CSI 2140 Machinery Health Analyzer

- Easy data collection and powerful analysis tools in a single unit
- Four-channel data collection for faster route completion and advanced diagnostics
- Embedded intelligence guides test set up and data analysis
- Ergonomically designed to improve usability in the field
- Convenient uploading of data wirelessly to AMS Suite from the field

The CSI 2140 Machinery Health Analyzer is best in class for speed and performance in vibration data collection and field analysis.

Overview

In today's economy, plants are continually looking for ways to remain competitive in the market place. For maintenance departments, this often translates into fewer staff and smaller budgets. In this do-more-with-less environment, maintenance personnel can't afford to continuously chase the next breakdown. They need to quickly and accurately identify developing faults and determine the root cause of the machinery problem so it can be fixed.

The CSI 2140 is the next generation in a family of industry-leading vibration analyzers and data collectors from Emerson. As with previous models, the CSI 2140 can provide:

- Route vibration collection
- Advanced vibration analysis
- Cross-channel analysis
- Transient analysis
- Dynamic balancing
- Motor monitoring
- ODS modal analysis

In addition to providing fast, actionable information, an effective solution must take advantage of modern communication and interface innovations that make tasks easier and more intuitive. Emerson's CSI 2140 Machinery Health Analyzer was designed specifically with these goals in mind.

Wirelessly upload route data and corrective maintenance jobs from the field to AMS Suite: Machinery Health Manager for analysis and reporting. AMS Machinery Manager integrates data from multiple technologies, including vibration, oil analysis, thermography, and balancing into a single database. Alerts generated by AMS Machinery Manager can be exported automatically to AMS Suite: Asset Performance Management where they are combined with alerts from other plant assets to provide a unified view of your plant's health. Together, the CSI 2140 and AMS Suite deliver the predictive intelligence necessary for increasing availability and reliability in the plant.

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The Four-Channel Advantage

While the CSI 2140 is available in single and dual channel options, it is the four-channel option that delivers the most advantages to a predictive maintenance program. The CSI 2140 is already 30% faster than the CSI 2130 (one of the fastest data collectors in the industry) when collecting a measurement point. With four-channel capabilities, speed through the data collection route is increased even more. And unlike other four-channel units on the market, the CSI 2140 delivers all four channels when you need them the most – critical equipment startup and troubleshooting diagnostics.

Monitor More Machines in Less Time Using True Four-Channel. Using a triaxial accelerometer, the CSI 2140 simultaneously collects vertical, horizontal, and axial readings on a bearing. Place the sensor on the measurement point, press the button, and when collection is complete move on to the next bearing. Data collection time is reduced by as much as 50% compared to the CSI 2130, and even more when compared to other vibration collectors. Faster data collection translates into less time in harsh or hazardous environments, more machines monitored, and more time dedicated to higher value tasks like analysis and diagnostics.

Four-Channel Data Collection Enables Powerful Diagnostic Options. Perform additional advanced diagnostics and deeper dive diagnostic tests using four-channel collection. With four-channel monitoring, you will gain additional data and diagnostic tools to help you identify the root cause of your toughest equipment problems. For example,

- View dual orbit plots, one on either side of the coupling or dual orbit plots of both sleeve bearings on a turbine, fan, or other production asset to see how the shaft is moving in relation to the bearing races.
- Collect ODS Modal data 66% faster to animate physical movement of machinery, an important tool in identifying the root cause of chronic or complex machinery problems.

Having the information you need for advanced diagnostics faster allows you to move more quickly towards identifying machinery faults or determining if it is safe to continue startup of turbo machinery.

scenario

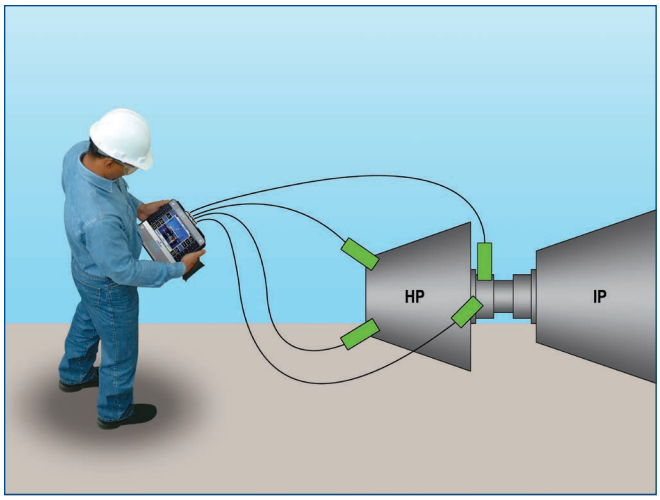
Where is the Vibration Coming From: Coherence Testing in One Step

