

## Centerfire Elite™ LWD System

The Centerfire LWD system is the preferred choice for operators who need to combine high temperature resistivity capabilities with the reliable performance of the Tensor Elite MWD platform. Recognizing the need for greater reliability as drilling environments become increasingly challenging, Black Diamond has introduced the Centerfire Elite™ LWD system, which outperforms all existing high temperature systems in its class. Centerfire Elite retains the key benefits of Centerfire, including three standard sizes – 4.75", 6.91" and 8.25", operating temperatures up to 175°C, eight different depths of investigation [DOI] borehole compensated resistivity, and full compatibility with Tensor MWD.

A series of improvements based on the Smart Connect system greatly improve performance, increase reliability, improve resistance to adverse drilling conditions, reduce power consumption and simplify maintenance, all of which improve service quality and reduce total cost of ownership. Black Diamond understands that by reducing electronic and mechanical failures while maintaining high-quality measurements in extreme drilling environments and sustained temperatures up to 175 °C/347 °F, the Centerfire Elite system opens up new lucrative markets for operators of all sizes. Coupled with the best-in-class support provided by Black Diamond, users can count on Centerfire Elite for continued success in the most challenging environments.

### Features and Benefits

#### Ruggedization

Antenna wiring and packaging damage are the main causes of failure in harsh environments while drilling. Centerfire Elite uses industry-leading materials and advanced manufacturing processes that greatly improve the system's erosion, wear, impact and temperature fatigue resistance. This reduces service costs and maximizes system utilization. Centerfire Elite also features a locking mechanism that ensures that the LWD drill collar and MWD tool string cannot be separated downhole. When operating downhole, even in high vibration environments and when operating in high-angle wells, the system ensures constant mechanical and electrical connection.

#### Market-Leading Pulsar Options

The Smart Connect Pulsar draws on technology used in the market-leading Tensor Elite Motor Driven Pulsers [MDP] and completely redesigns the Smart Connect system, resulting in unparalleled reliability and performance, with pulse widths typically as low as 0.5 Second.

By using the Tensor Elite connection system, the CTF can be connected using an top-mounted Pulsar, or a standard bottom mounted Pulsar can be run in a UBHO under the Centerfire drill collar.



#### Reduced Power Consumption

The most significant operating expense of any LWD resistivity system is the battery. By reducing power consumption, Centerfire Elite significantly reduces operating costs, maximizing service profits. Combined with a low-power motor-driven pulser, the Centerfire Elite system operates reliably on two standard batteries for more than seven days.

#### Rotary Connectors

The Tensor Elite rotary connector system allows Centerfire components to be fully or partially assembled in the workshop before being shipped to the drilling site. This greatly reduces operation time and risk when deployed at the drilling site.

#### Surface System Compatibility

By developing a stand-alone application, Centerfire Elite data can be decoded by any Tensor-style decoder and processed and displayed by any logging software package that supports WITS.

# Centerfire Elite LWD System - Specifications

Technical 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 ½ 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	configurable*	configurable*	
	Resistivity	73.25 in.	73.00 in.	80.87 in.
	Gamma	-22.7 in.*	-22.7 in.*	29.00 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)			

\*Directional Module and/ or Gamma Module can be run above or below the Centerfire collar

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

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MWD & LWD EXCELLENCE