VIBRATION CONTROLLER
BUYERS GUIDE

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peak

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FIND THE RIGHT VIBRATION CONTROLLER

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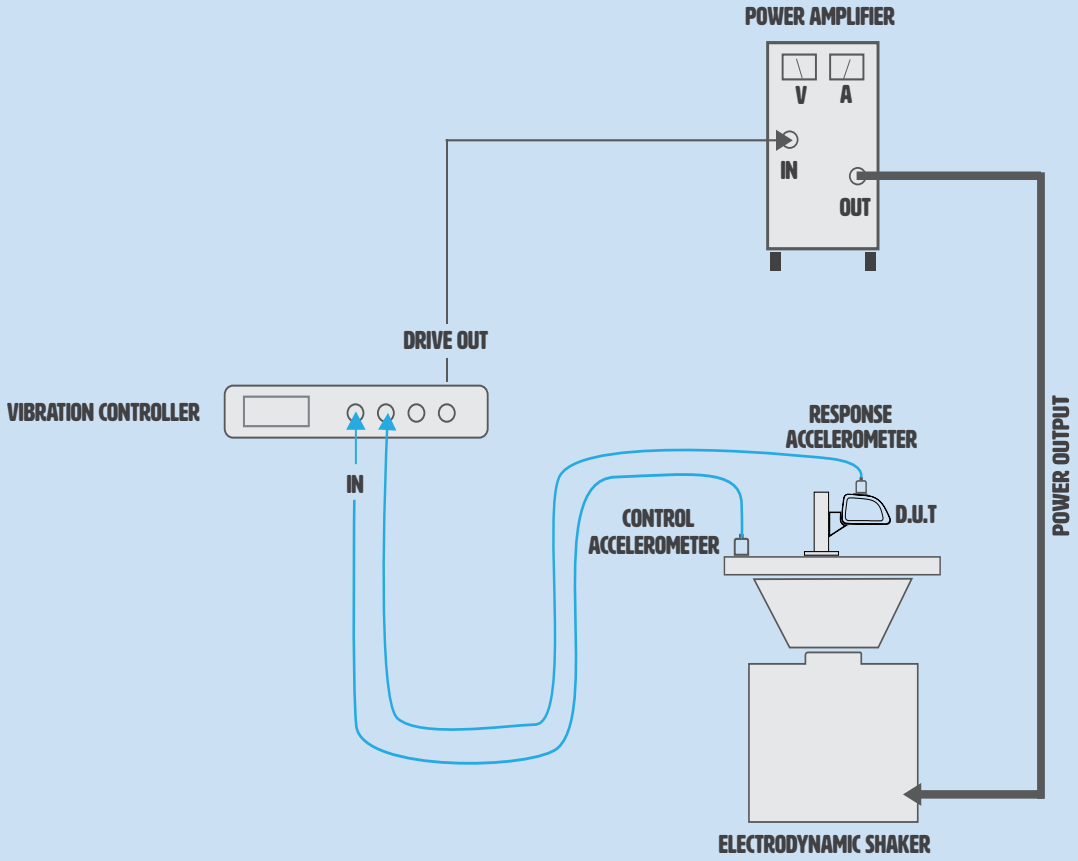
WHAT IS A VIBRATION CONTROLLER?

A **vibration controller** is a device used in the field of vibration testing to generate and control vibrations in a test article or device. The controller is normally used in conjunction with a vibration shaker.

On an **electro-dynamic shaker** system (ED), the vibration controller drive output connects to the power amplifier input. An accelerometer on the ED table (aka head expander) senses the vibration and sends feedback to the controller and is used as the control loop..

