Total Vibration™ Monitor 2 Sensor

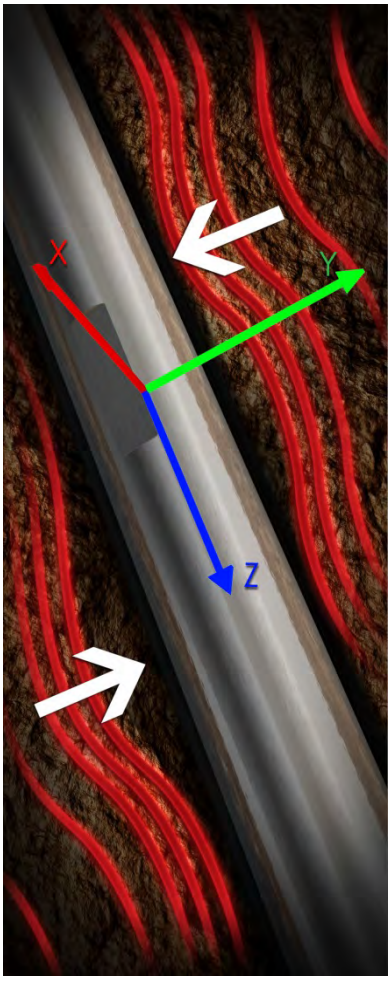
Provides real-time shock and vibration indicators and high-resolution recorded data to optimize drilling and prevent downhole BHA damage

Applications

- Real-time and post-run drilling optimization
- Damage prevention and root-cause analysis
- Detection of rotational dynamics, including stick-slip and torsional oscillation*
- Condition-based monitoring for preventative maintenance
- Advanced drilling research*

Features and Benefits

- Three-axis shock and vibration data enables the user to identify all vibration modes, isolate the source of vibration, and implement effective mitigation strategies.
- Color-coded severity levels enhance the accuracy of real-time and post-processed data interpretation.
- When combined with the hostile-environment-logging (HEL™) system, the Total Vibration monitor (TVM) 2 sensor provides real-time shock and vibration data at the surface. The HEL system can be configured to transmit shock and vibration data when levels exceed safe limits, which reduces telemetry bandwidth requirements.
- The TVM 2 sensor can be upgraded to the TVM 2+ sensor by adding the industry's first high-temperature angular-rate gyroscope (ARG). The ARG measures high-speed, angular rotation downhole, which enables detection of all modes of torsional vibration and stick-slip. With the ARG, the TVM 2+ sensor takes reliable measurements even when subjected to severe vibration and magnetic interference.
- A standard memory log captures shock and vibration data continuously at a rate of one sample per second.
- A rapid-sample log captures high-fidelity shock, vibration, and angular-rate* snapshots at 1,000 samples per second.
- Multiple TVM 2 sensors can be placed in the same drilling assembly to gather distributed vibration measurements.
- By combining downhole data from the TVM 2 sensor with surface data, users can gain a more comprehensive analysis of the drilling environment.



The TVM 2 sensor has three accelerometers: one tangential (X), one radial (Y), and one axial (Z) relative to the centerline of the toolstring.

** Features and applications exclusive to the TVM 2+ sensor*

Total Vibration™ Monitor 2 Sensor

Tool Description

The Weatherford TVM 2 sensor measures lateral, torsional, and axial shock and vibration, and provides critical logging-while-drilling (LWD) data in both real-time and recorded formats. The sensor maximizes the amount of real-time data delivered while minimizing the amount of transmission bandwidth used, which enables operators to use the remaining bandwidth for other operations such as geosteering and formation evaluation.

The TVM 2 sensor provides industry-standard shock and vibration measurements as well as more advanced data. The TVM 2+ sensor, which includes a high-temperature ARG based on microelectrical mechanical machine (MEMS) technology, enables detailed measurement of downhole angular rate. The ARG accurately measures the true angular rotation rate even when subjected to severe downhole vibration and magnetic interference—two parameters that lead to unreliability in conventional magnetometer- or accelerometer-based devices.

Both the TVM 2 and the TVM 2+ sensors are compatible with the Weatherford Revolution® rotary-steerable system (RSS), HEL system, and WAVE LWD tools. With greater insight into the root causes of downhole shock and vibration, the user can make fast, informed decisions regarding remedial actions.

