

EM Telemetry System

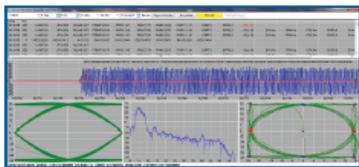


EFTECH DRILLING SOLUTIONS



Features

- > Data rates up to 12 bps
- > High-power 50 W transmitter
- > Downhole selectable data sequences – choose the optimum combination of directional, LWD and pressure measurements for the drilling operation
- > EM Downlinking – Quickly adjust power, bit rate, carrier frequency and telemetry sequences for the conditions
- > Plug-and-Play compatibility with APS SureShot downhole and surface equipment
- > Quad channel digital surface receiver to rapidly select the best signal from among 4 antenna pairs as the well progresses
- > Turbine alternator option for extended bit runs and high current draw applications
- > Unique rugged, reliable dual gap sub
- > WPR resistivity compatible



EM Telemetry

The APS EM system communicates by transmitting electromagnetic waves through the formation instead of pressure pulses through a fluid column. Benefits include time saved by transmitting surveys during a connection, high data rates and the ability to operate in conditions where mud pulse telemetry cannot.

Applications

- > High ROP drilling with frequent surveys
- > High data density LWD and drilling optimization applications
- > Underbalanced drilling
- > Foam and air drilling
- > Extreme lost circulation conditions



SureShot EM

SureShot EM is a state-of-the-art system. The downhole tool features two-way EM communication. The sequence and frequency of transmitted measurements is EM downlink selectable. Whether it's a higher density log to pick a casing point, more pressure measurements for drilling optimization or emphasis on directional measurements while sliding, SureShot EM enables the operator to quickly choose the optimum data sequence for the drilling operation.

Power, data rate and carrier wave are user adjustable while drilling – helpful for transmitting through changing formations and when automatic adjustments are ineffective due to overburden or changing surface conditions. The innovative quad surface receiver is actually four receivers in one. The receiver can decode using one antenna while simultaneously monitoring up to four antennas. As the wellbore changes direction the operator can select antennas at the optimum time for best reception. Utilizing the strongest signal conserves batteries and allows for higher data rates. The gap sub is a dual gap design for added reliability. Features include ceramic sleeves to prevent loss of power due to arcing; no coating to wear and arc; dual insulator rings for more reliability; and higher power due to the formation due to gap distance.

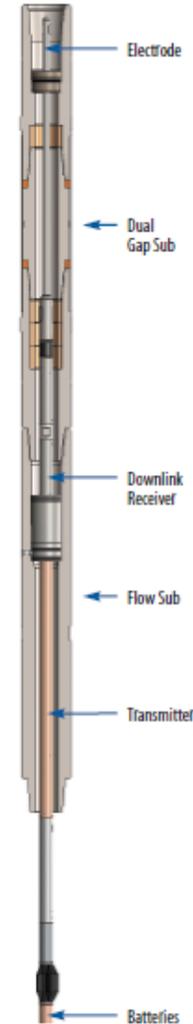
Fixed-mount and retrievable configurations are available. The fixed-mount tool features a sliding electrode contact ring – no need for spacers to accommodate various length subs. The fixed-mount tool is field configurable to work with different size drilling tubulars.

The EM tool operates with batteries or turbine alternator. The turbine alternator enables longer downhole time, high transmitting power for longer periods and power for high draw applications with multiple sensors. The turbine alternator configuration includes backup batteries for operation during periods of no flow.

Depth tracking options include the SureShot Depth Tracker, the SureShot mud pulse SIU and WITS.

Compatibility

SureShot EM works with all APS downhole sensors. The EM transmitter uses the same flow subs and is a drop-in alternative for the mud pulse transmitter, having many parts in common with the SureShot mud pulse system. Operators benefit from reduced inventory cost and increased flexibility when providing a mix of EM and mud pulse MWD services.



Product Specifications

Downhole Transceiver		
Data Rate	1 to 12 bps uncompressed; selectable	
Power Output	2 to 50 W, selectable	
Power Source	2 - 4x 10 DD lithium battery or APS Turbine Alternator + 1x 10 DD lithium battery	
Downlink Methods	EM and flow	
Downlink-adjustable Parameters	Data Rate Power Output Operating Frequency Data/Survey Sequences Survey-on-command	
Operating Frequency	2 to 12 Hz; selectable	
Collar OD	8.0 in. 6.75 / 6.50 in. 4.75 in.	204 mm 172 / 165 mm 121 mm
Flow Rate Limits	8.0 in. – 300 to 1100 gpm 6.75 / 6.50 in. – 150 to 750 gpm 4.75 in. – 125 to 350 gpm	203 mm – 19 to 69 L/sec 171 / 165 mm – 9 to 47 L/sec 121 mm – 7.9 to 22 L/sec
Sand Content	< 1% by volume recommended	
Operating Temperature	-13° to 302°F	-25° to 150°C
Maximum Pressure	20,000 psi	138 MPa
Surface System		
Operating Temperature	32° to 158°F	0° to 70°C
Storage Temperature	14° to 185°F	-10° to 85°C
Surface Sensors	Depth encoder, hookload, standpipe pressure	
SureShot MWD with EM		
Downhole Configurations		
Available Platforms	Fixed-mount or retrievable	
Fixed-mount System	Battery Battery and PWD Turbine, battery and PWD	
Retrievable System	Battery Battery and PWD	
Available Sensors	Directional, gamma, vibration, WPR, annular and bore pressure	
Length	Equal to mud pulse transmitter; 30 - 31 ft for DGMWD collar	
Surface System		
Surface System	Surface receiver, downlink transmitter, laptop, rig floor display	
Depth Options	WITS, SureShot Depth Tracker, SIU 1 or SIU 2	

Rotary Pulser

Fixed-mount or Retrievable Positive Mud Pulse Transmitter

APS Technology's patented Rotary Pulser* is the toughest, most advanced mud pulse transmitter in the industry. Our Rotary Pulser chews through LCM content which would choke any other pulser, over a wide range of mud weights and conditions.

APS's commitment to continuous improvement has increased reliability and decreased power consumption in our pulser. Recent improvements include an ultra-reliable, high-efficiency DC brushless motor and controller which can run thousands of hours without a failure. The motor/controller combo is 30% more efficient when pulsing and consumes 1/3 the quiescent power of the previous generation. Other improvements include more durable shafts and seals, and better serviceability.

The APS Rotary Pulser is designed to operate with batteries or with the APS Turbine Alternator.† It offers a reliable, economical alternative to pulsers from other OEMs. Crossovers to other popular MWD systems are available, or can be custom-designed. All materials are highly wear-resistant to provide exceptional reliability and service life in demanding drilling environments.

