Leonova™ infinity

Technical data sheets

SPM
condition monitoring solutions

Leonova™ Infinity – Platform

Leonova™ Infinity is a hand-held machine condition analyser with colour touch screen, operating under Windows CE. Following functions are always included for unlimited use:

- Data logging with Condmaster®Nova
- ISO 2372 vibration monitoring
- Speed measurement
- Temperature measurement
- Analog signals, current and voltage
- Reading from and writing to CondID® memory tags
- Manual recording, free quantity
- Check points, free text

The main Leonova functions are user selected, see TD-212. With synchronous measurement, enveloping, true zoom and up to a 12 800 line spectrum over 0.5 Hz up to 40 kHz, Leonova™ Infinity has full vibration analysis capacity. SPM has also incorporated the evaluation tables of the new ISO 10816 standards for broad-band measurement of vibration velocity, acceleration and displacement. For single and dual plane rotor balancing, an easy to use graphical guide calculates balancing weights and their position. For shaft alignment, Leonova Infinity uses advanced laser technique with easy targeting, modulated line laser beam and automatic precision calculation of shaft positions.

Parts of the Leonova Infinity system are specified on the technical data sheets (TD) listed below:

Instrument specifications	TD-211
Selection of instrument functions	TD-212
SPM Shock pulse measurement, dBm/dBc	TD-213
SPM Shock pulse measurement, LR/HR	TD-214
SPM Spectrum™	TD-218
ISO 2372 vibration monitoring	TD-225
ISO 10816 vibration monitoring with spectrum	TD-219
FFT with symptoms	TD-220
EVAM® Evaluated vibration analysis	TD-221
2 channel simultaneous vibration monitoring	TD-222
Run up/Coast down and Bump test	TD-223
Orbit analysis	TD-224
Balancing	TD-226
Shaft alignment	TD-227
Long-time recording	TD-228
Order tracking	TD-306
Services	TD-229
Protective cover	TD-246
Transducers and measuring cables	TD-247
LineLazer[II] detector units	TD-267

Ordering numbers

LEO801	Leonova Infinity, Grey, incl. wrist strap and stylus
LEO802	Leonova Infinity, Blue, incl. wrist strap and stylus
90362	Charger 9.3 V/1.33 A, 100-240 V AC, Euro-plug
90379	Charger 9.3 V/1.33 A, 100-240 V AC, US-plug
90380	Charger 9.3 V/1.33 A, 100-240 V AC, UK-plug
CAB46	Communication cable, USB
CAB47	Communication cable RS232, 9 pin
14715	Belt clip
15310	Protective cover
CAS16	Carrying case, plastic with foam insert

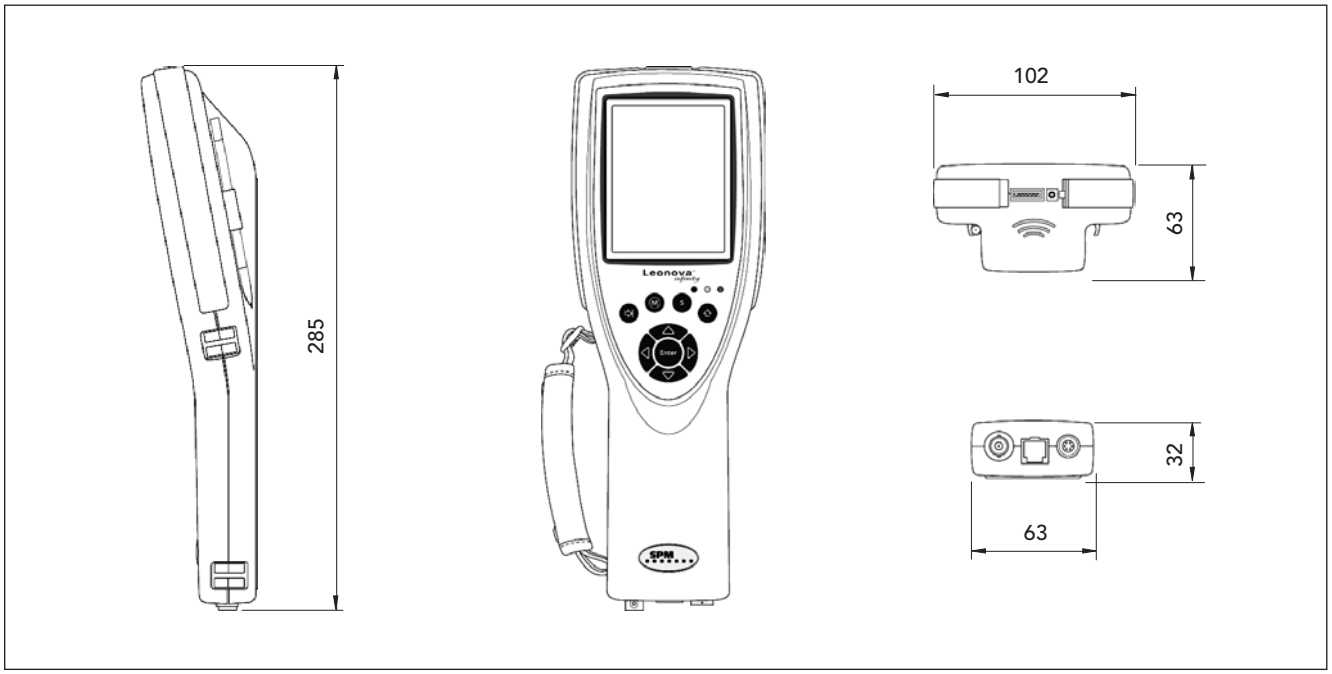
Spare parts

15178	Stylus for touch screen
14661	Wrist strap
PRO49	Leonova Service Program
71789	Instruction "Getting started"
71792	Leonova Infinity User guide

Patent No.: US7313484, US7167814, US7200519, US7054761, US7324919
EPO1474664, DE60304328.3, FR1474664, GB1474664, NL1474664, SE03731865.6

SPM®

Leonova™ Infinity – Instrument Specifications



Leonova Infinity is a multi-function, hand-held data logger. The instrument is operated via keypad and touchscreen. Basic data for the measurement set-up can be input manually or downloaded from Condmaster®Nova.

Leonova Infinity is always programmed for an unlimited use of the measuring functions listed below (Platform). Other diagnostic and analytic functions, for shock pulse measurement, vibration measurement, orbit analysis, rotor balancing and shaft alignment, are user selected. For technical information and specifications, see respective data sheets listed on TD-212.

Technical data, instrument (Platform)

Housing:	ABS/PC, Santoprene, IP54
Dimensions:	285 x 102 x 63 mm (11.2" x 4" x 2.5")
Weight:	580 g (20 oz.)
Keypad:	sealed, snap action
Display:	touch screen, TFT colour, 240 x 320 pixels, 54 x 72 mm (2.1 x 2.8 inch), adjustable backlight
Main processor:	400 MHz Intel® XScale®
Memory:	64 MB RAM, 32 MB Flash expandable up to 4 GB
Operating system:	Microsoft Windows® CE.net
Communication:	RS232 and USB
Dynamic range:	16 bit A/D converter, automatic gain settings
Condition indication:	green, yellow and red LEDs
Power supply:	rechargeable Lithium-Ion batteries
Battery power:	for minimum 8 hours normal use
Operating temperature:	0 to 50 °C (32 to 120 °F)
Charging temperature:	0 to 45 °C (32 to 113 °F)
General features:	language selection, battery charge display, transducer line test, metric or imperial units
Meas. point identification:	RF transponder for communication with CondID™ tags, read/write distance max. 50 mm (2 inch)

Vibration severity (ISO 2372)

