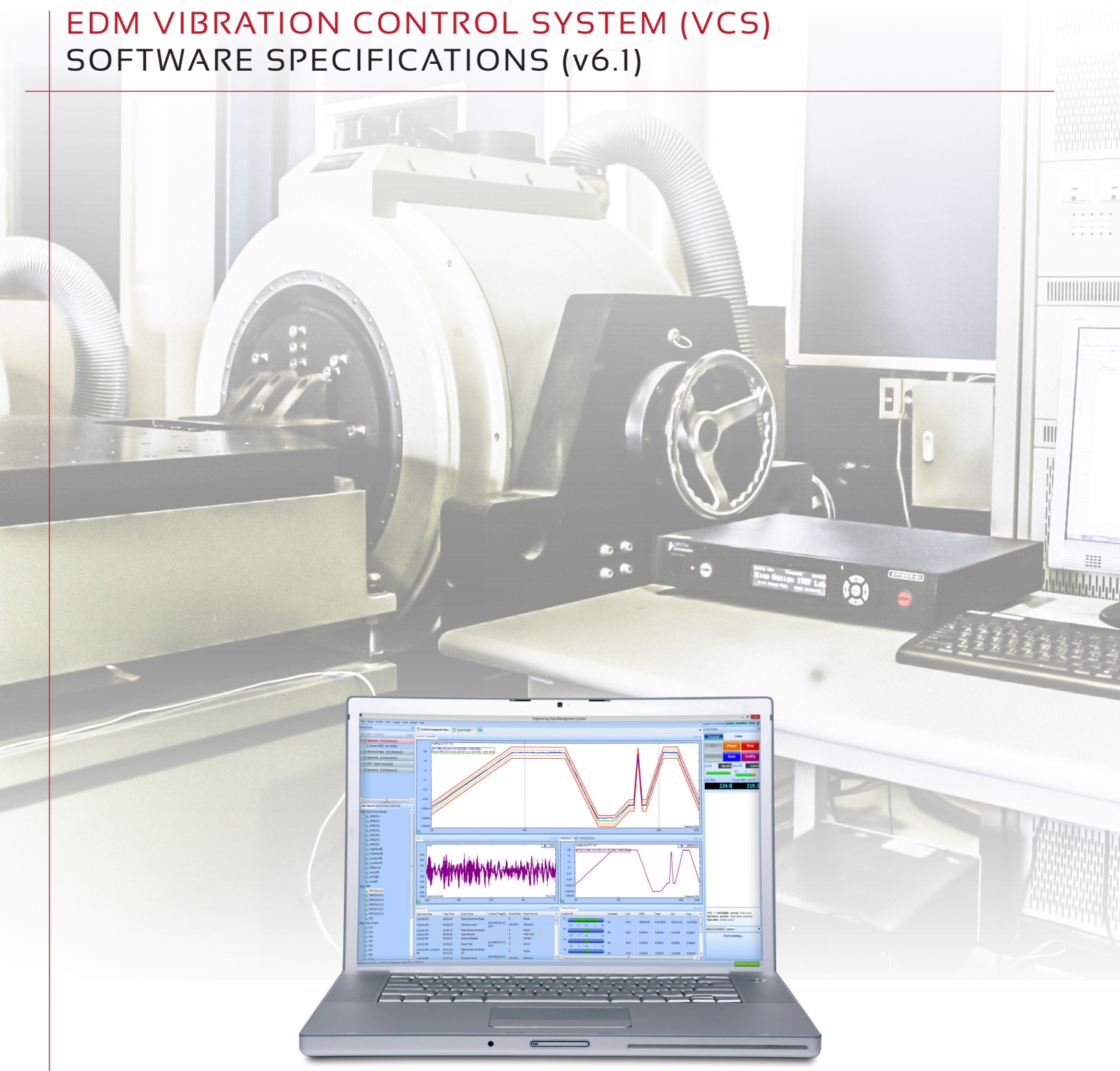
CRYSTAL INSTRUMENTS

EDM VIBRATION CONTROL SYSTEM (VCS)
SOFTWARE SPECIFICATIONS (v6.1)



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EDM VIBRATION CONTROL SYSTEM (VCS) MODE SOFTWARE

EDM (Engineering Data Management) is a PC testing environment designed for vibration control and real-time data processing. The VCS (vibration control system) functions include *Random, Sine-on-Random, Random-on-Random, Swept Sine, Resonance Search and Dwell, Sine Oscillator, Classic Shock, Transient Time History, Shock Response Analysis/Synthesis, Time Waveform Replication, Transient Random, Multi-Sine, Multi-exciter Control* and all typical applications used for environment testing. EDM includes a user interface with multiple languages. Template-based report functions provide testing results in seconds.

