

# EDM MIMO Control System Software Specifications

*Includes the following:*

- MIMO Random Control
- MIMO Sine Control
- MIMO Classical Shock
- MIMO Transient Time Control
- MIMO Shock Response Spectrum (SRS)
- MIMO Time Waveform Replication (TWR) Control
- MESA Random Control
- MESA Sine Control



*Designed for Multiple-Input Multiple-Output Vibration Control*

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## EDM Multiple-Input Multiple-Output Control System Software

EDM (Engineering Data Management) is a PC testing environment designed for vibration control and real-time data processing. It contains EDM testing, EDM Machinery and EDM utility installation packages.

The Multiple-Input Multiple-Output (MIMO) Control System is contained in the EDM Testing installation package. It includes MIMO and Multiple Exciter Single Axis (MESA) control. MIMO control types are MIMO Random Control, MESA Random Control, MIMO Sine Control, MESA Sine Control, MESA Sine on Random Control, MIMO Classical Shock, MIMO Transient Time Control, MIMO Shock Response Spectrum (SRS), MIMO Time Waveform Replication (TWR) Control and all typical applications used for environmental testing.

Visual selection of shaker table config is available when a new MIMO VCS test is created. The popular shaker table configurations include the Push-push, push-pull, vertical, as well as the 3-axis shaker table, etc.

### Test Management

Tests are managed through a MSSQL Server database. Signal files, test setup, and UUT (machine) information are stored in the database. Users can search previous tests using keywords, time, or date information. The database can be installed on a local computer or server on LAN.

### Spider Hardware System Management

A Spider system can consist of one or more Spider hardware front-ends. The user constructs the system by combining Spider front-ends detected on the same LAN. The software validates and displays hardware attributes of each Spider front-end.

### User Management and Access Code Control

The administrator can edit access privileges of other users. Each Spider front-end has its own access control password to prevent unauthorized access on the LAN.

### Black Box Mode: Running Without PC

A supported front-end can operate in Black Box mode which allows it to acquire data without a PC. In this mode, a PC is used only to configure the system before the test and then to download the data after the test is complete. During the test, the front-end can be operated according to a preset schedule or from a variety of external devices, such a Wi-Fi enabled PDA or iPad. For hardware with version 7.3 and higher, up to 8 tests can be uploaded and stored on each front-end.

### Measurement Quantities

The user has an option to select a wide range of measurement quantities. Typical measurement quantities

include acceleration, velocity, displacement, force, strain, torque, temperature, voltage, angle, phase, resistance, tacho speed, pressure, voltage, time, frequency, angular velocity, current, sound pressure, and mass.

### Measurement Data Storage

- **Data Format:** compliant with ASAM-ODS hierarchy and structure
- **Signal Data Structure:** all signals are combined and saved in one file per each save command executed

### Export Data File Formats

ASAM-ODS XML, UFF ASCII, UFF Binary, ASCII, Excel, CSV, Matlab, .Wav

### Import Data File Formats

ASAM-ODS XML, UFF ASCII, UFF Binary, ASCII, Excel CSV, SIG format

### Languages

English, Russian, Japanese, simplified and traditional Chinese are available. Languages can be switched without reinstalling software.

### Report

**Formats Available:** Open XML, MS Word (.doc, .docx), PDF

### Digital I/O Interface

Each Spider-80M system has 2 isolated digital inputs and 2 isolated digital outputs corresponding to the pins on the Digital I/O connector, which is used to send and receive low-level electrical signals to and from other devices to coordinate their operation during a test.

- **Configurable Actions for Digital Inputs:** start test, flash screen, beep, create report, save screen, send emails, send Windows message to other program, set digital output signals, start recording, stop recording, save signals in the list, next level, increase level, decrease level, abort test, abort check-off, abort check-on, open control loop, close control loop
- **Configurable Digital Output Events:** user stop, channel overload, output maximum, exceed high abort or alarm line, below low abort or alarm line, RMS high than alarm or abort, RMS lower than alarm or abort
- **Configurable Digital Input and Output:** each isolated pin is configurable to be used as a digital input or output. This flexibility allows users to change the number of digital inputs or outputs according to their application.
- **Output Pulse Types:** High-Low, Low-High and variations

**Test Sequence**

Create a list of tests and run them sequentially. Test sequences can be initiated and controlled by a user command, digital input event, or a Windows socket message.

**Send Emails and IM as Event-Actions**

Users can send emails or instant messages as custom actions in response to a system or user event. Email contents can be customized.

**Remote Operation Communication Using Socket Messages**

Communicate with and control Spider systems remotely with Windows socket messages. Socket messages also allow communication with other hardware, such as temperature chambers. Please refer to the Socket Message document for detailed specifications.

**System Failure Protection**

- **Power Loss Emergency Shutdown:** When a power loss is detected, the system will save all test data into non-volatile flash memory and safely shut down.
- **Ethernet Connection Loss Detection:** When a network loss is detected, the system can be configured to either save all data and ramp down the test or continue running the test in Black Box mode.

