



# Vibration Controller K2+

## **Common hardware that supports all vibration tests.**

The K2+ controller provides the precision and repeatability required to execute vibration testing with confidence in both the development and production phases. The K2+ offers connectivity to multiple technologies, including charge, TEDS technology and network-connected computers. The K2+ expandable solution adapts to meet real customer need.

The K2+ was developed in-house, giving IMV full design control of both the hardware and software of this important part of a vibration system. The IMV shaker database is included to allow for accurate and secure test operation and test check capacity. IMV is constantly enhancing functions and operability based on the most advanced technologies and incorporating feedback from our customers and market requirements. The features and operability of the K2+ also take advantage of these resources. The K2+ vibration controller is compatible with previous IMV controllers, such as the K2, and K2 vibration controller setup and test information can be used directly with the K2+. IMV engineers are working continuously to make improvements to the IMV controller system and we regularly release new features and software updates.





# Vibration Controller K2+

## ■ Features

### Ethernet interface

The K2+ uses Ethernet, so installation is easy and a laptop can be used for operation. IMV secures your tests' data accuracy, providing a solution that reduces the risks of using long cables. The conditioner is as close to the sensor as possible. You can also easily control K2+ applications from your own software using simple XML commands\*. \*The TCP/IP server option is required.

### User-friendly interface

Easily-recognized icons are used for file management. Built-in "quick help" provides guidance for each operation. Simple interfaces are available for Sine, Random and Shock and allow test setup to be completed on one simple page. Operators can set up a complex profile in one click, and profiles are saved directly to the test program, reducing potential setup error.

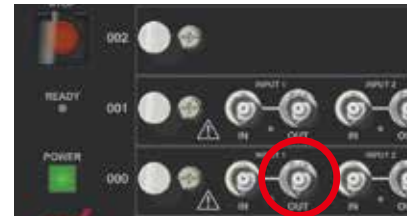


### Built-in analog front end (charge amplifier, etc.)

With the built-in charge amplifier, IEPE (ICP) power supply and TEDS connectivity, there is no need for an external signal conditioner. Any type of accelerometer can be connected to the K2+ vibration controller directly.

### Parallel monitor terminal

The parallel terminals allow easy connection of additional measurement equipment, for example to record time and date or to evaluate test data within dedicated hardware and software for the specimen under test. For sensitive applications such as satellite testing, your time domain can then back up data for post processing.

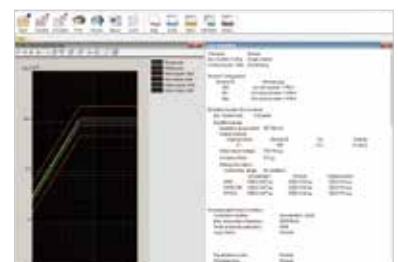


### Wide dynamic range

The high-precision built-in 32 bit ADC and DAC ensure extreme control accuracy over a wide dynamic range (121 dB input and 120 dB output) from very low to very high values in one single measurement range. You won't miss any details.

### Web monitor

The user can monitor vibration tests remotely by connecting over the Internet. Furthermore, a screen capture is automatically generated and can be read from an external browser. No complicated apps are necessary for you to access remote information from your system.



### Digital input and output

Every vibration controller allows 8 digital inputs and 8 digital outputs. You can easily set up different functions for each digital channel and adjust the K2+ to fit the requirements for any test environment. Managing the interface from your test bench won't be an issue. The K2+ controller can share controller status with a climatic chamber to sync vibration and temperature cycles.



## ■ Basic Software

### Sine

Three types of tests are available in K2+/Sine.

#### ◆ Sweep test

The sweep test is the most popular testing method used in sine vibration tests. In this test, the system executes sine vibration control by changing the frequency continuously according to the specified conditions.

#### ◆ Spot test

A spot test is a test in which the specified frequency and the reference level are specified in advance, and the excitation of the specified conditions is performed sequentially.

#### ◆ Manual test

A manual test is a special test run by manual operation only. Control reference conditions can be changed during test operation.

## ■ Specifications

#### ◆ Control Algorithm

Continuous closed-loop control of true rms level

#### ◆ Control Frequency Range

0.1 - 20000 Hz

#### ◆ Control Dynamic Range

More than 120 dB

#### ◆ Operation Modes

- 1) Continuous sweep, Spot, Manual
- 2) Closed-loop, Open-loop

#### ◆ Measurement Method

Average, RMS, Tracking

#### ◆ Multiple-Channel Control Modes

Average control, Maximum control, Minimum control

#### ◆ Input Channels

Maximum 20

\*Specifications may be affected by other conditions.