Features	Advantages	Benefits
New DC brushless motor	> Increased reliability > Improved power consumption	> Improved MTBF > Works with 8 DD cell (28v) and 10 DD cell (36v) systems
Oscillating rotary motion	> Self-clearing > Low shaft speed	> Reliable operation with high LCM concentrations > Improved seal reliability / life
Open flow path	> No screens to plug	> Enhanced reliability in wells with poor solids control
Direct-drive magnetic coupling	> Rugged drive train > No rotating seals in mud	> Enhanced service reliability > Reduced service cost
Tungsten carbide flow surfaces	> Superior fluid erosion properties	> Extended component life > Reduced service cost
Adjustable pulse width and magnitude	> Adaptable to all flow rates, depths and mud weights	> Extends the range of reliable operation
Wide range of pulser sizes for 3.125 in. (79 mm) to 9.5 in. (241 mm) or larger BHAs	> Easily convertible between sizes, and between fixed-mount or retrievable configurations	> Reliable operation in any hole size > Reduced inventory
Retrieval or fixed-mount options	> Basic design and construction are consistent without regard to configurations	> Adaptable to fit customer needs > Reliable service in all configurations

Product Specifications

Signal Transmission	Positive mud pulse	
Pulse Height	Adjustable	
Retrieval/Reseatable	Available	
Fixed Mount	Available	
Activation	Electromechanical	
Operating Voltage	28 - 40 VDC	
Pulser Sub O.D.	9.5 [§] , 8, 6.25 to 6.75, 4.75, 3.5 & 3.125 in.**	241 [§] , 203, 159 to 171, 121, 89 & 79 mm**
Flow Ranges (8.4 ppg mud)	9.5 in. or larger – 650 to 1200 gpm 8 in. – 300 to 1100 gpm 6.25 to 6.75 in. – 150 to 750 gpm 4.75 in. – 150 to 350 gpm 3.125 & 3.5 in. – 70 to 250 gpm	241 mm or larger – 41 to 76 L/sec 203 mm – 19 to 69 L/sec 159 to 171 mm – 9 to 47 L/sec 121 mm – 9 to 22 L/sec 79 & 89 mm – 4 to 16 L/sec
Sand Content	< 1% by volume recommended, 3% by volume maximum	
LCM Tolerance	50 lb. per bbl medium nut plug	143 kg/m ³ medium nut plug
Operating Temperature	-13° to 302°F; 347°F option	-25° to 150°C; 175°C option
Maximum Pressure	20,000 psi; 25,000 psi option	137.9 MPa; 172.4 MPa option
Differential Pressure	No requirement	
Dogleg Capability	API connection limited	

* Specifications subject to change without notice

[§] Larger O.D. subs can be accommodated using the pulser for 9.5 in. (241 mm) O.D.

** Pulsers for 3.125 in. (79 mm) & 3.5 in. (89 mm) BHAs are available in fixed-mount only



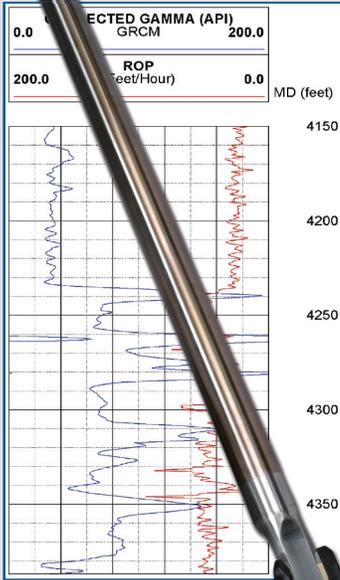
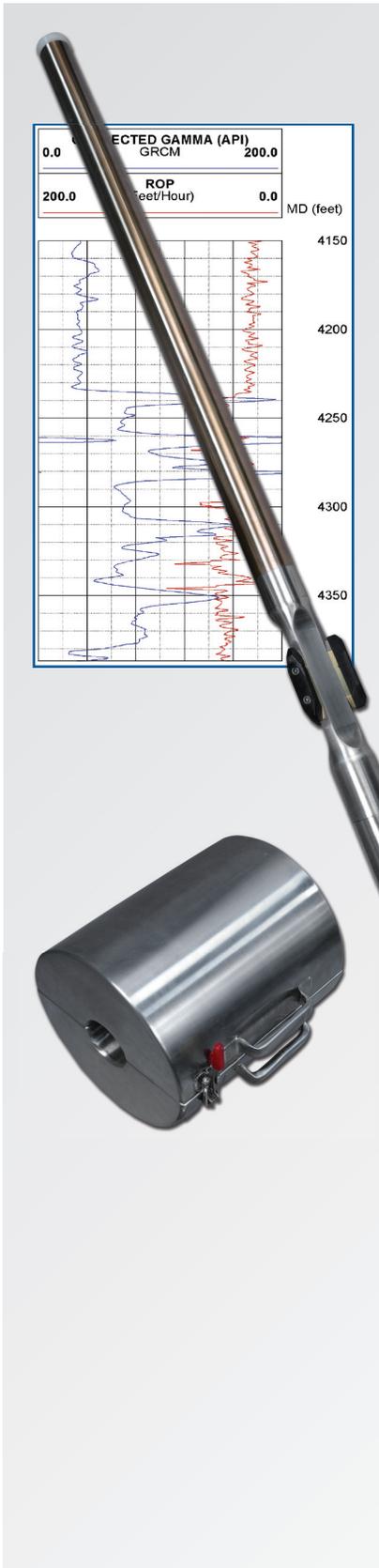
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SureShot™ MWD Gamma Sensor with Environmental Monitoring

EDS's next-generation SureShot natural gamma sensor employs a rugged scintillation counter and photomultiplier mounted in a specially designed package which provides protection against the high levels of shock and vibration encountered in the drilling environment. In addition, this extensively qualified new design offers environmental monitoring capability and lower power consumption, while maintaining back-compatibility with APS's earlier sensor designs.

EDS's gamma sensor is an add-on to our SureShot Measurement-While-Drilling (MWD) system. The APS gamma sensor is calibrated to API-standard units, and a wellsite check source is available to verify tool performance in the field or maintenance repair shop. The easy-to-use SureShot surface system scales natural gamma ray data to API units; corrects for borehole size, mud weight and drill collar effects; assigns each point a depth from the depth tracking system; and plots both real-time displays and configurable hard copy logs. Data can be exported in standard industry formats (WITS and LAS).

The SureShot MWD downhole system can be programmed to send a combination of gamma ray and tool face data transmissions to allow logging while steering and sliding. A rotation sensor in the directional package enables the tool to optionally transmit only gamma ray data while rotating. The SureShot MWD can store up to 32 MB of gamma data for retrieval during trips.



