

At NOV<sup>®</sup>, our focus is taking technology downhole. We are committed to providing BHA solutions that are rugged and reliable, from design through repair and maintenance. Combined with our responsive customer service and support, this translates to increased BHA performance and reduced drilling costs for our clients.



*Our QA/QC and product testing procedures ensure the delivery of a structurally sound and reliable tool kit for every application.*

*All tools are manufactured and assembled in our state-of-the-art facility by the most experienced and knowledgeable technicians in the business.*



**Manufacturing / Service**  
The BlackStar EM MWD tool is manufactured, assembled and tested in NOV's Houston facility. The system is carefully packed in sturdy shipping containers and ready for delivery at a moment's notice. This compact packaging allows for ease of handling and the assurance that all parts arrive in an orderly and reliable condition.

**Commitment**  
As a worldwide leader in downhole drilling tools, NOV is dedicated to serving the oil and gas industry with quality equipment, reliable service, and the most experienced and knowledgeable people in the business. Our commitment to leading edge technology, precision manufacturing, and rigorous quality assurance allows us to focus on providing the most cost efficient tools available, around the clock and all over the globe.

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For a complete list of NOV's Downhole locations, visit us online:

[www.nov.com/DownholeLocations](http://www.nov.com/DownholeLocations)

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**BLACKSTAR™**  
Electromagnetic Measurement While Drilling Tools

Downhole Solutions

Drilling Solutions

Engineering and Project Management Solutions

Lifting and Handling Solutions

Production Solutions

Supply Chain Solutions

Tubular and Corrosion Control Solutions

Well Service and Completion Solutions



**DOWNHOLE**

**Measurement While Drilling (MWD)**

National Oilwell Varco® is a world leader in downhole tools, services and technology. Our state-of-the-art BlackStar Electromagnetic (EM) MWD system sets the standard for downhole data acquisition. Combining the latest in EM technology with the most durable and efficient design on the market, BlackStar provides you with a cost effective solution for EM MWD applications. We offer purchase with qualified training and 24/7 engineering support, as well as lease and rental options.

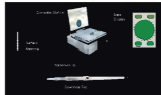
**BlackStar EM MWD Tools**

MWD applications involve the sending of measurements made by instruments located at the bottom of the hole back to the surface to allow the driller to understand such things as the location and orientation of the drill bit. Traditional MWD systems transmit information to the surface by sending pressure pulses through the drilling fluids or wire transmission.

EM systems send information to the surface through the earth's crust utilizing low frequency electromagnetic waves. Information is received at a surface antenna, decoded then processed by a computer and distributed to the driller's readout display without the encumbrance of mud or wire transmission.

**BlackStar Applications**

Since BlackStar's EM transmission is continuous, survey data can be transmitted during connections resulting in considerable savings in rigtime.



EM systems are the preferred MWD strategy in many applications, including:

- Under-balanced drilling
- Coal Bed Methane (CBM)
- Under-pressured formations
- Lost circulation
- Vertical control drilling
- Directional drilling
- Horizontal drilling
- Re-entry wells
- Contaminated mud systems

**Features / Benefits**

As a result of many years of field tests and design applications, the BlackStar EM MWD offers many key advantages over more traditional MWD systems. Some of these include:

- Key data points including:
  - magnetic/gravity tool faces
  - inclination
  - near-bit inclination
  - downhole RPM
  - azimuth
  - high side gamma
  - low side gamma
  - total gamma (directional and 360°)
- EM MWD will work in a variety of fluid conditions such as:
  - aerated mud
  - while pumping LCM material
- Programmable to meet local field conditions
- Variable data transmission speeds
- Separate steering and survey frames
- Compact and battery powered
- Electronic design eliminates mechanical parts
  - Does not require pump pressure
  - Data output in standard WITS format
  - Can be used with a variety of tubular sizes

Sensor Specifications			
Parameter	Range	Resolution	Accuracy
Inclination	0 - 180°	0.05°	+/- 0.2°
Azimuth	0 - 360°	0.18°	+/- 1.0°
Tool Face	0 - 360°	0.18°	+/- 1.5°
Dip Angle	0 - +/- 90°	0.1°	+/- 0.2°
Mag Field	0 - 70,000 gamma	100	+/- 200
High Side Gamma	2000 cps	1 cps	+/- 1 max RPM 120
Low Side Gamma	2000 cps	1 cps	+/- 1 max RPM 120
Gamma Ray	2000 cps	1 cps	+/- 1
Annular Pressure	0 - 15,000 psi	1 to 8 psi depending upon Selected full-scale range	1% Selected (6.89 to 55.15 kPa)
Temperature	-20 - 150°C (-4 - 302°F)	0.07°C (1°F)	+/- 1.0°
Total Vibration	0 - 30 g rms	0.01 grms	+/- 0.5 g rms
Downhole RPM	0-120 RPM	1 RPM	+/- .5 RPM
Near-Bit Inclination	80-100°	0.05°	+/- 0.1°
	80-70° and 100-110°	0.05°	+/- 0.5°