## ■ Optional Software

#### ◆ R\_DWELL: Resonance Dwell

Resonance is detected by measuring the phase difference between the control point and the response signal from a resonant part of the item under test. The test frequency is controlled in order to maintain resonance as the structure fatigues. After holding at the resonance for a pre-defined duration, sweeping can be resumed until the next resonance is detected.

#### ◆ A\_DWELL: Amplitude Dwell\*

A transmissibility plot is taken from two points on the structure under test and resonances listed. A sine test can then be run at each resonant frequency, with tracking of the resonance by either amplitude or phase.

#### ◆ LIMIT CONTROL

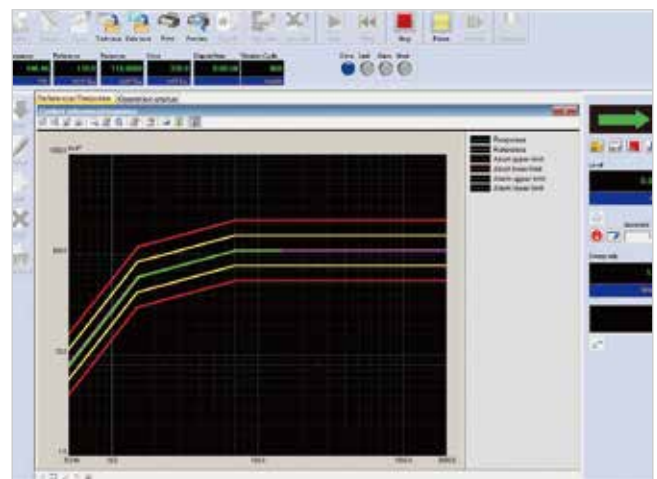
Response channels can be specified as limit control channels. If the level on a limit control channel is likely to exceed its limit, the test level is reduced accordingly.

#### ◆ Multi Sweep Sine\*

A traditional wide-band sine sweep is divided into several narrower-band sine sweeps, which when added together combine to cover the original wide band. Running the narrow band sweeps in parallel significantly reduces the test time required.

\*These features will be released soon.

Please contact your local distributors for more information.





# Vibration Controller K2+

## ■ Basic Software

### Random

Three types of tests are available in K2+/Random.

#### ◆ Random test

A vibration test using random vibration.

## ■ Specifications

#### ◆ Control Algorithm

Closed-loop control of PSD within each spectral line

#### ◆ Control Frequency Range

Maximum 20000 Hz

#### ◆ Number of Control Lines

Maximum 25600 lines

#### ◆ Control Dynamic Range

More than 98 dB

#### ◆ Loop Time

200 ms (fmas=2000 Hz, at L=400 line)

#### ◆ Multiple-Channel Control Modes

Average control, Maximum control, Minimum control

#### ◆ Input Channels

Maximum 20

\*Specifications may be affected by other conditions.

## ■ Optional Software

#### ◆ SOR test

An SOR test is a vibration test composed by adding random vibration to sine vibration simultaneously. It is possible for sine vibration to be swept in this test.

#### ◆ ROR test

An ROR test is a vibration test composed by superimposing a stationary broadband random vibration with a narrow band random vibration that is swept according to given sweep conditions.

#### ◆ EXTENDED ROR

The extended ROR makes it possible to execute an ROR test with greater freedom when defining separate NBR references.

#### ◆ PSD LIMIT: PSD limit control

Response channels can be specified as limit control channels. If the PSD on a limit control channel is likely to exceed its limit, the test level is reduced over that range of frequencies to keep within the limit level.

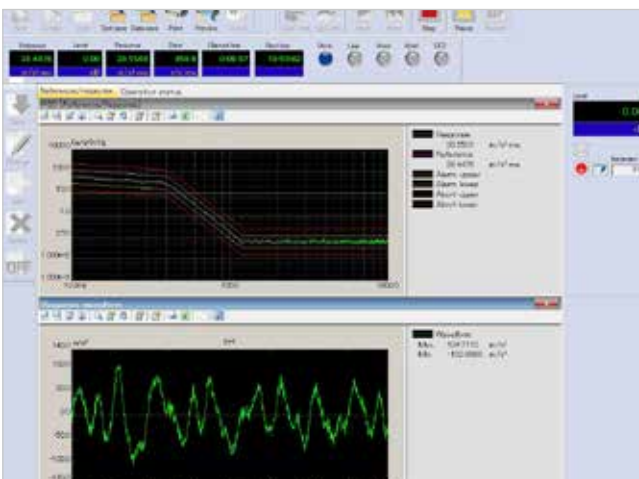
#### ◆ Soft-Clipping

A clipping function that can reduce the peak value of the output voltage without affecting control performance.

