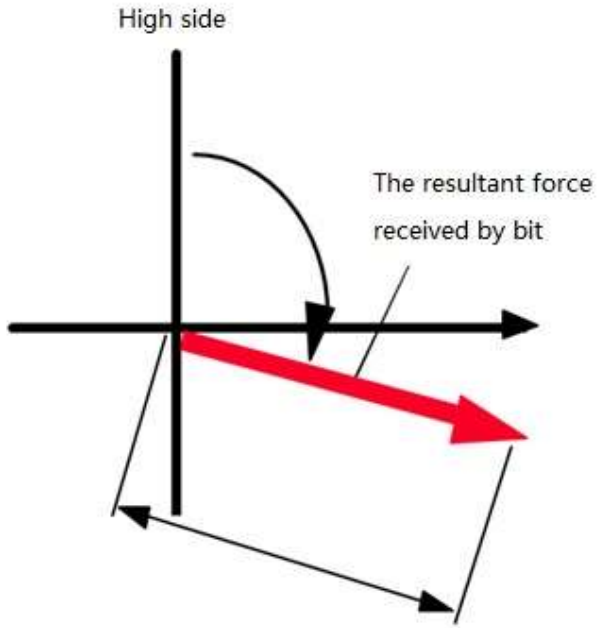
- RUS has three ribs
- Each rib has a separate hydraulic unit
- Each rib is controlled by a separate motor controller
- The ribs have two compensation holes for stable pressure
- In the ribs off mode, the reset spring plate will automatically retract the ribs(it takes about 6 minutes to retract)

High Build Rate Logging While Drilling System (HbuildLWD)

The composition and working principle of the Rotary steering unit (RSU)

The direction of the resultant force generated by the three ribs is the direction in which the bit will drill:





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High Build Rate Logging While Drilling System (HbuildLWD)

Inclination & Azimuth Unit (MWD-B) Specification :

Measurement	Range	Resolution	Accuracy
Inclination	0° - 180°	0.1°	±0.1°
Azimuth	0° - 360°	0.35°	±1.0°
Toolface Magnetic Gravity	 0° - 360° 0° - 360°	 1.4° 1.4°	 ±15° ±1.5°
Temperature	50° F - 300° F, 350° F Optional	1.1°	±2.0°
Total Magnetic Field	30,000 - 66,000 gamma	100	±200
Transmission rates	0.4 bit/s～2 bits/s Pulse Width Selectable:3.0/2.0/1.5/1.0/0.8/0.5/0.36/0.32/0.24 sec		
MTF/GTF Switching, Inclination Degrees: MTF/GTF Switching, Operator Selectable (default set at 5°) Inclination Degrees			

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High Build Rate Logging While Drilling System (HbuildLWD)

Azimuth Gamma Unit Specification:

Sensor Type:	Scintillation
Measurement:	API GR
Real Time:	Yes
Recorded:	Yes
Range:	0 - 500 API
Accuracy:	±3% of full scale
Statistical Repeatability:	±3 API @ 100 API and ROP = 60 ft/hr
Vertical Resolution:	6"

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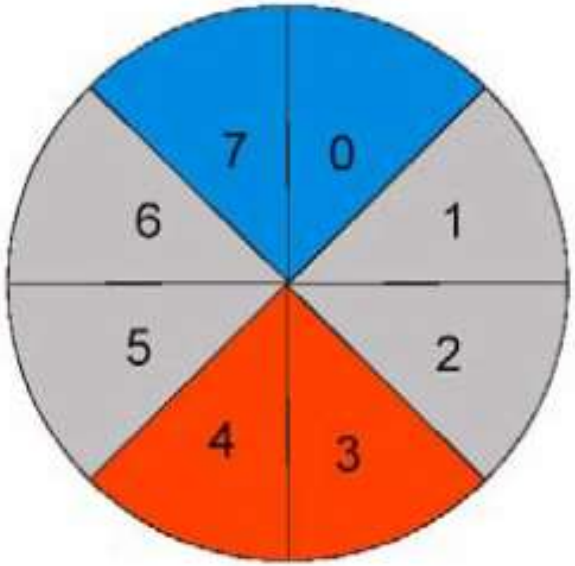
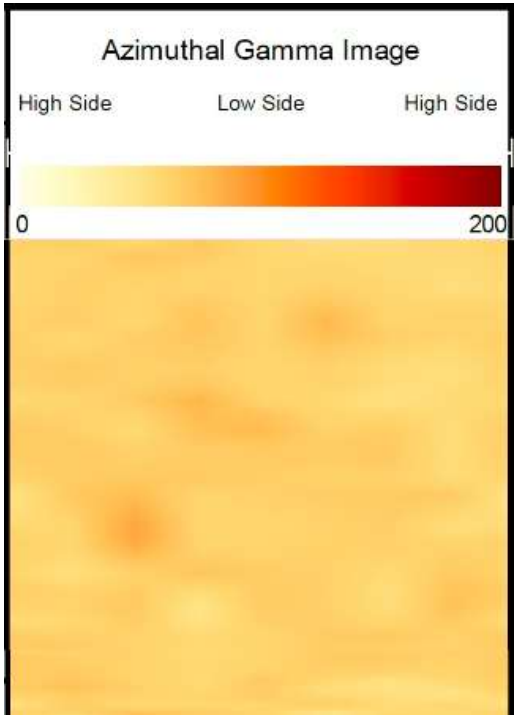
High Build Rate Logging While Drilling System (HbuildLWD)

The azimuth probe tube can instantly provide the high-side tool face angle to the circuit board of the azimuth gamma. The gamma probe can measure the gamma in all directions in real time, divide the gamma on the circle into 8 sectors by calculation, and then merge the real-time uploaded data into upper (0, 7) , lower (3, 4) , Left (5, 6), Right (1, 2) four directions according to the weight. Gamma imaging of the wellbore can be performed after software processing.





