About **RL-C21M**

RL-C21M is a top-of-the-line vibration control system for electrodynamic shakers. A direct successor to RL-C21M, it features improved technical and metrological characteristics and expanded testing capabilities.

The device has multichannel scalable architecture and constructively comes in two modifications — with four or eight input channels in one unit. **RL-C21M** can be scaled up to 64 input and 16 output channels.

Powered by our advanced vibration testing software, RL-C21M supports the widest range of vibration tests and sensor types, including voltage current and temperature sensors.

Potential areas of usage are vibration control and shock testing in various modes, multichannel data acquisition and combined environmental tests. **RL-C21M** system can manage additional test equipment — climate chambers and power amplifiers.

Key Features

— Extended frequency range: DC ÷ 80000 Hz

— Combined vibration and climatic tests

— Power amplifier control

— Control by strain gauge and force sensors

— Scaling up to 64 input and 16 output channels

— Multishaker tests

— Extended voltage measurement range up to 40 V

— Direct current and voltage measurement

— Temperature and thermocouple connection

— Automatic recording and visualization of temperature-related data

— Stand-alone functionality

RL-C21M Controller Parameters

General Features	
Maximum number of measuring channels	1 ÷ 64
Number of output control channels	1 ÷ 16
Frequency range	DC to 80 kHz
Sample rate	Up to 216 kHz
Maximum number of systems stacked	8
Test types	Sine Random Shock SRoR SRS TTH FDR FDS Advanced Sine MIMO Transient Capture Fatigue
Inputs	
Number of channels per unit	1 ÷ 8
Sensor types	IEPE Charge TEDS Displacement Velocity Force and other
ADC resolution	24 bits
Noise floor	< 20 µV
Voltage range	±10 V ± 40V

FRF non-linearity on the frequency of 1 kHz
    In ±10 V range
    In ± 40V range
	
	±0.05 dB
	±0.2 dB

Outputs	
Number of channels per unit	2
DAC resolution	24 bit
Voltage range	±10 V

FRF non-linearity on the frequency of 1 kHz
    In the frequency range from 0.1 to 80 000 Hz
    In the frequency range from 10 to 35 000 Hz
	
	±0.5 dB
	±0.1 dB

Digital Inputs and Outputs	
Number of inputs	8
Number of outputs	8
Maximum input voltage	15 V
Maximum output current	0.1 A
Number of auxiliary input functions	12
Number of auxiliary output functions	7
Other	
Operating temperature range	10 – 40 °C
Power consumption	< 50 VA
Supply voltage	110 – 245 V, 47 – 63 Hz
Weight, kg	2.7
Dimensions (L x W x H)	< 395 x 280 x 55 mm

RL-C21M Configuration

RL-C21M comes in two solutions with a different number of input and output channels to suit the user's needs.

Flexible channel configuration covers the most common vibration testing requirements and provides the ability to build multichannel vibration sets.

Configuration	Input Channels	Output Channels
Vibration Control System	8	2
	4	2

RL-C21M
Vibration Control System

RL-C21M vibration control system provides outstanding accuracy of control, reliability and high safety standard. Vibration control systems produced by RULA Technologies are used with a specialized software package for running vibration tests – TestUP. The software supports all types of vibration tests: Sine, Random, Shock, SRoR, SRS, TTH, FDR, etc. Furthermore, the software enables running and controlling multishaker tests.

Pre-Start Check

The RL-C21M system runs a pre-start check of the vibration system by providing sine vibration with the preset amplitude and frequency.

This mode verifies the operation of the amplifier, controller, shaker and sensors. All the relevant information and graphs, such as spectrum scope and oscilloscope, are available to the user.

Test Duration

Test duration is not limited in the RL-C21M system. Any test can be paused and resumed later by the user's command. All data, including test progress, frequency, test schedule, etc. will be saved.

Demo Version

You can easily download a free demo version of the software from our website. The software demonstrates all the capacities of our system without the actual RL-C21M controller.

Shaker Compatibility

The RL-C21M system works with any electrodynamic, servo-hydraulic and servo-electric shakers.

Scalability

It is possible to stack up to 8 controllers providing up to 64 input channels and 16 output channels.

The construction can be easily installed on the table or mounted in the rack. The modules are connected together with Ethernet cables.