Measurement quantity:	vibration velocity, RMS, range 10 – 1000 Hz
Evaluation table selection:	menu guided, ISO 2372
Vibration transducer input:	< 18 Vpp. Transducer supply of 4 mA for IEPE* (ICP) type can be set On/Off
Transducer types:	Any transducers (disp., vel. or acc.) with voltage output
Vibration channels:	2, simultaneous measuring

Speed measurement

Measuring range:	10 to 60 000 rpm
Resolution:	1 rpm
Accuracy:	± (1 rev. + 0.1% of reading)
Transducer type:	TAD-18, TTL-pulses

Temperature measurement

Measuring range:	–50 to +440 °C (–58 to 824 °F)
Resolution:	1 °C (1 °F)
Transducer type:	TEM-11 with TEN-10 (surface temperature) and TEN-11 (liquids)

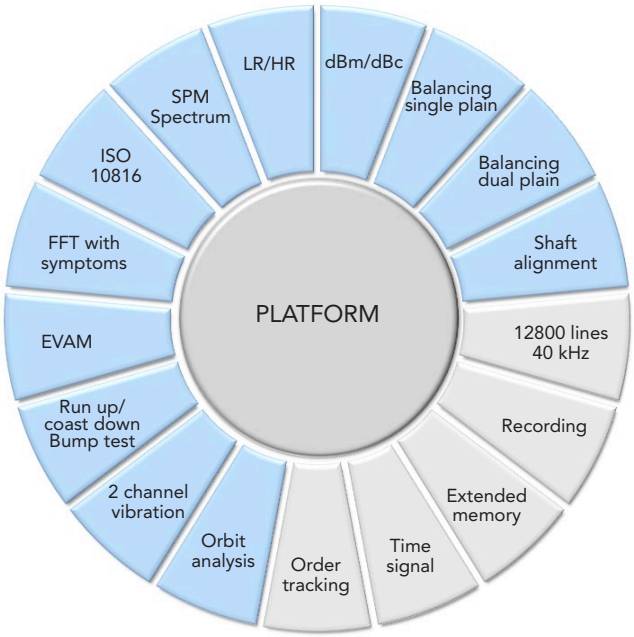
Analog signals

Measurement range:	0 to 1 V DC, 0 to 10 V DC, 0 to 20 mA, 4 to 20 mA

* Integral Electronic PiezoElectric

Patent No.: US7313484, US7167814, US7200519, US7054761, US7324919
EPO1474664, DE60304328.3, FR1474664, GB1474664, NL1474664, SE03731865.6

Leonova™ Infinity – User selected functions



Leonova™ Infinity Platform, always included for unlimited use

- Data logging with Condmaster®Nova
- RMS vibration, ISO 2372
- Speed measurement
- Temperature measurement
- Analog signals, current and voltage
- Reading from and writing to CondID® memory tags
- Manual recording, free quantity
- Check points, free text

To obtain the optimal performance range and instrument price for their purpose, Leonova users can select any or all of the 16 condition diagnosis and maintenance functions below, under two alternative conditions of sale. The choice is between unlimited and limited use (Function & Use).

When use is limited, the price for the function itself is much lower. Instead, the user prepays a tankful of 'credits'.

Leonova automatically deducts credits from the tank when its 'Measure' key is pressed. Thus, the user's operating costs depend on the number of measurements taken. Credit tanks are refilled, and/or new functions added, by loading a coded file ordered via the local distributor.

Free and limited functions can be combined at will. Platform functions are always included and their use is unlimited.

Functions for Unlimited Use

LEO130	Shock pulse method dBm/dBc
LEO131	Shock pulse method LR/HR
LEO132	SPM Spectrum
LEO133	ISO 10816 vibration monitoring with spectrum
LEO134	FFT with symptoms
LEO135	EVAM evaluated vibration analysis, time signal
LEO136	2 channel simultaneous vibration monitoring
LEO137	Run up / coast down & bump test
LEO138	Orbit analysis
LEO151	Shock pulse method dBm/dBc and LR/HR
LEO152	Balancing, single plane
LEO153	Balancing, dual plane
LEO154	Balancing, single and dual plane
LEO155	Shaft alignment

Options and additional functions

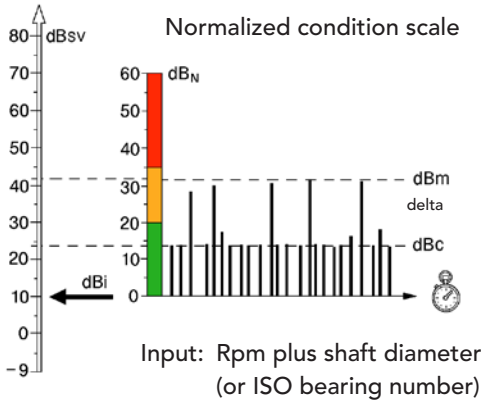
LEO139	12 800 lines /40 kHz, option to FFT with symptoms and EVAM
LEO160	Recording function
LEO161	Extended memory, 512 MB
LEO162	Extended memory, 1 GB
LEO163	Extended memory, 4 GB
LEO164	Time signal, option to FFT with symptoms
LEO165	Order tracking, option to FFT with symptoms and EVAM

Functions for Limited Use (Function & Use)

LEO230	Shock pulse method dBm/dBc (1)
LEO231	Shock pulse method LR/HR (2)
LEO232	SPM Spectrum (2)
LEO233	ISO 10816 vibration monitoring with spectrum (1)
LEO234	FFT with symptoms (2)
LEO235	EVAM evaluated vibration analysis, time signal (2)
LEO236	2 channel simultaneous vibration monitoring (4)
LEO237	Run up / coast down (50) and Bump test (25)
LEO238	Orbit analysis (5)
LEO251	Shock pulse method dBm/dBc and LR/HR
LEO252	Balancing, single plane (4 runs 16, 2 runs 42)
LEO253	Balancing, dual plane (80)
LEO254	Balancing, single and dual plane
LEO255	Shaft alignment (30)

Credit consumption is stated within brackets.

Leonova™ Infinity – Shock pulse measurement, dBm/dBc



For over 30 years, the original Shock Pulse Method (SPM) has been very successfully used to obtain 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.

Unlike vibration transducers, 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:

- the shock carpet level (approx. 200 incoming shocks per second. This level is displayed as **dBc** (decibel carpet value).
- the maximum level (highest incoming shock under 2 seconds). This level is displayed as **dBm** (decibel maximum value). Using a blinking indicator or earphones, the operator can establish a peak value 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.

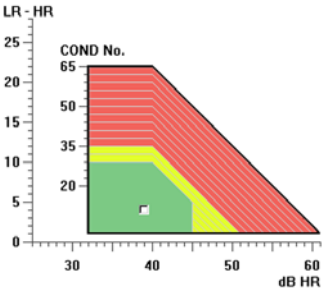
Technical data

Measuring range:	–9 to 99 dBsv
Resolution:	1 dBsv
Accuracy:	± 1 dBsv
Transducer types:	SPM 40000/42000, probe transducer and quick connector transducer for adapters
Input data:	Rpm, shaft diameter (or ISO bearing number)
Output:	Maximum value dBm, evaluated green - yellow -red, carpet value dBc, peak value, audible shock pulse signal (earphones).

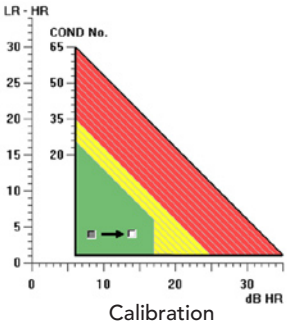
Ordering numbers

LEO130	Shock pulse method dBm/dBc, unlimited use
LEO230	Shock pulse method dBm/dBc, limited use

Leonova™ Infinity – Shock pulse measurement, LR/HR



Evaluation boxes determined by bearing geometry and speed



Calibration

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 the dBm/dBc method (TD-213). The shock pulse meter counts the rate of occurrence (incoming shock pulses per second) and varies the gain until two amplitude levels are determined:

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

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

Input data

The LR/HR method requires more precise data on the bearing, because bearing geometry, as well as size and speed, affect 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.

