

## Centerfire LWD System

The Centerfire resistivity system is the Black Diamond high-temperature LWD offering. Rated to 175 °C (347 °F) the system is available in three standard sizes - 4.75 in., 6.91 in. and 8.25 in.. The collar uses an industry standard transmitter-receiver design to provide eight different depth of investigation [DOI] borehole compensated resistivities.

The Centerfire collar is designed to provide existing Tensor Elite MWD customers an easy upgrade from directional or directional-gamma services to LWD while minimizing the total cost of ownership.

Black Diamond's commitment to customer success is demonstrated by an exemplary support network encompassing market leading repair services, comprehensive training (both e-learning and hands-on), localized support teams, and a dedicated website delivering best in class support materials.

### Features and Benefits

#### Borehole Compensated Measurements

Industry standard antenna layout with 19 in. & 41 in. antenna spacings, measuring both phase difference and attenuation, provides eight borehole compensated measurements, any of which can be transmitted in real time.

#### Deep-Reading Measurements

The deep-reading 400 kHz measurements from the 41 in. antenna spacings are ideal for geosteering and bed-boundary detection when combined with the shallower reading 2 MHz measurements from the 19 in. antenna spacings. The 2 MHz measurements also offer excellent vertical resolution for thin bed identification.

#### High Temperature as Standard

The Centerfire system is recognized as the system of choice for hot hole applications, with 347 °F operating temperature as a non-price premium standard.

#### Retrievable MWD String

The use of a wet connect assembly to provide communication between the MWD string and the resistivity collar enables retrieval of the directional module if the BHA becomes stuck or lost in the hole.



#### Cost Effective Fleet Management

Use of standard Tensor Elite MWD and Gamma modules, together with various surface system options, allows Centerfire users to maximize their fleet usage.

#### Easily Maintained

Centerfire was designed to enable simple maintenance. Wear parts are easily serviced and all electronics are accessible below hatch covers to allow drop-in replacement, where required. Calibration by way of air hang can be completed in less than 1 hour.

#### Proven Performance

With a history of successful deployments, including notable multi-lateral applications in China and Russia and offshore deployments in Mexico, the Centerfire system enables independent service companies to expand their service options, allowing them to compete in technologically advanced markets, with a cost-effective, proven platform.

# Centerfire LWD System - Specifications

Nominal OD		4.75 in.	6.91 in.	8.25 in.
Tool OD (antennas / wearbands)		5.0 in. / 5.25 in.	6.91 in. / 7.16 in.	8.25 in. / 8.5 in.
Length		14.5 ft (174 in.)	14.5 ft (174 in.)	15.16 ft (182 in.)
Tool Connections		NC 38	NC 50	6 5/8 in. API REG
Equivalent Collar Stiffness (OD x ID)		5.00 in. x 2.81 in.	6.58 in. x 2.81 in.	8.25 in. x 2.81 in.
Make-up Torque		9,600 lbf-ft	24,000 lbf-ft	46,000 lbf-ft
Flow Rate Range		200 - 350 usgpm	300 - 750 usgpm	450 - 1,200 usgpm
Max. Dogleg Rotation		12°/ 100 ft	8°/ 100 ft	7°/ 100 ft
Max. Dogleg Sliding		25°/ 100 ft	17°/ 100 ft	14°/ 100 ft
Measurement Points from Tool Bottom	Directional	22.2 ft (266 in.)	22.2 ft (266 in.)	22.9 ft (275 in.)
	Resistivity	6.1 ft (73.2 in.)	6.1 ft (73.2 in.)	6.8 ft (81.6 in.)
	Gamma	2.8 ft (33.6 in.)	2.5 ft (30 in.)	2.2 ft (26.4 in.)
Max. Pressure		20,000 psi	Max. Temperature	347 °F
Max. Sand		1.0% at maximum fluid velocity	Max. Mud Weight	18 ppg
Max. Rotation		200 RPM		
Max. LCM Tolerance		40 ppb any type, thoroughly and evenly mixed, with use of surface drill pipe screens		
Memory Capacity		14 MB (~250 hrs @ 10 second update)		

Sensor Specifications					
	Frequency	Spacing	Range	Accuracy	DOI*
Phase Difference	2 MHz	41 in.	0.1 to 2,000 ohm-m	± 2% (0.1 to 20 ohm-m) ± 1 mmho/m (>20 ohm-m)	49 in.
		19 in.	0.1 to 1,000 ohm-m	± 1% (0.1 to 10 ohm-m) ± 1 mmho/m (>10 ohm-m)	32 in.
	400 kHz	41 in.	0.1 to 500 ohm-m	± 2% (0.1 to 10 ohm-m) ± 2.0 mmho/m (>10 ohm-m)	66 in.
		19 in.	0.1 to 250 ohm-m	± 3% (0.1 to 5 ohm-m) ± 6 mmho/m (>5 ohm-m)	42 in.
Attenuation	2 MHz	41 in.	0.1 to 50 ohm-m	± 5% (0.1 to 16 ohm-m) ± 3 mmho/m (>16 ohm-m)	71 in.
		19 in.	0.1 to 50 ohm-m	± 5% (0.1 to 8 ohm-m) ± 6 mmho/m (>8 ohm-m)	47 in.
	400 kHz	41 in.	0.1 to 10 ohm-m	± 3% (0.1 to 3 ohm-m) ± 10 mmho/m (>3 ohm-m)	104 in.
		19 in.	0.1 to 10 ohm-m	± 5% (0.1 to 3 ohm-m) ± 15 mmho/m (>3 ohm-m)	73 in.
Vertical Resolution		6 in. in conductive beds < 10 ohm-m			

\*Diameter of Investigation - Radial diameter, centered on the tool axis, at which the Integrated Geometric Factor is 50%. Data presented relates to a modeled formation with  $R_t = 10$  ohm-m and  $R_{xo} = 1$  ohm-m