Today is your first chance to use the new CSI 2140 Machinery Health Analyzer with four-channel data collection capabilities to collect route data on the eight critical motor/pumps that drive 80% of your production. On pump #3, you notice some unusual vibration readings. Is this a problem in motor/pump #3, or something else?

Last month there was high vibration levels in pump #5 – you remember because you spent hours trying to find and fix the problem and ended up missing the game on TV that night. Turned out that motor/pump #5 – vibration from motor/pump #6 was being transferred to #5. If coherence testing had been an efficient option with your old analyzer, you would have known how to find the true source of the vibration and gotten home on time.

Here you are today with the power of four-channel data collection in your hands. You can perform coherence testing of motor/pump #3 and its neighbors in just two minutes. You already have a sensor attached to motor/pump #3, so you attach a sensor to each of its neighbors.

Pressing Enter on the analyzer shows you the results. There is no coherence among the motor vibrations. Number three is truly the motor you need to address. Now you can confidently get to work to solve the issue.



The CSI 2140 provides four-channels of simultaneous data collection plus phase, delivering real-time views into the most complex machinery problems.

The comfort strap is easy to detach and reattach, and simplifies single-handed use in the field.

More Power That is Easy to Carry into the Field

Route data collection can be a long process – and you need an analyzer that has the battery power to last an entire shift and comfortable enough to carry around all day. The CSI 2140 takes advantage of ergonomic principles and advanced engineering to address these needs. This thinner, lighter analyzer is comfortable to carry on long routes and operate with one hand. The shoulder strap has a large, slip-proof padded area to reduce friction on the neck and back. Connecting the strap is as simple as the push of a button, making it easy to quickly reconfigure for left- or right-hand users.

Visibility in Any Environment. Struggling to see the details of spectrum or waveform data due to sunlight or other lighting conditions is a thing of the past. The CSI 2140's glove-friendly touch screen features an auto light sensor that adjusts the screen's backlight to the ambient lighting of the environment for optimal viewing. Visibility is maintained as you move from one area of the plant to another – from direct sunlight to darker interior locations. A backlit keypad allows continued operation of the unit in the darkest environments. In the office, the built-in stand sets the unit at the best angle for viewing data. Charger and communication cables are located at the top of the unit so they do not interfere with the standing position.

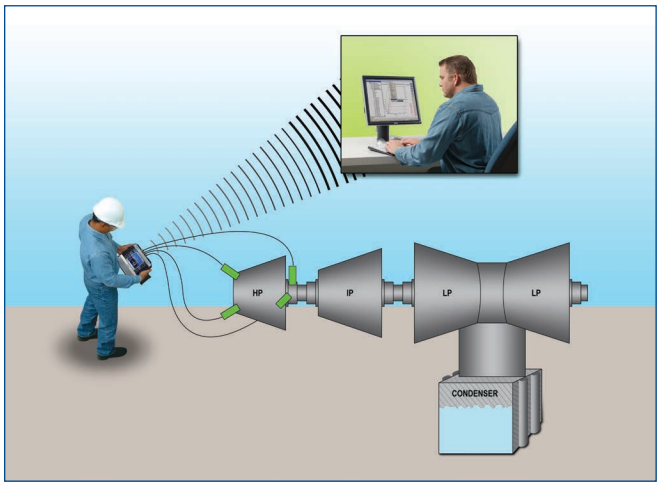
Uninterrupted Route Collection. The CSI 2140 has the longest battery life available in the market, which means no more long trips back to the office to dump data or deal with a dead battery. New Lithium-Ion batteries extend battery life and route coverage to a full shift – maybe two – from a single charge. If you do choose to change out the battery, the unit is re-engineered to make the task simple enough to accomplish even in the field. In addition, an external charger allows you to charge a spare battery while you continue to use your analyzer in the field. A car charger option enables you to deliver a charge en route.

