

Model AP250 Electric Dipole System

Measures and transmits downhole data including accelerometer and magnetometer values

Datasheet

Features

- Proven design with high reliability and an MTBF above 2500 hours
- Data transmission from depths of 3000+ meters in favorable conditions
- Real time Annulus Pressure, Drill Collar Internal Pressure and Gamma

Applications

- Underbalanced Drilling
- High Speed Drilling where fast data rates are required
- Low Pressure Formations or Lost Circulation Situations

Description

The Model AP250 Electric Dipole System measures and transmits downhole data to the surface, enabling the directional drilling of a borehole. Data transmitted typically includes the inclination and azimuth angles of the borehole, the drilling system toolface (roll angle), and the tool temperature. The system can also be configured to transmit accelerometer and magnetometer sensor values, which can then be used to calculate the borehole angles.

Figure 1 shows the downhole parts of the electric dipole system. At the top of the system, a non-magnetic drill collar with an electrically insulated gap sub is used. To generate electromagnetic signals that propagate to the surface, a low frequency phase modulated signal is applied across the insulating gap. An upper electrode and the bolt in dipole head are used to apply the signal across the gap.

The gap sub signal is generated by the power driver electronics unit mounted in a pressure barrel just below the dipole head.

Typically, two 29V, 29 Amp-hour batteries encased in pressure barrels are used to power the electric dipole system, although use of three or more batteries is possible for situations where high power output for a long period is required.

The borehole angular orientation and drill string toolface are measured by a directional sensor mounted in a pressure barrel below the batteries. A gamma sensor is mounted directly below the system directional sensor.

The Electric Dipole System is typically approximately 150 inches long and utilize 1-7/8" diameter pressure barrels for system electronics and batteries. The same basic system can be used with 4-3/4", 6-1/2", 8" and 9" drill collar sizes. Mounting spacers enable the use of drill collar sizes greater than 4-3/4".

To stabilize the tool string in the drill collars, rubber finned centralizers are used to connect the various system pressure barrels.

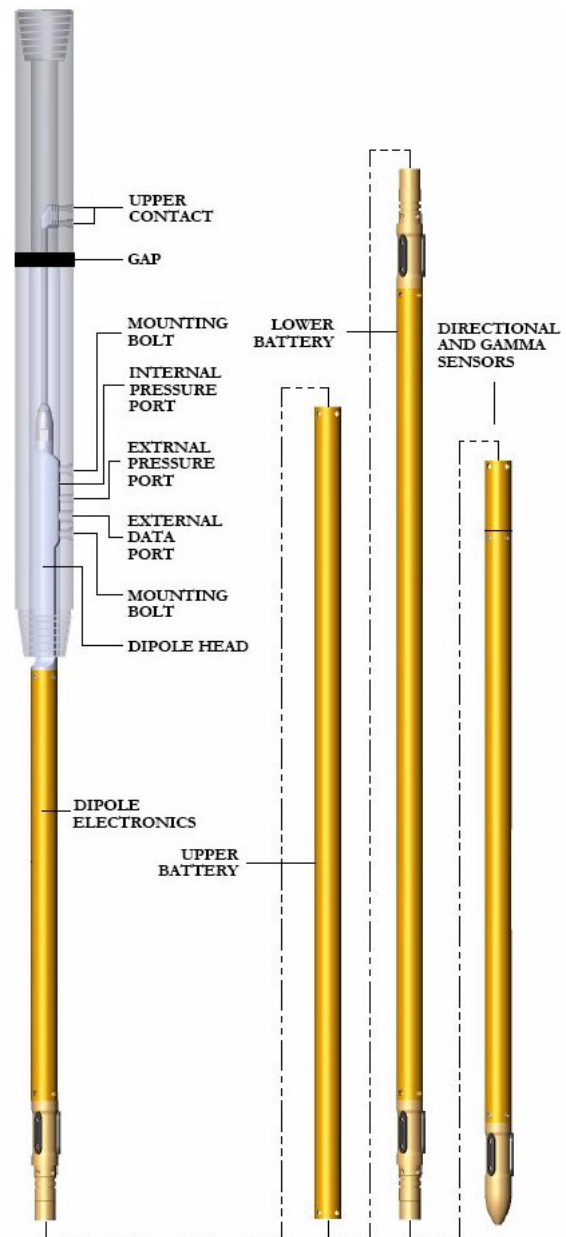


Figure 1. Model AP250 Electric Dipole System

Contents

1. Configuration and Deployment of the System.....	2
2. Reliability and Usage	2
3. Downhole System	2
4. Uphole System.....	3

1. Configuration and Deployment of the System

Before deploying a dipole system downhole, it is configured for the desired operating parameters by connecting to a side port connector mounted on the dipole head. Typical parameters that are programmed into the tool include the following:

1. Power level (0 to 40 Watts)
2. Frequency (2 to 10 Hz.)
3. Type of data packet desired (13 distinct data packets are available)
4. Initial dwell time before start of transmission
5. Secondary Power level value and time to activate
6. Downlinking time period

Some dipole configuration parameters programmed into the tool at the surface can be changed later by using the system downlinking capability. Downlinking is accomplished by energizing electrodes mounted in the ground at the surface. Downhole transmit power level is a common parameter to change using downlinking in order to conserve battery life and maintain an acceptable received signal level at the surface.

