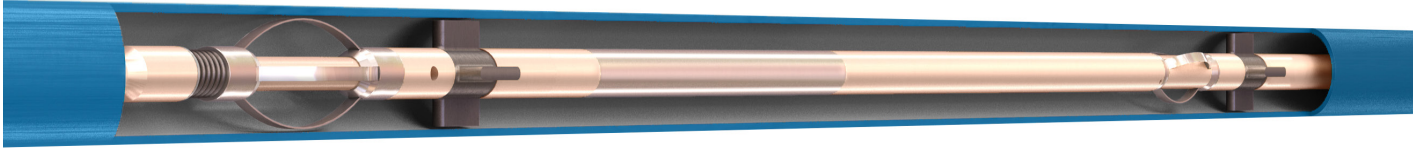
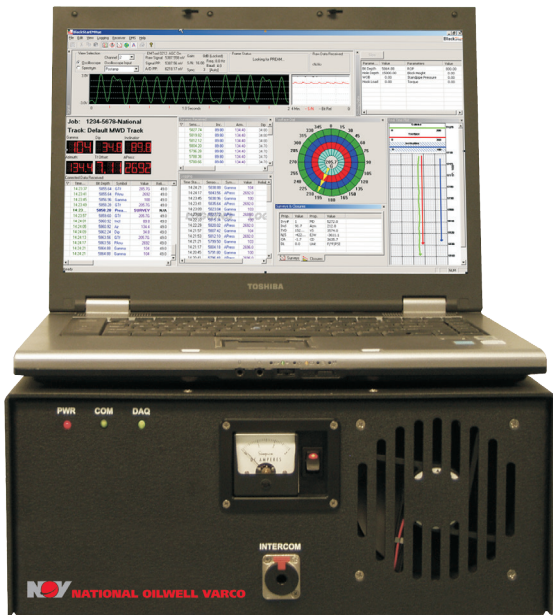


BlackStar II Dual-Telemetry MWD Tool



NOV's BlackStar™ II dual-telemetry MWD system combines the capabilities of both electromagnetic (EM) and mud-pulse (MP) data transmission, allowing for continuous drilling operations in the most challenging of conditions. With our BlackStar II retrievable MWD system, switching from EM to MP transmission can be performed via EM or RPM downlinking to avoid costly trips to change out equipment.

The BlackStar II tool's modular design allows flexibility in configuring the toolstring to maximize operational capabilities. Directional, drilling, and formation data are measured downhole and transmitted to surface as either EM waves or pressure pulses, where they are processed and displayed on the drilling console.



BlackStar EM MWD computer and surface amplifier

Features and Benefits

Diverse power management capabilities

- Enables increased power output (up to 40 watts)
- Offers the ability to shut down the transmitter while rotating
- Allows modules to operate from a single 28 V battery stack
- Provides dual-battery support

User-configurable options

- Offers multiple user-programmable frames: survey, steering, and rotation
- Allows for multiple open-circuit voltages in step increments
- Enables additional measurement channels: axial, radial, and total vibration

Onboard memory logging

- Directional module – surveys stored in memory
- Gamma module – gamma ray stored in memory

Third-party integration

- Allows compatibility with stepper and brushless DC motors or solenoid type pulser
- Enables use with downhole instruments using generic variables

Gamma and pressure modules

- Integration of gamma (360° and DRG) module, with optional annular and internal pressure

BlackStar II Dual-Telemetry MWD Tool

General Tool Specifications

Length	Single battery (directional only): 28.90 ft (8.81 m) Single battery (360° gamma/DRG): 30.75 ft (9.37 m) Dual battery option: add 7.45 ft (2.27 m) to toolstring length PWD option: add 23 in. (0.6 m) to toolstring length Mud-pulse option: add 54 in. (1.4 m) to toolstring length
Size	OD 1.875-in. (4.762-cm)
Pressure rating	20,000 psi (137,895 kPa)
Powered by lithium battery	80 to 130 operating hours depending upon borehole conditions and transmitter power selection. Up to 260 hours of operation maybe achieved for the dual battery option. Mud pulse-only mode up to 400 hours.
Operating temperature	-40 to 302°F (-40 to 150°C)
Downhole data storage	DRG <ul style="list-style-type: none">Log duration: 217 to 3,472 hrLogging interval: 15 seconds to 4 minutes Time, gamma, high-side gamma, low-side gamma, left-side gamma, right-side gamma, temperature, axial vibration (max), radial vibration (max) 360° gamma <ul style="list-style-type: none">Log duration: 150 to 2,400 hrLogging interval: 15 seconds to 4 minutes Time, gamma, axial vibration (average), radial vibration (average), axial vibration (max), radial vibration (max) Smart directional sensor <ul style="list-style-type: none">Log duration: Up to 1,000 hr (configuration dependent) Survey: Gx, Gy, Gz, Hx, Hy, Hz, DS temperature, axial vibration, radial vibration Steering: Gx, Gy, Gz, Hx, Hy, Hz, SDS temperature, axial vibration, radial vibration Rotation: SDS temperature, axial vibration, radial vibration Alert: <ul style="list-style-type: none">High temperatureHigh vibrationReady for EM downlinkEM downlink successTool entering sleep modeLow battery voltage
Downlinking	RPM and EM to change tool's mode of operation