Test Management
Tests are managed through a Microsoft SQL Server database. Signal files, test setup, and UUT (machine) information is stored in the database. Users can search the previous tests using keywords, time, or date information. Sine and Random LDS Laser projects can be imported automatically.

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. Once constructed, multiple Spider front-ends operate as one integrated system. A self-test utility is included with each system for verifying the conditions of the input and output channels using an internal precise signal source. The test validates that the input channels are within factory defined tolerances.

Hardware Access Code Control
Administrative users can edit access privileges to the hardware. Each Spider front-end has its own access control password to prevent unauthorized access on the LAN.

Engineering Units
The user selects the preferred physical quantity at the user interface level with corresponding Engineering Units (EU). Transducer sensitivity (mV/EU) can be set for each input channel. Typical physical 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
- Data Precision: data saved in 32 bit (4 byte) words with single floating point precision
- Signal Data Structure: all signals are combined and saved in one file per each save command executed

Export Data File Formats
- ASAM-ODS XML: ASAM Open Data Source binary format (default, recommended)
- UFF ASCII: ASCII format of UFF files
- UFF Binary: binary format of UFF files
- ASCII: User-defined format with selectable attributes.
- Excel CSV: Comma Separated Value, CSV, can be opened directly in Microsoft Excel
- MATLAB: *.mat binary format can be opened and analyzed using MATLAB
- .WAV: sound wave files

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
Testing reports are directly created in the Open XML format that can be read by Microsoft Word or many open source Office tools. Reports can also be created in Microsoft word (.doc / .docx) formats as well as PDF format. Fields and attributes are customizable. Logo and report layout preview are provided.

Administrator Control
Different users can access certain sections of test settings (testing parameters, profile, channel and display) depending on the specified account level, with the privileges managed by an administrator.

Digital I/O Interface
Each Spider-81 front-end has 8 isolated digital inputs and 8 isolated digital outputs (Spider-81B/80X has 4 of each), 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. (Available for Spider-80X/80Xi only.)
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 are able to send emails or instant messages as custom actions in response to a system or user event. Content of emails 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
- 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 front-ends.
- 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.
- Channel Library: settings are saved to a library and reused in different tests
- Single or multiple channel settings in a row may be copied and pasted on other channels in the same 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 limits are calculated from the shaker parameters and the weight of the Unit Under Test (UUT).

- Shaker Parameters: maximum amplifier input voltage, shaker acceleration, velocity, displacement, force, drive frequency, and mass of UUT
- 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.
- UUT Weight: is changed per test in the confirmation page

Pre-Test
Pre-test checks the integrity of all signal paths and measures the system FRF. (VCS-00-05 is required for Random excitation pre-test in Sine/RSTD/Shock/TTH/SRS tests)

- Pre-test Options: measure the FRF in a closed-loop, run with FRF saved on the PC
- Drive Voltage: user-defined initial drive voltage and 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 Sine/RSTD): save FRF function, show pre-test results
- User Commands (only in Sine/RSTD): hold sweep, sweep up, sweep down, release sweep, increase frequency, set frequency

Multiple Point Control
Enables multiple control channels to be used for the control signal:
Multiple Point Control Strategies (Random/Sine/RSTD/Transient Random): weighted average, maximum, and minimum
Multiple Point Control Strategies (Shock/TWR): weighted average

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, for 250 GB disk space in total, typical recording time 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.

(This function was sold separately before as one of VCS-20-03, VCS-40-06, VCS-60-04, VCS-80-04)

Data Transfer Tool
The tool is installed with EDM or from an individual setup file. The tool transfers all EDM databases including data files and environment parameters from one computer to another, or from one database server to another. Data may be transferred via storage media or network connections.