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High Build Rate Logging While Drilling System (HbuildLWD)

Electromagnetic Resistivity (EPR-B) Specification:

Max Operating Temp		300° F (150℃)	
Max Working Pressure		20000 psi (137.9 MPa)	
2 MHz	Phase Difference	Range	0.1 - 3,000 ohm-m
		Accuracy	± 1% [0.1 - 50 ohm-m]; ±0.5mmho/m [> 50 ohm-m]
	Attenuation	Range	0.1 - 500 ohm-m
		Accuracy	± 2% [0.1 - 25 ohm-m]; ±1.0mmho/m [> 25 ohm-m]
		Vertical Resolution	8in.(conductive bed)
400 kHz	Phase Difference	Range	0.1 - 1000 ohm-m
		Accuracy	± 1.0% [0.1 - 25 ohm-m]; ±1.0mmho/m [>25 ohm-m]
	Attenuation	Range	0.1 - 200 ohm-m
		Accuracy	± 5.0% [0.1 - 10 ohm-m]; ±5.0mmho/m [>10 ohm-m]
		Vertical Resolution	12in.(conductive bed)

High Build Rate Logging While Drilling System (HbuildLWD)

Advantage:

Increase Build rate, can be flexible combination, adopt insert mode, different size (4.75 "/ 6.75" / 9.5 ") instrument can share circuit, reduce the cost.

Provide

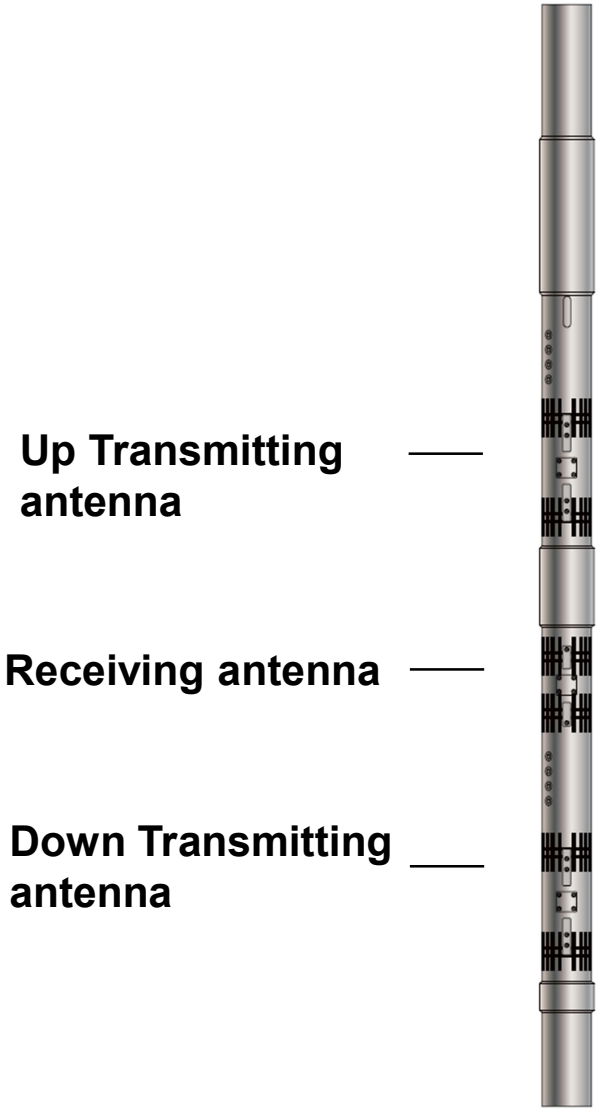
32 curves

8 compensation curves

Parameter

Applicable to all types of mud

Max Temperature 175º C



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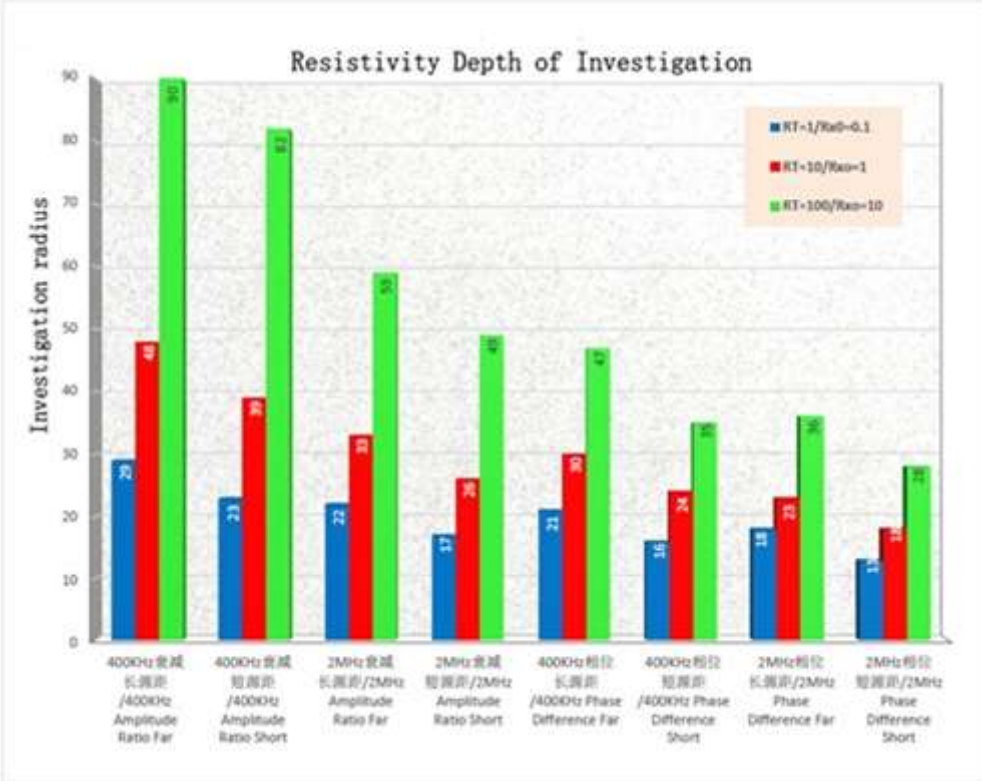
High Build Rate Logging While Drilling System (HbuildLWD)