Product Specifications

Physical Parameters		
Length	46 in.	117 cm
Outside Diameter	1.875 in.	48 mm
Measurement		
Sensor	Nal scintillation detector with PMT	
Measurement Range Accuracy (Apparent API Units)	API-calibrated 0 - 800 API ± 3 API @ 100 API (based on typical API scale factor of 1.35 API counts/sec)	
Vertical Resolution	6 in.	152 mm
Max. Data Sampling	Every 5 sec	
Update Resolution (real time)	2.5 to 3.5 points/ft at 50 ft/hr; 0.8 to 1.2 points/ft at 150 ft/hr	
Environmental		
Operating Temperature	0° to 347°F	0° to 175°C
Maximum Pressure	20,000 psi; 25,000 psi option	137.9 MPa; 172.4 MPa option



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SureShot™ MWD Gamma Sensor with Environmental Monitoring

Gamma Controller Environmental Data Files and Event Log

File Number	Reason	Format	Record Period	FileSizeInBlocks	NumberOfRecords	File Time
0	POR	MinMaxTempAndAccel	5	1	4	Thu Aug 16 13:54:00 2012
1	TimeChange	MinMaxTempAndAccel	5	1	6	Thu Aug 16 14:13:52 2012
2	POR	MinMaxTempAndAccel	5	14	224	Thu Aug 16 14:47:54 2012
3	POR	MinMaxTempAndAccel	5	6	93	Fri Aug 17 09:33:29 2012
4	POR	MinMaxTempAndAccel	5	1	1	<unknown>
5	POR	MinMaxTempAndAccel	5	1	3	<unknown>
6	POR	MinMaxTempAndAccel	5	1	2	<unknown>
7	POR	MinMaxTempAndAccel	5	1	3	<unknown>
8	POR	MinMaxTempAndAccel	5	7	109	Tue Aug 21 08:04:10 2012
9	POR	MinMaxTempAndAccel	5	15	240	Thu Aug 23 11:50:43 2012
10	POR	MinMaxTempAndAccel	5	12	188	Wed Aug 29 16:38:35 2012
11	POR	MinMaxTempAndAccel	5	2	31	<unknown>
12	POR	MinMaxTempAndAccel	5	1	13	<unknown>
13	POR	MinMaxTempAndAccel	5	1	7	Thu Aug 30 13:16:21 2012
14	POR	MinMaxTempAndAccel	5	2	19	Thu Aug 30 13:56:46 2012
15	POR	MinMaxTempAndAccel	5	15	230	Thu Aug 30 15:33:29 2012

Time Stamp	Min Temperature	Max Temperature	Lateral Accel	Axial Accel
Thu Aug 23 11:50:43 2012	123	124	2	2
Thu Aug 23 11:55:43 2012	124	124	1	2
Thu Aug 23 12:00:43 2012	124	124	1	1
Thu Aug 23 12:05:43 2012	124	124	1	1
Thu Aug 23 12:10:43 2012	124	124	2	2
Thu Aug 23 12:15:43 2012	124	125	1	2
Thu Aug 23 12:20:43 2012	125	125	42	50
Thu Aug 23 12:25:43 2012	125	125	1	2
Thu Aug 23 12:30:43 2012	125	125	1	1
Thu Aug 23 12:35:43 2012	125	125	1	3
Thu Aug 23 12:40:43 2012	126	126	1	1
Thu Aug 23 12:45:43 2012	124	124	2	3
Thu Aug 23 12:50:43 2012	126	126	1	1
Thu Aug 23 12:55:43 2012	126	126	1	3
Thu Aug 23 13:00:43 2012	126	126	1	1
Thu Aug 23 13:05:43 2012	126	126	2	3

Environmental Monitoring

The gamma sensor's built-in accelerometers measure axial and lateral vibration. Peak axial shock, lateral shock, and temperature data are stored in on-board memory every 5 minutes, up to 5,000 hours. Information on the service history of the tool is also stored in on-board memory.

This lifetime log provides valuable information to evaluate the health of the tool, and to develop preventative maintenance cycles base on the actual operating environment over time rather than total downhole hours alone. Vibration measurements can also be used to justify claims for repairs that are a result of out-of-spec drilling conditions.

Gamma module environmental data can be downloaded using APS's MWD Master Interface PC application. Future APS software releases will run the downloaded data through an "Accumulated Damage Model" to enable Condition-Based Maintenance scheduling based on the gamma module's operating history.

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SureShot™ MWD System

*Fixed-mount
Pulser*



EDS's SureShot family of directional and directional plus gamma systems provides reliable and flexible measurement-while-drilling performance in combination with our second-generation Rotary Pulser. The system can be powered by our battery modules, our turbine alternator, or a combination of the two. This MWD system provides highly accurate azimuth and inclination data for all applications from straight-hole through horizontal drilling. Rapid and accurate toolface transmission enables the most complex well paths to be drilled with confidence.

SureShot's downhole portion includes a rugged directional sensor package with NIST-traceable magnetometer calibration; a reliable, field-proven, Rotary Pulser*; and battery and/or turbine alternator for power. SureShot's modular design allows the addition of other functions like high-quality gamma and/or vibration logging. Each package is protected by a state-of-the-art vibration isolation system and is mounted in beryllium copper or high-strength steel pressure barrels. A small, robust surface decoder interfaces with a computer running APS's SureShot Control Center software. The SureShot MWD can store up to 32 MB of MWD/LWD and diagnostic data for retrieval during trips.

SureShot's patented second-generation Rotary Pulser* is the toughest, most advanced, most LCM-tolerant mud pulse transmitter in the industry. Our pulser's ultra-reliable, high-efficiency DC brushless motor and controller, single open-flow path, positive pulse output and anti-jamming control virtually eliminates jamming or blockage, and the on-board memory allows post-run analysis of pulser performance. The Rotary Pulser is easily converted between fixed-mount and retrievable configurations.



*SureShot Lite with DTS,
Laptop, Standard Rig Floor
Display, Depth Encoder and
Hook Load Sensor*

- > The highly reliable EDS second-generation Rotary Pulser converts easily from fixed-mount to retrievable, providing fixed-mount reliability or retrievable lost-in-hole security.
- > Additional sensors including gamma, vibration monitoring and resistivity can be quickly incorporated into our "LWD-Ready" system.
- > The surface system presents data in a simple, user-friendly control and display module. The data is transferred to a central control PC from which it can be directed back to a dedicated wireless rig-floor display and/or rig monitoring system.
- > Multiple encoding schemes and advanced decoding enable rapid customization of the data stream for maximum speed or maximum data integrity.
- > The unique EDS power management module enables the system to be powered through dual battery packs or a combination of battery power and EDS turbine alternator †.