General Tool Specifications	
Length	30.75 ft. (9.373 meters)
Size	1.875" OD (0.5715 meters)
Pressure rating	20,000 psi (137,895 kPa)
Power/Lithium Battery;	80 to 130 operating hours depending upon borehole conditions and transmitter power selection. Dual Battery Options available on 2006 series tools providing up to 260 hours of operation.
Operating Temperature	-20°C to +150°C
Downhole Data Storage	Up to 144 hours of Gamma, Annular Pressure, Total Vibration, and Temperature stored at 1-minute intervals.
Downlinking	Pumps On/Off cycling sequence to change tool mode of operation.

**Operating Specifications and Limits**

Data Transmission	
Type	Low frequency electromagnetic waves
Operating Frequency	Field Programmable, 2 Hz to 12 Hz
Data Rates	1, 1.5, 2, 2.4, 4, 4.8, and 6 Bits per Second
Transmitted Parameters	Field Programmable
Data Update Rates	18 sec @ 1 baud; 3 sec @ 6 baud

**Formation Parameters**

Formation Resistivity	3 ohm/meters to 1000 ohm/meters depending upon Formation Strata, and Borehole Conditions
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EM Signal Modeling	EM signal modeling program available for prejob planning
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**Environmental - All Tools**

Shock	Operating 1000 g, .05 msec, ½ sine Survival- 2000 g, .05 msec ½ sine
Vibration	Operating: Sine Vibration - 15 gpeak, 50 to 800 Hz Random Vibration - 10 grms maximum Survival: Sine Vibration - 30 gpeak, 50 to 800 Hz Random Vibration - 20 grms maximum

**Specifications**

System Size	Pressure Drop at Maximum Flow Rate with 8 lb mud
3.750" (95 mm) OD X 2.313" (58.7 mm) ID	180psi (1241kPa) @ 160 gpm (0.60m³/min)
4.750" (121 mm) OD X 2.688" (68.3 mm) ID	76psi (524kPa) @ 370 gpm (1.40m³/min)
6.500" (165 mm) OD X 3.250" (82.6 mm) ID	39psi (269kPa) @ 700 gpm (2.65 m³/min)
8.000" (203 mm) OD X 4.000" (101.6 mm) ID	21psi (145kPa) @ 1200 gpm

System Size	Hole Size	Max Dog Leg - Degree/100 ft (Degree/30m)	
		Sliding	Rotating
3.750" OD (95 mm)	4.750" to 5.875" ID (121 to 149 mm)	60	20
4.750" OD (121 mm)	5.875" to 7.875" ID (149 to 200 mm)	28	12
6.500" OD (165 mm)	7.500" to 9.875" ID (191 to 251 mm)	20	10
8.000" OD (203 mm)	9.875" to 12.50" ID (251 to 311 mm)	12	7

**Mud or Fluid Parameters**

Conventional Drilling	Mud Flow Rate: Maximum dependent on NMDC ID, Fluid velocity/flowing past tool not to exceed 40 f/sec (12 m/sec)
Underbalanced/Air Drilling	Mud Sand Content: Maximum 0.5% for continuous operation at maximum flow rate/higher content tolerable at low flow rates Minimum fluid injection rates: 30 gpm (114 l/min)

**Computer Requirements**

RAM: minimum: 512 MB  
Recommended: 1GB  
HardDisk Space: 600 MB Free Space  
Processor: Pentium® III Compatible or higher  
Minimum: 600 MHz  
Recommended: 1GHz or higher  
Operating Systems:  
Microsoft® Windows® XP Professional Sp2  
Microsoft® Windows® 2000 Professional Edition Sp4  
Microsoft® Windows® Vista®  
CD Rom or CD RW  
LAN 10/100 base T connection  
Serial port (DB9 connection)  
Parallel Printer port



signal detection and decoding

Signal verification windows  
Detailed logging data  
Tool face histogram  
Database verification window

Every BlackStar kit is carefully packed and transported in durable, water-proof cases and available for rent, lease, or purchase with qualified training and 24/7 technical support available.