RULA

Data Acquisition System and Spectrum Analyzer **RL-R19**

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Solutions

About RL-R19

RL-R19 is a smart and flexible device designed for the harsh environment. With outstanding battery lifetime and powerful multichannel analog-front-end subsystem, RL-R19 is ready to help you with different kinds of complicated measurements. Our software and hardware team has worked to develop a convenient tool, which enables you to:

- collect data from 1 to 8 sensors per device simultaneously;
- check the key test parameters while acquisition is in progress;
- stack up to 8 devices with IEEE1588-v2-based synchronization subsystem to collect data from 1 to 64 sensors;
- examine the health of your equipment in real time using a powerful vibration diagnostic tool;
- balance rotating parts of different equipment;
- analyze analog signals in real time with FFT-based software instruments;
- generate various types of test signals with the embedded DAC.

Possible Applications

- Data acquisition and analysis in product research and development;
- Acoustic and vibration measurements;
- Analysis and diagnostics of industrial machines;
- Balancing rotating parts of various machines and mechanisms.

Key features

Operation Modes

RL-R19 device can operate in one of the two modes: DAQ system and Signal Analyzer.

In the DAQ system mode the device enables you to:

- collect signals;
- transfer data to PC for subsequent or online processing.

The Signal Analyzer mode allows the user to:

- make measurements, register and analyze data;
- perform various types of spectral analysis;
- perform diagnostics of possible equipment defects (in bearings, gearings, etc.);
- perform dynamic balancing of rotors and rotating parts.

Sensors

RL-R19 works with the following sensor types:

- IEPE;
- TEDS;
- tacho-sensors;
- force sensors;
- laser range finders with voltage outputs;
- other sensors with linear output by voltage.

Inputs and Outputs

- From 4 to 8 analog input channels adjustable to work in different modes;
- 1 analog output channel for the signal generator and repeater modes;
- 1 tachometric input channel for rotation sensors;
- 4 auxiliary logical inputs, which can be used for remote control of RL-R19, e.g. you can turn the recording on and off by sending the corresponding signal to the inputs;
- 4 auxiliary logical outputs, which can be used for remote control of external devices.

Supply

The power supply for RL-R19 devices can come from:

- an embedded accumulator;
- a AC 230 V 50 Hz supply through a power supply adapter;
- a DC 12-36 V.

RL-R19 Complete Set

- RL-R19 device;
- Power supply adapter;
- 32-Gb memory card;
- Ethernet cable for connecting the device to PC;
- User Guide;
- CD with VisAnalyser desktop software (a powerful software package for flexible and accurate signal analysis);
- Set of sensors and cables depending on the specific user requirements.

Figure 1. RL-R19 DAQ system and spectrum analyzer

Technical Features

Inputs and Outputs	
Number of input measuring channels	from 4 to 8
Number of input tacho-channels	1
Number of output channels	1
DC	
DC measurement range, V	from -20 to +20
Relative error of DC voltage, %	± 1
Frequencies	
Frequency range, Hz	0.1 – 60000
Relative error of frequency measurement, %	$5 \cdot 10^{-3}$
Sample rate, Hz	1024 – 144000
Rotation frequency range, RPM	6 – 60000
AC	
RMS voltage range, V	0.001 – 14.5
FRF non-linearity of inputs, %, not more than:	
• in the frequency range from 1 Hz to 40 kHz	2
• in the frequency range from 0.1 Hz to 60 kHz	5
THD range (frequency from 20 to 5000 Hz), %	0,01 – 90
Absolute THD error, %	± (0.1 • THD + 0.03)
Measurement ranges	
Acceleration RMS, g	
• for 10 mV/g sensor sensitivity	0.1 – 1450
• for 500 mV/g sensor sensitivity	0.002 – 29
Velocity, mm/s for 5 mV/mm/s sensor sensitivity	0.2 – 2900
Displacement, μm for 50 mV/μm sensor sensitivity	0.02 – 290
Power supply	
DC, V	12 – 36
AC, V	230 (50 Hz)
Power consumption, VA, not more than	50
Continuous work time from accumulator battery, h	up to 8
Screen	
Screen size	5.7''
Resolution, pixel	640 x 480
Memory	
Embedded memory capacity	is limited by the memory capacity of the memory card
Continuous recording time (on 1 channel, 32 Gb), h:	
• using 5 kHz sample rate	477
• using 144 kHz sample rate	16
Operating conditions	
Ambient temperature, °C	-30 … +60
Relative humidity (at the temperature of 25 °C), %, not more than	80
Atmosphere pressure, kPa	84 – 106.7
Degree of protection	IP65
General information	
Dimensions, (length – width – height), mm, not more than:	
• with the handle raised	292 x 190 x 55
• without the handle	260 x 152 x 55

Available Options

The modular principle of building up RL-R19 software provides an opportunity of forming a set of functional options to meet any specific user requirements. The «Basic Software» package is included in the system by default, other options can be added in various configurations.