Strain Measurement
As an integrated function into the 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. (Not available with Spider-80Xi)

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 function makes the bridge-balancing process easy. It can be done with Shunt calibration simultaneously in one step, resulting in a balanced and calibrated strain gage.

Remote Sensing function makes long-distance measurement possible. This function allows the user 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. which could be set and configured as necessary.

EDM SOFTWARE SPECIFICATIONS: VIBRATION CONTROL MODULES

RANDOM VIBRATION CONTROL (VCS-20)

The Random Vibration Control System provides precise, real-time, multi-channel control and analysis. Random supports up to 512 input channels. Up to 128 channels can be enabled for control and notching. The rest can be 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. Optional Kurtosis control can create a non-Gaussian random signal.

Control Parameters

- Frequency Range: automatically calculated based on profile, or selectable from multiple ranges: up to 4,900 Hz (High Frequency option VCS-20-02 available)
- Spectral Resolution: 200, 400, 800, 1,600, 3,200 and 6,400. 3,200 for all 8 channels. 25,600 for 1 channel. Resolution higher than 1,600 may reduce the maximum channel count and the highest allowed overlap ratio.
- 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”. (The real-time control bandwidth of the Spider-81 in Random mode is about 80 Hz.)
- Average Number: 1 – 500 (2 – 1000 DOFs)
- Overlap Ratio: none, 50%, 75%, and 87.5%
- Control Dynamic Range: 90 dB
- Control Accuracy: ±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)

Output Channels

- First Output: drive channel
- Second Output: configurable as one of followings: no output, same as the first output, negative of first output, control RMS level, or RMS or Peak value of any input channel. Not available for the Spider-81B.

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, 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

- 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: The profile is scaled using RMS value.
- Profile Import: A 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: A 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.

Drive Notching/Limiting for Random

Limiting is applied to control or monitor channels. Available frequency domain limiting types include notching, abort, and alarm limit. Limiting profiles may be edited by amplitudes and frequencies of breakpoints or imported from a CSV file. The max expected peak acceleration, velocity, and displacement of profile is calculated. There is also a time domain limit available for any input channel to raw data or RMS value. Supports up to 512 input channels.

Displacement Optimization for Random (previously VCS-20-11)
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.)

Multiresolution
Regular random control systems use a uniform frequency resolution over the entire frequency range. Some profiles have more detail or greater sharpness in the low frequency range where uniform frequency resolution doesn't provide enough detail and the control performance is impacted.

The multi-resolution control algorithm enhances the spectral resolution to 8 times in the low frequency range to provide much higher control accuracy in that range.

When the function is enabled, the max frequency is up to 8000 Hz and the maximum number of channels is 512. It is not supported in Sine on Random and Random on Random.

OPTIONAL RANDOM VIBRATION CONTROL FUNCTIONS (VCS-20-XX)

Software options VCS-20-XX can be applied to basic Random Vibration Control VCS-20.

High Frequency Control for Random (VCS-20-02)
Extend the frequency range from 4.9 kHz up to 46 kHz. This may reduce the maximum channel count and highest allowed overlap ratio. Max frequency range is 12.5 kHz when all 512 input channels are enabled.

Kurtosis Control (VCS-20-06)
Kurtosis is a measure of the frequency of occurrences of large peaks in a waveform. Kurtosis control allows the user to specify the target kurtosis of the random control signal, and the controller will adjust the amplitude distribution of the vibration to match the target. This is done with minimal effect on the frequency content and dynamic range. Possible kurtosis values are 3 – 10. Supports up to 512 input channels.

Sine on Random Control (VCS-20-08)
- Sweeping Mode: free sweeping mode where each sine tone has their own schedule and sweeping speed, and harmonic mode where the first tone controls the sweeping speed
- Number of Sine Tones: 1 – 12 in free-sweeping mode; 1 – 20 in harmonic mode, up to 32 when RoR is disabled.
- Operation Controls: Tone On and Tone Off controlled by run schedule, external events or user commands
- Supports up to 512 input channels.

Random on Random Control (VCS-20-09)
- Sweeping Mode: free sweeping mode where each narrow random band has its own schedule and sweeping speed
- Number of Bands: 1 – 12, up to 32 when SoR is disabled.
- Operation Controls: Band On and Band Off controlled by run schedule, external events or user commands
- Supports up to 512 input channels.

