ANALYSIS AND DIAGNOSTICS

Condmaster® RUBY 2020

TD SHEETS

Australian / New Zealand Distributor---------

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SPM®

Trademarks

Patents

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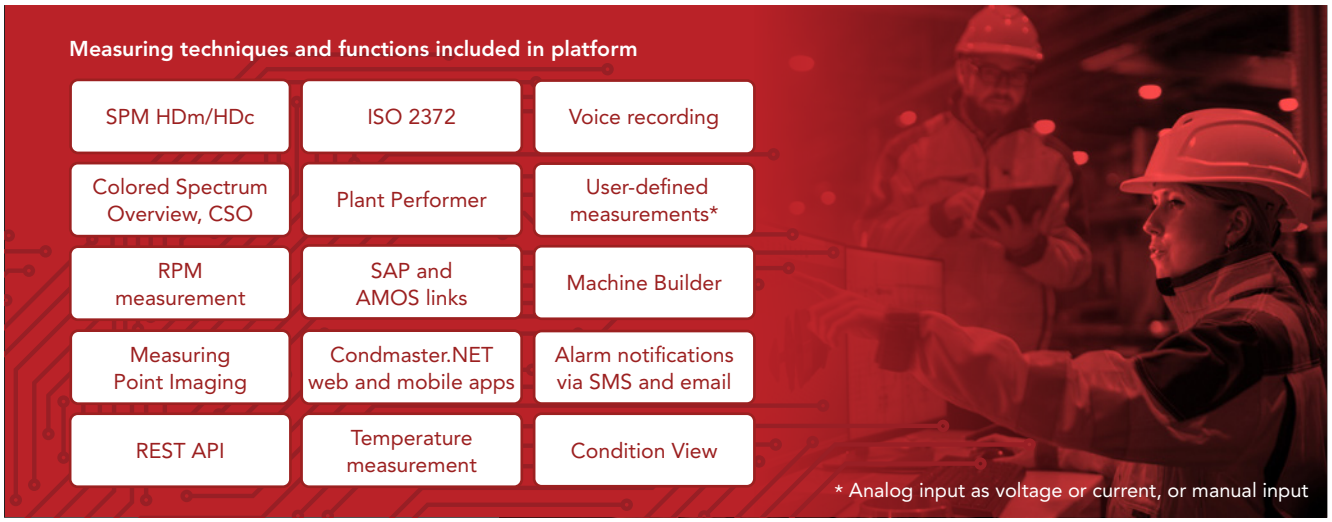
Condmaster® Ruby 2020 – Platform



Condmaster Ruby 2020 is a comprehensive condition monitoring and predictive maintenance program. Module built, it can be tailored to your selected hardware.

Condmaster Ruby communicates with all SPM handheld data logging instruments and Ethernet compatible online systems for continuous condition monitoring. It works under Windows 7 or later and uses SQL Server 2016 or later (SQL Server 2019 Express Edition is included in the installation media, managing up to 10 GB of data).

The measuring techniques included in the platform are:

- Shock pulse technology SPM HDm/HDc. The scalar decibel value HDm represents the highest shock pulses found during the measuring cycle, and is the primary value for determining the severity of a bearing damage, and also to trigger alarms. HDc, also a scalar dB value, is useful to determine lubrication condition.
- ISO2372 vibration measurement.
- Two user-defined measurements, with special input window for temperature (data input as analogue voltage or current, or manual).
- RPM measurement.
- Temperature measurement.

The basic program functions are:

- Checkpoint (free text describing maintenance activity). It also has a runtime counter for machine operating hours.
- Contact-free identification tags, CondID®, can be loaded with basic data and the latest measuring results.
- Measuring point definition, using a customer-defined numbering system and including input data for all active measuring techniques.
- Graphical overview, showing measuring point location as a hierarchical structure and/or with pictures, from plant down to machine or measuring point level.
- Measuring rounds and communication with portable measuring devices (data logging, time planning).
- Measuring Point Imaging for connecting photographs and/or images to measuring points.
- Alarm messages and lists, statistics and reports.
- REST API, a web-based service enabling other resources, systems or devices to access Condmaster data for further processing or analysis.
- In Machine Builder, machines can be built from a component library. Measuring points, measurement assignments, and fault symptoms are automatically generated.
- Condmaster.NET, a web application and downloadable mobile app that provides easy access to measurement data through a user-friendly interface.
- Condition View combines multiple graphs in one window.
- SAP and AMOS links send alarm messages to the receiving software and accepts a work order number in return.
- Plant Performer compiles and visualizes statistics relating to technical and economic KPIs for display, evaluation, and printing in Condmaster.NET.
- Colored Spectrum Overview shows large numbers of spectrums over a longer period of time and provides a good overall picture of machine condition development.
- Voice recording of comments linked to measuring points.
- Display and printout of all measuring results as graphics and lists.

Further modules can be added as needed (see TD-584).

Minimum system requirements for Condmaster Ruby:

- Windows 7 or later (Windows 8 or later if SQL Server 2016 is installed on the same computer)
- 1 GHz 32-bit (x86) or 64 bit (x64) processor
- 1 GB of RAM memory
- 15 GB free disc space
- Microsoft SQL Server 2016 or later

NOTE: Microsoft SQL Server 2016 requires Windows 8 (64-bit) or later with at least 1.4 GHz CPU. Condmaster Entity Server (CES) requires 64-bit Windows. LinX (handling online systems) and CES require higher data performance.

For recommended system requirements, see '*Condmaster Ruby Installation and system administration*' manual, 72260.

Part numbers

PRO350	Condmaster Ruby 2020, Platform, CD
PRO350-USB	Condmaster Ruby 2020, Platform, USB

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Condmaster® Ruby 2020 – Modules

Measuring techniques and functions included in platform

SPM HDm/HDc	ISO 2372	Voice recording	REST API	Condition View
Measuring Point Imaging	Temperature measurement	RPM measurement	User-defined measurements*	Machine Builder
Condmaster.NET web & mobile apps	SAP and AMOS links	Alarm notifications via SMS and email	Plant Performer	Colored Spectrum Overview, CSO

Additional measuring techniques and functions ordered separately

dBm/dBc	LR/HR and Lubmaster	SPM Spectrum	SPM HD Expert	ISO 10816	
FFT with symptoms	EVAM incl. Condition Manager	HD Analysis	Intellinova, Online	Run up/Coast down Bump test, FRF	High resolution and frequency
Orbit analysis, Shaft Centerline Plot	LR/HR HD and Lubmaster	HD ENV	ISO 6954	Rule-Based Evaluation, RBE	Multi-channel measurement

* Analog input as voltage or current, or manual input

Condmaster Ruby 2020 is modular. Its functionality can be tailored to specific requirements and personal preference. Modules can be ordered at any time as update files.

For further information on the Condmaster Ruby 2020 platform and the measuring techniques and functions included in the platform, see technical datasheet TD-583.

TD sheet	Module	Part numbers	Tester T30	Analyzer A30	Leonova Infinity	Leonova Emerald	Leonova Diamond	Intellinova Standard	Intellinova Compact	Intellinova Parallel EN	Airius
TD-583	Platform	PRO350	●	●	●	●	●	●	●	●	●
TD-585	dBm/dBc	MOD130	●		●	●	●	●			
TD-586	LR/HR and Lubmaster	MOD131		●	●	●	●	●			
TD-587	SPM Spectrum	MOD132			●	●	●	●			
TD-588	SPM HD Expert	MOD195				●	●	●	●	●	
TD-589	Vibration ISO 10816	MOD133			●	●	●	●	●	●	●
TD-590	FFT with symptoms	MOD134	●*	●**	●	●	●	●	●	●	●
TD-591	EVAM incl. Condition Manager	MOD135	●*	●**	●	●	●	●	●	●	●
TD-592	Multi-channel measurements *****	MOD192					●			●	●
TD-593	Run up/Coast down, Bump test, FRF	MOD137			●		●	●***	●***		
TD-594	Orbit analysis, Shaft Centerline Plot	MOD138			●****		●	●****		● ****	
TD-595	High resolution and frequency *****	MOD194					●			●	
TD-596	Rule-Based Evaluation, RBE	MOD181	●	●	●	●	●	●	●	●	●
TD-599	Intellinova, Online	MOD187						●	●	●	●
TD-603	Vibration Expert	MOD193					●				
TD-604	Vibration Supreme	MOD197				●					
TD-606	LR/HR HD and Lubmaster	MOD131+MOD195				●	●	●	●	●	
TD-607	Vibration ISO 6954	MOD198					●				
TD-608	HD ENV	MOD199				●	●	●	●	●	
TD-609	HD Analysis	MOD140				●	●	●	●	●	

* T30-3 ** A30-3
*** Run up/Coast down only **** Orbit analysis only
***** The number of measuring channels as well as the maximum resolution and frequency range depends on the measuring equipment.

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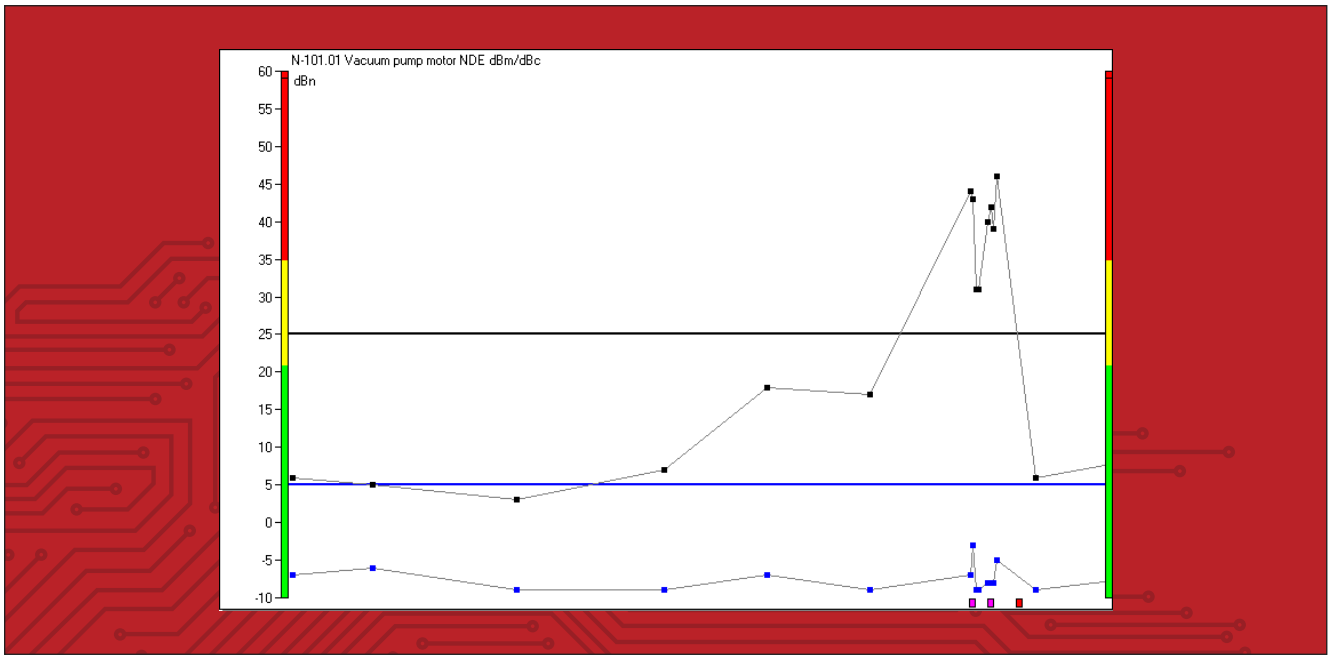
Condmaster® Ruby 2020 – dBm/dBc



For more than 50 years, the Shock Pulse Method (SPM) has successfully provided a fast, easy and reliable diagnosis of the operating condition of rolling element bearings.

The signal

Throughout their lifetime, bearings generate shocks in the interface between the loaded rolling element and the raceway. These shocks 'ring' the SPM transducer which outputs electric pulses proportional to the shock magnitude.

The shock pulse transducer responds at its carefully tuned resonance frequency of about 32 kHz, which allows a calibrated measurement of the shock pulse amplitudes.

Measurement

The shock pulse meter counts the rate of occurrence (incoming shock pulses per second) and varies the measuring threshold until two amplitude levels are determined:

- dBc (decibel carpet value): The shock carpet level (approx. 200 incoming shocks per second).
- dBm (decibel maximum value): the maximum level (highest incoming chock during the measuring time). Using a blinking indicator or earphones, a peak value can be established by increasing the measuring threshold until no signal is registered.

Because of the very large dynamic range, shock pulses are measured on a decibel scale (1000 x increase between 0 and 60 dB).

Shock pulse amplitude is due to three basic factors:

- Rolling velocity (bearing size and rpm)
- Oil film thickness (separation between the metal surfaces in the rolling interface). The oil film depends on lubricant supply and also on alignment and pre-load.
- The mechanical state of the bearing surfaces (roughness, stress, damage, loose metal particle).

Input data

The effect of rolling velocity on the signal is neutralized by giving rpm and shaft diameter as input data, with 'reasonable accuracy'. This sets an initial value (dBi), the start of the ´normalized' condition scale.

Evaluation

The initial value and the range of the three condition zones (green – yellow – red) was empirically established by testing bearings under variable operating conditions. The maximum value places the bearing into the condition zone. The height of the carpet value and delta (dBm minus dBc) indicated lubrication quality or problems with bearing installation and alignment.