**Input Channels**

- **Location ID:** allows the naming of signals by the physical location of the sensor on the UUT
- **Profile:** unique short label + long name selectable from the list for each control channel
- **Level Display:** bar graphs display the input level of each channel. Indicator shows IEPE sensor detection
- **Sensitivity:** user defined engineering unit and input sensitivity setting for each channel
- **Input Types:** AC/DC, differential or single-ended, IEPE, charge coupling
- **Channel Type:** control, monitor and limiting. Up to 8 control channels are enabled on the master front-end. Monitoring and limiting channels are enabled on both master and slave frontends.
- **TEDS:** Read TEDS, Read all TEDS
- **Integration/Differentiation:** when acceleration is selected as the measurement physical quantity, integration or double integration can be applied to obtain velocity or displacement quantity. When velocity is selected as the measurement quantity, integration or differentiation can be applied to obtain displacement or acceleration.
- **High-Pass Filter:** user-defined cutoff frequency

- **Channel Library:** settings are saved to a library and reused in different tests
- **Copy/Paste:** Ctrl+c / Ctrl+v supported in channel table

**Event-Action Rules**

Test events such as alarms and digital inputs will trigger the user-assignable actions.

- **Event Types:** user-stop, channel overload, output maximum, exceed high abort or alarm line, below low abort or alarm line, RMS high than alarm or abort, RMS lower than alarm or abort, any of digital input events
- **Actions:** flash screen, beep, create report, save screen, send emails, send Windows message to other programs, set digital output signals, start recording, stop recording, save signals in the list, next level, increase level, decrease level, abort test, abort check-off, abort check-on, open control loop and close control loop

**Shaker Parameters**

Shaker configuration defines output channels enabled, each assigned with a drive label, and associated with a shaker.

- **Drives:** active, sigma clip, drive limit setting, pretest drive setting (when set pretest drive RMS checked)
- **Max.** Control DOF: Default, 1, 2, ...
- **Condition Number Threshold (%):** user defined from 0
- **Shaker Parameters:** maximum drive voltage, shaker acceleration, velocity, positive/negative displacement, force, min/max drive frequency, armature mass
- **Shaker Library:** settings are saved to a library and used repeatedly in different tests. Shaker parameters are imported from or exported to a Microsoft Excel spreadsheet.
- **Payload Mass:** updated per test in the confirmation page

**Pre-Test**

Pre-test checks the integrity of all signal paths and measures the system FRF matrix.

- **Pre-test Options:** measure FRF, run with FRF saved on the PC
- **Drive Voltage:** user-defined initial drive voltage, max drive voltage with selectable ramp-up rate
- **Noise Floor Measurement:** measures the noise floor and compares with the control signals
- **Checks:** IEPE sensor check, open loop check, safety check

### Manual Controls During Test

- **User Commands:** run, stop, hold, pause, continue, level up, level down, restore level, set level, abort check on/off, schedule clock timer on/off, closed loop control on/off, reset average, next schedule, save signals or record time stream signals
- **User Commands (not in MIMO Sine):** save FRF function, show pre-test results
- **User Commands (only in MIMO Sine):** hold sweep, sweep up, sweep down, release sweep, increase frequency, set frequency

### Review Mode

Review Mode is used to recall multiple saved signals in a user-defined format. When signals are saved to a PC, the parameters (such as level, RMS, elapsed time) of the test are also saved to the same file. The signals, along with the test parameters and run log values, are viewable under Review Mode. Reports including selected runs may be generated in Review Mode.

### Data Recorder Function During Control

Continuously record all input signals while running any controller application on the front-end. The additional purchase of the Spider-NAS attached storage device will allow data recording to a system that hosts one or two SATA hard-disks.

Typical Continuous Recording Time: 4 hours for 4 input channels with a frequency range of 2,000 Hz and with 4 GB flash memory installed. If the Spider-NAS is installed, the typical recording time for 250 GB of disk space is: 4660 hours for 4 channels at 1 kHz/ch; 3 hours for 64 channels at 102.4 kHz/ch; 6 hours for 128 channels at 20.48 kHz/ch.

### Data Transfer Tool

The Data Transfer tool is included in the EDM Utility package. All EDM databases including data files and environmental parameters can be transferred from one computer to another, or from one database server to another, via storage media or network connections.

### Strain Measurement

As an integrated function in VCS mode, strain can be measured with the Spider-80SG hardware. Full, half and quarter bridge configurations are compatible. The advantage of this integrated design is that VCS can be run along with strain measurement simultaneously.

**Shunt Calibration** consists of three convenient steps. 1. Locating the shunt resistor 2. Measure the input 3. Finalize calibration. The software allows the user to switch the location of the shunt resistor between available bridge legs.

**Offset-Nulling** simplifies the bridge-balancing process. It

can be accomplished simultaneously with Shunt Calibration in one step, resulting in a balanced and calibrated strain gage.

**Remote Sensing** enables long-distance measurement. This function allows users to locate the UUT further away from the Spider-80SG and measure strain with the same accuracy.

**Test Parameters:** several test parameters are included in the channel table including strain gage type, excitation voltage, gain factor, Poisson ratio etc. Users can set and configure these parameters as necessary.

### Monitoring Through EDM Cloud (<https://cloud.go-ci.com/>)

All EDM-VCS tests support status checking through EDM Cloud. EDM Cloud allows users to set up any VCS test to upload live data or run logs for completed tests to their secure cloud storage account provided by Crystal Instruments.

The EDM Cloud website is located at <https://cloud.go-ci.com/> and is conveniently accessed from anywhere in the world to check the status of current or past tests. With a secure login to access the cloud, the status can only be checked by authorized personnel with credentials to access the account. The option to create multiple logins to access the same EDM Cloud account is provided.