Printrex Plotter

* U.S. Patents #6,714,138 and #7,327,634 † U.S. Patent #7,201,239



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Retrievable Pulsar with Stinger



Low-temperature Rig Floor Display



SureShot Ruggedized System with Integrated Server and Terminal

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SureShot™ MWD System

Operating Specifications		
Inclination Range	0° - 180°	
Inclination Accuracy	± 0.1°	
Azimuth Range	0° - 360°	
Azimuth Accuracy	± 1.0° (Inc > 10°, Dip < 70°)	
Tool Face (Gravity)	± 1.0° (Inc > 10°)	
Tool Face (Magnetic)	± 2.25° (Dip < 70°)	
Gamma (Optional)	API-calibrated 0 - 800 API ±5% to 300°F (150°C) ±10% to 350°F (175°C) (based on typical API scale factor of 1.35 API counts/sec)	
Sensors		
Directional	Tri-axial fluxgate magnetometer with NIST-traceable calibration; quartz accelerometer	
Gamma (Optional)	Scintillator/PMT unit	
Product Specifications		
Signal Transmission	Positive mud pulse	
Pulse Height	Adjustable	
Retrievable/Reseatable	Available	
Fixed-mount	Available	
Activation	Electromechanical	
Operating Voltage	28 - 40 VDC	
Pulsar sub O.D.	9.5 [§] , 8, 6.25 to 6.75, 4.75, 3.5 & 3.125 in.**	241 [§] , 203, 159 to 171, 121, 89 & 79 mm**
Flow Ranges	9.5 in. or larger – 650 to 1200 gpm 8 in. – 300 to 1100 gpm 6.25 to 6.75 in. – 150 to 750 gpm 4.75 in. – 125 to 350 gpm 3.125 & 3.5 in. – 70 to 250 gpm	241 mm or larger – 41 to 76 L/sec 203 mm – 19 to 69 L/sec 159 to 171 mm – 9 to 47 L/sec 121 mm – 7.9 to 22 L/sec 79 & 89 mm – 4 to 16 L/sec
Sand Content	< 1% by volume recommended, 3% by volume max	
LCM Tolerance	50 lb/bbl medium nut plug	143 kg/m ³ medium nut plug
Operating Temperature	-13° to 302°F; 347°F option	-25° to 150°C; 175°C option
Maximum Pressure	20,000 psi; 25,000 psi option	137.9 MPa; 172.4 MPa option
Differential Pressure	No requirement	
Dogleg Capability	API connection limited	
Surface System		
SIU 2 & Plotter General Specifications		
Electrical Requirements	100 - 240 VAC, 47 - 63 Hz, 13 W	
Operating Temperatures	32° to 158°F	0° to 70°C
Storage Temperatures	14° to 185°F	-10° to 85°C
"Ruggedized" System		
Directional	Case – 19 in. EIA Standard 17 in. (h) x 27 in. (w) x 34.25 in. (d) Weight – 119 lb	Case – 483 mm EIA Standard 431 mm (h) x 686 mm (w) x 870 mm (d) Weight – 54.0 kg
Directional & Depth Tracking	Case – 19 in. EIA Standard 17 in. (h) x 27 in. (w) x 34.25 in. (d) Weight – 119 lb	Case – 483 mm EIA Standard 431 mm (h) x 686 mm (w) x 870 mm (d) Weight – 54.0 kg
"Lite" System		
Directional	5.5 in. (h) x 22 in. (w) x 20 in. (d) Weight – 12 lb plus laptop	140 mm (h) x 559 mm (w) x 508 mm (d) Weight – 5.4 kg plus laptop
Directional & Depth Tracking	5.5 in. (h) x 22 in. (w) x 20 in. (d) Weight – 12 lb plus laptop	140 mm (h) x 559 mm (w) x 508 mm (d) Weight – 5.4 kg plus laptop
Printrex Plotter		
	7.25 in. (h) x 22 in. (w) x 20 in. (d) Weight – 37 lb	184 mm (h) x 559 mm (w) x 508 mm (d) Weight – 16.8 kg
Rig Floor Displays		
Standard	Certified Zone 1 Division 2; 9 in.; wireless -4° to 140°F (-20° to 60°C) operating; -40° to 167°F (-40° to 75°C) storage	
Low-temperature	Certified Zone 1 Division 2; 15 in.; wired/wireless -40° to 122°F (-40° to 50°C) operating; -40° to 167°F (-40° to 75°C) storage	
Surface Sensors		
Pressure Transducer	4 - 20 mA current loop; certified intrinsically safe Class 1 Division 1, Class 1 Zone 0 -40° to 250°F (-40° to 121°C) operating; -67° to 302°F (-55° to 150°C) storage	
Hook Load Sensor	4 - 20 mA current loop; certified intrinsically safe Class 1 Division 1, Class 1 Zone 0 -40° to 180°F (-40° to 80°C) operating; -40° to 257°F (-40° to 125°C) storage	
Depth Encoder	Standard NAMUR Type; certified intrinsically safe Class 1 Zone 0 -40° to 180°F (-40° to 80°C) operating; -40° to 257°F (-40° to 125°C) storage	

[§] Larger O.D. subs can be accommodated using the pulsar for 9.5 in. (241 mm) O.D.

** Pulsars for 3.125 in. (79 mm) & 3.5 in. (89 mm) BHAs are available in fixed-mount only.



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SureShot™

MWD Pressure While Drilling Sensor



EDS's Pressure While Drilling (PWD) sensor measures annular and drill pipe pressures in all collar sizes. Captured data may be transmitted in real time via APS's SureShot™ MWD/LWD system, or stored in downhole memory for later download and analysis. Real-time data or pressure alarms may be transmitted via SureShot.

Applications include:

Managing Downhole Pressures

Measurement and real-time monitoring of hydrostatic and dynamic circulating fluid pressures for balanced, managed pressure drilling (MPD), and underbalanced drilling (UBD).

Maintaining Formation and Borehole Integrity

Real-time annular and bore pressure measurements help assess the optimum pressures required within narrow fracture and pore pressure windows.

Managing Hydraulics Programs

Real-time determination of equivalent circulating density (ECD) for hole cleaning, swab and surge pressures for borehole stability, and BHA pressure loss.

Supporting Early Detection Programs

Timely annular, bore, and differential pressure readings facilitate early detection of fluid influx and lost circulation.

Product Preliminary Specifications

Measurement		
	Range	Accuracy
Annular Pressure	0 - 20 kpsi (137.9 MPa)	±0.1% of FSR
Drill Pipe Pressure	0 - 20 kpsi (137.9 MPa)	±0.1% of FSR
Resolution	1.0 psi (6,895 Pa)	
Local Temperature Compensation	Yes	
Data Sampling Rate	5 seconds total (annular + drill pipe)	
Data Storage	Raw and compensated data are time-stamped and stored in SureShot memory.	
Environmental		
Operating Temperature	-13° to 347°F (-25° to 175°C)	
Maximum Pressure	20 kpsi (137.9 MPa)	

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SureShot™

Surface Systems & Components

EDS's SureShot family includes our modular approach to building MWD decoding and logging systems according to your business's changing needs.

The base model of our expandable SureShot surface system is the Sensor Interface Unit 2 (SIU 2) which includes everything needed to measure, filter, decode, display, store, retrieve, transmit and remotely access data for basic survey jobs. A separate PC and rig floor display can be added when needed for full directional MWD capability, and a depth-tracking system (DTS) SIU 2 retrofit and Printrex plotter can be added for LWD service when required. SureShot's intuitive, menu-based operating system allows you to lock-out some parameter changes while allowing the field engineer to still make necessary adjustments on the job. SureShot systems are available in both "ruggedized" and "lite" versions.