The CSI 2140 uses local hotspot availability to wirelessly transfer data back to the office for quick analysis or from remote locations to a centralized server. Your team can perform route collection and analysis in parallel to maximize your efficiency.

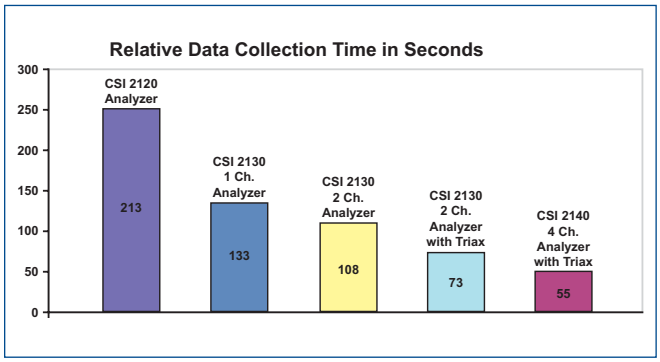
Embedded Intelligence

The ability to perform additional diagnostic tests at the machine site transforms simple data collection into an effective machinery health program. In today's demanding work environment, it is difficult to find the time to acquire advanced analysis skills. Embedded intelligence, enabled through Analysis Experts, allow even a novice user to conduct sophisticated troubleshooting tests with the touch of a button. Technicians don't need to remember the complexity of setting up a test they only perform a few times a year – yet they can gain the benefit of its diagnostics when needed. The bottom line impact is that users can quickly do more in the field with the CSI 2140, avoiding further deterioration of equipment condition.

The backlit keypad and ambient lighting of the larger, brighter screens makes the CSI 2140 visible in any environment.



Wireless transmission of route data from the field to the analyst back at the office allows collection and analysis to be performed in parallel



Building on Field-Proven Technology

Emerson's next generation vibration analyzer builds on the field-proven, industry-leading technology of its predecessors. The same great capabilities you count on in the CSI 2130 are available in the CSI 2140.

Earliest Detection of Bearing and Gear Wear – Detecting imbalance or misalignment is simple with most data collectors, but these issues are the least impactful of the faults you will find on your equipment. Over 50% of mechanical faults are due to bearing and gearbox issues. And most data collectors do not have the technology to detect these faults as they are developing – and can only find them when the machinery is already damaged and near failure.

The CSI 2140 uses Emerson's patented PeakVue™ processing and applies digital technology to determine bearing and gear wear earlier than any other technology. By measuring stress waves emitted from impacting – the earliest sign of bearing and gear wear – the CSI 2140 gives you time to plan for maintenance on your machine – while avoiding significant, and costly, damage.

State	Bearing Life Remaining	Vibration (in/sec)	PeakVue (g's)
New	Full	0.15	0
1	<20%	0.15	10
2	<10%	0.15	20
3	<5%	0.16	30
4	<1%	0.18	40
Failure	0%	>0.45	>50+

Typical values for a Horizontal Pump, direct coupled, with machine speed of 600-60000 RPM.

PeakVue data provides the earlier indication of developing faults in bearings and gearboxes

PeakVue technology not only offers the earliest warning of developing faults, it also provides an indication of severity. Measurements can be translated into reliable trends to determine the optimal timing for maintenance. Machinery faults are clearly visible in the waveform, opening up new options for fault detection and diagnosis.

Full Range of Measurement – The CSI 2140 sets the industry bar with its exceptional frequency range. The CSI 2140 can accurately measure signals on critical low speed equipment that would be out of range for other vibration analyzers/ collectors. The CSI 2140 also boasts the highest frequency range in the market. It can measure signals up to 80,000 Hz, critical for accurate diagnosis of centrifugal compressors and other high speed machinery.