#### ◆ Non-Gaussian\*

A vibration testing method which precisely reproduces non-Gaussian vibrations, for example transportation vibrations, with large spikes.

\*This feature will be released soon. Please contact your local distributors for more information.





# Vibration Controller K2+

## ■ Basic Software

### Shock

Two types of tests are available in K2+/Shock.

#### ◆ Shock test

A shock test for replicating the finite arbitrary reference waveform given in a digital format by using it as the control reference value.

Ex) Classical shock waveform, Sine beat, replicating a measured waveform test

- ◆ SRS shock test \*SRS option is necessary Shock test for replicating the excitation of the generated reference waveform data with a given reference SRS. The result is judged by SRS analysis.

## ■ Optional Software

#### ◆ LONG WAVEFORM

The standard length of a reference waveform is 16 K points. This can be increased to 200 K points by adding the LONG WAVEFORM option. At a sampling frequency of 512 Hz for example, this produces approximately 6.5 minutes of waveform, compared to the standard length of approximately 30 seconds.

#### ◆ MEGAPOINT

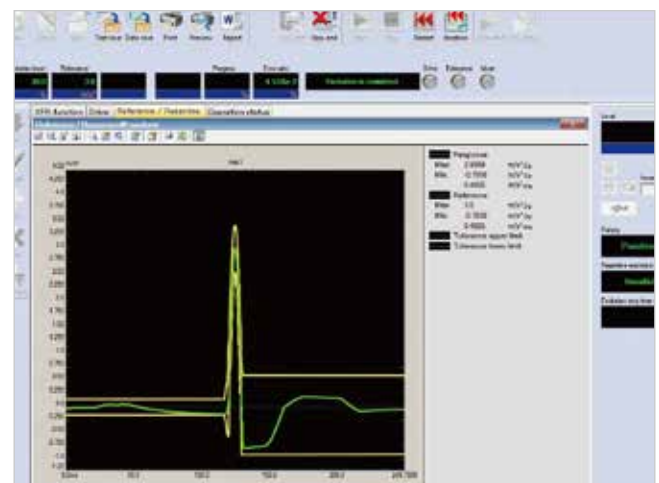
A further increase in waveform duration can be obtained by adding the MEGAPOINT option to the LONG WAVEFORM option. This increases the record length to 5000 K points, about 163 minutes at 512 Hz sampling rate.

- ◆ SRS: Shock Response Spectrum SRS (Shock Response Spectrum) can execute a test in which the test condition and evaluation are conducted not based on the waveform itself, but on SRS analysis. With standard shock test selected, SRS analysis of the response waveform is also possible.

## ■ Specifications

- ◆ Control Algorithm  
Finite-length waveform controlled by feed forward method
- ◆ Control Frequency Range  
Maximum 20000 Hz
- ◆ Number of Control Lines  
Maximum 25600 lines
- ◆ Control Dynamic Range  
More than 98 dB
- ◆ Type of Reference Waveform  
Classical shock waveform (Half-sine, Haversine, Saw-tooth, Triangle, Trapezoid etc.), Sine beat waveform, Measured waveform etc.
- ◆ Input Channels  
Maximum 20

\*Specifications may be affected by other conditions.





# Vibration Controller K2+

## ■ MIMO Software for Multiple Shakers\*

### Multi Sine

Two types of tests are available in K2/Multi Sine.

#### ◆ Sweep test

The sweep test is the most popular testing method used in sine vibration tests. In this test, the system executes sine vibration control by changing the frequency continuously according to the specified conditions.

#### ◆ Spot test

Spot test is a test which the specified frequency and the reference level are specified in advance, and the excitation of the specified conditions is sequentially performed.

## ■ Specifications

#### ◆ Control Algorithm (Three modes of control)

- 1) Amplitude:  
Continuous closed-loop control of true rms level
- 2) Phase:  
Real-time waveform controlled by feed forward method
- 3) Monitoring and minimising of cross-axis component

#### ◆ Control Frequency Range

0.1 - 10000 Hz

#### ◆ Frequency Resolution

Better than  $10^{-4}$  of frequency

#### ◆ Control Dynamic Range

More than 114 dB

#### ◆ Operation Modes

- 1) Continuous sweep, Spot test
- 2) Control and monitoring in various physical units