RL-C21M
Main Features

Enhanced technical features:
— Wider frequency range DC to 80 000 Hz
— Extended voltage range up to 40 V
— Up to 64 input channels
— 4-8 inputs in one unit

New measurement capabilities

RL-C21M back panel has designated inputs for DC voltage and current measurements, connectors for K-type thermocouples and PT-100 temperature sensors.

Range of sensor types

The system works with IEPE, TEDS, charge accelerometers, force, velocity, displacement and temperatures sensors.

Power amplifier control

RL-C21M automates vibration testing process allowing you to control the state and gain of the power amplifier from your PC via ModBus TCP protocol.

Combined vibration and climatic test

RL-C21M unique hardware configuration and program capabilities enable running combined vibration and climatic tests via Modbus TCP protocol.

Multishaker tests

The system can control up to 8 shakers and runs a number of multishaker tests in 6 DoF with unmatched accuracy.

Autonomous tests

The system can work stand-alone with a remote control unit. The critical test parameters are displayed on the front panel LCD screen.

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Comprehensive Graphs

The graphic subsystem of TestUP is built around a convenient contextual menu with a number of quality-of-life features: autoscale option, unlimited number of user cursors, additional grid lines, textual notes and ability to display several graphs in one window.

Report Creation

TestUP software automatically produces ready-to-use, detailed reports at the end of a testing procedure. The user can select the information to be included in the report.

Test Schedule

Test schedule is specified in a sequence of commands, e.g.: run the preset number of shocks at level, change the level, run a sine sweep from one frequency to another, hold frequency, etc. There is an option to form a cycle of commands, which is executed repeatedly a number of times.

LCD

The front panel of RL-C21M has an LCD that displays the information about the vibration level and system status. This way the user is able to see all the information relevant to the current test directly on the controller.

Autonomous Mode

The RL-C21M system can run tests without a PC or laptop connected. The tests to be run are uploaded to the flash memory of the controller. User is able to see all the information relevant to the current test directly on the controller.

Safety System

The system has a number of safety checks to protect the shaker and the object under test from being damaged. During the test the controller monitors the shaker limits, maximum drive voltage, sensor connection status and other critical parameters.

Sine Test

Sine tests with fixed or swept frequency provides highly accurate multichannel control in real time. Resonance Search and Tracking option helps to determine FRF peaks of the object under test.

Modes:

- Swept frequency
- Fixed frequency
- Resonance search and tracking dwell

Sweep Rate

The user can specify linear (Hz/s, min/sweep, cycles) or logarithmic (Oct/min, min/sweep, dec/min, cycles) sweep rate for each profile segment.

Resonance Search and Tracking

RL-C21M determines resonance frequencies automatically. After resonance search is done, the system can continue operating on one of the resonances for the preset time or until the user stops the test. Resonance tracking is possible in two modes:

- tracked dwell;
- display of a number of parameters on the graphs.

▶ Figure 1. Sine Test

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Advanced Sine Test

This test type allows using up to independent 8 sine tones simultaneously. Each sine tone has its own individual schedule. Besides, you can divide the frequency range of the profile into segments to have a sine tone run on each of them. Such a procedure helps to considerably decrease test time.

Advanced Sine Test Features

- Number of sine tones to run simultaneously: 1 – 8.
- Sine tone amplitude can be set in the units of acceleration, velocity and displacement.
- Each sine tone is controlled independently to get the best possible accuracy.
- Sweep rate for any profile segment can be calculated automatically or preset by the user.
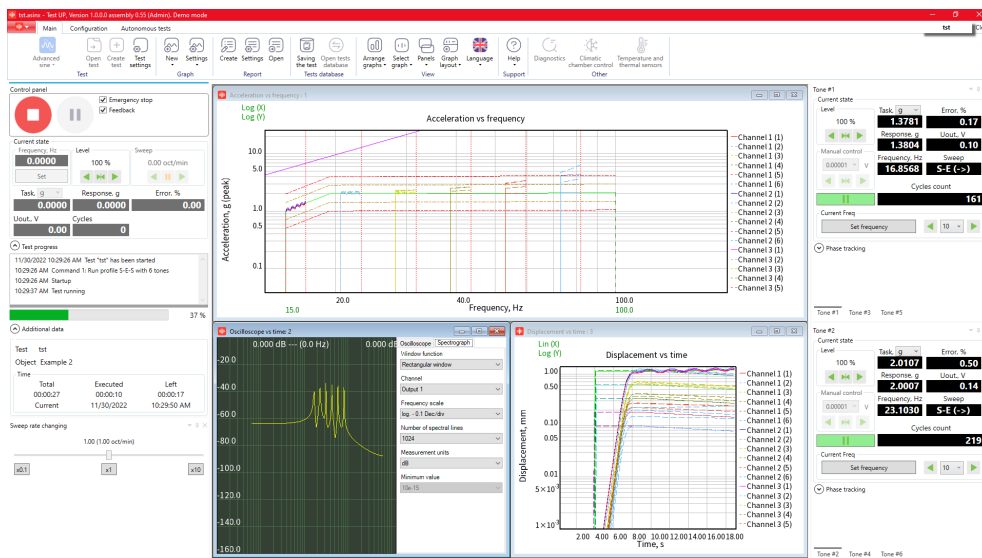
▶ Figure 2. Advanced Sine Test