In-Field Analysis – When your reliability goals require more advanced care of your equipment and the diagnosis of complex machine faults than standard route spectrum and waveform data can provide, you need a vibration analyzer with advanced analysis tools. The CSI 2140 delivers advanced in-field analysis tools, including:

- Waveform autocorrelation for distinguishing between periodic impacting from bearings and gears versus random impacting associated with lubrication issues.
- Fault frequency overlays to match and identify the specific source of energy peaks in the vibration spectrum
- Trending of up to 12 narrow band parameters for as long as two years, allowing you to see where on the trend your immediate measurement acquisition appears as compared to previous data
- Fourteen predefined analysis experts (such as coast down, bump tests, time synchronous averaging, order tracking, MCSA, high resolution, high frequency, etc.) for troubleshooting difficult machine problems
- View up to 8 plots for comparisons of multiple measurements

Variable Speed Analysis – Variable speed analysis is essential to any effective machinery health program because many critical pieces of equipment are operated at varying speeds to accommodate the changing production demands. While most vibration systems do not take variable speed into account during data collection, the CSI 2140 automatically adapts its diagnostic tools to variable turning speeds during routine data collection. This helps eliminate data blur/smear and provides an accurate trend for evaluation of developing problems in the field.

Predict Catastrophic Failure of Sleeve Bearings – Many online monitoring systems installed in plants today serve as nothing more than a shutdown switch in the case of a catastrophic condition. By collecting the signals from these systems with the CSI 2140, you can add predictive capabilities by identifying faults before a major issue occurs. Four-channel data collection allows for the simultaneous monitoring of orbit plots from both of the bearings on sleeve bearing equipment. These orbit plots can identify problems such as oil whirl/oil whip, misalignment and shaft rubs. Trending data can uncover developing cracks and other types of structural faults.

Monitoring Problem Machines – The CSI 2140 can also serve as a temporary online monitor. With line power, you can continuously monitor machine health for up to a month. The CSI 2140 can automatically acquire and store data, including overall vibration, fault frequency bands associated with specific fault types, or even the complete spectrum over an extended period of time. Capture the break-in period for new equipment or ensure that a machine with a known fault can make it to the next outage.

Capture Machine Startups/Shutdowns – For analysis of transient events, the CSI 2140 collects a continuous waveform that can have specific data extractions during startup, coast-down, or process changes. Spectra extracted from the transient waveform can be viewed individually or in a Cascade plot to show changes with speed and time. This analysis can be very useful for identifying critical and resonant frequencies for turbo machinery.

Correlate Vibration and Process Variables – The CSI 2140 has the ability to measure, store, and trend process variables associated with equipment in addition to the equipment vibration signals. The process variables such as pressure, temperature, speed, flow, etc. can either be measured through the voltage inputs or manually entered via the touch screen user interface. These process variables can be correlated with vibration to provide information about the health of the machine or help determine root cause operational conditions for the machinery health.

Modular Design to Match Your Needs

The CSI 2140 can be configured to specifically address your current needs – and is modular to expand as your needs change in the future. Easily and affordably expand your capabilities while protecting your initial investment. This versatile unit can be purchased as a single-, dual-, or four-channel analyzer – with or without route measurement capability or as a dedicated field balancer. Put together any combination of capabilities to match your requirements. Additional modules are also available for transient and structural analysis.

Advanced Cross-Channel Analysis – Standard data collection serves as an excellent base for identifying developing machinery faults, but cross-channel analysis is often required to identify the root cause of the fault. In addition to regular data collection, the advanced cross-channel application also measures coherence and transfer functions between the measured channels. Cross-channel analysis enhances the vibration data by helping to determine the actual movement of the shaft during operation and identifying structural faults such as cracks and resonance. Cross-Channel data is typically collected between a reference sensor and up to three other sensors, and full transfer function, phase and coherence data is available with every channel.

Operating Deflection Shape (ODS) Modal Analysis – ODS data allows for a structural modeling of a machine that is then animated using actual operating vibration data. Analysts can observe visually how the machine is moving during operation, and could identify the need for a structural correction. Data is collected while the machine is running and shows motion due to a combination of structural resonances (typically seen in modal analysis) and operational forces such as misalignment or imbalance. Using four-channel data collection is a non-intrusive means for easily capturing all the necessary data without interrupting production. The pairing of a triaxial and regular single axis accelerometer combined with simultaneous 4-channel collection can make the ODS data acquisition simple and efficient.