#### ◆ Estimation Method

Average, RMS, Tracking

#### ◆ Multiple-Channel Control Modes

Average control, Maximum control, Minimum control

#### ◆ Input Channels

Maximum 20

#### ◆ Output Channels

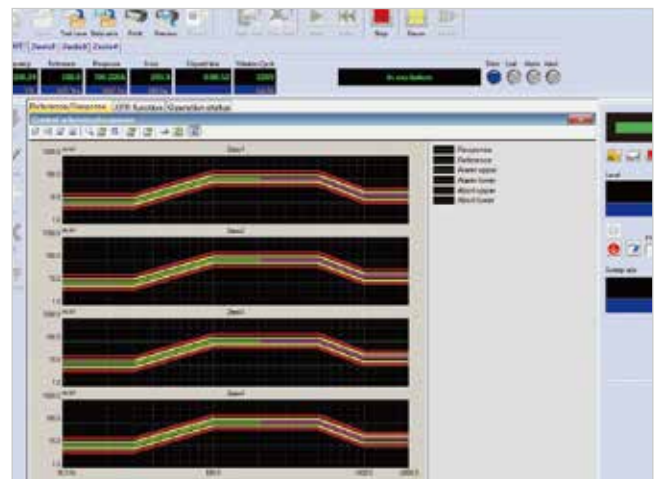
Maximum 12

\* Specifications may be affected by other conditions

## ■ Optional Software

#### ◆ LIMIT CONTROL

If a response point is specified to be a limit control channel, the level of that response point will not exceed the level specified in the test.



\*These features will be released soon.  
Please contact your local distributors for more information.



# Vibration Controller K2+

## ■ MIMO Software for Multiple Shakers\*

### Multi Random

One type of test is available in K2/Multi Random.

#### ◆ Random test

A vibration test using random vibration.

## ■ Specifications

#### ◆ Control Algorithm (Three modes of control)

- 1) PSD of random signal closed loop control by spectrum density for each frequency segment
- 2) Real-time waveform controlled by feed forward method
- 3) Monitoring and minimising of cross-axis component

#### ◆ Control Frequency Range

Maximum 10000 Hz

#### ◆ Number of Control Lines

Maximum 3200 lines

#### ◆ Control Dynamic Range

More than 90 dB

#### ◆ Loop Time

450 ms (3-input, 3-output control, 120 DOF,  $f_{max} = 2000$  Hz,  $L = 200$  line cross-talk information averaging times = 8 times/loop)

#### ◆ Multiple-Channel Control Modes

Average control, Maximum control, Minimum control

#### ◆ Input Channels

Maximum 20

#### ◆ Output Channels

Maximum 12

\* Specifications may be affected by other conditions

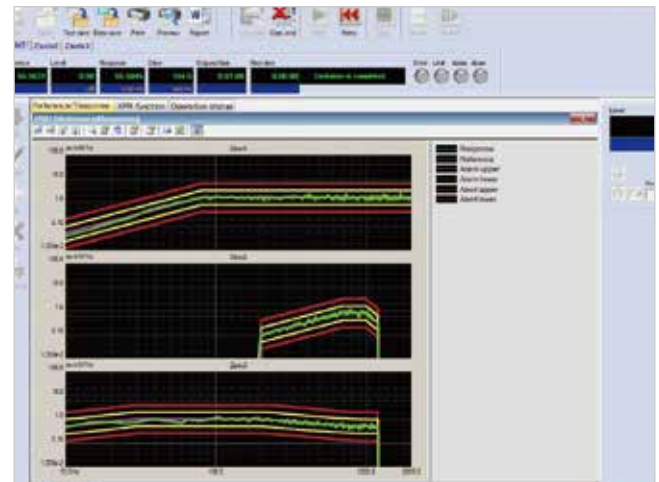
## ■ Optional Software

#### ◆ PSD LIMIT: PSD limit control

Response channels can be specified as limit control channels. If the PSD on a limit control channel is likely to exceed its limit, the test level is reduced over that range of frequencies to keep with the limit level.

#### ◆ Non-Gaussian

A vibration testing method which precisely reproduces non-Gaussian vibrations, for example transportation vibrations, with large spikes.



\*This feature will be released soon.

Please contact your local distributors for more information.



## ■ MIMO Software for Multiple Shakers\*

### BMAC

Three types of tests are available in K2/Shock.

#### ◆ Shock test

A shock test for replicating the finite arbitrary reference waveform given in a digital format by using it as the control reference value.

Ex) Classical shock waveform, Sine beat, replicating measured waveform tests

#### ◆ SRS shock test \*SRS option is necessary

A shock test for replicating the excitation of the generated reference waveform data with a given reference SRS. The result is judged by SRS analysis.