Part numbers

MOD130 dBm/dBc

SPM

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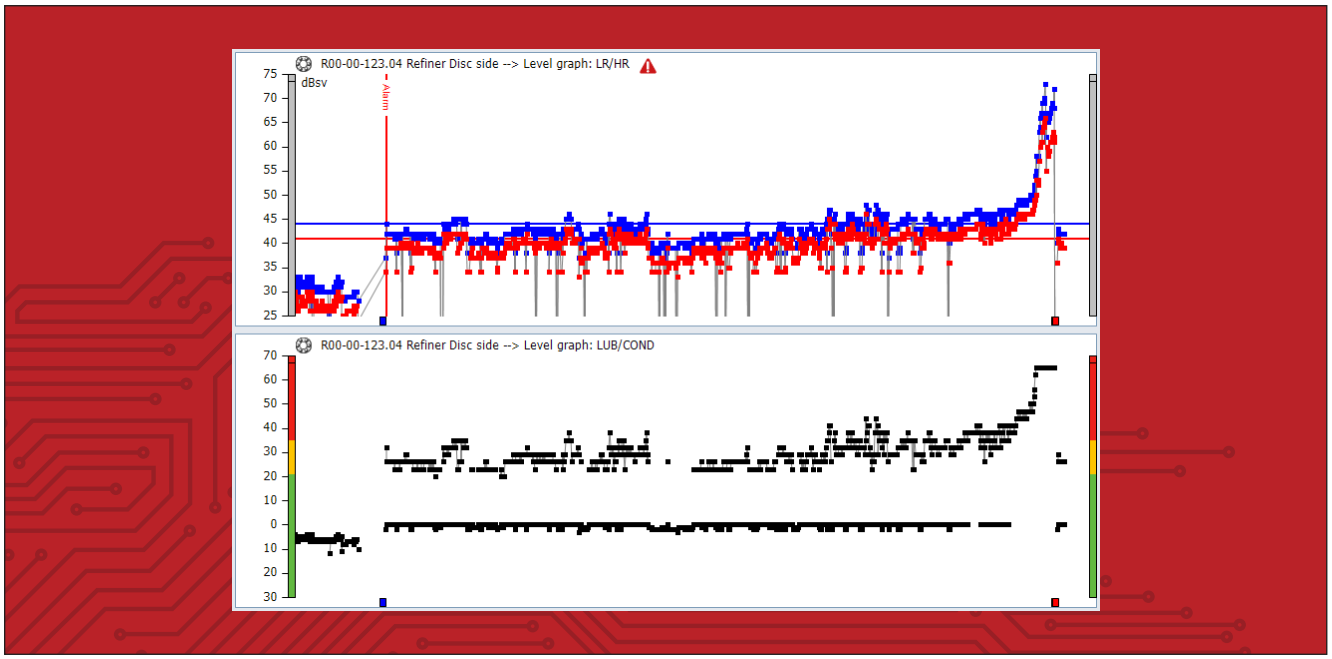
Condmaster® Ruby 2020 – LR/HR and Lubmaster



The LR/HR method was developed from the original Shock Pulse Method for condition diagnosis of rolling element bearings. It allows a precision analysis of oil film condition in the rolling interface and contains calculation models for finding the optimal lubricant. Poor lubrication is the root cause of most bearing failures.

Signal and measurement

Transducer and measuring procedure are the same as for dBm/dBc (TD-585). The shock pulse meter counts the rate of occurrence (incoming shock pulses per second) and varies the gain until two amplitude levels are determined:

- LR: low rate of occurrence, quantifying the strong shock pulses (approx. 40 incoming shocks per second).
- HR: high rate of occurrence, quantifying the shock carpet (approx. 1000 incoming shocks per second).

LR/HR are 'raw values', measured in dBsv (decibel shock value).

Input data

LR/HR requires more precise data on the bearing, because bearing geometry, as well as size and speed, affects the shock carpet and thus the analysis of oil film condition in undamaged bearings. The rpm is needed, plus a definition of the bearing type and size. This is best input by stating the ISO bearing number, which links to the bearing catalogue in Condmaster Ruby.

Evaluation

After measurement the measuring device returns

- a general description of bearing condition (CODE)
- a value for oil film condition (LUB)
- a value for surface damage (COND).

A LUB no. of 0 means dry running, the value increases with oil film thickness. A COND no. of around 30 indicates surface stress or early damage, the value increases with damage severity. The general assessment is:

CODE A	Good bearing
CODE B	Poor lubrication
CODE C	Damage in early stage
CODE D	Damage

A program part, LUBMASTER, uses the shock values plus data on lubricant type, viscosity, load and operating temperature to calculate the bearing's life expectancy under present condition. It also calculates the effect of changes in oil type and viscosity.

Calibration

The accuracy of LR/HR is increased by a calibration factor (COMP no.) used in case of bearings with minimal load or poor quality measuring points (in both cases the signal strength is below normal). On the basis of the bearing's catalogue data and the lubricant properties, Leonova calculates the normal shock level for a good bearing and compensates for an abnormally low signal before returning the evaluation results.

Part numbers

MOD131 LR/HR and Lubmaster

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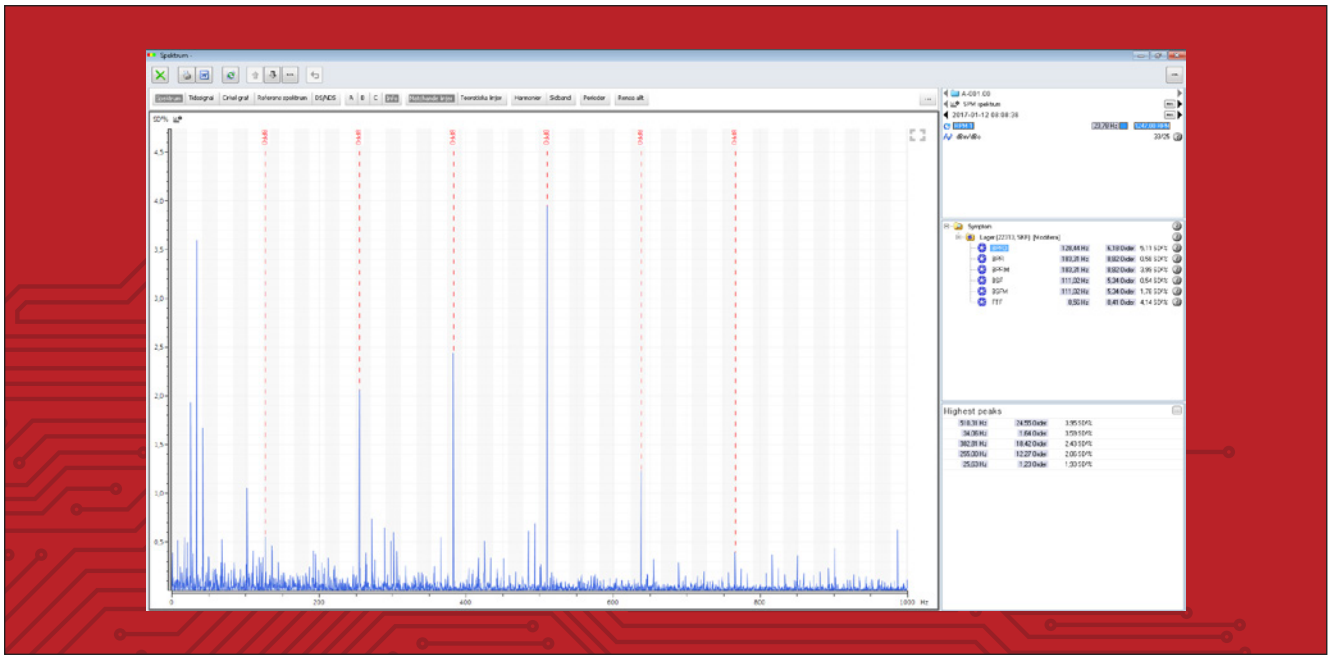
Condmaster® Ruby 2020 – SPM Spectrum



The SPM Spectrum measuring technique is a complement to the SPM dBm/dBc and LR/HR techniques. The purpose of SPM Spectrum is to verify the source of high shock pulse readings. Shocks generated by damaged bearings will typically have an occurrence pattern matching the ball pass frequency over the rotating race. Shocks from e.g. damaged gears have different patterns, while random shocks from disturbance sources normally do not coincide with the pattern of the machine element of interest.

Signal and measurement

The resonance frequency of the SPM shock pulse transducer, calibrated to 32 kHz, constitutes the ideal carrier wave for transients caused by shocks. The output of this transducer is the same type of demodulated signal produced by 'enveloping', with this important difference: both frequency and amplitude response of the SPM transducer are precisely tuned, so there is no need to find uncertain and shifting machine resonances to get a signal.

The measuring system measures the shock amplitude by a shock pulse measurement with the dBm/dBc or the LR/HR method. The results are the bearing condition data, evaluated in green – yellow – red.

The second measurement produces a time record that is subjected to a Fast Fourier Transform (FFT). The resulting spectrum is used mostly for pattern recognition. Spectrum line amplitudes are influenced by too many factors to be reliable condition indicators, so all condition evaluation is based on the dBm or the HR values.

One unit for amplitude in an SPM spectrum is SD (Shock Distribution unit), where each spectrum is scaled so that the total RMS value of all spectrum lines = 100 SD = the RMS value of the time record. The alternative is SL (Shock Level unit), the RMS value of the frequency component in decibel. Alarm levels are manually set for each symptom to show evaluated results in green – yellow – red. Various types of spectra can be produced.

Input data

Pattern recognition demands precise data on the bearing and exact measurement of the rpm. The rpm should preferably be measured, not preset. The factors that define the bearing frequencies are obtained from the bearing catalogue in Condmaster by stating the ISO bearing number.

Evaluation

The frequency patterns of bearings are preset in Condmaster Ruby. Linking the symptom group 'Bearing' to the measuring point allows the user to highlight a bearing pattern by selecting its name. Other symptoms may be added when appropriate, e.g. for gear mesh patterns. Finding a clear match of a bearing symptom in the spectrum is proof that the measured signal originates from the bearing.

Part numbers

MOD132 SPM Spectrum

NOTE: MOD130 or MOD131 is required for the function to work.

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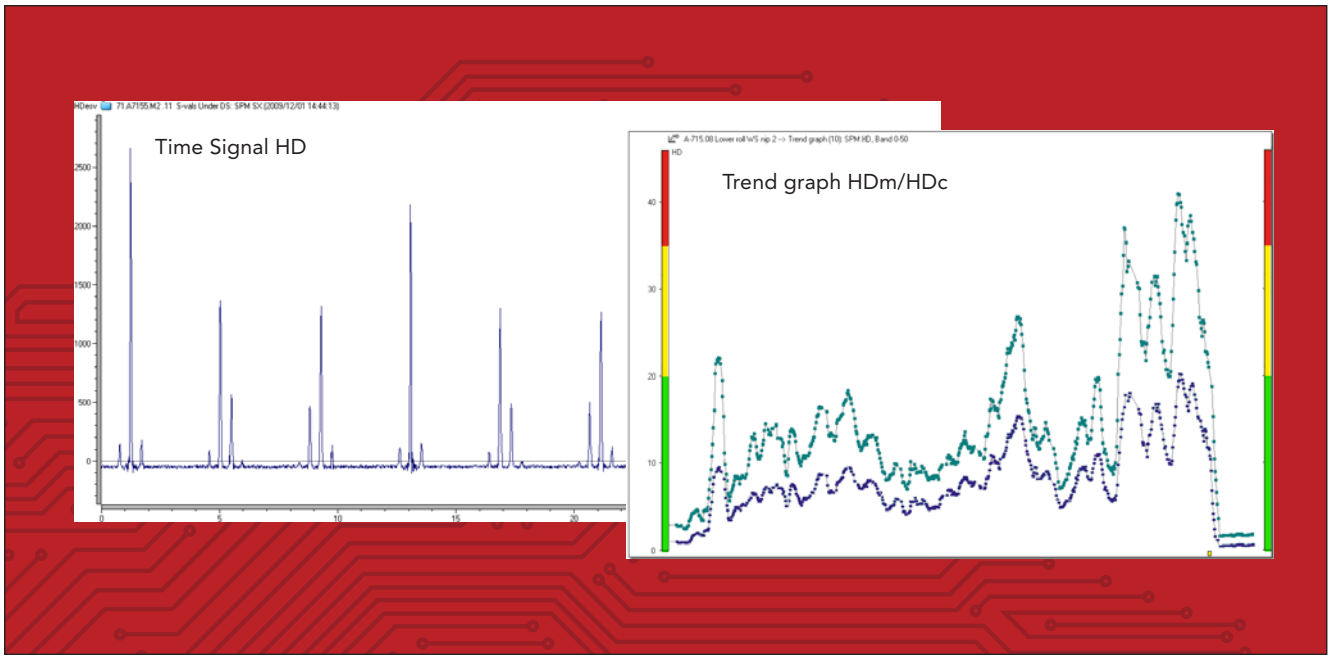
Condmaster® Ruby 2020 – SPM HD® Expert



SPM HD Expert is a complement to SPM HDm/HDc and LR/HR. Advanced digital technique, RPM-based sampling frequency and measuring time automatically adjusted to RPM makes SPM HD particularly well suited for measurement on low speed applications. Extraordinary signal quality and 24 bit A/D conversion provides razor-sharp resolution and exceptional detail in spectrums and time signals.

The signal

Throughout their lifetime, bearings generate shocks in the interface between the loaded rolling element and the raceway. These shocks 'ring' the SPM transducer which outputs electric pulses proportional to the shock magnitude.

Shock pulse amplitude is due to three basic factors:

- Rolling velocity (bearing size and rpm).
- Oil film thickness (separation between the metal surfaces in the rolling interface). The oil film depends on lubricant supply and viscosity as well as alignment and pre-load.
- The mechanical state of the bearing surfaces (roughness, stress, damage, loose metal particle).

Input data

The effect of rolling velocity on the signal is neutralized by entering rpm and shaft diameter as input data, with 'reasonable accuracy'. This sets an initial value (HDi), the start of the ´normalized' condition scale.

High Definition Order Tracking is a function used with Leonova Diamond, Leonova Emerald and Intellinova, primarily for analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders to be covered is input by the user. HD Order Tracking also minimizes the risk of smearing in the spectrums.

Condition Manager enables users to experiment freely in order to find the optimal alarm setup for any given application. This "learning phase" can continue until the criteria is saved. When it is saved, the criteria is activated and Condmaster starts to evaluate measuring results according to the criteria setup. If at some later time it turns out the alarm settings yield unsatisfactory results, the criteria can be edited.

Output data

The SPM HD method produces different types of results:

- **HDm/HDc** is part of the Condmaster Ruby platform (see TD-583).
- **Time Signal HD** is extremely useful to locate where in the bearing a possible damage is located. In many cases it is also possible to determine the nature of the damage (cracked inner race with spalling all around or a single crack etc.). The Time signal HD is a result of very advanced digital algorithms where repetitive shocks are enhanced and random signals are suppressed.
- **SPM Spectrum HD** is the result of applying FFT algorithms on the Time Signal HD. The SPM HD spectrum is useful to determine where a possible bearing damage is located. It is also useful for trending purposes (applying symptom and band values).

Evaluation

The initial value and the range of the three condition zones (green – yellow – red) was empirically established by testing bearings under variable operating conditions. The maximum value places the bearing into the condition zone. The height of the carpet value and delta (HDm minus HDc) indicates lubrication quality or problems with bearing installation and alignment.