- **Information Available for Cloud Upload:** live status for currently running tests, run logs for all runs of any test, abort conditions for any run of any test, EDM information, license information, hardware device information
- **Storage Limit:** 20 MB per account (free users)
- **Number of Account Users:** Up to 10 users per account
- **Security:** ability to turn on/off data upload, secured account with password control, ability to control type of data upload

### MIMO Control Module Specifications: MIMO Random Control (VCS-20-Cxx-Sxx)

The MIMO Random Control System provides precise, real-time, multi-channel control and analysis. MIMO Random supports up to 512 input channels and up to 8 output channels (shakers). Besides the control channels, the rest of the input channels can be set up as monitoring and time data recording channels. The recording option records time stream data at the full sample rate on all input channels. A unique hardware design provides a fast loop time of less than 15 ms.

### Control Parameters

- **Frequency Range:** automatically calculated based on profile, or selectable from multiple ranges: up to 4,900

Hz

- **Spectral Resolution:** 200, 400, 800, 1,600
- **Loop Time:** 12.5 ms for 2000 Hz. Loop time is the maximum time rate at which a controller executes complete cycles of sampling, processing data and transmitting control signals. It is the inverse of the so called "real-time control bandwidth".
- **Average Number:** 1 - 500 (2 - 1000 DOFs)
- **Overlap Ratio:** none, 50%, 75%, and 87.5%
- **Control Dynamic Range:** 90 dB
- **Control Accuracy:**  $\pm 1$  dB at 99% confidence with 200 DOF
- **Drive Sigma Clipping:** 3 - 10, or disabled
- **Ramp-up Rate:** Fast (20 dB/s), Slow (2 dB/s), Fastest (60 dB/s)
- **Control Strategy:** Single channel, Weighted average, Maximum, Minimum
- **Advanced Settings:**
  - **Min Energy Control Freq:** check box to enable or disable, with user defined frequency

#### Output Channels

- **Number of Output:** 2 to 8

#### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, high alarm, low abort, low alarm, control spectrum, profiles, noise spectrum, auto-power spectra for all channels, user defined transmissibility, and strip chart plots for the time history of RMS, Peak, and Peak-Peak level of each channel. Limiting signals are optional. Transmissibility signals are in complex format with real/imaginary parts.
- **Display Windows:** composite, signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window and channel status window
- **Status Display on Control Panel:** control level, drive peak, control RMS, target RMS, remaining time, full level elapsed time, total elapsed time, peak-to-peak displacement, peak velocity, cursor readings
- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

#### Safety

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjusted between customizable lower and upper

bounds

- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for the control signal and each input channel. Detection is based on maximum control loss or maximum RMS rate of change in the input channels.
- **RMS Limits:** RMS limits for control signal
- **Control Spectral Limits:** spectral limits for control signal, starts at full level or low level
- **Max Drive Limit:** maximum voltage limit for drive output
- **Shutdown:** user-defined shutdown rate in dB per second

#### Reference Profile and Run Schedule

- **Control Mode:** Magnitude only; Mag and Phase
- **Short Label:** user defined label for control
- **Long Name:** user selectable reference profile
- **Control Channels:** list of control channels associated with the profile
- **Control Null:** the target of the control channel will be minimized
- **Profile Definition:** control profiles are defined by breakpoints and connecting lines, and are edited in a table or graphically by dragging points on a plot
- **Breakpoints:** defined as level or slope
- **Crossover Calculation:** by entering "?" the crossover frequency and amplitude is automatically calculated
- **Alarm and Abort:** limits defined in dB or % relative to reference profile
- **Profile Scaling:** profile is scaled using RMS value.
- **Profile Import:** profile is imported from ASCII and other file types.
- **Profile Library:** settings are saved to a library and used repeatedly in different tests
- **Run Schedule:** schedule includes an unlimited number of test stages and user events

#### Random Profile Import, Editing, and Reduction

Any saved power spectrum data, in various file formats, can be imported, modified, and used as the random profile.

For compatible file formats, refer to the general EDM specifications. The imported spectrum may be modified by reducing the number of break points between two cursors and editing the profile table.

#### Limit Channels

Limiting can be applied to control or monitor channels.



- **Types:** Frequency Domain, Time Domain

### Frequency Domain Limiting

- **Limit Types:** notching limit, abort limit, and alarm limit.

Limiting profiles are edited by the amplitudes and frequencies of breakpoints or are imported from a CSV file. Users can define the notching limit, abort limit, and alarm limit profiles together or separately and display the result with the test profile to show the relationship while editing.

Notching, abort, and alarm limits can change with the test level. The function of “rescale” is a fast way to scale the limit profile.

### Time Domain Limiting

Compares raw data or the RMS value of input channels to the high limit. The occurrence of exceeding the high limit is one of the system events to which desirable actions can be added.

The function of “fill down” and “fill to” provides a convenient method to copy the limiting profile of one channel to other channels in frequency domain limiting and time domain limiting.

### Displacement Optimization for Random

A proprietary algorithm was developed to minimize displacement during Random Vibration Control testing.

Displacement is reduced by 10% to 20% while the target PSD profile can still be reached. (Patent pending.)

### MESA Random Control (VCS-22-Cxx-Sxx)

The MESA Random Control System provides precise, real-time, multi-channel control and analysis. MESA Random supports up to 512 input channels, and up to 8 output channels (shakers). Besides the control channels, the rest input channels can be set up as monitoring and time data recording channels. The recording option records time stream data at the full sample rate on all input channels.

A unique hardware design provides a fast loop time of less than 15 ms.

