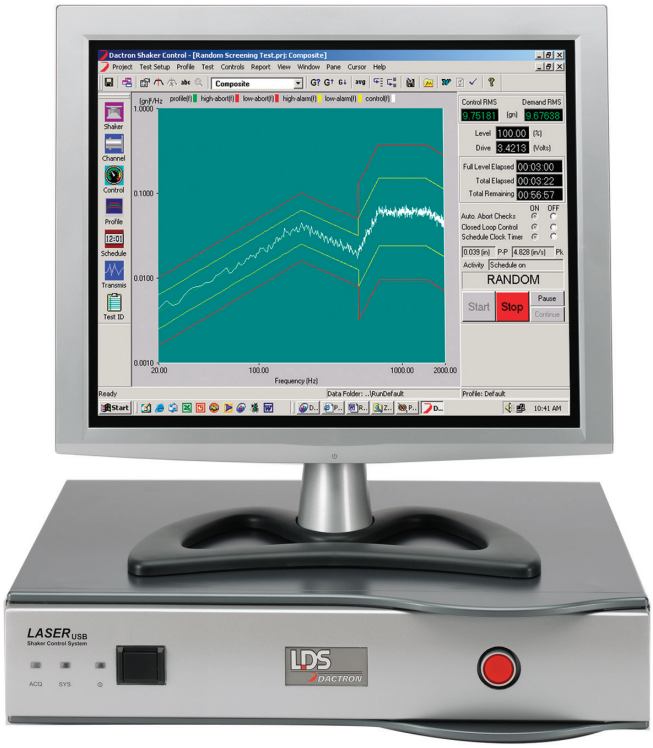
SYSTEM DATA

LDS LASER$_{USB}$™

Vibration Control System



Combining convenience, performance, flexiblity, and safety, LASER$_{USB}$ is the ideal controller for your test lab. It has 24-bit precision with wide control dynamic range, and fast loop times to provide superb control for your most challenging tests.

Key Benefits

- Supports both 32 and 64-bit Windows® operating systems
- Full capability for vibration control and data reduction
- Multi-channels, with 4 to 16 channels for multi-point control
- 24-bit resolution gives wide dynamic range to control highly dynamic structures
- Fast and safe with 100 ms loop time
- Amplifier and thermal chamber interfaces for seamless lab integration
- Automatic safety checks to protect your valuable equipment
- USB connectivity for easy installation
- Kurtosis parameter control for non-gaussian random testing
- Fatigue monitor protects test article and shaker

Uses

- Vibration testing in both R&D and production environments with applications that include:
  - – Random vibration control
  - – Swept sine vibration control
  - – Resonance dwell vibration control
  - – Classical shock vibration control
  - – Random- and sine-on-random vibration control
  - – Shock SRS vibration control
- Simulation of automobile, military vehicle and ground transportation vibration
- Fatigue tests
- Intended to drive a switching power amplifier (HPAK, SPA-K, D-PAK)
- Synchronised environmental chamber and vibration tests

Brüel & Kjær

Specifications - LASER$_{USB}$ Shaker Control System

Inputs	
Analogue Channels	4 standard, expandable to 16 simultaneous channels. Each can be controlled, monitored or disabled. All are differential inputs with 220 kΩ impedance.
Electronics	Differential amplifier, programmable gain amplifier, anti-aliasing filters, and 24-bit Analog-to-Digital Converter (ADC).
Filtering	An analogue filter plus a 160 dB/octave digital filter eliminates non-linear phase distortion and aliasing.
Frequency Range	Up to 42 kHz analysis frequency (96000 samples per second).
Voltage Ranges	± 10, 1, 0.1 V
Input Coupling	DC or AC (analogue circuitry)
Signal Conditioning	Voltage or CCLD* sensor power (4.7 mA, 23 V peak open circuit) and TEDS (Transducer Electronic Data Sheet).
Max. Input	±36 V peak without damage
Resolution	24-bit
Dynamic Range	120 dBfs, 110 dB minimum in FFT mode
Accuracy	±0.08 dB (1 kHz sine at full scale)
Channel Match† Amplitude	Within ± 0.04 dB
Channel Match† Phase	Within ± 0.1 degree to 2 kHz ± 0.5 degree to 20 kHz
Signal-to-Noise	>100 dB (from DC to 1000Hz measured with half full scale sine wave)
Cross-talk	< –110 dB
Total Harmonic Distortion	< –105 dBfs
Digital Input and Output	48 parallel lines for 5 V TTL signals. Used for remote start/stop/pause/continue and other functions such as close/open control loop, manual/auto schedule, and enable/disable aborts.

* Channel match specification per 8-channel front end.

† CCLD is Constant Current Line Drive, the generic name for a constant power supply for accelerometers with built-in electronics.

Outputs	
Analogue Channels	Drive and COLA (Constant Output Level Amplitude)/ shock trigger outputs standard.
Output Protection	Prevents output transient if power is switched off
Electronics	24-bit Digital-to-Analogue Converter (DAC), anti-imaging filter, programmable gain attenuator, and shutdown circuitry. Single-ended output with 50 Ω impedance.
Filtering	A 160 dB/octave digital filter plus an analogue filter elminates non-linear phase distortion and imaging.
Frequency Range	Up to 22 kHz output frequency (48000 samples/sec)
Voltage Range	±10 Vpeak with adjustable attenuator
Resolution	24-bit
Dynamic Range	110 dBfs

Hardware	
AC Power	100 to 240V, 50/60 Hz, auto-sensing
Power Consumption	30W
Dimensions	Height: 8.9 cm (3.5 in) Width: 41.9 cm (16.5 in) Depth: 36.3 cm (14.3 in)
Weight	6 kg (13 lb)
Temperature	5 to 55° C (41 to 132° F)
Humidity	10% to 90% RH non-condensing
Front-end DSP Box	Control loop processing done independent of PC using dual DSP chips. Rear panel connectors for inputs and outputs, connection to PCI card, and 48 digital I/O lines. Front panel power switch, abort button and status LEDs
PC Requirements	USB 2.0 port Windows 7(32 and 64-bit), Windows 8 (64-bit), or Windows 10 (64-bit) operating system Microsoft® Word With more than 8 channels: 8MB graphics card (recommended)
PC Expansion	PC upgrades and peripheral additions do not delay or interrupt the control loop processing

Software	
Architecture	Distributed processing removes the PC from the control loop process. True multi-tasking allows the PC to deliver maximum graphics performance and responsiveness. Software provides on-line test status & management via text displays, software toggle buttons, and displays of multiple time and/or frequency signals.
Applications	Random; Sine-on-Random; Random-on-Random; Sine-and-Random-on-Random; Swept Sine; Resonance Search; Track and Dwell; Sine Oscillator; Classical Shock; Shock Response Spectrum; Transient Time History Control; Long Time History Control (for road simulation testing).
Features	Online help; consistent management of user defined engineering units; on-line graphics, one-click Word-based test reports with active data plots that can be rescaled, add cursors etc.; project sequencing for automated testing to a mission profile.