Transient Analysis – The Advanced Transient Analysis application allows you to record the raw vibration signal over a prolonged period of time for post-processing and analysis. This is essential for diagnostics of turbomachinery startup and coastdown or machines with short, repetitive duty cycles. Unlike other offerings the CSI 2140 captures transient waveform data as a single continuous block of data and not multiple shorter data blocks that are then pieced together in the software. This continuous waveform data ensures that nothing is missed in the collection or diagnosis. This data can be examined directly on the CSI 2140 or even replayed live in AMS Machinery Manager.

The triaxial accelerometer collects data at the measurement location from a vertical, horizontal, and axial directions simultaneously.

Field Balancing – The Advanced Balancing application allows you to use the CSI 2140 as a field balancer. This application combines advanced technology with simple, straightforward operation for a fast, effective solution to your balancing problems. The graphical user interface automatically guides you through the balance checklist so only minimal training is required for effective operation. The application offers a basic mode for simpler machine trains and an advanced balancing mode with up to 4-planes for longer more complex machine trains. Full job documentation can be printed or stored in AMS Machinery Manager.

Advance Balancing

The Advanced Balancing application offers two solutions to the typical challenges of field balancing:

- **Vector Averaging** – This technique systematically removes background vibration that would otherwise contaminate the calculated solution.
- **Balancing Watchdog** – This patented technology automatically checks the vibration data on the machine while you perform the balance job. The Watchdog is able to identify and alert you of structural faults (such as looseness or resonance) that would otherwise make the job difficult or impossible to complete. You can take corrective action to correct the structural fault, balance the rotor, and leave the machine in reliable operating condition.

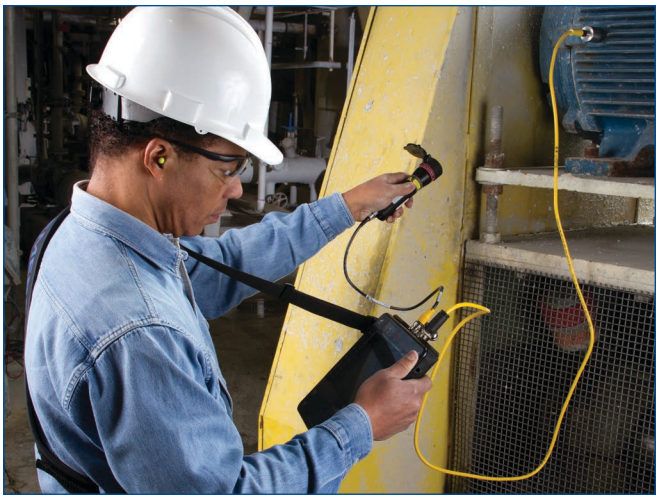
Motor Current Analysis – The CSI 2140 comes standard with an MCSA Analysis Expert for detecting broken or cracked rotors bars in AC induction motors using a current clamp around the motor electrical leads. If used together with the Motor Diagnostics module in AMS Machinery Manager, the CSI 2140 performs non-intrusive analysis of the rotor and stator condition in AC induction motors. This can be accomplished with a standard current clamp or Emerson's patented fluxcoil monitoring. Flux, temperature, and current data can be used to identify motor-related electrical faults such as broken rotor bars, high-resistance joints, voids in aluminum cast rotors, stator winding shorts, and voltage unbalance in AC induction motors without turning the motor off.

Industrial Ratings

Designed for use in industrial environments, the CSI 2140 has received an IP 65 rating certifying that it is dust- and splash water-tight. It also complies with international safety standards for FM and CSA Class 1 Division 2 Groups (A, B, C, D) and ATEX and IECeX Zone 2 hazardous areas in the United States, Canada, and Europe.

Accessory Options

Speed Detection – Accurate detection of the shaft turning speed is critical to effective machinery health analysis. The CSI 430 Laser Speed Sensor allows you to determine shaft speed without requiring machine shutdown to apply reflective tape or specific markings on the machine.



The CSI 430 Laser Speed Sensor determines shaft speed without shutting down the machine - even in extremely tight locations.

Triaxial Accelerometer – The Model A0643TX is a revolutionary new triaxial sensor. This sensor can be magnetically mounted to the machine and provides high-quality readings in all three directions. All three measurement orientations on a bearing can be collected simultaneously with a four-channel CSI 2140.

Proximity Probe Connections – Use BNC-type cables to measure orbits from a protection system. The phase reference can be read using the tachometer cable.

