AccuWave®
Electromagnetic
MWD System

Reliable data transmission in all drilling environments
The AccuWave® Electromagnetic Measurement While Drilling (MWD) system is the premier solution for reliable data transmission in all drilling environments.

ACCUWAVE® ELECTROMAGNETIC MWD SYSTEM

AccuWave™ is a state-of-the-art collar mounted Electromagnetic MWD system utilizes the latest technology and design techniques.

ACCUWAVE® SYSTEM FEATURES

- Utilizes the latest technology to reduce circuit board count and eliminate connectors
- Single collar mounted design eliminates rig site assembly. Tools arrive ready for operation supporting manned or unmanned operations
- Compression mounted inside collar to better handle shock and vibration
- Proprietary electronics mounting collar to mitigate shock and vibration
- Capable of operating at 175°C (347°F) temperatures at 100 G’s shock / vibration levels

ACCUWAVE® MEASUREMENTS

- Directional Measurements
  - Standard Survey
  - 6 Axis Vector Survey
  - Gravity and Magnetic toolface
- Shock and Vibration
  - Axial and Lateral-Peak, RMS, Average
- Continuous Inclination
- API Gamma ray
- All measurements stored in memory at high resolution.

UNLIMITED LCM CAPABILITIES

Because the AccuWave® system has no mechanical moving parts to become plugged or packed off, it has no limit on the amount or type of lost circulation material (LCM), making it an ideal solution for areas where lost circulation is an issue.

SMART TELEMETRY

AccuWave® incorporates a telemetry switching scheme to maximize bandwidth use during rotating and sliding operation. This eliminates toolfaces while rotating when they are not needed to maximize log quality without sacrificing steerability while sliding.

EM FEATURES

- No moving parts
- Operates in all drilling environments
- Unlimited LCM tolerance
- Transmits survey during connections
- Advanced proprietary decoder

RIGLINE 24/7™

- Remote directional drilling and MWD operations:
  - Infrastructure capable to perform multiple directional & MWD jobs
  - DD, MWD and drillers trained on remote directional drilling
- Supporting operations with
  - QA/QC of sensor data and reports to ensure consistent and reliable reporting
  - 24/7 support for troubleshooting
  - Standard escalation process to include SMEs, engineers etc. to support field staff
  - As required, technicians/support staff dispatched to ensure fast response

CASE STUDY

An operator drilling the Wolfcamp in Crockett County needed an MWD solution to run in high LCM environments. The AccuWave® EM MWD system was chosen due to its unlimited LCM tolerance. As an added bonus, the AccuWave® System transmits survey data during connections, eliminating all time associated with mud pulse surveys and allowing for tagging bottom as soon as the pumps are turned on. Additionally, continuous inclination eliminated check shot surveys in the lateral. The breakdown of time savings can be seen in the table to the right.

<table>
<thead>
<tr>
<th>Time savings of using AccuWave® EM System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Time</td>
</tr>
<tr>
<td>No Check Shots</td>
</tr>
<tr>
<td>BHA Makeup</td>
</tr>
<tr>
<td>Total Time Savings</td>
</tr>
</tbody>
</table>

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AccuWave® EM MWD System Specifications

**Data Resolution**

- Inclination ± 0.1° (Range: 0-180°)
- Azimuth ± 0.5° (Range: 0-360°)
- Toolface ± 0.1° (Range: 0-360°)

**Continuous Inclination**

- ± 2° (0°-5°)
- ± 1° (5°-8°)
- ± 0.5° (8°-13°)
- ± 0.1° (greater than 13°)

**Gamma ray** ± 2% (Range: 0°C-150°C); ± 5% (150°C-175°C)

**Signal Transmission**

- Electromagnetic (EM)

**Collar OD**

<table>
<thead>
<tr>
<th>Size</th>
<th>OD</th>
<th>OD</th>
<th>OD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 in</td>
<td>6.5 in</td>
<td>8 in</td>
<td></td>
</tr>
</tbody>
</table>

**Collar Length**

- 25 ft

**Flow Ranges**

<table>
<thead>
<tr>
<th>Size</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 in</td>
<td>0-325 gpm</td>
</tr>
<tr>
<td>6.5 in</td>
<td>0-800 gpm</td>
</tr>
<tr>
<td>8 in</td>
<td>0-1200 gpm</td>
</tr>
</tbody>
</table>

**Sand Content**

- < 1% by volume

**LCM Tolerance**

- No limit

**Battery Life**

- 250-500 hours (formation dependent)

**Operating Temperature**

- 175°C (347°F)

**Maximum Pressure**

- 20,000 psi

**Maximum Vibration, g**

- 20 (rms, random, 15-1,000 Hz)

**Max. Shock, g**

- 500

**Dog Leg Capability**

<table>
<thead>
<tr>
<th>Collar OD</th>
<th>Max Dogleg Rotating @ 30 RPM</th>
<th>Max Dogleg Sliding</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 in</td>
<td>4 3/4</td>
<td>4 3/4</td>
</tr>
<tr>
<td></td>
<td>6 1/2</td>
<td>6 1/2</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>6.5 in</td>
<td>12°/100 ft</td>
<td>17°/100 ft</td>
</tr>
<tr>
<td></td>
<td>10°/100 ft</td>
<td>15°/100 ft</td>
</tr>
<tr>
<td></td>
<td>5°/100 ft</td>
<td>8°/100 ft</td>
</tr>
<tr>
<td>8 in</td>
<td>15°/100 ft</td>
<td>20°/100 ft</td>
</tr>
<tr>
<td></td>
<td>13°/100 ft</td>
<td>18°/100 ft</td>
</tr>
<tr>
<td></td>
<td>7°/100 ft</td>
<td>10°/100 ft</td>
</tr>
<tr>
<td>Slick BHA</td>
<td>17°/100 ft</td>
<td>22°/100 ft</td>
</tr>
<tr>
<td></td>
<td>15°/100 ft</td>
<td>20°/100 ft</td>
</tr>
<tr>
<td></td>
<td>8°/100 ft</td>
<td>11°/100 ft</td>
</tr>
<tr>
<td>Slick with Flex NMDC BHA</td>
<td>12°/100 ft</td>
<td>17°/100 ft</td>
</tr>
<tr>
<td></td>
<td>13°/100 ft</td>
<td>18°/100 ft</td>
</tr>
<tr>
<td></td>
<td>7°/100 ft</td>
<td>10°/100 ft</td>
</tr>
</tbody>
</table>

**MUD PULSE**

- PUMPS OFF (10-20 sec.)
- SET SLIPS (10-20 sec.)
- MAKE CONNECTION (1-2 min.)
- PUMPS ON (30 sec.)
- RECEIVE SURVEY (4 min.)
- CALCULATE SLIDE (1-2 min.)
- DRILL AHEAD

**EM**

- PUMPS OFF (10-20 sec.)
- SET SLIPS (10-20 sec.)
- MAKE CONNECTION (1-2 min.)
- PUMPS ON (10-20 sec.)
- DRILL AHEAD

AccuWave® System transmits during connections, eliminating all time associated with surveys.