Sine and Random on Random Control
Available with the purchase of Sine on Random Control (VCS-20-8) and Random on Random Control (VCS-20-09) together.

Dual-Shaker Control for Random (VCS-20-10)
This option enables the system to output two random drive signals simultaneously to control two shakers. The phase difference between each drive and control signal is calculated and taken into account during real-time operation. This option can be applied to two shaker systems in push-pull or parallel configurations. Supports up to 512 input channels. The availability of this feature is subject to U.S. export laws and regulations.

Fatigue Damage Spectrum (VCS-20-11)
- Fatigue Damage Spectrum (FDS) lets the user compare the potential damage caused by different random profiles. It allows the user to create a random profile from time stream data.
- Max Number of Profile Points: 400
- Display: APS and FDS
- Options: low and high frequency at 1/24 octave max, target life and test duration.

iPad Application for Random (VCS-20-15)
Any Random test uploaded to the front-end is operated and controlled by the EDM iPad app. The control options in the app include reset average, next entry button, level adjustments, and ON/OFF switch for abort checks, closed loop and schedule timer apart from Run, Pause, and Stop buttons. For further details please refer to the EDM App specifications.

SWEPT SINE CONTROL (VCS-40)

The Spider Swept Sine Vibration Control System provides precise, real-time, multi-channel control and analysis. Swept Sine supports up to 512 input channels. Up to 128 channels can be enabled for control and notching and the rest can be 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. Black Box mode allows a user to run the controller without a PC.

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: ±1 dB through resonance with Q of 50 at 1 Oct/min
- Frequency Resolution: as fine as 0.000001 Hz

Output Channels
- First Output: drive channel
- Second Output: configurable as one of the followings: no output, same as the first output, COLA type 1, COLA type 2, first output plus DC (VCS-00-24)
- COLA Types: constant amplitude sweeping sine signal or voltage signal that is proportional to the sweeping frequency.

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 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.
- 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
- 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: by entering "?" the crossover frequency and amplitude is automatically calculated.
- 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 is assigned to each frequency separately.

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

Total Harmonics Distortion (THD) Measurement
This option adds the ability of computing Total Harmonics Distortion (THD) of the control and input signals. It is available in both Step Sine and Swept Sine. Previously this is option VCS-40-05, which is standard now.

Drive Notching/Limiting
Limiting is applied to control or monitor channels. Available spectrum limiting types are notching limit, abort limit, and alarm limit. Limiting profiles may be edited by the amplitudes and frequencies of breakpoints or imported from a CSV file. The max expected peak acceleration, velocity and displacement of profile is calculated. Also available is the time domain limit to any input channel to raw data or RMS value. Supports up to 512 input channels.

OPTIONAL SWEPT SINE VIBRATION CONTROL FUNCTIONS (VCS-40-XX)

Software options VCS-40-XX can be added to the Swept Sine Control VCS-40.

Resonance Search and Tracked Dwell (RSTD) Control (VCS-40-01)
The search function determines the resonant frequencies using a transmissibility signal between input channels on the master front-end. In real-time control, the tracked dwell entry tracks each resonant frequency. Dwell entries (fixed dwell, tracked dwell, phase tracked dwell) may be added manually or automatically after a sweep entry is done or the list of resonances is determined. Supports up to 512 input channels.

Resonant Frequency Search: Uses Q or amplitude of transmissibility to automatically search the resonances within a certain range.

Tracked Dwell: Resonant frequencies are manually entered or loaded from the search table. Dwelling continues until time duration is reached, resonant frequency changes out of limits, or amplitude changes out of limits. The "Tracked Dwell" entry must be added to the schedule.

Phase Tracked Dwell: Resonant frequencies are manually entered or loaded from the search table. Dwelling continues until time duration is reached or resonant phase changes out of limits. The "Phase Tracked Dwell" entry must be added to the schedule.

High Frequency Control for Sine (VCS-40-03)
Extend the frequency range from 4.9 kHz up to 46 kHz. 1 input for up to 46kHz; 4 inputs up to 32kHz; all (up to 512) channels up to 20kHz.