Part numbers

MOD195 SPM HD Expert

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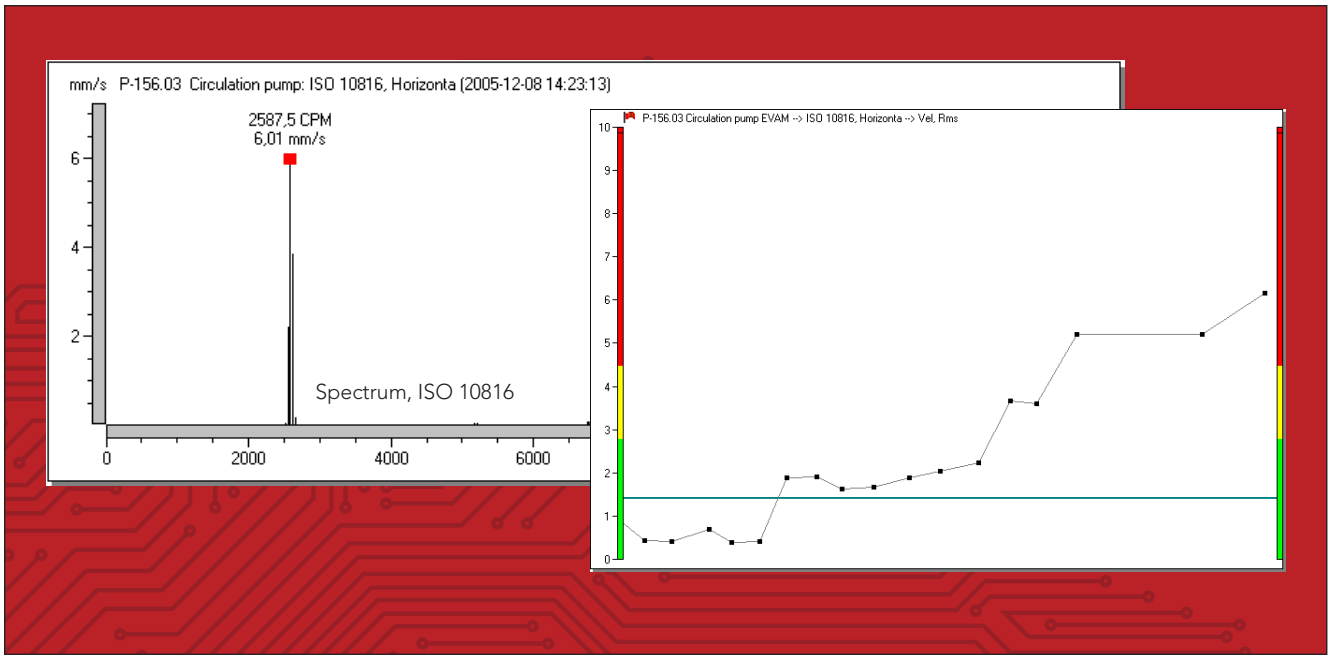
Condmaster® Ruby 2020 – Vibration ISO standard 10816



Broadband vibration measurement is the most widely used and cost-efficient method for the diagnosis of general machine condition.

There are two ISO recommendations concerning machine condition monitoring by this type of measurement: the much used ISO 2372 and the more recent ISO 10816, which is a replacement of the older standard.

ISO 2372 measurement is always included in the Condmaster Ruby platform (see TD-583), while ISO 10816 can be ordered as a module (see TD-584) through part number MOD133.

Features of ISO 10816 are:

- Measurements are made in three direction (horizontal, vertical, axial).
- Machine condition is generally diagnosed on the basis of broadband vibration measurements returning an RMS value. ISO 10816 keeps the lower frequency range flexible between 2 and 10 Hz, depending on the machine type. The upper frequency is 1000 Hz.
- ISO 10816 operates with the term vibration magnitude, which, depending on the machine type, can be an RMS value of vibration velocity, acceleration or displacement. If two or more of these parameters are measured, vibration severity is the one returning the relative highest RMS value. For certain machines, ISO 10816 also recognises peak-to-peak values as condition criteria.
- The standard consists of several parts, each treating a certain type of machines, with tables of limit values differentiating between acceptable vibration (green range), unsatisfactory vibration (yellow range), and vibration that will cause damage unless reduced (red range).

In Condmaster Ruby, ISO part, machine group and foundation type are entered using a multiple-choice guide that displays the various ISO definitions and leads to the limit values.

Exceeding the requirements of the ISO standard, Condmaster Ruby also provides a 1600 line spectrum.

Part numbers

MOD133 VIB ISO 10816 and spectrum

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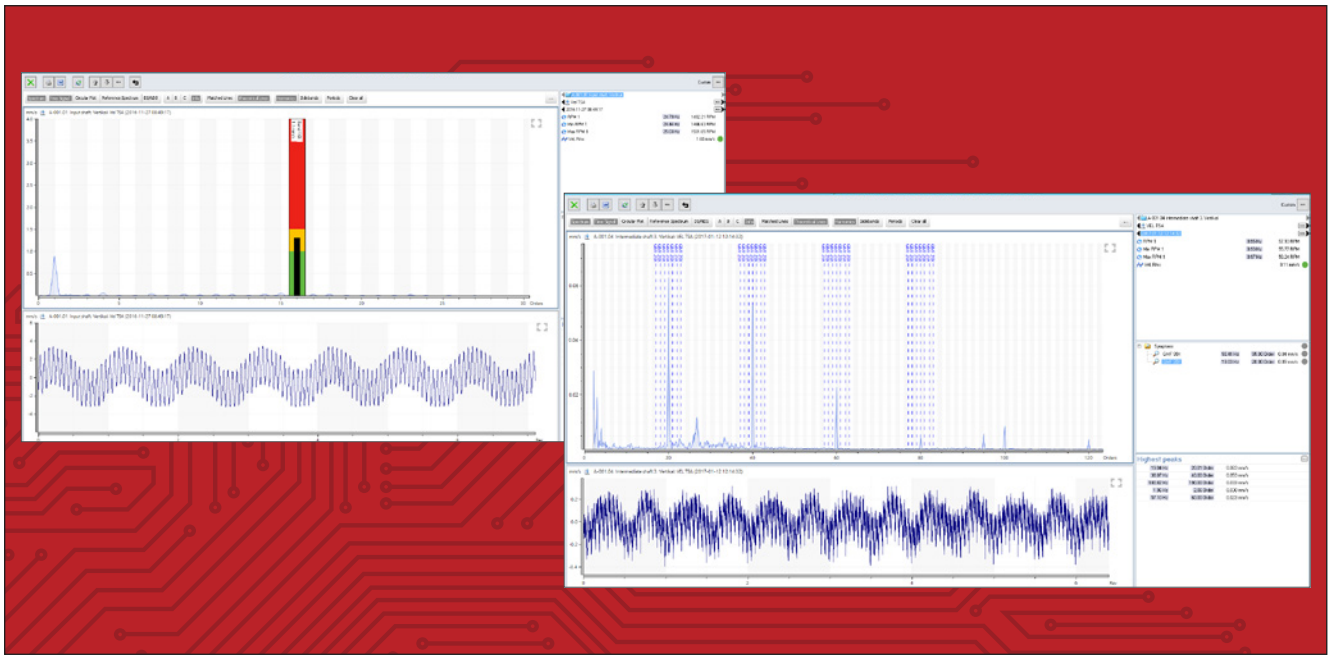
Condmaster® Ruby 2020 – FFT with symptoms



FFT Spectrum with symptoms is a vibration analysis function offered with Leonova and Intellinova. It is a reduced form of EVAM (see TD-591), lacking the statistical evaluation by means of criteria.

This function generates three sets of machine condition data:

- Condition parameters, which are measured and calculated values from the time domain, describing various aspects of machine vibration.
- Vibration spectra where significant line patterns are found, highlighted and evaluated with preset fault symptoms.
- Trending of symptom values. Alarm levels are manually set for evaluation in green – yellow – red.

For each measuring point, users can make an individual selection and define the type of data best suited for the monitoring of an individual machine. Alternatives include

- FFT
- enveloping HD ENV
- time synchronous averaging
- band values and averaging of measurement results for improved alarm reliability. Random high readings caused by resonance or other sources of disturbance are filtered out, minimizing the number of false alarms.

Condition parameters are measured for a selected frequency range. They can be individually activated and are shown in measuring result tables and as diagrams. Available are:

VEL	RMS value of vibration velocity
ACC	RMS value of vibration acceleration
DISP	RMS value of vibration displacement
CREST	Crest value, difference between peak and RMS
KURT	Kurtosis, the amount of transients in the vibration signal
SKEW	Skewness, the asymmetry of the vibration signal
NL1 - 4	Noise level in the four quarters of the frequency range

Peak and peak-to-peak values are shown in the unit selected for the time signal. Values can be displayed in dB according to European or US Navy standard as well as user defined.

Spectrum analysis with symptoms: For easy pattern recognition in spectra, a range of ready made 'symptoms' are available in Condmaster Ruby. These are instructions to highlight a spectrum line pattern and display the sum of the lines' RMS values as a symptom parameter (which can be trended). Most symptoms are automatically configured by using the rpm as a variable, for some an input is needed, e.g. the number of vanes on a rotor.

Phase is a time delay expressed in degrees of rotation. Leonova or Intellinova calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits. Phase difference in between two signals can also be displayed.

HD ENV (TD-608) is an ideal complement to conventional vibration techniques. Capable of detecting at a very early stage such machine problems which are generally difficult to find in good time with non-enveloping techniques – for example bearing damages and gear damage – the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes.

Order Tracking is primarily used for analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders is input by the user. Order Tracking also minimizes the risk of smearing in spectrums.

Part numbers

MOD134 FFT with symptoms, incl. HD ENV

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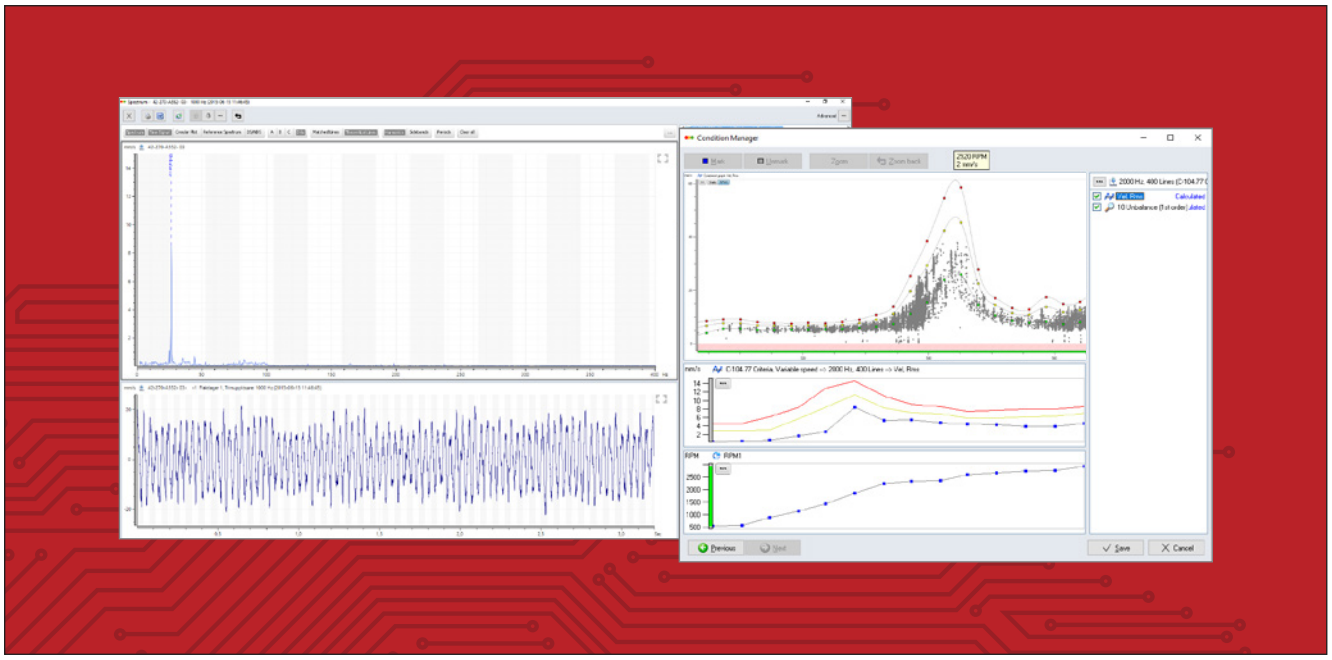
Condmaster® Ruby 2020 – EVAM incl. Condition Manager



With Leonova and Intellinova, EVAM (Evaluated Vibration Analysis Method) is offered as an analysing function. The method generates three sets of machine condition data:

- Condition parameters, which are measured and calculated values describing various aspects of machine vibration.
- Vibration spectra where significant line patterns are found, highlighted and evaluated with the preset fault symptoms.
- Machine specific condition codes (green – yellow – red) and condition values, based on a statistical evaluation of the condition parameters and symptom values.

For each measuring point, the user can make an individual selection and define the type of data best suited for the surveillance of an individual machine. Alternatives include

- enveloping HD ENV
- time synchronous averaging
- band values and averaging of measurement results for improved alarm reliability. The number of false alarms is minimized by filtering out randomly high readings caused by disturbance.

Condition parameters are measured for a selected frequency range. They can be individually activated and are shown in measuring result tables and as diagrams. Available are:

VEL	RMS value of vibration velocity
ACC	RMS value of vibration acceleration
DISP	RMS value of vibration displacement
CREST	Crest value, difference between peak and RMS
KURT	Kurtosis, the amount of transients in the vibration signal
SKEW	Skewness, the asymmetry of the vibration signal
NL1 - 4	Noise level in the four quarters of the frequency range

Peak and peak-to-peak values are shown in the unit selected for the time signal. Values can be displayed in dB according to European or US Navy standard as well as user defined.

For easy pattern recognition in spectra, EVAM supplies a range of ready-made 'fault symptoms'. These are instructions to highlight a spectrum line pattern and display the sum of the lines' RMS values as a symptom parameter (which can be evaluated and trended). Most symptoms are automatically configured by using the rpm as a variable. Suitable symptoms and symptom groups are selected in Condmaster Ruby when the measuring point is set up. As an alternative, cepstrum analysis can be used for gearboxes.

In Condmaster Ruby, alarm limits can be set on all active parameters. Once measuring results are collected, an EVAM 'criterion' can be created that compares new parameter values with the statistical mean value and displays a dimensionless condition value against a green – yellow – red scale.

Phase is a time delay expressed in degrees of rotation. Leonova or Intellinova calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits. Phase difference in between two signals can also be displayed.

HD ENV (see TD-608) is capable of detecting machine problems at a very early stage, which are generally hard to find in good time with non-enveloping technologies – the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes.

Order Tracking is primarily used for analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders is input by the user. Order Tracking also minimizes the risk of smearing in spectrums.