Control Loop	
Random Dynamic	Random: 95 dB Sine: 100 dB
Loop Time	Random: 100 ms typical

Regulatory Compliance	
Compliance	CE marking
Safety	EN/IEC 60950–1
EMC	FCC Part 15 (CFR47) Class A, EN 61326 Class A, CISPR22 Class A

Specifications - Premier Random Vibration Control

Control Parameters	
Frequency Range	0 to 10 kHz* in seventeen ranges. Closed loop control up to 4000 Hz standard.
Resolution	110, 225, 450, 900, or 1800 lines
Δ F Resolution	User-selectable, including 5Hz and its multiples.
Dynamic Range	Up to 95 dB
Randomization	Frequency domain phase randomization technique produces a true gaussian distribution.
Loop Time	Typically 100 ms
Variable Resolution	Provides enhanced low frequency control with up to 8-to-1 improvment in spectral resolution.
Transfer Function	Measure during pre-test or, for quickest test start-up, recall a function from disk.
DOF	2 to 1000
Control Strategy	Single or multiple input channels combined by minimum, maximum, or weighted average. Drive clipping 2 to 6 sigma or disabled.
Kurtosis Control	An option that provides a better simulation of real world data and enhances fatigue testing. The system uses continuous feedback control to achieve a user-specified target K value.
Limiting	Any channel can be enabled as a Limit or Abort channel. Each Limit channel has a corresponding amplitude vs. frequency profile.
Non-acceleration Control	Control using a force, velocity, or displacement transducer; or control to angular acceleration.

* High frequency option extends to 10 kHz

Reference Profile	
Entered as a table of breakpoints, recalled stored profile, PSD, or imported ASCII or UFF file. Reference can be rescaled to a new rms value.	
Breakpoints	Unlimited combination of PSD levels and slopes (dB/ octave) at user-defined frequencies.
Abort/alarm	High and low profile limits defined independently at each breakpoint in dB with respect to reference. RMS high and low limits calculated automatically from profiles or specified by user.
Validation Tools	Profile displayed and updated as it is created. Automatic listing of rms and peak acceleration, velocity, and displacement values for profile. Profiles are validated against shaker parameters.
Engineering Units	English, SI, metric, mixed; linear or angular

Test Schedule	
User-defined sequence of events or 'profiles', that are automatically executed during test.	
Events	Level & duration, timed pause, save signals, abort enable/disable, digital output trigger, and control loop close/open; logic for sequence & nested loops.
Profile Sequencing	Flow diagram of blocks with each block defining a Profile and Schedule.

Test Management	
Control panel toggle buttons and toolbar icons provide easy access to test controls. Commonly used commands are also accessible via keyboard function keys. Text messages and numerical readouts on the control panel enhance test status monitoring.	
Buttons	Start/stop, pause/continue, enable/disable, abort check, loop close/open, schedule clock on/off.
Icons	Test level set/increase/decrease, reset average, move to next event/profile, save signals.
Status Displays	Control and demand rms acceleration, demand velocity and displacement, test %/dB/ratio level, peak drive volts, full level and total test time elapsed, time remaining, activity status, and a red alert message box.

Safety Features	
Control Signal	Automatic detection of input overload, open loop, and loss of control signal.
Line-abort Trigger	Ratio of spectral lines allowed to exceed limits to total number of lines; From 0 to 1.
Test Shutdown	Shutdown initiated by operator or software is performed gracefully at a user-specified rate.
Abort Rate	1 to 120 dB/sec
Email Support	Email message automatically sent on abort

Fatigue Monitor	
The Fatigue Monitor automatically stops the test if the inverse of the system transfer function (Hinverse) or selected transmissibility, or input channel spectrum, exceeds specified abort limits. Hinverse could change because of fatigue in the test article, looseness in the fixture and mounting, or degradation of the shaker value.	
Signals	Hinverse, any transmissibility or input spectrum
Source	Active signal or imported from disk file
Tolerances	User-specified upper/ lower aborts and alarms in dB
Check Level	From 10% to 100% of the full test level

Test Execution	
The system performs pre-test checks, equalises the load and then executes the schedule.	
Pre-test	System performs safety checks then gradually increases the drive per the user-specified peak drive voltage (initial and maximum), response level goal, and ramp-up rate (slow or fast).
Automatic Mode	System executes the events specified in the schedule. If a Profile Sequence is defined, profile schedule blocks in the flow diagram are sequentially executed. The reference is changed in one loop, eliminating the need to stop and restart the test to change the profile
Manual Mode	User can override automatic mode to manage the test using manual commands.

Signal Displays	
Unlimited number of display windows in tile or cascade format with click & drag zoom, user annotation, and cursors.	
Window Format	Per window choice of single, dual, or four pane formats. Each pane can display single or multiple signals overlaid in either time or frequency. Independent choice of colour and texture for signals, grids, tick marks, labels, titles, etc.
Scale Format	Linear or logarithmic scales for X and Y axes with automatic or manual scaling.
Cursors	Single or dual with X, Y, ΔX, ΔY, ΔRMS and Q value readouts; manual peak marks; automatic peak/ valley detection and marks; harmonic and sideband cursors.
Frequency Signals	Control, any input, transfer function (amplitude and phase), coherence, drive, profile, alarms, and aborts.
Strip Chart Plots	Scrolling record (data point per frame) of input channel rms, max, min, or mean values.
Oscilloscope Plots	Drive and input time histories

Online Math
This feature allows you to create customised signals. All signals are calculated and displayed 'live' during testing. Operations include addition, subtraction, multiplication, division, and transmissibility between PSDs for any two inputs or an input PSD and the control PSD.

Post-test Documentation
Icon for single-click generation of data plots and test reports, including setup parameter listings, test logs and formatted signal plots, within Microsoft® Word.

Specifications - Premier Swept Sine Vibration Control

Control Parameters	
Frequency Range	0.1 Hz to 12 kHz Up to 4 kHz standard; high frequency option extends to 12 kHz
Resolution	512, 1024, or 2048 points per sweep
Dynamic Range	Up to 100 dB
Loop Time	Typically 10 ms
Control Accuracy	1 dB through peak-notch with a Q of 50 at 1 octave/min, 8 control channels with 25% proportional tracking filters.
Compression Rate	Adaptive or fixed 0.3 to 3000 dB/sec
Control Strategy	Single or multiple input channels combined by minimum, maximum, or weighted average. Input amplitude estimated with peak, mean, rms, or digital tracking filter on a per channel basis.
Tracking Filter	Proportional – Bandwidth: 7 to 100% of drive frequency Fixed – Bandwidth: 1 to 500 Hz
Sweep Rate	Linear from 0 to 6 kHz/min, or logarithmic from 0 to 100 octave/min.
Limiting	Any channel can be enabled as a limit or abort channel. Each limit channel has a corresponding amplitude vs. frequency profile.
Non-acceleration Control	Control using a force, velocity, or displacement transducer; or control to angular acceleration.