Application	MWD Tool	Gamma Sensor	SIU 2	SIU 2 with DTS option	PC* with SureShot Software	Printrex Plotter	Rig Floor Display	Surface Sensors**		
								Pressure	Hook Load	Depth
Survey-on-connection	✓		✓					✓		
MWD	✓		✓		✓		✓	✓		
Gamma / LWD	✓	✓		✓	✓	✓	✓	✓	✓	✓

* Server ("Ruggedized") or laptop ("Lite")

** Intrinsicpak® barriers provide an intrinsically safe connection to all surface sensors which connect to the SIU 2 in a nonhazardous environment.

✓ = required



SureShot Lite with DTS, Laptop, Standard Rig Floor Display, Depth Encoder and Hook Load Sensor





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SureShot™

Surface Systems & Components

Product Specifications

Surface System		
SIU 2 & Plotter General Specifications		
Electrical Requirements	100 - 240 VAC, 50 - 60 Hz, 13 W	
Operating Temperatures	32° to 158°F	0° to 70°C
Storage Temperatures	14° to 185°F	-10° to 85°C
"Ruggedized" System		
Directional	Case – 19 in. EIA Standard 17 in. (h) x 27 in. (w) x 34.25 in. (d) Weight – 119 lb	Case – 483 mm EIA Standard 482 mm (h) x 686 mm (w) x 870 mm (d) Weight – 54.0 kg
Directional & Depth Tracking	Case – 19 in. EIA Standard 17 in. (h) x 27 in. (w) x 34.25 in. (d) Weight – 119 lb	Case – 483 mm EIA Standard 482 mm (h) x 686 mm (w) x 870 mm (d) Weight – 54.0 kg
"Lite" System		
Directional	3.5 in. (h) x 19 in. (w) x 16 in. (d) Weight – 12 lb plus laptop	89 mm (h) x 483 mm (w) x 406 mm (d) Weight – 5.4 kg plus laptop
Directional & Depth Tracking	3.5 in. (h) x 19 in. (w) x 16 in. (d) Weight – 12 lb plus laptop	89 mm (h) x 483 mm (w) x 406 mm (d) Weight – 5.4 kg plus laptop
Printrex Plotter		
	7.25 in. (h) x 22 in. (w) x 20 in. (d) Weight – 37 lb	184 mm (h) x 559 mm (w) x 508 mm (d) Weight – 16.8 kg
Rig Floor Displays		
Standard	Certified Zone 1 Division 2; 9 in.; wireless -4° to 140°F (-20° to 60°C) operating; -40° to 167°F (-40° to 75°C) storage	
Low-temperature	Certified Zone 1 Division 2; 15 in.; wired/wireless -40° to 122°F (-40° to 50°C) operating; -40° to 167°F (-40° to 75°C) storage	
Surface Sensors		
Pressure Transducer	4 - 20 mA current loop; certified intrinsically safe Class 1 Division 1, Class 1 Zone 0 -40° to 250°F (-40° to 121°C) operating; -67° to 302°F (-55° to 150°C) storage	
Hook Load Sensor	4 - 20 mA current loop; certified intrinsically safe Class 1 Division 1, Class 1 Zone 0 -40° to 180°F (-40° to 80°C) operating; -40° to 257°F (-40° to 125°C) storage	
Depth Encoder	Standard NAMUR Type; certified intrinsically safe Class 1 Zone 0 -40° to 180°F (-40° to 80°C) operating; -40° to 257°F (-40° to 125°C) storage	



*Low-temperature
Rig Floor Display*



*SureShot Ruggedized
System with Integrated
Server and Terminal*



Printrex Plotter

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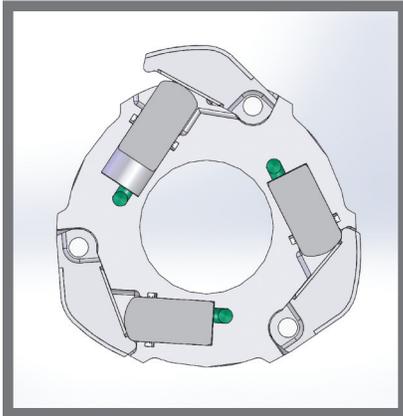
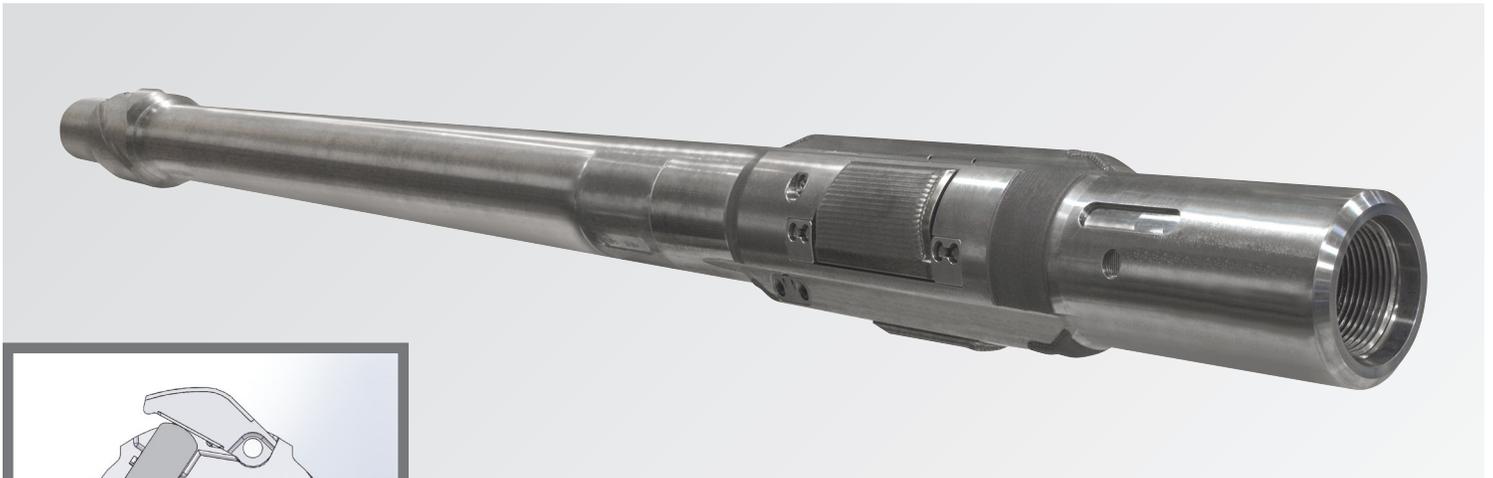


EFTECH DRILLING SOLUTIONS
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SureSteer™ 475-*RSS* Rotary Steerable System

Designed for directional drilling applications throughout the world, the EDS SureSteer Rotary Steerable tools provide “major service company” rotary steerable system functionality with the straightforward directional control procedures used with steerable motors. Utilizing EDS’s proprietary control systems, SureSteer can be programmed to use a closed-loop feedback system for vertical or tangent angle control, or to operate with surface-supplied instructions to efficiently drill any directional well plan.