### Control Parameters

- **Frequency Range:** automatically calculated based on profile, or selectable from multiple ranges: up to 4,900 Hz
- **Spectral Resolution:** 200, 400, 800, 1,600
- **Loop Time:** 12.5 ms for 2000 Hz. Loop time is the maximum time rate at which a controller executes complete cycles of sampling, processing data and transmitting control signals. It is the inverse of the so called “real-time control bandwidth”.

- **Average Number:** 1 - 500 (2 - 1000 DOFs)
- **Overlap Ratio:** none, 50%, 75%, and 87.5%
- **Control Dynamic Range:** 90 dB
- **Control Accuracy:**  $\pm 1$  dB at 99% confidence with 200 DOF
- **Drive Sigma Clipping:** 3 - 10, or disabled
- **Ramp-up Rate:** Fast (20 dB/s), Slow (2 dB/s), Fastest (60 dB/s)
- **Control Strategy:** Single channel, Weighted average, Maximum, Minimum
- **Advanced Settings:**
  - **Min Energy Control Freq:** check box to enable or disable, with user defined frequency

### Output Channels

**Number of Output:** 2 to 8

### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, high alarm, low abort, low alarm, control spectrum, profiles, noise spectrum, auto-power spectra for all channels, user defined transmissibility, and strip chart plots for the time history of RMS, peak, and peak-peak level of each channel. Limiting signals are optional. Transmissibility signals are in complex format with real/imaginary parts.
- **Display Windows:** composite, signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window and channel status window
- **Status Display on Control Panel:** control level, drive peak, control RMS, target RMS, remaining time, full level elapsed time, total elapsed time, peak-to-peak displacement, peak velocity, cursor readings
- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

### Safety

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjusted between customizable lower and upper bounds
- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for the control signal and each input channel. Detection is based on maximum control loss or maximum RMS rate of change in the input channels.

- **RMS Limits:** RMS limits for control signal
- **Control Spectral Limits:** spectral limits for control signal, starts at full level or low level
- **Max Drive Limit:** maximum voltage limit for drive output
- **Shutdown:** user-defined shutdown rate in dB per second

#### Reference Profile and Run Schedule

- **Control Mode:** same mag/phase, different phase, different mag/phase
- **Short Label:** user defined label for control
- **Long Name:** user selectable reference profile
- **Control Channels:** list of control channels associated with the profile
- **Profile Definition:** control profiles are defined by breakpoints and connecting lines, and are edited in a table or graphically by dragging points on a plot
- **Breakpoints:** defined as level or slope
- **Crossover Calculation:** entering “?” automatically calculates the crossover frequency and amplitude
- **Alarm and Abort:** limits defined in dB or % relative to reference profile
- **Profile Scaling:** profile is scaled using RMS value.
- **Profile Import:** profile is imported from ASCII and other file types
- **Profile Library:** settings are saved to a library and used repeatedly in different tests
- **Run Schedule:** schedule includes an unlimited number of test stages and user events

#### Random Profile Import, Editing, and Reduction

Any saved power spectrum data in various file formats can be imported, modified, and used as the random profile.

For compatible file formats, refer to the general EDM specifications. The imported spectrum may be modified by reducing the number of break points between two cursors and editing the profile table.

#### Limit Channels

Limiting can be applied to control or monitor channels.

**Types:** Frequency Domain, Time Domain

#### **Frequency Domain Limiting**

**Limit Types:** notching limit, abort limit, and alarm limit.

Limiting profiles are edited by the amplitudes and frequencies of breakpoints or are imported from a CSV file.

Users can define the notching limit, abort limit, and alarm limit profiles together or separately and display the result with the test profile to show the relationship while editing.

Notching, abort, and alarm limits can change with the test level. The function of “rescale” is a fast way to scale the limit profile.

#### **Time Domain Limiting**

Compares raw data or the RMS value of input channels to the high limit. The occurrence of exceeding the high limit is one of the system events to which desirable actions can be added.

The function of “fill down” and “fill to” provides a convenient method to copy the limiting profile of one channel to other channels in frequency domain limiting and time domain limiting.

#### MESA Sine on Random Control (VCS-28-Cxx-Sxx)

- **Sweeping Mode:** free sweeping mode where each sine tone has its own schedule and sweeping speed, and harmonic mode where the first tone controls the sweeping speed
- **Number of Sine Tones:** 1 - 32
- **Operation Controls:** Tone On/Off controlled by a run schedule, external events, or user commands
- **Dedicated Signals:** profile of each tone, peak of each tone, envelope of all tone sweep
- **Broadband and Tone Display:** test profile page and display window supporting second spectrum type
- **Sweeping Duration Estimation:** sweep rate, number of sweeps, sweep time
- **Sweeping Type:** log, linear, fixed frequency
- **Variable Sweep Rate:** customizable frequency of the sine tone at different time

#### MIMO Sine Control (VCS-40-Cxx-Sxx)

The MIMO Sine Control System provides precise, real-time, multi-channel control and analysis. MIMO Sine supports up to 512 input channels, and up to 8 output channels (shakers). Input channels can be enabled for control, monitoring, and time data recording channels. The recording option records time stream data at the full sample rate on all input channels, regardless of the total channel number. A unique hardware design provides a fast loop time of less than 10 ms.