The resistivity is composed of symmetrical four transmitting coils and two receiving coils. The transmitter is located at the two ends of the drill collar. In the middle are two receivers. The transmitter frequency is 2 MHz and 400 kHz electromagnetic waves. Through the two receivers, 4 attenuation curves and 4 compensated phase curves can be obtained after processing. The measuring depth of resistivity is shown in the figure below:



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High Build Rate Logging While Drilling System (HbuildLWD)

Pressure & Caliper Unit (PCD) Specification :

The independent pressure caliper unit (PCD) can measure the caliper in real time, monitor the bottom hole pressure, and ensure the safety of operation.

Sensor Type:	Ultrasonic detector
Measurement:	Pressure & Caliper
Real Time:	Yes
Recorded:	Yes
Pressure Range:	0 -25000 psi
Pressure Accuracy:	±0.25% of full scale
Ultra-Sonic measurement range	7.3 in.-9.3 in.(185 mm-236 mm)
Accuracy	±0.2 in.

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High Build Rate Logging While Drilling System (HbuildLWD)

Two kinds of Bi-directional Communication & Power(BCP-B)

1. Consist of the main valve, pulse, generator, rectification and processing circuit.

Advantage: Reliability and easy for maintenance, wide range flowrate

2. Consist of rotary pulser, RPA-E, alternator, rectification and processing circuit.

Advantage: Higher reliability, able to adapt to hostile mud environment

High Build Rate Logging While Drilling System (HbuildLWD)

Bi-directional Communication & Power Unit

The Bi-directional Communication & Power Unit are mainly composed of main valve, pulser, generator, rectifier and processing circuit. The main valve and pulser can transmit the data collected downhole to the ground in the form of mud pulses. The signals are collected by the pressure sensor on the ground, and then processed by the computer to visually display the data on the computer screen.

The generator is a unit that supplies power to the entire instrument string, and the mud drives the impeller of the generator to generate electricity.

Rectification and processing circuit functions: 1. Convert the three-phase alternating current output by the generator into 33 V direct current. 2. Drive the pulse generator to act. 3. Receive and decode commands from the ground up and down to the downhole tools, and conduct bi-directional communication.

High Build Rate Logging While Drilling System (HbuildLWD)

Bi-directional Communication function

Sending commands from the ground to the well is achieved by changing the size of the mud displacement. A negative pulse generator on the ground is controlled by a computer, and the bypass valve connected to the main mud pipeline on the ground is opened and closed according to a certain code. Changing the mud displacement in the well will directly cause the generator speed to change according to a certain rule. After the BCP-O downhole circuit is processed, the command issued by the ground computer can be decoded.

Furthermore, the three push arms of the rotating guide head sub-section are operated to move, thereby realizing the function of real-time guidance.

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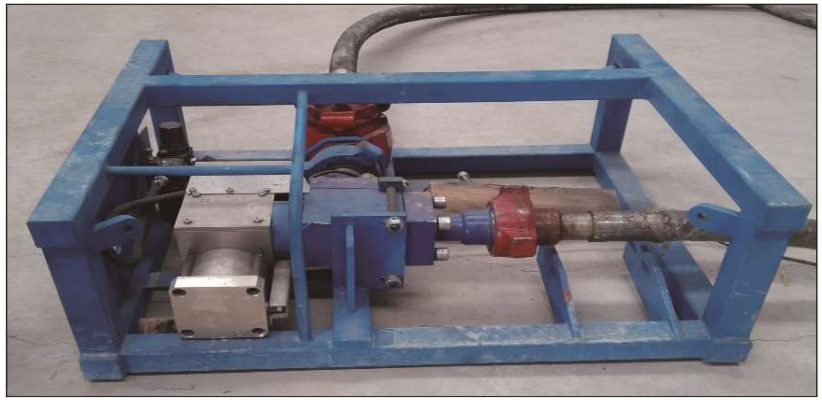
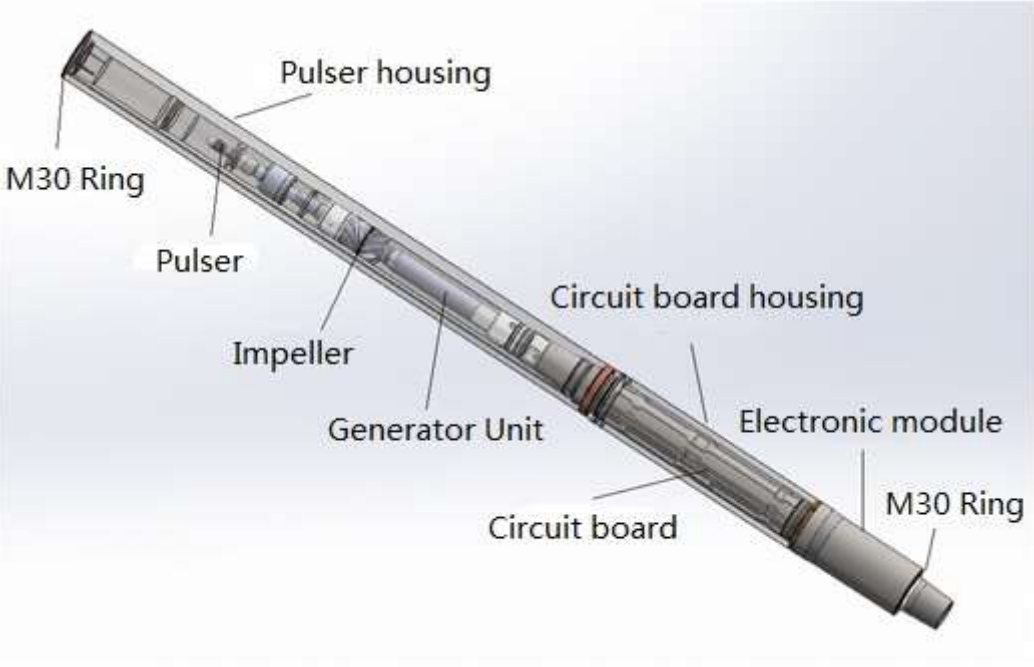
BCP & Downlink System