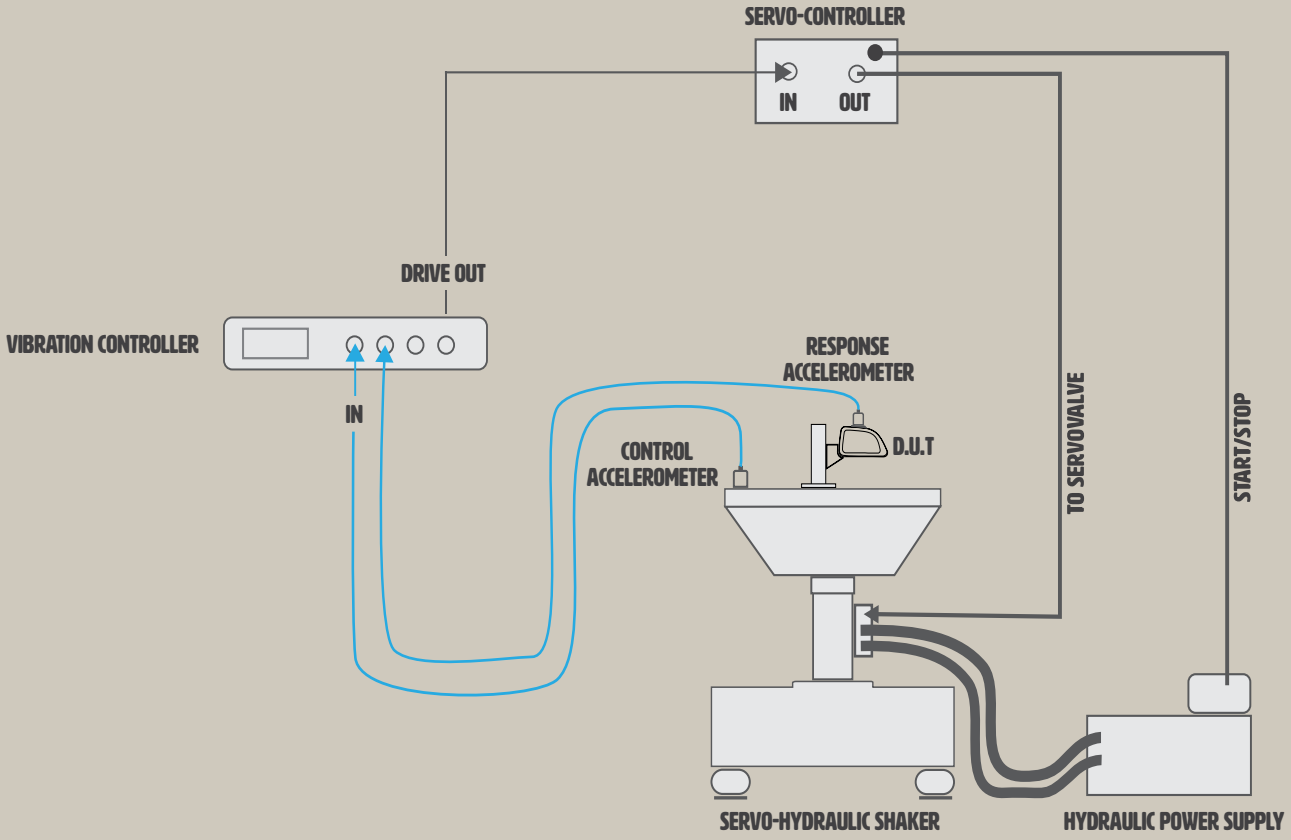
VIBRATION CONTROLLER W/ ED SHAKER



WHAT IS A VIBRATION CONTROLLER?

On an **servo-hydraulic shaker** system the vibration controller drive output connects to the servo-controller input. An accelerometer on the servo-hydraulic table senses the vibration and sends feedback to the controller and is used as the control loop.

VIBRATION CONTROLLER W/ SERVO-HYDRAULIC SHAKER



1 - COMPATIBILITY

WILL IT WORK ON MY SHAKER?

One of the most important factors to consider when selecting a vibration controller for shaker testing is compatibility. Consider these three points.

1. SENSORS (INPUT TYPES)

Sensor inputs for control and response channels - will the controller work with your sensors and will you need additional external conditioning equipment for those sensors or will the controller supply the conditioning (such as IEPE/ICP®, charge type, etc).

2. DRIVE OUTPUT VOLTAGE

The drive output from the vibration controller connects to your shaker's power amplifier input (for electro-dynamic shakers) or servo-controller input (for servo-hydraulic/servo-electric shakers). The drive voltage should be in the range of ±1 to ±10V, the actual output voltage and range will depend on the shaker model and type and test you are performing. Having a wider drive voltage range will give you flexibility to use the vibration controller on a wide variety of shaker models and types.

3. INTEGRATED FUNCTIONS

Will you need the vibration controller to interact with any other device such as a climatic chamber? Or perhaps you would like to consolidate the shaker system start-up controls or monitor the shaker operating conditions (such as air bag level control, exhaust blower, shaker temperature, amplifier volt and current output, safety locks etc) into one control system. In this case consider equipping the vibration controller with a digital i/o interface to manage and control this functionality.

2 - SAFETY FEATURES

WILL IT PROTECT MY SHAKER?

