



Leonova®

DIAMOND

Technical data sheets
2019-03



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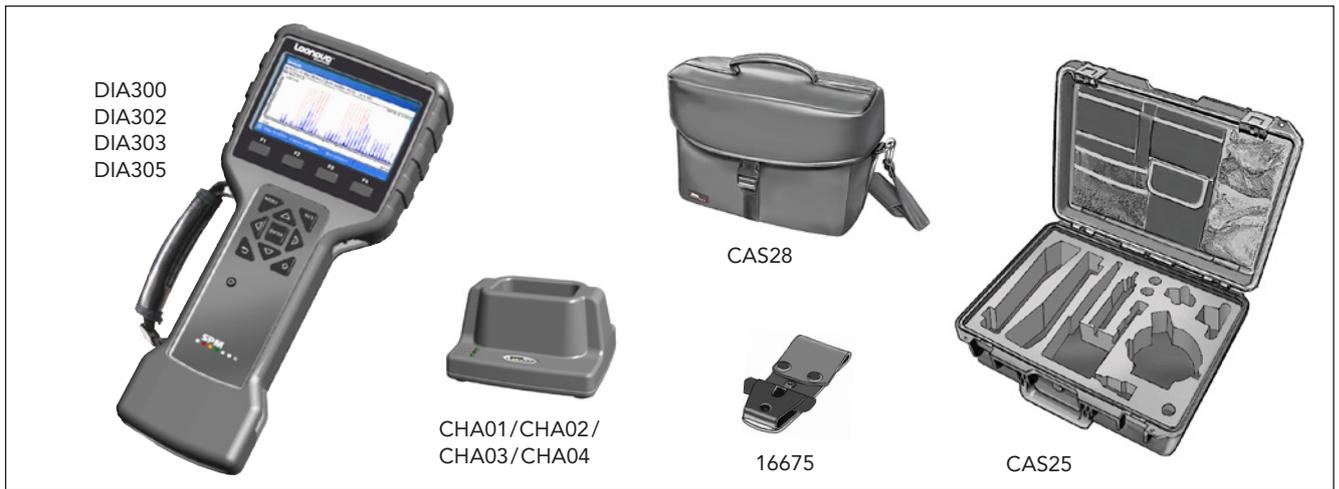
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SE#13744257.0 - AU# 2015203361 - RU# 027452 - GB# 2505984 - US# 9,772,219



Leonova Diamond® – Platform



DIA300
DIA302
DIA303
DIA305

CAS28

CHA01/CHA02/
CHA03/CHA04

16675

CAS25

Leonova Diamond is a three-channel handheld machine condition analyser designed for use in harsh environments. The following functions are always included for unlimited use:

- Data logging with Condmaster®Ruby
- ISO 2372 vibration monitoring
- Speed and temperature measurements
- Analog signals, current and voltage
- Automatic recording, up to 50 hours
- Stethoscope function
- Reading from and writing to CondID® memory tags
- Recording of vocal comments

The main Leonova functions are user selected, see TD-359. With synchronous measurement, enveloping, true zoom and up to a 25 600 line spectrum over DC up to 40 kHz, Leonova Diamond has full vibration analysis capacity. The evaluation tables of the ISO 10816 standards for broadband measurement of vibration velocity, acceleration and displacement are also incorporated. For single and dual plane rotor balancing, an easy-to-use graphical guide calculates balancing weights and their position. For shaft alignment, Leonova Diamond uses advanced laser technique with easy targeting, modulated line laser beam and automatic precision calculation of shaft positions.

Part numbers

DIA300	Leonova Diamond, SPM HDm/HDc
DIA302	Leonova Diamond, Balancing, single and dual plane
DIA303	Leonova Diamond, SPM LR/HR
DIA305	Leonova Diamond, SPM HDm/HDc and LR/HR
DIA162	Extra memory, 4 GB
DIA163	Extra memory, 8 GB
16573	Optional battery pack
16644	Battery charger unit
CHA01	Battery charger incl. AC adapter, Euro plug
CHA02	Battery charger incl. AC adapter, UK plug
CHA03	Battery charger incl. AC adapter, US plug
CHA04	Battery charger incl. AC adapter, AU plug
93484	Car charger cable 12V
CAB94	Communication cable, USB-mini USB
16675	Belt clip, complete
16646	Shoulder strap with safety buckle
CAS25	Carrying case, plastic with foam insert 54x41x21 cm
CAS28	Carrying case, soft with modular insert 37x20x27 cm
81468	Code lock, TSA approved, for CAS25

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

Instrument specifications	TD-357
User selected functions	TD-359
Shock pulse method SPM HD	
frequency and time domain analysis	TD-361
SPM Shock pulse method dBm/dBc	TD-406
SPM Shock pulse method LR/HR	TD-362
SPM Spectrum®	TD-407
Vibration monitoring ISO 2372	TD-408
Vibration monitoring ISO 10816 with spectrum	TD-363
Vibration monitoring ISO 6954	TD-484
3-channel simultaneous vibration monitoring	TD-364
Vibration Advanced	TD-459
FFT spectrum with symptoms	TD-460
HD ENV	TD-511
Vibration Expert	TD-365
EVAM evaluated vibration analysis	TD-401
HD ENV	TD-511
Run up/Coast down and Bump test	TD-402
HD Order tracking	TD-403
Frequency Response Function, FRF	TD-402
HD Analysis	TD-514
Vibration Expert	TD-365
SPM HD Expert	TD-361
Orbit analysis/Shaft centerline plot	TD-368
Balancing, single and dual plane	TD-369
Shaft alignment	TD-370
Recording function	TD-409
Alignment Sensors	TD-524
Transducers and measuring cables	TD-377
Leonova Service Program	TD-379
Tachometer/Temperature probe	TD-380

Spare parts

16645	Protection foil for display
14661	Wrist strap
81469	Silica gel (moisture absorbent) spare for CAS25
90362	AC adapter, Euro plug, 100-240 V AC
90380	AC adapter, UK plug, 100-240 V AC
90379	AC adapter, US plug, 100-240 V AC
90528	AC adapter, AU plug, 100-240 V AC
16574	Battery charger
PRO52	Leonova Service Program
71950	Leonova Diamond User guide

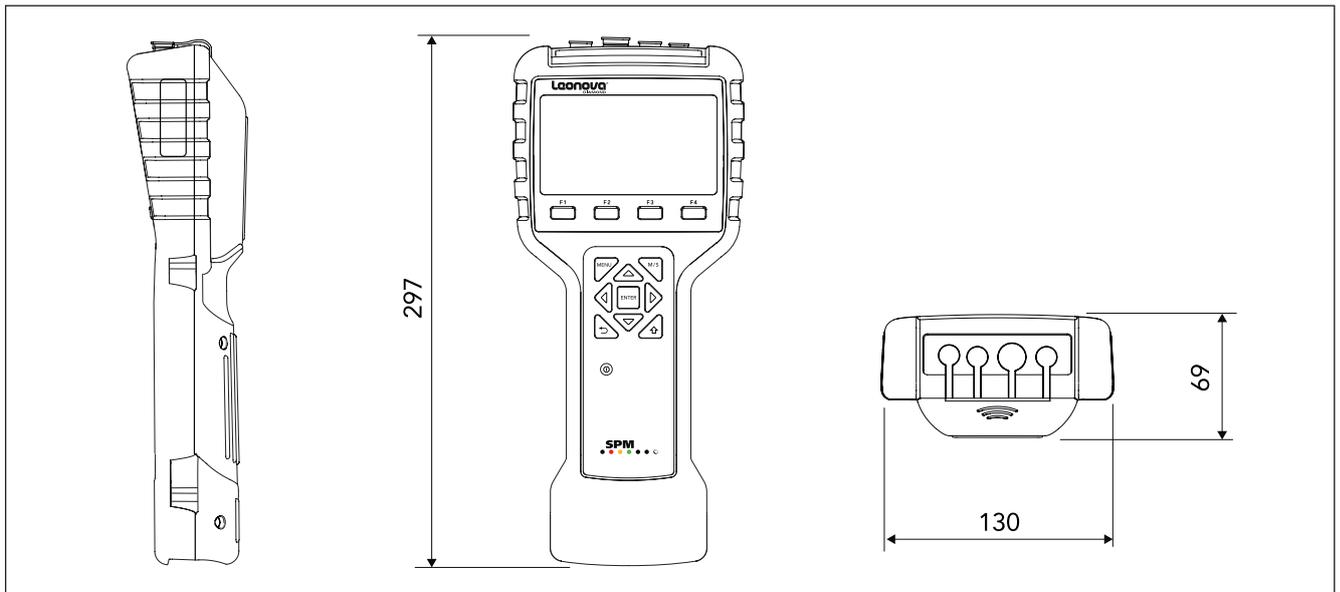
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Leonova Diamond® – Instrument specifications



Technical specifications

Housing:	ABS/PC/TPE, IP65
Dimensions:	297 x 130 x 69 mm
Weight:	890 g
Keypad:	Sealed, snap action
Display:	TFT colour, 480 x 272 pixels, 4.3 inch widescreen, adjustable backlight
Main processor:	400 MHz ARM
Memory:	256 MB RAM, 512 MB Flash, SD card 1GB expandable up to 8GB
Operating system:	Microsoft Windows® CE
DSP processor:	375 MHz floating point
Communication:	USB 2.0
Power supply:	Rechargeable Lithium-Ion battery pack, 5200 mAh or power adapter
Battery power:	For min. 16 hours normal use (20°C)
Operating temperature:	-20 to 55 °C , non condensing
Charging temperature:	0 to 45 °C
General features:	Language selection, battery status indication, transducer line test, metric or imperial units
Meas. point identification:	NFC transponder for communication with CondiD™ tags, read/write distance max. 50 mm (2 inch)

Vibration monitoring

Vibration channels:	3 simultaneous
Dynamic range:	up to 120 dB, 24 bit A/D converter
Frequency range:	0 (DC) to 40 kHz
Resolution:	Max. 25 600 lines
Vibration transducer input:	< 24 Vpp. Transducer supply of 2,5 mA for IEPE (ICP) type can be set On/Off
Transducer types:	Any transducers (disp., vel. or acc.) with voltage output
Measuring techniques:	ISO 2372, ISO 10816, HD ENV, EVAM Evaluated Vibration Analysis, FFT Spectrum with Symptoms, Orbit analysis, 3 channels simultaneously, balancing

Bearing monitoring

Measuring range:	SPM HD: -30 to 110 dBsv (44000 transducer) dBm/dBc: -9 to 99 dBsv LR/HR: -19 to 99 dBsv
Resolution:	0,2 dB/HD, 1 dB dBm/dBc and LR/HR
Transducer types:	SPM 40000, 42000, 44000, probe and quick connector transducers, DuoTech
Measuring range:	1 to 150 000 PPM
Resolution:	1 pulse
Accuracy:	± (1 pulse + 0.01% of reading)
Transducer types:	TTP10, TTL pulses, keyphasor and proximity switch NPN/PNP.
Output:	TTL output for stroboscope and 12 VDC

Analog signals

Measurement range:	0 to 10 V DC, 0 to 20 mA
Resolution:	18 bit A/D converter
Accuracy:	± 1% of reading + 0,1 V/mA

Output/input

Headphones/microphone:	3.5 mm stereo plug
Communication:	Mini USB

Temperature measurement

Inputs:	TTP10 or via analog input
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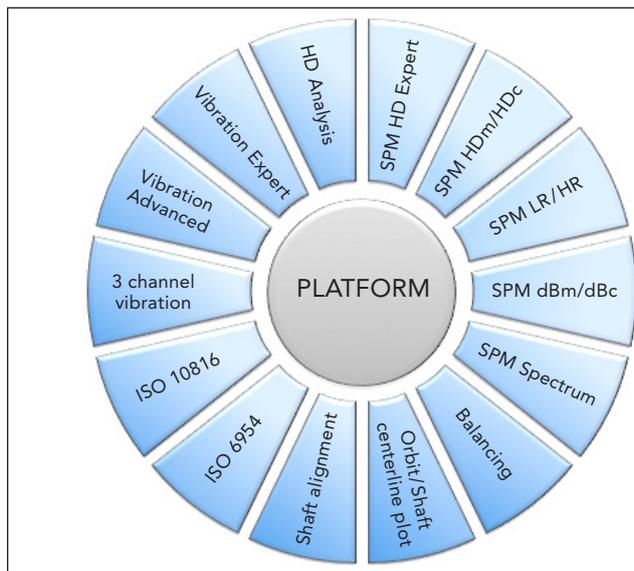
Stethoscope

Transducer types:	Shock pulse and vibration transducer
Settings:	Filter, volume and gain

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Leonova Diamond® – User selected functions



PLATFORM

always included for unlimited use

- Platform function (see TD355)
- RMS vibration, ISO 2372
- Speed measurement
- Temperature measurement
- Stethoscope function
- Analog signals, current and voltage
- Time signal recording
- Reading from and writing to CondiD® memory tags
- Automatic recording, up to 50 hours
- Check points, free text
- Recording of vocal comments
- Supports 2 channel simultaneous vibration measurements
- Supports up to 12.800 lines, 20 kHz

Module in Ruby

MOD136
MOD139

To obtain the optimal performance range and instrument price, Leonova users can select any or all of the 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.

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

Functions for Unlimited Use

Module in Ruby

DIA195	SPM HD Expert, time and frequency domain analysis	MOD195
DIA197	Shock pulse method HDm/HDc	(Platform)
DIA130	Shock pulse method dBm/dBc	MOD130
DIA131	Shock pulse method LR/HR	MOD131
DIA132	SPM Spectrum, 12.800 lines/20 kHz	MOD132 MOD139
DIA133	Vibration ISO 10816 with spectrum	MOD133
DIA198	Vibration ISO 6954	MOD198
DIA138	Orbit analysis/Shaft centerline plot	MOD138
DIA192	3 channel simultaneous vibration	MOD192
DIA193	Vibration Expert HD ENV EVAM evaluated vibration analysis 25.600 lines/40 KHz HD Order Tracking Time signal, Post trigger Run up/coast down, Bump test and FRF	MOD193
DIA194	Vibration Advanced HD ENV FFT spectrum with symptoms 12.800 lines/20 kHz, Time signal, HD Order Tracking, Post trigger	MOD135+MOD139
DIA140	HD Analysis Vibration Expert SPM HD Expert	MOD140
DIA109	Balancing, single and dual plane	
DIA155	Shaft alignment	

Functions for Limited Use (Function & Use)

DIA295	SPM HD Expert, time and freq. domain analysis (3)
DIA297	Shock pulse method HDm/HDc (2)
DIA230	Shock pulse method dBm/dBc (1)
DIA231	Shock pulse method LR/HR (2)
DIA232	SPM Spectrum (2)
DIA233	Vibration ISO 10816 with spectrum (1)
DIA298	Vibration ISO 6954 (1)
DIA238	Orbit analysis (5), Shaft centerline plot (5)
DIA292	3 channel simultaneous vibration (6)
DIA293	Vibration Expert incl. HD Order Tracking, Time signal and 25.600 lines/40 KHz (no credit consumption) HD ENV (3) EVAM evaluated vibration analysis (2) Post trigger (25) Run up / coast down (50) Bump test (25) Frequency Response Function, FRF (25)
DIA294	Vibration Advanced incl. HD Order Tracking, Time signal and 12.800 lines/20 kHz (no credit consumption) HD ENV (3) FFT spectrum with symptoms (2) Post trigger (25)
DIA240	HD Analysis Vibration Expert (3–50) SPM HD Expert (3)
DIA209	Balancing, single and dual plane Single plane (4 runs: 16 / 2 runs: 42) Dual plane (80)
DIA255	Shaft alignment (30)

Credit consumption is stated within brackets.

DIA290 Credits for limited functions

DIA291 Credits for limited functions, refill



Leonova Diamond® – Shock pulse measurement, SPM HD®



Gear symptoms SPM HD time signal

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, enabling a calibrated measurement of the shock pulse amplitudes.

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.

Technical specifications

Measuring range:	-30 to 110 dBsv (44000 transducer)
Resolution:	0.2 dBsv
Accuracy:	± 1 dB
Transducer type:	SPM 40000/42000/44000 probe transducer and quick connector transducer for adapters
Input data:	rpm, plus bearing type and mean diameter (or ISO bearing number)
Output quantity:	HDm, HDc, Time Signal HD SPM Spectrum HD
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800, 25600
Measuring time:	1 to 10000 rev (default same as FFT)
Symptom enhancement factor:	Off, 1-10 (Default = off)

Output data

HDm/HDc (part of platform)

HDm is a scalar value expressed in decibels. It is the primary value to use to determine the severity of a bearing damage. It represents the highest shock pulses found during the measuring cycle. This value is also used for triggering alarms. HDc is a scalar value expressed in decibels. This value represents the level where 200 shocks/second are present. It is useful to determine lubrication condition.