Reference Profile	
Entered as a table of breakpoints for acceleration, velocity and displacement segments.	
Breakpoints	Unlimited combination of amplitudes (A, V or D) right and/or left constant A/V/D slopes at defined frequencies; automatic crossover calculations.
Abort/alarm	High and low profile limits defined independently at each breakpoint in dB with respect to reference.
Validation Tools	Profile displayed and updated as it is created. Automatic listing of peak acceleration, peak velocity, and peak-to-peak displacement values for profile. Profiles are validated against shaker parameter table.
Engineering Units	English, SI, metric, mixed; linear or rotary

Test Schedule	
User-defined sequence of events or 'profiles', that are automatically executed during test.	
Events	Sweeps (duration, sweep range and start frequency, sweep direction, and sweep rates), dwells (frequency and cycle or time duration), level, timed pause, digital output trigger, enable/disable abort checking, control loop open/close, and save results; logic for sequence loop and nested loops.
Profile Sequencing	Flow diagram of blocks with each block defining a profile and schedule.

Safety Features	
Control Signal	Automatic detection of input overload, open loop, and loss of control signal.
Abort Trigger	Continuous time allowed abort limits: From 0 – 1 sec
Test Shutdown	Shutdown initiated by operator or software is performed gracefully at a user-specified rate.
Abort Rate	1 to 120 dB/sec
Email Support	Email message automatically sent on abort

Test Execution	
The system performs pre-test checks, equalises the load and then executes the schedule.	
Automatic Mode	System executes events specified in the schedule. If a Profile Sequence is defined, profile-schedule blocks in the flow diagram are sequentially executed.
Manual Mode	User can override automatic mode to manage the test using manual commands.

Test Management	
Control panel toggle buttons and toolbar icons provide easy access to test controls. Commonly used commands are also accessible via keyboard function keys. Text messages and numerical readouts on the control panel enhance test status monitoring.	
Buttons	Start/stop, pause/continue, enable/disable, abort check, loop close/open, schedule clock on/off.
Icons	Test level set/increase/decrease, reset average, move to next event/profile, save signals.
Status Displays	Control and demand rms acceleration, demand velocity and displacement, test %/dB/ratio level, peak drive volts, full level and total test time elapsed, time remaining, activity status, and a red alert message box.

Signal Displays	
Unlimited number of display windows in tile or cascade format with click & drag zoom, user annotation, and cursors.	
Window Format	Per window choice of single, dual, or four pane formats. Each pane can display single or multiple signals overlaid in either time or frequency. Independent choice of colour and texture for signals, grids, tick marks, labels, titles, etc.
Scale Format	Linear or logarithmic scales for X and Y axes with automatic or manual scaling. Dimension: A, V or D.
Cursors	Single or dual with X, Y, ΔX, ΔY, ΔRMS and Q value readouts; manual peak marks; automatic peak/valley detection and marks; harmonic and sideband cursors.
Frequency Signals	Control, any input, transfer function (amplitude and phase), coherence, drive, profile, alarms, and aborts.
Strip Chart Plots	Scrolling record of peak value versus time for the control signal or any input signal; frequency versus time.
Oscilloscope Plots	Input time histories
Resonance Search	Table display of resonance frequencies and Q factors

COLA Features	
Constant Amplitude	Sine output with programmable amplitude from 0.1 to 10 V
DC Proportional	Varying DC output proportional to frequency; programmable frequency with linear or log interpolation

Online Math
This feature allows you to create customised signals. All signals are calculated and displayed 'live' during testing. Operations include addition, subtraction, multiplication, division, and transmissibility between spectra for any two inputs or an input spectrum and the control spectrum.

Post-test Documentation
Icon for single-click generation of data plots and test reports, including setup parameter listings, test logs and formatted signal plots, within Microsoft® Word.

Specifications - Premier Classical Shock Transient Control

Control Parameters	
Frequency Range	0 to 22 kHz
Frame Size	128 to 16384 points or automatically optimised. Linear filter design minimises distortion and preserves the true waveform shape.
Transfer Function	Measure during pre-test or, for quickest test start-up, recall a function from disk.
Averaging	User-specified coefficient from 1 to 500
Filtering	User specifies cut-off frequency for low-pass filtering applied to the reference waveform, drive, and all input channels.
Pulse Delay	User-specified delay between pulses from 0 to 1000 sec

Reference Waveform	
Convenient pulse selection from a waveform library. User-specified duration and peak acceleration.	
Pulse Types	Half-sine, haversine, initial and terminal peak sawtooth, triangle, rectangle and trapezoid.
Pulse Duration	From 0.5 to 3000 ms
Compensation	Pre-and post-pulse, post-pulse only, or pre-pulse only. Single- or double-sided for minimum acceleration and full use of shaker stroke. Choice of displacement optimum, half-sine, rectangular, rounded rectangular, or triangular compensation pulses. Pre-pulse and post-pulse amplitudes definable in percentage of reference peak acceleration.
Abort Limits	Set to MIL–STD810 guidelines or customised by user in percentage of reference waveform amplitude and percentage of pre-pulse and postpulse amplitudes.
Validation Tools	Waveform displayed and updated as it is created. Automatic display of profile acceleration, velocity, and displacement waveforms together with shaker limits. Shock profile is validated against shaker parameter table
Engineering Units	English, SI, metric, mixed

Test Schedule	
User creates a schedule of events to perform during the test. Looping and nested looping logic speed and simplify programming.	
Events	Level and number of pulses, digital output trigger, abort enable/disable, and loop open/close, save results, pause, invert pulse.

Test Management	
Control panel toggle buttons and toolbar icons provide easy access to test controls. Commonly used commands are also accessible via keyboard function keys. Text messages and numerical readouts on the control panel enhance test status monitoring.	
Buttons	Start/stop, pause/continue, enable/disable, abort check, loop close/open, schedule clock on/off.
Icons	Test level set/increase/decrease, reset average, move to next event/profile, save signals.
Status Displays	Control and demand rms acceleration, demand velocity and displacement, test %/dB/ratio level, peak drive volts, full level and total test time elapsed, time remaining, activity status, and a red alert message box.

Safety Features	
Control Signal	Automatic detection of input overload, open loop, and loss of control signal.
Point-abort Trigger	Allowable ratio of points exceeding abort limits to total number points in a frame: 0 to 1.
Test Shutdown	Shutdown initiated by operator or software is performed gracefully.
Email Support	Email message automatically sent on abort.

Test Execution	
The system performs pre-test checks, equalises the load and then executes the schedule.	
Pre-test	System performs safety checks then gradually increases the drive per the user-specified peak drive voltage (initial and maximum), response level goal, and ramp-up rate (slow or fast).
Automatic Mode	System sequentially executes each event in the schedule.
Manual Mode	User can override automatic mode to manage the test using manual commands.