Multi-Exciter Single-Control for Sine (VCS-40-10)
This option enables the system to output up to four Sine drive signals that can simultaneously excite up to four shakers. The phase difference between each drive and control signal is calculated

and taken into account during real-time operation. This option is applied to up to four shaker systems in parallel configurations. When VCS-40-01 option is ordered, the dual drive option instead will be applicable to RSTD. It supports up to 512 input channels. The availability of this feature is subject to U.S. export laws and regulations.

Multi-Sine Control (VCS-40-11)

- Multi-Sine Control enables multiple sine tones sweeping simultaneously and ensures that multiple resonant frequencies of the structure can be excited. With multiple sine tone excitation, the required time duration of sine testing can be reduced significantly. Independent tracking filters are applied to each tone separately.
- Number of Sine Tones: up to 10 tones
- Type of Sine Tone interval: even interval, user defined interval, or Harmonic type
- Operation Controls: Tone On and Tone Off controlled by run schedule, or user commands
- Number of Inputs: Supports up to 512 input channels

**Not supported by Spider-81, 5.x hardware.*

Control Parameters

- Frequency Range: automatically calculated based on profile, up to 4,900 Hz.
- Sweeping speed: Log (Oct/Min): 0.01 to 6000; Log (Dec/Min): 0.001 to 2000; Linear (Hz/Sec): 0.001 to
- Spectrum Display Resolution: 256 to 4,096
- Control Dynamic Range: 90 dB typical
- Tracking Filters: Proportional bandwidth: 7%, 12%, 25%, 50%, 100%; Fixed bandwidth (Hz): is automatically calculated
- Control Accuracy: ±1 dB at 99% confidence with 100 average number
- Frequency Resolution: as fine as 0.0001 Hz
- Average Number: 1 – 2000

Run Schedule

- Run Schedule: a schedule includes an unlimited number of test entries and user-defined events.
- Multi-Sine sweep entry: fixed range and speed for multiple tones
- Multi-Sine dwell entry: set dwell time duration and level for multiple tones.

Limiting

Limiting is applied to control or monitor channels. Abort limit is the only available type. Limiting profiles may be edited by the amplitudes and frequencies of breakpoints. The max expected peak acceleration, velocity and displacement of profile is calculated. Supports up to 512 input channels.

The specifications of Measured Signals are the same as that of Swept Sine Control.

iPad Application for Sine (VCS-40-15)

Any Sine test uploaded to the hardware can be operated and controlled by the EDM iPad app. The control options for the test include reset average, next entry, level adjustments, sweep speed, sweep direction, sweep status and ON/OFF switch for abort checks, closed loop and schedule timer apart from Run, Pause and Stop buttons. For details please refer to EDM App specifications.

CLASSIC SHOCK CONTROL (VCS-60)

The Spider Classic Shock Vibration Control System provides precise, real-time, multi-channel control and analysis for transient time domain control. Up to 8 channels can be enabled for control, alarm checking, and time data recording on master module. Up to 511 channels can be enabled for monitoring and time data recording. Classical pulse types include half-sine, haver-sine, terminal-peak sawtooth, initial-peak saw tooth, triangle, rectangle, and trapezoid. The Transient Time History Control option is typically used for low frequency seismic testing. 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. Black Box mode allows a user to run the controller without a PC.

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. (32,768 points for 4 inputs; 65,536 points for 2 inputs. For newer hardware (v7.x and later), supports 65,536 points for 4 inputs. Include previous VCS-60-06)
- Average Number for Control: 1 – 4
- 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

- First Output: drive channel
- Second Output: configurable as one of followings: no output, same as the first output, reverse of the first output

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

- Test Standards: MIL-STD-810F, MIL-STD-202F, ISO 9568, IEC 60068, User-defined
- 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
- 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 unlimited number of pulse entries and user-defined events

Shock Response Spectrum (SRS) for Shock and TTH (previous VCS-60-02)

Shock response spectra of measured signals are available for analysis.

- Analysis type: positive, negative, maximax (absolute)
- Octave Spacing: 1 to 24
- Damping: 0.001 to 100%

OPTIONAL SHOCK VIBRATION CONTROL FUNCTIONS (VCS-60-XX)

Software options VCS-60-XX are applied to basic Shock control VCS-60.