Bypass controller



Negative pulse generator



Bi-directional Communication & Power (BCP-O)

Specification:

Out Put: 33 Vdc

Power: 300 W

Azimuthal Resistivity Drilling

Azimuthal Resistivity Drilling (ARD)(Optional)

The azimuth electromagnetic wave resistivity can determine the azimuth close to the formation interface in real time, such as the shale lens, caprock, or oil-water interface. The detection radius from the borehole axis can be as high as 17 feet (5.2 meters).

The tool can be used for water-based mud, synthetic-based mud or oil-based mud.

When used with geosteering, the distance to the layer interface can be estimated, and the reliability and accuracy of geosteering are enhanced.

The azimuth electromagnetic wave resistivity (ARD) while drilling can obtain the azimuth resolution of 16 sectors close to the formation. Its dynamic compensation can eliminate environmental interference.

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Azimuthal Resistivity Drilling

Azimuthal Resistivity Drilling Specification

Hole Size: 8 3/8 ” -10 5/8” (213 mm-270 mm)

Tool OD: 6 -3/4 ” (172 mm)

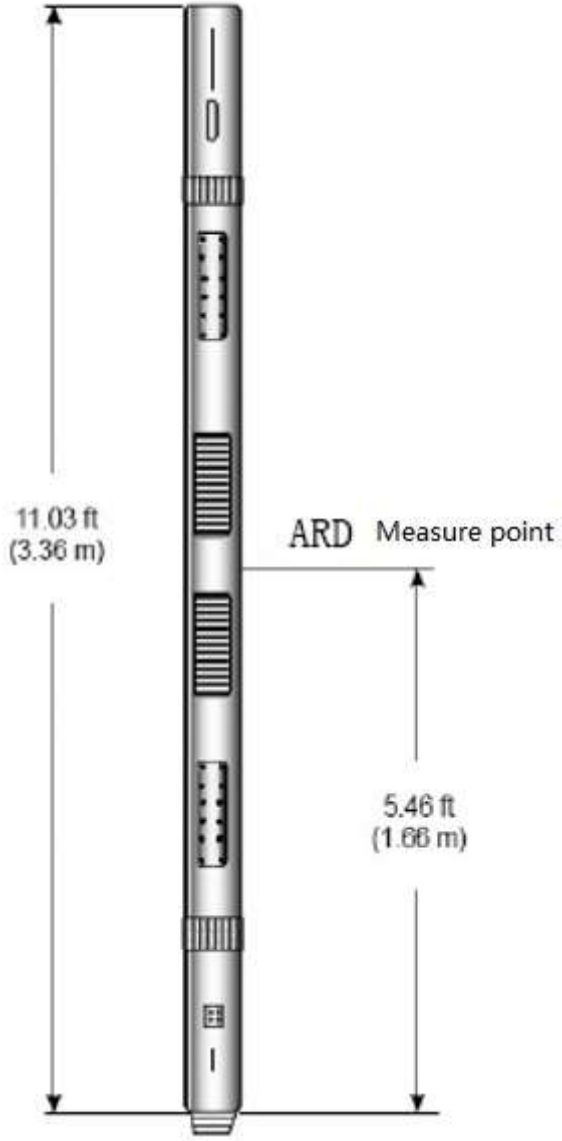
Measure Point: 5.46 ft. (1.66 m)

Detection Boundary: 17 ft. (5.2 m)

Statistical Repeatability: ±2%

Vertical Resolution: 24” (61 cm)