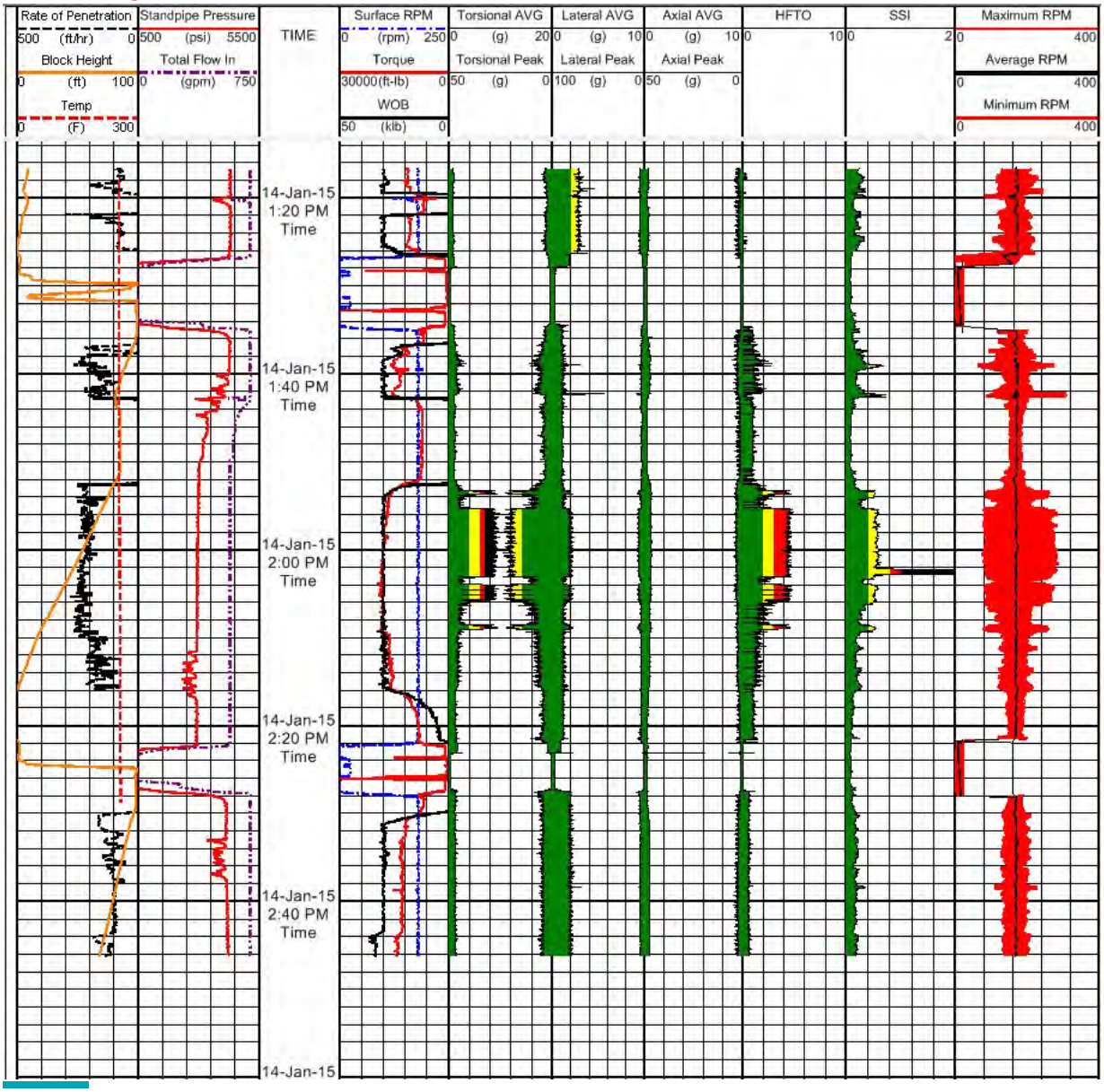
Total Vibration™ Monitor 2 Sensor

Specifications

Model	TVM 2	TVM 2+
Sensor type	3 x 200-G accelerometers for lateral, torsional, and axial shock and vibration	3 x 200-G accelerometers for lateral, torsional, and axial shock and vibration ARG for downhole rpm
Measurement range	−200 G to 200 G	
Measurement resolution	Real-time: 0.8 G Recorded: 0.2 G	
Sample rate	1,000 Hz	
Logging rate (continuous log)	User-defined, ≥1 Hz	
Maximum operating temperature	356˚F (180˚C)	329˚F (165˚C)
Maximum operating pressure	30,000 psi (207 MPa)	

Total Vibration™ Monitor 2 Sensor

Standard Log – TVM 2+ Sensor



The standard log produced by the TVM 2+ sensor with ARG includes stick-slip index (SSI) and rpm measurements (two right-most tracks) in addition to shock and vibration data, all captured at a rate of one sample per second.