Time Signal HD

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 highly advanced digital algorithms where repetitive shocks are enhanced and random signals are suppressed.

SPM Spectrum HD

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).

High Definition Order Tracking

This function is primarily used for analysis on variable speed machines and adjusts extremely well to quick changes and variations in the RPM during measurement, see TD 403.

Evaluation

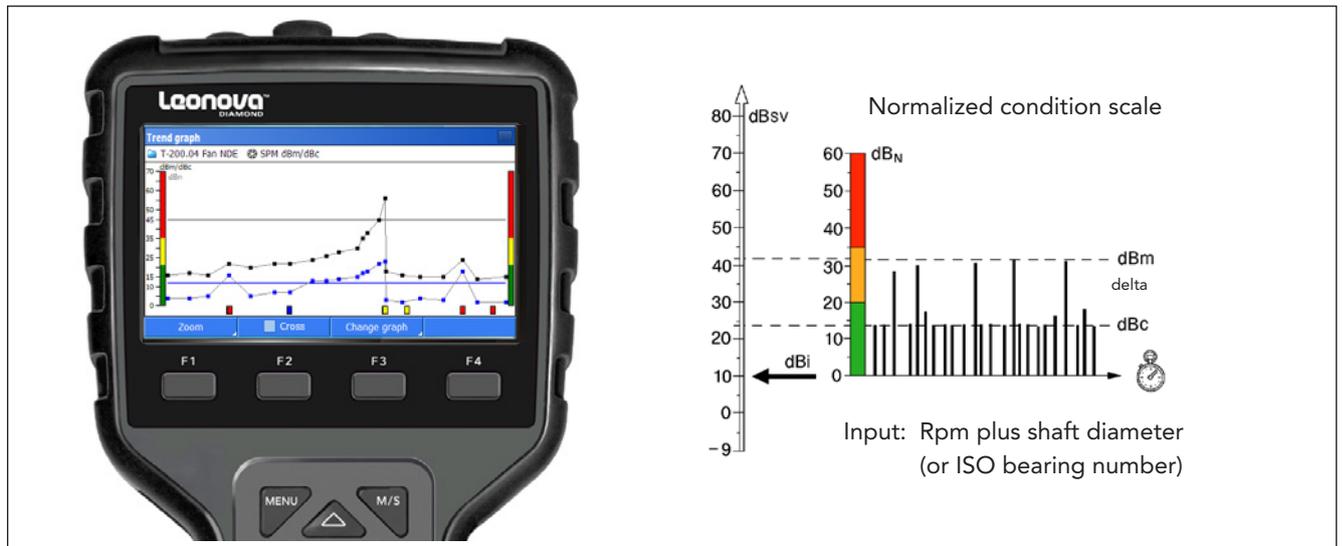
The initial value and the range of the three condition zones (green-yellow-red) was established empirically by testing bearings under variable operating conditions. The maximum value places the bearing into the condition zone. The height of the carpet value and delta (HDm – HDc) indicated lubrication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

Part numbers

DIA195 Shock pulse method SPM HD Expert, unlimited use
DIA295 Shock pulse method SPM HD Expert, limited use
DIA197 Shock pulse method HDm/HDc, unlimited use
DIA297 Shock pulse method HDm/HDc, limited use



Leonova Diamond® – Shock pulse measurement, dBm/dBc



For over 40 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 one second). 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).

SPM



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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 established empirically, 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 specifications

Measuring time: 1.5 sec

Measuring range: -9 to 99 dBsv

Resolution: 1 dBsv

Accuracy: ± 1 dB

Transducer types: SPM 40000/42000/44000, 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).

Part numbers

DIA130 Shock pulse method dBm/dBc, unlimited use
DIA230 Shock pulse method dBm/dBc, limited use

Leonova Diamond® – Shock pulse measurement, LR/HR



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 computation 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. 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).

For time signal, use the DIA 195 module, see TD-361.

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 computes the normal shock level for a good bearing and compensates for an abnormally low signal before returning the evaluation results.

Technical specifications

Measuring range: -19 to 99 dBsv

Measuring time: 1.5 sec

Resolution: 1 dBsv

Accuracy: ± 1 dB

Transducer types: SPM 40000/42000/44000, 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.
(Time signal, use DIA 195.)

Part numbers

DIA131 Shock pulse method LR/HR, unlimited use

DIA231 Shock pulse method LR/HR, limited use



Leonova Diamond® – SPM 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 one 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 Diamond® 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 LR 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 rpm. The rpm should be meas-

ured, 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 specifications

Compatible with:	dBm/dBc or LR/HR
Frequency range:	0 to 25, 32, 40, 50, 80,100, 125, 160, 200, 250, 320, 400, 500, 625, 800,1000, 1250, 1600, 2000, 2500, 4000, 5000, 8000,10000, 20000 Hz, (40000 Hz only with DIA193)
Number of spectrum lines:	400, 800, 1600, 3200, 6400, 12800, 25600
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Spectrum types displayed:	Linear, power
Averages:	Time synchronous, FFT linear, FFT peak-hold
Frequency units:	Hz, CPM, orders
Saving options for spectrum:	Full spectrum, peaks only
Amplitude scale unit:	S_D (Shock Distribution), S_L (Shock Level)
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 40000/42000/44000

Part numbers

DIA132	SPM Spectrum, unlimited use
DIA232	SPM Spectrum, limited use



Leonova Diamond® – HD ENV



HD ENV time signal

With Leonova, the HD ENV method is offered as an analysing function for either limited or unlimited use. It is a part of the packages Vibration Expert DIA193/293 (TD-365) and Vibration Advanced DIA194/294 (TD-459).

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.

Input data:

A number of predefined filters are available to detect damages or anomalies in different stages of development; two of which are specifically designed for bearing monitoring and two of which are recommended for of non-bearing related problems.

Output data:

HD Real Peak

The unit of measurement is HD Real Peak, a scalar value expressed in decibels. Representing the true highest peak found in the enveloped 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 Time Signal

HD Env Time Signal 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 (a single crack or spalling all around etc.).

HD Env Spectrum

HD Env Spectrum is the result of applying FFT algorithms on the Time Signal HD. The HD Env spectrum is useful to determine where a possible bearing damage is located. It is also useful for trending purposes (applying symptom and band values).

Patented algorithms:

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.

High Definition Order Tracking

This function is primarily used for analysis on variable speed machines and adjusts extremely well to quick changes and variations in the RPM during measurement, see TD-403.

Random Impact Rejection

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

Technical specifications

Frequency, upper*:	in orders
Env. high pass filters*:	100, 200, 500, 1000, 2000, 5000, 10000 Hz
Env. band pass filters*:	Filter 1 (5-100 Hz) Filter 2 (50-1000 Hz) Filter 3 (500-10 000 Hz) Filter 4 (5000 - 40 000 Hz)
Averages:	Time synch
Spectrum lines*:	400, 800, 1600, 3200, 6400, 12800, 25600
Frequency units:	Hz, CPM, orders
Saving options:	Full spectrum, time signal and FFT, condition parameters
Transducer types:	Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output, or DuoTech accelerometer

*Spectrum lines, frequency and envelope filter limits are regulated by what is included in the above mentioned packages.

Part numbers

DIA199 HD ENV, unlimited use**

DIA299 HD ENV, limited use**

**Only for upgrading existing Vibration Expert DIA193/293 and Vibration Advanced DIA194/294 packages with HD ENV functionality.



Leonova Diamond® – HD Analysis



HD ENV time signal

The HD Analysis module is a combination of the package Vibration Expert (DIA193/293, TD-365) and SPM HD Expert (DIA195/295, TD-361).

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 (see below). 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.

The unit of measurement is HD Real Peak, a scalar value expressed in decibels. Representing the true highest peak found in the enveloped 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.

See TD-365 for more information about the Vibration Expert package, and TD-511 for more information about HD ENV.

SPM HD

SPM HD Expert is a complement to the SPM HDm/HDc and LR/HR techniques. 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 Leonova Diamond platform. For further information, see technical data sheet TD-359.

- **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).

For more information about SPM HD, see TD-361.

Patented algorithms

HD ENV and SPM HD both incorporate sophisticated and patented algorithms which contribute to reliable and crystal clear readings:

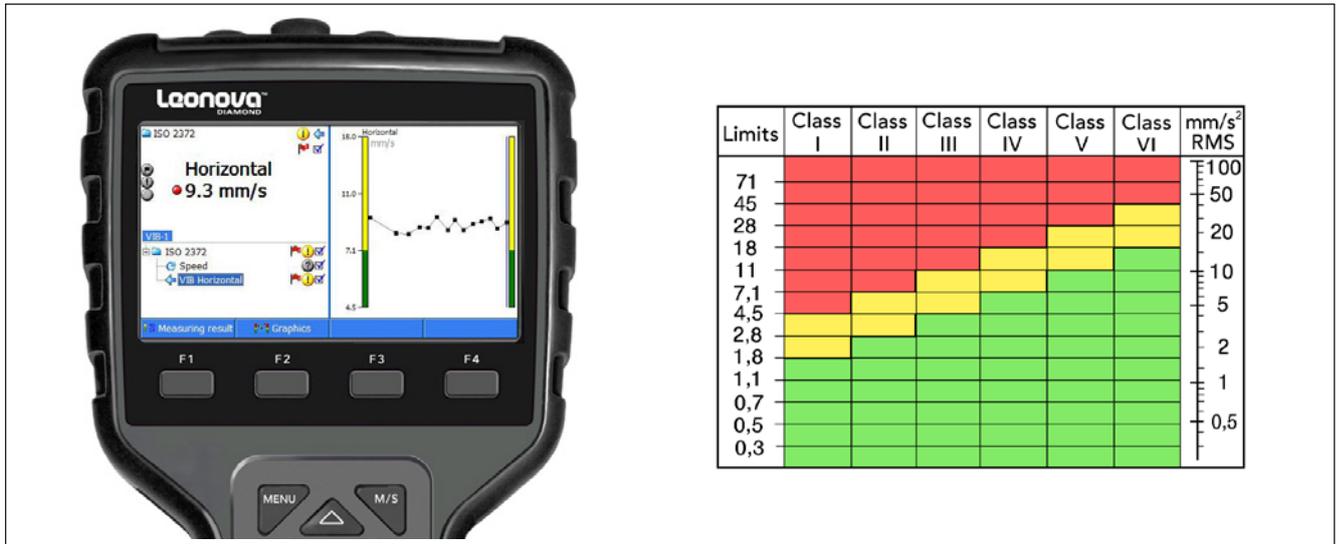
- **High Definition Order Tracking:** Used primarily for analysis on variable speed machines, HD Order Tracking is capable of handling $\pm 50\%$ RPM variations during data acquisition. The number of orders to be covered is input by the user.
- **Symptom enhancement** looks for repetitive signals in the time domain. As a result, random signals are suppressed and repetitive signals enhanced.
- **Random impact rejection** filters out randomly occurring high readings which may cause false alarms.

Part numbers

DIA140 HD Analysis, unlimited use
DIA240 HD Analysis, limited use



Leonova Diamond® – Vibration ISO 2372



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 this type of machine condition monitoring; the much used ISO 2372 and the more recent ISO 10816, which is an 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 broadband 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-363.

Technical specifications

Measurement quantities: Velocity, RMS value in mm/s over 10 to 1000Hz

Transducer type: Vibration transducer SLD144 or IEPE* (ICP®) type transducers with voltage output

* Integral Electronic PiezoElectric



Leonova Diamond® – Vibration ISO 10816 with spectrum



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 an ongoing replacement of the older standard.

With Leonova, ISO 2372 measurement is a platform function, always included for unlimited use.

ISO 10816 is an option with ordering numbers DIA 133 (unlimited use) and DIA 233 (limited use).

Features of ISO 10816 are:

- Measurements are made in three directions (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 recognizes 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 Diamond also provides a 1600 line spectrum up to 10 kHz.

Technical specifications

Measurement quantities:	Velocity, acceleration and displacement
Spectrum unit:	Velocity, mm/s or inch/s
Transducer type:	Vibration transducer SLD144 or IEPE* (ICP®) type transducers with voltage output
Quick mode:	Yes

* Integral Electronic PiezoElectric

Settings

Direction:	Horizontal, vertical, axial
Part:	2, 3, 4, 5, 6
Group:	2, 3, 4, 5, 6
Support:	Rigid, Flexible

Part numbers

DIA133	Vibration ISO 10816 with spectrum, unlimited use
DIA233	Vibration ISO 10816 with spectrum, limited use



Leonova Diamond® – Vibration ISO 6954



The International Standard ISO6954 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 that interferes with duties or reduces comfort is objectionable and often results in adverse comments from crew and passengers. This International 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, and
- 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 ship owner) prior to any assessment of the habitability.

Leonova Diamond perform measurements and presents overall frequency-weighted RMS vibration values according to ISO6954 standard. These values are then to be exported in xml format via the Leonova Service program for evaluation in an external software program.

Vibration ISO 6954 for Leonova Diamond includes the following functionality:

- 3 channel simultaneous vibration monitoring
- Time signal
- Spectrum
- Waterfall diagram

Technical specifications

Frequency range:	0 Hz (DC) to 500 Hz
Spectrum lines:	6400
Spectrum unit:	Velocity, mm/s or inch/s
Transducer type:	Vibration transducer 90546 or IEPE* (ICP®) type transducers with voltage output
Time signal:	Acc
Spectrum:	Vel
Save:	Time signal and spectrum
Window:	Flat top
FFT type:	Amplitude
Averaging:	Linear
Overlap:	50%
Number of averages:	9
ISO weighting frequency:	1 to 80 Hz

* Integral Electronic PiezoElectric

Part numbers

DIA198	Vibration ISO 6954, unlimited use
DIA298	Vibration ISO 6954, limited use



Leonova Diamond® – Vibration Expert



EVAM evaluated vibration analysis

- Condition parameters, which are measured and computed 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.

HD ENV

HD ENV 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.

Time signal

This option enables you to see the measured data in the time domain. This is useful in all kinds of analysis. Two cursors are available.

Run up/coast down, Bump test and FRF

Run up/coast down measurements, Bump test and Frequency Response Function (FRF) are three vibration analysis functions offered with Leonova Diamond®, included in the Vibration Expert package. 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. All of these functions are selected from the menu of an ordinary vibration measurement assignment.

25600 lines/40 KHz

This option expands spectrum resolution to 25600 lines and the upper frequency limit to 40 KHz. Mostly for high speed applications and detection of resonances and harmonics in high frequencies.

Post trigger

This function enables your system to be armed and triggered to measure directly on the trigger point. When this function is enabled on the measurement, the system prepares the measurement with settling time and autogain adjustment, so when the trigger fires, the system can start measuring directly.

Trigger level: 0-1000 mm/s, m/s², μm

Delay: 0-30 sec

High Definition Order Tracking

High Definition Order Tracking is a part of the Vibration Expert package. For shock pulse measurements, it is included in the SPM HD module DIA195/295. This function 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 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 minimize the risk of smearing when using FFT averaging.

The package consists of:

- EVAM evaluated vibration analysis (TD-401)
- HD ENV (TD-511)
- 25600 Lines/40 KHz
- Run up/coast down (TD-402)
- Bump test and Frequency Response Function (TD-402)
- High Definition Order Tracking (TD-403)
- Time signal
- Post trigger
- Live Phase
- Cepstrum Analysis
- Time Signal Recording

Part numbers

DIA193 Vibration Expert for unlimited use

DIA293 Vibration Expert for limited use



Leonova Diamond® – Vibration Advanced



FFT Spectrum with Symptoms

FFT Spectrum with Symptoms is a vibration analysis function offered with Leonova. 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.

HD ENV

HD ENV 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.

High Definition Order Tracking

High Definition Order Tracking is a part of the Vibration Advanced package. For shock pulse measurements, it is included in the SPM HD module DIA195. This function 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 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 minimize the risk of smearing when using FFT averaging.

Time signal

This option enables you to see the measured data in the time domain. This is useful in all kinds of analysis. Two cursors are available.

Post trigger

This function enables your system to be armed and triggered to measure directly on the trigger point. When this function is enabled on the measurement, the system prepares the measurement with settling time and autogain adjustment, so when the trigger fires, the system can start measuring directly.