- Basic Software: oscilloscope, spectrum analyzer; RMS, frequency, THD measurements;
- Signal recorder;
- Part-octave analysis;
- Statistical analysis: RMS, min, max, mean, etc.;
- Balancing (1 plane, up to 8 points);
- Signal generator: sine, random, recorded signal;
- Repeater (repeating the signal from an input to the output);
- Automatic measurements (user-defined schedule of measurement, report creation);
- Filtration;
- Transient Capture;
- IEEE 1588-v2-based synchronization.

Basic Software

The basic software includes oscilloscope, spectrum analyzer and a set of measuring options.

Input Channels

The input channels can work in the following modes:

- IEPE;
- Single-ended;
- Differential.

For each channels the user can specify measurement units: V, mV, g, m/s^2, mm/s, μm. If the channel is assigned the units of velocity, displacement or acceleration, sensitivities are specified for the sensors connected to this channel.

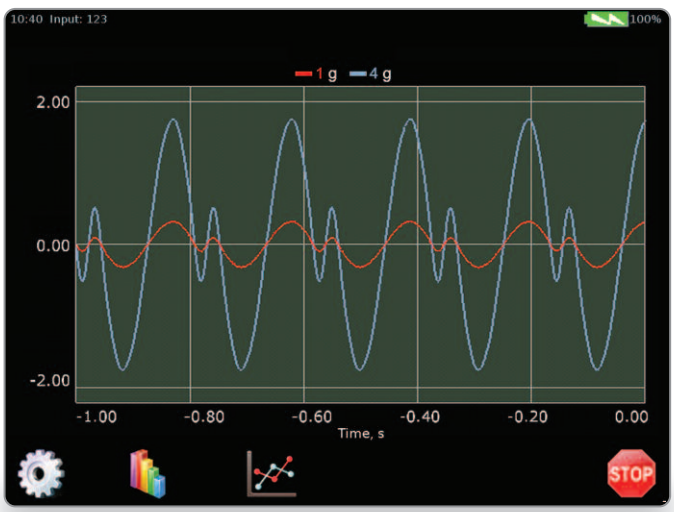

Figure 2. Oscilloscope

Screenshots

It is possible to make a screenshot, save it on the memory card.

Digital oscilloscope

- Number of channels: up to 9 channels (up to 8 basic channels + 1 tacho-channel);
- Scale adjustment;
- Image freeze.

Digital spectrum analyzer

- Number of channels: up to 9 channels (up to 8 basic channels + 1 tacho-channel);
- FFT window length is specified by the user from the range of 1024 – 65536;
- Type of window functions: rectangular, Hamming, Hann, Blackman, Nuttall, Blackman-Harris, Blackman-Nuttall, flat-top;
- Scale adjustment;
- Image freeze.

Types of Digital Measurements

- RMS;
- Frequency of the main harmonica;
- THD;
- Phase *;
- Rotations *;
- Amplitude of the rotation harmonica *;
- RMS of the rotation harmonica *.

* Available if a rotation sensor is connected.

Number of simultaneously measured parameters: up to 4 (for each input channel).

Number of measurement channels: up to 8 channels.

Figure 3. RMS, frequency and THD measurement

Recording

With RL-R19 you can easily record signals from input channels to the embedded SD-card. Simply turn the device on, set up the channels and press the «Recording» button.

Duration

The duration of continuous recording is determined by the number of recording channels, sample rate and the memory card capacity.

Continuous recording time (on one channel, using a 32-Gb memory card):

- at the sample rate of 5 kHz: 477 h;
- at the sample rate of 144 kHz: 16 h.

Viewing the Recording

Any recording file can be viewed using VisAnalyser desktop software, as well as on the RL-R19 device itself (PC is not required).

You can choose to review only the channels relevant to you.

Manual Viewing

- Step-by-step transfer from one fragment of the file to another in any direction.
- Changing the size of the displayed fragment.

Automatic Viewing

- Animated viewing of the recorded data;
- «Start», «Pause», «Stop» functions;
- Adjustable viewing speed.

Recording Analysis

For more detailed recording analysis, you can use our powerful desktop software VisAnalyser. The recording files to be processed in VisAnalyser can be uploaded directly from the memory card, as well as through Ethernet connection.