Signal Displays	
Unlimited number of display windows in tile or cascade format with click & drag zoom, user annotation, and cursors.	
Window Format	Per window choice of single, dual, or four pane formats. Each pane can display single or multiple signals overlaid in either time or frequency. Independent choice of colour and texture for signals, grids, tick marks, labels, titles, etc.
Scale Format	Linear or logarithmic scales for X and Y axes with automatic or manual scaling. Dimension: A, V or D.
Cursors	Single or dual with X, Y, ΔX, ΔY, ΔRMS, and Q value readouts; manual peak marks; automatic peak/ valley detection and marks; harmonic and sideband cursors.
Time Signals	Control, drive, any input, profile, aborts, composite (control, profile, aborts).
Frequency Signals	Control, any input, transfer function (amplitude and phase), coherence, drive, profile, alarms, and aborts.
Strip Chart Plots	Scrolling record (data point per frame) of input channel rms, max, min, or mean values.
SRS Analysis	Up to 14 octave range (maxi-max, negative maximum, and positive maximum). User specifies high and low frequency, centre frequency, damping ratio or Q value, and resolution (1/1, 1/3, 1/6, 1/12, 1/24, or 1/48).

Post-test Documentation
Icon for single-click generation of data plots and test reports, including setup parameter listings, test logs and formatted signal plots, within Microsoft® Word.

Specifications - Resonance Search, Track and Dwell (RSTD) Vibration Control

Test Setup and Management
All of the features of Swept Sine Vibration Control software are included in the RSTD package. Users can follow familiar procedures for quick test setup. In Schedule, the user defines a Search Event by frequency range, sweep rate, and minimum Q and amplitude for resonance detection. Schedule also allows easy definition of a Dwell Event by selecting either a frequency locked dwell or tracked dwell at the resonances in the Dwell List generated during the Search Event. During the resonance search all of the control buttons, icons and status displays are available as in the Swept Sine package.

Resonance Search	
Resonance search creates a Dwell List from a measured transmissibility function using specified detection criteria.	
Transmissibility	Measurement between any pair of inputs or an input and the control signal.
Search Range	User-selected start and end frequencies within the frequency range defined by the reference profile.
Sweep Rate	Default to the sweep rate for the reference profile or user-specified special sweep rate.
Detection Criteria	Identification of resonances based on Q and transmissibility amplitude thresholds.

Resonance Dwell and Tracked Dwell	
Automated and interactive test modes reduce test time and allow tailored testing.	
Test Modes	Choice of three modes: 1 Search and dwell as each resonance is detected during the sweep. 2 Search then automatically dwell using the generated Dwell List. 3 Search, pause for user review and editing of the Dwell List, then automatically dwell using the edited Dwell List.
Dwell Modes	Fixed frequency or tracked resonance dwell. Tracked dwell adjusts the drive frequency to track the resonance as its frequency changes during dwelling.
Dwell Duration	Time or cycles using true cycle counting.
Drift Criteria	Programmed end to resonance track on a frequency drift exceeding a specified percentage of the initial resonant frequency, a specified shift in frequency over a specified time interval, or a specified change in amplitude ratio.

Signal Displays	
RSTD offers all of the flexible window displays and plot attribute selections available in the Swept Sine Control package. RSTD also provides a special four-pane window that updates during search and dwell operations:	
Search Log	Provides a time-stamped list of all activities including search start/end, resonance frequencies found, and resonance tracking status.
Dwell List	Shows the frequency, amplitude, phase, Q, and elapsed time for each resonance found. Interactive editing via Add and Remove buttons: Add inserts a resonant frequency value, Remove deletes resonances based on screening by list entry number, Q, or amplitude.
Amplitude Plot	Plot of transmissibility magnitude versus frequency.
Phase Plot	Plot of transmissibility phase angle versus frequency.

Special Displays	
Special displays for monitoring resonance dwells include:	
Dwell Histories	Control acceleration versus time and drive frequency versus time.
Frequency Signals	Control acceleration, derived velocity, or derived displacement versus frequency.

Post-test Documentation	
Documentation and reports of both setup parameters and signals produced through Microsoft® Word as printed media or saved files on disk.	
Run Log	Time and test frequency (Hz) stamped list of all test operations including test start/end, schedule actions, operator commands, and error or abort conditions.
Search Log	Time-stamped list of all resonance search and dwell operations including search start/end, resonance frequencies found, and dwell start/end.
Resonance List	Tabulated list of resonance frequencies and corresponding amplitude, phase, Q, dwell status, and dwell duration.
Data Plots	Transmissibility function, control acceleration versus time, drive frequency versus time; saved either automatically or manually.

Specifications - Sine-on-Random (SoR) Vibration Control

Test Setup and Control

SoR includes all of the features of the Random Vibration Control package with one exception – the maximum frequency is limited to 4000 Hz (5500Hz with the High Frequency option).

Set up of a SoR broadband Power Spectral Density (PSD) profile is the same as in the Random package. Up to 20 sine tones are added. Automatic on/off switching (at arbitrary intervals) of each of the sine tones, or even the broadband random, can be set in the schedule.

Broadband Control Technique

The broadband control process is the same as that used in the Random package. The PSDs for the drive and control channels are calculated on a per frame basis and used to continuously update the control loop transfer function. The broadband random drive signal has a true gaussian distribution.

Sine Tone Control Technique

Up to 12 tones can be controlled simultaneously. An individual phase-locked tracking filter is applied to each sine tone to accurately extract its amplitude from the control feedback signal. The sine tone portions of the drive signal are generated digitally with updates to amplitude and frequency made on a per point basis or at zero-crossings.

A high precision waveform generator creates pure sine tones with extremely low amplitude distortion. The Total Harmonic Distortion (THD) of each sine tone is less than –90 dB. Tone frequencies are changed with anlaogue-like smoothness. The tone sweep characteristics are not linked to the broadband random spectral resolution or the frame acquisition time.

Special Features

Validation Tools	Automatic listing of acceleration, velocity and displacement values for the broadband, tones and overall profile. The sum of the rms values of all active components (sine tones and broadband random) is used to calculate the overall expected peak vibration levels. The peak A/V/D levels are automatically validated against the shaker limits prior to starting a test and before implementing any manual mode changes during testing.
RMS Limits	High/low rms alarm/abort limits can be automatically calculated based on profiles or entered by the user.

Special Displays

SoR provides the following special data displays:

Tone Tracks	Acceleration versus frequency online displays for all sweeping tones.
Sweep Envelope	Amplitude versus frequency sweep envelope for tones, provides pre-test validation of the setup.