Part numbers

MOD135 EVAM incl. Condition Manager and HD ENV

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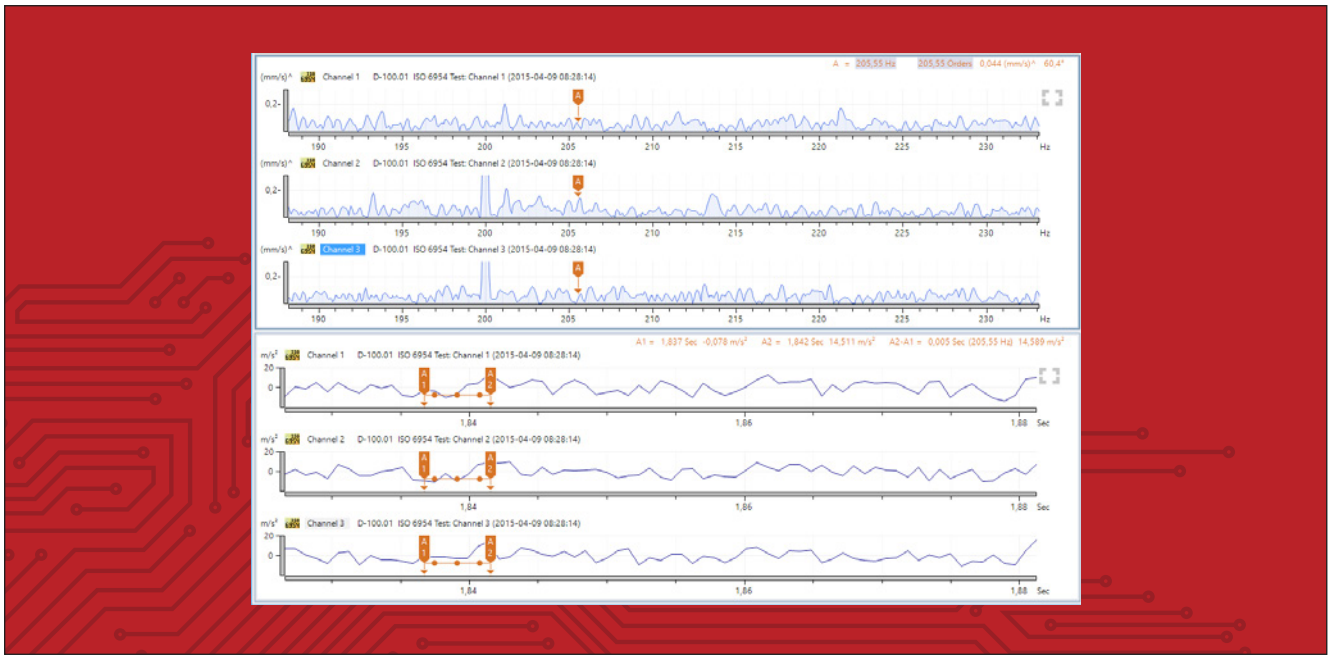
Condmaster® Ruby 2020 – Multi-channel simultaneous vibration



Multi-channel simultaneous vibration monitoring, including both two-channel and three-channel measurements, is a module function in Condmaster Ruby that requires either 'FFT with symptoms' or 'EVAM' to be active.

This type of measurement allows the user to study machine movement in two/three dimensions by observing the difference of the phase angles measured on the channels.

Measurement requires the set-up of two/three vibration measuring assignments with identical parameters. A multi-channel measuring cable is used to connect both transducers to the Leonova vibration transducer input. The procedure is the same as for the corresponding measurement with a single transducer. For Intellinova Parallel EN, a multi-channel measurement must be set up within the same group of four channels, i.e. within channel 1-4, 5-8, 9-12 or 13-16.

Condmaster Ruby displays the RMS values for DISP, VEL and ACC for all channels. Three graphs are available for each measurement:

- Spectrum.
- Phase spectrum.
- Time signal.

The image is showing the spectrum and the time signal for the channels.

The two cursors show the difference in phase angle at the actual frequency. A phase is a time delay expressed in degrees of rotation. Leonova or Intellinova calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits.

Part numbers

MOD192 Multi-channel simultaneous vibration

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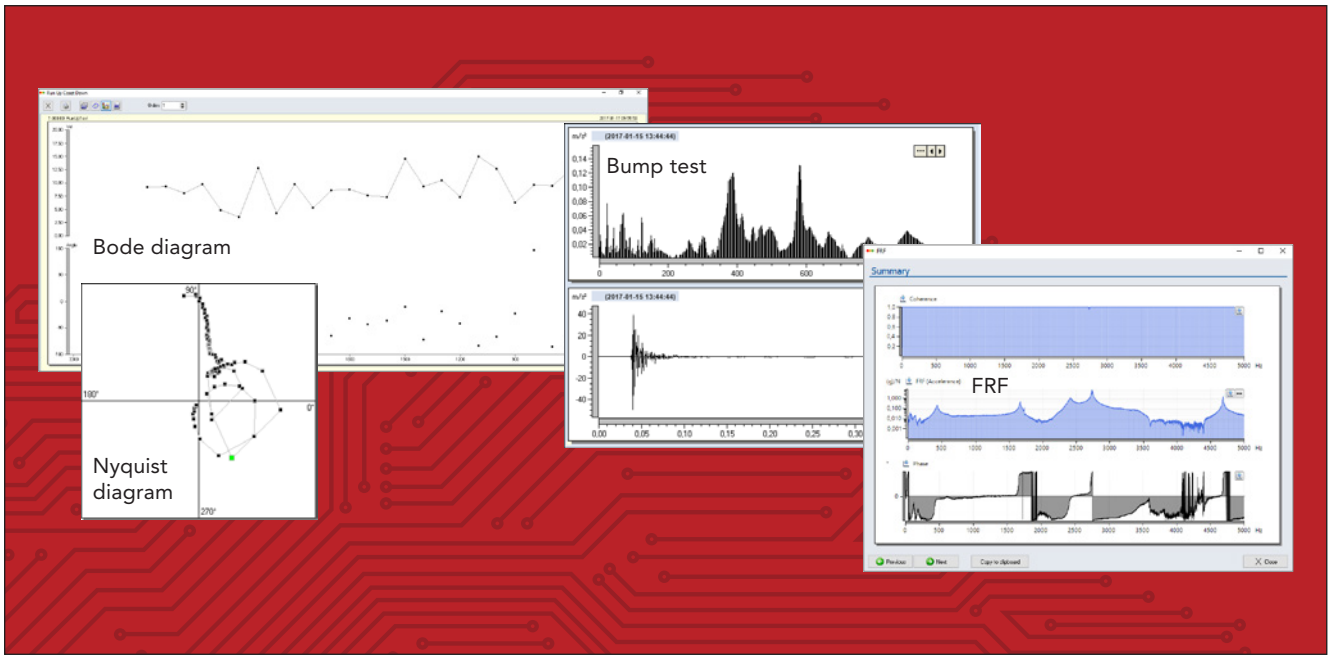
Condmaster® Ruby 2020 – Run up/Coast down, Bump test, FRF



Run up/coast down measurements, Bump test and FRF are vibration analysis functions offered as a module for Leonova and Intellinova.

Run up/coast down records the changes in vibration while the machine is run up to operating speed or after it has been shut off and is slowing down.

For this test, both the signal unit and the unit for the spectrum can be selected. The measuring interval can be either time based (interval in seconds) or speed based (interval in rpm). The speed range is also chosen, e.g. 400 to 3000 rpm.

Waterfall diagram can be viewed after the measurement is done. For each individual measurement, a spectrum can be called up.

Nyquist diagram shows the phase angle and amplitude. A phase is a time delay expressed in degrees of rotation. Leonova calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits.

Bode diagram can be selected for vibration amplitude and angle, showing all measurements in time sequence. In all diagrams, a blue dot shows the position of the measurement marked on the list.

Bump test is employed to check out the typical vibration response of a machine structure at standstill, by hitting it e.g. with rubber mallet (bump test).

The user sets the measuring range in Hz, which automatically sets the sampling time, e.g. 0.20 seconds for 2000 Hz/400 lines. A pre-trigging time, 5% to 25% of the sampling time, is also chosen.

The peak amplitude of the measured signal is displayed (velocity in mm/s) and a trigger level can be set to 1% – 90% of the amplitude.

The actual test returns an FFT spectrum and a time signal (sampling time plus pre-trigging time). The spectrum can be stored as reference spectrum for any measuring assignment.

Frequency Response Function (FRF) is used to measure the vibration response (natural frequencies) of a machine structure, similar to the 'Bump test'. FRF however is more sophisticated, measuring the response resulting from a known applied input by using an impact hammer and a vibration transducer connected to Leonova Diamond's vibration input using a split cable.

The FRF measuring assignment is set up in Leonova Diamond and the settings and measuring results can be viewed in Condmaster Ruby after the measuring round is uploaded.

Part numbers

MOD137 Run up/Coast down, Bump test and FRF

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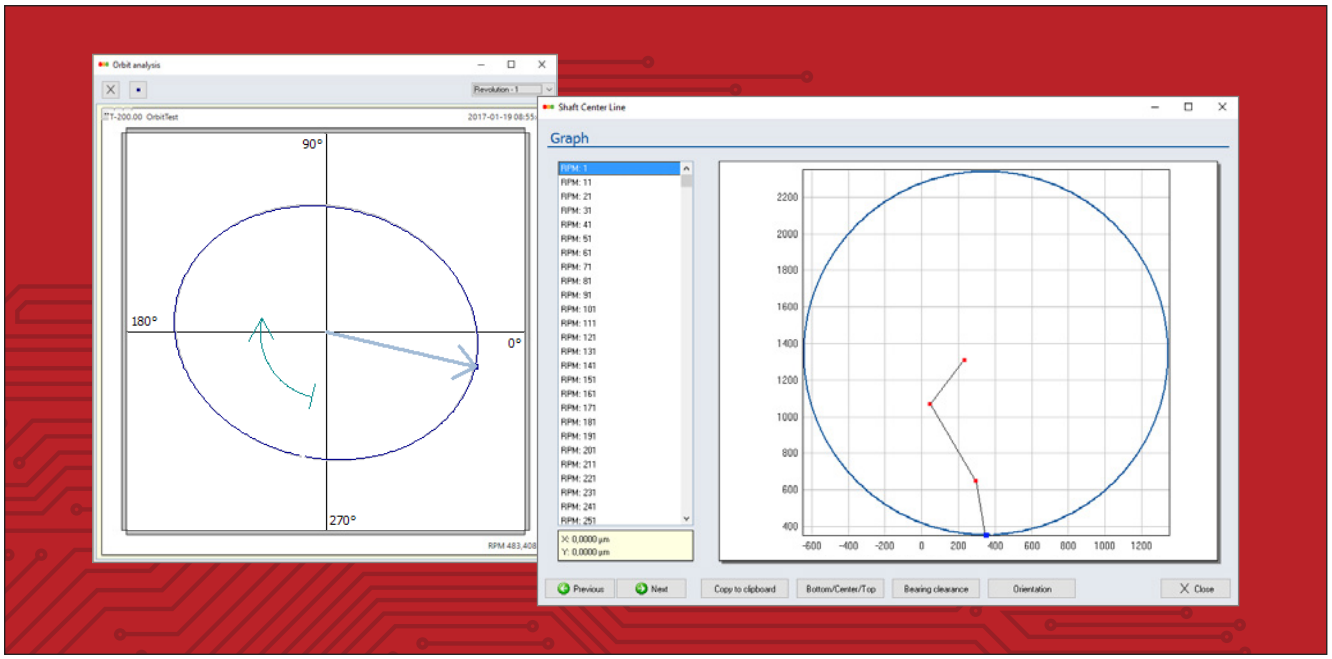
Condmaster® Ruby 2020 – Orbit Analysis and Shaft Centerline Plot



Orbit Analysis is a vibration measurement function offered as a module for Condmaster Ruby. The resulting orbit graph shows the movement of the shaft's centerline and is used to detect failures like rubs, unbalance, misalignment or oil whip on machinery with journal bearings.

Measurements are normally performed with Leonova Diamond, Intellinova Standard or Intellinova Parallel EN on the buffered outputs of a machine protection system. Intellinova Parallel EN requires a Displacement Signal Interface (see TD-549) for measurements on buffered outputs of a machine protection system.

Measurements can also be made with e.g. accelerometers to get a two-dimensional graph of the mechanical forces on the bearing housing. Required are two channel simultaneous vibration measurement and two transducers placed at an angle of 90° to each other, plus a trigger signal from a tachometer probe.

Settings include transducer type, signal unit and filter type, either bandpass (default) or lowpass. Orders is set to 1 by default, but the user can select from 1 to 5 orders. The number of revolutions parameter, max. 25, specifies the number of shaft revolutions to acquire and display in the orbit graph.

The orbit graph shows an overlay of the graphs for each measured revolution plus their average. The user can select each individual revolution as well as the average of all revolutions.

The selected graph is marked blue, with a blue arrow showing the angle and the x/y values at that angle. The user can move the arrow on the screen in the orbit graph.

When the orbit assignment is set up in Condmaster Ruby, alarm limits can be set on the X and Y axis, resulting in an evaluated measurement (green – yellow – red scale).

Shaft Centerline Plot is a function available with Leonova Diamond. Especially useful for assessment of lubrication during start-up of a machine with journal bearings, the plot displays changes in radial rotor position over a range of speed. Settings for Shaft centerline plots are made in Leonova Diamond. The results can be viewed in Condmaster Ruby after the measuring round is uploaded.

Part numbers

MOD138 Orbit analysis and Shaft Centerline Plot

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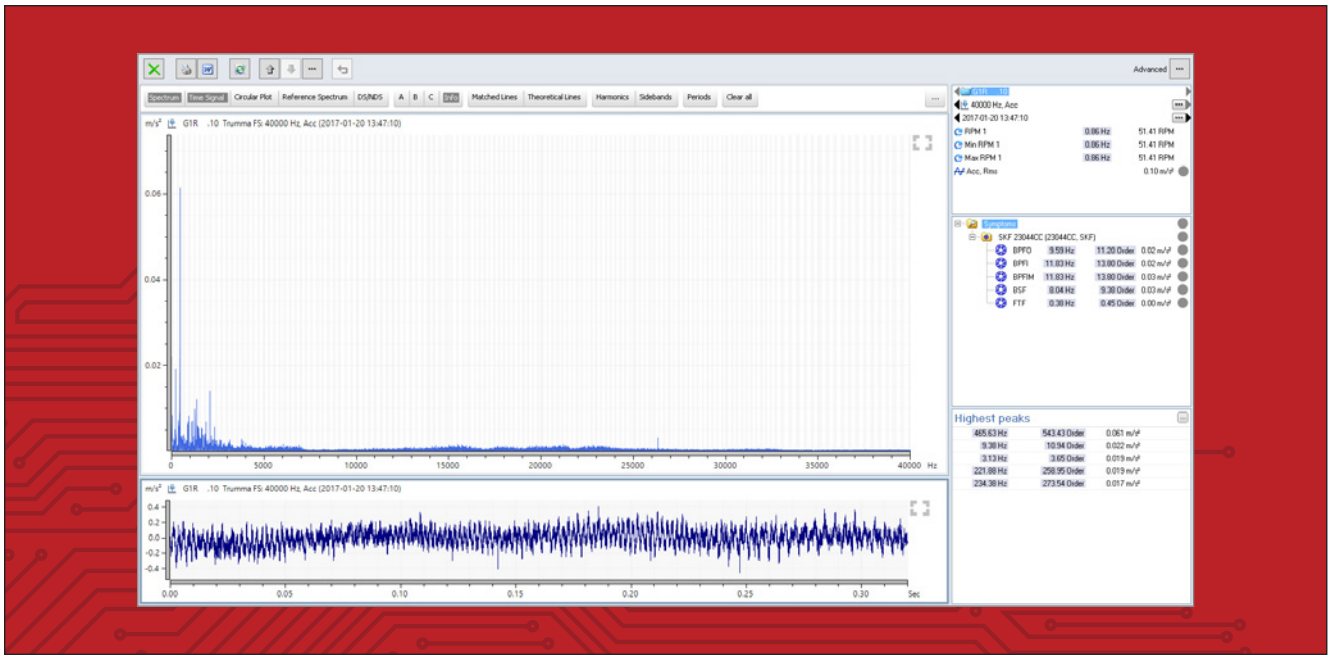
Condmaster® Ruby 2020 – Extended resolution and frequency range



When higher resolution and frequency range are required for FFT with symptoms, EVAM, SPM HD Expert or SPM Spectrum, e.g. when monitoring high-speed gearboxes in turbines, MOD194 extends the maximum of these parameters. The lower frequency limit is then 0, 0.5, 2, 10 or 100 Hz. The upper limit is 40 000 Hz. The number of spectrum lines can be extended to max. 12 800 or 25 600.