Random Test

In case of random vibration the object under test is subject to true random signal with specified PSD, and either Gaussian or non-Gaussian amplitude statistics.

Kurtosis

RL-C21M supports tests with non-Gaussian random signals. Kurtosis control allows increasing the probability of peak acceleration values. Specifying the value of Kurtosis approximates the impact on the device under test to the actual operating conditions.

Constant Number of Degrees of Freedom (CDOF)

The option of using constant number of degrees of freedom (CDOF) makes it possible to obtain an averaged value of the power spectral density in just a few seconds.

The efficiency of this method of averaging is much higher than that of conventional methods, so the user can apply it to track resonances, evaluate the noise of the object under test and rigging more accurately.
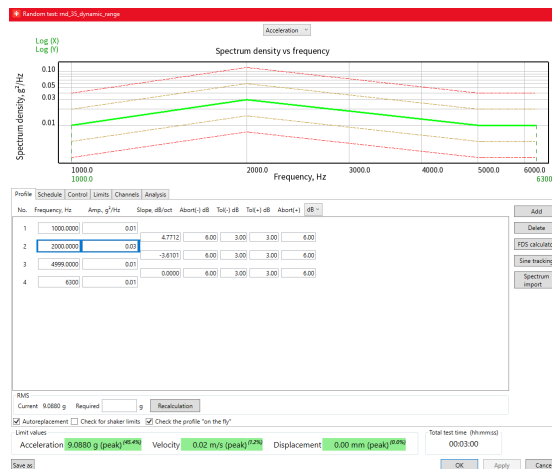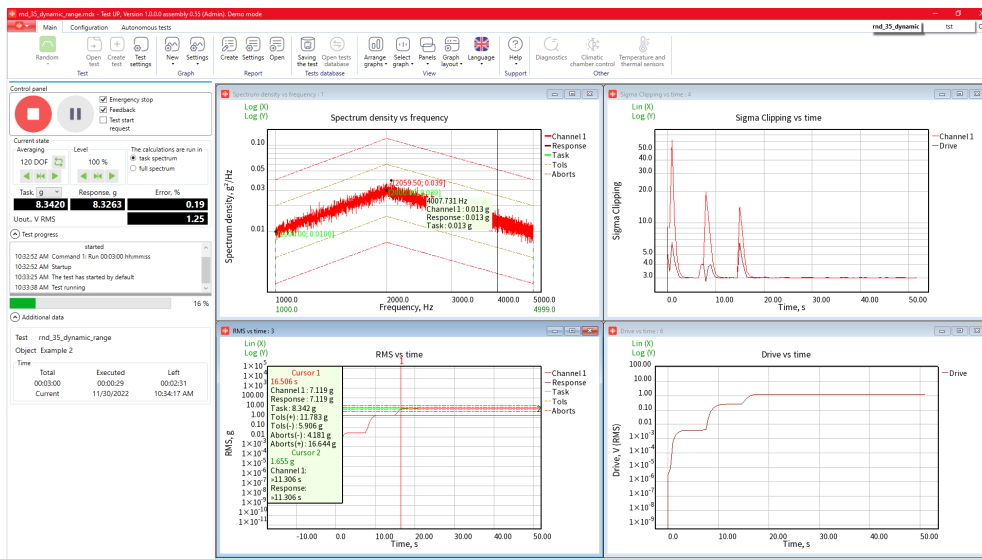
▶ Figure 3. Random Test

SRoR Tests

RL-C21M controller enables running the following types of tests:

- Sine on Random.
- Random on Random.
- Sine and Random on Random.
- Sine on Sine.