Azimuth Quadrant: 16



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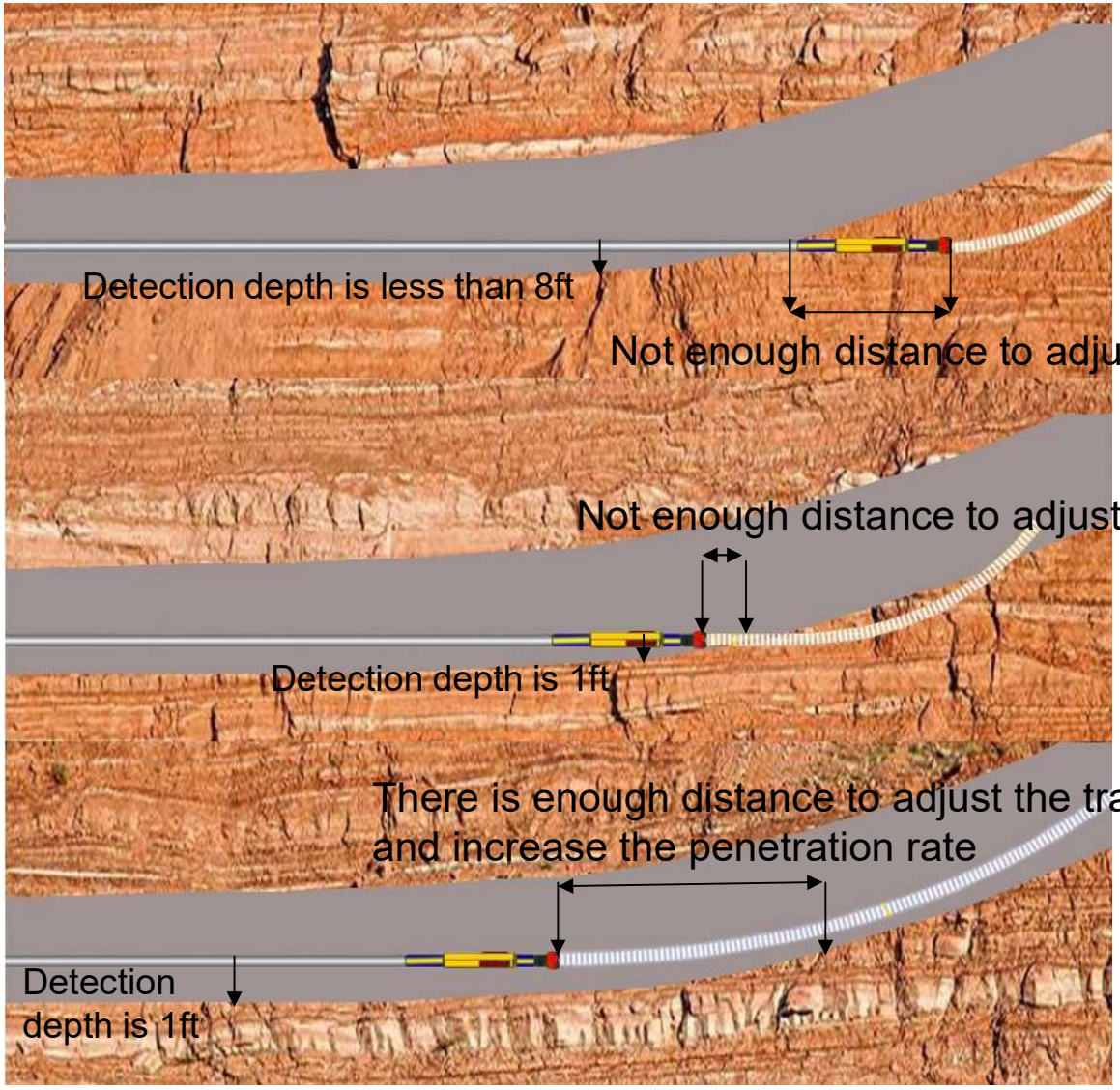
Azimuthal Resistivity Drilling

Azimuthal Resistivity Drilling advantage



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Neutron & Density Logging While Drilling (LithoLWD)

LithoLWD includes Caliper Corrected Neutron Porosity (CCN) and Rotational Azimuth Density (RAD). It can measure formation porosity, 16-sector high-resolution real-time formation azimuth density imaging, which is very important for the identification of hydrocarbons; accurate caliper measurement can provide an accurate wellbore profile to calculate the wellbore volume, for cementing and drilling safety has guiding significance.

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Neutron & Density Logging While Drilling (LithoLWD)

Caliper Corrected Neutron Porosity (CCN) Specification:

Diameter	4.75 in. With 5.59 in. upset	6.75 in. with 7.50 in. upset	8.25 in. With 10.125 in. upset
Max.Pressure	20000 psi (137.9 MPa)		
Max. Temperature	300° F (150° C)		
Weight	1100 lbs. (498 kg) (CCN 4 and RAD 4)	893 lbs. (405 kg)	1325 lbs. (600 kg)
Service	Formation Porosity		
Tool Type	Caliper Corrected Neutron		
Max. Dogleg Severity	15° /100 ft. (15° /30 m) Rotating 30° /100 ft. (30° /30 m) Sliding	9° /100 ft. (9° /30 m) Rotating 16° /100 ft. (16° /30 m) Sliding	6.5° /100 ft. (6.5° /30 m) Rotating 12° /100 ft. (12° /30 m) Sliding

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Neutron & Density Logging While Drilling (LithoLWD)

Caliper Corrected Neutron Porosity (CCN) Specification:

Detectors	Lithium-6 Iodide Crystal with Photomultiplier tube for both Near and Far detectors
Porosity Accuracy	0.5 p.u. below 10 p.u.; 5% of reading for 10-50 p.u.
Vertical Resolution	24 in. (61 cm)
Statistical Repeatability	± 0.6 pu @ 20 pu @ 200 ft./hr.
Max. Logging Speed	180 ft./hr (@ 2 points/ft.)
Depth of Investigation	10 in. estimated for 8.5 in. 10 p.u. borehole
Radioactive Source	Am 241 - Be Strength: 5 Curies (185 GBq)
Measure Point	4.6 ft. (1.4 m) (From downhole tool end)
Voltage	30 Vdc
Current Draw	160 - 170 mA