Your shaker system is a big investment and you want to ensure the vibration controller takes all of the appropriate safety measures to protect your shaker from costly damage.

SHAKER LIMITS

The ability to enter shaker limits into the vibration controller is essential. These limits prevent the controller from pushing the shaker beyond its capabilities. If, for any reason the controller detects an over limit condition it should safely shut down the test and provide feedback to the user on what the detected problem is.

PRE-TEST CHECKS

Before any test proifle begins, the vibration controller should be able to predict what the full level shaker conditions will be. This is done by running a low level test for some pre-determined amount of time to allow the shaker system to stabilize and determine if the test can be performed at full level without any issues.

DEDICATED PROCESSING

The ideal vibration controller will process all of the important calculations needed for the test profile control loop and safety checks internally using a dedicated DSP, instead of relying on a computer's processor to do so. In the event of a PC crash or lockup, the vibration controller should detect a communication error and safely shut down the test.

QUICK STOP

In the event the user needs to urgently stop the test in progress, for whatever reason, the vibration controller should have a physical button present for the user to quickly press and stop the test. This quick stop bypasses the controller software which may take longer for the user to initiate a shut down.

3 - INPUT CHANNELS

WHAT ARE INPUT CHANNELS USED FOR?

The two most common types of input channels used with a vibration controller are 'control' and 'response' channels.

CONTROL

The control channel is used for the control loop which is needed to meet the test profile conditions. In cases where a single shaker is used, a single control channel is normally used. If the shaker table (aka head expander) is very large a second control channel might be used to offset table resonances by averaging the two control channel inputs.

RESPONSE

The response channels are used to measure the vibration from your device under test (DUT) during the test. Normally the larger the DUT, the more response channels are used.

TYPES OF SENSORS

Sensors are connected to the controllers input channels to measure vibration. Most vibration tests use an accelerometer for the control channel, but in some cases a different sensor might be used (i.e laser vibrometer). Response channel sensors can differ widely depending on the type of analysis needed. Again an accelerometer is typically used, but other types would include a laser vibrometer, microphone, encoder or strain gauge, to name a few. Ideally the vibration controller would be able to accept any sensor that has a known output per unit of measurement. It is also important to note that there are a variety of accelerometer types that have specific advantages in certain applications. The two most common are IEPE/ICP® and charge type.

SENSOR CONDITIONING

Most sensors require signal conditioning (power supply). Ideally the vibration controller hardware will include built-in signal conditioning for as many sensor types so there is no need for additional, costly hardware.

DIGITAL I/O

In some cases you may want to measure other sensors or interact with with other devices but don't necessarily want use one of the controller's front-end input channels. This can be accomplished using a digital i/o interface that supplies additional channels at a lower sampling rate and not needed for direct vibration measurements.

4 - FREQUENCY RANGE

WHAT IS THE MIN & MAX FREQUENCY OF YOUR TEST?

The frequency range of a vibration controller is the range of frequencies that it can produce. The frequency range you need will depend on the type of testing you will be conducting. If you need to perform to a test standard, the frquency range will be listed in the standard protocol. If you are designing your own test profile, and your DUT will be exposed to high-frequencies in its service environment, you will need a controller that can match those frequencies. Typically, vibration controllers offer frequency ranges between 1 Hz and 35 kHz, although some controllers can produce up to 106 kHz.

SHAKER SYSTEM CONSIDERATIONS

It is important to note that the shaker system itself has a specific frequency range capability and may not match that of the vibration controller. In most cases they don't. Normally the shaker system is the limiting factor to what frequency range test you'll be able to perform. For example, if we compare electro-dynamic (ED) shakers with servo-hydraulic shakers, ED shakers typically have better higher frequency capabilities and servo-hydraulic shakers have better low frequency capabilities. In either case, it will be important to understand the potential limitations of the shaker system when deciding on your next vibration controller and the frequency range capability you need.

USING THE VIBRATION CONTROLLER AS AN ANALYZER

Many companies performing shaker testing also have a need to perform noise and vibration analysis testing. In this case you may want to consider combining both needs into a single system, especially if you don't have a consistent need for either type of testing. In this case you'll want to find a vibration controller that has both the desired analysis capabilities and a wider frequency range capability since noise and vibration analysis usually require higher analysis frequencies.

5 - TEST TYPES

WHAT TYPE OF TEST DO YOU NEED TO PERFORM?

There are a large number of test types that can be performed on a shaker, here are the most common types with a brief explainer.