Sine Tone Characteristics

Number	Up to 20 tones
Target Amplitude	Fixed acceleration or amplitude versus frequency profile table.
Profile Breakpoints	Unlimited combination of amplitudes (A, V or D) and right and/or left constant A/V/D slopes at defined frequencies.
High Abort/alarm	Limits specified in dB with respect to the target amplitude.
Frequency Range	High, low, and initial frequency in Hz (all with a resolution as fine as .000001 Hz).
Initial Direction	Increasing or decreasing from the initial frequency.
Sweep Mode	Linear or logarithmic specified as rate or time.
Sweep Rate	Linear at 0 to 1000 Hz/min, or logarithmic at 0 to 20 oct./min.
Sweep Time	User-defined in minutes/sweep.
Ramping Rate	0 to 200 dB/sec (the amplitude changes between 0 and the target at this rate after the tone is switched on/off).
Burst On and Off	Independent time on time off with resolution of 0.001 sec.
Harmonic Mode	Sets tones no. 2, 3, 4,... to be integer multiples of sine tone no. 1's frequency parameters.

Sine-on-Sine

The broadband random may be totally suppressed allowing multi-sine excitation with up to 20 sine tones simultaneously.

Test Management

SoR includes all of the automatic and manual test controls that are included in the Random software package, with the addition of a control panel that allows the user to switch on/off individual sine tones or the broadband random.

Automatic Mode	While creating the test schedule, the user arranges events using looping and nested looping logic similar to creating a schedule in Random. In SoR, the control panel can be repeatedly inserted as an event to switch on/off individual sine tones or the broadband random at any time. One typical application of this feature is to delay the start time of the sine tones until after the random has reached full level. This flexible implementation of the schedule allows users to write their own script for the test.
Manual Mode	During testing, the user can use the control panel to activate or deactivate any of the components at any time. The software will validate the overall required rms value against shaker limits before implementing any changes.

Specifications - Random-on-Random (RoR) Vibration Control

Test Setup and Control
RoR includes all of the features of the Random Vibration Control package with one exception – the maximum frequency is limited to 4000 Hz (5500Hz with the High Frequency option). Set up of a RoR broadband Power Spectral Density (PSD) profile is the same as in the Random package. Up to 12 narrowbands are added. Automatic on/off switching (at arbitrary intervals) of each of the narrowbands, or even the broadband random, can be set in the schedule.

Broadband Control Technique
The broadband control process is the same as that used in the Random package. The PSDs for the drive and control channels are calculated on a per frame basis and used to continuously update the control loop transfer function.

Narrowband Control Technique
The reference profile is updated on a per frame basis. The total drive signal, made up of the broadband random plus the random narrowbands, has a true gaussian distribution.

Special Displays	
RoR provides the following special data displays:	
Sweep Envelope	PSD amplitude versus frequency sweep envelope for narrowbands, provides pre-test validation of the setup.

Safety Features	
Automated and interactive test modes reduce test time and allow tailored testing.	
Validation Tools	Automatic listing of acceleration, velocity and displacement values for the broadband, tones and overall profile. The sum of the rms values of all active components (sine tones and broadband random) is used to calculate the overall expected peak vibration levels. The peak A/V/D levels are automatically validated against the shaker limits prior to starting a test and before implementing any manual mode changes during testing.
RMS Limits	High/low rms alarm/abort limits can be automatically calculated based on profiles or entered by the user.

Narrowband Characteristics	
Number	Up to 12 narrowbands.
Target Amplitude	Acceleration PSD (for example, G/Hz, or (min/sec)/Hz, etc.).
Profile Breakpoints	Unlimited combination of PSD levels with right and left slopes (dB/octave) at user-defined frequencies.
Narrowband Width	Frequency width specified in Hz.
High Abort/alarm	Limits specified in dB with respect to the target amplitude.
Frequency Range	High, low, and initial frequency in Hz (specified for the centre frequency of the narrowband).
Initial Direction	Increasing or decreasing from the initial frequency.
Sweep Mode	Linear or logarithmic specified as rate or time.
Sweep Rate	Linear at 0 to 500 Hz/min, or logarithmic at 0 to 10 oct./min.
Sweep Time	User-defined in hours:minutes:seconds.
Ramping Rate	0 to 60 dB/sec (the amplitude changes between 0 and the target at this rate after the narrowband is switched on/off).
Harmonic Mode	Sets narrowbands no. 2, 3, 4,... to be integer multiples of narrowband no. 1's frequency parameters.
Profile Composition	Sum of narrowbands and broadbands or maximum between narrowbands and broadband.

Test Management	
RoR includes all of the automatic and manual test controls that are included in the Random software package, with the addition of a control panel that allows the user to switch on/off individual narrowbands or the broadband random.	
Automatic Mode	While creating the test schedule, the user arranges events using looping and nested looping logic similar to creating a schedule in Random. In RoR, the control panel can be repeatedly inserted as an event to switch on/off individual narrowbands or the broadband random at any time. One typical application of this feature is to delay the start time of the narrowbands until after the random has reached full level. This flexible implementation of the schedule allows users to write their own script for the test.
Manual Mode	During testing, the user can use the control panel to activate or deactivate any of the components at any time. The software will validate the overall required rms value against shaker limits before implementing any changes.

Specifications - Sine-and-Random-on-Random (SRoR) Vibration Control

This add-on module for the SoR and RoR Vibration Control software packages, allows for the user to create a vibration environment by combining fixed or sweeping sine tones, and fixed and sweeping random narrowbands with broadband random vibration.

The ultimate in closed loop control applications, SRoR enables the user to simulate the most demanding environments in their test lab. Similar to SoR and RoR, the user can individually activate and deactivate any component (sine tone, narrowband, or broadband) of the environment.

SRoR is very easy to set up and run, and is unique in that it uses the power of 60 MHz DSPs (with floating point math) to execute an advanced phase-locked tracking filter technique simultaneously on each of the independent sine tones. For gunfire simulations, it allows for exceptionally fine control of burst time on/off. Abrupt changes in level, when switching the sine tones or narrowbands on and off, are managed with a user-defined ramping rate.

Test Setup and Control
SRoR includes all of the features of the Random, SoR and RoR vibration control packages with one exception – the maximum frequency is limited to 4000 Hz (5500 Hz with the high frequency option). Set up of a SRoR broadband Power Spectral Density (PSD) profile is the same as in the Random package. Up to 12 sine tones and 12 narrowbands are added. Automatic on/off switching (at arbitrary intervals) of each of the sine tones and narrowbands, or even the broadband random, can be set in the schedule. During testing, the system simultaneously controls the sine tones, random narrowbands and broadband random.

Broadband Random Control Technique
Same as for the Random Vibration Control package.

Sine Tone Control Technique
Same as for the SoR Vibration Control package.

Sine Tone Characteristics
Same as for the SoR Vibration Control package.

Narrowband Control Technique
Same as for the RoR Vibration Control package.

Narrowband Characteristics
Same as for the RoR Vibration Control package.

Test Management
Same as for the SoR and RoR Vibration Control packages.

Safety Features
Same as for the SoR and RoR Vibration Control packages.

