

Features

- Operational temperature to 175°C
- High accuracy: $\pm 0.1^\circ$ for toolface (roll) and inclination, $\pm 0.3^\circ$ for azimuth
- Digital serial input/output
- Real-time vibration monitoring
- Accurate "Inclination-while-drilling"
- Real-time rotation monitoring with accurate RPM reporting to 200 RPM
- Optional integrated axial shock mounts



Applications

- Replacement directional module for legacy MWD systems
- High-temperature drilling applications for oil, gas, and geothermal

The Model 1160 Directional Sensor enables high-accuracy measurement of the toolface (roll), inclination, and azimuth orientation angles in borehole logging and drilling applications. The unit can be a direct replacement for Tensor MWD directional sensors; for example, sensor length is the same as Tensor units, and the Tensor 10 pin Q-Bus is implemented to carry signals through the sensor.

The Model 1160 sensor contains both a 3-axis fluxgate magnetometer and a 3-axis accelerometer. The combination of these two sensor systems enables determination of the toolface, inclination, and azimuth angles of the 1160 reference frame. The toolface and inclination angles are calculated from the accelerometer sensor outputs, while azimuth angle is calculated from the magnetometer sensor output.

To maintain high accuracy over the temperature range of the system, the sensors are temperature-compensated. This enables an accuracy of $\pm 0.1^\circ$ for toolface and inclination and an accuracy of $\pm 0.3^\circ$ for azimuth to be achieved over the full temperature range of the system.

In addition to the Tensor A-to-D and flash memory interfaces, the Model 1160 has a digital serial interface. This interface is capable of transmitting either the magneto-

meter and accelerometer outputs or the system orientation angles. The data transmitted over the digital interface is temperature-calibrated and can be transmitted in either ASCII or binary format.

The 1160 transmits digital data upon command or autosends data upon power up. The serial in and serial out lines of the digital interface operate at TTL/CMOS levels and are normally set to operate at 9600 baud with one stop bit and no parity. Other baud rates can be user programmed.

The Vibration Detection feature transmits a Vibration Severity variable as a 3-bit, 1 to 5 scale (1 = very low, 5 = extremely high), which allows the operator to mitigate downhole vibration in real time (1-2 normal, 3-4 = possible tool damage, 5 = imminent tool damage). The Vibration Severity algorithm reduces the timing impact of this additional data to the logging sequence. Peak G levels can be transmitted real time, or logged to memory for retrieval after the run.

The 1160 sensor also includes a Rotation Monitoring feature that displays the current downhole RPM, and an "Inc-While-Drilling" sensor with an accuracy of $\pm 3^\circ$. This gives the Directional Driller the measurement needed to monitor changes in inclination, without having to stop drilling for a survey.

Model 1160

Advanced High Temperature Directional Sensor



Applied Physics
Systems



PHYSICAL

Outside Diameter (O.D.)	1.360" (35 mm)
Length	29.2" (742 mm)
Weight	1.5 lbs (681g)
Top Connector	MDM21PH003F (ITT Cannon)
Bottom Connector	MDM15SH003B (ITT Cannon)

ELECTRICAL

Input Voltage Range	+12V to +30V
Current Draw	70 mA @ 15V
Logic Level	TTL / CMOS
Baud Rate	User programmable to 9600 Baud
Protocol	User Selectable, ASCII or Binary

ENVIRONMENTAL

Shock	1000 G 1ms half sine wave
Vibration	5G RMS random, 50-200Hz
Azimuth Accuracy	$\pm 0.3^\circ$
Roll (Toolface) Accuracy	$\pm 0.1^\circ$
Inclination Accuracy	$\pm 0.1^\circ$ ($\pm 0.5^\circ$ while drilling at 50RPM)
Operating Temperature Range	0°C to +175°C
Storage Temperature Range	-25°C to +195°C

Specifications within this document are subject to change without notice.

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