

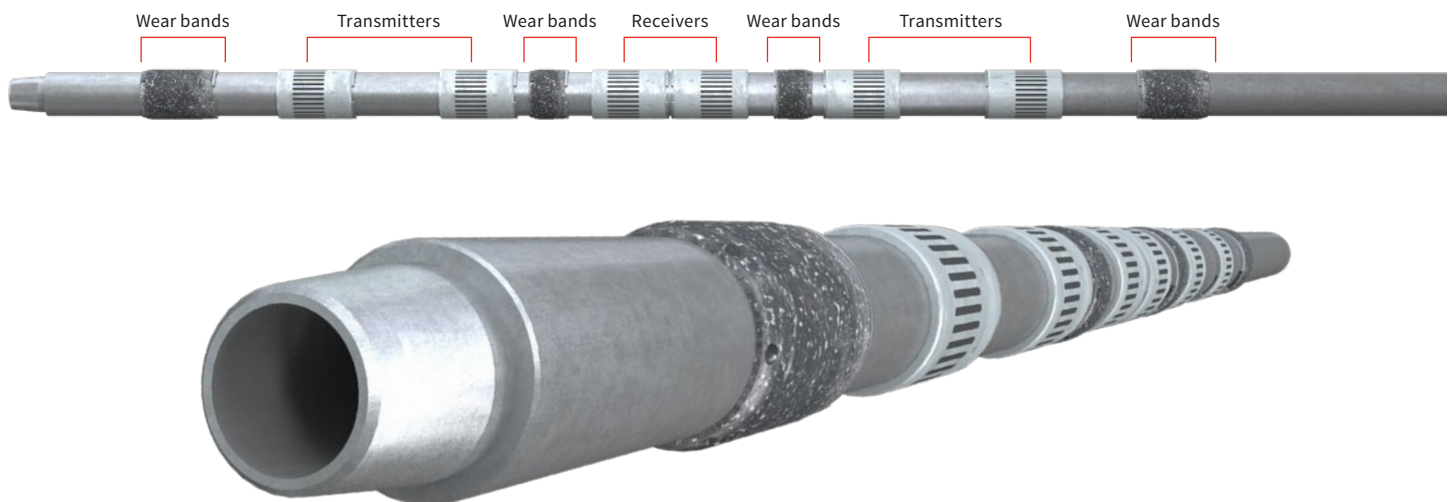
Tolteq Symmetric Propagation Resistivity MARK II Tool

The Tolteq™ symmetric propagation resistivity (SPR) MARK II tool offers real-time LWD resistivity combined with advanced, high-bandwidth MWD tools. The tool creates high-quality resistivity logs with both phase and attenuation measurements in real time, and measurement capabilities with multiple depths of investigation and vertical resolutions help with the drilling process. With a total of eight curves recorded into memory, the SPR MARK II has extremely high-resolution memory data with fast data dump capability. This feature enables field operators to create high-resolution logs after the run is complete with no negative impact on drilling time. The eight resistivity measurements can be further enhanced by applying borehole corrections in ToolTracker™, a user friendly data handling application.

The SPR MARK II is equipped with many new features such as an increased temperature rating of 160°C for high temperature applications, a more durable design that increases tool life in harsh applications, and it includes a new universal surface kit for easier rigsite operation. In addition, MARK II offers a rugged, fixed connection option based on the proven SureMate™ interconnection for reliable performance in challenging drilling conditions while an improved wet connect provides a rapid deployment option. The tool is now available as an integrated option with the NOV™ VectorZIEL™ rotary steerable system (RSS).