Trigger level: 0-1000 mm/s, m/s², μ m

Delay: 0-30 sec

The package consists of:

- FFT spectrum with symptoms, 12800 lines/20 KHz (TD-460)
- HD ENV (TD-511)
- HD Order Tracking (TD-403)
- Time signal
- Post trigger
- Live Phase

Part numbers

DIA194 Vibration Advanced for unlimited use

DIA294 Vibration Advanced for limited use



Leonova Diamond® – EVAM evaluated vibration analysis



With Leonova, the EVAM method is offered as an analysing function for either limited or unlimited use. EVAM is a part of the Vibration Expert package DIA193/293 (TD-365).

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 pre-set 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 predefined '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. Some require an input, 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

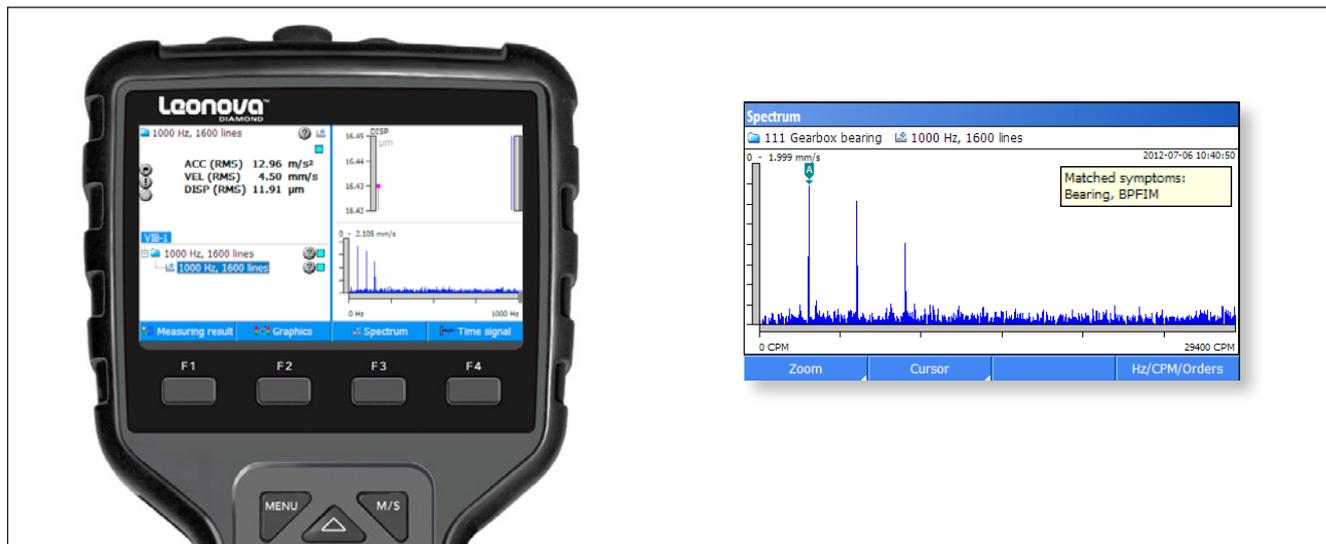
In Condmaster, alarm limits can be set on all active parameters. Once measuring results are collected, an EVAM 'criterion' can be created which compares new parameter values with the statistical mean value and displays a dimensionless condition value against a green - yellow - red scale.

Technical specifications

- Frequency limit, lower: 0, 0.5, 2, 3, 5, 10, 20 100 or 200 Hz
- Frequency limit, upper: 25, 32, 40, 50, 80,100, 125, 160, 200, 250, 320, 400, 500, 625, 800, 1000, 1250, 1600, 2000, 2500, 4000, 5000, 8000, 10000, 20000, 40000 Hz
- Envelope high pass filters: 100, 200, 500, 1000, 2000, 5000, 10000 Hz
- Measurement windows: Rectangle, Hanning, Hamming, Flat Top
- Averages: Time synch, FFT linear, FFT peak-hold
- Spectrum lines: 400, 800, 1600, 3200, 6400, 12800, 25600
- Frequency units: Hz, CPM, orders
- Quick mode: Yes, can be set on/off
- Saving options: Full spectrum, time signal, time signal and FFT, condition parameters
- Spectrum types displayed: Linear, power, PSD, amplitude, cepstrum
- Zoom: True FFT zoom, visual zoom
- Transducer types: Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output



Leonova Diamond® – FFT spectrum with symptoms



FFT Spectrum with Symptoms is a vibration analysis function offered with Leonova Diamond, part of DIA194/294.

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 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 specifications

Frequency limit, lower:	0, 0.5, 2, 3, 5, 10, 20, 100 or 200 Hz
Frequency limit, upper:	8, 10, 16, 20, 25, 32, 40, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500, 625, 800, 1000, 1250, 1600, 2000, 2500, 4000, 5000, 8000, 10 000, 20000 Hz
Band pass filters:	5-100, 50-1000, 500-10000, 5000-40000
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, 12800
Frequency units:	Hz, CPM, orders
Quick mode:	Yes, can be set on/off
Saving options:	Full spectrum, time signal, time signal and FFT, condition parameters
Spectrum types:	linear, power, PSD, amplitude, cepstrum
Zoom:	visual zoom
Transducer types:	vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output

Part numbers

DIA194	Vibration Advanced, unlimited use
DIA294	Vibration Advanced, limited use



Leonova Diamond® – 3 channel simultaneous vibration



Three channel simultaneous vibration monitoring is a Leonova Diamond® function for unlimited use (DIA192) or limited use (DIA292).

This type of measurement allows the user to study machine movement in three dimensions by observing the difference of the phase angles measured on the three channels. It can also save time by measuring three different assignments simultaneously. Three channel simultaneous vibration monitoring requires the Vibration Expert package (DIA193 and DIA293).

Measurement requires the setup of three vibration assignments with identical parameters. The three channel measuring cable CAB88 is used to connect the transducers to the Leonova vibration transducer input. The procedure is the same as for the corresponding measurement with one or two transducer(s).

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

- Spectrum
- Time signal
- Phase spectrum

In the spectrum and time signal, the channels are overlaid in blue, red and green.

Normal setup is:

Z = channel 1

X = channel 2

Y = channel 3

Technical specifications

Frequency limit, lower:	0, 0.5, 2, 3, 5, 10, 20, 100 or 200 Hz
Frequency limit, upper:	25, 32, 40, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500, 625, 800, 1000, 1025, 1600, 2000, 2500, 4000, 5000, 8000, 10000, 20000, 40000Hz
Envelope high pass filters:	100, 200, 500, 1000, 2000, 5000, 10000 Hz
Envelope band pass filters:	5-100, 50-1000, 500-10000, 5000-40000 Hz
Measurement windows:	Rectangle, Hanning, Hamming, Flat Top
Averages:	time synch, FFT linear, FFT peak-hold
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800, 25600
Saving options for spectrum:	Time signal, peaks only, full spectrum, time signal and FFT, condition parameters
Spectrum types displayed:	linear, power, PSD, amplitude, cepstrum
Zoom:	true FFT zoom, visual zoom
Transducer types:	Vibration transducer SLD144 or IEPE (ICP®) type transducers with voltage output

Part numbers

DIA192	3 channel vibration monitoring, unlimited use
DIA292	3 channel vibration monitoring, limited use
CAB88	3 channel split measuring cable, Lemo, 0.25 m
CAB110	Measuring cable, 8 pin-M12, 1.5 m, straight
CAB93	Measuring cable, 8 pin-2 pin, 1.5 m, straight
CAB82	Measuring cable, 8 pin-2 pin, 1.5 m, spiral



Leonova Diamond® – High Definition Order Tracking



High Definition Order Tracking is part of the modules Vibration Expert, Vibration Advanced, SPM HD Expert and HD Analysis. This function 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 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 minimize 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 during measurement.

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.

High Definition Order Tracking adjusts extremely well to quick changes and variations in the RPM during measurement.

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.



Leonova Diamond® – Orbit analysis and Shaft Centerline Plot



Orbit analysis and Shaft centerline plot is a vibration measurement function offered with Leonova Diamond®, for either unlimited (DIA138) or limited use (DIA238). 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 made on the buffered outputs of a machine protection system via the split cable CAB89 and two measuring cables CAB97, connected to the vibration input, plus cable CAB95 connected to the tachometer input on Leonova Diamond. The buffered outputs, channel X, channel Y and tachometer signal are connected via BNC connectors.

Measurements can also be made with e. g. accelerometers to get a two dimensional graph of machine movement. This requires two channel simultaneous vibration measurement and two transducers placed at an angle of 90° to each other, and 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 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 and their average. The user can select each individual revolution as well as the average of all revolutions.

The selected graph is marked in 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 using the instrument arrow keys.

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

Shaft centerline plot is a function 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 after the measuring round is uploaded.

Technical specifications

Orbit analysis

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 48 000 rpm
Transducer types:	Buffered outputs from API670 approved protection systems alternative vibration transducers type SLD or other transducers with matching IS parameters

Shaft centerline plot

Display functions:	Shaft centerline plot
Signal unit:	DISP
RPM range:	1 to 120 000 rpm
Measuring parameters:	rpm (start/stop), interval
Transducer types:	Displacement transducers or IEPE (ICP®) type transducers with voltage output, alternative buffered outputs from API670 approved protection systems

Part numbers

DIA138	Orbit analysis/Shaft Centerline Plot, unlimited use
DIA238	Orbit analysis/Shaft Centerline Plot, limited use
CAB89	2 channel vibration split cable, 8 pin, 0.25 m
CAB95	Tachometer cable, 5 pin-BNC, spiral 1.5 m
CAB97	Measuring cable, 8 pin-BNC, spiral 1.5 m



Leonova Diamond® – Run up/coast down, Bump test and FRF



Run up / coast down measurements, Bump test and Frequency Response Function are three vibration analysis functions offered with Leonova Diamond, included in the module Vibration Expert DIA193/293 (see TD-365). 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. Frequency Response Function (FRF) is used to measure the vibration response (natural frequencies) of a machine structure. All 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 Diamond 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 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-triggering 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-triggering time).

Frequency Response Function, FRF

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.

Technical specifications

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:	0 Hz (DC)
Frequency limit, upper:	25 to 40 000Hz
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800, 25600
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

Frequency Response Function (FRF)

Scale units:	Accelerance, Mobility, Compliance, Effective Mass, Impedance, Stiffness, Coherence, Phase
Frequency limit, lower:	0 Hz (DC)
Frequency limit, upper:	8 to 40 000 Hz
Spectrum lines:	400, 800, 1600, 3200, 6400, 12800, 25600
Window types :	
Hammer	Rectangle, Half-sine, Gaussian,
Machine	Exponential, Rectangle
Pre-trigger time:	% of sampling time
Double hit detection:	% of impact force
Transducer line test:	bias
Impact hammer:	IEPE (ICP) type. Transducer supply approx 2.5 mA

Part numbers

DIA193	Vibration Expert, unlimited use
DIA293	Vibration Expert, limited use



Leonova Diamond® – Recording function



The Recording function is part of the platform, always included for unlimited use. It allows the user to measure and record measuring results over longer periods of time. The recording function is an analysis tool which can show the interaction of various condition parameters over time.

Leonova has six channels on four separate connectors, for

- shock pulse measurement
- speed and temperature measurement
- vibration (three channels)
- analog measurement

Simultaneous measurement can be done on up to four channels.

The recording function for a single quantity, e. g. temperature, is accessed and set up from the default file saved under the respective technique window. To record different quantities at the same time, a measuring point file with all the different techniques activated is required.

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 and selecting techniques in any order. A technique can be used more than once in the sequence.

Recording is started with the M/S key and can be terminated with the 'Cancel' key (F4).

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.

Leonova Diamond® – Balancing



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

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.

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, 2 runs

This method uses one measurement without trial weight to determine the vibration severity (mm/s RMS) of the rotor, followed by one measurement 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.

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 4, minimum.

Leonova calculates a number of alternatives for correcting the unbalance:

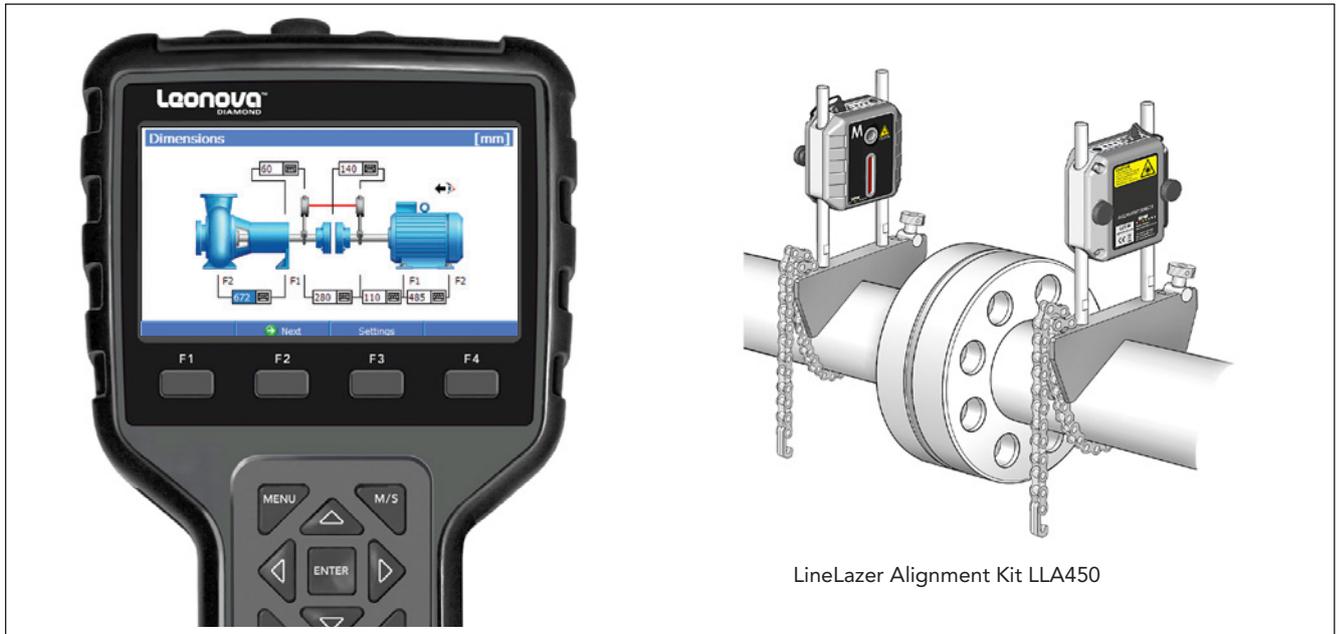
- Trial weight: Input rotor diameter, weight and rpm to obtain the suitable trial weight in grams.
- Split the correction mass: Input the number of rotor partitions to distribute the correction mass between two of them.
- Weight removal: Drill hole diameter and depth calculated for various materials.
- 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.

Part numbers

- | | |
|--------|---|
| DIA109 | Balancing, single and dual plane, unlimited use |
| DIA209 | Balancing, single and dual plane, limited use |



Leonova Diamond® – Shaft alignment



Shaft alignment is an optional Leonova function for 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 Alignment Kit LLA450 contains alignment sensors, brackets, chains, rods, battery charger, cables, Bluetooth dongle and a tape measure – all in a convenient carrying case. This kit fits a multitude of applications, e.g. compressors, gearboxes, generators, and pumps.

The alignment sensors provide maximum accuracy using a spread laser beam in combination with a 28.7 mm detector. Compensation values for thermal growth can be input. High precision inclinometers measure the angle of rotation of both assignment sensors 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 alignment sensors communicate wirelessly with Leonova Diamond via Bluetooth. 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 Diamond produces a log file with all alignment data for documentation and printing.

Measurement programs:

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

Part numbers

DIA155 Shaft alignment, unlimited use

DIA255 Shaft alignment, limited use

LineLazer Alignment Kit LLA450 (TD-525)

- LLS10 1 pc. Alignment sensor, S position (TD-524)
- LLM10 1 pc. Alignment sensor, M position (TD-524)
- 90624 1 pc. Charger, dual USB, incl. interchangeable AC plugs, 100–240V AC, 50-60 Hz, 17W
- CAB94 2 pcs. Charger cable, USB Type A to Mini-B USB, length 1.5 m
- LLD10 1 pc. Bluetooth dongle for Leonova Diamond
- LLB25 2 pcs. Shaft bracket for chain
- LLB11 2 pcs. Extension chain, length 1000 mm
- LLB12 2 pcs. Chain with tension adapter, length 500mm
- LLB13 1 set Supporting rod, 80 mm, set of 4
- LLB14 1 set Supporting rod, 150 mm, set of 4
- MAA70 1 pc. Tape measure
- TOL21 1 pc. Torquing tool for chains and rods
- 81339 1 pc. Plastic box
- CAS25A-1 1 pc. Carrying case, plastic with foam insert

LineLazer Alignment Kit LLA451

The LineLazer Alignment Kit LLA451 contains the same equipment as LLA450 but without the carrying case CAS25A-1.