#### ◆ Endurance test

Endurance test by repeating the excitation as stated above.

## ■ Specifications

#### ◆ Control Algorithm

Finite-length waveform controlled by feed forward method

#### ◆ Control Frequency Range

Maximum 20000 Hz

#### ◆ Number of Control Lines

Maximum 25600 lines

#### ◆ Control Dynamic Range

More than 84 dB

#### ◆ Type of Reference Waveform

Classical shock waveform (Half-sine, Haversine, Saw-tooth, Triangle, Trapezoid etc.), Sine beat waveform, Measured waveform etc.

#### ◆ Length of Reference Waveform

Maximum 5000 k points

#### ◆ Input Channels

Maximum 20

#### ◆ Output Channels

Maximum 12

\* Specifications may be affected by other conditions



\*This feature will be released soon.  
Please contact your local distributors for more information.



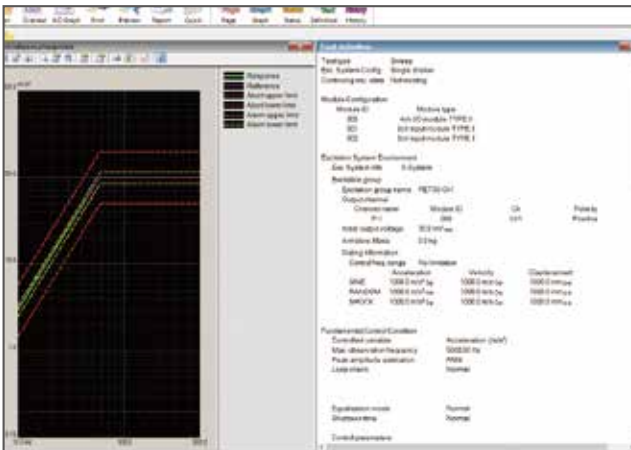


# Vibration Controller K2+

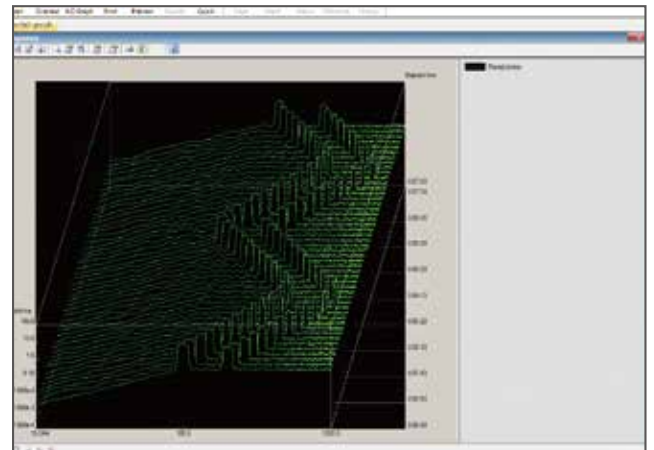
## ■ Free Software for generating reports

## K2+ DataViewer

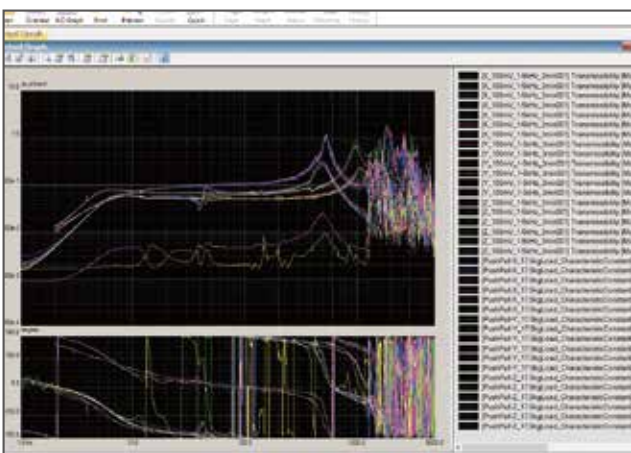
This is the software that displays the data files of test results saved after Sine, Random and Shock tests. It can be used for the display of test conditions and results graphs or for comparison between past test data (overlapping display) or generation of reports.