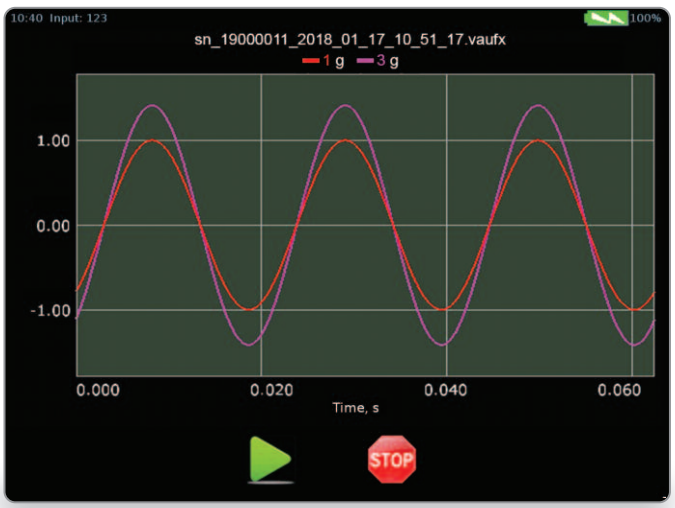

Figure 4. Reviewing the recorded signal

Part-Octave Analysis

Part-octave analysis enables calculating a part-octave spectrogram: 1/1, 1/3, 1/6, 1/12 octave.

Statistical Analysis

Statistical analysis shows the plots of the following signal parameters from time:

- minimum value;
- maximum value;
- average value;
- RMS.

All the values are calculated within the preset time fragment.

Balancing

RL-R19 provides the function of balancing rotors, shafts, blades, propellers and other rotating junctions of machines and mechanisms.

«Balancing Calculator»

RL-R19 has a «balancing calculator» function, in which the vibration value is not measured by RL-R19.

Additional Option

VisAnalyser desktop software also provides:

- balancing based on the influence coefficients;
- drawing polar vibration graphs;
- positioning the «the heavy point» and corrective weights;
- creating a report based on the results of balancing.

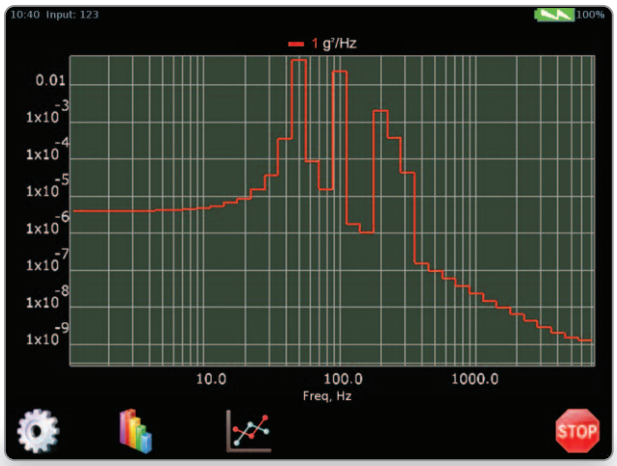

Figure 5. 1/3-octave spectrogram

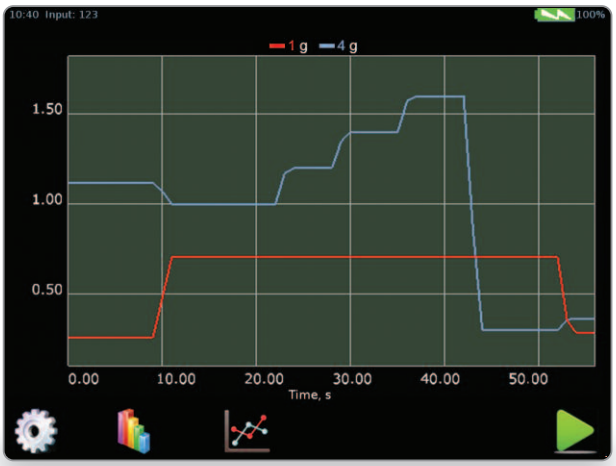

Figure 6. RMS from time

Output Signal Generator

RL-R19 is equipped with an advanced-segment 24-bit DAC, so it is able to generate a signal of complicated shape with the preset parameters.

Work Modes

The generator may operate in one of the three modes:

- Sine – frequency, RMS, THD and the numbers of harmonicas are specified;
- Random – RMS and frequency range are specified;
- User-defined (from the file) – the user is able to choose one of the previously recorded signals and reproduce it on the device.

Limits

- Output voltage level – ±3 V;
- Maximum power – 0.15 VA.

If the recording contains fragments with instant voltage value exceeding the 3 V limit, the signal is scaled on the amplitude.

Repeater

The output channel of RL-R19 can operate as an adaptive repeater of the signal from any of the input channels.

Automated Measurements

Automated measurements are available in the Diagnostics mode. This mode utilizes a powerful, yet comprehensive, command language that can help you automate routine measurements. For instance, it is possible to make a schedule of measurements for your regular vibration diagnostics procedure. All the scheduled commands with their results go into the protocol file, which can be subsequently transformed into the user-pre-defined report in VisAnalyser software.