SRoR Test Features

- Number of superimposed sine tones: 1 to 12.
- Number of superimposed random bands: 1 to 12.
- For each superimposed sine tone or random band the user can specify sweep rate, start and end frequency and amplitudes.
- Sine tone amplitude can be set in the units of acceleration, velocity and displacement.
- Kurtosis settings.
- Spectrum averaging with Constant Number of Degrees of Freedom (CDOF).
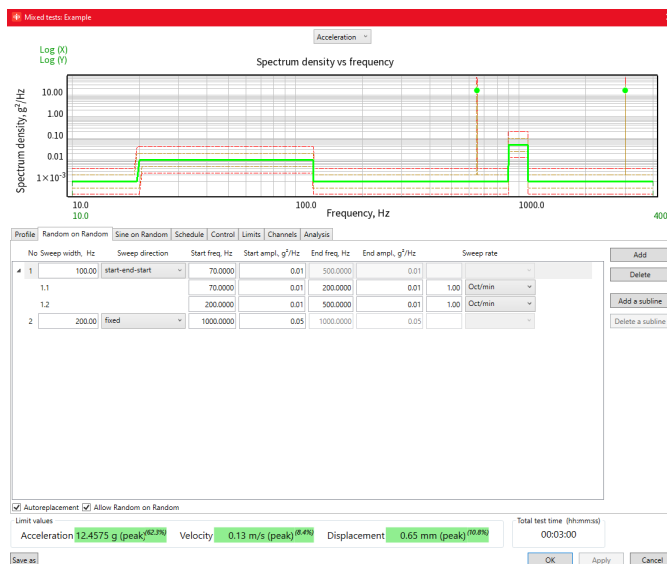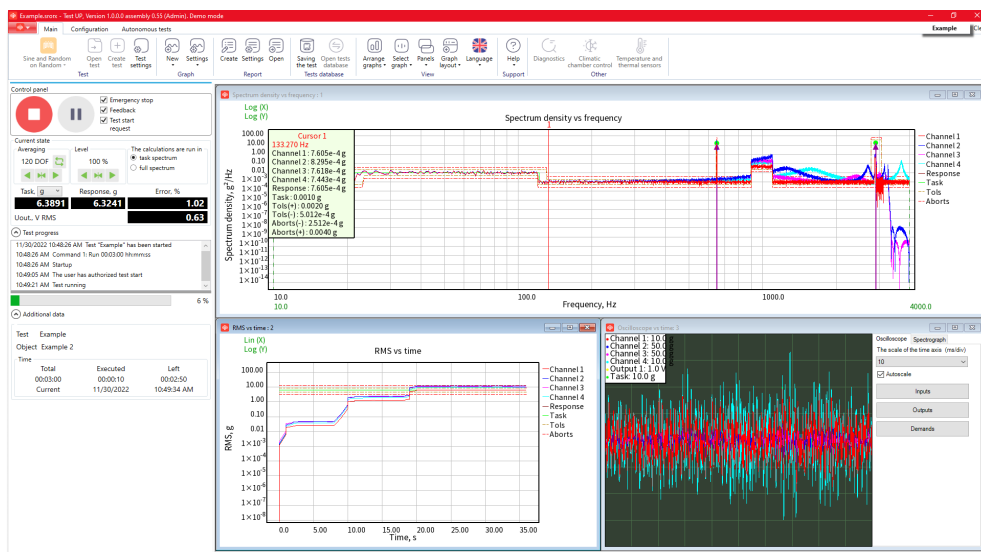
▶ Figure 4. SRoR Tests

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Shock Test

RL-C21M supports all the classical pulse types.