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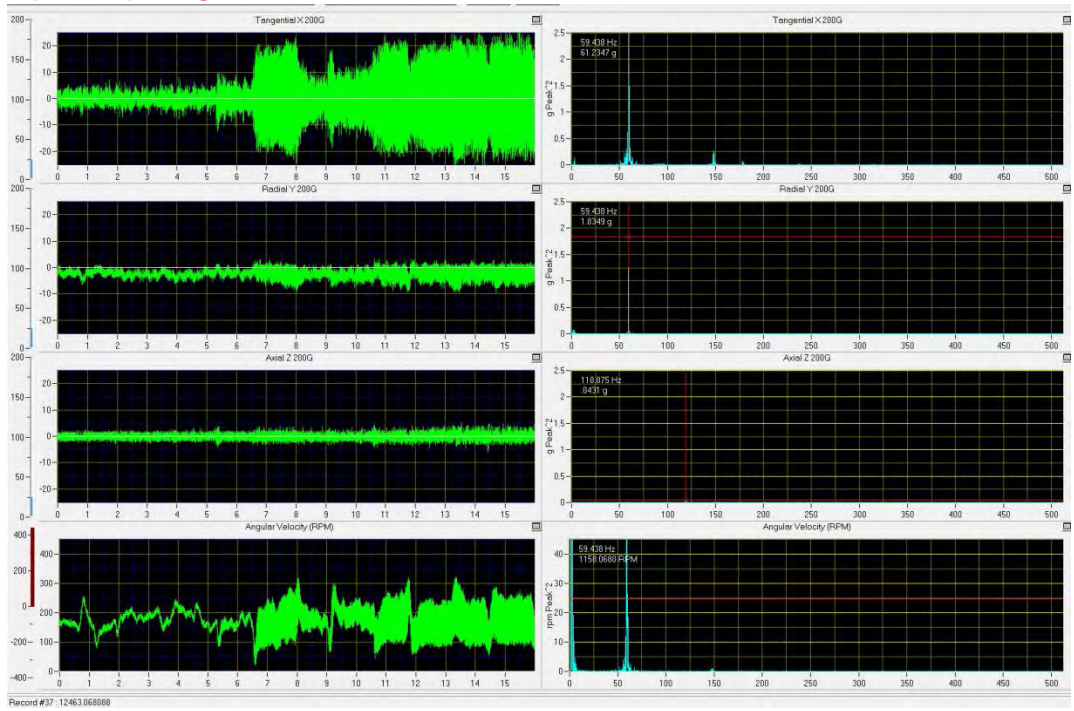
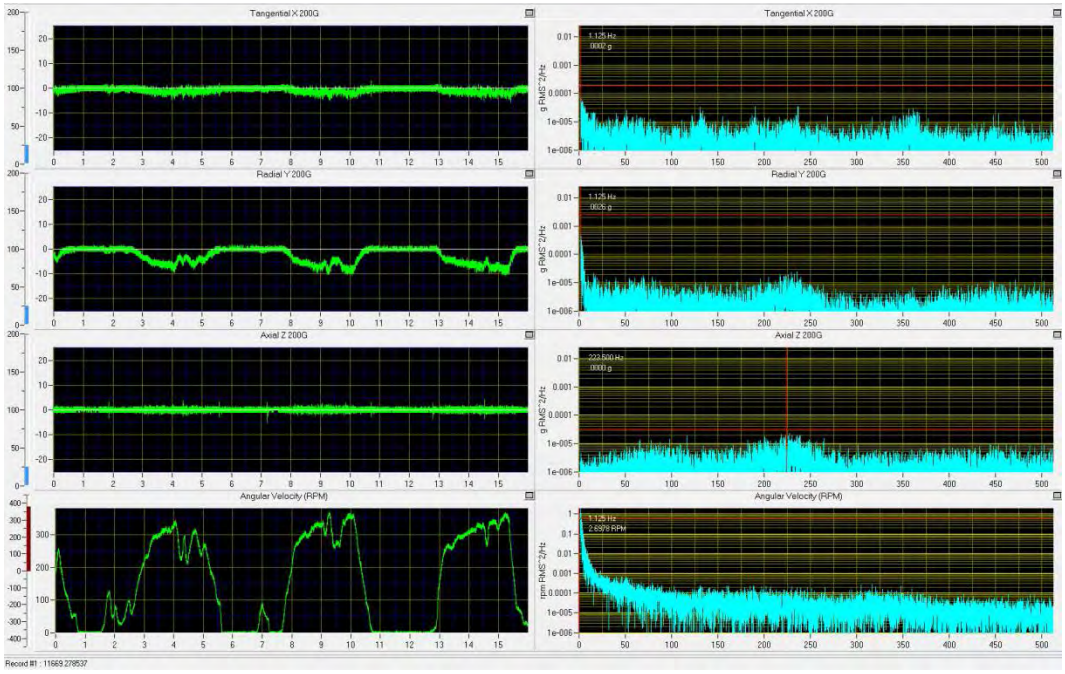
Rapid-Sample Log



Both the TVM 2 and the TVM 2+ sensors produce a rapid-sample log, which captures torsional, lateral, and axial vibration data at a high sample rate (burst data). The TVM 2+ sensor also records the angular rotation rate in the rapid-sample log. Analysis software provides high-resolution time and frequency domain analysis of vibration signatures. The above image is an extract from a rapid-sample log that shows high-frequency torsional bottomhole-assembly (BHA) resonances. The frequency domain analysis reveals a unique vibration frequency resulting from excitation of a resonant BHA mode.

Total Vibration™ Monitor 2 Sensor

Rapid-Sample Log Showing Full Stick-Slip Data



The TVM 2+ sensor also provides full slip-stick data. The above image is an extract from a rapid-sample log that shows full stick-slip characterized by distinct periods of 0 rpm during the stick phase followed by rapid increases in rpm during the slip phase.