The SureSteer-*RSM* is designed to maximize horsepower at the bit, and the SureSteer-*RSS* to maximize build rate. Together, they provide an unparalleled capability to match the major service companies’ advanced trajectory control.



SureSteer 475-*RSS* Description

The SureSteer 475-*RSS* steering head houses the steering pads; directional measurement and control electronics; and the electrical and hydraulic power systems, which are driven by an integrated turbine and alternator system. The control electronics provide timing signals to a hydraulic manifold to control the steering direction and force to achieve the desired directional objective.

Modes of Operation

Utilizing EDS’s proprietary control systems, the SureSteer 475-*RSS* can be programmed to use a closed-loop feedback system for vertical or tangent angle control, or to operate with surface-supplied instructions to efficiently drill any directional well plan. The mode of operation can easily be changed downhole. A series of timed pump speed changes allow for switching between modes or turning the tool off for events such as wiper trips, drilling out or back-reaming.

Programmable Downhole

The EDS SureSteer 475-*RSS* is straightforward to use. The desired tool face on the initial unit is set by surface orientation, similar to a steerable motor. This minimizes the amount of time required for downlinking. The desired build rate is communicated with timed pump speed changes. Depending on the deployment method, the SureSteer 475-*RSS* can be directly linked to an EDS MWD or LWD system for higher-level, comprehensive trajectory control.

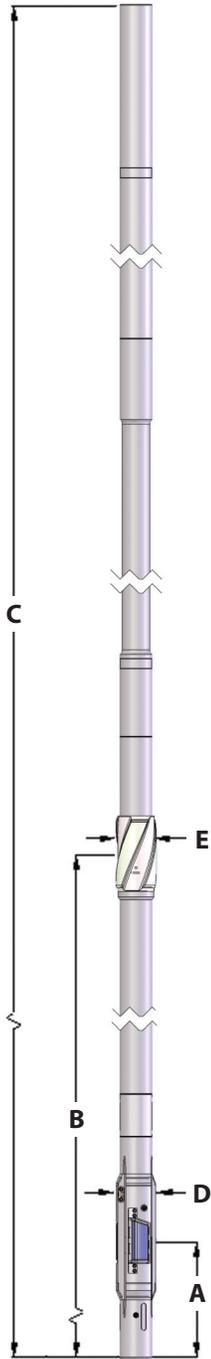


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SureSteer™ 475-RSS Rotary Steerable System

Product Specifications

The SureSteer 475-RSS can be run alone or with a variety of drilling motors. The specifications below are shown for the SureSteer 475-RSS alone. Contact our sales office for details.



Dimensions

DIM	Description	Dimensions	
	Nominal Hole Size	6.0 in. (152.4 mm)	6.75 in. (171 mm)
A	Bit Box to Center of Steering Pad	1.4 ft (0.4 m)	
B	Bit Box to Center of Sleeve Stabilizer	9.3 ft (2.8 m)	
C	Overall Length including Pulser	32.4 ft (9.9 m)	
	Steering Pad Dia. – Retracted	5.9 in. (149.9 mm)	
	Steering Pad Dia. – Extended	6.6 in. (167.4 mm)	7.0 in. (177.8 mm)
D	Steering Pad Upset Dia.	5.75 in. (146 mm)	
E	Sleeve Stabilizer Dia.	5.9375 in. (150.8 mm)	6.6875 in. (169.9 mm)
	Bottom Connection	3-1/2 in. API REG box	
	Top Connection – Standard, Housing	3-1/2 in. IF box	

Operational

Flow Rate	150 to 350 gpm (9.5 to 22 l/sec)
Maximum Drill String Rotation Speed	200 RPM
Maximum Operating Torque	9,700 ft-lbs (13,150 N-m)
Pressure Drop	200 psi @ 350 gpm (1.4 MPa @ 22 l/sec)
Build Rate Capability	To 12°/100 ft (30 m)

Environmental

Maximum Temperature	302°F (150°C)
Maximum Pressure	20,000 psi (137.9 MPa)
Maximum Bend Radius – Rotating	15°/100 ft
Maximum Bend Radius – Sliding	21°/100 ft

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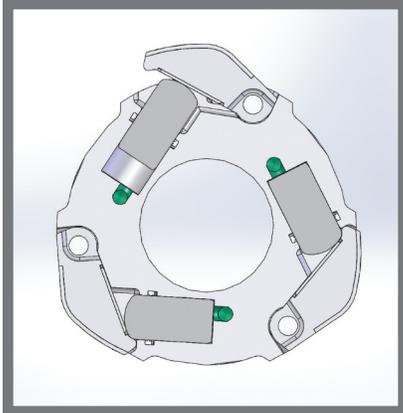


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SureSteer™ 675-*rsm*® Rotary Steerable Motor

The EDS SureSteer 675-*rsm* (RSM®) combines an advanced technology Rotary Steerable steering unit with a drilling motor power section. Using proven “Push-the-Bit” technology and designed with a very small auxiliary equipment footprint, the RSM provides rotary steerable control while continuously rotating the drill string with the optimum power and bit speed for the application. The SureSteer 675-*rsm* is unique in that it can be configured to operate with various types of available power sections, from the traditional Rotary Steerable-compatible, low-speed variety all the way up to high-speed configurations to deliver the ideal bit speed for the drilling application.

Designed for directional drilling applications throughout the world, the RSM provides “major service company” rotary steerable system functionality with the simple directional control commands commonly used with steerable motors.



SureSteer 675-*rsm* Description

The SureSteer 675-*rsm* steering head houses the steering pads; directional measurement and control electronics; and the electrical and hydraulic power systems, which are driven by the power section drive shaft. The control electronics provide timing signals to a hydraulic manifold to control the steering direction and force to achieve the desired directional objective.

Modes of Operation

Utilizing EDS's proprietary control systems, the SureSteer 675-*rsm* can be programmed to use a closed-loop feedback system for vertical or tangent angle control or to operate with surface supplied instructions to efficiently drill any directional well plan. The mode of operation may be easily changed downhole with a series of timed pump speed changes to switch between modes or to turn the tool off for back-reaming.

Programmable Downhole

The EDS SureSteer 675-*rsm* is straightforward to use. The desired tool face on the initial unit is set by surface orientation, similar to a steerable motor. The desired build rate is communicated with timed pump speed changes. Future plans include a short-range telemetry system linking the RSM and the EDS MWD system for higher-level control.