Transient Time History Control (TTH) (VCS-60-01)

Using template based importing tools, time waveform in various formats are imported into EDM. Scaling, editing, digital re-sampling, high-pass, low-pass filtering and compensation will tailor the waveform so it is duplicated on the 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, Sine, Triangle, Chirp, White Noise, Sine Beat, Sine Beat (multiple frequency), Door Slam (Ford).

An additional option (VCS-60-09) is required to run profiles with sampling frequency lower than 120 Hz. Supports up to 512 input channels.

Shock Response Spectrum (SRS) Synthesis and Control (VCS-60-03)

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. High frequency waveforms, Alarm and Abort tolerances may be applied to any active channel to provide an extra degree of safety for delicate test articles.

Shock Response Spectrum (SRS) is available for Shock and TTH control, with this option.

- 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

Low Frequency Control for TTH (VCS-60-09)

Supports imported profiles with sampling rate lower than 120Hz. Supports up to 512 input channels.

Transient Random Control (VCS-60-12)

Transient Random Control applies a chain of pulses with random nature to the shaker. The target profile power spectrum is defined in a same way as Random control, with the addition of defining transient pulse interval. Application includes simulation gunfire or road simulation. Supported by hardware v.7.x and above and supports up to 512 input channels.

Not supported by Spider-81, version 5.x hardware.

Control Parameters

- Sampling rate: automatically calculated based on profile, or selectable from multiple ranges up to 102.4 kHz
- Spectral Resolution: 200, 400, 800, 1,600, 3,200 and 6,400. 3,200 for all 8 channels. Resolution higher than 3,200 reduces the maximum channel count.
- Time Block Size: 512 to 65,536 points. (16,384 points for 4 inputs; 32,768 points for 2 inputs)
- Average Number: 1 – 500 (2 – 1000 DOFs)
- Drive Sigma Clipping: 3 – 10

Measured Signals and Display Status

The same as Classical Shock Control. In addition, it has the followings: high abort, high alarm, low abort, low alarm, control spectrum, profile, auto-power spectra for all channels.

Safety

The same as Classical Shock Control. In addition, it has the followings:

- Control Spectral Limits: spectral limits for control signal

Reference Profile and Run Schedule

The reference profile of Transient Random Control is defined in the frequency domain. It is the same as Random Vibration Control. In addition, user may define the drive shape, a customized window applied to the drive signal. Drive shape is defined in break points.

Random Profile Import, Editing, and Reduction

The same as Random Vibration Control.

TIME WAVEFORM REPLICATION (VCS-80)

Time Waveform Replication (TWR) provides precise, real-time, multi-channel control for long waveform duplication. TWR is capable of running an unlimited number of time profiles in a defined schedule. Multiple long waveforms can be duplicated precisely on the shaker just as they were recorded. It includes Waveform Editor (EDM-WE), a flexible importing and editing tools 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 511 channels can be enabled for monitoring and time data recording.

Key Features
- Number of Waveform Profiles: Infinite number of Waveform recordings (subject to the available flash memory) is 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. At a sampling rate of 200 samples / sec. It can replicate a waveform of about 50 days.
- Maximum Frequency Range: waveforms of up to 18 kHz (fa) can be replicated.
- Maximum Sampling Rate of Data: waveforms of any sampling rate up to 102.4kHz 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
- First Output: drive channel
- Second Output: configurable as one of following: no output, same as the first output, reverse of the first output

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 is imported and defined as a control
- 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 imported to EDM directly: 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: a 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.

Sine Oscillator (VCS-00-05)

Sine Oscillator is a diagnosis tool with manual control to the sine output while the system displays various time signals and frequency spectra. Random excitation can be enabled as a check-up function. Tracking filters are applied to each input channel to extract the signals at sweeping frequency. When the close-loop option is enabled, the Sine Oscillator is essentially a limited sine controller with more manual control functions.