To highlight low energy signals, the dB unit can be selected.

Part numbers

MOD194 12 800 or 25 600 lines, 40 kHz

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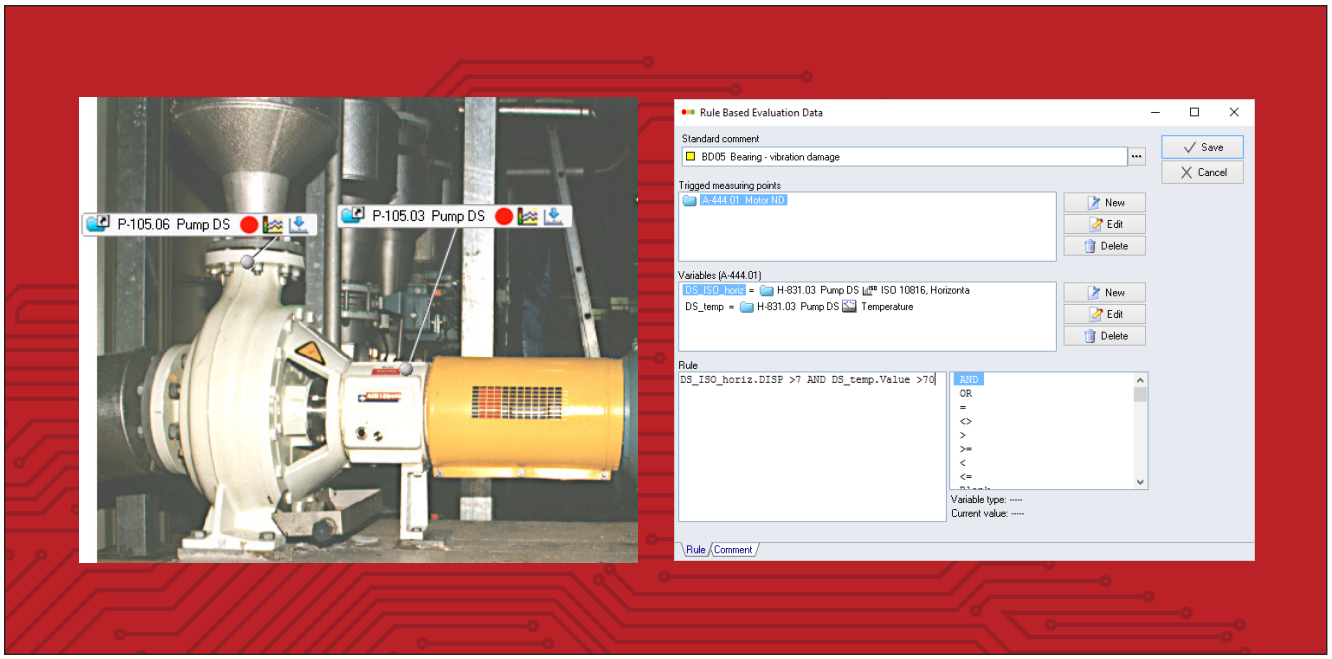
Condmaster® Ruby 2020 – Rule-Based Evaluation, RBE



Rule-Based Evaluation (RBE) is a module in Condmaster Ruby. The purpose of RBE is to give the user guidance on what to do when certain alarm conditions are met. RBE is an excellent tool in Product Integrated Maintenance (PIM).

RBE items concist of standard comments and user-defined texts to set up alarm parameters for triggered measuring points. Pictures can be attached to illustrate.

Each RBE item consists of a standard comment, one or more trigged measuring points, one or more variables and a rule that specifies under what conditions the alarm should be triggered. Measuring points can be added and deleted as required. When the conditions of a specific alarm are met, the alarm is triggered, suggesting appropriate measures.

If for instance there are high readings on a pump housing, the reason is most likely cavitation. If this condition arises, RBE could be set up to rectify the problem. The suggested actions might be to open valves, change speed or other relevant measures to correct the faulty condition.

Part numbers

MOD181 Rule-Based Evaluation, RBE

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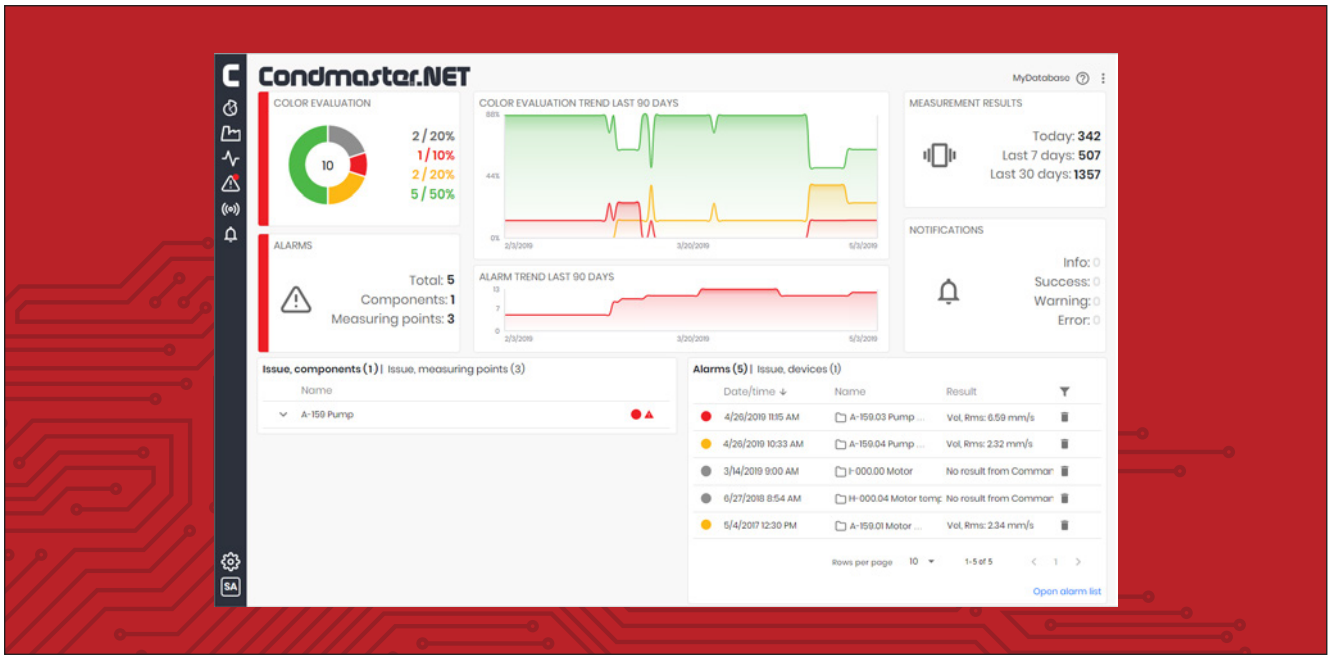
Condmaster® Ruby 2020 – Condmaster.NET



Condmaster.NET, which is included in the Condmaster Ruby platform (see TD-583), is a web application and downloadable app that can be used to access Condmaster Ruby data from all types of devices.

Condmaster.NET presents an intuitive and easily accessible overview of color evaluation and alarms and offers basic analysis functionality. Application-specific, customized dashboards to visualize and monitor process data can be created on request.

Condmaster.NET provides Condmaster Ruby users at all levels access to condition monitoring data on computers, tablets, and smartphones from anywhere in the world:

- Get a quick overview of the condition of critical assets in your plant.
- View the current condition status of all measuring points, as well as alarms and issues on machine, component, and measuring point level.
- Perform basic analysis of your condition monitoring program using spectrums, time signals, trends, and alarms.
- View Plant Performer (see TD-598) statistics – an effective tool to visualize the benefits of condition monitoring as well as its technical and economic impact.

Depending on the functions offered by your Condmaster Ruby system:

- Manage online measuring devices and view their activity in real-time.
- Monitor manufacturing process data in real-time.
- Use customized dashboards for a tailored overview of current condition status.

For the Airius sensor (see TD-567), Condmaster.NET is available as a cloud service (see TD-580). Users can log onto Condmaster.NET to view spectrums, time signals, trends, and alarms– all based on data residing in SPM Cloud.

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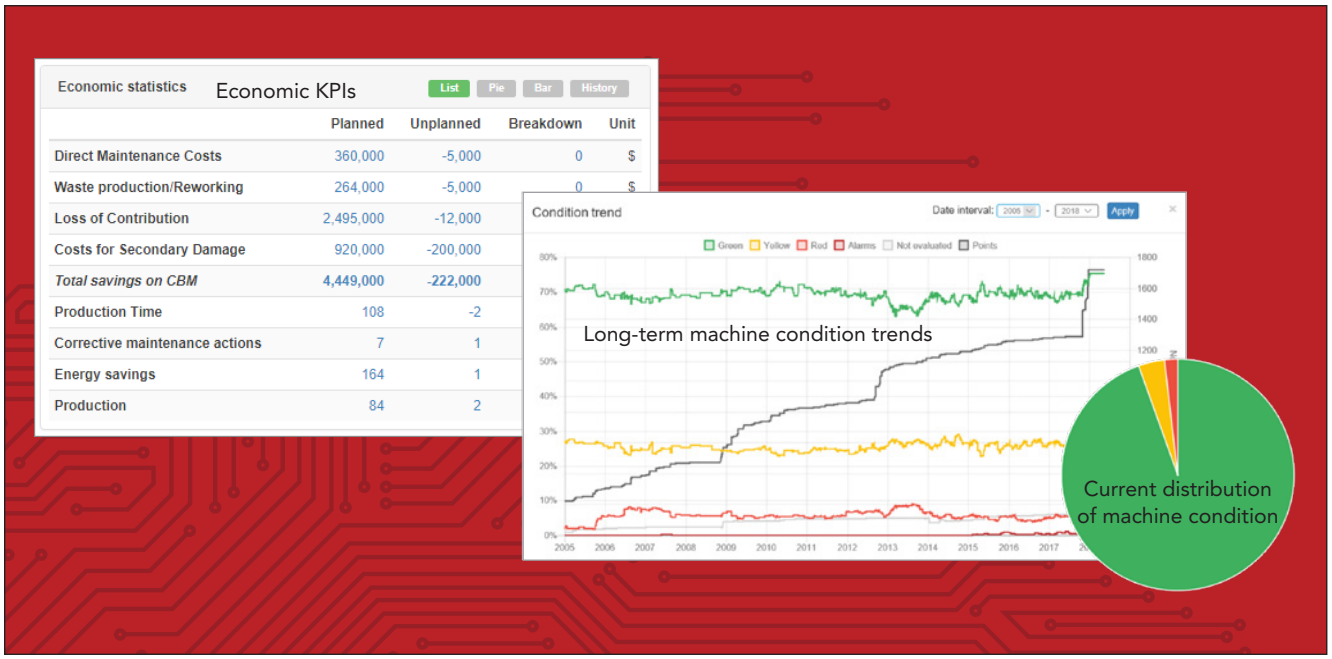
Condmaster® Ruby 2020 – Plant Performer™



Plant Performer compiles and visualizes statistics relating to technical and economic KPIs (Key Performance Indicators) in the OEE/TEEP area for display and evaluation in Condmaster.NET. Plant Performer, a part of the Condmaster Ruby platform (see TD-583), demonstrates the benefits of condition monitoring and communicates its technical and economic impact to all levels of the organization.

Basic data, including machine types, for the generation of Plant Performer statistics is entered in Condmaster Ruby. When corrective measures is taken, users enter information in a Corrective maintenance comment, which is then used to generate economic KPI statistics, such as Direct Maintenance Costs, Loss of Contribution, and Costs for Secondary Damage.

Technical KPIs are created at the measuring point level and linked to folders in the Measuring Point Tree. They can be calculated for all or a subset of machine types. For instance, the overall vibration level for electrical motors in a department, or an entire plant, calculated at user-defined intervals. Plant Performer offers the possibility to follow up on MTBF (Mean Time Between Failure), as well prewarning and planning times, per machine type.

Plant Performer includes database statistics, such as the number of measuring points or measuring rounds, or database size.

Statistics can be viewed at aggregate or database level with drill-down options, presented in lists, as pie or bar charts, and in timelines. Filter options can be used for a more narrow selection of data.

For economic statistics and machine condition trends, data can include either a specific year or all historic data, while current machine condition and database statistics provide a snapshot of the current situation.

Statistics from an unlimited number of Condmaster databases can be exported and imported into Plant Performer – such as from other divisions, production units, plants, or an entire group – for easy comparison of data.

Plant Performer data can be exported from Condmaster Entity Server to other systems by means of an application programming interface (API).

Statistical examples include:

- Total Loss of Contribution.
- Overall vibration level for a department/for all fans/for entire plant, etc.
- Operating condition (green – yellow – red) for all electrical motors.
- Number of fans in alarm condition.
- MTBF for centrifugal pumps with criticality A.

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Condmaster® Ruby 2020 – Intellinova®

The Intellinova module in Condmaster Ruby enables the software to communicate with all Ethernet compatible Intellinova systems, equipped with a user-selected combination of measuring units for bearing and/or vibration monitoring and/or units for analog and digital signals.

The core of the Intellinova system is Condmaster Ruby, which receives the measuring results from all condition monitoring devices for evaluation and presentation.

The Intellinova module offers advanced measurement, filtering and alarm options. These are used to set the system up to measure only when required, to discard what is insignificant and to raise only well justified alarms.

Based on extensive empirical data, international standards and machine statistics, the evaluation result is an easy-to-understand color code, highlighting potential trouble spots. By calibrating and adjusting limit values, the automatic evaluation process can be tuned with great precision and get an immediate, reliable diagnosis.

The module also works for the CMS online system.