Specifications - Shock Response Spectrum (SRS) Transient Control

Test Setup

All of the features of the Classical Shock Transient Control package are included in SRS. Users will recognise the same implementation of Schedule, Test Execution, Test Management, and Signal Displays.

Preparing the reference waveform is a three-step process:

1 The user specifies a Required Response Spectrum (RRS).
2 The software uses independent wavelets to synthesise a waveform matching the energy content of the RRS.
3 The software compensates the waveform to ensure zero final 6 matching the energy content of the RRS.

Required Response Spectrum (RRS)

The RRS is an acceleration versus frequency spectrum that can be defined with as few as two breakpoints. The user enters a table of breakpoints and high/low abort limits, then selects parameters to divide the RRS into discrete Nth-octave bands centred on the reference frequency.

Breakpoints	Unlimited combination of target acceleration amplitude with right and/or left slopes (dB/octave) up to 22 kHz.
Abort Limits	Specified in dB with respect to the target amplitude.
RRS Parameters	Low, high and reference frequency; damping ratio (%) or Q; Nth-octave bands (1/1, 1/3, 1/6, 1/12, 1/24, 1/48).

Waveform Synthesis

The software uses the wavelet parameters and synthesis parameters to automatically generate wavelets for each of the Nthoctave bands. The wavelets are combined (synthesised) to produce an initial estimate of the composite transient waveform. The SRS of that waveform is calculated and overlaid on the RRS. If the initial estimate has converged to the RRS, the user can either accept it and move on to Compensation, or modify the synthesis parameters and/or individual wavelet parameters, then iterate to achieve the desired level of convergence.

Wavelet Types	Half-cycle sinusoids with sine, exponential (gives damped sine), rectangular or Hann window.
Waveform Criterion	Pyro-shock, minimum acceleration, or specified time duration (ms).

Wavelet Parameters

Listing	Per wavelet list of frequency (Hz), RRS value (acceleration), synthesised amplitude (acceleration).
Definition	Number of half-cycles, delay (ms) and wavelet amplitude (acceleration).
Analysis Type	Maxi-max, positive maximum and negative maximum.
Damping	Percent of critical damping or Q value.
Resolution Reduction Factor	Allows the user to automatically deactivate every Nth wavelet, N = 2 to 48.
Error Display	Numeric display of rms difference between the RRS and synthesised spectrum.
Compensation	High-pass filtering or DC removal to bring the final acceleration, velocity and displacement to zero.

Test Execution

The system performs pre-test checks, equalises the load, and then executes the schedule.

Pre-test	System performs safety checks then gradually increases the drive per the user-specified peak drive voltage (initial and maximum), response level goal, and ramp-up rate (slow or fast).
Automatic Mode	System sequentially executes each event in the schedule.
Manual Mode	User can override automatic mode to manage the test using manual commands.
Signal Displays	During testing, the user can display measured waveforms as acceleration, velocity and/or displacement; standard SRS or A/V/D nomograph SRS.

Control Technique

The control loop transfer function is updated after each pulse. Following each pulse, the control SRS abort limits are checked.

Frame Size	Automatically optimised (up to 16384 points) for the reference waveform. Linear filters minimise distortion and preserves the true waveform shape.
Sampling Rate	Up to 48000 samples per second.
Transfer Function	Measure during pre-test or, for quickest test startup, recall a function from disk.
Averaging	User-specified coefficient from 1 to 500
Filtering	User specifies cut-off frequency for low-pass filtering applied to the reference waveform, drive, and all input channels.
SRS Analysis	Up to 14 octave range using maxi-max, negative maximum, and positive maximum analysis techniques. User specifies high and low frequency, reference frequency, damping ratio or Q value, and resolution (1/1, 1/3, 1/6, 1/12, 1/24, 1/48).
Line-abort Trigger	Allowable ratio of lines exceeding abort limits to total number of lines in the RRS: 0 to 1.
Pulse Delay	User-specified delay between pulses from 0 to 1000 sec.

Specifications - Transient Time History (TTH) Control

Profile Import	
Waveforms are imported by specifying the source file format and then using Browse to locate a file and import a profile. Digital resampling adjusts the data's sample interval (time step between data points) to match standard system sampling rates.	
File Formats	ASCII delimited format (tab, comma or space) using Y values or XY data pairs, ASCII UFF, MTS® RPC III and binary format.
Digital Resampling	From 48000 samples per second down to 20 samples per second in 24 stages.
Frame Size	256, 512, 1024, 2048, 4096, 8192 or 16384 samples.
Pre-stored Profiles	Bellcore Z1 and Z2, Bellcore Z3, Bellcore Z4, sine, chirp, burst sine, and other waveforms.

Profile Editing and Compensation	
Select and apply editing techniques to modify the profile while viewing the acceleration, velocity and displacement waveforms. Multiple compensation techniques ensure initial and final conditions of zero acceleration, velocity and displacement.	
Rescale	Adjust the reference waveform's magnitude or polarity by applying a scale factor to each data point.
Fill-in	Select a range of data points and specify a new Y value for all of those data points.
Taper End Points	Applies a Hann window over a specified percentage of the leading and trailing parts of the waveform.
Compensation	Pre- and post-pulses, brick wall high-pass filter, high-pass filter, DC removal, or disabled.

Transfer Function Equalisation	
TTH provides flexible and accurate control loop transfer function equalisation, with six methods offered:	
Quick Start Method	Browse through disk files, recall a stored transfer function and skip the pre-test.
Closed Loop Method	The system outputs a drive waveform and measures the transfer function. A new drive waveform is computed and the process repeated until the control response matches the profile at a specified goal level.
Open Loop Methods	1 Profile(t): Uses the profile waveform as the drive output. 2 Random White Noise: System creates the drive waveform from a flat broadband random profile. 3 Shaped Random Noise: System uses the spectrum shape of Profile(t) to create a shaped random output. The system outputs a drive waveform and measures the transfer function. This process is repeated several times with the exact same drive waveform output every time. The peak drive voltage and the number of outputs are user-specified.

Control Technique
Control process is identical to the Classical Shock Transient Control software. The spectra for the drive and control channels are calculated per data frame and used to adjust the control loop transfer function.

Test Management
TTH includes all of the automatic and manual test controls that are included in the Classical Shock package. Any or all of the input channels are available to display as acceleration, velocity or displacement waveforms during testing or for post-test analysis. During testing, a special stip chart scrolling display is standard on all time domain input signals. This display gives fast visual validation even for very low frequency tests.

Over-test Protection	
Waveforms are imported by specifying the source file format and then using Browse to locate a file and import a profile. Digital resampling adjusts the data's sample interval (time step between data points) to match standard system sampling rates.	
Validation Tools	Waveform displayed and updated as it is created, imported or edited. Automatic display of profile acceleration, velocity and displacement waveforms together with shaker limits. Profile demands are validated against the shaker parameters.
Automatic or Manual Abort	High and low abort limits can be entered directly by the user. Continuous point-abort checking is performed during testing. This allows aborts during a test rather than only at the end of an entire data frame (critical for long duration low-frequency events).