- Frequency Range: automatically calculated based on profile, or selectable from multiple ranges: 2 Hz to 5,000 Hz
- Sweeping Rate: Log (Oct/Min): 0.001 to 120; Log (Dec/Min): 0.001 to 40; Linear (Hz/Sec): 0.001 to 120
- Sweep Rate Control: Oct/Min, Hz/Sec, Dec/Min, Sweeps/Min, Sweep Duration/Sweeps
- Spectrum Display Resolution: 256 to 4096
- Tracking Filters: proportional: 7% – 100%; Fixed (Hz): 1 – 500 Hz
- Frequency Resolution: as fine as 0.000001 Hz
- Control Mode: either open-loop or with close-loop control

Non-Acceleration Control (VCS-00-12)

With this option, a non-acceleration measurement quantity can be applied to the control signal. This provides an option of choosing from multiple quantities including force, sound, and voltage to be controlled when appropriate sensors are used. Angular acceleration can be controlled in Sine and Random tests using the appropriate selection.

The controller is also capable of using mixed displacement, velocity and acceleration sensors to synthesize a control signal in the acceleration domain.

- Random: control in angular acceleration, control in any non-acceleration unit
- Sine: control in angular acceleration, control in any non-acceleration unit, control in linear acceleration while allowing displacement or velocity measurement
- Shock/TTH: control in any non-acceleration unit

Multi-Master Option (VCS-00-20)
Creates a special license key that allows multiple front-end systems to be split into several independent systems. Any front-end enabled with this license key can be used as a Master unit. Ordering this option will enable the same set of software running on each or any combination of the Spiders that are defined in this license key.

EMA DC-Offset Control (VCS-00-24)
Creates a second output that can be used with an Electro Magnetic Actuator (EMA) Control System. Output has DC component in addition to control signal. Available on the Spider-81 and Spider-80X.

Sensor Calibration (VCS-00-36)
The Sensor Calibration tool is used to calculate the sensitivity of sensors while the measurements of the sensors are compared against referenced sine wave input signals. The user enters the following information: calibration signal nominal frequency, select either RMS reading or dB RMS reading, and reference dB value. The front-end automatically calculates the RMS levels and updates the sensitivity table. The user accepts or rejects the calibration results and views the reports.

Spider Front-end Calibration Software (SPIDER-CAL)
The front-end is calibrated at the factory prior to shipping and should be recalibrated annually by a factory authorized calibration service. EDM has an optional stand-alone Front-End Calibration Tool (FECT) that is operable by either the user or a calibration specialist. Calibration data is stored inside of the Spider front-end.

FECT Functions: The calibration software calibrates the signal source and adjusts the DC and AC gains and offset. It also calibrates the input channels at all coupling types and adjusts the DC and AC error. The report includes the model number, text for the calibration meter, and the calibration operator's name. The report is viewed or printed from the host PC. For more detail, refer to the FECT spec document.

Time Waveform Editor (EDM-WE)
Time Waveform Editor is a Windows application that allows the user to edit, cut, paste and scale a time waveform. 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
- Minimum Processor Speed: 1.5 GHz Dual-Core x86
- Minimum RAM: 4 GB
- Minimum Free 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: 8G DDR3 1600 or higher
- PC storage: SSD

SOFTWARE BUNDLES					
Part Number	**Function**	**Bronze 1**	**Silver 1 – C08**	**Gold 1 – C08**	**Gold 2 – C08**
VCS-20	**Random**	✓	✓	✓	✓
VCS-20-02	High-frequency Control				
VCS-20-06	Kurtosis Control			✓	✓
VCS-20-08	SoR			✓	✓
VCS-20-09	RoR			✓	✓
VCS-20-10	Dual-Shaker Control				
VCS-20-15	EDM App - Random				
VCS-40	**Sine**	✓	✓	✓	✓
VCS-40-01	RSTD		✓	✓	✓
VCS-40-03	High-frequency Control				
VCS-40-10	Dual-Shaker Control				
VCS-40-11	Multi-Sine Control				
VCS-40-15	EDM App – Swept Sine				
VCS-60	**Shock**	✓	✓	✓	✓
VCS-60-01	TTH			✓	✓
VCS-60-03	SRS Synthesis and Control			✓	✓
VCS-60-09	Low-frequency Control for TTH				
VCS-60-12	Transient Random Control				
VCS-60-15	EDM App - Classic Sine Control in iOS				
VCS-80	**TWR**				✓
VCS-00-05	Sine Oscillator			✓	✓
VCS-00-12	Non-Acceleration Control			✓	✓
VCS-00-36	Sensor Calibration				
Spider-CAL	Front-end Calibration			✓	✓