Options

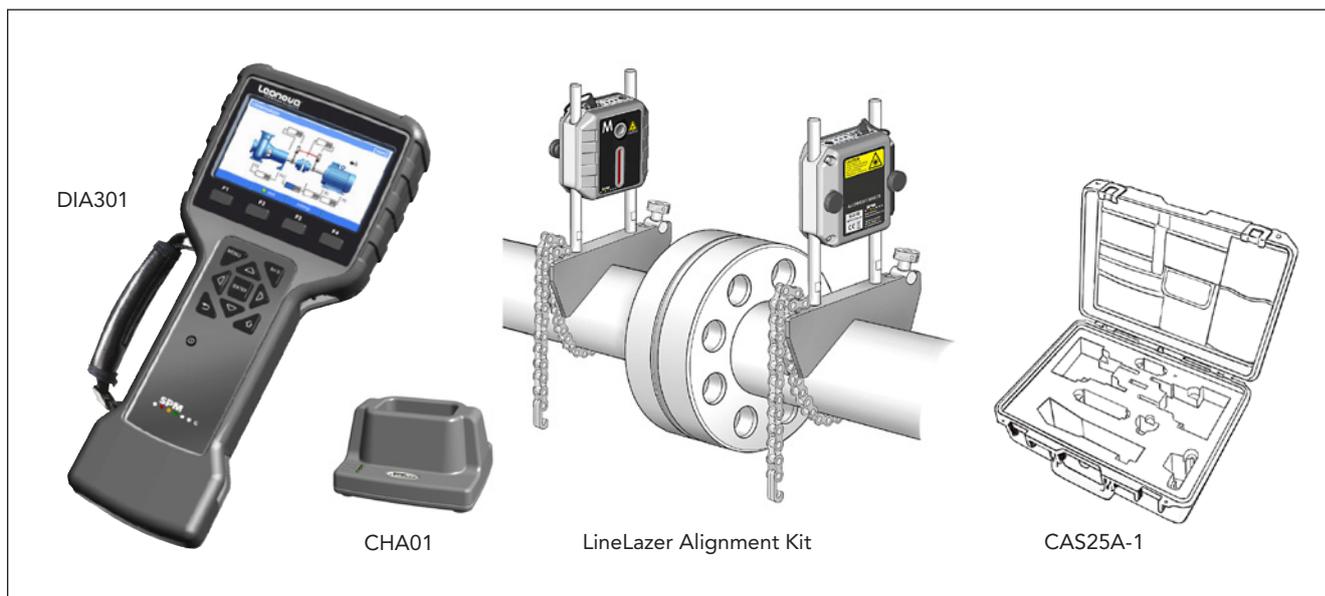
- LLB26 Magnetic bracket

Spare parts

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



Leonova Diamond® Aligner



Leonova Diamond Aligner Kit DIA750 is a complete kit of equipment for shaft alignment. The kit contains instrument, alignment sensors, brackets, chains, rods, cables and a tape measure, all in a carrying case. This kit fits a multitude of applications, e.g. compressors, gearboxes, generators, and pumps.

The alignment sensors use high precision digital CMOS linear image detectors. Compensation values for thermal growth can be input. High precision inclinometers measure the angle of rotation of both alignment sensors 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. A user-friendly graphical interface guides the user through the entire alignment procedure. Automatic calculations and instant correction and alignment data result in a perfect shaft alignment. Leonova produces a log file with all alignment data for printing a report.

Measurement programs:

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

Patents: DE#60304328.3 - US#7,054,761 - US#7,167,814 - US#7,200,519 - US#7,301,616 - US#7,313,484
 US#7,324,919 - US#7,711,519 - US#7,774,166 - DE#60336383.0 - US#7,949,496 - DE#60337804.8
 GB#1474662 - GB#1474663 - DE#60338365.3 - ZA#2011/04946 - SE#0951017-3 - DE#60341502.4
 GB#1474659 - SE#1000631-0 - US#8,762,104 - US#8,812,265 - US#8,810,396 - CN#ZL200980155994.1
 CN#ZL201080019737.8 - KZ#020791 - RU#020791 - AU#2009330744 - RU#021908 - KZ#021908
 US#9,200,980 - US#9,213,671 - CN#ZL201180006321.7 - KZ#022630 - RU#022630 - US#9,279,715
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 GB#2810027 - SE#13744257.0 - AU#2015203361 - RU#027452 - GB#2505984 - US#9,772,219



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Leonova Diamond Aligner Kit DIA750

DIA301	Leonova Diamond Aligner, incl. wrist strap
CHA01	Battery charger incl. AC adapter, 100-240V AC
LLA450	LineLazer Alignment Kit (see below)
71980B	User Guide 'Leonova Diamond Aligner'

LineLazer Alignment Kit LLA450 (TD-525)

LLS10	1 pc.	Alignment sensor, S position (TD-524)
LLM10	1 pc.	Alignment sensor, M position (TD-524)
90624	1 pc.	Charger, dual USB, incl. interchangeable AC plugs, 100-240V AC, 50-60Hz, 17W
CAB94	2 pcs.	Charger cable, USB type A to Mini-B USB, length 1.5 m
LLD10	1 pc.	Bluetooth dongle for Leonova Diamond
LLB25	2 pcs.	Shaft bracket for chain
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
MAA70	1 pc.	Tape measure
TOL21	1 pc.	Torquing tool for chains and rods
81339	1 pc.	Plastic box
CAS25A-1	1 pc.	Carrying case, plastic with foam insert

Options

16573	Optional battery pack for Leonova
16644	Battery adapter unit for Leonova
93484	Car charger cable 12V for Leonova
16675	Belt clip for Leonova, complete
16646	Shoulder strap with safety buckle
81469	Silica gel (moisture absorbent) spare for CAS25A-1
81468	Code lock, TSA approved, for CAS25A-1
LLB26	Magnetic bracket

Spare parts

LLB20	Supporting rod, 80 mm
LLB21	Supporting rod, 150 mm
16645	Protection foil for instrument display
14661	Wrist strap for Leonova
90362	AC adapter for Leonova, Euro plug, 100-240 V AC
PRO52	Leonova Service Program

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Leonova Diamond® – Services



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

- Print and save balancing and alignment reports
- Load credits and/or functions from the file 'Leonova.txt'
- Upgrade a Leonova software package
- Display and print a credit log containing all events in connection with measurement 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.

For example, a safety copy of the Leonova file can be sent to SPM for technical advice. Upon reload, you choose which part of your safety copy should be reloaded.

The file 'Leonova.txt' can contain measuring credits and/or Leonova functions 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.

Part numbers

PRO52	Leonova Diamond Service Program
DIA290	Credits
DIA291	Credits refill

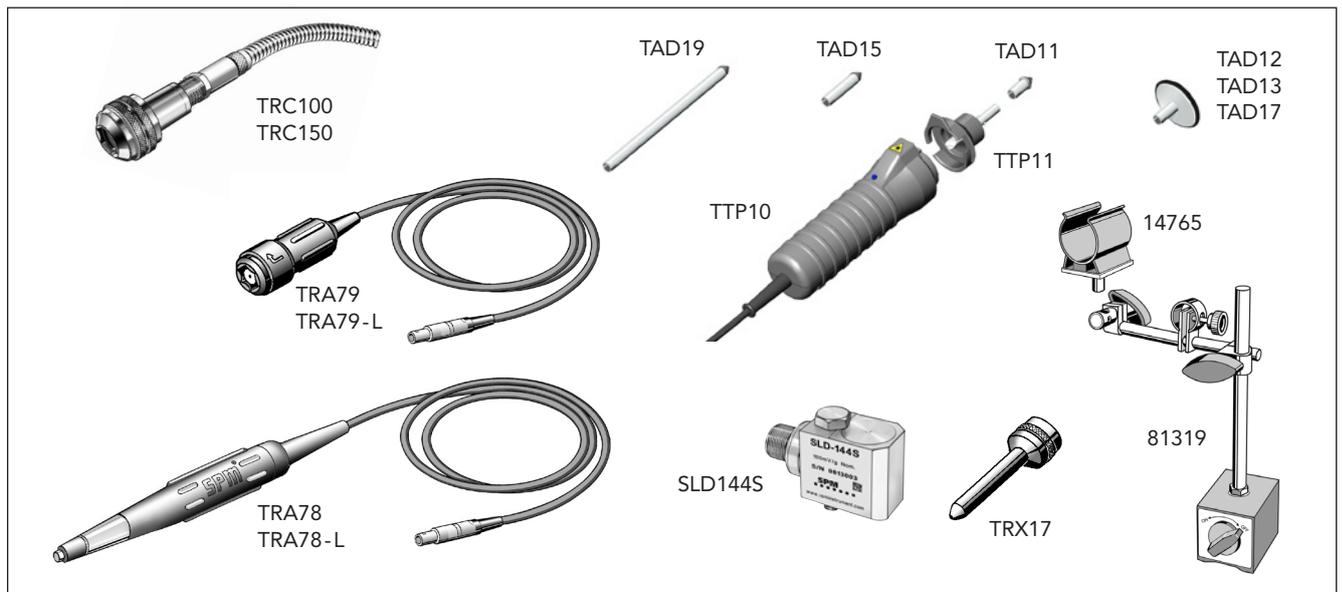
The credits required for a measuring round and the tank status are displayed in Leonova under 'Function and use'. There one can also set the values and time intervals for the 'tank low' warnings.

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
SPM HD Expert	2
SPM HDm/HDc	2
Shock pulse method dBm/dBc	1
Shock pulse method LR/HR	2
SPM Spectrum	2
Vibration ISO 10816 with spectrum	1
HD Enveloping	3
EVAM evaluated vibration analysis	2
FFT spectrum with symptoms	2
3-channel vibration measurement	6
Post trigger	25
Orbit analysis / Shaft Centerline Plot	5
Run up / coast down	50
Bump test and Frequency Response Function	25
Balancing, single plain 4 runs	16
Balancing, single plain 2 runs	42
Balancing, dual plane	80
Shaft alignment	30



Leonova Diamond®/Emerald® – Transducers and measuring cables



Shock pulse monitoring

- CAB80 Measuring cable, mini coax - BNC slip on, 1.5 m
- CAB81 Measuring cable, mini coax - BNC 1.5 m
- CAB101 Measuring cable, mini coax - TNC, 1.5 m
- TRA78 Shock pulse transducer with probe, cable length 1.5 m (TD-400)
- TRA78-L Shock pulse transducer with probe, L=cable length, max. 20 m (TD-400)
- TRA79 Shock pulse transducer with quick connector for measuring adapters, cable length 1.5 m (TD-410)
- TRA79-L Shock pulse transducer with quick connector for adapters, L=cable length, max. 20 m (TD-410)
- EAR12 Headphones with headband (TD-404)
- EAR13 Headphones with helmet brackets (TD-404)
- EAR15 Headphones with neckband (TD-404)
- EAR16 Headset with headband (TD-382)
- EAR17 Headset with helmet brackets (TD-382)
- EAR18 Headset with neckband (TD-382)
- EAS11 Hygiene set for headset and headphones

Vibration monitoring

- SLD144S Vibration transducer with side entry, M8
- TRC100 DuoTech accelerometer excl. cable (TD-518)
- TRC150 DuoTech accelerometer excl. cable (TD-551)
- TRX17 Probe for SLD vibration transducer, M8
- CAB110 Measuring cable, 8 pin-M12, 1.5 m, straight
- CAB93 Measuring cable, 8 pin-2 pin, 1.5 m, straight
- CAB108-L Measuring cable, 8 pin-M12, L=2, 5, 10 or 20 (length in meter), straight
- CAB109-L Measuring cable, 8 pin-M12, L=2, 5, 10 or 20 (length in meter), angled
- CAB82 Measuring cable, 8 pin-2 pin, 1.5 m, spiral
- CAB83 Measuring cable, 8 pin-2 pin 10 m
- CAB83-L Measuring cable, 8 pin-2 pin (L=length in meter)
- CAB89 2 channel split cable, 8 pin, 0.25 m (Diamond)
- CAB88 3 channel split cable, 8 pin, 0.25 m (Diamond)
- CAB97 Measuring cable, 8 pin-BNC, 1.5 m, spiral

Vibration transducers, see TD-260.

Magnetic mounting bases, see TD-548.

Current and voltage monitoring

- CAB85 Cable for analog signals, 5 pin -2 x banana, 1.5 m, spiral (Diamond)

Speed and temperature monitoring

- TTP10 Tachometer/Temp. Probe, 1.5m cable (TD-380)
- TTP12 Tachometer/Temp. Probe, 5m cable (TD-380)
- TAD11 Contact center, rpm, short, 30 mm
- TAD15 Contact center, rpm, long, 60 mm
- TAD19 Contact center, rpm, extra long, 170 mm
- TAD12 Contact wheel m/min.
- TAD13 Contact wheel yd./min
- TAD17 Contact wheel ft./min
- TAD16 Reflecting tape, 5 sheets
- CAB90 Stroboscope cable 5 pin-phones 3.5 mm, 1.5 m, spiral
- CAB92 Proximity switch cable, 5 pin-M12, 1.5 m, spiral
- CAB95 Keyphasor cable 5 pin-BNC 1.5 m, spiral

Proximity sensors, see TD-383 and TD-384.

Balancing

- 81319 Magnetic base
- 14765 Holder for tachometer probe TTP10

Spare parts

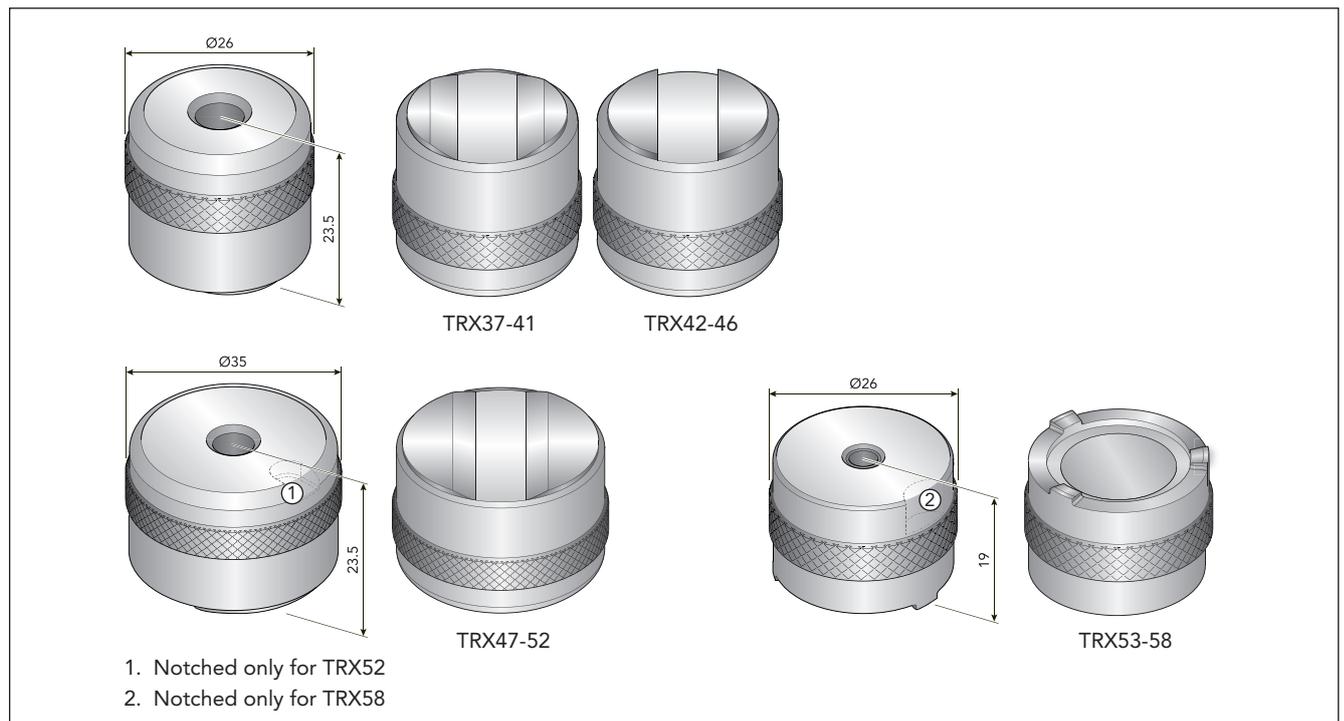
- 13108 Sleeve for probe tip (TRA78)
- TTP11 Contact adapter for TTP10
- CAB79 Cable for TRA78, 1.5 m
- CAB100 Cable for TTP10, 1.5 m, spiral
- CAB103 Cable for TRA79, 1.5 m
- CAB105 Cable for TTP12, 5 m

Others

- CAB94 USB communication cable, 1 m
- CAB96 Communication cable for 'iLearn'
- LLA450 LineLazer Alignment Kit (TD-525) (Diamond)



Magnetic mounting bases



Two-rail, 25 mm diameter, 13 kg (29 lbs) pull strength

The two rail type magnetic mounting bases are usually utilized on curved surfaces, such as motor and compressor housings, although they are also suitable for flat surfaces.