#### Control Parameters

- **Frequency Range:** automatically calculated based on profile, or selectable from multiple ranges: 0.1 Hz to 4,900 Hz (High Frequency option available)
- **Sweeping Speed:** Log (Oct/Min): 0.001 to 6000; Log



(Dec/Min): 0.001 to 2000; Linear (Hz/Sec): 0.001 to 6000

- **Sweep Rate Increment:** Log (Oct/Min): 0.001 to 6; Log (Dec/Min): 0.001 to 2; Linear (Hz/Sec): 0.001 to 6
- **Sweep Speed Control:** Oct/Min, Hz/Sec, Dec/Min, Sweeps/Min, Sweep Time/Sweep, Cycles/Min
- **Level Change:** customizable in both logarithmic and linear rate
- **Compression Rate:** Fast (60 dB/S), Slow (20 dB/S), and Customized (from 0.01 dB/S and up, pre-defined table available)
- **Ramp Rate:** Fast, Slow, Customized, Fastest
- **Spectrum Display Resolution:** 256 to 4,096
- **Loop Time:** 10 ms typical (Loop time is the maximum rate at which a controller executes complete cycles of sampling, processing data, and transmitting control signals.)
- **Control Dynamic Range:** 100 dB typical
- **Measurement Strategy:** Filter, RMS, Mean, Peak (multiple strategies allowed to each channel signal)
- **Tracking Filters:**
  - Proportional: 7% – 100%
  - Fixed (Hz): 1 – 500 Hz
- **Control Accuracy:**  $\pm 1$  dB through resonance with Q of 50 at 1 Oct/min
- **Frequency Resolution:** as fine as 0.000001 Hz

#### Output Channels

**Number of Output:** 2 to 8

#### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, high alarm, low abort, low alarm, control spectrum, profile, noise spectrum, spectra for all channels, independent sweep up and sweep down spectra for all channels, user defined transmissibility, and strip chart plots for RMS time history, peak and peak-peak level of each channel. Limiting signals are optional. Transmissibility signals are in complex format with real/imaginary parts.
- **Block Signals:** block time signals are used to display the time waveform or history of acceleration peak, velocity peak or displacement peak-peak
- **Display Windows:** composite, signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window, channel status window
- **Status Display on Control Panel:** control level, drive peak, control RMS, target RMS, remaining time, full level elapsed time, total elapsed time, peak-to-peak displacement, peak velocity, cursor readings

- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

#### Safety

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjusted between customizable lower and upper bounds
- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for the control signal and each input channel. Detection is based on the pre-defined lowest allowed control level or maximum level change rate.
- **Control Spectral Limits:** spectral limits for control signal
- **Max Drive Limit:** maximum voltage limit for drive output

#### Reference Profile

- **Control Mode:** magnitude, phase
- **Short Label:** user defined label for control
- **Long Name:** user selectable reference profile
- **Control Channels:** list of control channels associated with the profile
- **Profile Definition:** control profiles are defined by breakpoints and connecting lines and are edited in a table or graphically by dragging points on a plot.
- **Breakpoints:** defined as level
- **Crossover Calculation:** entering “?” automatically calculates the crossover frequency and amplitude
- **Alarm and Abort:** limits defined in dB or % relative to reference profile
- **Profile Maximum:** calculation of maximum expected acceleration, velocity and displacement, checked against shaker limits
- **Profile Library:** settings are saved to a library and reused in different tests

#### Run Schedule

- **Run Schedule:** a schedule includes an unlimited number of test entries and user-defined events
- **Sweep Entry:** fixed range and time or fixed range and speed
- **Fixed Dwell Entry:** set dwell time duration and level for multiple frequencies. Duration and level are assigned separately to each frequency.

#### Limit Channels

Limiting can be applied to control or monitor channels.

- **Types:** Frequency Domain, Time Domain

#### Frequency Domain Limiting

- **Limit Types:** notching limit, abort limit, and alarm limit

Limiting profiles are edited by the amplitudes and frequencies of breakpoints or are imported from a CSV file.

Users can define the notching limit, abort limit, and alarm limit profiles together or separately and display the result with the test profile to show the relationship while editing. Notching, abort, and alarm limits can change with the test level. The function of “rescale” is a fast way to scale the limit profile.

#### Time Domain Limiting

Compares raw data or the RMS value of input channels to the high limit. The occurrence of exceeding the high limit is one of the system events to which desirable actions can be added.

The function of “fill down” and “fill to” provides a convenient method to copy the limiting profile of one channel to other channels in frequency domain limiting and time domain limiting.

#### Step Sine Control

Step Sine uses a sequence of short dwells within a frequency range. The steps are uniformly distributed in a log or linear frequency scale.

- **Step Sine Entry in Run Schedule:** user defines the frequency range, step resolution and dwell durations or cycles at each frequency

#### MESA Sine Control (VCS-42-Cxx-Sxx)

The MESA Sine Control System provides precise, real-time, multi-channel control and analysis. MESA Sine supports up to 512 input channels and up to 8 output channels (shakers). Input channels can be enabled for control, monitoring, and time data recording channels.

The recording option records time stream data at the full sample rate on all input channels, regardless of the total channel number. A unique hardware design provides a fast loop time of less than 10 ms.