Specifications - Long Time History (LTH) Waveform Replication Control

Profile Import	
Waveforms are imported by specifying the source file format and then using Browse to locate a file and import a profile. Digital resampling adjusts the data's sample interval (time step between data points) to match standard system sampling rates.	
File Formats	ASCII delimited format (tab, comma or space) using Y values or XY values, ASCII UFF, MTS® RPC III and binary format.
Digital Resampling	From 20 to 12000 samples per second in 20 stages.
Pre-stored Profiles	Band-limited random, white noise, sine and chirp.

Profile Editing	
Select and apply editing techniques to modify the profile while viewing the acceleration, velocity and displacement waveforms.	
Build Waveform	Replace, insert, or append a waveform. A splice utility ensures waveform continuity between adjoining waveform segments.
Rescale	Adjust the reference waveform's magnitude or polarity by applying a scale factor to each data point.
Compensation	Acceleration DC removal, velocity, DC removal, high-pass filter, low-pass filter, decimation, none.
Shaped Random	Random profile with spectrum shaped specified by breakpoint table or imported PSD; user-specified kurtosis and skew.

Profile	
Single Profile	One profile with associated test schedule.
Multiple Profiles	Unlimited profiles each with independently specified number of repetitions and level.

Initial Equalisation	
Quick Start Method	Browse through disk files, recall a stored transfer function and skip the pre-test.
Shaped Random Method	A random noise drive signal, based on a defined PSD profile, is output and the transfer function measured using a closed loop method. The PSD profile is entered as an unlimited combination of PSD levels with right and/or left slope (dB/octave) at user-defined frequencies. Or, the PSD of the actual waveform may be used. The PSD profile may also be defined by a measured PSD, or imported ASCII or UFF file. The user can, in addition, rescale the PSD profile to a new rms value.

Signal Displays	
Unlimited number of display windows in tile or cascade format with click & drag zoom, user annotation, and cursors.	
Window Format	Per window choice of single, dual, or four pane formats. Each pane can display single or multiple signals overlaid. Independent choice of colour and texture for signals, grids, tick marks, labels, titles, etc.
Scale Format	Linear or logarithmic scales for X and Y axes with automatic or manual scaling. Dimension: A, V or D
Cursors	Single or dual with X, Y, ΔX, ΔY, ΔRMS and Q value readouts; manual peak marks; automatic peak/ valley detection and marks; harmonic and sideband cursors.
Time Signals	Control, profile, any input, aborts, composite (control, profile, aborts) and drive; scrolling input histories.
Frequency Signals	Control, profile and drive.

Over-test Protection	
Validation Tools	Waveform displayed and validated against the shaker parameters.
Automatic or Manual Abort	Continuous point-abort checking is performed during testing. This allows aborts during a test rather than only at the end of an entire output data frame.

Drive Generation
After the initial transfer function has been determined, a test can be started immediately. The drive signal is output with constant adjustments as the test progresses. A unique overlapped convolution algorithm ensures a continuous drive signal with smooth transitions between output frames.

On-line Control
The transfer function is continuously updated during the test at a user-specified rate. This technique adjusts for non-linear effects and changing load dynamics to deliver high accuracy without the need for multiple pre-test iterations.

Test Schedule
Pre-programmed schedule of test events including test level, number of output repetitions, and save results.

Post-test Documentation
Icon for single-click generation of data plots and test reports, including setup parameter listings, test logs, and formatted signal plots, within Microsoft® Word.

Specifications - Value Random, Swept Sine and Classical Shock Software

Value Vibration Control software provide an economical way to configure a $LASER_{USB}$ Vibration Controller for random, sine, and classical shock testing. Easy-to-use software, together with extensive automation features such as on-line transmissibility functions, also make the Value applications suitable for research and product development testing.

As your test needs grow, you can conveniently enhance the capabilities of your vibration controller by upgrading from Value packages to Premier packages. The upgrade is simple and no additional hardware is required to make the change. Plus, all of your existing Value test project files are fully compatible with the upgraded Premier packages.

Value Random Vibration Control	
Reference Profile	Breakpoint table with unlimited combination of PSD levels with right and/or left slope (dB/octave) at user-defined frequencies.
Frequency Range	0 to 2400Hz in eight ranges; 4000 Hz optional.
Resolution	110, 225 or 450 spectral lines; 800 lines optional.
Dynamic Range	Up to 95 dB.
Randomisation	Frequency domain phase randomisation technique produces a true gaussian distribution.
Loop Time	Typically 100ms.
Transfer Function	Measure during pre-test or for quickest test start-up, recall a function from disk.
DOF	2 to 1000
Control Accuracy	1 dB at 99% confidence with 200 DOF.
Number of Inputs	4 to 8
Control Strategy	Control to any single input channel; multiple channel option.
Drive Clipping	3 to 6 sigma or disabled.

Value Swept Sine Vibration Control	
Reference Profile	Unlimited combination of amplitudes (A, V or D) and right/left constant A/V/D slopes at defined frequencies.
Frequency Range	0.1Hz to 2400Hz; optional 4000 and 12000Hz ranges.
Dynamic Range	Up to 100 dB
Loop Time	Typically 10ms
Control Accuracy	1 dB through a peak-notch with a Q of 50, at 1 octave/min.
Compression Rate	Adaptive or fixed 0.3 to 3000 dB/sec.
Number of Inputs	4 to 8
Control Strategy	Control to any single input channel; multiple channel option. Peak, mean or rms input channel amplitude processing. Digital tracking filters optional.
Sweep Rate	Linear from 0 to 6000 Hz/min or logarithmic from 0 to 100 octaves/min.
Drive Resolution	As fine as 0.000001Hz
Sine Dwell	User-specified dwell frequency with duration specified in cycles or time.

Value Classical Shock Transient Control	
Pulse Types	Half-sine, Haversine, initial and terminal peak sawtooth, triangle, rectangle and trapezoid.
Compensation	Pre- and post-pulse, post-pulse only, or prepulse only. Single- or double-sided for minimum acceleration and full use of shaker stroke.
Frequency Range	0 to 22000 Hz
Frame Size	128 to 16384 points or automatically optimised. Linear filter design minimises distortion and preserves the true waveform shape.
Number of Inputs	4 to 8
Transfer Function	Measure during pre-test or for quickest test start-up, recall a function from disk.
Averaging	User-specified coefficient from 1 to 500
Filtering	User-specified cut-off frequency for low-pass filtering applied to the reference waveform, drive and all input channels.
Pulse Delay	User-specified from 0 sec. to unlimited.