Structural Analysis – For advanced structural analysis, use the modally-tuned hammer.

Wireless Headphones – To incorporate another dimension to your monitoring program, use wireless headphones to listen to your vibration signals.

Four-Channel Accessories Kit – The four-channel accessories kit includes everything you need to unlock the power of the CSI 2140 four-channel analyzer. The easy-to-install input adapter collects acceleration data from one side, volts data from the other. The kit includes the adapter plus the cables, accelerometers, and magnets necessary to perform most any kind of four-channel analysis.

Battery Charger for Car – The car charger allows charging of the CSI 2140 in route between remote locations. If used in conjunction with the External battery charger a spare battery can be left charging in the car while the CSI 2140 is being used to collect data in the field.

External Battery Charger – Take the CSI 2140 for data collection while a spare battery is charging in the office and switch them when needed.

Hardware Specifications

Physical Dimensions	
Dimensions	8.8” (248 mm) high, 1.57” (40 mm) deep, 8.9” (226 mm) wide
Weight	3.95 lbs (1.79 kg)
LCD Display	6” x 4.5” (151 x 115 mm) color TFT w/ LED backlight Resolution 640 x 480 pixels. Touchscreen - XY resistive
Keypad	Tactile Dome buttons, 12 tactile dome buttons with backlit keys, Electroluminescent panel illumination
Built-in stand	
Environmental	
Operating Temperature	-4° to 122°F (-20° to 50°C)
Long-term Storage Temperature	-4° to 95°F (-20° to 35°C) with battery[1]
Long-term Storage Temperature	-40° to 150°F (-40° to 65°C) without battery
Environmental Rating	Sealed enclosure, IP-65 rated

[1] *Storage at elevated temperatures will significantly reduce battery life.*

Hazardous Area Approvals	
	FM and CSA Class 1 Division 2 Groups (A, B, C, D)
	ATEX and IECEx Zone 2, CE EXII 3G, nA nC IIC T4
Battery and Charging	
Battery Type	Rechargeable Lithium-Ion battery pack
	7.2 Volts (Nominal) Protected Output
	On pack LED readout
	10+ hours of continuous use
	4 hours recharge time (Nominal)
	Charging temperature 50° to 95°F (10° to 35°C)

Measurement Specifications

Frequency Analysis	
A/D Converter	24 bits of precision
Automatic Integrator Correction	Allows precise measurement of low frequency vibrations down to 0.2 Hz
Averaging Modes	Normal, exponential, peak hold, order tracking, negative averaging, synchronous time
Cursors Spectrum	Single, Harmonic, Moving Harmonic, Sideband, and Time/Frequency for waveform
Dynamic Range	Converter has 120 dB dynamic range
Frequency Range	DC to 10 Hz minimum, DC to 80 kHz maximum
Frequency Units	Hz, CPM, Orders
Full-scale Range	Accelerometer input: 0-20V, Volts input -20V + 20V
Noise Floor	Typically less than 20 μV for a 400-line spectrum at 1,000 Hz maximum frequency
Number of Averages	5,000 in Route mode, 10,000 in Job mode
Resolution	100, 200, 400, 800, 1600, 3200, 6400, or 12800 lines of resolution. True Zoom provides effective resolution of up to 300,000 lines
Response	Flat to DC for non-integrated and DC-coupled signals; optional AC coupling -3 dB at 1 Hz
Scaling	Linear or Log, both X and Y
Windows	Hanning or uniform
Data Storage Capacity	
Internal Memory	1 GB
External Memory	SD (Secure Digital). Virtually unlimited memory with off the shelf SDHC SD cards up to 32 GB
Data Analysis Speed	
400 line, 1000 HZ spectrum	67% overlap 6 avg/sec
1600 line, 1000 Hz spectrum	67% overlap 3 avg/sec