Part numbers

MOD187 Condmaster Ruby, Intellinova

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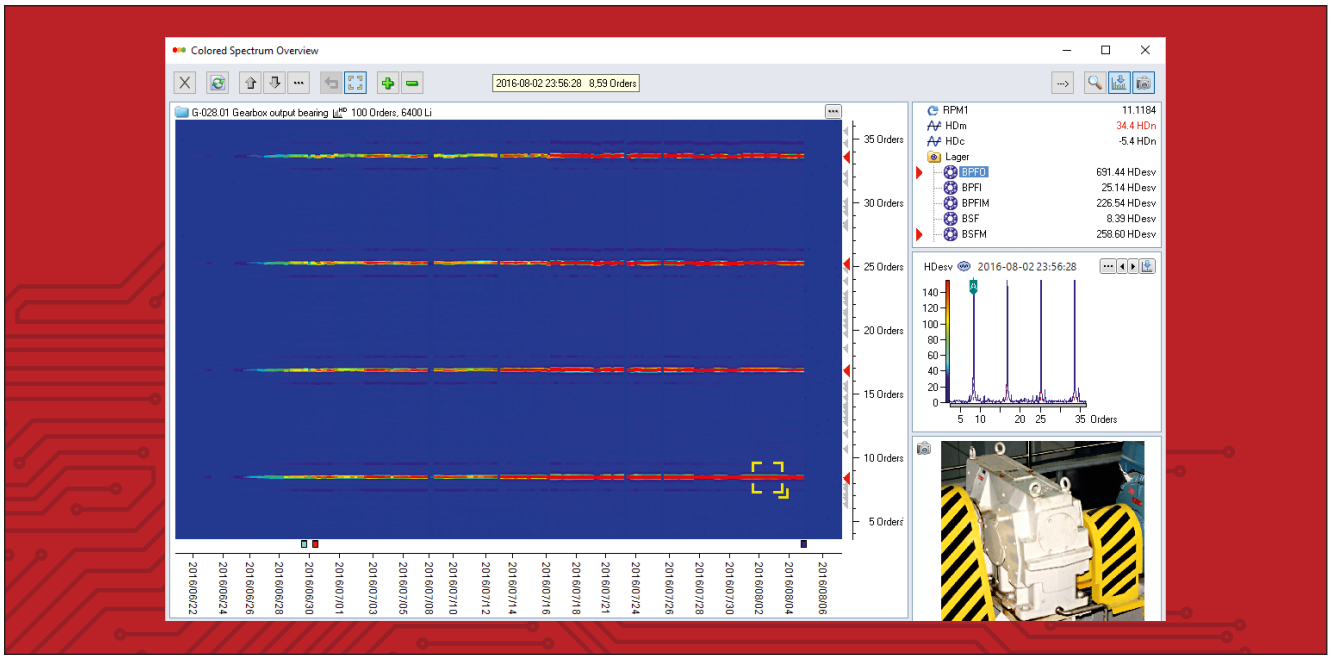
Condmaster® Ruby 2020 – Colored Spectrum Overview



Colored Spectrum Overview is included in the Condmaster Ruby platform (see TD-583).

The purpose of Colored Spectrum Overview is to simplify the process of identifying in spectrums the patterns and trends which indicate damages. It clearly distinguishes between signals that are always present in the machine and signals caused by developing damages. The module function provides a good overall picture of the machine condition development.

The overview shows multiple spectrums over a longer period of time. Spectrums is viewed in orders, CPM or Hz.

Among many features in Colored Spectrum Overview are:

- Zooming possibilities in x, y and z axes.
- Logarithmic or power spectrum.
- Symptoms activation to simplify damage identification.

In the overview, harmonics are always shown. Sidebands can be activated by the user.

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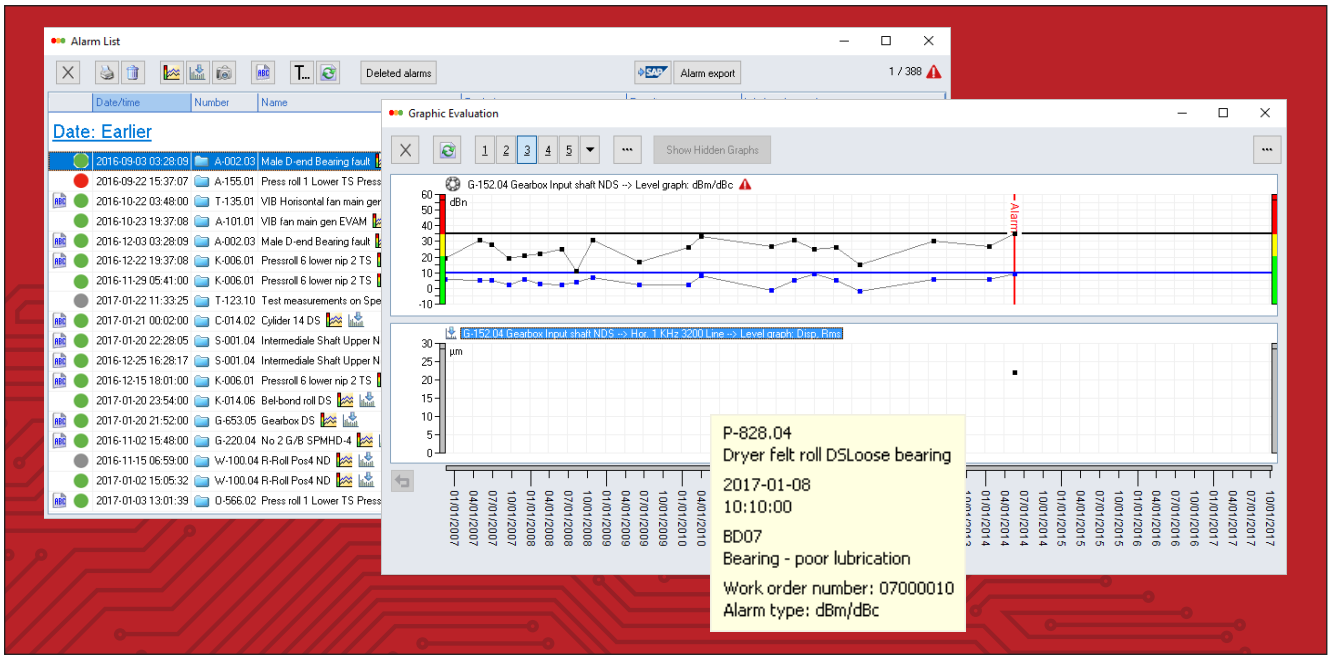
Condmaster® Ruby 2020 – SAP and AMOS links



The SAP and AMOS links are included in the Condmaster Ruby platform (see TD-583).

The function provides a link to SAP and/or AMOS software. Clicking the **Alarm export** (for AMOS) or **SAP** button on the Condmaster alarm list sends the marked alarm message to the receiving software. Returned is a SAP or AMOS work order number that locks the alarm, until a second message from SAP or AMOS deletes the alarm and sets a comment on the Condmaster measuring point, stating what has been done. In addition, the Condmaster measuring point setup now contains an optional field for SAP equipment numbers.

The operation requires no extra data input. The Condmaster operator simply presses the **SAP** or **Alarm export** button when an alarm merits a work order. The SAP or AMOS operator responds by sending a Standard Comment to a text file.

Standard Comments are a user defined register of short messages in Condmaster, e.g. "Bearing replaced". The SAP/AMOS operator can add free text. On receiving the comment, Condmaster deletes the alarm. The comment is added to the list of comments under the measuring point and is visible in the measuring result diagram.

Specific functions are required in the SAP/AMOS software for the communication to work properly. These functions are not provided by SPM Instrument AB, only a protocol description of the functions as seen from Condmaster.

Running the AMOS link requires a CBM module in AMOS. A register of planned actions equivalent to that in Condmaster must be implemented, and component numbers need to be the same in both systems.

Z_Condmaster is the function that needs to be implemented in SAP software. Condmaster calls Z-Condmaster in SAP and sends the measuring point and alarm information. SAP creates a work order and a file where Condmaster reads the SAP work order number. This file can be saved anywhere locally or on the server. It is normally placed in the Condmaster directory. The path has to be set in Condmaster.

There is no extra data input required on the SAP side. Condmaster measuring point numbers and Standard Comment codes are available to SAP software via a command to the SQL server that controls the Condmaster data base.

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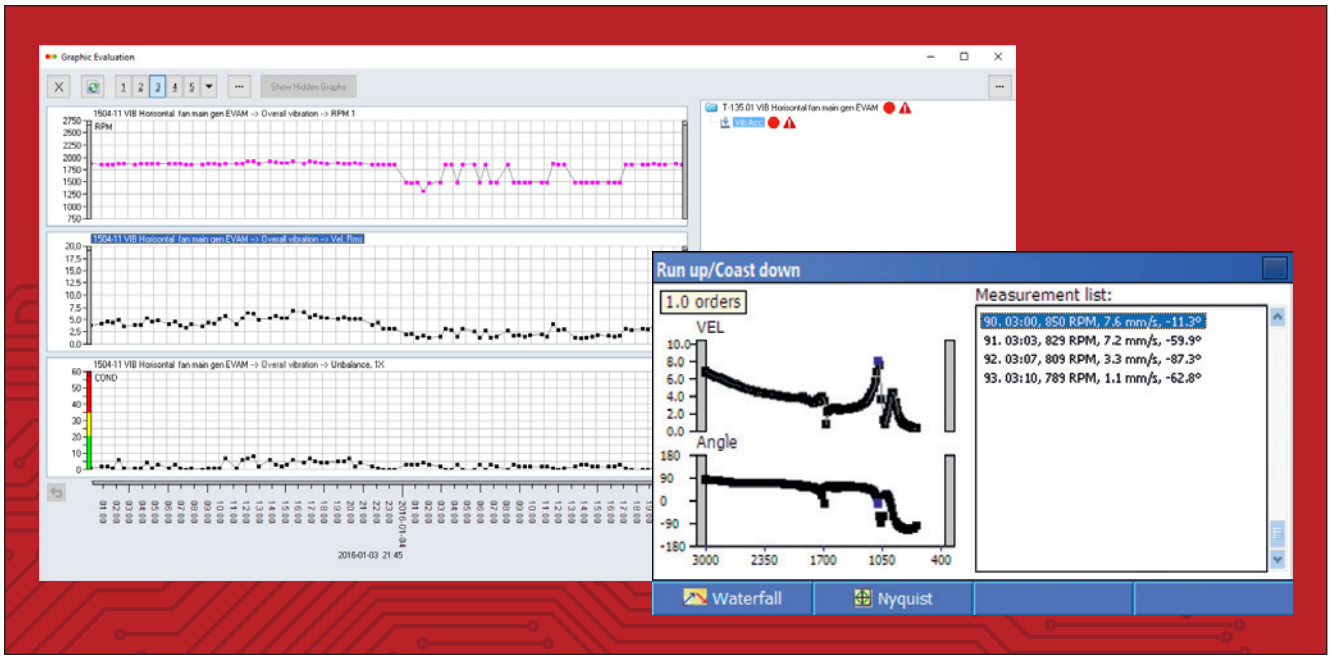
Condmaster® Ruby 2020 – Vibration Expert



Vibration Expert is a module in Condmaster Ruby for use with the portable instrument Leonova Diamond. As a combination of modules MOD135, MOD137 and MOD194, the Vibration Expert module contains:

EVAM (see TD-591) generates three sets of machine condition data:

- Condition parameters, which are measured and calculated values describing various aspects of machine vibration.
- Vibration spectra where significant line patterns are found, highlighted and evaluated with the preset fault symptoms.
- Machine specific condition codes (green – yellow – red) and condition values, based on a statistical evaluation of the condition parameters and symptom values.

For each measuring point, the user can make an individual selection and define the type of data best suited for the surveillance of an individual machine. Alternatives include

- HD ENV
- Time Synchronous Averaging (TSA)
- Band values and averaging of measurement results for improved alarm reliability.

Random high readings caused by disturbance are filtered out, minimizing the number of false alarms. As an alternative to spectrum analysis, cepstrum analysis can be used for gearboxes.

HD ENV (see TD-608) is an ideal complement to conventional vibration techniques. Capable of detecting at a very early stage such machine problems which are generally difficult to find in good time with non-enveloping techniques – for example bearing damages and gear damage – the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes.

Run up/coast down (see TD-593) records the changes in vibration while the machine is run up to operating speed or after it has been shut off and is slowing down.

For this test, both the signal unit and the unit for the spectrum can be selected.

Bump test (see TD-593) is employed to check out the typical vibration response of a machine structure at standstill, by hitting it e.g. with rubber mallet (bump test).

Frequency Response Function, FRF (see TD-593), is used to measure the vibration response (natural frequencies) of a machine structure, similar to the 'Bump test'. FRF however is more sophisticated, measuring the response resulting from a known applied input by using an impact hammer and a vibration transducer connected to Leonova Diamond's vibration input using a split cable.

Extended resolution and frequency range (see TD-595) are sometimes required for FFT with symptoms, EVAM, SPM HD Expert or HD ENV, e.g. when monitoring high-speed gearboxes in turbines. Vibration Expert provides 25 600 lines and 40 KHz.

Order Tracking is primarily used for analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders is input by the user. Order Tracking also minimizes the risk of smearing in spectrums.

Part numbers

MOD193 Vibration Expert

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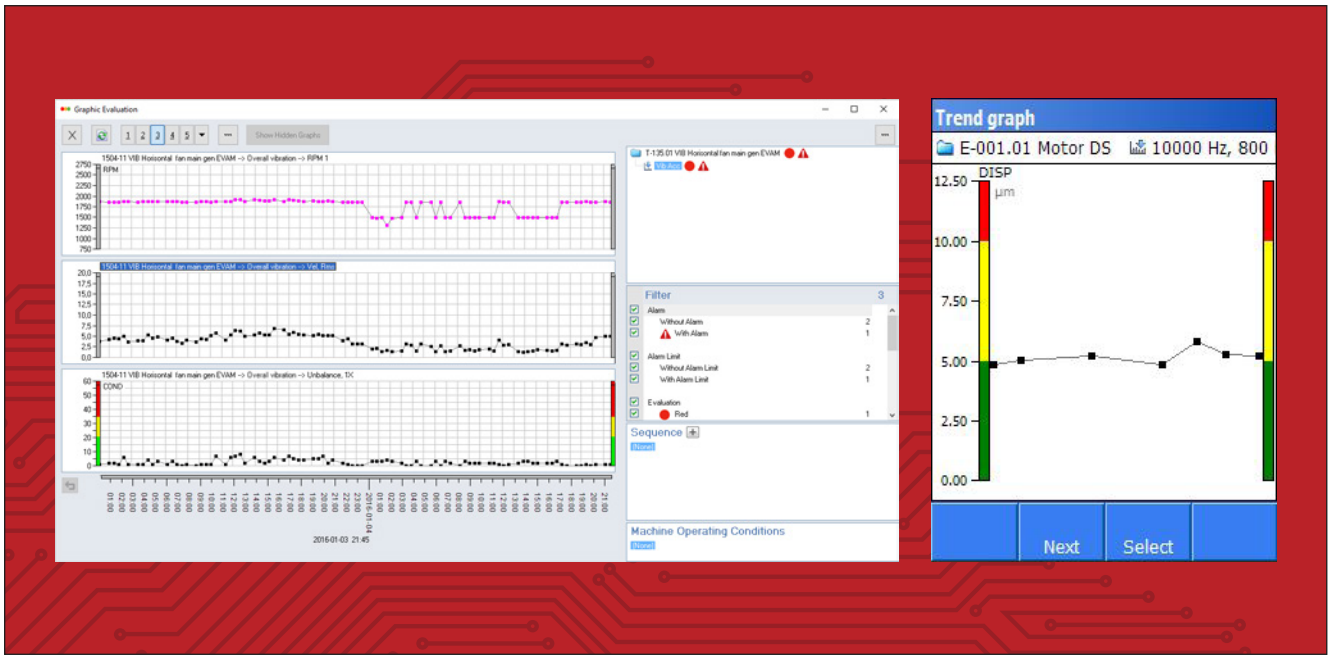
Condmaster® Ruby 2020 – Vibration Supreme



Vibration Supreme is a module in Condmaster Ruby for use with the portable instrument Leonova Emerald. As a combination of modules MOD135, MOD137, MOD139 and MOD199, the Vibration Supreme module contains:

EVAM (see TD-591) generates three sets of machine condition data:

- Condition parameters, which are measured and calculated values describing various aspects of machine vibration.
- Vibration spectra where significant line patterns are found, highlighted and evaluated with the preset fault symptoms.
- Machine specific condition codes (green – yellow – red) and condition values, based on a statistical evaluation of the condition parameters and symptom values.

