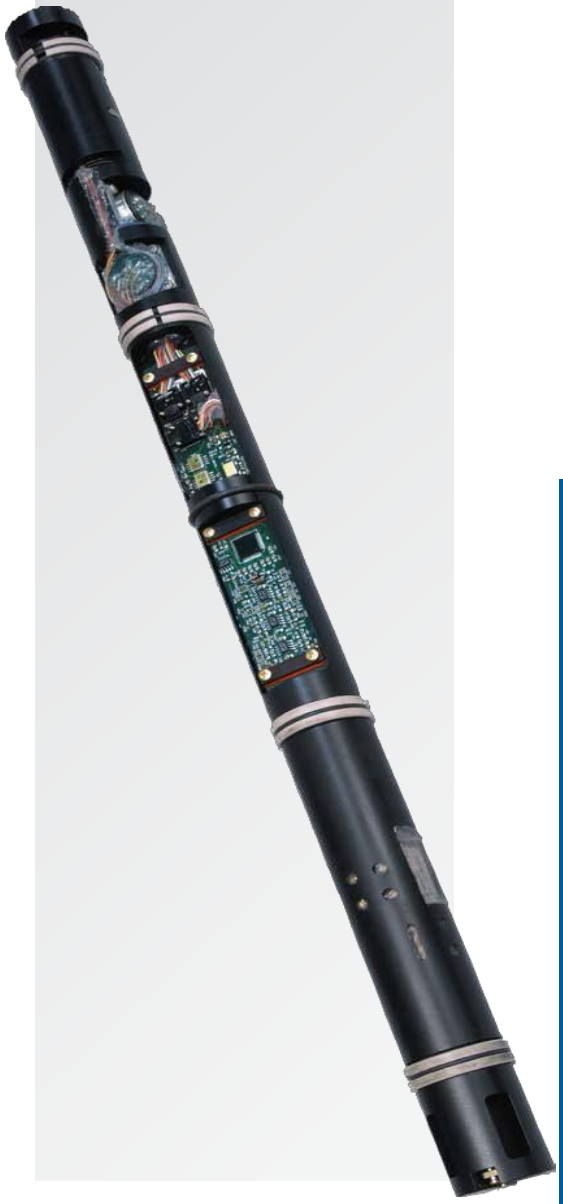
Digital Directional Sensor (DDS+VMM)

SureShot-DDS



APS directional sensor provides highly accurate azimuth, inclination, and vibrational data for all applications from straight-hole through horizontal drilling allowing for real time navigation and steering of the wellbore. The DDS in includes a tri-axial fluxgate magnetometer and three quartz accelerometers in APS's unique ruggedized package.

Simultaneous, 16-bit analog-to-digital conversion of all channels assures the best possible directional measurement while rotating. New hardware and a patent pending filtering algorithm provide consistent and accurate rotating/continuous inclination data for more precise wellbore placement. Rotating/continuous Azimuth is in field test now and will be available with a firmware change.

APS Technology offers local NIST-traceable DDS recalibration in China, Russia and the United States, which simplifies R&M logistics and improves asset utilization.

APS's directional sensor contains an integrated VMM sensor for real time vibration and stick-slip monitoring and post run analysis.

Product Specifications

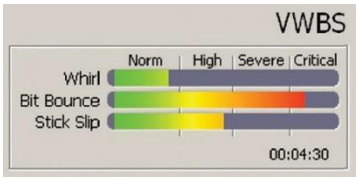
	Range	Absolute Accuracy
Inclination	0° - 180°	±0.1°
Rotating Inclination		±0.2°
Azimuth	0° - 360°	±0.75° (Inc >10°, Dip <70°)
Rotating Azimuth		±1° (Inc >10°, Dip <70°, Azm>10 ° from North/South)
Tool Face (Gravity)	0° - 360°	±1.0° (Inc >10°)
Tool Face (Magnetic)	0° - 360°	±0.5° (Inc >10°, Dip <70°)
Dip Angle		±0.3°
		±3.0° (1.0° <Inc <10°)
Total Gravity Field	± 1.2 *g*	± 0.003*g*
Total Magnetic Field	±70,000 nT (0.7 Gauss)	±300 nT (±0.003 Gauss)
Operating Temperature	-25° to 150°C; 175°C option	
Pressure	Standard: 20,000 Psi; High pressure: 25,000 Psi (Option) or Ultrahigh pressure: 30,000 Psi (Option)	

SureShot™ Vibration Memory Module (VMM™)

SureShot-VMM

APS's VMM™ is a software-enabled extension to our SureShot MWD tool that measures, analyzes, records and enables real time transmission of axial (bit bounce), lateral and torsional (stick-slip, chatter and whirl) vibrations and shocks. VMM allows users to assess the severity of downhole drilling to improve drilling efficiency and alert them to vibration conditions that could damage MWD and other downhole tools. The real time and memory data can be correlated to drilling events and equipment performance to improve drilling efficiency or prevent failures. The real time and memory data can also provide evidence for use in warranty claim resolution. Real time, memory and surface sensor data can be viewed with the SureShot VMM Viewer, plotted with APSPlot™ and exported in industry-standard formats (ASCII, LAS, WITS and WITSML).

Features	Advantages	Benefits
Software option in SureShot Control Center (SSCC™)	Vibration monitoring service can be easily added	Reduced operating cost and increased service flexibility
Configurable vibration level update times Real time vibration level alerts	Regular notification of vibration levels; increases awareness of downhole drilling conditions Notify rig personnel of severe vibration conditions	Allows optimization of drilling parameters for ROP maximization Modify drilling parameters before damaging equipment
Real time and memory vibration data	Evaluation of vibration data and drilling parameters to optimize drilling efficiency	Improved drilling efficiency
Vibration data export via SSCC	Vibration data can be shared with other packages or transmitted to customer's office	Vibration can be easily integrated with other wellsite services and data can be



SSCC's Real Time Vibration Alert Window

	VMM
Measurement Devices	Three ±120 *g* accelerometers, in APS MWD Controller Chassis 3-axis fluxgate magnetometer, in D&I Module
Data SamplingRate	Accelerometers – 100 samples/s max. Magnetometers – 100 samples/s
Real Time Telemetry	Configurable at rig site
VibrationMemorySize	Up to 32 MB
Memory Recording	Average and peak data stored on configurable intervals; event-driven bursts of configurable lengths recorded when configurable thresholds arecrossed
Data Recorded:	
Max. Lateral	0 to 169.7 *g*
Vibration RMS	0 to 169.7 *g*
LateralVibration	0 to 120 *g*
Max. AxialVibration	0 to 120 *g*
RMS Axial Vibration	±314 rad/s (±18,000 deg/s)
Memory Dump	Connect to sonde at surface to program and dump memory