Evaluation

After measurement Leonova 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 Dry bearing, risk of damage
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 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, Leonova calculates the normal shock level for a good bearing and compensates for an abnormally low signal before returning the evaluation results.

Technical data

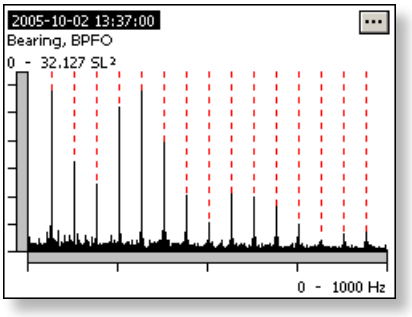
Measuring range:	–19 to 99 dBsv
Resolution:	1 dBsv
Accuracy:	± 1 dBsv
Transducer types:	SPM 40000/42000, probe transducer and quick connector transducer for adapters
Input data:	Rpm, plus bearing type and mean diameter (or ISO bearing number)
Output:	LR and HR (raw shock values), CODE A to D, evaluated green - yellow - red. LUB no. for oil film condition, COND no. for surface condition.

Ordering numbers

LEO131	Shock pulse method LR/HR, unlimited use
LEO231	Shock pulse method LR/HR, limited use

SPM

Leonova™ Infinity – SPM Spectrum



Pattern recognition:
Bearing with rotating inner race and a damaged outer race. BPFO = ball pass frequency outer race and its multiples dominate the shock pulse spectrum.

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 have none.

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.

Leonova first 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 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 S_D (Shock Distribution unit), where each spectrum is scaled so that the total RMS value of all spectrum lines = 100 S_D = the RMS value of the time record. The alternative is S_L (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. The recommended setting is a spectrum with a resolution of at least 0.25 Hz, e. g. 3200 lines over 500 Hz, saving peaks only.

Input data

Pattern recognition demands precise data on the bearing and exact measurement of the rpm. The rpm should be measured, not preset. The factors defining 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. Linking the symptom group 'Bearing' to the measuring point allows the user to highlight a bearing pattern by clicking on its name. Other symptoms can 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.

Technical data

Frequency range:	0 to 100, 200, 500, 1000, 2000, 5000, 10 000, 20 000 Hz
Number of spectrum lines:	400, 800, 1600, 3200, 6400
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Spectrum types displayed:	linear, power
Averages:	time synchronous, FFT linear, FFT peak-hold
Frequency units:	Hz, CPM
Saving options for spectrum:	full spectrum, peaks only
Amplitude scale unit:	S_D (Shock Distribution), S_L (Shock Level)
Scaling:	linear or logarithmic X and Y axis
Zoom:	true FFT zoom, visual zoom
Pattern recognition:	Bearing frequencies and optional patterns highlighted in the spectrum. Automatic configuration of bearing symptoms linked to ISO bearing no.
Transducer type:	Shock pulse transducers with probe and quick connector, SPM 40000/42000

As an option, the frequency range can be extended to 40000 Hz, the number of spectrum lines to 12800.

Ordering numbers

LEO132	SPM Spectrum, unlimited use
LEO232	SPM Spectrum, limited use
LEO139	12 800 lines, 40 kHz, option

SPM
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Leonova™ Infinity – Vibration ISO 2372

Broad band vibration measurement is the most widely used and cost-efficient method for the diagnosis of general machine condition. There are two ISO recommendations concerning this type of machine condition monitoring, the much used ISO 2372 and the more recent ISO 10816, which is a ongoing replacement of the older standard.

In Leonova, vibration measurement according to ISO 2372 is a platform function, always included for unlimited use.

The features are:

- Machine condition is diagnosed on the basis of broad band measurements returning an RMS value of vibration velocity in the frequency range of 10 to 1000 Hz. This is called vibration severity.
- Machines are grouped into six vibration classes.
- A table of limit values is presented for each vibration class, differentiating between acceptable vibration (green range), unsatisfactory vibration (yellow range), and vibration that will cause damage unless reduced (red range).
- Measurements are made in three direction (horizontal, vertical, axial). The highest value returned determines machine condition.
- Default limit values for the change from green to yellow and from yellow to red are set automatically when one of the six machine classes is input under the measuring point data.

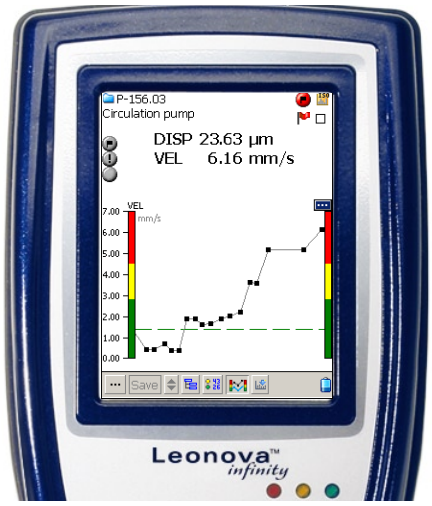
ISO 10816 is offered as a choice, see TD 219.

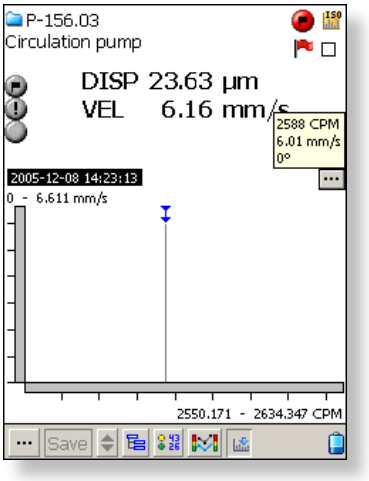
Technical data

Measurement quantities:	Velocity, RMS value in mm/s over 10 to 1000 Hz
Transducer type:	Vibration transducer SLD144 or IEPE* (ICP®) type transducers with voltage output

* Integral Electronic PiezoElectric

Leonova™ Infinity – Vibration ISO 10816 with spectrum





Broad band 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 an ongoing replacement of the older standard.

With Leonova, ISO 2372 measurement is a platform function, always included for unlimited use (see TD-225).
ISO 10816 is an option with ordering numbers LEO133 (unlimited use) and LEO233 (limited use).

Features of ISO 10816 are:

- Measurements are made in three direction (horizontal, vertical, axial).
- Machine condition is generally diagnosed on the basis of broad band 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 Leonova, ISO part, machine group and foundation type are input using a multiple choice guide which displays the various ISO definitions and leads to the limit values.

Exceeding the requirements of the ISO standard, Leonova also provides a 1600 line **spectrum**.

