

Wave Propagation Resistivity Sub (WPR™)

SureLog-WPR™



4.75 in.
(121 mm)
WPR

APS's SureLog™ 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.

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

APS 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

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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	T ₁	T ₂ *	R ₁	R ₂	T ₃ *	DH
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)

Headquarters • Wallingford • USA
7 Laser Lane, Wallingford, CT 06492 USA
Phone: 860.613.4450 • Fax: 203.284.7428
contact@aps-tech.com

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