Input Specifications

Input Signals	
	A 2-milliampere, 20-volt (nominal), constant-current power supply inside the analyzer powers sensors such as accelerometers connected to the accelerometer channel inputs
Full Scale Input Level	
Accel Channels A, B, C, D; Volts A, B, C, D	
Accelerometer Input	0-20V
	Full scale vibration level is +/- 90 g's when using a 100-mV/g accelerometer
Volts Input	-20V to +20V
Input Impedance	Greater than 125K ohms
Input Signal Types	
Dynamic Signals	Single channel/Dual channel/Four channel
DC Signals	Single channel/Dual channel/Four channel
RPM/tach Signal	TTL pulse
Keypad Entry	Full alphanumeric capability
Four-Channel Data Collection	
	Simultaneous four-channels Dynamic Input + Phase
	Simultaneous four-channels DC Input
	Simultaneous four-channel Route collection + Phase
	Simultaneous four-channel Display - Spectrum and Waveform
	Simultaneous four-channel Transient + Phase
	Simultaneous four-channel ODS/Modal + Phase
	Simultaneous four-channel Volt/Displacement + Phase (for sleeve bearing monitoring)
	Simultaneous Dual Orbits Display [accelerometer/displacement] (for rolling element/sleeve bearing monitoring)
	Simultaneous four-channel Cross Channel + Phase
In-field Route Analysis Tools	
Fault Frequency Overlays on Plot	Identifies source of vibration peaks
Parameter Trends	Up to 12 parameters trended over 2+ years
Colored Alarms	Shows specific parameter in alarm and percentage of alarm value
Waveform Autocorrelation	Identifies whether impacting is periodic or random
Input Sensor Types	
Portable Sensors	Accelerometers, velocity probes, RPM/tachometer probes, temperature sensors, flux coil, current clamp, pressure sensors, triaxial accelerometer, impact hammer
Installed Sensors	Any vibration or dynamic sensor with a voltage output; any DC-type signal

Input Unit Types			
Vibration Signals Units	Acceleration g's		
	Velocity In/sec or mm/sec		
	Displacement Mils or microns		
Other Dynamic Signals	Any user-specified unit		
DC Signals	Any user-specified unit		
Tachometer Input			
RPM Range	1 to 100,000 RPM		
Tach Input Level	TTL input, built in conditioning for non-TTL signals, adjustable trigger level. The tachometer input measures a once-per-rev pulse to measure RPM.		
Advanced Acquisitions			
PeakVue	Selectable filters		
Pseudo Tach	Generates tach pulses for hidden shafts		
Demodulation	Selectable filters		
Wireless			
Bluetooth	2.0 Class 2 (optional)		
	Range up to 10 meters		
Wireless	802.11 b/g		
	Range up to 33 meters		
RF Output Power Specifications:	Max EIRP (mW)	Antenna Gain (dBi)	Frequency Range - ETSI
Bluetooth	3.40 mW	1.9 dBi	2402 - 2480 MHz
Wireless LAN 802.11b	87.30 mW	1.4 dBi	2412 - 2472 MHz
Wireless LAN 802.11g	79.62 mW	1.4 dBi	2412 - 2472 MHz
Warranty			
	12 months warranty against manufacturing defects		

Connecting to a PC

Requirements	
Connections/Output	USB 2.0, 100M Ethernet.
Compatible Software	AMS Suite: Machinery Manager v5.6 or greater. Refer to **www.assetweb.com/mhm** under AMS Machinery Manager software for most currently operating requirements

Accuracy – all measurements taken at a temperature of 25C

For All Dynamic Input Channels:	
Frequency Accuracy (crystal based)	0.02%
Non-Integrated Spectral Amplitude Accuracy	5% over the range of 3Hz to 65kHz, 0.001 - 10 Vrms input, with SST on for measurements 3-20Hz
Single Integrated Spectral Amplitude Accuracy	5% over the range of 10Hz-20kHz, 3% over the range of 20Hz- 20kHz
DC Accuracy	3% +(5mv) over the input range of 0.1V to 20V
Overall Level (W/Averaging, band limited)	5% over the range of 5Hz - 65Khz, 0.001 to 10Vrms
Peak and Phase Measurements:	
1X Synchronous Peak Accuracy	3% over the range of 3Hz – 1,500Hz, 0.01 - 10.0 Vrms
1X Synchronous Phase Accuracy	5 deg over the range of 3 - 1,500Hz [180- 90,000 RPM]
Tachometer Frequency Accuracy	0.01% + (+/-0.1 rpm) over the range of 1-1,600Hz

Emerson Process Management
835 Innovation Drive
Knoxville, TN 37932
T (865) 675-2400
F (865) 218-1401
www.assetweb.com/mhm

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