Technical data

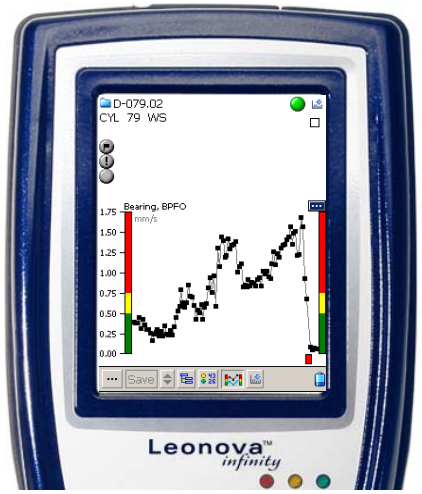
Measurement quantities:	Velocity, acceleration, and displacement, RMS values over 2 or 10 Hz to 1000 Hz, peak, peak-to-peak
Spectrum:	Linear, 1600 lines, Hanning window.
Spectrum unit:	Velocity, mm/s or inch/s
Transducer type:	Vibration transducer SLD 144 or IEPE* (ICP®) type transducers with voltage output

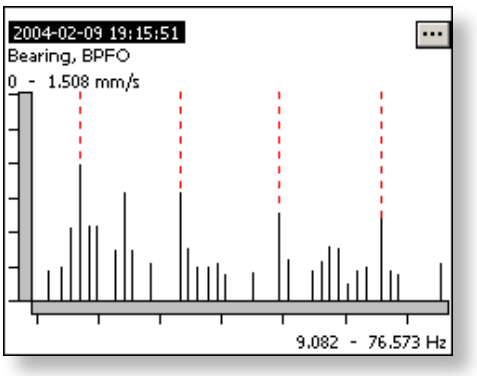
* Integral Electronic PiezoElectric

Ordering numbers

LEO133	Vibration ISO 10816 with spectrum, unlimited use
LEO233	Vibration ISO 10816 with spectrum, limited use

Leonova™ Infinity – FFT spectrum with symptoms





FFT Spectrum with Symptoms is a vibration analysis function offered with Leonova, for either limited or unlimited use. It is a reduced form of EVAM (Evaluated Vibration Analysis Method), lacking the statistical evaluation by means of criteria and possibility to display and save time signal (option).

This function 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 help of preset fault symptoms.
- Trending of symptom values. Alarm levels are manually set for evaluation in green- yellow - red.

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.

Condition parameters

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.

Spectrum analysis with 'symptoms'

For easy pattern recognition in spectra, a range of ready made 'fault symptoms' are downloaded from Condmaster. 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.

A special symptom group are the bearing symptoms (showing e. g. ball pass frequencies over inner and outer race) for which the Condmaster bearing catalogue contains all need data.

Suitable symptoms and symptom groups are selected from a menu in Condmaster when the measuring point is set up.

Technical data

Frequency limit, lower:	0.5, 2, 10 or 100 Hz
Frequency limit, upper:	100, 200, 500, 1000, 2000, 5000, 10 000 Hz
Envelope high pass filters:	100, 200, 500, 1000, 2000, 5000, 10 000 Hz
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Averages:	time synch, FFT linear, FFT exponential, FFT peak-hold
Spectrum lines:	400, 800, 1600, 3200, 6400
Frequency units:	Hz, CPM, orders
Saving options:	peaks only, full spectrum
Spectrum types displayed:	linear, power, PSD
Zoom:	true FFT zoom, visual zoom
Transducer types:	Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output

As options, the frequency range can be extended to 40000 Hz/12800 spectrum lines and possibility to save time signal.

Ordering numbers

LEO134	FFT with symptoms, unlimited use
LEO234	FFT with symptoms, limited use
LEO139	12 800 lines, 40 kHz, option
LEO164	Time signal, option to FFT with symptoms

SPM
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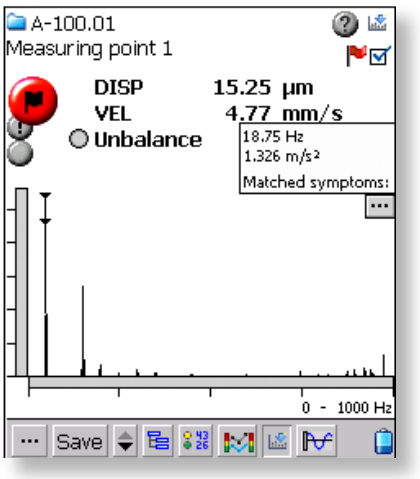
Leonova™ Infinity – EVAM evaluated vibration analysis



EVAM stands for Evaluated Vibration Analysis Method. With Leonova, the EVAM method is offered as an analysing function with either limited or unlimited use.

The EVAM 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 help of 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.

Condition parameters

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..

Spectrum analysis with 'symptoms'

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, for some an input is needed, e. g. the number of vanes on a rotor. Suitable symptoms and symptom groups are selected from a menu in Condmaster when the measuring point is set up.

Machine specific condition codes

In Condmaster, 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.

Technical data

Frequency limit, lower:	0.5, 2, 10 or 100 Hz
Frequency limit, upper:	100, 200, 500, 1000, 2000, 5000, 10 000, 20 000 Hz
Envelope high pass filters:	100, 200, 500, 1000, 2000, 5000, 10 000 Hz
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Averages:	time synch, FFT linear, FFT exponential, FFT peak-hold
Spectrum lines:	400, 800, 1600, 3200, 6400
Frequency units:	Hz, CPM, orders
Saving options:	peaks only, full spectrum, time signal
Spectrum types displayed:	linear, power, PSD
Zoom:	true FFT zoom, visual zoom
Transducer types:	Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output

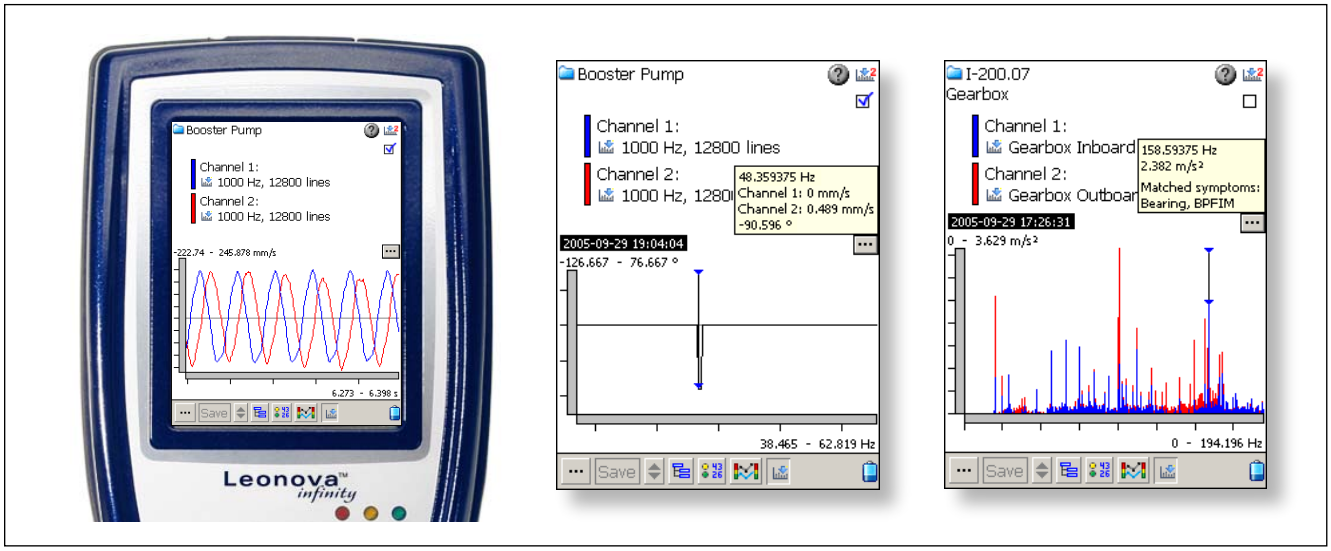
As an option, the frequency range can be extended to 40000 Hz, the number of spectrum lines to 12800.

Ordering numbers

LEO135	EVAM evaluated vibration analysis, unlimited use
LEO235	EVAM evaluated vibration analysis, limited use-
LEO139	12 800 lines, 40 kHz, option

SPM
SPM Instrument AB • Box 504 • SE-645 25 Strängnäs • Sweden

Leonova™ Infinity – 2 channel simultaneous vibration monitoring



Two channel simultaneous vibration monitoring is a Leonova Infinity function for limited (LEO236) or unlimited (LEO136) use. It requires that either the measuring technique 'FFT with symptoms' or 'EVAM' is active. The function 'FFT with symptoms' requires the option 'Time signal' (LEO164) for possibility to display and save time signal.

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

Measurement requires the set-up of two vibration assignments with identical parameters. The 2 channel measuring cable CAB51 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.