#### Control Parameters

- **Frequency Range:** automatically calculated based on profile, or selectable from multiple ranges: 0.1 Hz to 4,900 Hz (High Frequency option available)
- **Sweeping Speed:** Log (Oct/Min): 0.001 to 6000; Log (Dec/Min): 0.001 to 2000; Linear (Hz/Sec): 0.001 to 6000
- **Sweep Rate Increment:** Log (Oct/Min): 0.001 to 6; Log

(Dec/Min): 0.001 to 2; Linear (Hz/Sec): 0.001 to 6

- **Sweep Speed Control:** Oct/Min, Hz/Sec, Dec/Min, Sweeps/Min, Sweep Time/Sweep, Cycles/Min
- **Level Change:** customizable in both logarithmic and linear rate
- **Compression Rate:** Fast (60 dB/S), Slow (20 dB/S), and Customized (from 0.01 dB/S and up, pre-defined table available)
- **Ramp Rate:** Fast, Slow, Customized, Fastest
- **Spectrum Display Resolution:** 256 to 4,096
- **Loop Time:** 10 ms typical (Loop time is the maximum rate at which a controller executes complete cycles of sampling, processing data, and transmitting control signals.)
- **Control Dynamic Range:** 100 dB typical
- **Measurement Strategy:** Filter, RMS, Mean, Peak (Multiple strategy allowed to each channel signal)
- **Tracking Filters: Proportional:** 7% – 100%; Fixed (Hz): 1 – 500 Hz
- **Control Accuracy:**  $\pm 1$  dB through resonance with Q of 50 at 1 Oct/min
- **Frequency Resolution:** as fine as 0.000001 Hz

#### Output Channels

- **Number of Output:** 2 to 8

#### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, high alarm, low abort, low alarm, control spectrum, profile, noise spectrum, spectra for all channels, independent sweep up and sweep down spectra for all channels, user defined transmissibility, and strip chart plots for RMS time history, peak and peak-peak level of each channel. Limiting signals are optional. Transmissibility signals are in complex format with real/imaginary parts.
- **Block Signals:** block time signals are used to display time waveform or the history of acceleration peak, velocity peak or displacement peak-peak
- **Display Windows:** composite, signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window, channel status window
- **Status Display on Control Panel:** control level, drive peak, control RMS, target RMS, remaining time, full level elapsed time, total elapsed time, peak-to-peak displacement, peak velocity, cursor readings
- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

**Safety**

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjusted between customizable lower and upper bounds
- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for control signal and each input channel. Detection is based on the pre-defined lowest allowed control level or maximum level change rate.
- **Control Spectral Limits:** spectral limits for control signal
- **Max Drive Limit:** maximum voltage limit for drive output

**Reference Profile**

- **Control Mode:** magnitude, phase
- **Short Label:** user defined label for control
- **Long Name:** user selectable reference profile
- **Control Channels:** list of control channels associated with the profile
- **Profile Definition:** control profiles are defined by breakpoints and connecting lines and are edited in a table or graphically by dragging points on a plot.
- **Breakpoints:** defined as level
- **Crossover Calculation:** entering “?” automatically calculates the crossover frequency and amplitude
- **Alarm and Abort:** limits defined in dB or % relative to reference profile
- **Profile Maximum:** calculation of maximum expected acceleration, velocity and displacement, checked against shaker limits
- **Profile Library:** settings are saved to a library and reused in different tests

**Run Schedule**

Run Schedule: schedule includes an unlimited number of test entries and user-defined events

Sweep Entry: fixed range and time or fixed range and speed

Fixed Dwell Entry: set dwell time duration and level for multiple frequencies. Duration and level are assigned separately to each frequency.

**Limit Channels**

Limiting can be applied to control or monitor channels.

- Types: Frequency Domain, Time Domain

**Frequency Domain Limiting**

- Limit Types: notching limit, abort limit, and alarm limit

Limiting profiles are edited by the amplitudes and frequencies of breakpoints or are imported from a CSV file.

Users can define the notching limit, abort limit, and alarm limit profiles together or separately and display the result with the test profile to show the relationship while editing.

Notching, abort, and alarm limits can change with the test level. The function of “rescale” is a fast way to scale the limit profile.

**Time Domain Limiting**

- Compares raw data or the RMS value of input channels to the high limit. The occurrence of exceeding the high limit is one of the system events to which desirable actions can be added.
- The function of “fill down” and “fill to” provides a convenient method to copy the limiting profile of one channel to other channels in the frequency domain limiting and time domain limiting.

**Step Sine Control**

Step Sine uses a sequence of short dwells within a frequency range. The steps are uniformly distributed in a log or linear frequency scale.

- **Step Sine Entry in Run Schedule:** user defines the frequency range, step resolution and dwell durations or cycles at each frequency

**MIMO Classic Shock Control (VCS-60-Cxx-Sxx)**

The Spider MIMO Classic Shock Vibration Control System provides precise, real-time, multiple shaker table control and analysis for transient time domain control. Up to 8 output channels (shaker) can be enabled for control with an individual classical shock waveform defined for each control channel, alarm checking, and time data recording on master module. Up to 512 channels can be enabled for controlling/monitoring and time data recording. Classical pulse types include half-sine, haversine, terminal-peak sawtooth, initial-peak saw tooth, triangle, rectangle, and trapezoid. The recording option records time stream data at the full sample rate on all input channels. Shock response spectrum analysis can be applied to any input signals.

**Control Parameters**

- **Sampling Rate:** automatically calculated based on profile, or selectable from multiple ranges up to 102.4 kHz
- **Time Block Size:** 512 to 65,536 points.
- **Average Number for Control:** 1 – 4
- **Correction Rate:** 0.0 to 1.0
- **Test Start Method:** pretest runs with four excitation types: positive pulse, negative pulse, Random with

close-loop control, Random with open loop. Pretest may be skipped with saved FRF's (signal properties must match test settings).