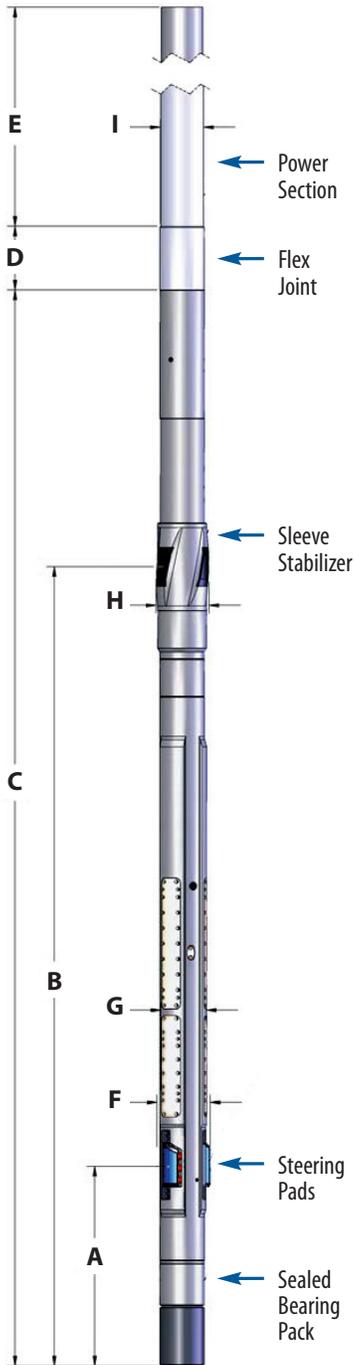


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SureSteer™ 675-rsm® Rotary Steerable Motor

Product Specifications

The SureSteer 675-rsm can be run with a variety of power sections. The specifications below are shown for the RSM itself, and in combination with a typical 6-3/4 in., 7/8, 5-stage motor power section. Contact our sales office for other available combinations.



Dimensions

DIM	Description	Dimensions		
		8.375 in. (213 mm)	8.5 in. (216 mm)	8.75 in. (222 mm)
	Nominal Hole Size			
A	Bit Box to Center of Steering Pad	2.8 ft (86.1 cm)		
B	Bit Box to Center of Sleeve Stabilizer	10.8 ft (3.3 m)		
C	Steering Unit Overall Length	14.5 ft (4.4 m)		
D	Flex Joint Housing	3.5 ft (1.1 m)		
E	Power Section Overall Length	17.2 ft (5.24 m)		
F	Steering Pad Dia. – Retracted	7.72 in. (196 mm)	7.97 in. (202 mm)	
F	Steering Pad Dia. – Extended	9.08 in. (231 mm)		9.33 in. (237 mm)
G	Steering Unit Upset Dia.	7.88 in. (200 mm)		
H	Sleeve Stabilizer Dia.	8.375 in. (213 mm)	8.5 in. (216 mm)	8.75 in. (222 mm)
I	Power Section Dia.	6.75 in. (171 mm)		
	Bottom Connection	4.5 in. API Reg.		

Operational

Flow Rate	300 to 600 gpm (19 to 39 l/sec)
Mud Motor Speed	100 to 175 RPM
Drill String Rotation Speed	20 to 80 RPM
Operating Torque	10,540 ft-lbs (15,000 N-m)
Pressure Drop (RSM)	130 psi @ 600 gpm (0.90 MPa @ 38 l/sec); water 150 psi @ 600 gpm (1.03 MPa @ 38 l/sec); 10 ppg mud
Build Rate Capability	8.0°/100 ft (30 m)

Environmental

Maximum Temperature	302°F (150°C)
Maximum Pressure	20,000 psi (137.9 MPa)
Maximum Bend Radius – Rotating	12°/100 ft
Maximum Bend Radius – Sliding	15°/100 ft

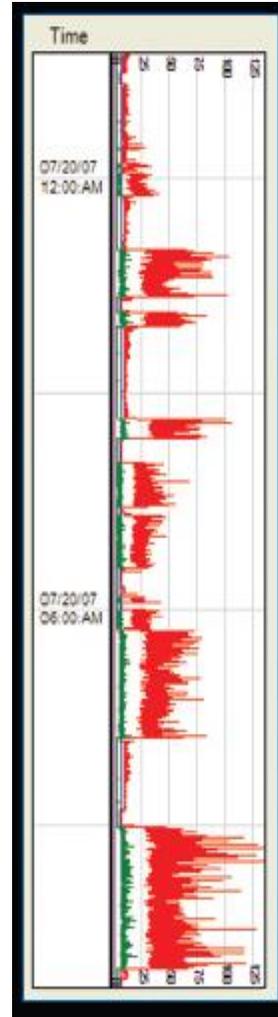
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SureShot™ Vibration Memory Module (VMM™)

APS's VMM is a software-enabled extension to our SureShot MWD tool that measures, analyzes, records and enables real time transmission of axial (bit bounce), lateral and torsional (stick-slip, chatter and whirl) vibrations and shocks. VMM allows users to assess the severity of downhole drilling to improve drilling efficiency and alert them to vibration conditions that could damage MWD and other downhole tools. The real time and memory data can be correlated to drilling events and equipment performance to improve drilling efficiency or prevent failures. The real time and memory data can also provide evidence for use in warranty claim resolution. Real time, memory and surface sensor data can be viewed with the SureShot VMM Viewer, plotted with APSPLOT™ and exported in industry-standard formats (WITS and LAS).

Features	Advantages	Benefits
Software option in SureShot Control Center (SSCC™)	Vibration monitoring service can be easily added	Reduced operating cost and increased service flexibility
Configurable vibration level update times	Regular notification of vibration levels; increases awareness of downhole drilling conditions	Allows optimization of drilling parameters for ROP maximization
Real time vibration level alerts	Notify rig personnel of severe vibration conditions	Modify drilling parameters before damaging equipment
Real time and memory vibration data	Evaluation of vibration data and drilling parameters to optimize drilling efficiency	Improved drilling efficiency
Vibration data export via SSCC	Vibration data can be shared with other packages or transmitted to customer's office	Vibration can be easily integrated with other wellsite services and data can be transmitted quickly to decision makers



SSCC's Real Time Vibration Alert Window

Left: Axial/Lateral Vibration vs. Time. Helps Staff identify problem combinations of weight-on-bit, RPM and rock formation in post-run memory analysis.

SureShot™ Vibration Memory Module (VMM™)

Product Specifications

Measurement	
Measurement Devices	Three ±120 g accelerometers, in APS MWD Controller Chassis 3-axis fluxgate magnetometer, in D&I Module
Data Sampling Rate	Accelerometers – 100 samples/s max. Magnetometers – 100 samples/s max.
Real Time Telemetry	Configurable at rig site
Vibration Memory Size	Up to 32 MB
Memory Recording	Average and peak data stored on configurable intervals; event-driven bursts of configurable lengths recorded when configurable thresholds are crossed
Data Recorded:	
Max. Lateral Vibration	0 to 169.7 g
RMS Lateral Vibration	0 to 169.7 g
Max. Axial Vibration	0 to 120 g
RMS Axial Vibration	0 to 120 g
Torsional Vibration	±314 rad/s (±18,000 deg/s)
Memory Dump	Connect to sonde at surface to program and dump memory



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Wave Propagation Resistivity Sub (WPR™)

EDS's WPR sub is a spatially compensated, dual frequency (400 kHz & 2 MHz), dual spacing device designed for wireline-equivalent Logging-While-Drilling (LWD) and Measurements-After-Drilling (MAD) services in all well types. Applications include geosteering, correlation, pore pressure trend analysis, casing point selection, wireline replacement, logging while tripping and logging with and without the flow switch enabled (for air- and foam-drilled wells).