Test condition, result graph



3D graph



Overlapping display



Report

## ■ System Requirement

### [Supported OS]

Windows 10 (64bit), Windows 7 (32bit/64bit)

### [Memory]

RAM of more than 512 MB is recommended

### [Hard Disk]

Free space of more than 200 MB is required



Application site

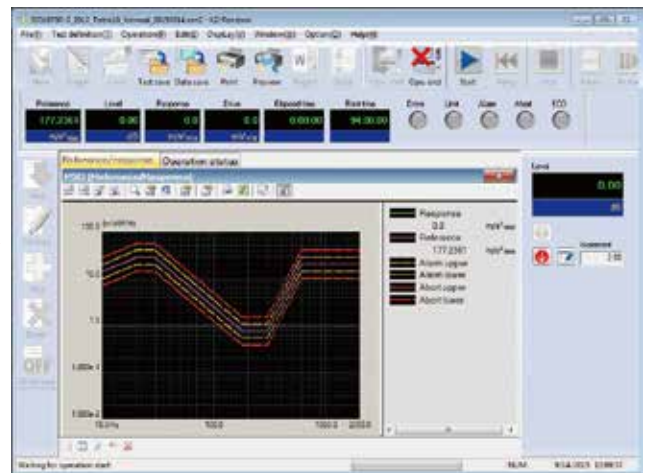
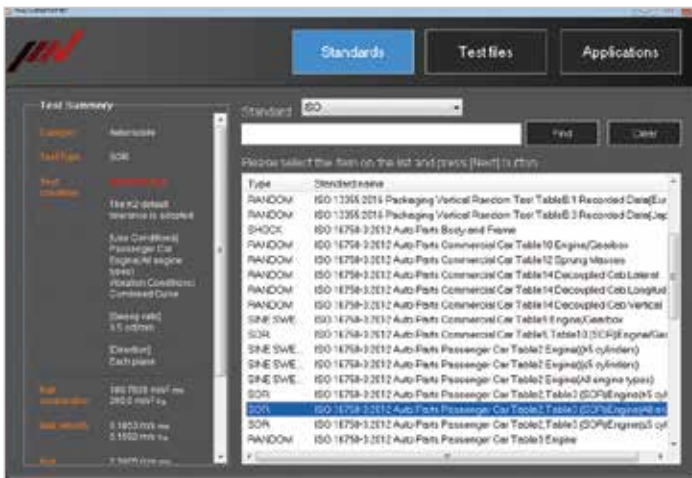


## ■ Optional Software

### Test standards \* Standard for A-series and K-series

Test files are automatically generated upon selection of the test conditions defined by the test standard. Minimizing control error is key for a good vibration control system, which is why we have included major vibration standards in the K2+ Quick Launcher software option. The operator doesn't have to worry about choosing the wrong profile.

\*Please refer to the following for the test standards.



### [Optional Standards]

The main test standards stored in the Launcher software (Ver 14.5.0.0 onwards) are as follows as of July 2020. The Launcher software is an option for K2+.

JIS C 60068	Sine, Random, Shock
JIS D 1601	Automotive parts simulated long-life test
JIS E 4031	Railway vehicle parts functional test, Simulated long-life test
JIS Z 0200	Transportation test
JIS Z 0232	Transportation test (Random)
JASO D 014	Automotive parts functional test
ASTM	Transportation test
UN	Lithium-ion battery test recommended by UN
ISO16750	Automotive parts test
ISO12405	Electric vehicle
IEC60068	Sine, Random, Shock
IEC62660	Random, Shock for secondary lithium-ion cells of electric vehicles
ISTA	Transportation test
IEC61373	Railway vehicle parts functional test
ISO13355	Transportation test (Random)
ISO4180	Transportation test
ISO19453	Electric vehicle parts

\*An additional cost is incurred for version upgrade.