Shock Test Features

• Pulse types: triangle, trapeze, rectangle, initial peak saw-tooth and terminal peak saw-tooth, full sine, half sine, haversine

• Displacement requirements optimization
• Test modes:
— «Automatic» – shocks are run with the preset interval. Interval duration is not limited
— «Manual» – shocks are run by user command
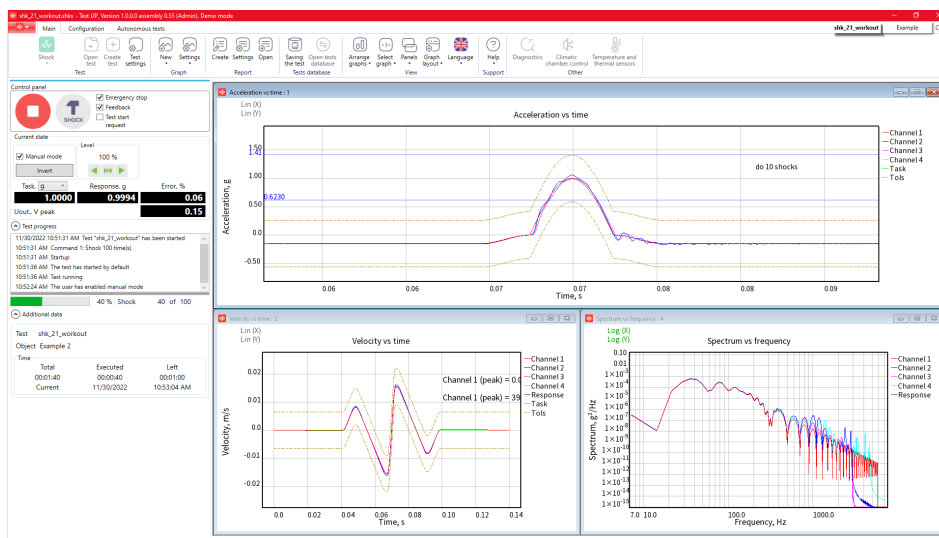
▶ Figure 5 Shocks

Shock Response Spectrum Test (SRS Shock)

SRS test provides the possibility to control SRS of the device under test to match the required one. RL-C21M supports all the classical types of wavelets.

SRS Test Features

• Pulse duration: up to 10 s
• Types of wavelets:
— WAVSYN

— ZERD
— Damped sine wave
— Burst Random
— Linear and Exponential Chirp and etc.
• Frequency range: DC to 80000 Hz.
• Test modes:
— «Automatic» –shocks are run with the preset interval. The interval duration is not limited.
— «Manual» – shocks are run only after the user presses the corresponding button
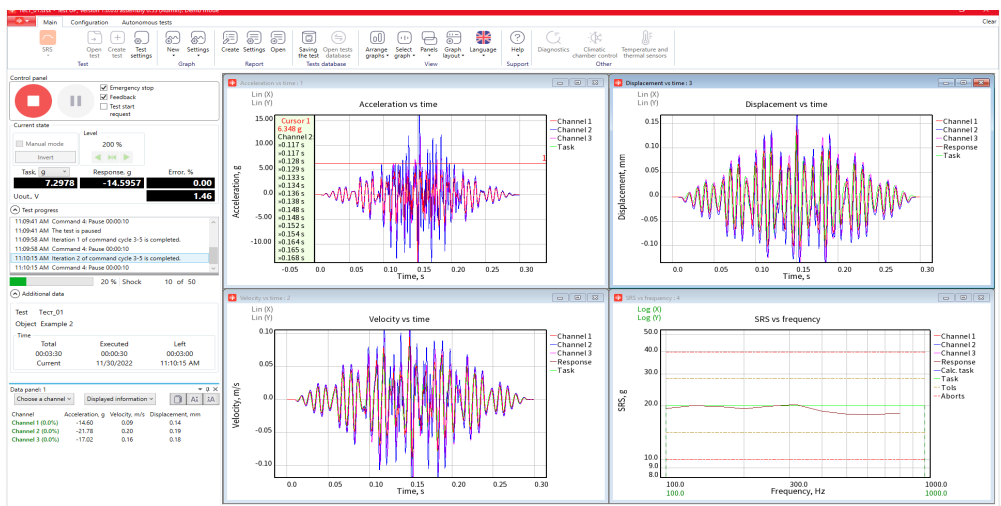
▶ Figure 6. SRS Shock

Transient Time History

Transient Time History (TTH) test provides the possibility to simulate seismic impact.

TTH Test Features

- Maximum pulse duration: 50 s.
- Shock types: enveloped sine, cosine, teardrop, random signal, etc.