After measurement, Leonova displays the RMS values for DISP, VEL and ACC for both channels. Three graphs are available for each measurement:

- Spectrum
- Phase spectrum
- Time signal (option to FFT with symptoms)

In the spectrum and the time signal, the channels are overlayed red and blue.

Technical data

Frequency limit, lower:	0.5, 2, 10 or 100 Hz
Frequency limit, upper:	100, 200, 500, 1000, 2000, 5000, 10 000, 20 000 Hz
Envelope high pass filters:	100, 200, 500, 1000, 2000, 5000, 10 000 Hz
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Averages:	time synch, FFT linear, FFT exponential, FFT peak-hold
Spectrum lines:	400, 800, 1600, 3200, 6400
Saving options for spectrum:	peaks only, full spectrum, time signal
Spectrum types displayed:	linear, power, PSD
Zoom:	true FFT zoom, visual zoom
Transducer types:	Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output

As an option, the frequency range can be extended to 40 kHz, the number of spectrum lines to 12800.

Ordering numbers

LEO136	2 channel vibration monitoring, unlimited use
LEO236	2 channel vibration monitoring, limited use
LEO139	12 800 lines, 40 kHz, option
LEO164	Time signal, option to FFT with symptoms
CAB 51	2 channel measuring cable, Lemo

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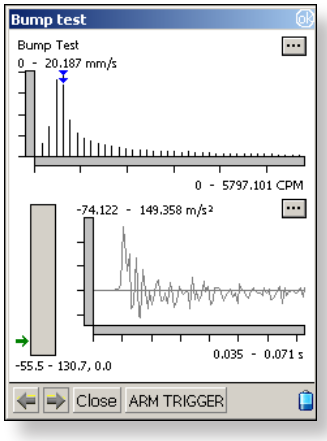
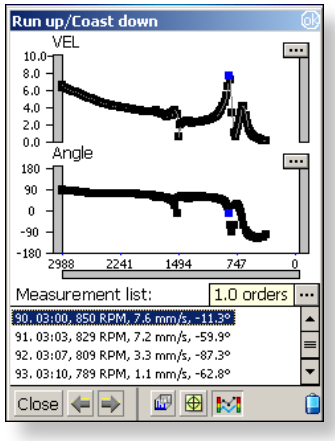
Leonova™ Infinity – Run up/coast down and Bump test





Run up / coast down measurements and Bump test are two vibration analysis functions offered with Leonova Infinity, for either limited or unlimited use. The 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). 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 to a stop. Both functions are selected from the menu of an ordinary vibration measurement assignment.

Run up / coast down

For this test, both the signal unit and the display unit for the spectrum can be selected. Leonova Infinity uses both digital and analog integration, so the signal unit can be set independent of the transducer type used.

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.

The first result is a list of the numbered measurements, showing rpm and RMS vibration value. The date and time of the first measurement are displayed.

For each individual measurement, a spectrum can be called up. Another list and diagram show the phase angles in degrees. Finally, the user can call up diagrams 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

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 gain level is set by hitting the machine frame with varying force. 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).

Technical data

Run up/coast down

Frequency limit, lower:	0.5, 2 10 or 100 Hz
Frequency limit, upper:	1 to 9999 orders
Measuring interval:	speed or time based
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800
Spectrum types displayed:	linear

Bump test

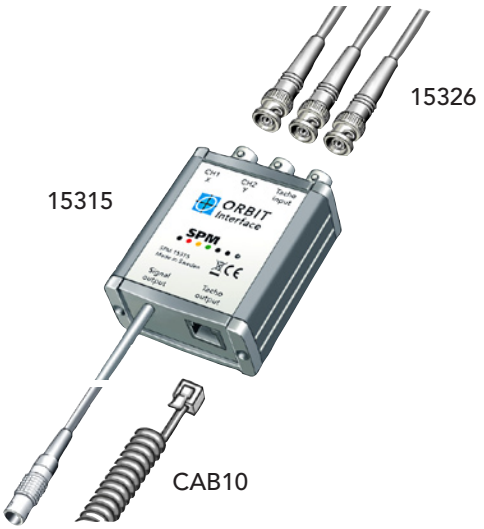
Frequency limit, lower:	2 Hz
Frequency limit, upper:	100, 200, 500, 1000, 2000, 5000, 10000, 20000, 40 000 Hz
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800
Spectrum types displayed:	linear
Pre-trigger time:	5%, 10%, 20%, 25% of sampling time
Transducer types:	Vibration transducer SLD144 or IEPE* (ICP®) type transducers with voltage output

* Integral Electronic PiezoElectric

Ordering numbers

LEO137	Run up/coast down and Bump test, unlimited use
LEO237	Run up/coast down and Bump test, limited use

Leonova™ Infinity – Orbit analysis



Orbit analysis is a vibration measurement function offered with Leonova infinity, for either unlimited (LEO138) or limited use (LEO238). 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.

The measurements are normally made on the buffered outputs of a machine protection system via the Orbit Interface 15315. The interface is connected to the vibration and the tachometer inputs on Leonova. Signal inputs, channel X, channel Y and tachometer are connected via BNC connectors.

Measurements can also be made with e. g. accelerometers to get a two dimensional graph of machine movement. 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.

During measurement, the result window shows displacement in the x and y direction per revolution. When the measurement is complete, the average of the measured number of revolutions is shown.

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 via tap and hold on the orbit graph.

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

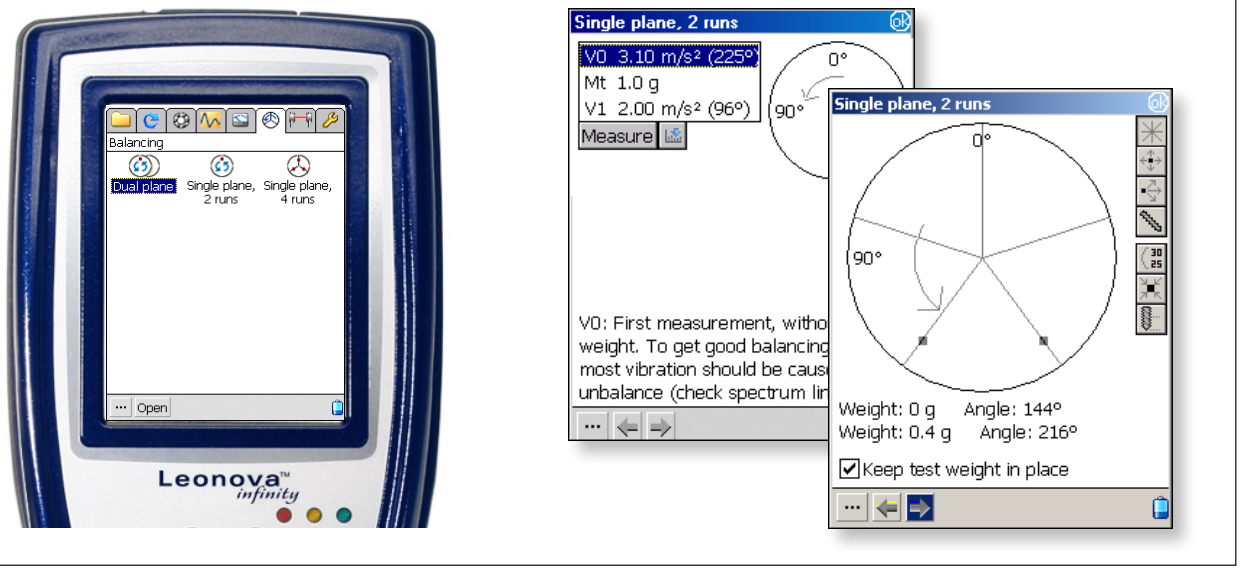
Technical data

Orders:	1 to 5, default 1
Filter types:	None, band pass, low pass
Signal unit:	DISP, VEL, ACC
Trig threshold:	Automatic
Measuring time:	1 to 25 revolutions
RPM range:	15 to 20 480 rpm
Transducer types:	Buffered outputs from **API670 approved** protection systems via Orbit Interface 15315, alternative vibration transducers SLD144 or IEPE (ICP®) type transducers with voltage output

Ordering numbers

LEO138	Orbit analysis, unlimited use
LEO238	Orbit analysis, limited use
15315	Orbit Interface with belt clip
15326	Set of measuring cables, 3 x BNC - BNC
CAB10	Tachometer cable, spiral

Leonova™ Infinity – Balancing



Single and dual plane balancing are optional Leonova functions with either limited or unlimited use. In case of limited use, credits are deducted for each vibration measurement.