Features and benefits

- High-quality, real-time LWD data enhances well placement
- Multiple depths of investigation
- Symmetric design for improved data quality
- Borehole correction data
- Low-maintenance, reliable design
- Integration with Top Mount Pulser allows for short bit to gamma and bit to resistivity distance
- Easily removable and replaceable hard-faced wear bands for cost effective operation in abrasive environments



Tolteq Symmetric Propagation Resistivity Tool

Mechanical and operational specifications

General	400	600	800
Maximum operating pressure	20,000 psi	20,000 psi	20,000 psi
Maximum operating temperature	320°F (160°C)*	320°F (160°C)*	320°F (160°C)*
Maximum flow rate	400 gal US/min	750 gal US/min	1,200 gal US/min
Maximum sand content	3% by volume	3% by volume	3% by volume
Drill collar nominal OD	4.75 in.	6.75 in.	8.25 in.
Diameter at wear bands	5.50 in.	7.36 in.	9.00 in.
Makeup length	14.7 ft	13.7 ft	13.9 ft
Total tool weight	800 lbm	1,700 lbm	2,600 lbm
Top thread connection	NC 38 box	NC 56 box	API 7½ Reg box
Bottom thread connection	NC 38 pin	NC 56 pin	API 7½ Reg pin
Maximum rotation speed	300 rpm	300 rpm	300 rpm
Torque			
Maximum operating rotary torque	8,000 ft-lbf	15,000 ft-lbf	60,000 ft-lbf
Connection makeup torque	9,000 ft-lbf	30,000 ft-lbf	58,000 ft-lbf
Bending			
Maximum tool curvature	Rotating 15°/100 ft - Sliding 30°/100 ft	Rotating 8°/100 ft - Sliding 16°/100 ft	Rotating 8°/100 ft - Sliding 15°/100 ft
Axial			
Maximum jarring load	200,000 lbf	330,000 lbf	1,328,000 lbf
Maximum tensile load	30,000 lbf	40,000 lbf	185,000 lbf
Electrical Power (average)			
	6W	6W	6W
Memory			
	64 MB	64 MB	64 MB
Standard sampling rate	10 s (1 data set**/foot at 360 ft/hr)	10 s (1 data set**/foot at 360 ft/hr)	10 s (1 data set**/foot at 360 ft/hr)
Max data recording time at 10 s sampling	728 hours	728 hours	728 hours

*175°C option available upon request. **One data set consists of eight borehole compensated measurements.

Measurement specifications

Resistivity Range and Accuracy - Range values are for 22 in. TX-RX spacing; 40 in. spacing matches or exceeds the listed numbers.

Measurement	Frequency	Range (Ω.m)	Accuracy	Range (Ω.m)	Accuracy
Attenuation	400 KHz	0.1-5	±2%	5-35	±8 mS/m
Attenuation	2 MHz	0.1-25	±2%	25-60	±1 mS/m
Phase shift	400 KHz	0.1-25	±1%	25-2,200	±1 mS/m
Phase shift	2 MHz	0.1-125	±1%	125-3,000	±0.2 mS/m

Depth of investigation (ft) - Radial depth in a plane transverse to the tool axis at which the integrated geometrical factor reaches 50%.

Measurement	Frequency	Resistivity = 1 Ω.m		Resistivity = 10 Ω.m	
		TX-RX spacing 22 in.	TX-RX spacing 40 in.	TX-RX spacing 22 in.	TX-RX spacing 40 in.
Attenuation	400 KHz	2.5	3.3	5.1	6.3
Attenuation	2 MHz	1.7	2.2	3.0	4.0
Phase shift	400 KHz	1.4	2.0	2.1	3.2
Phase shift	2 MHz	1.0	1.4	1.6	2.3

Vertical resolution (ft) - Distance along the tool axis at which the normalized response function is 50% of its maximum.

Measurement	Frequency	Resistivity = 1 Ω.m		Resistivity = 10 Ω.m	
		TX-RX spacing 22 in.	TX-RX spacing 40 in.	TX-RX spacing 22 in.	TX-RX spacing 40 in.
Attenuation	400 KHz	4.1	4.0	6.3	9.0
Attenuation	2 MHz	2.1	2.1	4.7	5.4
Phase shift	400 KHz	1.3	1.3	1.7	2.0
Phase shift	2 MHz	1.0	1.0	1.4	1.5