After configuration at the surface, the dipole system is typically carried to the rig floor in 4 pieces (dipole head, 2 battery pressure barrels, and directional/gamma sensor pressure barrel). After mounting the gap sub to a top non-magnetic drill collar (monel), the dipole system is assembled piece by piece before being lowered into the hole.

2. Reliability and Usage

One of the most important characteristics of the Model AP250 dipole system is the reliability of the system which exceeds 2500 hours (MTBF). This high reliability stems mainly from the mechanical simplicity of the system (e.g., no moving parts) and a superior shock mounting design for the electronic components.

A well-known characteristic of electric dipole systems is that the transmission signal level received at the surface decreases as the depth increases. Signals transmitted to the surface can also be attenuated by low conductivity strata above the gap sub transmitter. To achieve success in transmitting data to the surface, it is sometimes advisable to use the highest power level (40 Watts) and lowest frequency (2 Hz). Battery life under this condition is about 20 hours for each 29 A-H battery stack. To achieve long downhole times, sometimes 4 or 5 batteries must be used.

More commonly, a power level of 20 Watts and a frequency of 4 Hz are used resulting in a run time per battery stack of 40 hours.

3. Downhole System

Table 1. Downhole System Specifications

Frequencies	2-10 Hz, user selectable
Baud rate	One half of the transmission frequency. For instance, for a transmission frequency of 9Hz a 4½ baud rate is achieved.
Power	Batteries typically consist of two Double D stacks of 8 moderate rate cells each, producing 29V at 29 ampere-hour capacity. Battery lifetime depends upon transmit power selected. - At 10 Watts power level, battery life is 80. - At 20 Watts power level, battery life is 40 hours. - At the maximum power level of 40 Watts, battery life is 20 hours.
Mechanical	
Gap Sub Sizes	4¾" OD X 67.375 L; 3½ IF pin at bottom, box at top 6½" OD X 72.0" L
Tool string approximate length with 2 batteries	222"

Table 1. Downhole System Specifications

750 Directional Sensor	
Angular accuracy (0-150°C) - Azimuth (latitude <55°C) - Toolface (roll) - Inclination	±0.3° ±0.1° ±0.1°
Operating Temperature Range	0 to 150°C
Shock	1000G 1ms half sine wave
Vibration	20G rms 5-1000Hz
Digital Interface - Logic level - Baud rate - Protocol	TTL/CMOS User programmable up to 38400 baud User selectable ASCII, binary, or APS .NET format
Connector	MDM15SH003P (ITT Cannon)
Mating Connector	MDM15PH003L (ITT Cannon)
751 Gamma Sensor	
Scintillation Crystal	1" diameter X 5" long mounted SST Case
Photomultiplier Tube	Hamamatsu Model R1288
Sensitivity (in a 1-7/8" Beryllium Copper pressure barrel)	1 Count per API
Accuracy	±5%
Thin Bed Resolution (8" hole diameter) - Operating Temperature Range - Storage Temperature Range	6" (236mm) Temperature Range 0°C to 150°C -25°C to 160°C
Shock	1000 G 1ms half sine wave
Vibration (random)	10 G rms, 50-250Hz

4. Uphole System

4.1. General Description

At the surface, signals from the downhole system are measured by surface mounted electrodes. Typically one electrode is connected to the BOP and a second electrode is driven into the ground in the vicinity of the drilling rig.

Signal processing is accomplished by use of a low noise amplifier/filter system (Model 560 Processor). The amplified and filtered system is digitized by using a National Instruments high speed A to D system mounted on a laptop computer.

Two Windows based programs are used to further process the downhole signal: 1) Detect and 2) Virtual Drill

The Detect program contains sophisticated "brick wall" filters and additional digital processing algorithms to enable detection of weak signals in the presence of the ambient electrical noise present.

The output of the Detect program is transmitted by means of a TCP/IP link to the Virtual Drill Windows program. This program provides display of the downhole data and logging of the data to a MySQL data base. Graphing of the received data is also provided by this program.

The surface computer is also used to control and initialize downlinking to the downhole system to change power level, frequency and other parameters. The high power drive required to downlink is provided by the Model 574 downlink system. This system can provide downlinking on either the system receiving electrodes or separate electrodes driven into the ground in the rig vicinity.

4.2. Uphole Component Specifications

Table 2. Uphole System Specifications

Model 560 preamplifier/filter system	
Preamp gain selectable	0 to 42
Amplifier gain selectable	0 to 96
Power	115V @ 1A 220V @ 0.5A
Size	19"W x 13"D x 3 ½"H (rack mountable)
High Pass Filter	0.22 to 11 Hz roll off, user selectable
Low Pass Filter	3 to 21 Hz roll off, user selectable
Model 574 Downlink System	
Main power	115V @ 10A 220V @ 2.5A
Size	16"W x 12"D x 7 ½"H
Laptop Computer	Off-the-shelf unit with 16-bit A/D installed. One RS 232 port required for Driller's Display.

4.3. 560/574 Units

The Uplink Receiver (560 Unit) boosts and filters the analog signals from the antennas. The Downlink Transmitter (574 Unit) provides the high power required for downlinking to the downhole system.



Uplink Receiver — 560 Unit



Downlink Transmitter — 574 Unit

Figure 2. 560/574 Receiver/Transmitter Units