### Output Channels

- **Number of Output:** 2 to 8

### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, low abort, control signal, profile, strip chart plots for the time history of RMS, peak, peak-peak level of each channel
- **Display Windows:** control composite, signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window, channel status window
- **Status Display on Control Panel:** control level, drive peak, control Peak/RMS, target Peak/RMS, remaining pulses, full level elapsed pulses, total elapsed pulses, peak-to-peak displacement, peak velocity, cursor readings
- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

### Safety

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjustable between customizable lower and upper bounds.
- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for control signal and each input channel. Detection is based on maximum control loss or maximum RMS rate of change in the input channels.
- **Control Limits:** enforces abort time limits for control signals. Allowable ratio of points exceeding abort limits to total number points in a frame: 0 – 100%
- **Max Drive Limit:** maximum voltage limit for drive output
- **Time Domain Limit:** Raw or RMS to any input channel

### Reference Profile and Run Schedule

- **Control Channel:** selection of control channel for profile editing
- **Use one profile for all control channels:** checkbox provided. One profile is assigned to all control channels if box is checked.
- **Shock Wave Types:** half-sine, haver-sine, terminal-peak saw tooth, initial-peak saw tooth, triangle, rectangle, and

trapezoid

- **Pulse Duration:** 0.05 ms to 100,000 ms
- **Test Standards:** MIL-STD-810F, MIL-STD-810G, MIL-STD-202F, ISO 9568, IEC 60068, user-defined
- **Compensation Shapes:** half-sine, rectangular, double rectangular, rounded-rectangular or displacement optimum
- **Compensation Locations:** pre-pulse, post-pulse, or pre-post compensation
- **Profile Maximum:** calculation of maximum expected acceleration, velocity and displacement, checked against shaker limits
- **Abort Limits:** according to testing standards or custom
- **Profile Library:** settings are saved to a library and reused in different tests
- **Run Schedule:** a schedule includes user defined number of pulse entries and user-defined events

### Optional MIMO Classical Shock Vibration Control Functions (VCS-6X-Cxx-Sxx)

The following software options for VCS-60-XX are available in addition to basic Shock Control VCS-60.

### MIMO Transient Time History Control (TTH) (VCS-61-Cxx-Sxx)

Using template based importing tools, time waveform in various formats is imported into EDM VCS. Scaling, editing, digital re-sampling, high-pass, low-pass filtering, and compensation will tailor the waveform and duplicate it on a shaker. Compensation methods include pre-pulse, post-pulse, DC removal and high-pass filters.

Pre-stored profiles include Bellcore Z1 & Z2, Bellcore Z3, Bellcore Z4, (Burst) Sine, Triangle, Chirp, Burst Chirp, White Noise (Burst Random), Sine Beat, Sine Beat (multiple frequency), Door Slam (Ford), Decay Sine (linear/angular frequency), Sine Burst.

The additional option required to run profiles with a sampling frequency lower than 120 Hz is included by default since EDM 7.0. Supports up to 512 input channels.

### MIMO Shock Response Spectrum (SRS) Synthesis and Control (VCS-63-Cxx-Sx)

The SRS vibration control package provides controls to meet a target Required Response Spectrum (RRS). Waveforms are automatically synthesized from a user-specified SRS reference profile using sine wavelets. The Transient Control option allows control of imported transient files. Users can apply high frequency waveforms and alarm and abort tolerances to any active channel to provide an extra degree of safety for delicate test articles.

- **Waveform Synthesis Methods:** control time waveform is generated from damped sine or sine beat components  
Damped Sine Parameters: frequency, amplitude, critical damping factor, delay
- **Sine Beat Parameters:** frequency, amplitude, number of half sine delays
- **Component Generation:** auto or manually controlled
- **Synthesis Parameters:** waveform duration, max % of error, max number of iterations
- **Extend SRS Fa:** None, 2:1, 4:1

### MIMO Time Waveform Replication (TWR) Control (VCS-80-Cxx-Sxx)

The MIMO Time Waveform Replication (TWR) Control System provides precise, real-time, multi-channel control for long waveform duplication. MIMO TWR is capable of running an unlimited number of time profiles in a defined schedule. Multiple long waveforms can be precisely duplicated on a shaker just as they were recorded. It includes Waveform Editor (EDM-WE), a flexible importing and editing tool for long waveform signals. The recording option allows the recording of time stream data at the full sample rate on all input channels. Up to 8 channels can be enabled for control and time data recording on master front-end. Up to 512 channels can be enabled for control or monitoring and time data recording.

### Key Features

- **Number of Waveform Profiles:** infinite number of waveform recordings (subject to the available flash memory) are supplied simultaneously to automatically run one after the other on the test specimen
- **Maximum Number of Points:** all internal flash memory space is used for storing profile data (currently 3.7 GB), which corresponds to approximately 1 billion data points. The sampling rate is 200 samples / sec. Can replicate a waveform of approximately 50 days.
- **Maximum Frequency Range:** can replicate waveforms of up to 18 kHz (fa)
- **Maximum Sampling Rate of Data:** waveforms of any sampling rate up to 102.4 kHz can be imported into the Waveform Editor tool and converted to a suitable frequency range

### Control Parameters

- **Sampling Rate:** up to 18 kHz, automatically calculated based on profile
- **Display Time Block Size:** up to 4,096 points
- **Transfer Function Update Ratio:** transfer function is updated continuously in real-time depending on the transfer update ratio which can be entered by the user between 0 – 0.5

- **Pretest:** a random close-loop pretest logic is built-in to generate an initial FRF value

### Output Channels

- **Number of Output:** 2 - 8

### Measured Signals and Display Status

- **Measured Signals:** drive signal, input time stream, drive signal spectrum, system transfer function, high abort, low abort, control signal, profile, strip chart plots for the time history of RMS, Peak, Peak-Peak level of each channel
- **Display Windows:** signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window, channel status window
- **Status Display on Control Panel:** control level, drive peak, control RMS, target RMS, remaining time, full level elapsed time, total elapsed time, peak-to-peak displacement, peak velocity, cursor readings, RMS error (%)
- **Runlog:** a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024.