- Test modes:
— «Automatic» – shocks are run with the preset interval. The interval duration is not limited
— «Manual» – shocks are run only after the user presses the corresponding button
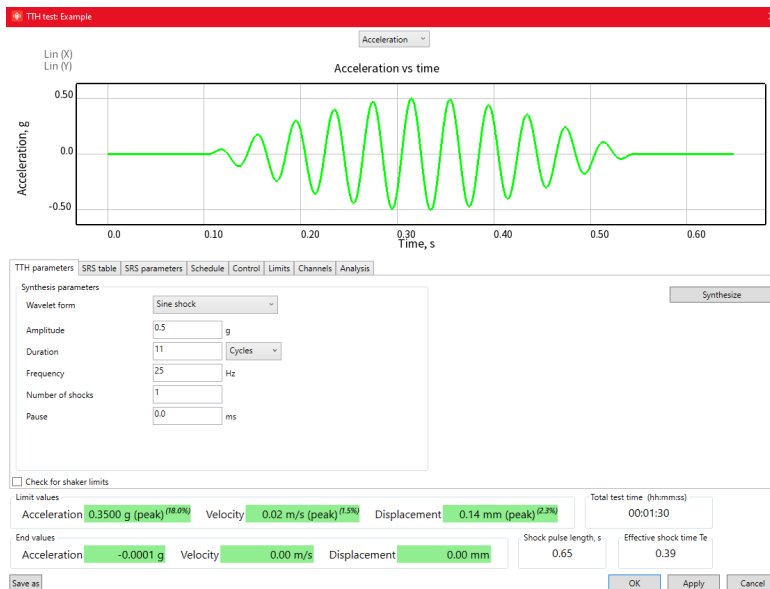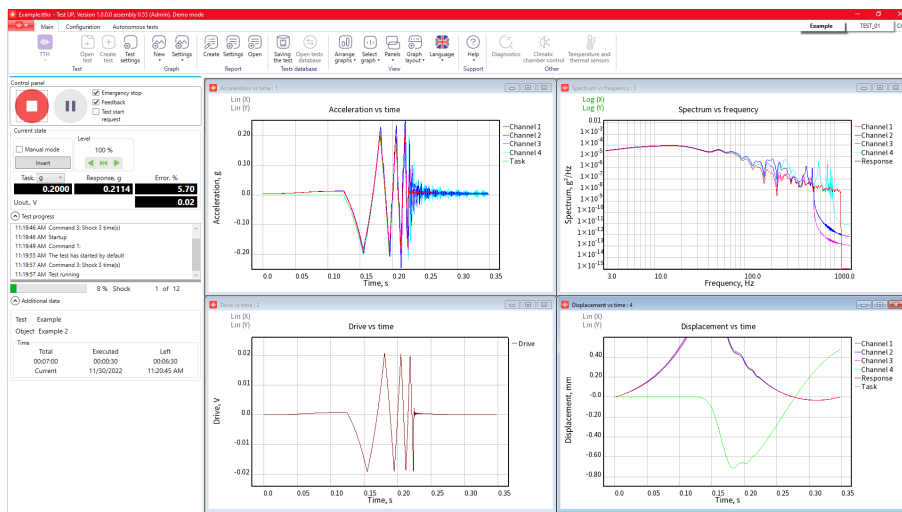
▶ Figure 7. Transient Time History

Data Recording

The data from input channels are recorded into a file of a specialized open format. Sample rate of the recording can be changed, so that to achieve the optimal accuracy-to-file size ratio.

The recorded file may be used in the «Field Data Replication» test or analyzed in any specialized software.

The duration of data recording is only limited by hard drive capacity.

Field Data Replication

Field Data Replication test provides the possibility to reproduce the acquired field data on a shaker in the lab. This test gives the user highly accurate reproduction of the environment, avoiding imitations used in Sine, Random or SRoR tests.

Supported File Formats

RL-C21M supports importing data from sound files of .au, .wav and .uff formats and text files of .txt, .csv and .dat formats. While importing is in progress, the user can aggregate data from several channels into one by means of averaging.