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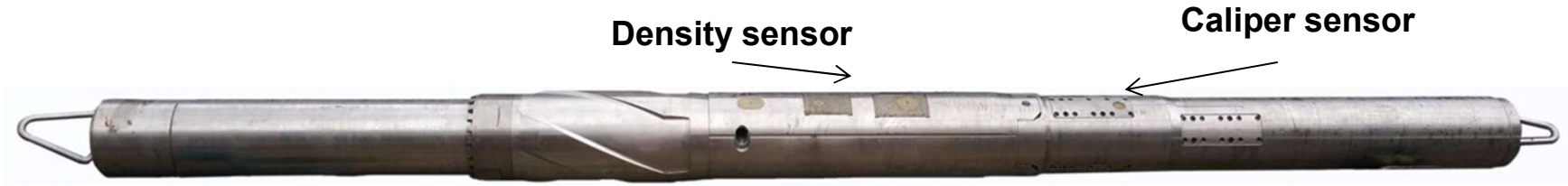
Neutron & Density Logging While Drilling (LithoLWD)

Rotary Azimuthal Density (RAD) Specification:

Diameter		4.75 in. With three Ultrasonic caliper sensor	6.75 in.	8.25 in.
Max Pressure		20000 psi (137.9 MPa)		
Max Temperature		300° F (150° C)		
Weight		1100 lbs. (498 kg) (CCN 4 & RAD 4)	1092 lbs. (495 kg)	1945 lbs. (881 kg)
Service		Formation Bulk Density Service with Hole Caliper		
Tool Type		Rotational Azimuthal Density		
Max Dogleg	Rotating	15° /100 ft. (15° /30 m)	9° /100 ft. (9° /30 m)	6.5° /100 ft. (6.5° /30 m)
	Sliding	30° /100 ft. (30° /30 m)	16° /100 ft. (16° /30 m)	12° /100 ft. (12° /30 m)
Detectors		NaI Scintillation Crystal with photomultiplier tube for both Long and Short Spaced detectors		

Caliper Sensor



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Neutron & Density Logging While Drilling (LithoLWD)

Rotary Azimuthal Density (RAD) Specification:

Density Specifications	
Range	1.6-3.1 g/cc
Accuracy	± 0.015 g/cc
Statistical Repeatability	± 0.025 g/cc@200 ft./hr (60 m/hr) and 2.5 g/cc
Vertical Resolution	18 in. (45 cm) (full resolution)
Downhole End Measure Point	5.1 ft. (1.5 m)
Photoelectric Factor Specifications	
Range	1-10 Barnes/electron (B/e)
Accuracy	± 0.25 B/e from 2-5 B/e
Statistical Repeatability	± 0.25 B/e @ 200 ft/hr (60 m/hr)
Vertical Resolution	6 in. (150 mm) (full resolution)
Downhole End Measure Point	5.1 ft. (1.5 m)
Acoustic Standoff Caliper Specifications	
Range	0-2 in. (Out of housing)
Accuracy	±0.075 in. (0 to 0.5 in.) / ±0.125 in. (0.5 to 1.0 in.) / ±0. 25 in. (1.0 to 2.0 in.) Out of housing
Max. Logging Speed	180 ft./hr (@2 points/ft)
Radioactive Source	Cs137 Strength: 2 Curies (74 GBq)
Voltage	30V
Current Draw	350 mA~390 mA

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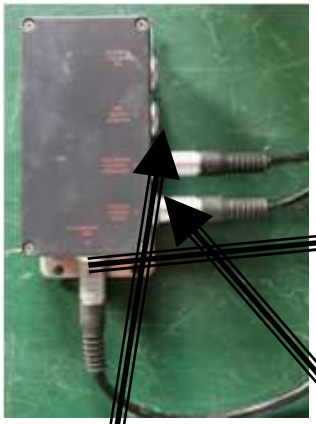
LWD Surface System (PILWD)

Integrated software platform, the system with multiple product lines and well site services and support between the department office services. Software system laid the foundation for future continue to upgrade, to support existing and future services.

- Support ComLWD and HbuildLWD system
- System database based on SQL Server 2000
- Support access to the data directly from SQL Server database
- Support a full range of LWD equipment

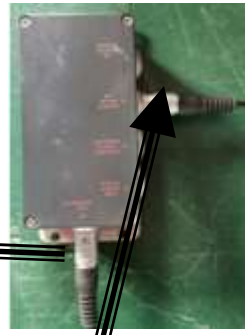
LWD Surface System (PILWD)