For each measuring point, the user can make an individual selection and define the type of data best suited for the surveillance of an individual machine. Alternatives include

- HD ENV
- Time Synchronous Averaging (TSA)
- Band values and averaging of measurement results for improved alarm reliability.

Random high readings caused by disturbance are filtered out, minimizing the number of false alarms. As an alternative to spectrum analysis, cepstrum analysis can be used for gearboxes.

HD ENV (see TD-608) is an ideal complement to conventional vibration techniques. Capable of detecting at a very early stage such machine problems which are generally difficult to find in good time with non-enveloping techniques – for example bearing damages and gear damage – the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes.

Extended resolution and frequency range (see TD-595) are sometimes required for FFT with symptoms, EVAM, SPM HD Expert or HD ENV, e.g. when monitoring high-speed gearboxes in turbines. Vibration Supreme provides 12 800 lines and 40 KHz.

Order Tracking is primarily used for analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders is input by the user. Order Tracking also minimizes the risk of smearing in spectrums.

Part numbers

MOD197 Vibration Supreme

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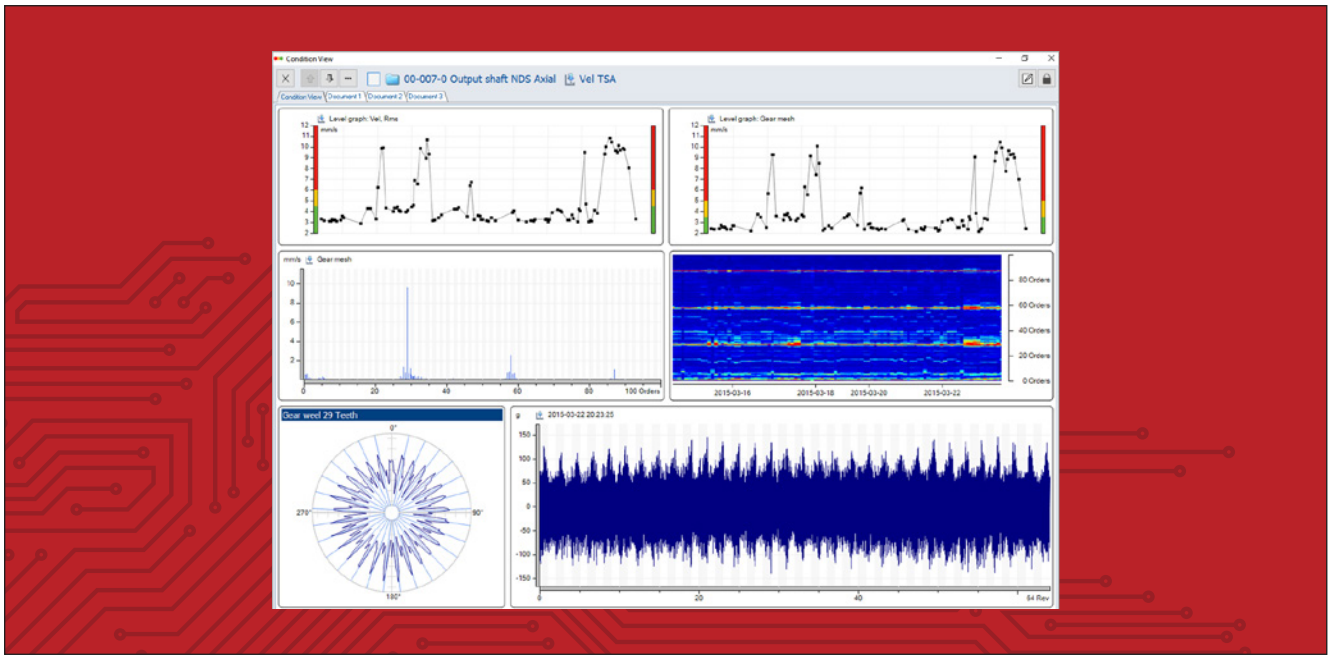
Condmaster® Ruby 2020 – Condition View



Condition View is a flexible and powerful function that makes it possible to combine multiple graphs in Condmaster into a single window for presentation and further analysis. The function can be used to show current machine condition, recent condition development or maintenance actions, e.g. to clarify or justify planned maintenance activities.

Condition View provides a useful overview of the most interesting condition data and any complementary information for a particular measuring point. For one or more measuring points, trend graphs, spectrums, time signals, Colored Spectrum Overview graphs, and circular plots, etc. can be combined as desired. It is also possible to include different measuring techniques in the same view.

The default settings of the Condition View function can be modified to suit customer preferences.

The function is user-friendly, with ability to set cursors, zoom and rescale graphs directly in Condition View mode, and quickly navigate from there to individual graphic functions. The content can be printed and/or saved as MS Word files. Condition View also offers the possibility to customize and export its content, including cursors and notes, to the Condition View Report function as a basis for report generation.

The Condition View function is part of the Condmaster Ruby platform (see TD-584).

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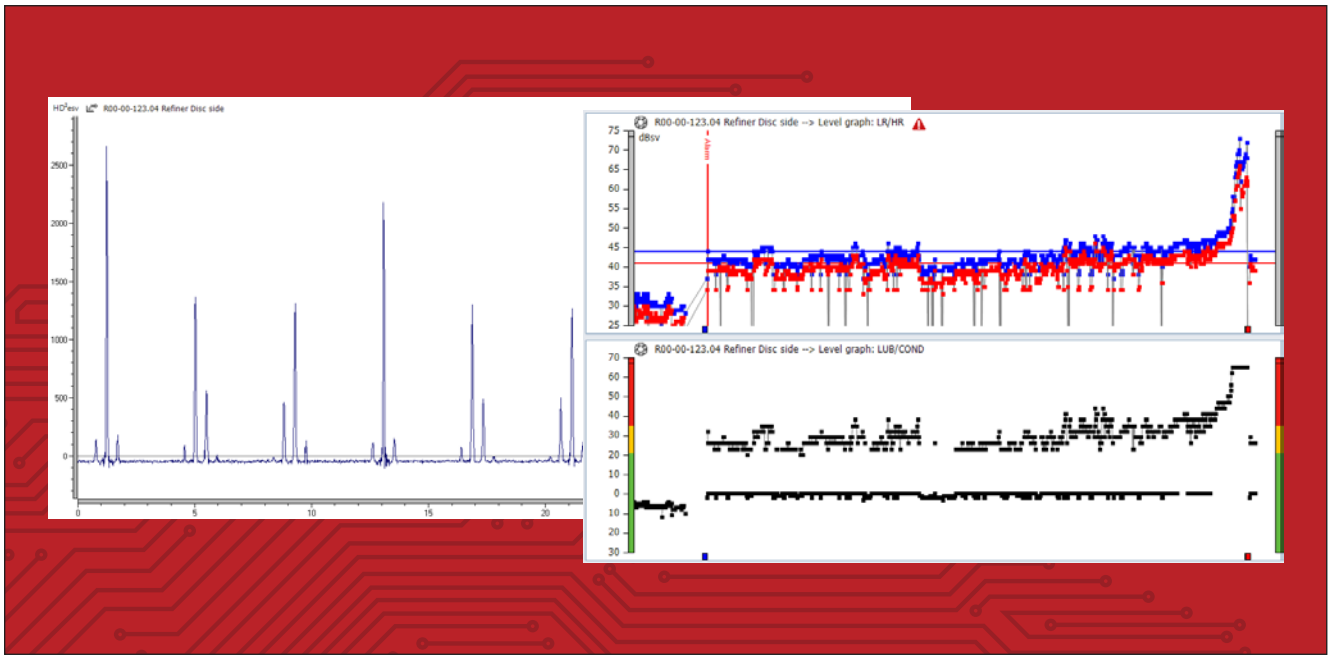
Condmaster® Ruby 2020 – LR/HR HD and Lubmaster



LR/HR HD is a combination of the modules LR/HR (MOD131) and SPM HD Expert (MOD195).

Like the LR/HR method (see TD-586), LR/HR HD provides diagnosis of rolling element bearings and precision analysis of oil film condition in the rolling interface, and contains calculation models for finding the optimal lubricant. Further benefits of the LR/HR HD method include:

- Signal processing with state-of-the-art 24-bit A/D conversion in combination with HD technology yields spectrum and time signals with razor-sharp resolution and exceptional level of detail.
- High Definition Order Tracking for analysis on variable speed machines providing reliable data and crystal clear measuring results even when RPM varies greatly during the course of measurement.
- Symptom Enhancement – an algorithm that looks for repetitive impacts in the time domain. As a result, random signals are suppressed and repetitive signals are enhanced in order to display relevant data.

Signal and measurement

Transducer and measuring procedure are the same as for the dBm/dBc method (see TD-585) and the LR/HR method The shock pulse meter counts the rate of occurrence (incoming shock pulses per second) and varies the gain until two amplitude levels are determined:

- LR: low rate of occurrence, quantifying the strong shock pulses (approx. 40 incoming shocks per second).
- HR: high rate of occurrence, quantifying the shock carpet (approx. 1000 incoming shocks per second).

LR and HR are 'raw values', measured in dBsv (decibel shock value).

Input data

The rpm is needed, plus a definition of the bearing type and size. This is best input by stating the ISO bearing number, which links to the bearing catalogue in Condmaster.

Evaluation

After measurement the measuring device returns

- a general description of bearing condition (CODE)
- a value for oil film condition (LUB)
- a value for surface damage (COND).

A LUB no. of 0 means dry running, the value increases with oil film thickness. A COND no. of around 30 indicates surface stress or early damage, the value increases with damage severity. The general assessment is:

CODE A	Good bearing
CODE B	Poor lubrication
CODE C	Damage in early stage
CODE D	Damage

A program part, LUBMASTER, uses the shock values plus data on lubricant type, viscosity, load and operating temperature to calculate the bearing's life expectancy under present condition. It also calculates the effect of changes in oil type and viscosity.

Calibration

The accuracy of the LR/HR HD method is increased by a calibration factor (COMP no.) used in case of bearings with minimal load or poor quality measuring points (in both cases the signal strength is below normal). On the basis of the bearing's catalogue data and the lubricant properties, the instrument calculates the normal shock level for a good bearing and compensates for an abnormally low signal before returning the evaluation results.

Part numbers

MOD131 LR/HR
MOD195 SPM HD Expert

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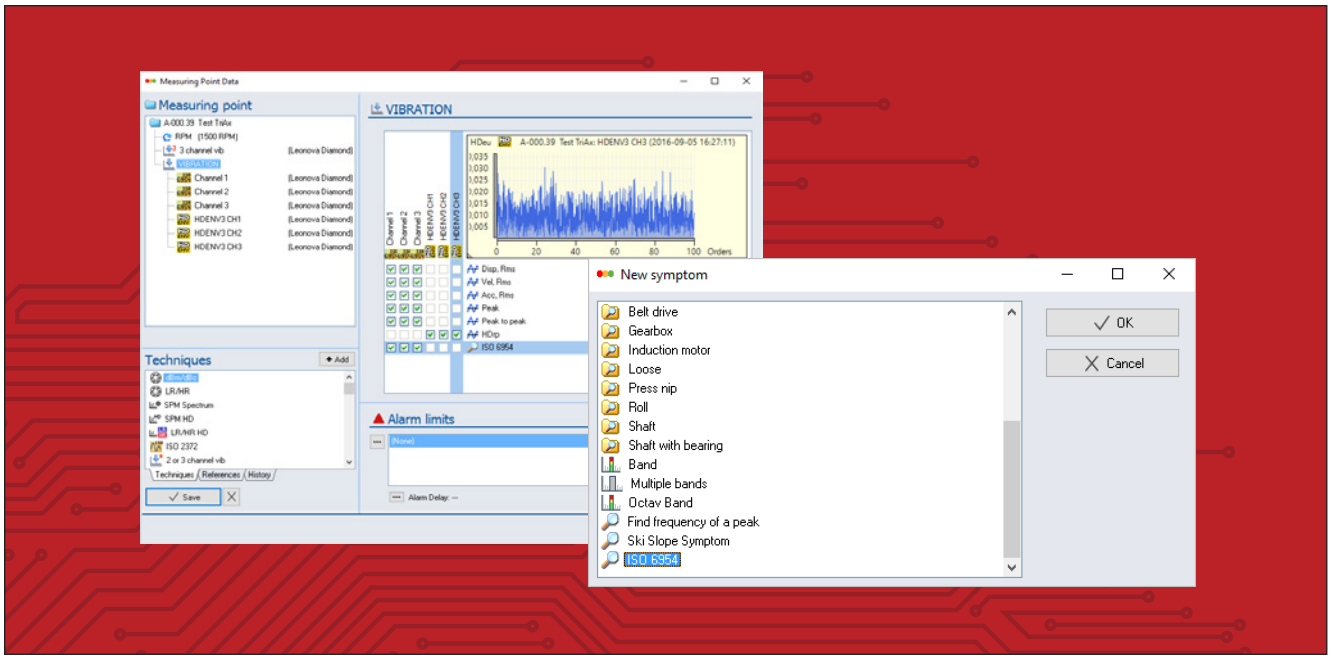
Condmaster® Ruby 2020 – Vibration ISO 6954



The International Standard ISO 6954 contains guidelines for the evaluation of vibration with regard to habitability on a passenger or merchant ship, as well as requirements for the instrumentation and the method of measurement in normally occupied spaces.

Shipboard vibration interfering with duties or reducing comfort is objectionable and often results in adverse comments from crew and passengers. This international ISO standard gives the guidelines for evaluating the habitability of different areas on a ship. The habitability is evaluated by the overall frequency-weighted RMS vibration values from 1 Hz to 80 Hz.

Vibration data acquired in accordance with this international standard are also useful for

- comparison with ship specifications
- comparison with other vessels
- further development and improvement of vibration standards.

It is recommended that the classification to be applied to the various areas of a ship be agreed between the interested parties (e.g. shipbuilder and shipowner) prior to any assessment of habitability.