▶ Figure 8. Data Recording
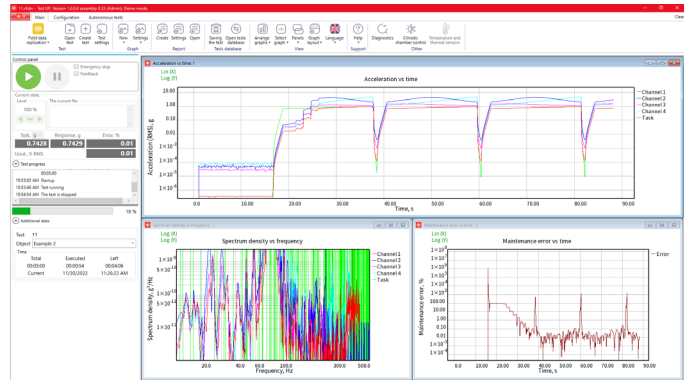
▶ Figure 9. Field Data Replication

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Sequences of Tests

This option provides the possibility to run a sequence of tests by pressing one button.

E.g. if the object under test is to be tested in Sine test first, and then in a series of shocks, all the user needs to do is to join these tests together into a sequence and start it. For example, the system runs Sine test first, then automatically closes it, opens Shock test and starts it.

Running tests in sequences does not differ from running them in the usual mode. All the windows and buttons are the same. The only difference is the sequence control panel located on the right side of the screen.

Test sequences save the user's time, when a series of tests is to be executed.

Multishaker Tests

RL-C21M system can control vibration shakers with up to 6 degrees of freedom. The system identification algorithm is based on computation of transfer-function matrix. This approach allows controlling vibration as well as rotation.

Multishaker Test Mode Features

- Supported test types are Sine, Random, Shock, FDR, SROR.
- Number of control channels: 2 – 8.
- Number of control outputs: 2 – 8.
- Number of measuring channels: 1 – 64.
- Number of shakers: 2 – 8.
- For each shaker in the vibration set the user specifies a control loop which corresponds to an input and output channel. The shaker may be placed along X, Y or Z axis.
- 2-axial and 3-axial phase control
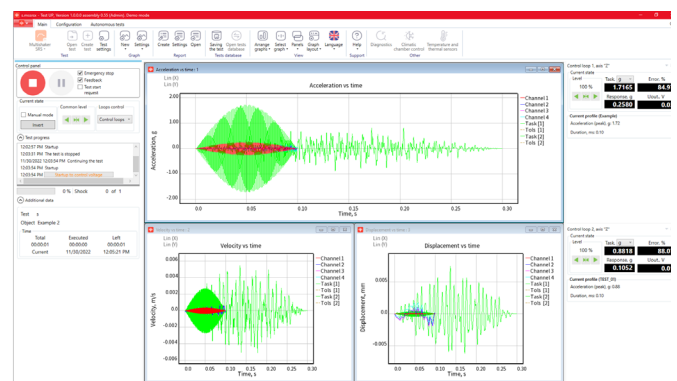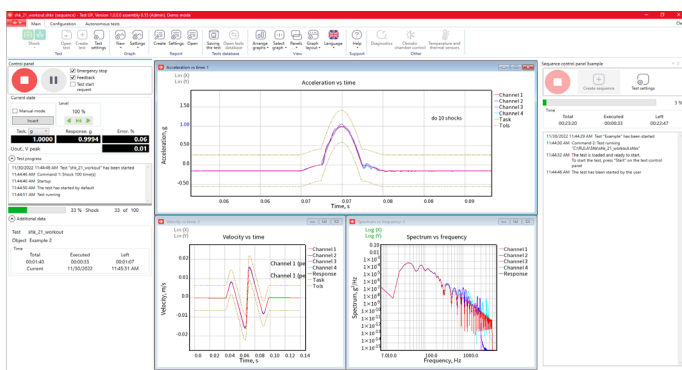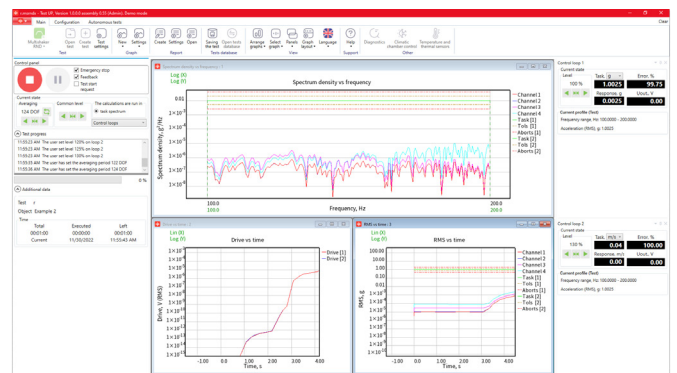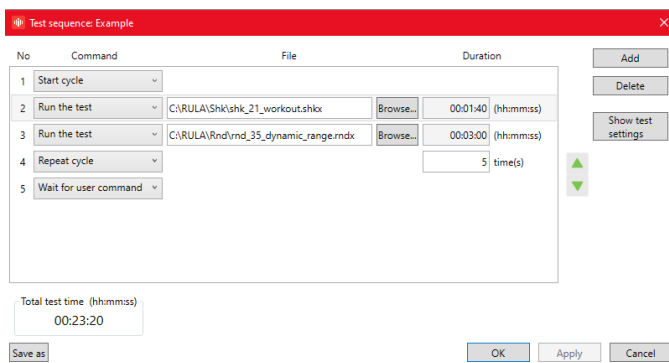
▶ Figure 10. Sequences of Tests