Junction Box Assemble



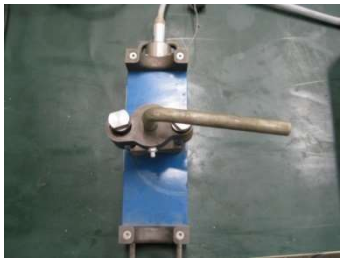
Safe Acquisition
Remote Area

PC



Junction Box Assemble

Stand Pipe Pressure
Transducer



Hookload Wireline
Tension

Remote Driller's Dial

Depth Encoder

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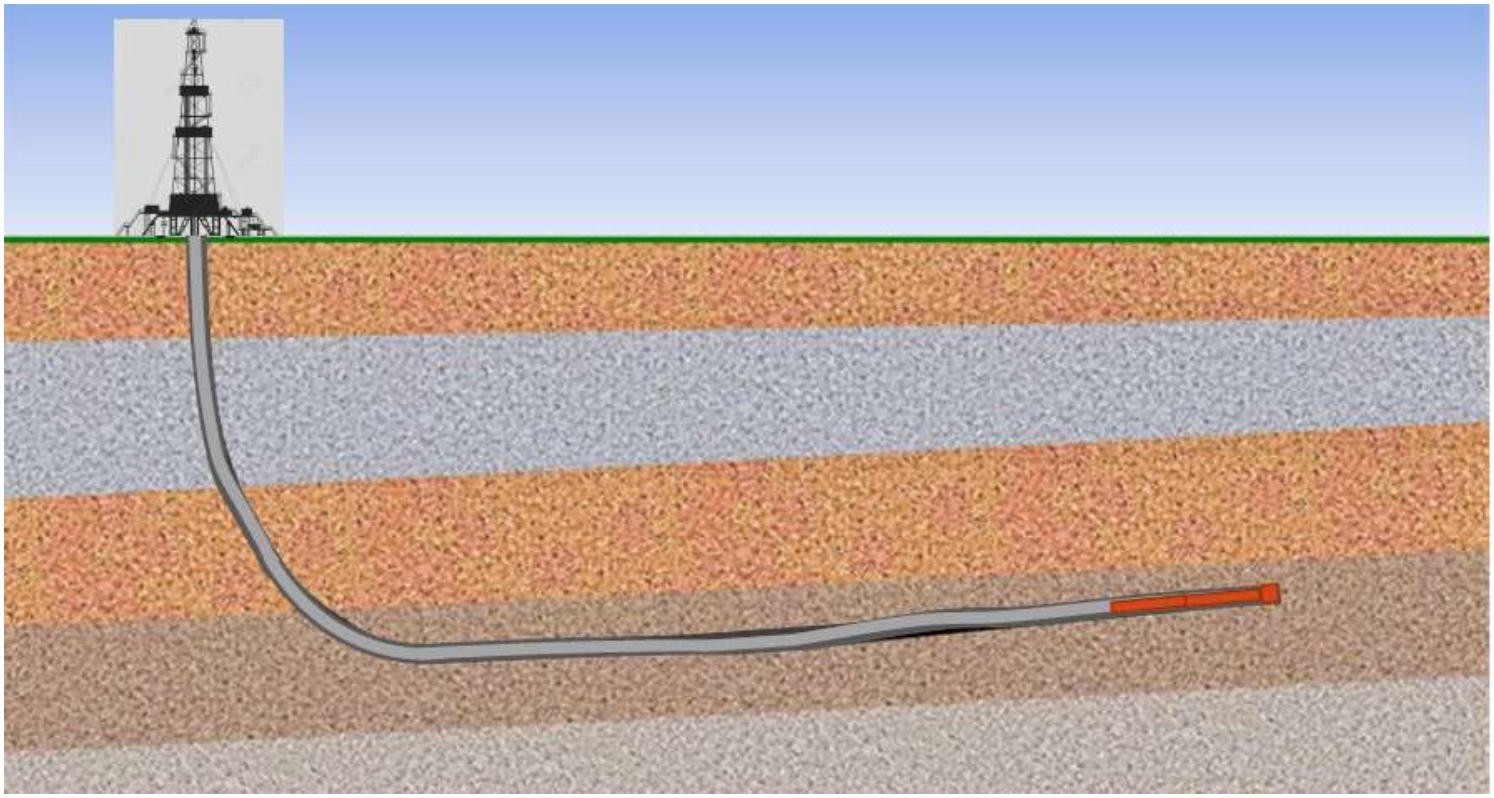
Near-bit Azimuth Gamma Ray (NGR/AP600)

The effect of near-bit azimuth gamma ray:

Near-bit azimuth gamma can measure gamma values above and below the target oil layer. In this way, geologists at the drilling site can cooperate with the directional drilling party to correct the drilling trajectory with the help of the inclination measurement, keep the borehole in the reservoir, and increase the rate of single well oil layer drilling.