TRX37	Magnetic mounting base, M6
TRX38	Magnetic mounting base, M8
TRX39	Magnetic mounting base, M10
TRX40	Magnetic mounting base, UNF 1/4
TRX41	Magnetic mounting base, UNC 5/16

Flat, 25 mm diameter, 13 kg (29 lbs) pull strength

The flat magnetic mounting bases are optimal for smooth, flat surfaces.

TRX42	Magnetic mounting base, M6
TRX43	Magnetic mounting base, M8
TRX44	Magnetic mounting base, M10
TRX45	Magnetic mounting base, UNF 1/4
TRX46	Magnetic mounting base, UNC 5/16

Two-rail, 35 mm diameter, 25 kg (55 lbs) pull strength

The two rail type magnetic mounting bases are usually utilized on curved surfaces, such as motor and compressor housings, although they are also suitable for flat surfaces. A large diameter enables magnetic mounting on two heat sinks for an electric motor, for example.

TRX47	Magnetic mounting base, M6
TRX48	Magnetic mounting base, M8
TRX49	Magnetic mounting base, M10
TRX50	Magnetic mounting base, UNF 1/4
TRX51	Magnetic mounting base, UNC 5/16
TRX52	Magnetic mounting base for triaxial transducers, UNF 10-32

Three-rail, 25 mm diameter, 10 kg (22 lbs) pull strength

The three rail type magnetic mounting base are usually utilized on curved or uneven surfaces.

TRX53	Magnetic mounting base, M6
TRX54	Magnetic mounting base, M8
TRX55	Magnetic mounting base, M10
TRX56	Magnetic mounting base, UNF 1/4
TRX57	Magnetic mounting base, UNC 5/16
TRX58	Magnetic mounting base for triaxial transducers, UNF 10-32

Technical specifications

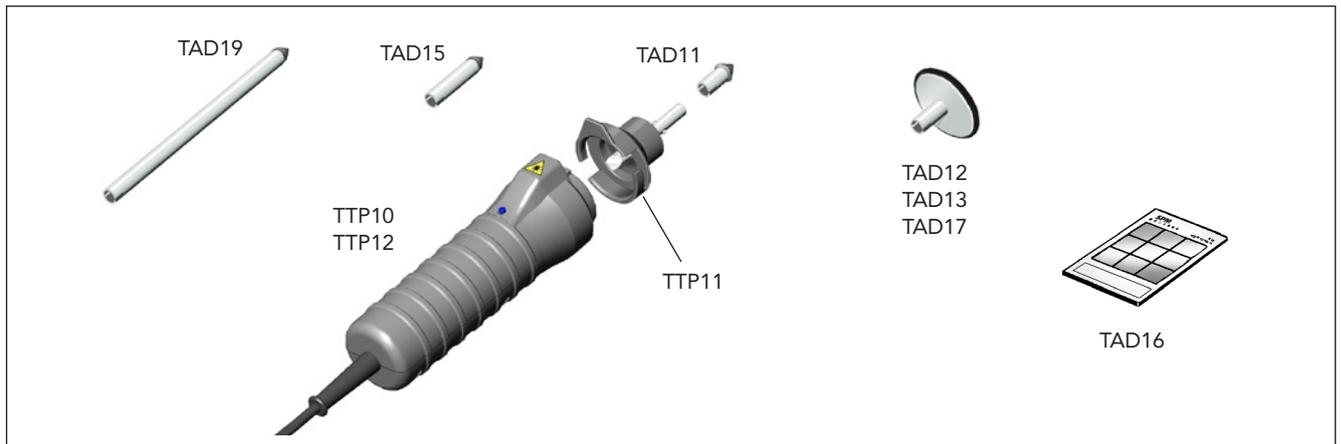
Material:	stainless steel
Temperature:	up to 100 °C
Grip:	knurled edge

Options

16065	Mounting disc for 26 mm diameter magnetic mounting base (TRX37-46 and TRX53-58)
18033	Mounting disc for 35 mm diameter magnetic mounting base (TRX47-52)



Tachometer and Temperature Probe TTP10 / TTP12



The Tachometer and Temperature Probe TTP10/12 is used together with Leonova Diamond® and Emerald® instruments for optical or contact measurement of the rate of rotation and for contact measurement of peripheral speed. It also has a built-in temperature sensor.

Optical measurement of the rate of rotation

A laser light beam is directed against a reflecting tape on the rotating object, from a distance of 30-2000 mm and from an angle of 5-75°.

Contact measurement of rpm

The contact adapter TTP11 with a rubber tipped contact center, TAD-11/15/19, is attached onto the probe and then held against the center of a shaft end or a wheel.

Contact measurement of peripheral speed

The contact adapter TTP11 with contact wheel is held against the circumference of a shaft, a belt, etc. The speed is read out in units, depending on which contact wheel is used: TAD-12/13/17.

Temperature measurement

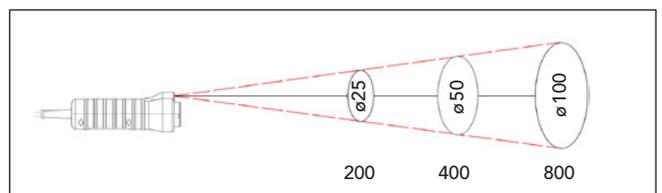
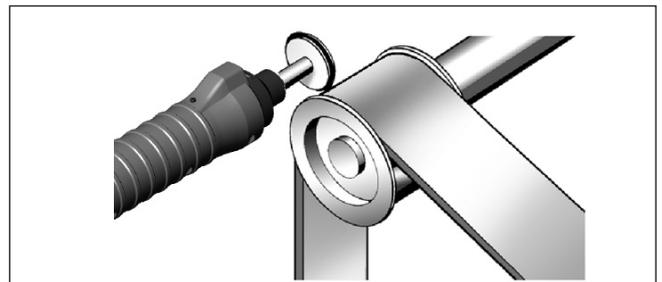
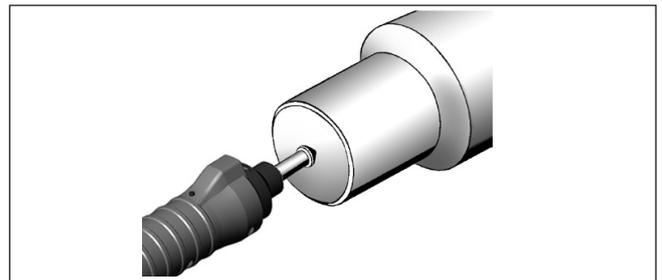
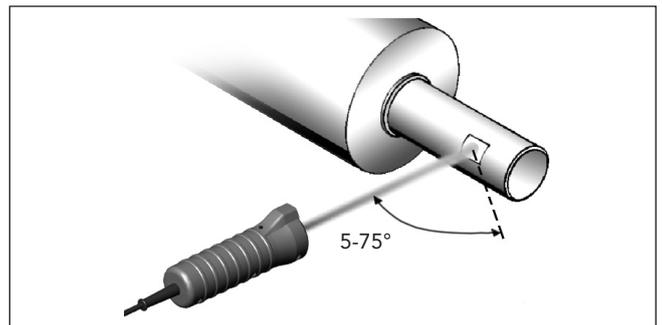
The Tachometer and Temperature Probe TTP10/12 is also used together with Leonova Diamond/Emerald for temperature measurements with a thermopile element in the range -20 to +300 °C.

Part numbers

TTP10	Tachometer and Temperature Probe, incl. TTP11 and cable, spiral 1–2 m
TTP12	Tachometer and Temperature Probe, incl. TTP11 and cable, straight 5 m
TAD11	Contact center, rpm, short, 30 mm
TAD15	Contact center, rpm, long, 60 mm
TAD19	Contact center, rpm, extra long, 170 mm
TAD12	Contact wheel m/min.
TAD13	Contact wheel yd./min
TAD17	Contact wheel ft./min
TAD16	Reflecting tape for thin shafts, 5 sheets
TTP11	Contact adapter (spare part)
CAB100	Cable, spiral (spare part for TTP10)

Technical specifications

Measuring range, rpm	max. 100 000 (pulses) optical
Measuring distance, rpm	30 to 2000 mm
Indicator, rpm	blue LED
Measuring range, temp.	-20 to +300 °C



Measuring accuracy, temp.	± 2,5° C*
Dimensions	137 x 50 mm, 179 x 50 mm incl. TTP11
Operating temperature	0 to + 40 °C
Weight	160 g (TTP10), 300 g (TTP12)
D:S	8:1

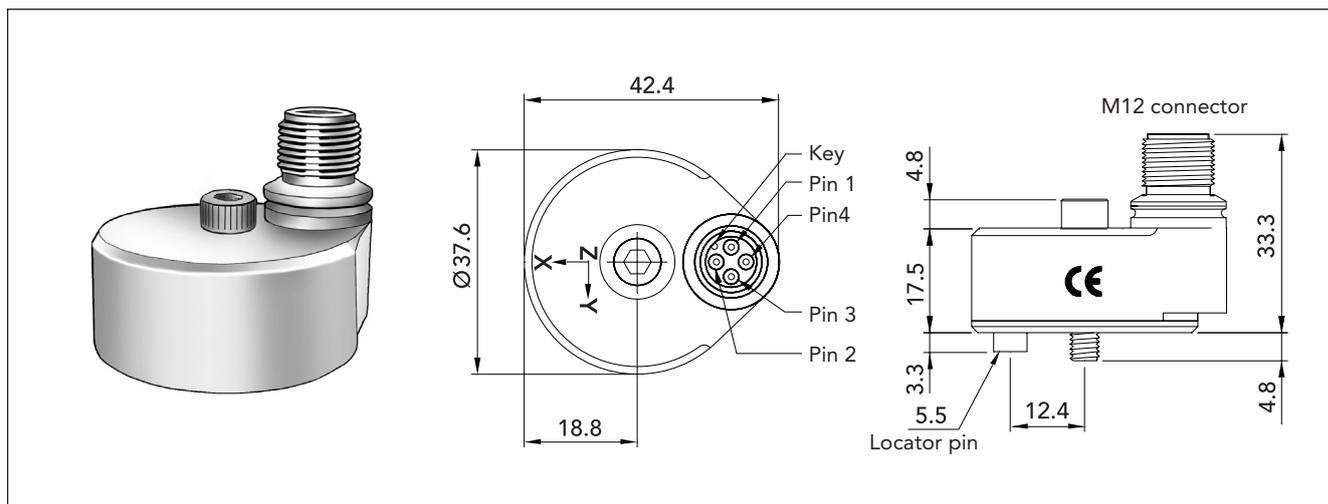
* If RF emission is present at 625MHz to 655MHz, the accuracy is possibly reduced to ±2.5°C – 10% of full scale

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Triaxial Vibration Transducer 90546



SPM 90546 is a low noise triaxial vibration transducer in rugged design with broad frequency response. It features a versatile M12 connector and an external case in a thick shell for high resistance to impact. Designed for both route-based and permanent-mount applications, this triaxial accelerometer hosts three general purpose, 100 mV/g vibration sensors with $\pm 10\%$ sensitivity tolerance. It has EMI/RFI and ESD protection.

Technical specifications

Dynamic

Sensitivity, $\pm 10\%$, 25° C	100 mV/g
Acceleration range	60 g peak
Amplitude nonlinearity	1%
Frequency response:	
Z Axis ± 3 dB	2-10 000 Hz
X and Y axis ± 3 dB	2-7000 Hz
Transverse sensitivity, max	7% of axial

Electrical

Power requirement:	
Voltage source	18-30 VDC
Current regulating diode	2-5 mA
Electrical noise, equiv. g nominal:	
Broadband 2.5 Hz to 25 kHz	160 μ g
Spectral	10 Hz 10 μ g/ $\sqrt{\text{Hz}}$
	100 Hz 2.0 μ g/ $\sqrt{\text{Hz}}$
	1000 Hz 1.5 μ g/ $\sqrt{\text{Hz}}$

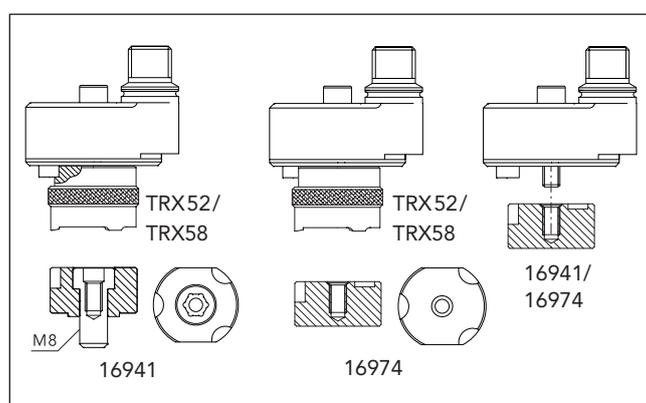
Output impedance, max	400 Ω
Bias output voltage	12 VDC
Grounding	Case isolated, internally shielded
Turn-on time	< 1 sec

Environmental

Temperature range	-50 to 120 °C
Vibration limit	500 g peak
Shock limit	5000 g peak
Electromagnetic sensitivity, equiv. g.	100 μ g/gauss
Sealing	Hermetic
Base strain sensitivity, max	0.0005 g/ μ strain

Physical

Weight	124 g
Case material	316L stainless steel
Mounting	UNF 10-32



Output connector	4 pin, M12 male
Mating connector	M12S female
Recommended cabling	4 conductor, shielded
Accessories supplied	Captive screw, calibration data

Connections

Axis X, power/signal	Connector pin 1
Axis Y, power/signal	Connector pin 2
Axis Z, power/signal	Connector pin 3
Common (all channels)	Connector pin 4
Ground	Shell

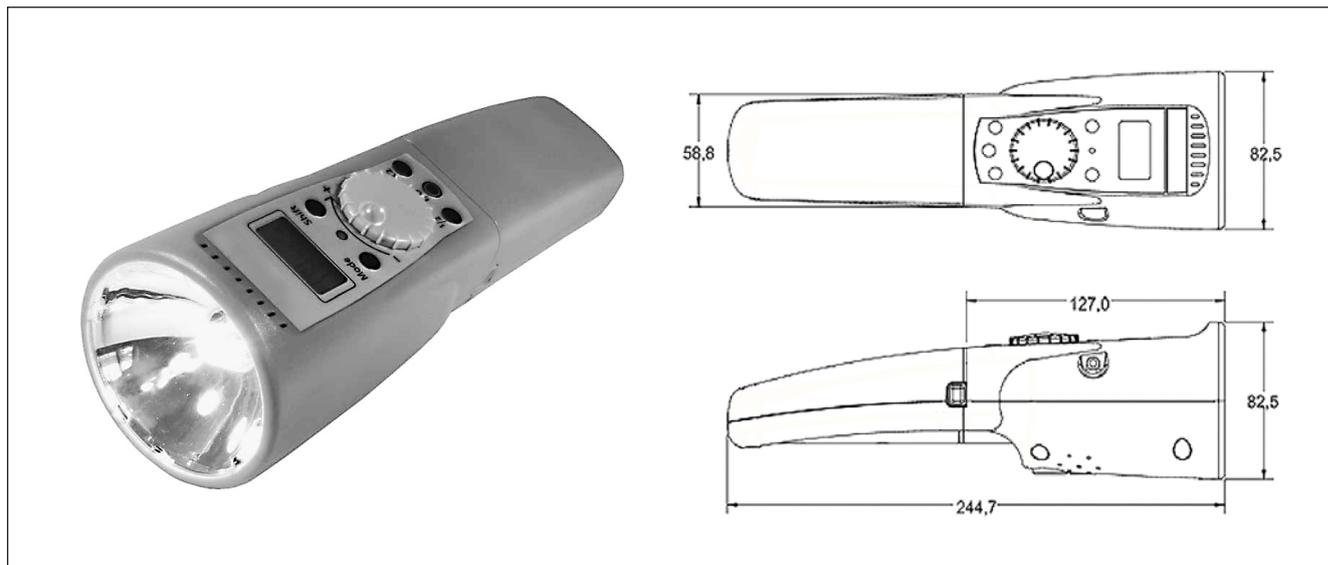
Part numbers

90546	Triaxial vibration transducer
CAB91	Cable for 90546, 8-pin/4-pin M12 connectors
16941	Mounting foot for 90546, screw
16974	Mounting foot for 90546, glue
90510	Connector M12S female, straight

Magnetic mounting bases for triaxial transducers, see TD-548.