Single plane balancing, 4 runs

This method uses one measurement without trial weight to determine the vibration severity (mm/s RMS) of the rotor, followed by three measurements with trial weights at 0°, 120° and 240° to calculate the weight and position of the correction mass.

Single plane balancing, two runs

This method uses one measurement without trial weight to determine the vibration severity (mm/s RMS) of the rotor, followed by one measurements with a trial weight to calculate the weight and position of the correction mass. It requires time synchronised vibration measurement (trigger pulse supplied by a pulse from the SPM tachometer probe or a proximity switch) to find the relative phase angle between the two vibration measurements.

Dual plane balancing

The same two run method as used for single plane balancing, but with vibration measurement and weight correction in two planes. These measurements can be made by shifting the vibration transducer or by connecting two transducers.

For all methods, a final run can be made to check the balancing results and, if needed, get the data for further adjustments. Leonova then saves a balancing log file.

Leonova guides step-by-step through the balancing procedure. One can shift the rotation direction and change the measured parameter from velocity to acceleration or displacement.

In addition to the RMS value, a spectrum is shown to help find the part of vibration that is due to unbalance. For the two run methods, the number of samples for obtaining a time synchronous average is set to min. 4.

Leonova calculates a number of alternatives for correcting the unbalance:

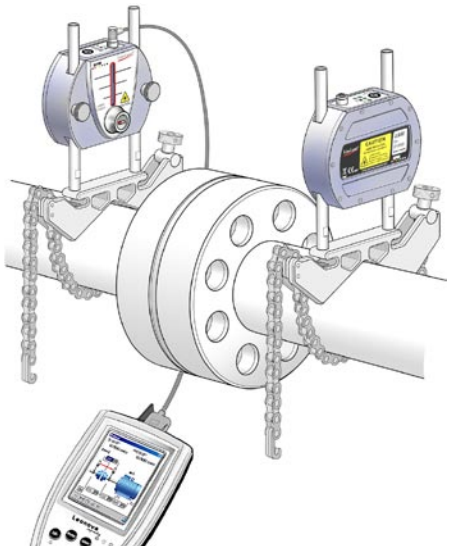
- Trial weight: Input rotor diameter, weight and rpm to obtain the suitable trial weight in grams.
- Split the correction mass: Input the number of rotor partitions to distribute the correction mass between two of them.
- Weight removal: Drill hole diameter and depth calculated for various materials.
- Radial displacement: Input the change in radial distance to recalculate the weight.
- Degrees to length: change from angle to length measured along the rotor circumference.
- Keep trial weight: Calculate the correction mass with the trial weight remaining in place.
- Sum up weights: Replace all correction masses on the rotor by one.

Ordering numbers

LEO152	Balancing, single plane, unlimited use
LEO252	Balancing, single plane, limited use
LEO153	Balancing, dual plane, unlimited use
LEO253	Balancing, dual plane, limited use
LEO154	Balancing, single and dual plane, unlimited use
LEO254	Balancing, single and dual plane, limited use

SPM

Leonova™ – Shaft Alignment



Shaft Alignment is an optional Leonova™ function for quick and easy shaft alignment, with either limited or unlimited use. In case of limited use, credits are deducted for each alignment assignment. The function is user-friendly and easy to learn.

The LineLazer Accessory Set contains detector/transmitter units, brackets, chains, rods, cables and a measuring tape, all in a carrying case. This set fits a multitude of applications, e.g. compressors, gearboxes, generators, and pumps.

The detector units have position detectors (PSD) with a large reception area, which makes fine tuning unnecessary. Compensation values for thermal growth can be input. Integrated precision inclinometers measure the angle of rotation of both detector units at all times. This allows measurement in fully automatic mode, with much less than a half-turn of the shaft. Measurement results are displayed in 100ths of millimetres or 1000ths of an inch.

The Leonova instrument is the control and display unit. The interaction between the graphical display and the user is kept as simple as possible. A self-explanatory display based on icons and graphics guides the user to make a perfect shaft alignment. Leonova produces a log file with all alignment data for documentation and printing.

Measurement programs:

- Alignment of horizontally mounted machines (automatic measurement or manual promts)
- Alignment of vertically and flange mounted machines
- Softfoot measurement
- Compensation for thermal growth
- Feet lock function
- Shaft alignment log

Ordering numbers, Leonova™ Infinity

LEO155	Shaft alignment, unlimited use
LEO255	Shaft alignment, limited use

Ordering numbers, Leonova™

LEO220	Shaft alignment, unlimited use, upgrade
LEO420	Shaft alignment, limited use, upgrade

LineLazer Accessory Set LLA300

LLB30	1 pc.	LineLazer detector, lower beam (TD-267)
LLB31	1 pc.	LineLazer detector, upper beam (TD-267)
LLB11	2 pcs.	Extension chain, length 1000 mm
LLB12	2 pcs.	Chain with tension adapter, length 500 mm
LLB13	1 set	Supporting rod, 80 mm, set of 4
LLB14	1 set	Supporting rod, 150 mm, set of 4
LLB15	2 pcs.	Shaft bracket for chain
CAB50	1 pc.	Communication cable between LineLazer and Leonova Infinity, length 3 m
CAB75	1 pc.	Charger cable, length 1.5 m
MAA70	1 pc.	Measuring tape
TOL21	1 pc.	Torquing tool for chains and rods
CAS19	1 pc.	Carrying case, plastic with foam insert

Battery charger

90362	Charger, 100-240 V AC, 50-60 Hz, Euro-plug
90379	Charger, 100-240 V AC, 50-60 Hz, US-plug
90380	Charger, 100-240 V AC, 50-60 Hz, UK-plug

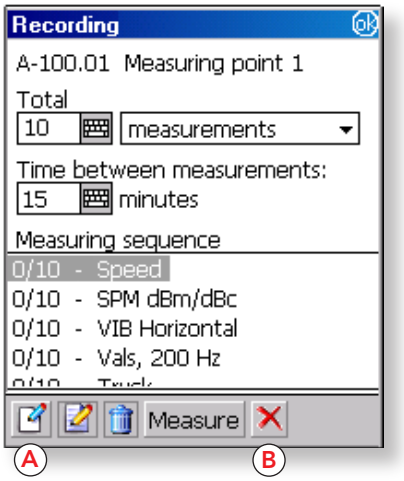
Options

Magnetic brackets, offset brackets 50 mm and offset brackets 100 mm on request.

Spare parts

LLB20	Supporting rod, 80 mm
LLB21	Supporting rod, 150 mm

Leonova™ Infinity – Recording function



Recording is an optional Leonova function with unlimited use. It allows the user to measure simultaneously with up to three different transducers and record measuring results for as long as the battery charge will last. Thus, 'Recording' is an analysis tool that can show the interaction of various condition parameters over time.

Leonova has three separate input connectors, for
- shock pulse measurement
- speed or temperature measurement
- vibration or analogue measurement.

Thus, shock pulse recording can be combined with either of the alternatives given by the other two input.

The recording function for a single quantity, e. g. temperature, can be reached and set up from the default file saved under the respective technique window. To record different quantities at the same time, one needs a measuring point file where all the different techniques are activated.