In this mode the device can also be controlled by logical inputs and generate control logical signals for external devices and indicators.

Filtration

RL-R19 has an option of filtering the signals before processing, which is done with the help of the adjustable IIR and FIR filters.

Transient Capture

Transient Capture option provides the possibility to capture a transient waveform with its parameters (such as duration, amplitude and spectrum) for post-processing with the help of VisAnalyser desktop software.

Synchronization

The user can stack up to 8 RL-R19 devices to obtain a synchronized DAQ system with up to 64 channels. The set is controlled by one of the devices, which is called master.

Stacking the devices provides the synchronization of the signal recording with up to 100 ns accuracy according to the IEEE 1588v2 protocol.

Desktop Software
VisAnalyser

VisAnalyser desktop software is a powerful program complex intended for the detailed analysis of recordings made with RL-R19 or other RULA devices.

VisAnalyser has an expanded graphical subsystem, providing:

- a convenient contextual menu;
- a possibility to represent several graphs in one window;
- autoscale;
- unlimited number of user cursors;
- additional grid lines;
- textual notes.

Integration with RL-R19

The software is able to work with RL-R19 files and create reports, based on the measurement results received from RL-R19.

RL-R19 can be controlled via Ethernet connection to make complicated measurements in a more convenient way.

Data Analysis

The data analysis function provides the following options:

- Reviewing graphs of the recorded signals;
- Creating spectrograms: calculating power spectral density, RMS spectrum or amplitudes;
- Part-octave analysis;
- Statistical analysis: calculating the absolute acceleration value on three axes; calculating RMS, median, minimum and maximum values of the specified signals; integration and double-integration of the signal; calculating absolute value and sigma-clipping level calculation;
- Cross-plot;
- Tacho-analysis: calculating the rotation frequency based on signal frequency received from the tacho-sensor, calculating vibration phase and imbalance vector, plotting the corresponding diagrams;
- Arithmetic operations: a signal can be added to a signal or a constant, multiplied, divided, subtracted or a logarithm can be taken; arithmetic operations are specified using an equation constructor;
- Filtering: VisAnalyser supports FIR and IIR filters. For each filter a type is specified: low-pass, high-pass, band-pass or band-stop, as well as the cutoff frequency (or frequencies), sharpness of the transition edge and other parameters;
- Shock response spectrum calculation of the specified signal;
- Waterfall analysis;
- File Editor: editing the signal by exporting part of it to another file, normalizing the signal to the specified value, filtering the signal;
- Export: signals and measurement results can be exported into textual or binary file format. The obtained file can be viewed in many mathematical packages: for example, Matlab, LabVIEW and other;
- Modal analysis.

Figure 7. VisAnalyser interface

Balancing

VisAnalyser desktop software also provides a powerful balancing wizard, which enables the user to:

- Perform balancing on 1 plane with up to 20 points of vibration measurement;
- Displaying the "heavy point", imbalance point and positions of corrective weights on the polar graphs;
- Making a report based on the results of balancing.

In case there is no recording from the device, the balancing wizard can work as a «balancing calculator». In this mode the vibration data are entered manually.

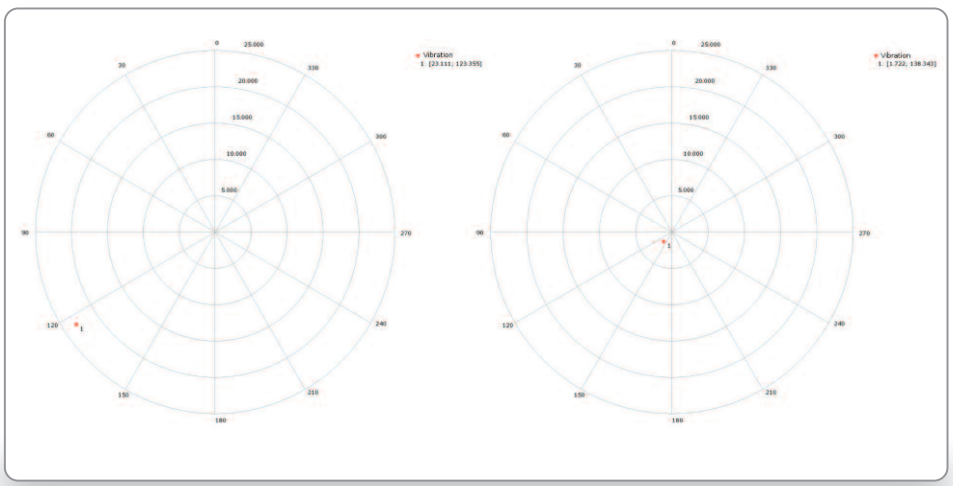

Figure 8. Rotor vibration vector before (left) and after (right) balancing

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