Parameter Specifications

Parameter	Range	Resolution	Accuracy
Inclination	0 to 180°	0.05°	+/- 0.1°
Azimuth	0 to 360°	0.18°	+/- 1.0°
Toolface	0 to 360°	0.18°	+/- 1.5°
Dip angle	+/- 90°	0.1°	+/- 0.2°
Mag field	0 to 70,000 nT (gamma)	100 nT	+/- 200 nT
* High-side gamma	2,000 cps Window size 0 to 120°	1 cps	+/- 1 max RPM 120
* Low-side gamma	2,000 cps Window size 0 to 120°	1 cps	+/- 1 max RPM 120
* Left-side gamma	2,000 cps Window size 0 to 120°	1 cps	+/- 1 max RPM 120
* Right-side gamma	2,000 cps Window size 0 to 120°	1 cps	+/- 1 max RPM 120
Gamma	2,000 cps	1 cps	+/- 1 max
* Annular pressure	0 to 20,000 psi	8 psi	1%
* Pipe pressure	0 to 20,000 psi	8 psi	1%
Temperature	-40 to 302°F (-40 to 150°C)	1°F (0.07°C)	+/- 1.0°
* Tool rotary speed	0 to 120 RPM	4 RPM	+/- 2 RPM
* Radial vibration	0 to 18 g rms	0.01 g rms	+/- 0.5 g rms
* Axial vibration	0 to 18 g rms	0.01 g rms	+/- 0.5 g rms
* Gap current	60 to 2000 mA	60 mA	+/- 30 mA

*EM only or EM transmission

Data Transmission

Type	Low-frequency EM waves	Mud-pulse
Operating frequency	Field configurable 2 to 12 Hz	N/A
Data rates	1, 1.5, 2, 2.4, 4, 4.8, 6.0 bits per second	1 to 3 bits per second
Transmitted parameters	Field configurable	Field configurable
Data update rates	18 sec at 1 baud 3 sec at 6 baud	10 to 28 sec

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Formation Parameters (EM transmission only)

Formation resistivity 3 to 1,000 ohm meters, depending upon formation strata and borehole conditions

EM signal modeling service is available through NOV for prejob planning

Tubular Sizes and Pressure Drop

Size	Pressure drop at maximum flow rate with 8 ppg mud
3.75-in. OD, 2.3125-in. ID	180 psi at 160 gpm
4.75-in. OD, 2.6875-in. ID	76 psi at 370 gpm
6.5-in. OD, 3.75-in. ID	39 psi at 700 gpm
8.0-in. OD, 4.0-in. ID	21 psi at 1,200 gpm
9.50-in. OD, 4.0-in. ID	21 psi at 1,200 gpm

Tubular Sizes and Max Dogleg

Tubular size	Hole size	Max dogleg – Degree/100 ft	
		Sliding	Rotating
3.75 in.	4.750 to 5.875 in.	33	14
4.75 in.	5.875 to 7.875 in.	28	12
6.5 in.	7.5 to 9.875 in.	20	10
8.0 in.	9.875 to 12.5 in.	12	7
9.5 in.	12.5 to 14.5 in.	12	7

Mud and Fluid Parameters

Conventional drilling	Mud flow	Maximum dependent on NMDC ID fluid velocity flowing past tool not to exceed 40 ft/sec
	Mud sand content	Maximum 0.5% for continuous operation at maximum flow rate. Higher content tolerable at low rates
Underbalanced air/mist drilling	Minimum fluid injection rate: 30 gpm	
LCM tolerance		40 to 50 ppb concentration, any size, premixed