Digital Hand Stroboscope 16936



The Digital Hand Stroboscope 16936 is suitable for non-contact RPM measurements and for observation of fast, repeated motions of machines, their moving components or handled material from a distance of 20 to 50 cm.

The revolving or oscillating machine component can be visualised as a stop-motion picture by adjusting the light flashes synchronously to the rate of the movement.

With the multiplier/divider function, the actual RPM or frequency of the motion can be determined accurately. The phase-shift function enables visual positioning of the observed component, as well as the incremental observation of a complete course of motion in 5° steps.

Due to its flash rate with low deviation from the actual motion frequency, the courses of motion can be observed under a slow-motion effect.

Technical specifications

Range:	40 to 12500 fpm
Accuracy:	0.01% (+/-0,5 fpm)
Resolution:	0.1 fpm
Phase shift:	360°
Multiplier:	X 2, X ½
Output signal:	5 V TTL
	Low <0.5 V / High >4.0 V / pulse length 20 to 24 µs
Input Signal:	5 V TTL
	Low <0.8 V / High >2.8 V / pulse >5 µs
Illuminance:	50 cm distance / 6.000 fpm > 400 Lux @ D=10 cm > 150 Lux @ D=20 cm
Flash tube:	Xenon 10 W, white 6500°K Life time 100 mio flashes Flashing time 10 to 15 µsec Flash energy ~ 400 Lux
Display type:	2 x 8-digit Dot-Matrix
Battery:	Removable rechargeable NiMH battery pack 2,6 Ah
Operation time:	approx. 120 min @ 1500 fpm
Recharge time:	approx. 2 to 4 h, overcharge protection
Battery charger:	100 to 240 VAC (50 to 60 Hz) universal adapter EU/USA/GB/AUS
Temp. range:	Operation 10 to 40 °C Storage -20 to 45 °C
Weight:	650 g (instrument with battery)
Housing material:	Polycarbonate
Tripod fixing:	1/4-20 UNC, length 8 mm

Part numbers

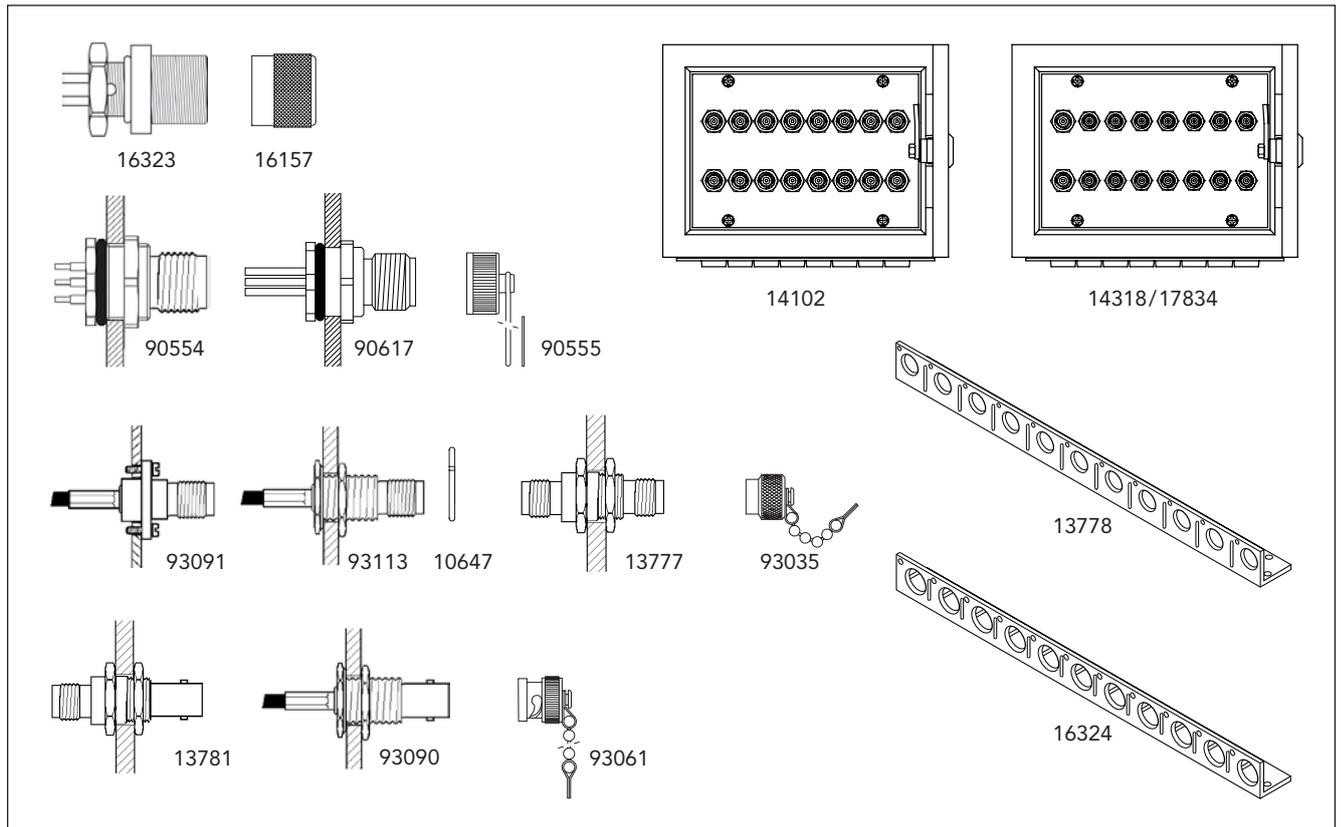
16936	Stroboscope incl. battery pack, battery charger with exchangeable plugs, spare flash tube, operation manual, plastic carrying case with foam insert
CAB90	Stroboscope cable for Leonova Diamond/Emerald 5 pin - phones 3.5 mm, 1.5 m, spiral

Spare parts

90545	Rechargeable battery pack
90544	Spare flash tube
81508	Spare front glass



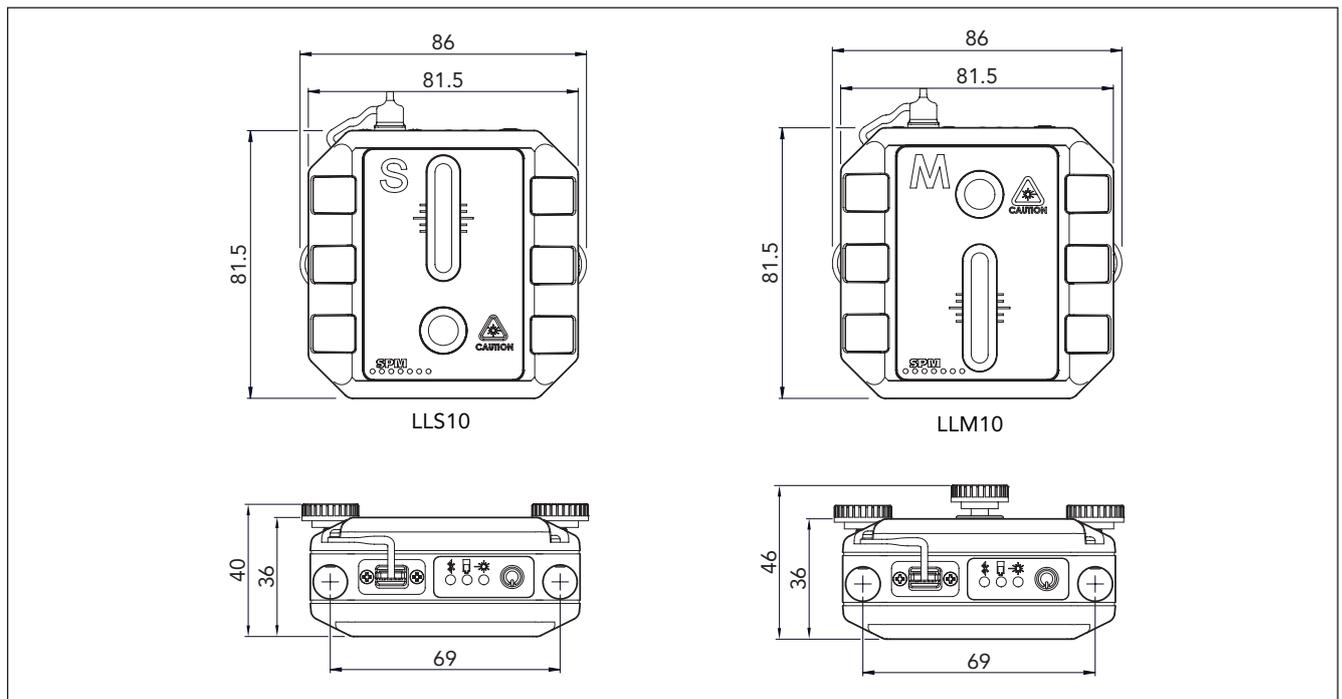
Accessories for remote measuring points



Part number	Description	Connector type	Backing	Mounting	Cap	IP class	DIA/EME measuring cable	TD sheet
90554	Connector	M12	Solder	Counternut	90555	IP67	CAB92	TD384
90617	Connector	M12	Cable 0.5m	Counternut	90555	IP67	CAB92	TD384
90555	Protection cap	M12						TD480
13777	Connector	TNC	TNC	Counternut	93035/10647	IP64, mated	CAB80/CAB81	TD081
93091	Connector	TNC	Crimp	Flange	93035/10647	IP64, mated	CAB80/CAB81	TD019
93113	Connector	TNC	Crimp	Counternut	93035/10647	IP68, mated	CAB80/CAB81	TD019
10647	Attaching ring for 93113							TD154
93035	Protection cap	TNC						TD081
13781	Connector	BNC	TNC	Counternut	93061	IP64, mated	CAB80/CAB101	TD081
93090	Connector	BNC	Crimp	Counternut	93061	IP64, mated	CAB80/CAB101	TD019
93061	Protection cap	BNC						TD154
16323	Connector	2-pin	Crimp	Counternut	16157		CAB93	TD154
16157	Protection cap	2-pin						
14102	Terminal cabinet	16 M12		Counternut				TD154
14318	Terminal cabinet	2 M12, 14 BNC/TNC/2-pin		Counternut		IP66		TD154
17834	Terminal cabinet, IS version	2 M12, 14 BNC/TNC/2-pin		Counternut		IP66		TD561
13778	Terminal bracket	BNC/TNC/2-pin		Counternut				TD154
16324	Terminal bracket	M12		Counternut				TD154



Alignment sensors



The alignment sensors LLS10 and LLM10 are two measuring units for shaft alignment with the multi-function datalogger Leonova Diamond. The alignment sensors are identical with exception of the position of laser detector and the knob for adjustment of the laser on the alignment sensor marked M. The alignment sensors communicate wirelessly with Leonova Diamond via Bluetooth. The Bluetooth dongle LLD10 for Leonova Diamond is included in LineLazer Alignment Kit LLA450 and LLA451.

The alignment sensors provide maximum accuracy using a spread laser beam in combination with a 28.7 mm detector. Through digital filtering, the laser beam can be distinguished from interfering light sources. Both alignment sensors are transmitters/detectors.

The alignment sensors have dual axis high precision inclinometers which measure the angle of rotation of both alignment sensors 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 alignment sensor has a power off switch and LED indicators that show battery status and communication mode. The batteries are recharged with the USB charger 90624.

The LineLazer Alignment Kit (see TD-525) contains alignment sensors, brackets, chains, rods, battery charger, cables, Bluetooth dongle and a tape measure – all in a convenient carrying case. This kit fits a multitude of applications, e.g. compressors, gearboxes, generators and pumps.

Technical specifications

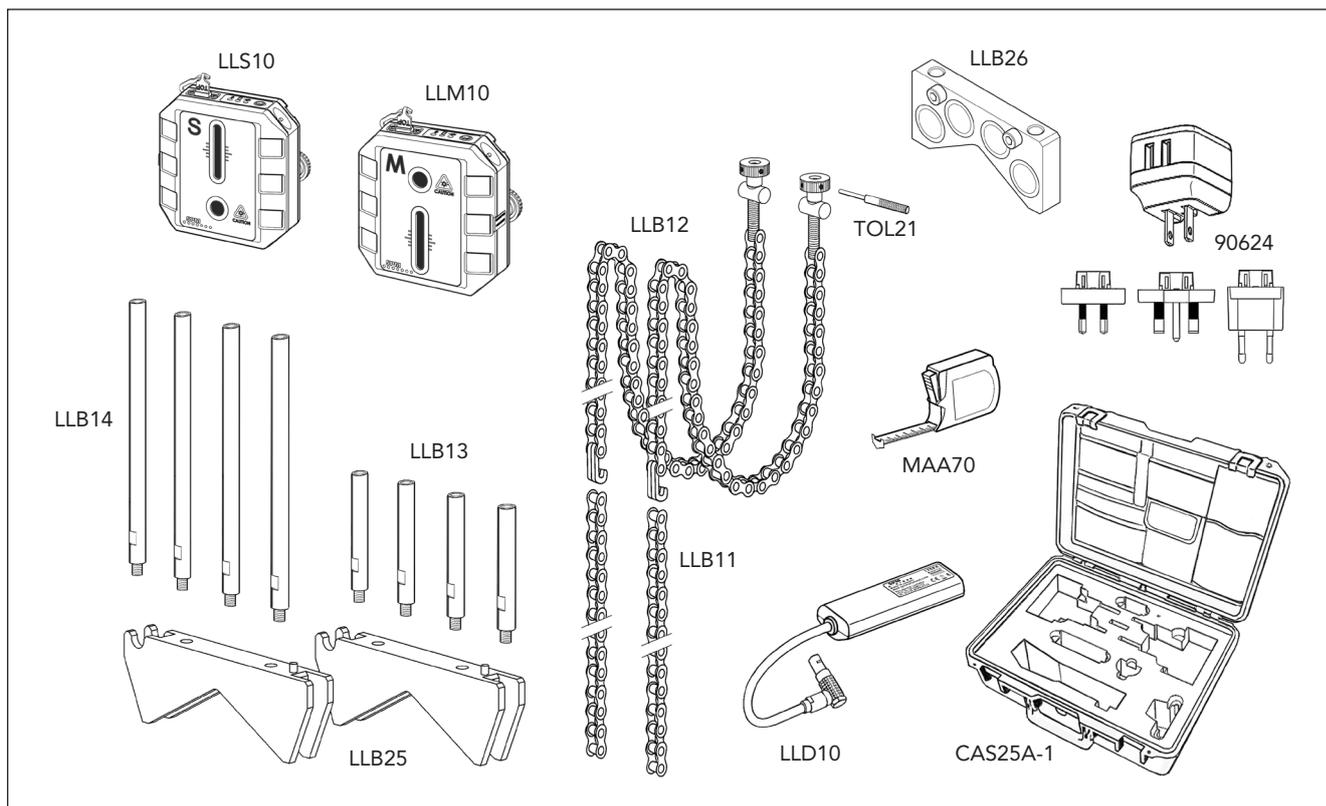
Laser type:	line laser, visible red light
Laser output power:	≤ 1 mW
Laser safety class:	Class II
Laser wavelength:	635 nm (Typ.)
Detector type:	CMOS Linear image sensor
Detector resolution:	7 μm
Detector accuracy:	≤ 0.3% ± 7 μm
Detector protection:	optical filtering (from ambient light)
Detector size (length):	approx. 28.7 mm (≈ 1.13 in)
Measuring range:	up to 10m (32.8 ft)
Inclinometer type:	MEMS
Inclinometer resolution:	0.01°
Inclinometer accuracy:	≤ ± 0.2°
Firmware:	built in self diagnosis and functions for calibration, signal processing
Internal batteries:	Li-ion, rechargeable
Operating time:	> 12 hours normal use
Operating temp.:	-10 to +50 °C (14 to 122 °F)
Keyboard:	sealed membrane
Control indicators:	LED, red/yellow/blue
Connector type:	mini-B USB for communication and battery charge
Communication:	Bluetooth v4.0 Class II
Housing:	PC plastic/anodized aluminium
Protection:	IP65
Dimensions:	LLS10; 86x81.5x40mm (3.4x3.2x1.6 in) LLM10; 86x81.5x46mm (3.4x3.2x1.8 in)
Weight:	approx. 230 g

Part numbers

LLA450 LineLazer Alignment Kit for Leonova Diamond
LLA451 LineLazer Alignment Kit for Leonova Diamond, without carrying case



LineLazer Alignment kit



The LineLazer Alignment kit LLA450 contains alignment sensors, brackets, chains, rods, battery charger, cables, Bluetooth dongle and a tape measure – all in a convenient carrying case. This kit fits a multitude of applications, e.g. compressors, gearboxes, generators, and pumps. Compensation values for thermal growth can be input. High

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. Specifications for the alignment sensors, see *TD-524*.