In the example shown above the measuring point is configured for the techniques SPM dBm/dBc with spectrum (which automatically asks for a speed measurement), for ISO 2372 vibration measurement and for EVAM vibration measurement.

Under 'Total' in the recording window, the desired number of measurements is input, alternatively the total recording time in minutes.

Under 'Time between measurements' the interval is input in minutes. 0 minutes means 'as fast as possible'.

The measuring sequence is set by opening the list of available measuring techniques with NEW (A) and selecting techniques in any order. A technique can be used more than once in the sequence.

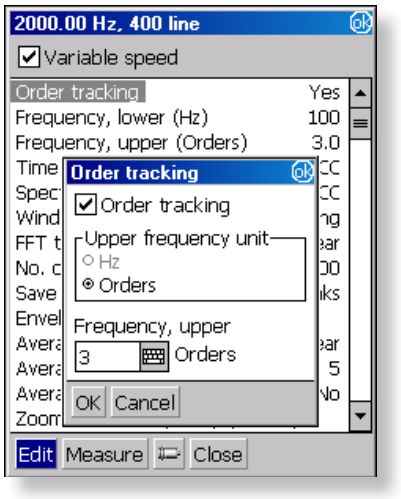
Recording is started with the 'Measure' key and can be terminated with the 'Cancel' key (B).

Leonova displays the number of measurements taken and powers down when all are recorded. The batch is then saved by the user and can be transferred to Condmaster.

Ordering number

LEO160 Recording function, unlimited use

Leonova™ Infinity – Order tracking



Order tracking is an optional Leonova function primarily used for vibration analysis on variable speed machines. The method uses multiples of rotational speed (orders), rather than absolute frequency (Hz). The number of orders to be shown is input by the user. Leonova will then automatically set the sampling frequency to an exact multiple of the measured rpm. Order tracking will also minimise the risk of smearing when using FFT averaging.

The purpose of using orders is to lock the display to the rotational speed (1X) and its multiples, which means that the ordered components in the spectrum always remain in the same position in the display, even if the rotational speed varies between the measurements.

Two or several spectra from the same machine with variable speed can therefore more easily be compared if they are expressed in orders. Using order tracking, the frequency range will always cover the symptoms of interest, regardless of the rotational speed of the machine.

In the example shown above the measuring point is configured for vibration analysis with order tracking. Under 'Measuring point data' order tracking is marked and the upper frequency is input in orders. The lower frequency is input in Hz or CPM under 'Measuring point data'. 'Variable speed' must be marked and rpm has to be measured.

Leonova displays the spectrum within the selected number of orders. A number of measurements can be displayed in a three dimensional waterfall diagram, where 1X (rpm) and its harmonics remain in the same position in the diagram. The measurements are then saved by the user and can be transferred to Condmaster. Setup of order tracking assignments in Condmaster require the optional software module, MOD188 Order tracking.

Ordering number

LEO165 Order tracking, unlimited use

Leonova™ Infinity – Services

The service program Leonova.exe is part of the basic function package for Leonova Infinity. It is used to

- print balancing and alignment reports.
- load credits and/or functions from the file 'Leonova.txt'
- upgrade a Leonova version from the file 'P70.EXE'.
- display and print a credit log containing all events in connection with measurements credits, up to 10000.
- make and reload safety copies of the Leonova files (file extension .lsc).

The operation of the service program is very simple: connect Leonova to the PC, put it in communication mode, then click on the desired service function. Follow the guidance on the screen.

A safety copy of the Leonova measurement file can be used to export one or more measuring points and, for example, send them to SPM for technical advice.

The file 'Leonova.txt' can contain measuring credits and/or Leonova function that are new for the instrument or changed from limited to unlimited use. It is coded to fit the individual instrument and ordered via the local SPM distributor.

Ordering number

PRO49 Leonova Service Program

The credits required for a measuring round and the tank status are displayed by Leonova under 'Function and use'. There one can also set the values and time intervals for the ´tank low´ warnings.

The amount of credits deducted when the 'Measure' command is given depends on the method used, see table. For balancing, credits are deducted for each vibration reading. The table shows the min. requirement.

Functions with limited use	Credit consumption
Shock pulse method dBm/dBc	1
Shock pulse method LR/HR	2
SPM Spectrum	2
Vibration ISO 10816 with spectrum	1
EVAM evaluated vibration analysis /time signal	2
FFT with symptom	2
2 channel simultaneous vibration measurement	4
Orbit analysis	5
Run up/Coast down	50
Bump test	25
Balancing, 1 plane 4 runs	16
Balancing, 1 plane 2 runs	42
Balancing, 2 plane	80
Shaft alignment	30

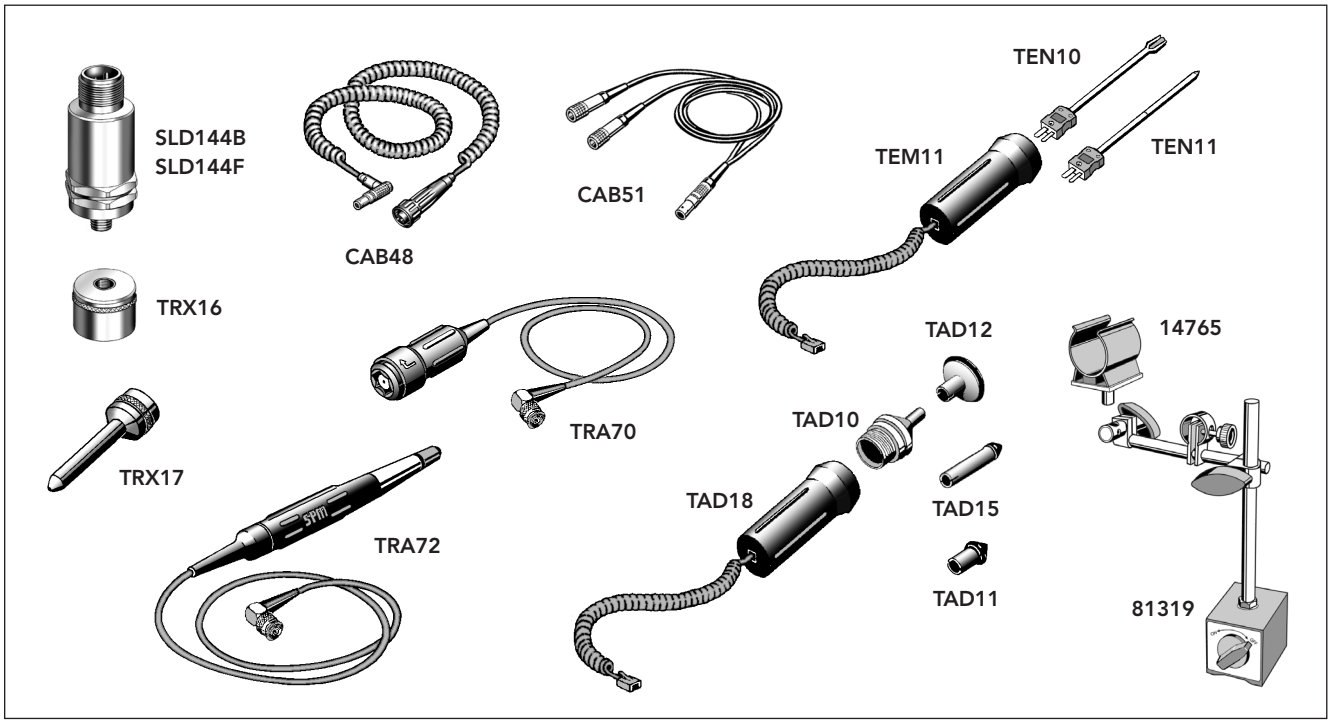
Leonova™ Infinity – Protective cover 15310

Protective cover 15310 is an optional accessory for the hand-held machine condition analyser Leonova™ Infinity. The cover, made of foamed polyester fabric, protects the instrument against shocks, splashes and dirt (IP64). The transparent plastic window makes Leonova easy to operate via the keypad and can be opened to facilitate the use of the touch screen. The cover is provided with holders for wrist strap and stylus.