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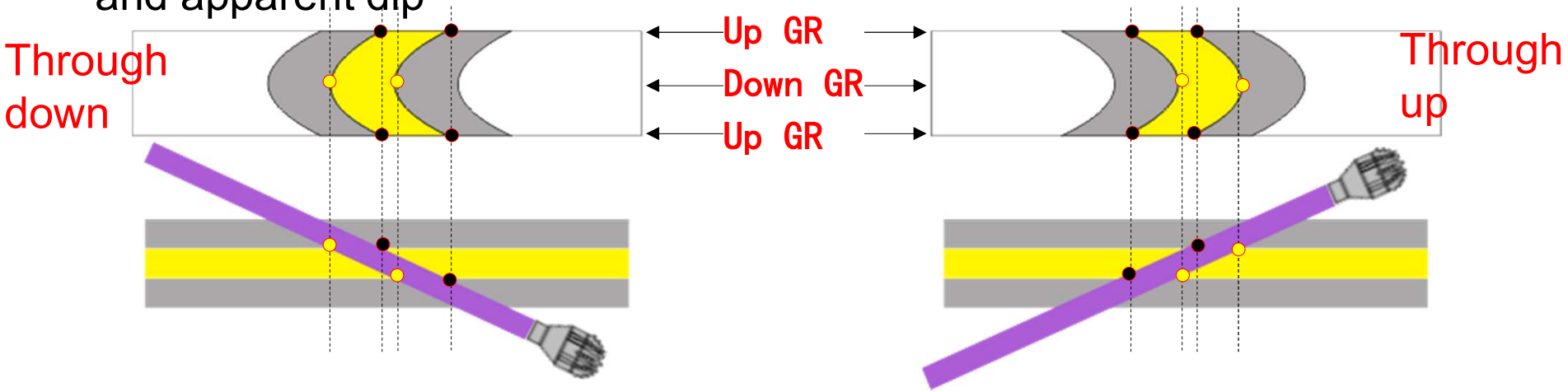
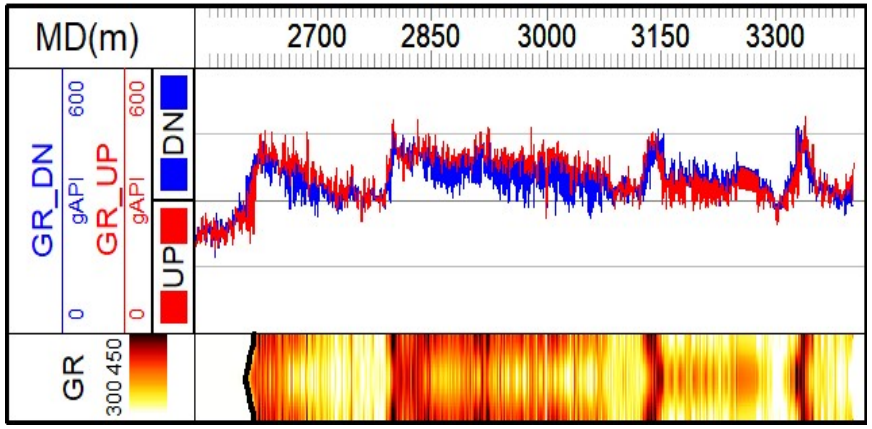
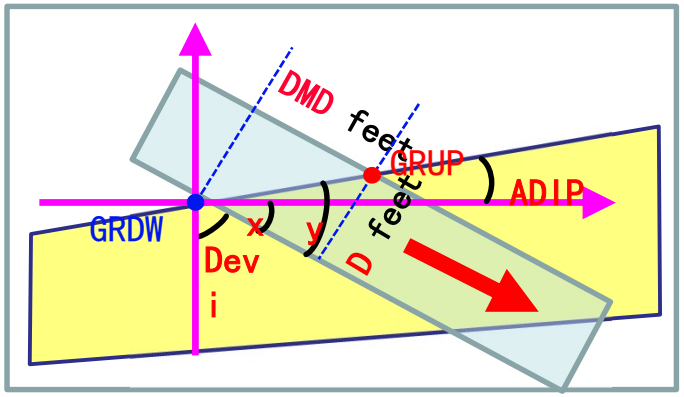
Near-bit Azimuth Gamma Ray (NGR/AP600)

Geosteering method

GR image formation boundary method: can sure the going through posture and apparent dip







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Near-bit Azimuth Gamma Ray (NGR/AP600)

Near-bit Azimuth Gamma Ray (LWD+NGR) (Electromagnetic wave type)

Near-bit Azimuth Gamma Ray (AP600) (Current type)

The near-bit azimuth gamma system is a high-temperature near-bit measurement while drilling tool for measuring well inclination, azimuth gamma, rotational speed and other parameters. This system mainly consists of two short sections, one is the transmitting short section connected to the front end of the motor, and the other is the receiving short section connected to the lower end of the LWD instrument. The transmitting short section sends the measured data pass the motor through electromagnetic waves or electric current to the upper receiving short section, the receiving short section transmits the information to the MWD instrument through decoding, and finally transmits the data measured by itself and the data near the drill bit to the ground through the mud pulse.

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Near-bit Azimuth Gamma Ray (NGR/AP600)

General Specification :

Tool OD	6.75 in.
Max Pressure	20000 psi (137.9 MPa)
Max Temperature	300° F(150℃)
Gamma Specification	
Crystal Type	Scintillation
Measurement	API GR
Measuring Range	0-500 API
Measuring Accuracy	±3% API of full scale
Vertical Resolution	6 in. (153 mm)
Inclination Specification	
Sensor Type	X-Y axis accelerometer Z axis accelerometer
Measuring Range	0-180°
Measuring Accuracy	±1° @INC＞30°

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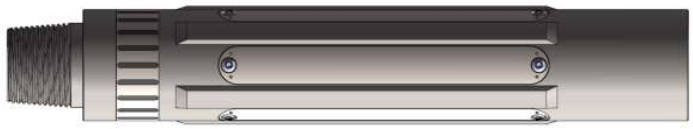
Near-bit Azimuth Gamma Ray (NGR/AP600)

Electromagnetic wave type near-bit azimuth gamma ray (NGR) specification :



Tool Length	914 mm
Tool OD	7.25 in. (184 mm)
Modulation Type	ASK
Baud Rate	20 Baud
Supply Voltage	7.3 V
Current and Power	470 mA @ 7.3 V (3.43 W)
Connection	4-1/2 REG
Transmission Distance	20 m
Battery working time	150 hours
Inclination and gamma measurement points	450 mm(Behind the drill bit)

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Near-bit Azimuth Gamma Ray (NGR/AP600)

Current type near-bit azimuth gamma ray (AP600) specification :

Tool Length	914 mm
Tool OD	7.25 in.(184 mm)
Modulation Type	GMSK
Baud Rate	20 Baud
Supply Voltage	+12V to +24V
Current and Power	120 mA @ 22V (2.64 W)
Connection	4-1/2 REG
Transmission Distance	20 m
Battery working time	240 hours
Inclination and gamma measurement points	450 mm(Behind the drill bit)