▶ Figure 11. Multishaker Tests

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Transient Capture

Transient Capture option provides the possibility to capture a transient waveform for post-processing.

Transient Capture Features

- Triggers: positive, negative, «by absolute value»
- Digital FIR filters
- Operation modes:
— «Acquisition» – the program is continuously analyzing the data from the sensors and transient processes in them
— «View» – viewing previously captured processes

- TestUP software provides an option to specify the reference pulse form. This form is to be shown on graphs in order to compare it with the detected pulse.
- It is possible to change all the data acquisition parameters while the measurements are in progress.
- For each detected transient process, the system displays a waveform, spectrum and SRS.
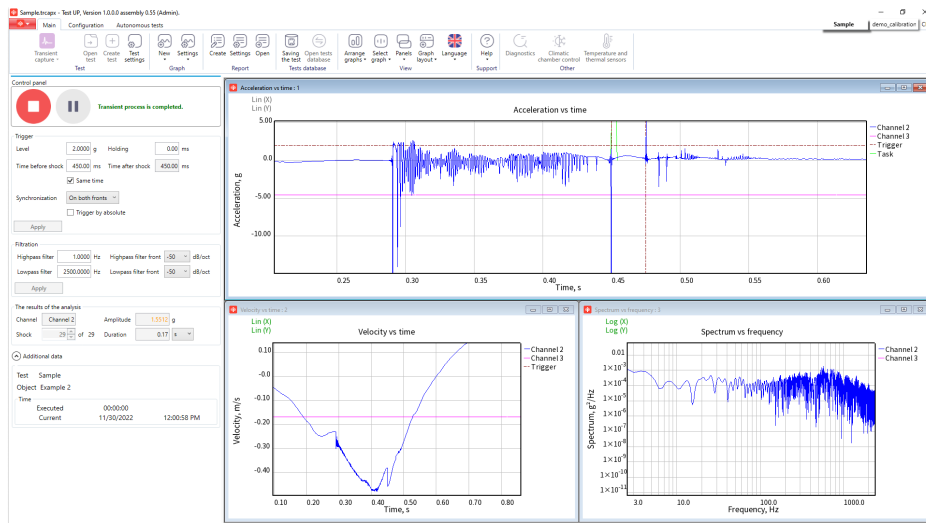
▸ Figure 12. Transient Capture

Fatigue Tests

RL-C21M provides the possibility to run specialized fatigue tests, intended to evaluate durability of turbine and compressor blades.

This mode enables running Sine test, searching for resonances and tracking several frequencies at the same time.

Fatigue Test Features

- Each resonance is controlled independently to get the best possible accuracy
- Working with resonances using laser vibrometers and velocity sensors
- Automated resonance adjustment
- Number of resonance tracked simultaneously: 1 – 8

Resonance Search and Tracking

RL-C21M determines resonance frequencies in the automated mode. After the resonance search is done, the system can continue operating on several resonance frequencies for the preset time, until the user stops the test or until the object under test is destroyed. For each resonance, the system provides independent control by amplitude and frequency.

Control by Displacement and Velocity

It is possible to control a resonance frequency using displacement and velocity sensors, including laser vibrometers.

Expanded Safety System

In addition to the standard safety checks, Fatigue Test checks the shift of resonance frequency.

▶ Figure 13. Fatigue Tests