Measuring rounds can be set up using three-channel vibration assignments with ISO6954 as a symptom. Results from measurements and overall frequency-weighted RMS vibration values measured according to ISO6954 can be presented in Condmaster Ruby, but the evaluation is to be handled in an external software program.

Features of ISO 6954 are:

- Vibration measurement in three directions (horizontal, vertical, axial).
- Frequency 0 Hz (DC) to 500 Hz.
- Frequency-weighted RMS value 1 to 80 Hz.
- Time signal.
- Spectrum, 6400 lines.

Part numbers

MOD198 Vibration ISO 6954

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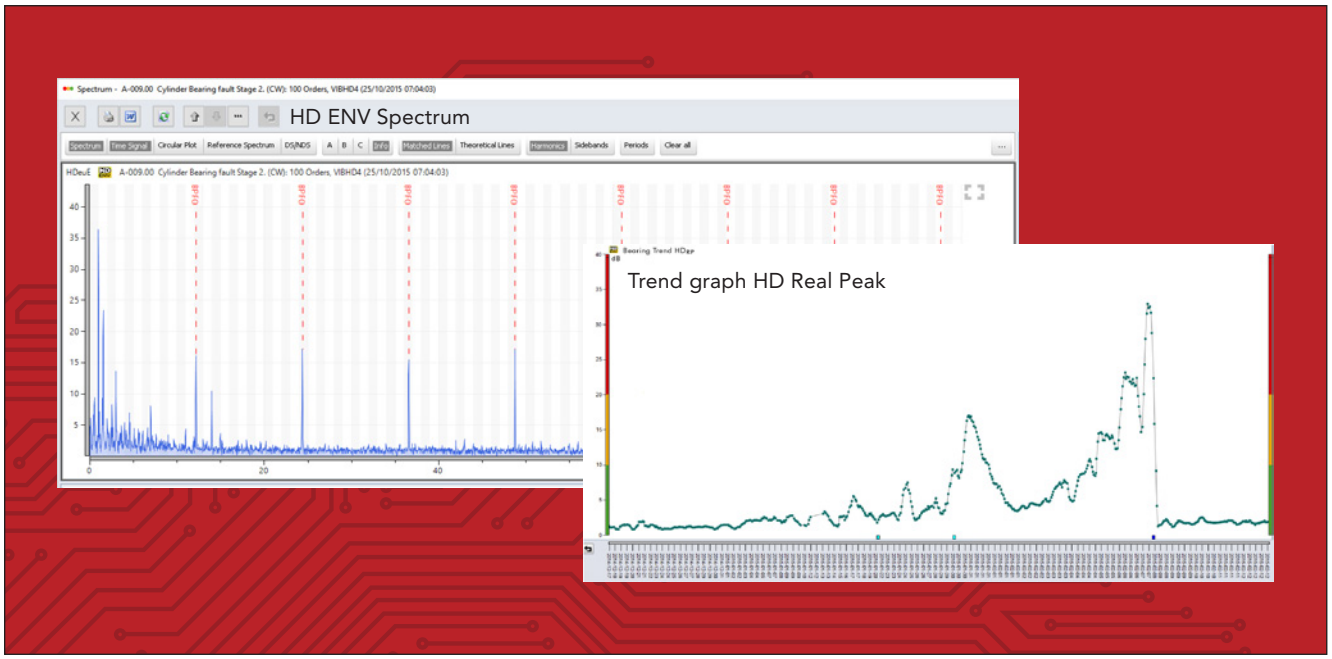
Condmaster® Ruby 2020 – HD ENV



HD ENV is an ideal complement to conventional vibration techniques. Capable of detecting at a very early stage such machine problems which are generally difficult to find in good time with non-enveloping techniques – for example bearing damages and gear damage – the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes. Signals buried in machine noise are revealed through high definition digital enveloping, extracting and enhancing the signals of interest from the overall machinery vibration signal while preserving the true highest peaks.

Input data

The setup of HD ENV measurements in Condmaster Ruby is straightforward. A number of predefined filters are available to detect damages or anomalies in different stages of development; two of which are designed specifically for bearing monitoring and two which are recommended for detection of non-bearing related problems.

High Definition Order Tracking

HD Order Tracking is used with Leonova Diamond, Leonova Emerald and Intellinova, primarily for analysis on variable speed machines. The method uses multiples of rotational speed (orders) – rather than absolute frequency (Hz) – and is capable of handling ±50% RPM variations during data aquisition. The number of orders to be covered is input by the user. HD Order Tracking provides reliable data and crystal clear measuring results even when RPM varies greatly during the course of measurement.

Symptom enhancement

Symptom enhancement is an algorithm that looks for repetitive impacts in the time domain. As a result, random signals are suppressed and repetitive signals enhanced. The output is an HD Env Time signal, where relevant bearing and gear data are displayed. Using HD Order Tracking and symptom enhancement, applying FFT on the signal is very useful to determine the source of the signal.

Random Impact Rejection

Randomly occurring high readings which may cause false alarms are filtered out by means of the random impact rejection algorithm.

Output data

The unit of measurement is HD Real Peak, a scalar value expressed in decibels. Representing the true highest peak found in the envelope signal, HD Real Peak is the primary value to use for determining the severity of a bearing or gear damage. It is also used for triggering alarms.

HD ENV is very suitable for detecting equipment damages which typically have short development times, for instance due to high rotational speed or high temperature industrial environments.

The HD ENV module requires either the EVAM (MOD135) or FFT with symptoms (MOD134) module to also be in use.

Part numbers

MOD199 HD ENV

NOTE: A new license with MOD135 (EVAM) and/or MOD134 (FFT with symptoms) automatically includes HD ENV. Only use MOD199 for upgrading an existing license (Condmaster Ruby 2014 or older) that already has MOD135 and/or MOD134.

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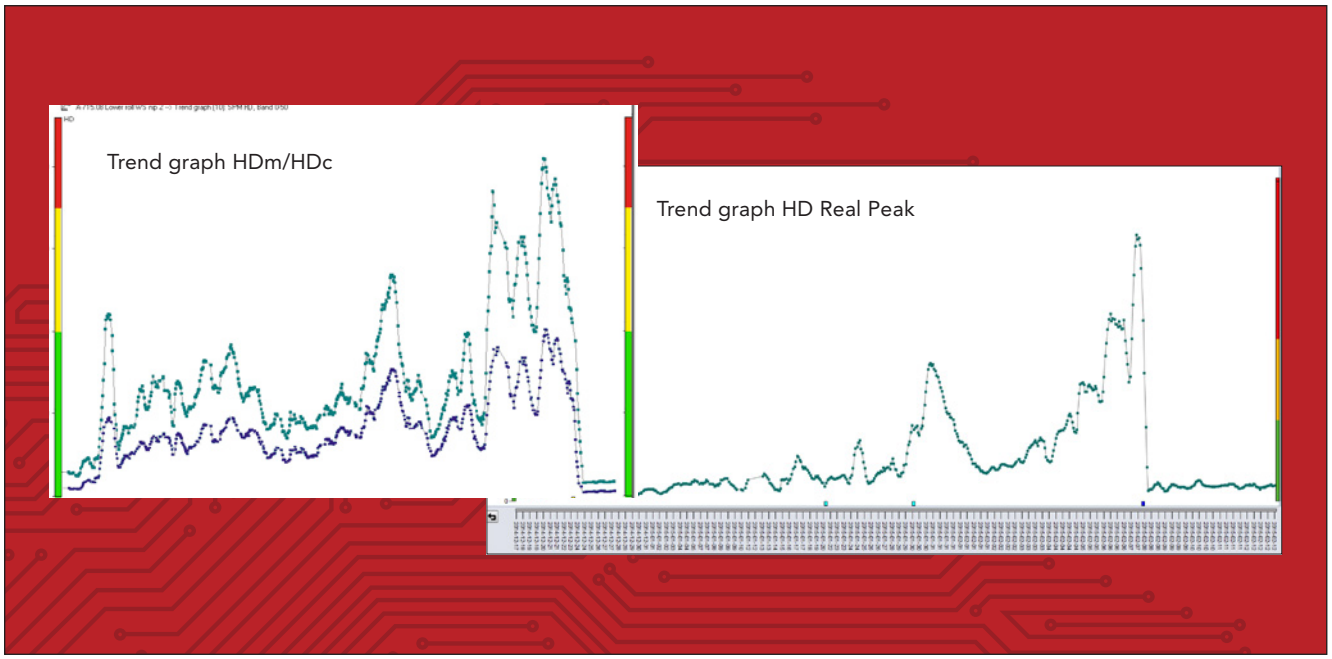
Condmaster® Ruby 2020 – HD Analysis



The HD Analysis module is a combination of the modules SPM HD Expert (MOD195) and Vibration Expert (MOD193) for use with the portable instruments Leonova Diamond and Leonova Emerald.

SPM HD Expert (see TD-588) is a complement to SPM HDm/HDc and LR/HR. Advanced digital technique, RPM-based sampling frequency and measuring time automatically adjusted to RPM makes SPM HD particularly well suited for measurement on low-speed applications. Extraordinary signal quality and 24 bit A/D conversion provides razor-sharp resolution and exceptional detail in spectrums and time signals.

The SPM HD method produces different types of results:

- **HDm/HDc** are part of the Condmaster Ruby platform (see TD-583).
- **Time Signal HD** is extremely useful to locate where in the bearing a possible damage is located. In many cases it is also possible to determine the nature of the damage (cracked inner race with spalling all around or a single crack etc.). The Time signal HD is a result of very advanced digital algorithms where repetitive shocks are enhanced and random signals are suppressed.
- **SPM Spectrum HD** is the result of applying FFT algorithms on the Time Signal HD. The SPM HD spectrum is useful to determine where a possible bearing damage is located. It is also useful for trending purposes (applying symptom and band values).

EVAM (see TD-591) generates three sets of condition data:

- Condition parameters, which are measured and calculated values describing various aspects of machine vibration.
- Vibration spectra where significant line patterns are found, highlighted and evaluated with the preset fault symptoms.
- Machine specific condition codes (green, yellow, red) and condition values, based on a statistical evaluation of the condition parameters and symptom values.

HD ENV (see TD-608) is an ideal complement to conventional vibration techniques. Capable of detecting at a very early stage such machine problems which are generally difficult to find in good time with non-enveloping techniques - for example bearing damages and gear damage - the method utilizes cleverly engineered algorithms for digital signal processing to obtain optimal data for trending purposes.

Run up/coast down (see TD-593) records the changes in vibration while the machine is run up to operating speed or after it has been shut off and is slowing down.

Bump test (see TD-593) is employed to check out the typical vibration response of a machine structure at standstill, by hitting it e.g. with rubber mallet (bump test).

Frequency Response Function, FRF (see TD-593), is used to measure the vibration response (natural frequencies) of a machine structure, similar to the 'Bump test'. FRF however is more sophisticated, measuring the response resulting from a known applied input by using an impact hammer and a vibration transducer connected to Leonova Diamond's vibration input using a split cable.

Extended resolution and frequency range (see TD-595) are sometimes required for EVAM, SPM HD Expert and HD ENV, e.g. when monitoring high-speed gearboxes in turbines, MOD140 provides 25.600 lines and 40 KHz.

Part numbers

MOD140 HD Analysis

SPM

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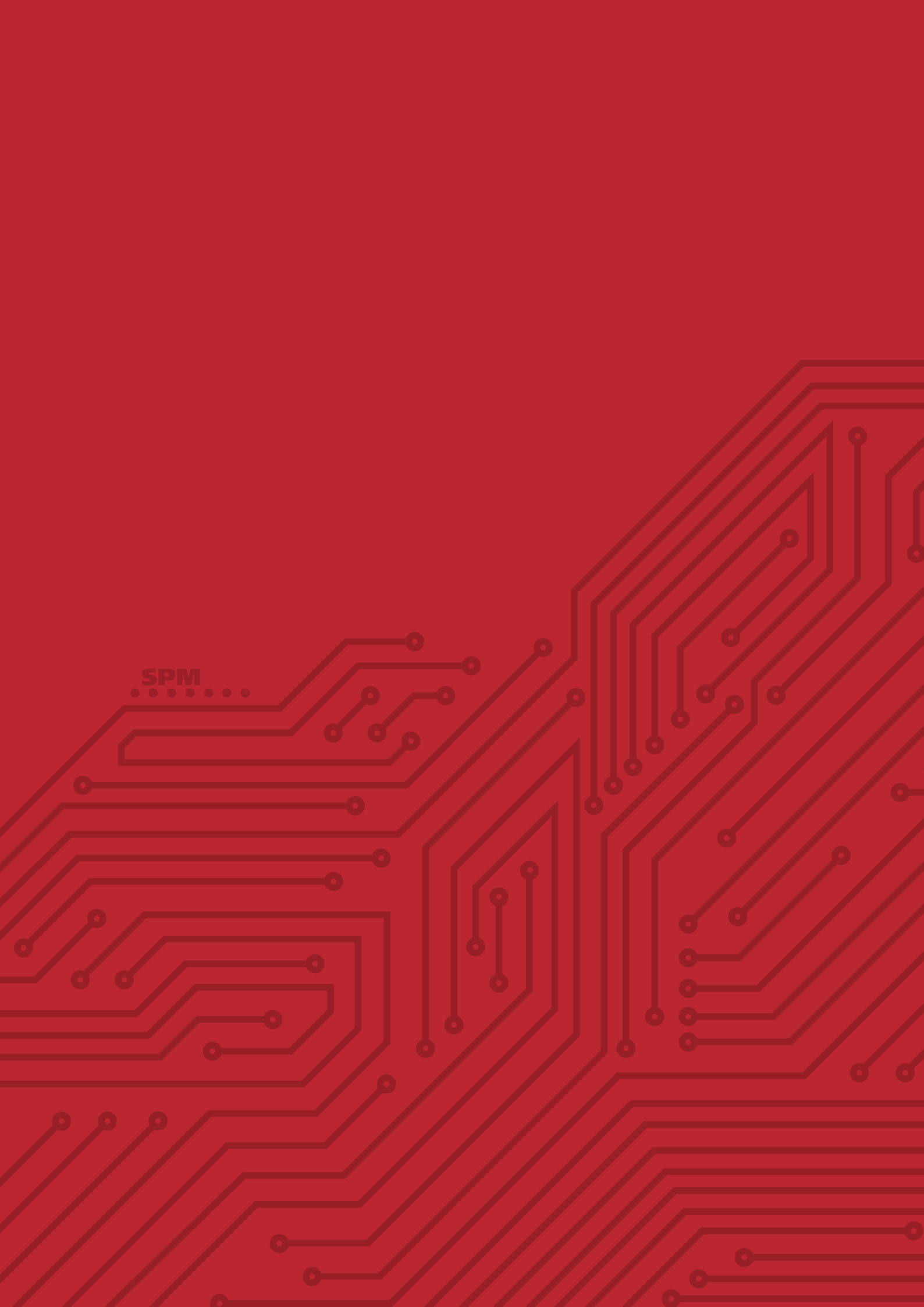
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