Sine Sweep Test: This test applies a continuous sine wave vibration to a device or product at increasing or decreasing frequencies to determine the resonance frequency and the ability of your product to withstand vibration at different frequencies.

Sine Resonance Dwell Test: Typically the follow up test to the sine sweep test, the product is held as its resonance frequency(s), looking at the response of the product to harmonic vibration, and measuring the amplitude and phase of the vibration.

Random Vibration Test: This test applies a random vibration with a defined frequency range and amplitudes to simulate real-world conditions and to determine the durability and reliability of the product.

Kurtosis: Kurtosis control is a subset of random vibration testing and is designed to redistribute the acceleration energy in a random test profile so the peaks match more closely to what was recorded in the field. If the recorded waveform had a gaussian distribution, kurtosis control would not be needed.

Fatigue: Another subset of random vibration, fatigue testing is intended to provide a more realistic test profile that can be used to quantify your product's life expectancy and also considers the products material characteristics into generating the test profile and test time.

Superimposed testing: This is where you can combine two test types into a single test profile. This includes sine on random, random on random, sine & random on random, and sine on sine. These test modes are designed to simulate complex vibration environments that your product might see in its service environment.

Classical Shock Test: This test applies a high-intensity shock pulse with a predefined acceleration, duration, and pulse shape to simulate mechanical shocks and impacts that a product may experience during transportation or operation.

Transient Vibration Test: This test applies a short-duration pulse or shock to a product to simulate sudden impacts or events that may occur during operation. The transient test waveform is defined by the user.

Transient Capture: A transient capture test is a type of measurement and analysis technique that is used to capture and analyze transient signals or events in a system.

5 - TEST TYPES CONTINUED

CONTINUED....

Shock Response Spectrum: In this test, a mechanical shock or vibration pulse with the desired frequency content is entered into the vibration controller software and a waveform is synthesized with the corresponding amplitude and duration.

Time History Waveform Playback: In this test a recorded waveform from a data recorder or logger is uploaded and used as the test profile. The vibration controller will playback the waveform exactly as it was recorded. This type of test (also called field data replication) will provide the closest match to what your product is exposed to in the field. Some considerations for using this type of test are: test time and if a single recording provides an accurate representation of all service environments of your product.

Sequence Testing: Although this is not a test profile in itself, the ability for your vibration controller to perform a sequence of different test types automatically provides an efficiency to your testing program.

Test Recording: The ability to independently record a time waveform of any given test will provide additional confidence the test was performed as expected. The recorded test waveform can be exported and analyzed by any external software of your liking.

Shaker Considerations: There a mulitiude of test types available for your product testing. The vibration controller used to perform these tests is only one part of the test system. The other part is the shaker which must have the capabilities to physically perform the desired test. One of the best ways to check if a given shaker can perform a test is by creating that test profile in the vibration controller software. The software will compare the test profile requirements to the shaker limits and calculate if the test can be performed. The shaker limits should include values for force, displacement, velocity, acceleration, and mass size for each of the test types.

6 - SIGNAL PROCESSING

WHY IS SIGNAL PROCESSING IMPORTANT?

The quality of the signal processing offered by a vibration controller is an essential consideration. Good signal processing will ensure the vibration signal is delivered accurately and reliably, which is a must for accurate testing results.

FILTERING

Filtering is a process that removes unwanted noise or frequencies from a signal. There are many types of filters, including low-pass, high-pass, band-pass, and notch filters.

ANALOG-TO-DIGITAL CONVERSION (ADC)

Before an analog signal can be processed by a computer, they must be converted into digital form using an ADC. This process involves sampling the analog signal at regular intervals and assigning a numerical value to each sample.

SAMPLING

Also known as sampling frequency, refers to the number of samples per second taken from an analog signal to convert it into a digital signal. It is expressed in Hertz (Hz), which represents the number of samples taken per second.

BIT DEPTH

In general, a higher bit depth means that each sample can represent a wider range of values, resulting in a more accurate and precise representation of the original analog signal. For example a 16-bit ADC can represent 2^16 (65,536) levels. A 24-bit ADC (Analog-to-Digital Converter) can represent 2^24 (16,777,216) discrete levels.

DYNAMIC RANGE

Dynamic range is a measure of the difference between the highest and lowest levels of a signal that can be accurately represented by a system. It is typically expressed in decibels (dB), and a higher dynamic range indicates that the system is capable of accurately representing a wider range of signal levels.

DIGITAL-TO-ANALOG CONVERSION (DAC)

Once the signal has been processed, it needs to be converted back to analog form using a DAC. This process involves converting the digital signal into a continuous waveform that can be used to drive the shaker system.