LineLazer Alignment kit LLA450 for Leonova Diamond

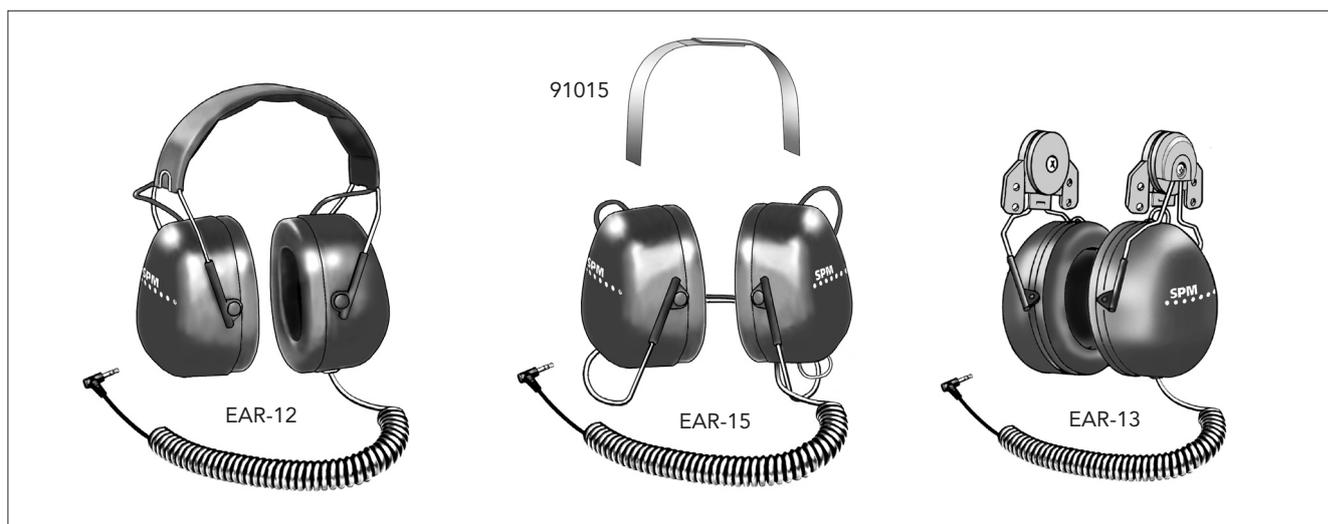
LLS10	1 pc.	Alignment sensor, S position (TD-524)	MAA70	1 pc.	Tape measure
LLM10	1 pc.	Alignment sensor, M position (TD-524)	TOL21	1 pc.	Torquing tool for chains and rods
90624	1 pc.	Charger, dual USB, incl. interchangeable AC plugs, 100–240V AC, 50–60 Hz, 17 W	81339	1 pc.	Plastic box
CAB94	2 pcs.	Charger cable, USB Type A to Mini-B USB, length 1.5 m	CAS25A-1	1 pc.	Carrying case, plastic with foam insert
LLD10	1 pc.	Bluetooth dongle for Leonova Diamond	Options		
LLB25	2 pcs.	Shaft bracket for chain	LLB26	Magnetic bracket	
LLB11	2 pcs.	Extension chain, length 1000 mm	Spare parts		
LLB12	2 pcs.	Chain with tension adapter, length 500 mm	LLB20	Supporting rod, 80 mm	
LLB13	1 set	Supporting rod, 80 mm, set of 4	LLB21	Supporting rod, 150 mm	
LLB14	1 set	Supporting rod, 150 mm, set of 4			

LineLazer Alignment Kit LLA451 for Leonova Diamond

The LineLazer Alignment Kit LLA451 contains the same equipment as LLA450 but without the carrying case CAS25A-1.



Headphones in eardefenders



EAR12/13/15 are specially selected headphones providing excellent sound reproduction even in noisy environments.

- Individually sprung headband wires of stainless sprung steel provide an even distribution of pressure around the ears. Steel headband wires retain their resilience better than plastic through a wide temperature range.
- Low, two-point fasteners and easy height adjustment with no protruding parts.
- Soft, wide foam and fluid-filled sealing rings with built-in pressure-evening channels provide low pressure, effective sealing and ideal comfort.
- Connection cord, 0.75 to 1.4 m, of soft spiral polyurethane with a 3,5mm stereoplug.

The headphones are tested and approved in accordance with PPE directive 89/686/EEC and EMC directive 89/336/EEC to meet the demands for CE labelling.

Headphones with headband, EAR12

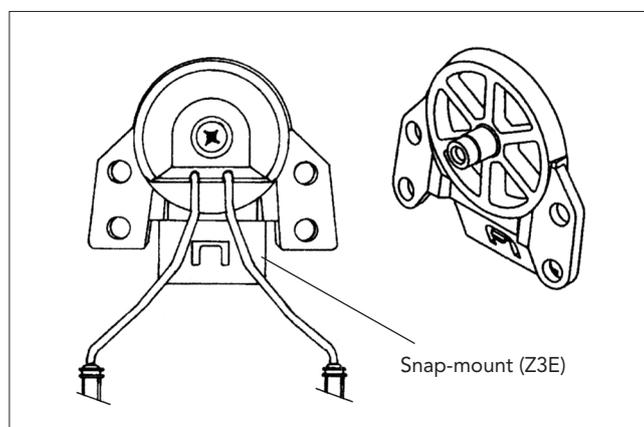
EAR12 is a headphone set with two parallel connected earphones. It has a collapsible headband for convenient storage when you are not using the headphones with eardefenders.

Headphones with neckband, EAR15

EAR15 is a headphone set with two parallel connected earphones. It is equipped with neckband for use with or without helmet. A soft headband with velcro is optional.

Headphones for helmet, EAR13

The headphones EAR13 is a headphone set with one connected earphone. The headphones fit most safety helmets available in the market today. The headphones have standard snap-mounts (Z3E) and are adapted to a specific helmet by a simple manipulation.



To mount the headphone, snap the helmet attachment into the slot on the helmet. Note, The cups can be set in three positions: working position, ventilation position and parking position. When in use, the cups must be placed in working position. Press the wires inward until you hear a click on both sides. Make sure that the cup and the headband wire in working position are not pressing on the helmet lining or the edge of your hardhat so that leakage can occur. Parking position should not be used if the cups are damp inside after an intense period of use.

Part numbers

EAR12	Headphones with headband
EAR13	Headphones with helmet brackets
EAR15	Headphone with neckband
EAS11	Hygiene set (consists of two sets of attenuating cushions and snap-in sealing rings)
91015	Headband with velcro for EAR15



Headset with microphone



EAR16/17/18 are specially selected headsets for Leonova Diamond/Emerald, providing excellent sound reproduction even in noisy environments. The headphones are equipped with microphone for voice recording of comments to the measuring points.

- Individually sprung headband wires of stainless sprung steel provide an even distribution of pressure around the ears. Steel headband wires retain their resilience better than plastic through a wide temperature range.
- Low, two-point fasteners and easy height adjustment with no protruding parts.
- Soft, wide foam and fluid-filled sealing rings with built-in pressure-equalizing channels provide low pressure, effective sealing and ideal comfort.
- Connection cord, 0.75 to 1.4 m, of soft spiral polyurethane with a 3.5 mm stereo plug.

The headsets are tested and approved in accordance with PPE directive 89/686/EEC and EMC directive 89/336/EEC to meet the demands for CE labelling.

Headset with headband, EAR16

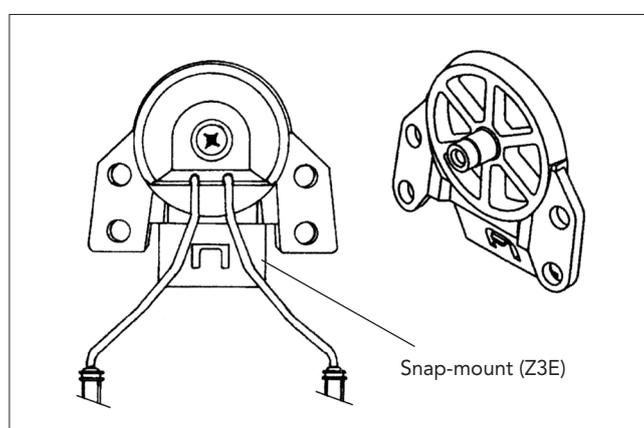
EAR16 is a headset with two parallel connected earphones and a microphone. It has a collapsible headband for convenient storage when you are not using the headset.

Headset, EAR18

EAR18 is a headset with two parallel connected earphones and a microphone. It has a neckband for use with or without helmet. A soft headband with velcro is optional.

Headset for helmet, EAR17

The headset with microphone EAR17 is a headset with two parallel connected earphones and a microphone. The headset fits most safety helmets available in the market today. The headphones have standard snap-mounts (Z3E) and are adapted to a specific helmet by simple manipulation.



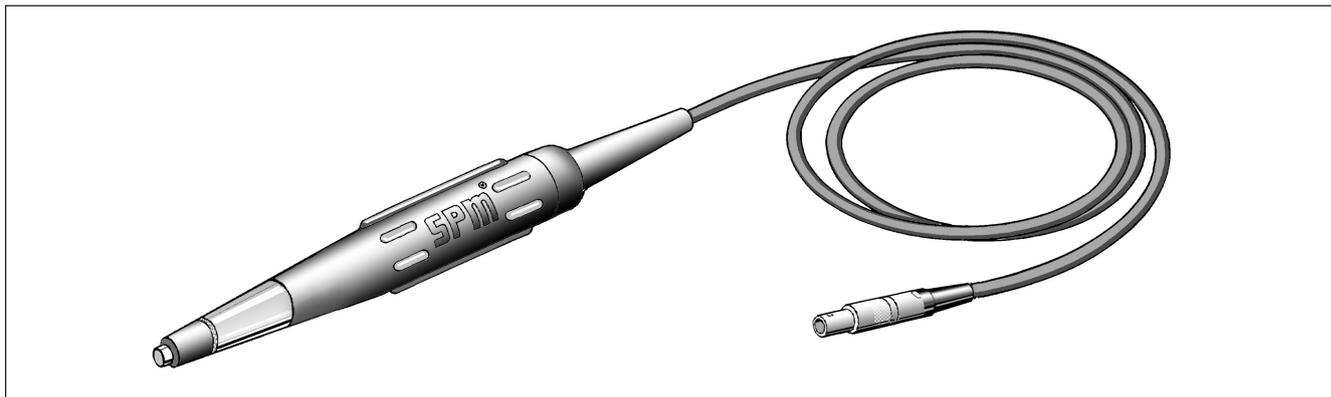
To mount the headphone, snap the helmet attachment into the slot on the helmet. Note! The cups can be set in three positions: working position, ventilation position and parking position. When in use, the cups must be placed in working position. Press the wires inward until you hear a click on both sides. Make sure that the cup and the headband wire in working position are not pressing on the helmet lining or the edge of your hard hat so that leakage can occur. Parking position should not be used if the cups are damp inside after an intense period of use.

Part numbers

EAR16	Headset with headband
EAR17	Headset with helmet brackets
EAR18	Headset with neckband
EAS11	Hygiene set (consists of two sets of attenuating cushions and snap-in sealing rings.)
91015	Headband with velcro for EAR18



Shock Pulse Transducer with Probe TRA78



TRA78 is a handheld probe, used together with Leonova Diamond® and Emerald®. The probe is directionally sensitive and must be held aligned against the bearing and not deviate from this direction by more than $\pm 5^\circ$. The probe tip is spring loaded and moves within a sleeve made of chloroprene rubber (neoprene) and tolerates 110°C (230°F). Standard cable length is 1.5 m. Other lengths up to 20 m can be ordered.

Measuring points for the probe transducer should be located directly on the bearing housing and the signal path should be in a direct line to the contact area. The strongest shock pulses are emitted from the loaded region of the rolling interface in the bearing. The loaded region for radial load covers a sector of $\pm 45^\circ$ from the load direction. For axial load the region is 360° . Since the transfer of shock pulses to the bearing housing is limited by the width of the bearing, direct radiation of pulses will be restricted to a sector of $\pm 60^\circ$ from the perpendicular to the rolling surface. Measuring points should be clearly marked, for instance with the SPM marker BEX19.

To maintain a steady pressure on the tip, press the probe tip against the measuring point until the rubber sleeve is in contact with the surface. Avoid pressing the probe tip against cavities and fillets which are smaller than the probe tip.

Technical specifications

Coaxial cable: PVC, standard length 1.5 m (5 ft) or other length, max 20 m (65.6 ft.)
 Measuring range: Max. 85 dBsv
 Temp. range: -30° to $+70^\circ\text{C}$
 Connector: Mini coax
 Dimensions: 260 x 25 mm (10.2 x 1 in)
 Weight: 275 g (9.7 oz)

Part numbers

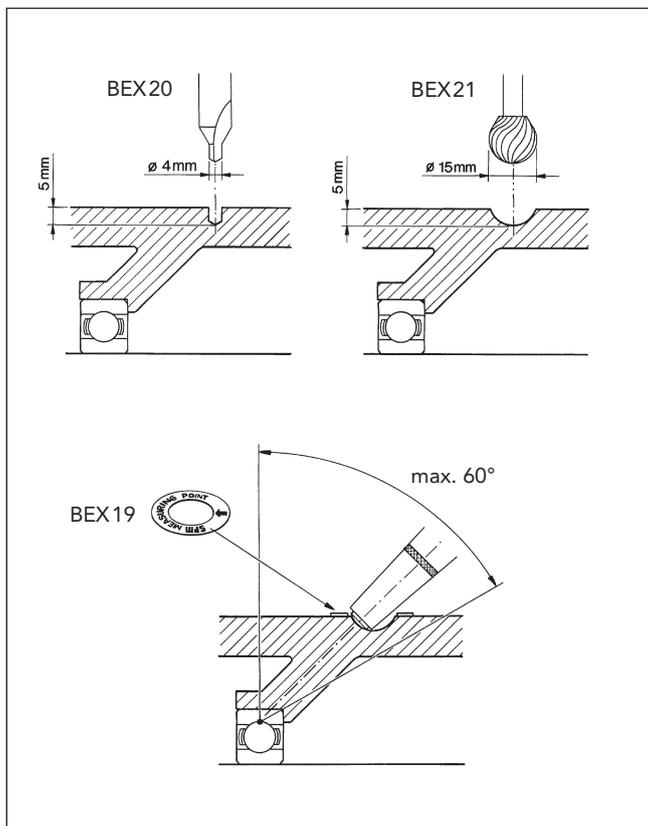
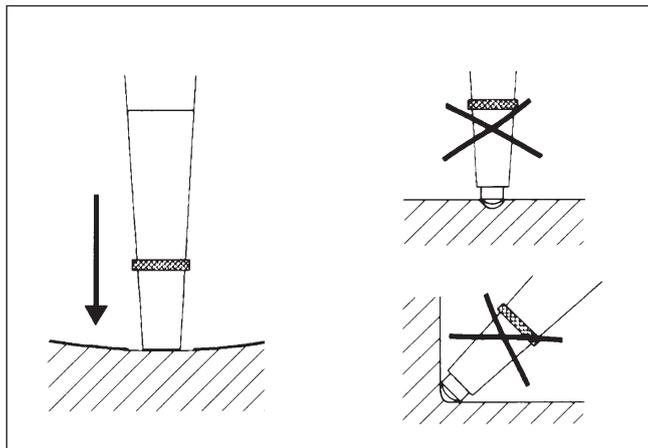
TRA78 Shock pulse transd. with probe, cable length 1.5 m
 TRA78-L Shock pulse transd. with probe, L= cable length, max 20 m
 BEX19 Measuring point marker
 BEX20 Center drill
 BEX21 Rotary file

Spare parts

TRA15 Transducer with probe
 16626 Probe handle
 CAB79 Cable for TRA78, mini coax connector, 1.5 m (5 ft)
 13108 Sleeve for probe tip

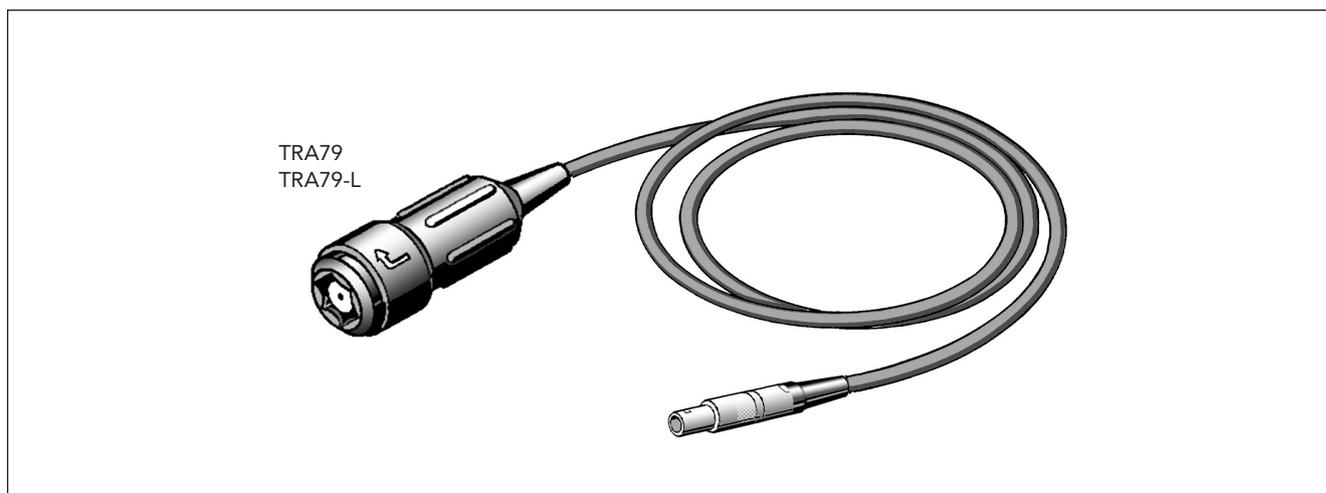


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Shock pulse transducer with quick connector TRA79



TRA79 is a shock pulse transducer with quick connector, used together with the handheld instrument Leonova Diamond® and Emerald®, for measurements on permanently installed adapters. The quick connector forms a bayonet connection together with the permanently installed adapter. Standard cable length is 1.5 m. Other lengths up to 20 m can be ordered.

