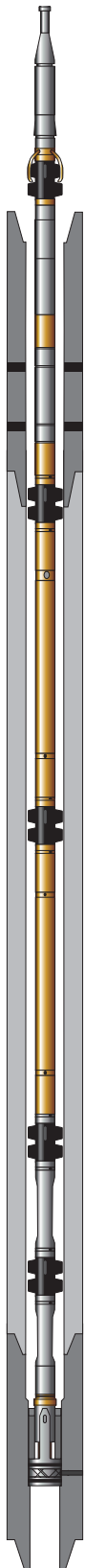


Electro-Trac EM MWD System



The Electro-Trac EM MWD system combines Tensor Drilling Technology's industry leading sensor package with state of the art EM technology. A revolutionary patented signal detection scheme – Data Fusion – allows simultaneous signal processing from up to 8 input channels to which ground breaking detection algorithms and noise characterization are applied. This allows the downhole tool to operate at lower power settings and at higher transmission frequencies while maintaining market leading detection success.

Based on the proven Tensor MWD mechanical architecture, the system is fully retrievable and replaceable with a Tensor MWD mud-pulse system. Bi-directional EM communication means the tool is always configured for optimal results.

Tensor Drilling Technologies 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 v Mud Pulse Telemetry

Improved Drilling Efficiency

Data transmission is independent of circulation allowing surveys to be completed during connections. Up to 12 bps allows less "hidden NPT" when orienting the BHA. Operating independently of flow rate allows drilling parameters to be optimized during unconsolidated kick-offs or lost circulation operations with no impact on detection.

Extended Applications

Independence of drilling fluid properties the system operates in air, mist, foam, gas-cut and under-balanced applications.

Reduced NPT risk

No moving parts and less wash allows for simpler and more cost-effective maintenance. Complete LCM tolerance removes pulser blockage issues or LCM limitations.

Features and Benefits v Other EM MWD

Cost Efficient

Using a standard non-magnetic drill collars and UBHO subs, the Gap Sub is the only non-standard BHA component. Mechanical compatibility with Tensor MWD means reduced equipment and inventory costs together with improved fleet utilization. Total cost of ownership is further reduced by minimal downhole power requirements (>200 hours per battery) and proprietary Gap Sub coating techniques which greatly extend Gap Sub operating life.

Extended Operating Envelope

Processing of up to 8 signal inputs allows detection of signals of $<0.05 \mu\text{V}$ enabling operation in formations and at depths (> 13600 ft TVD) in which other systems fail. EM downlinking to modify transmitted data sequences or operating variables (power, frequency etc.) minimizes costly trips for tool set up.

Simple Set Up and Maintenance

The modular probe is easy to transport and assemble at the rig site. A single lift and load to the collar minimizes NPT during BHA handling. All probe modules are easily maintained allowing quick kit turn around and high fleet utilization.

Electro-Trac EM MWD System - Specifications

Gap Sub Specifications

Collar OD	4.0 in.	4.75 in.	6.5 in.	6.75 in.	7.75 in.	8.0 in.	9.5 in.
Tool Connections	2 7/8 in. PH6	3 1/2 in. IF	4 1/2 in. IF/ 4 1/2 in. XH	4 1/2 in. IF	6 5/8 in. REG	6 5/8 in. H90/ 6 5/8 in. REG	7 5/8 in. REG/ 6 5/8 in. H90
Make-up Torque (lbf-ft)	6,200	8,000	24,000	24,000	42,000	55,000	85,000
Max. Flow Rate Range (usgpm) ¹	140	300	700	700	900	950	1200
Max. Dogleg Rotating (°/100 ft)	25	15	10	10	5	5	4
Max. Dogleg Sliding (°/100 ft)	37	25	18	18	8	7	6

1. Dependent on NMDC ID. Flow limited to 40 ft/sec

Probe Specifications

Probe OD	1.875 in.		
Probe Length	25.5 ft. and 26.9 ft. with Gamma (minimum - adjusted to monel length)		
Max. Pressure	20,000 psi		
Temperature - Operating	0 - 150 °C / 32 - 302 °F	Temperature - Survival	-40 - 175 °C/ -40 - 347 °F
Sand Content	0.25 %		
Shock Limit - Operating	1,000 g/ 0.05 ms, 1/2 sine	Shock Limit - Survival	2,000 g/ 0.05 ms, 1/2 sine
Vibration Limit - Operating	15 g peak (50 tp 800 Hz sine)	Vibration Limit - Survival	30 g peak (50 tp 800 Hz sine)
Battery	Hermetically-sealed Lithium Thionyl Chloride cells		
Battery Life	Up to 200 hours operating under typical operating conditions (6 bps & 50% power)		

Sensor Specifications

Directional	Tri-axial Fluxgate Magnetometers and Q-flex Accelerometers			Gamma	Sodium Iodide Scintillator Crystal			
	Measurement	Range	Resolution		Accuracy	Measurement	Sensitivity	Resolution
Inclination	0 - 180°	0.1°		+/- 0.1°	Gamma	1.7 cts / API	6.8 in.	+/- 5%
Azimuth	0 - 360°	1.0°		+/- 0.25°				
Toolface	0 - 360°	1.0°		+/- 0.5°				
Temperature	0 - 150 °C -32 - 302 °F	0.1 °C 0.1 °F		+/- 0.5 °C +/- 2 °F				
TMF	0 -100 µT	0.01 µT		+/- 0.075 µT				
Dip	-90 - 90°	0.1°		+/-0.15°				
GT	+/- 1.67 g	0.003 g		+/- 0.003 g				

System Specifications

Transmitted Data Rate	2 to 12 BPS (field selectable)		
Update Rate	Steering	8 to 12 seconds (4 parameters, user selectable)	
	Survey	20 to 30 seconds (8 parameters, user selectable)	

Surface System Specifications

Rig Floor Display & Rig Floor Sensors	ATEX Zone 1
Surface System	110 v or 240 v
Downlink power amplifier - maximum power	200 W