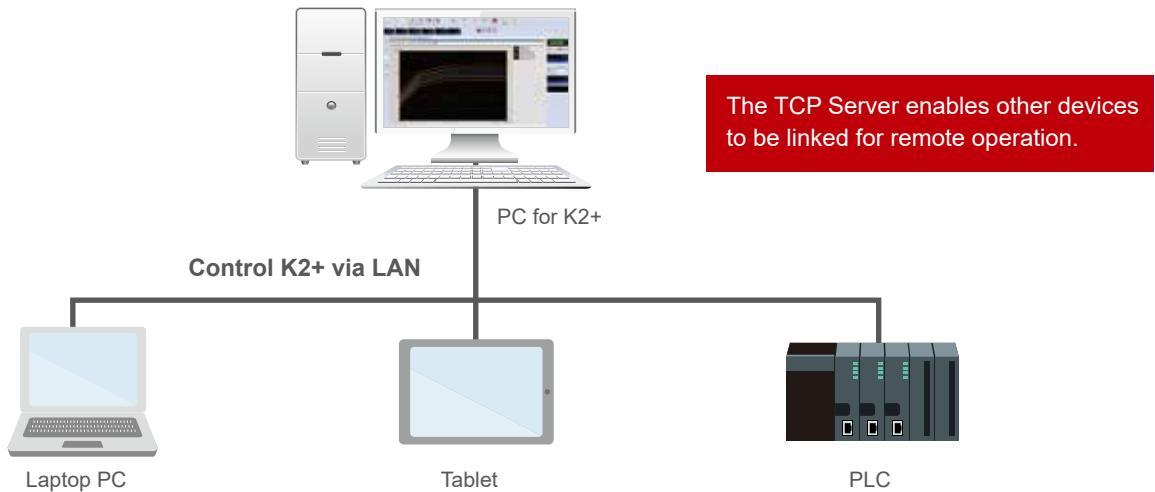


# Vibration Controller K2+

## ■ Optional Software

### • TCP Communication Server

TCP communication server software that allows external applications to operate K2+ applications and acquire vibration data and operating status by sending and receiving commands via TCP/IP.



### • System Monitor

\*Standard for A-series and K-series

The System Monitor is a program that shows a remote display of test status. By using System Monitor, the user has a one-stop service station to monitor information\* on test systems that are run through a PC or tablet. Since test data is displayed on a standard web browser, special software on the PC or tablet PC is not required. Test engineers or technicians will have access to key information from the IMV shaker. They can monitor (in real-time) amplifier output level, acceleration level, main interlock status and of course, if using an ECO-Shaker, real-time power saving information.

\*This software requires an IMV shaker system.



Home screen

### • Combined Test System

This system integrates a vibration test and temperature/humidity test and allows centralized control of a series of scheduled tests.





# Vibration Controller K2+

## ■ Automatic energy savings

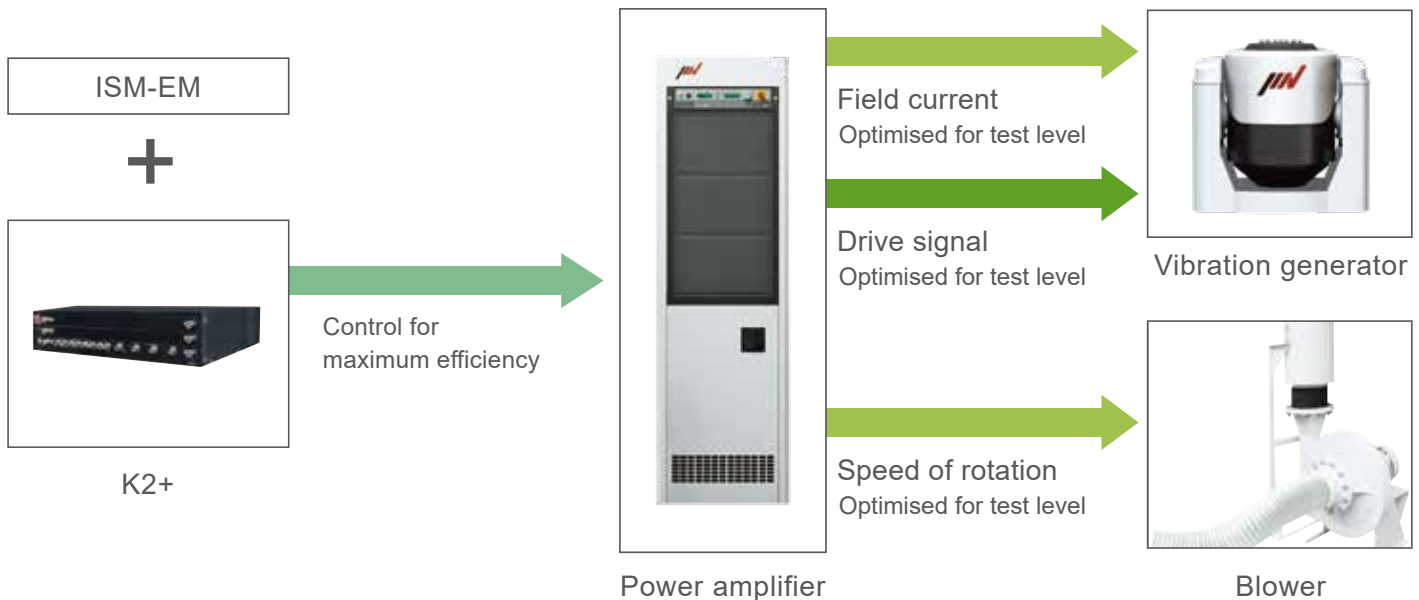
The Integrated Shaker Manager (ISM-EM) technology incorporated within the ECO-shaker system automatically controls the power amplifier output, field level and blower speed to achieve maximum efficiency under all test conditions. By using K2+ in combination with ISM, fully-automatic energy saving is realised. Complicated manual settings are no longer needed. Changes in the operating environment or in test level are accommodated without operator intervention.