WPR's symmetrical design, with centrally located receive antennas, provides real-time compensation, eliminates invasion effects due to measurement delays, and improves accuracy by canceling variations in receiver channels.

WPR operates in all mud types including oil-based and salt-saturated and provides real-time resistivity with flexible transmission formats. High-resolution data is stored in downhole memory which can be retrieved and processed during trips.

EDS provides a complete set of software-enabled borehole corrections and applications with WPR, including a dipping bed model for geosteering.

EDS offers a Pressure-While-Drilling (PWD) option for 4.75 in., 6.75 in. and 8.0 in. WPR.

WPR General Specifications – Operational

"Tool Size"	Borehole Size	Maximum Dogleg Severity		Connection	Max. Flow Rate, gpm (L/sec)
		Sliding	Rotating		
3.5 in. (89 mm)	4.625 - 4.75 in. (117 - 121 mm)	40°/100 ft	16°/100 ft	2 7/8 AOH	120/150 ^[1, 6] (7.6/9.5)
3.75 in. (95.25 mm)	4.75 - 5.63 in. (121 - 143 mm)	38°/100 ft	15°/100 ft	2 7/8 AOH	200 ^[2, 6] (12.61)
4.75 in. (121 mm)	5.625 - 6.125 in. (142 - 165 mm)	25°/100 ft	13°/100 ft	NC38	280/350 ^[3, 6] (17.7/22.1)
6.75 in. (172 mm)	8.375 - 9.875 in. (213 - 251 mm)	24°/100 ft	10°/100 ft	NC50	700 ^[4, 6] (44.2)
8.0 in. (204 mm)	12.125 - 14.75 in. (308 - 375 mm)	15°/100 ft	8°/100 ft	6 5/8 Reg.	900/1,200 ^[5, 6] (63.1/75.7)

- 120 gpm (7.6 L/sec) for Non-extended Flow Guide and 150 gpm (9.5 L/sec) for Extended Flow Guide. Operation from 120 - 150 gpm (7.6 - 9.5 L/sec) will accelerate erosion and will reduce service life. Operation above 150 gpm (9.5 L/sec) will result in severe erosion.
- Operating above 200 gpm (12.61 L/sec) will accelerate erosion and will reduce service life.
- Operation from 280 - 350 gpm (17.7 - 22.1 L/sec) will accelerate erosion and will reduce service life. Operating above 350 gpm (22.1 L/sec) will result in severe erosion.
- Operating above 700 gpm (44.2 L/sec) will result in severe erosion.
- Operation from 900 - 1,200 gpm (63.1 - 75.7 L/sec) will accelerate erosion and will reduce service life. Operating above 1,200 gpm will result in severe erosion.
- Sand Content: < 1% by volume recommended.

Mechanical and electrical connections and interface to APS SureShot™ MWD

- > Resistivity sub is a node on the SureShot RS-485 bus

Power requirements

- > Low operating power for maximum battery life
- > Designed to run with turbine alternator and 0x/1x/2x/3x battery (10 cell DD), or 3x/4x batteries

Tool Programming and Data Dump Port

- > Hatch cover for easy access via cable connection to allow tool programming and memory dump. Memory data dumps and tool programming can also be performed when the tool string is disconnected from the resistivity via the tool string lower end.
- > 32 MB integrated FLASH memory



4.75 in.
(121 mm)
WPR



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Wave Propagation Resistivity Sub (WPR™)

Product Specifications

Environmental

Operating Temperature	0° to 302°F; 347°F option (-18° to 150°C; 175°C option)
Pressure	20,000 psi (138 MPa)

Compensated Resistivity Measurements

Frequency	Measurement	Range	Accuracy
2 MHz	Phase Difference All Spacings	0.1 – 4,000 ohm-m	± 2% [0.1 – 25 ohm-m] ± 0.5 mmho/m [above 25 ohm-m]
	Attenuation Near Spacing	0.1 – 300 ohm-m	± 2% [0.1 – 25 ohm-m] ± 1.0 mmho/m [above 25 ohm-m]
	Attenuation Far Spacing	0.1 – 500 ohm-m	± 2% [0.1 – 25 ohm-m] ± 1.0 mmho/m [above 25 ohm-m]
400 kHz	Phase Difference All Spacings	0.1 – 4,000 ohm-m	± 1% [0.1 – 25 ohm-m] ± 1.0 mmho/m [above 25 ohm-m]
	Attenuation Near Spacing	0.1 – 300 ohm-m	± 1% [0.1 – 25 ohm-m] ± 2.0 mmho/m [above 25 ohm-m]
	Attenuation Far Spacing	0.1 – 500 ohm-m	± 1% [0.1 – 25 ohm-m] ± 2.0 mmho/m [above 25 ohm-m]

3.5 in.
(89 mm)
WPR

Transmitter / Receiver Spacings

	Measure Point					
	UH					DH
	T ₁	T ₂ *	R ₁	R ₂	T ₃ *	T ₄
in.	-36.00	-22.50	-4.25	+4.25	+22.50	+36.00
mm	-914.4	-571.5	-107.9	+107.9	+571.5	+914.4

Depth of Investigation, Vertical Resolution

R _f = 1 ohm-m R _{xo} = 0.5 ohm-m	Depth of Investigation		Vertical Resolution**
	Short Spacing Radius	Long Spacing Radius	
2 MHz Phase Difference	21 in. (533 mm)	28 in. (711 mm)	8 in. (203 mm)
400 kHz Phase Difference	30 in. (762 mm)	39 in. (991 mm)	12 in. (305 mm)
2 MHz Attenuation	34 in. (866 mm)	44 in. (1,118 mm)	8 in. (203 mm)
400 kHz Attenuation	52 in. (1,321 mm)	66 in. (1,676 mm)	12 in. (305 mm)
R _f = 10 ohm-m R _{xo} = 0.5 ohm-m	Depth of Investigation		Vertical Resolution**
	Short Spacing Radius	Long Spacing Radius	
2 MHz Phase Difference	26 in. (660 mm)	37 in. (940 mm)	8 in. (203 mm)
400 kHz Phase Difference	36 in. (914 mm)	49 in. (1,245 mm)	12 in. (305 mm)
2 MHz Attenuation	40 in. (1,016 mm)	53 in. (1,346 mm)	8 in. (203 mm)
400 kHz Attenuation	60 in. (1,524 mm)	76 in. (1,930 mm)	12 in. (305 mm)

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* Not included in 3.5 in. and 3.75 in. size. ** 90% response in conductive beds.