Technical specifications

Material:	Polyester fabric with foam lining and window of soft transparent PVC foil
Fastenings, seals:	Velcro tape, polyamide
Weigth:	95 g

Leonova™ Infinity – Transducers and measuring cables



Transducers and measuring cables for Leonova™ Infinity are selected in accordance with the individual instrument's range of measuring functions. The ordering numbers are listed below.

For shock pulse monitoring, only use original SPM shock pulse transducers. For vibration monitoring, any vibration transducer with voltage output can be used.

Shock pulse monitoring

TRA70	Shock pulse transducer with quick connector for measuring adapters
TRA72	Shock pulse transducer with probe
CAB36	Measuring cable, BNC slip-on, 1.5 m
EAR10	Earphone in ear defenders, headset, with cable
EAR11	Earphone in ear defenders, for helmet, with cable

Vibration monitoring

SLD144B	Vibration transducer M8 (2-10 000 Hz)
SLD144F	Vibration transducer UNF 1/4"-28 (2-10 000 Hz)
TRX16	Magnetic foot for vibration transducer M8
TRX17	Probe for vibration transducer M8
CAB48	Measuring cable, spiral, angle Lemo-2 pin
CAB48-L	Measuring cable, Lemo-2 pin (L=length in m)
CAB51	2 channel measuring cable, Lemo
CAB41	Communication cable for 'iLearn'

Temperature monitoring

TEN10	Temperature probe tip, surface
TEN11	Temperature probe tip, liquid
TEM11	Temperature probe with cable

Current and voltage monitoring

CAB42	Cable for analog signals

Speed monitoring

TAD10	Contact adapter for tachometer probe
TAD11	Contact centre, rpm, short
TAD15	Contact centre, rpm, long
TAD12	Contact wheel, meter/min.
TAD13	Contact wheel, yards/min.
TAD17	Contact wheel, feet/min.
TAD14	Reflecting tape, pad of 5 sheets
TAD16	Reflecting tape for thin shafts, 5 sheets
TAD18	Tachometer probe with cable

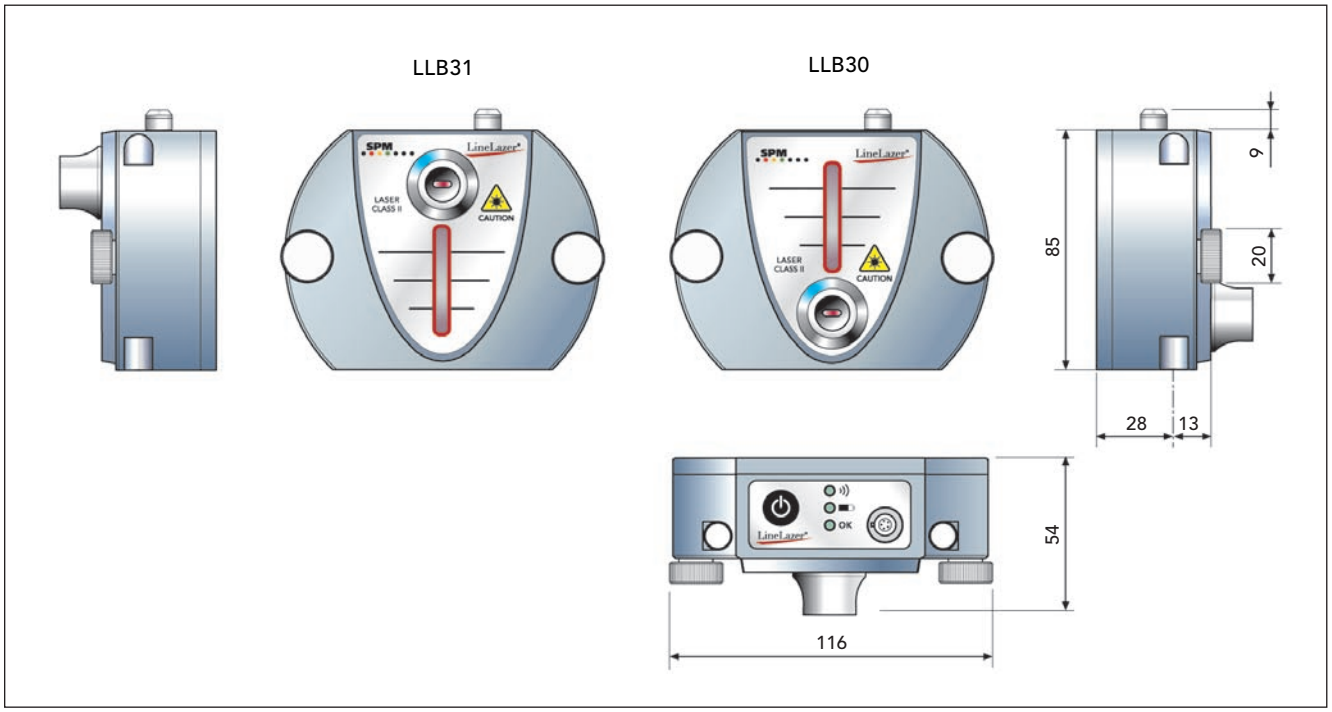
Balancing

CAB43	Cable for TAD18, length 5 m
81319	Magnetic base
14765	Holder fot tachometer probe TAD18

Spare parts

13108	Sleeve for probe tip (TRA-72)
CAB37	Cable for TRA-72, 1.5 m (5 ft)
CAB10	Spiral cable for TAD-18, TMM-11

Leonova™ Infinity – LineLazer¤ detector units



LineLazer¤ LLB30 and LLB31 are two detector/transmitter units for shaft alignment with the multi-function datalogger Leonova™. The detectors are identical with exception of the position of laser diode and sensor.

Using a horizontally spread laser beam in combination with a 37 mm vertical sensor (PSD) makes fine tuning unnecessary. The laser beam is modulated and thus easily and automatically distinguished from interfering light sources. The laser beam is not mirrored, both units are true detectors/transmitters. The communication between them is wireless, only one of the units is cable connected to Leonova.

The detector units have integrated double axis precision inclinometers which measure the angle of rotation of both detector units at all times. This allows measurement in fully automatic mode, with much less than a half-turn of the shaft. Measurement results are displayed in 100ths of millimetres or 1000ths of an inch.

The control panel on the detector has a power off switch and LED indicators to show correct aim, battery status, and communication mode. The batteries are recharged with the standard Leonova Infinity chargers SPM 90362 (EU), 90379 (US) or 90380 (UK).

Technical specifications

Laser type:	line laser, visible red light
Laser power :	<1 mW
Laser safety class:	Class 2
Laser wavelength:	635 to 657 nm
Laser modulation:	200 kHz
Sensor resolution :	1 µm
Sensor linearity :	< 2% deviation
Sensor size :	37 x 1 mm (1.5 x 0.03 in)
Operating range :	50 to 3000 mm (2 to 120 in)
Inclinometer resolution :	0.5°
Batteries:	NiMH rechargable
Operating time :	> 16 hours normal use
Operating temperature:	0 to +50 °C (32 to 122 °F)
Storage temperature:	-25 to +55 °C (14 to 140 °F), non condensing
Keyboard:	sealed membrane
Control indicators:	LED, red/green
Connector type:	LEMO 5 pins, for communication with Leonova and battery charger
Housing:	aluminium, blue anodized
Protection:	IP65
Dimensions:	116 x 94 x 54 mm (4.6 x 3.7 x 2.1 in)
Weight:	450 g

Patent No.: US7301616, SE 0400586-4