



Wave Propagation Resistivity Sub (WPR™)

DrilPro'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.

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

DrilPro 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 ^[1] (7.6)
4.75 in. (121 mm)	5.625 - 6.125 in. (142 - 165 mm)	25°/100 ft	13°/100 ft	NC38	350 ^[2] (22.1)
6.75 in. (172 mm)	8.375 - 9.875 in. (213 - 251 mm)	24°/100 ft	10°/100 ft	NC50	700 (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.	1,000 ^[3] (63.1)

1. 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.
2. Operation from 280 - 350 gpm (17.7 - 22.1 L/sec) will accelerate erosion and will reduce service life. Inspect the flow guide at the throat of the bore regularly.
3. Operation from 1,000 - 1,200 gpm (63.1 - 75.7 L/sec) will accelerate erosion and will reduce service life.

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 on 3x/4x batteries (10 cell DD) or 0x/1x/2x/3x battery and turbine alternator.



Measure • Communicate • Act™



MWD/LWD Sensors, Telemetry & Surface Systems



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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

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	0.1 – 3,000 ohm-m	± 1% [0.1 – 50 ohm-m] ± 0.5 mmho/m [above 50 ohm-m]
	Amplitude Ratio	0.1 – 500 ohm-m	± 2% [0.1 – 25 ohm-m] ± 1.0 mmho/m [above 25 ohm-m]
400 kHz	Phase Difference	0.1 – 1,000 ohm-m	± 1% [0.1 – 25 ohm-m] ± 1.0 mmho/m [above 25 ohm-m]
	Amplitude Ratio	0.1 – 200 ohm-m	± 5% [0.1 – 10 ohm-m] ± 5.0 mmho/m [above 10 ohm-m]

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

* Not included in 3.5 in. size.

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	21 in. (533 mm)	28 in. (711 mm)	8 in. (203 mm)
400 kHz Phase	30 in. (762 mm)	39 in. (991 mm)	12 in. (305 mm)
2 MHz Amplitude	34 in. (866 mm)	44 in. (1,118 mm)	8 in. (203 mm)
400 kHz Amplitude	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	26 in. (660 mm)	37 in. (940 mm)	8 in. (203 mm)
400 kHz Phase	36 in. (914 mm)	49 in. (1,245 mm)	12 in. (305 mm)
2 MHz Amplitude	40 in. (1,016 mm)	53 in. (1,346 mm)	8 in. (203 mm)
400 kHz Amplitude	60 in. (1,524 mm)	76 in. (1,930 mm)	12 in. (305 mm)

Specifications subject to change without notice.

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** 90% response in conductive beds.