### Safety

- **Abort Sensitivity:** a single parameter allows the sensitivity and tolerance of various safety checks to be easily adjusted between customizable lower and upper bounds.
- **Shaker Safety Limits:** limits for shaker acceleration, velocity, and displacement
- **Open Loop Detection:** open loop detection for control signal and each input channel. Detection is based on maximum control loss or maximum RMS rate of change in the input channels.
- **Control Limits:** enforces abort time limits for control signals. Allowable ratio of points exceeding abort limits to total number points in a frame: 0 – 100%
- **Max Drive Limit:** maximum voltage limit for drive output
- **Time Domain Limit:** Raw or RMS to any input channel

### Reference Profile and Run Schedule

- **Profile Definition:** any existing signal is treated as a profile and can be imported and defined as a control; multiple channels of data can be contained in one profile and assigned to multiple control channels of the MIMO control channels.
- **Profile Import:** waveforms with any of the following file types are imported into Waveform Editor: UFF ASCII (.uff, .unv), UFF Binary (.buff, .bunv), CI-ODS format (\*.ods), EDM View Project (.vpj), TIM format (\*.tim), RSP



format (\*.rsp), ASCII data format (\*.asc), user defined ASCII format (\*.txt, \*.csv) and ODS ATF/XML format (.atfx). Waveforms with any of the following file types are directly imported to EDM: ODS ATF/XML format (.atfx), CI-ODS format (\*.ods), and user defined ASCII format (\*.txt, \*.csv).

- **Profile Editing:** waveforms with any sampling rates are digitally re-sampled, rescaled, filtered, and different compensation techniques are applied to edit the profile using the EDM Waveform Editor tool. Also contains options for cropping, appending and inserting parts of waveforms.
- **AVD Plot:** calculation of other two quantities among Acceleration, Displacement or Velocity when profile imported is of any quantity
- **Profile Maximum:** calculation of maximum expected acceleration, velocity and displacement, checked against shaker limits
- **Abort Settings:** custom abort settings are implemented using the Advanced Abort setup; this will allow different user-defined abort limits at different points of time in the profile.
- **Profile Library:** settings are saved to a library and reused in different tests
- **Run Schedule:** schedule includes an unlimited number of profile entries and user-defined events

### General Software Options

The software options listed in this section can be applied to any vibration control software module.

### Monitoring Through EDM Cloud (Cloud.go-ci.com)

All tests in EDM-DSA support status checking through EDM Cloud. FFT Spectral Analysis is widely used for monitoring applications. With EDM Cloud support, users can configure Spiders to continuously monitor input channels and conveniently upload the status information to the user's cloud storage account provided by Crystal Instruments.

The EDM Cloud website located at Cloud.go-ci.com is conveniently accessed from anywhere in the world to check the status of current or past tests. With a secure login to access the cloud, the status can only be checked by authorized personnel with credentials to access the account. The option to create multiple logins to access the same EDM Cloud account is provided.

Information available for Cloud Upload: live status for currently running tests, run logs for all runs of any test, abort conditions for any run of any test, EDM information, license information, hardware device information

**Storage Limit: 20 MB per account (free users)**

Number of Users per Account: up to 10 users per account  
Security: option to turn on/off data upload, secured account with password control, option to control type of data upload

### Time Waveform Editor (EDM-WE)

Time Waveform Editor is a Windows application that allows the user to edit, cut, paste and scale time waveforms. It can also apply displacement compensation so that the resulting waveform can be reproduced on a shaker using a Vibration Control System with Time Wave Replication (TWR) software. From EDM 6.0 release and above, this option is included in each VCS shipment.

- **Editing:** cut, paste, rescale, fill in, taper end points, apply windows, decimate
- **Displacement Compensation:** brick-wall high pass filter, high pass filter, DC removal, or disabled
- **Compensation Template:** high pass filter, low pass filter, band pass filter, acceleration DC removal, velocity DC removal.
- **Signal View:** time waveform of acceleration, velocity and displacement; FFT spectra; shaker limits; histogram
- **Editing Redo:** allows the user to redo a previous editing
- **Window:** half sine, Hann, triangle



**PC Requirements for EDM Software****Minimum System Requirements:**

- **Operating System Support:** Windows 7 SP1 or higher
- **Operating System Type:** 32-bit or 64-bit
- **Processor Speed:** 1.5 GHz Dual-Core x86
- **RAM:** 4 GB
- **Available Storage Space:** 10 GB

**Recommended System Requirements (Minimum for Spider systems higher than 16 channels):**

- **Operating System:** Windows 10, 64-bit
- **Processor:** Intel Core i7, 2.0 GHz or higher
- **RAM:** 8 GB DDR3 1600 or higher
- **Available Storage Space:** 10 GB

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