To attach the TRA79 to an adapter, push the transducer firmly onto the adapter and twist it clockwise.

Twist counter clockwise to unfasten the transducer.

Technical specifications

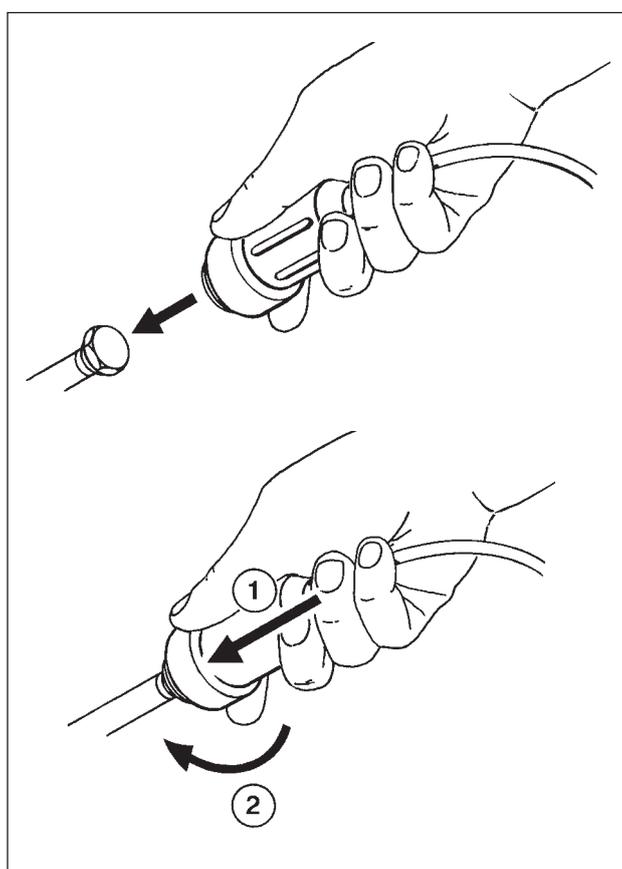
Measuring range:	Max. 100 dBsv
Design:	Sealed
Temperature range:	-30° to +70 °C (-22° to +158 °F)
Material, spanner:	Black oxide steel
Handle cover:	Polyurethane
Coaxial cable:	PVC, standard length 1.5 m (5 ft) or other length, max 20 m (65.6 ft.)
Connector:	Mini coax
Dimensions:	90x30 mm (1.2x3.5 in)
Weight:	210 g (7,4 oz)

Part numbers

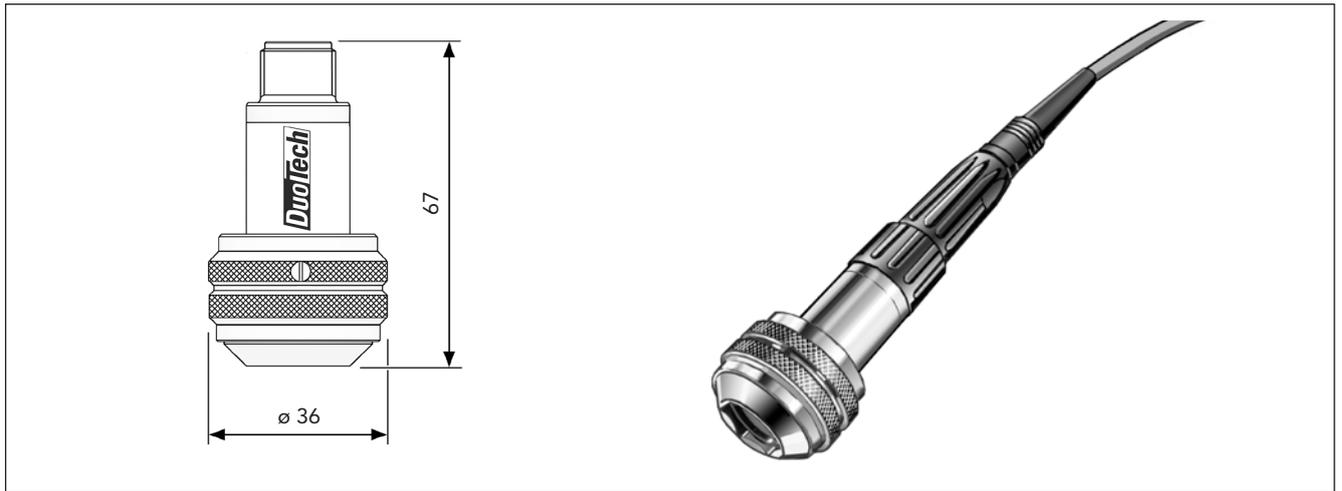
TRA79	Shock pulse transducer with quick connector, cable length 1.5 m
TRA79-L	Shock pulse transducer with quick connector, L=cable length, max. 20 m

Spare part

CAB103 Cable for TRA79, 1.5 m, mini coax. connector



DuoTech Accelerometer with Quick Connector TRC100



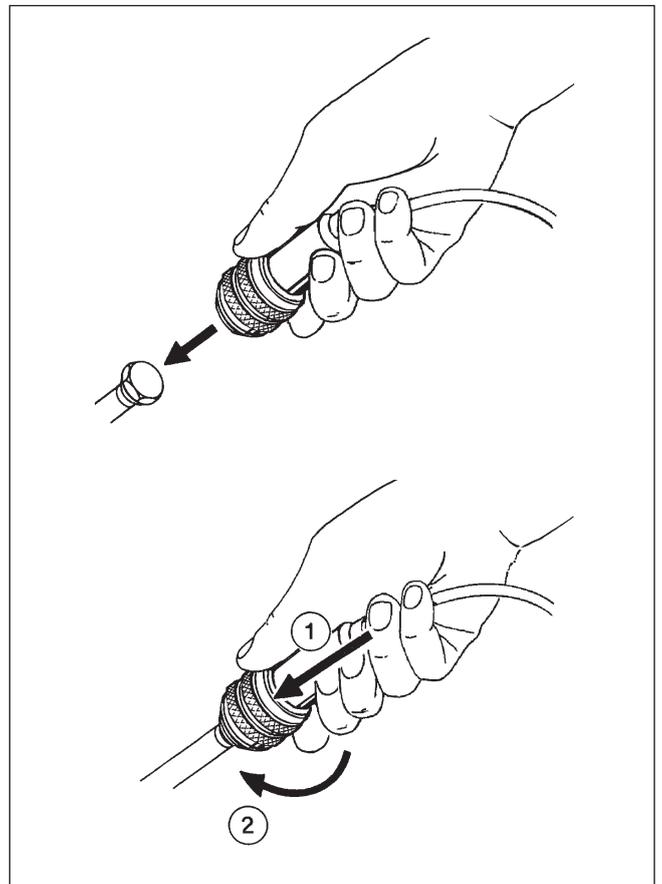
TRC100 is a DuoTech accelerometer with quick connector, used together with the handheld instrument Leonova Diamond and Emerald, for measurements on permanently installed adapters. The quick connector forms a bayonet connection together with the permanently installed adapter. The accelerometer is internally isolated in a Faraday shield providing maximum protection from ground loops and RF interference.

To attach the transducer to an adapter, push the transducer firmly onto the adapter and twist it clockwise. Twist counter clockwise to unfasten the transducer.

Technical specifications

Nom. sensitivity, main axis:	100 mV/g *
Measuring range, vibration:	600 m/s ² = 60 g
Measuring range, shock pulse:	-12 to 75 dB
Transverse sensitivity:	max. 10%
Base strain sensitivity:	0.01 m/s ² /μ strain
Frequency range, vibration:	2 Hz to 5 kHz (±3dB)
Settling time:	3 sec.
Bias point:	10 to 13V (typical 12V)
Power supply:	24 V, 4 to 5 mA
Design:	sealed IP66/67
Temperature range:	-40° to + 125° C
Material:	stainless acid proof steel, Sandvik Grade:1802, EN:1.4523
Sealings:	Viton (fluor rubber)
Connector:	2-pin MIL-C-5015
Cable length:	max. 100m
Weight:	165 g

* Individual value given on the calibration chart.

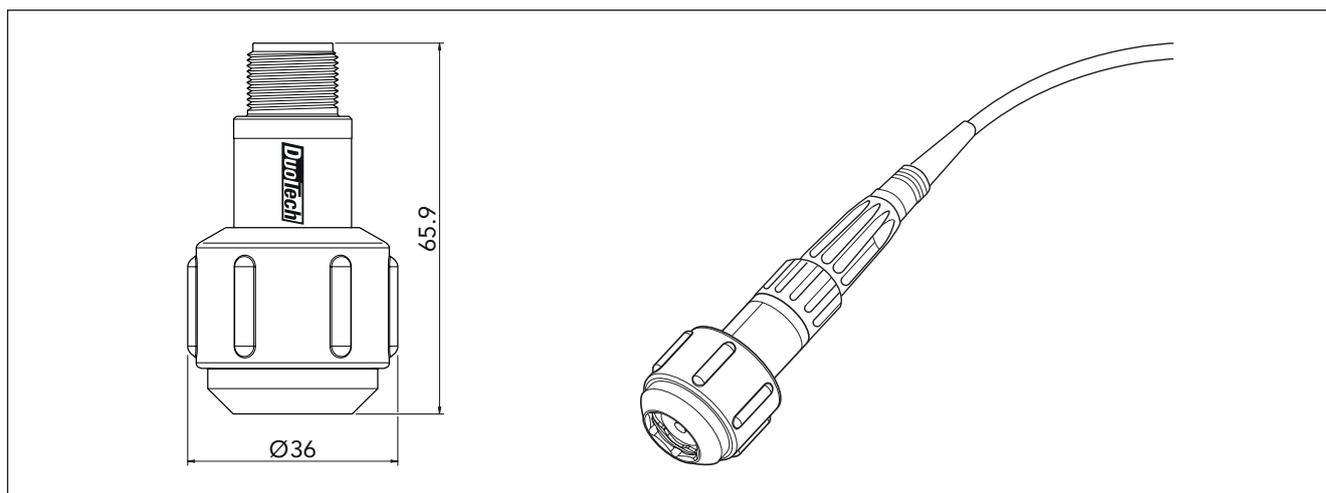


Part numbers

TRC100	DuoTech accelerometer with quick connector for SPM adapters
CAB110	Measuring cable, 8 pin-M12, 1.5 m, straight
CAB93	Measuring cable, 8 pin-2 pin, 1.5m, straight
CAB82	Measuring cable, 8 pin-2 pin, 1.5m, spiral
CAB83	Measuring cable, 8 pin-2 pin, 10m
CAB83-L	Measuring cable, 8 pin-2 pin (L=length in meter)



DuoTech accelerometer with quick connector TRC150



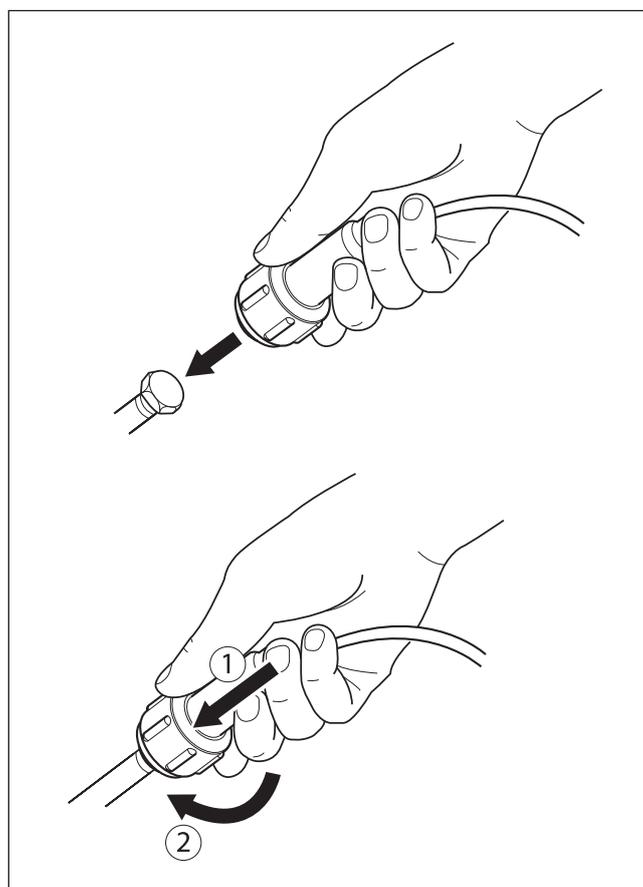
TRC150 is a DuoTech accelerometer with quick connector, used together with the handheld instrument Leonova Diamond and Emerald, for measurements on permanently installed adapters. The quick connector forms a bayonet connection together with the permanently installed adapter. The accelerometer is internally isolated in a Faraday shield providing maximum protection from ground loops and RF interference.

To attach the transducer to an adapter, push the transducer firmly onto the adapter and twist it clockwise. Twist counter clockwise to unfasten the transducer.

Technical specifications

Nom. sensitivity, main axis:	100 mV/g*
Measuring range, vibration:	600 m/s ² = 60 g
Measuring range, shock pulse:	-12 to 75 dB
Transverse sensitivity:	max. 10%
Base strain sensitivity:	0.01 m/s ² /μ strain
Frequency range, vibration:	2Hz to 3 kHz (±3dB)
Settling time:	3 sec.
Bias point:	10 to 13V (typical 12V)
Power supply:	24 V, 4 to 5 mA
Design:	sealed IP66/67
Temperature range:	-40° to +125 °C
Material:	stainless acid proof steel, Sandvik Grade:1802, EN:1.4523
Material, sleeve:	Isothane 3085AU
Sealings:	Viton (fluor rubber)
Connector:	2-pin MIL-C-5015
Cable length:	max. 100m
Weight:	165 g

*Individual value given on the calibration chart.



Part numbers

TRC150	DuoTech accelerometer with quick connector for SPM adapters
CAB93	Measuring cable, Lemo 8 pin-2 pin, 1.5m, straight
CAB82	Measuring cable, Lemo 8 pin-2 pin, 1.5m, spiral
CAB83	Measuring cable, Lemo 8 pin-2 pin, 10m
CAB83-L	Measuring cable, Lemo 8 pin-2 pin (L=length in meter)