Premier and Value Software Package Comparison and Feature Guide

General Features	Software Package Value	Premier
Setup Features		
Validation Tools:		
Listing of dynamic limits	✓	✓
Overlay of shaker limits	✓	✓
Shaker limit checks	✓	✓
Engineering Units	✓	✓
Test Execution		
Test Schedule	✓	✓
Pre-test Modes:		
Automatic test start-up	✓	✓
Hold for operator prompt	✓	✓
Operation Modes:		
Automatic	✓	✓
Manual	✓	✓
Safety Features		
Control Signal Loss Checks	✓	✓
Automatic Line-abort Trigger	✓	✓
Test Shutdown:		
Automatic graceful shutdown	✓	✓
Manual abort	✓	✓
Post-test Documentation Features		
Quick reports in Word	✓	✓

Swept Sine Vibration Control	Software Package Value	Premier
Maximum Frequency Range (kHz)	2.4; 4, 12 opt.	4; 12 opt.
Loop Time	10 ms	10 ms
Maximum Input Channels	8	16
Compression Rate:		
Fixed (dB/sec)	0.3 – 3000	0.3 – 3000
Adaptive	✓	✓
Control Strategies:		
Single channel control	✓	✓
Multiple channel control	option	✓
Digital tracking filters	option	✓
Peak, rms and mean	✓	✓
Non-acceleration control	–	✓
Sweep Type and Rate:		
Linear (Hz/min)	6000	6000
Logarithmic (octaves/min)	100	100
Maximum Input Channels	unlimited	unlimited
Signal Displays:		
One, two and four pane	✓	✓
Math operations and displays	–	✓
Application Expansion:		
Resonance Search, Track and Dwell	–	✓
Automatic drive notching/limiting	–	✓

Random Vibration Control	Software Package Value	Premier
Maximum Frequency Range (kHz)	2.4; 4 opt.	4; 10 opt.
Maximum Frequency Resolution (lines)	450; 800 opt.	1800
Loop Time	100 ms	100 ms
Maximum Input Channels	8	16
Control Strategies:		
Single channel control	✓	✓
Multiple channel control	option	✓
Non-acceleration control	–	✓
Loop Transfer Function:		
Pre-test equalization	✓	✓
Stored disk file	✓	✓
Import Profile	option	✓
Signal Displays:		
One, two and four pane	✓	✓
Math operations and displays	–	✓
Scrolling strip chart plots	–	✓
Oscilloscope plots	–	✓
Application Expansion:		
Sine-on-Random	–	✓
Random-on-Random	–	✓
Sine- and Random-on-Random	–	✓
Automatic drive notching/limiting	–	✓

Classical Shock	Software Package Value	Premier
Maximum Frequency Range (kHz)	22	22
Maximum Frame Size	16384	16384
Loop Transfer Function:		
Pre-test equalization	✓	✓
Stored disk file	✓	✓
Maximum Input Channels	8	16
Low-pass Filtering	✓	✓
Classical Pulse Types:		
Half-sine	✓	✓
Haversine	✓	✓
Sawtooth	✓	✓
Rectangle	✓	✓
Triangle	✓	✓
Trapezoid	✓	✓
SRS Analysis	–	✓
Control Strategies:		
Single channel control	✓	✓
Multiple channel control	–	✓
Non-acceleration control	–	✓
Signal Displays:		
One, two and four pane	–	✓
Scrolling strip chart plots	–	✓
Application Expansion:		
SRS Synthesis and Control	–	✓
Transient Time History Control	–	✓

Ordering Information

Hardware

LAS-200 LASER$_{USB}$ Shaker Control System, including:

- Four inputs
- One output
- COLA
- Digital I/O for remote control

Software Bundles

SCO-101	**Premier Bundle 1** Random, Swept Sine, RSTD, Classical Shock, Sine Oscillator, and Analyse Anywhere
SCO-102	**Premier Bundle 2** Random, SOR, Swept Sine, RSTD, Classical Shock, TTH, Sine Oscillator, and Analyse Anywhere
SCO-103	**Premier Bundle 3** Random, SOR, ROR, Swept Sine, RSTD, Classical Shock, SRS, Sine Oscillator, and Analyse Anywhere
SCO-104	**Premier Bundle 3** Random, SOR, ROR, SROR, Swept Sine, RSTD, Classical Shock, TTH, SRS, Password, Sine Oscillator, and Analyse Anywhere
SCO-107	**Value Bundle** Value random, value Sine, Value Classical Shock, and Analyse Anywhere

Software Packages

PREMIER SOFTWARE

SCO-01P	Premier Random Vibration Control
SCO-02P	Premier Swept-sine Vibration Control
SCO-03P	Premier Classical Shock Transient Control

VALUE SOFTWARE

SCO-01V	Value Random Vibration Control
SCO-02V	Value Swept-sine Vibration Control
SCO-03V	Value Classical Shock Transient Control

Optional Hardware and Software

OPTIONAL HARDWARE

LAS-201	Single-channel Analog Input (with voltage, CCLD sensor power and TEDS input coupling)
LAS-203	Remote Abort Button
LAS-204	Rack Mounting Kit
LAS-210	Channel Expansion Box
ACC-101	Wireless Remote Control Pendant (includes hardware and software)

OPTIONAL PREMIER SOFTWARE

SCO-01P-01	Sine-on-Random Vibration Control
SCO-01P-02	Random-on-Random Vibration Control
SCO-01P-03	Sine- and Random-on-Random Vibration Control
SCO-01P4	Kurtosis Parameter Control
SCO-02P-01	Resonance Search, Track and Dwell Vibration Control
SCO-03P-01	Transient Time History Control
SCO-03P-02	Shock Response Spectrum Transient Control
SCO-04P	Long Time History Road Simulation Control
SCO-05P	Sine Oscillator

OPTIONAL VALUE SOFTWARE

SCO-01V-02	Resolution Extension for Value Random
SCO-01V-03	Frequency Range Extension for Value Random
SCO-01V-04	Import of PSD as Reference for Value Random
SCO-02V-03	Frequency Range Extension for Value Swept-sine

OPTIONAL GENERAL SOFTWARE

SCO-100-02	Multi-layer Password Security System
SCO-100-03	High Frequency Control
SCO-100-06	Advanced Graphics Option (waterfalls and spectograms)
SCO-110	Analyze Anywhere for Shaker Control
SCO-111	Waveform Editor
SCO-113	Thermal Chamber Communication and Control
SCO-114	Amplifier Control Interface
DSA-100-08	Signal Reader (ActiveX® commands to access binary files)

NETWORK ENABLED SOFTWARE

NET-103-01	NET-Integrator™ ActiveX Command and Communication Interface
NET-104-01	NET-Integrator Run-time License (per seat)

CALIBRATION

VTS-CTRL-CAI	Initial Accredited Calibration (Main and Expansion Box)

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Brüel & Kjær Sound & Vibration Measurement A/S
DK-2850 Nærum · Denmark · Telephone: +45 77 41 20 00 · Fax: +45 45 80 14 05
www.bksv.com · info@bksv.com
Local representatives and service organizations worldwide