7 - USER INTERFACE

EASE OF USE

A well-designed UI can make it easy for users to interact with the system, reducing the learning curve and making it more accessible to a wider range of users.

EFFICIENCY

An efficient UI can reduce the time and effort required for users to perform tasks, allowing them to complete tasks more quickly and effectively.

ACCURACY

A well-designed UI can help users avoid errors and mistakes by providing clear and concise information and guidance.

SATISFACTION

A good UI can create a positive user experience, improving user satisfaction and increasing the likelihood of continued use.

CUSTOMIZATION

A flexible UI can allow users to customize the system to their specific needs and preferences, enhancing the overall usefulness of the system.

VIEWING RESULTS

A good UI can make it easier for users to interact with and interpret the processed signals, providing a more intuitive and user-friendly experience.

SECURITY

A secure UI can help to protect sensitive data and information, reducing the risk of data breaches and other security threats.

INNOVATION

A UI that is designed with innovation in mind can help to facilitate the development of new and creative solutions to problems, leading to more effective and efficient systems.

FEEDBACK

A well-designed UI can provide users with feedback and alerts, helping them to stay informed and aware of important changes or events in the system.

8 - SUPPORT

GOOD SUPPORT, NOT GOOD LUCK

When selecting a vibration controller for shaker testing, you should consider the level of support offered by the manufacturer. A good manufacturer will offer technical support, training, and maintenance services to help you get the most out of your controller. You should choose a manufacturer that offers reliable and responsive support, as well as a good warranty and repair policy.

TECHNICAL SUPPORT

Technical support can involve a range of activities, including troubleshooting, bug fixes, and assistance with installation and operation. This type of support can be provided through a variety of channels, such as phone, email, or web-based support.

TRAINING

Training: Training can help users to better understand how to use the system and its various features, increasing their efficiency and effectiveness. Training can be provided through a variety of formats, such as online tutorials, user manuals, on-site or web-based training sessions.

DOCUMENTATION

Documentation provide users with detailed information about the system and its various features, including how to use them effectively. This can include user manuals, online help files, and other types of documentation.

UPDATES & UPGRADES

Vibration control systems may need to be updated or upgraded over time to address bugs, security vulnerabilities, or to add new features or functionality. Support can include providing users with access to these updates or upgrades, as well as assistance with the installation process. Consider the cost of future software upgrades or software maintenance costs in the overall cost of operation.

CUSTOMIZATION & INTEGRATIONS

Support can also involve providing users with assistance in customizing the system to their specific needs or integrating it with other systems or tools they may be using.

9 - PRICE

SO, HOW MUCH IS THIS GOING TO COST?

While cost is always a factor, it should not be the only consideration. Consider the features and capabilities of the controller, as well as any additional costs such as software licenses, maintenance fees, and support contracts, when determining the overall value of the controller.

FEATURES & FUNCTIONALITY

More advanced and sophisticated signal processing systems will typically be more expensive than simpler systems with fewer features and functionality.

SCALABILITY

Systems that are designed to scale to meet changing needs and requirements may be more expensive than systems that are not as flexible.

PERFORMANCE

High-performance systems that can handle large volumes of data or complex processing tasks may be more expensive than systems with lower performance capabilities.

LICENSING OR SUBSCRIPTION COSTS

Some vibration controller systems may require ongoing licensing or subscription costs to access the software upgrades.

SUPPORT & MAINTENANCE COSTS

Ongoing support and maintenance costs can also impact the overall price of a vibration controller system.

CUSTOMIZATION & INTEGRATION COSTS

Customizing or integrating the system with other tools or systems may require additional costs for development or consulting services.

YOU'RE READY NOW!

We hope you found this buyer's guide helpful and you're ready to find the right vibration controller for your vibration testing. Feel free to share any feedback or questions you might have with us at:

sales@peak-g.com

ABOUT.

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Entrepreneur-in-Residence

A BRIEF HISTORY OF ABOUT PEAK-G.

After 33 years in the test equipment industry, PEAK-G opened its Michigan doors in 2022 to offer high quality test equipment in North America from leading manufacturers around the globe. We know many companies view testing as a “necessary evil”, and for good reason. We want to change that. Our mission is to inspire testing by offering innovative yet budget-friendly test equipment. If our test products can improve the effectiveness of your testing and keep costs down, you will test because you want to, not because you have to.

If you have any questions or feedback please reach out to us anytime. Thank you for your trust and support.

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