### [Features]

- Vibration test levels are set automatically by test definition
- Automatic response to changes in sample under test or test level
- Continuous monitoring of temperatures used to control blower speed

\*Operation condition selection system and method (JP Patent No. 4231095)

\*Operation condition selection system and program (JP Patent No. 4263229)



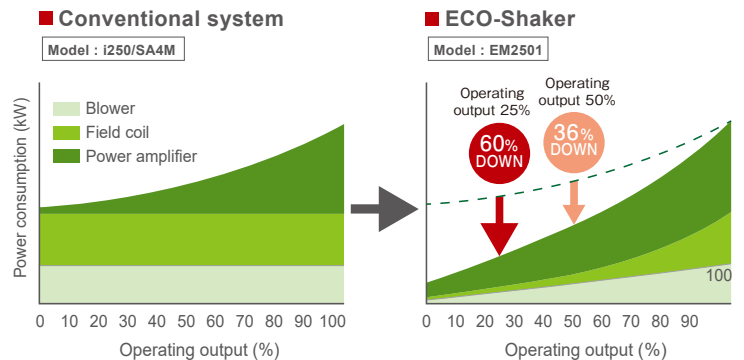
## ■ Effects of energy savings

The lower the system output, the more energy savings can be achieved.

Calculation method	Calculation of CO <sub>2</sub> reduction, referring to actual data from our i250/SA4M (Maximum force 32 kN)
Conditions	1) Random 2) Average operating output: 25% 3) Average operating ratio per year: 70% <small>*Results may vary for systems, test conditions and cases.</small>

Save up to **80%** on your running costs

Reduce your CO<sub>2</sub> emissions by up to **80%**



Comparison of power consumption vs. the conventional system



# Vibration Controller K2+

## ■ Hardware Specifications

Main Enclosure	
Number of Slots	3
AC Power	Single-phase AC, 100 V-240 V (auto-selected)
External Communication	Contact I/O (for emergency stop)
Ambient Conditions	0-40°C, below 85% RH, non-condensing
Dimensions	W430 × H100 × D383 mm (not including projecting parts)
Mass	Approximately 7.0 kg

### Minimum Specifications of PC

- One LAN port Gigabyte ethernet port and Gigabyte ethernet cable
- Microsoft Windows 10 Pro (64 bit) or Windows 10 IoT Enterprise (64 bit)\*
- Memory required (for 8 input channels) 4 GB or more
- DVD-ROM Drive (required for installation)
- One USB port (necessary for protect device)
- Resolution of monitor and PC required 1280 x 1024 or more
- \* Recommended OS and memory vary depending on software, options, number of I/O channels, etc.

\*Please note that optional software "Program K2+" used for vibration controller K2+ also requires Japanese government export license (E/L).

		4-channel Input and 4-channel Output Module (standard)		8-channel Input Module (option)		
Input Section	Number of Channels	4		8		
	Input Connector	BNC				
	Input Signal	Charge, Voltage (Single-ended/Differential), IEPE				
	Charge Amplifier Sensitivity	1.0 mV/pC or 10 mV/pC				
	Charge Amplifier Cut-off	0.32 Hz				
	Maximum Input	Charge Input	±10000 pC or ±1000 pC			
		Voltage Input	±10000 mV			
		IEPE input	±10000 mV			
	Sampling Frequency	102.4 kHz maximum				
	Voltage Input Coupling	AC or DC				
AC Coupling Cut-off	0.1 Hz					
CCLD Amplifier (IEPE)	+24 VDC, 3.5 mA					
TEDS (IEPE)	Version 0.9, Version 1.0					
A/D Converter	Type	ΔΣ				
	Resolution	32 bit				
	Dynamic range	121 dB				
	Digital filter	Pass-band ripple: +0.001, -0.06 dB, Stop-band attenuation: 85 dB				
	Output Section	Number of Channels	4 (One channel is reserved for drive output)			
		Output Connector	BNC			
Output Signal		Voltage				
Maximum Output		±10000 mV				
Sampling Frequency		102.4 kHz maximum				
D/A Converter		Type	ΔΣ			
	Resolution	32 bit				
	Dynamic range	120 dB				
	Digital filter	Pass-band ripple: ±0.005 dB Stop-band attenuation: 100 dB				



4ch



20 ch

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\*The specifications and design are subject to change without notice.

\*\*some of the K2+ options and features need to be purchased separately.

