

**Control Methods**

**Control loop** Patented adaptive control method with cross-coupling compensation, frequency response matrix updating and coherence smoothing to accurately and quickly compensate for non-linear and time varying changes in the dynamic load. Control channel response vector controlled to user specified spectral density matrix (SDM).

**Advanced features** See separate sheet for optional methods including rectangular control and I/O matrix transformations.

**Outputs/ Inputs**

**Output channels** 2 to 12. Consult the factory if more are needed.

**Input channels** 6 to 96 (depends on outputs and chassis type).

**Control Performance**

**Dynamic range** Up to 80 dB.

**Output signals** True Gaussian random with no periodicity.

**Equalization accuracy** For each control channel, control PSD within  $\pm 1$ dB. Between control channels, relative phase within  $\pm 2$  degrees and coherence within  $\pm 0.1$ . Assumes flat and equal reference PSDs and 120 DOF, 90% statistical confidence (accuracy may be limited by exciter system and instrumentation).

**Loop time** Less than 0.7 seconds typical for 4 control channels, 4 new frames per loop, 2000 Hz BW, 200 lines, 4 spectrum averages and 120 DOF (dependent on host model).

**Re-equalization rate** For an instantaneous change of 6 dB in all control spectrum lines, the RMS re-equalizes to  $\pm 1$  dB within 8 control loops for a flat reference with 120 DOF, 90% statistical confidence.

**Reference SDM**

**Definition** For each control channel, easily defined by a combination of up to 100 frequency breakpoints (PSD value and relative coherence and phase to other control channels) and PSD slopes (dB/octave).

**Phase specification** From -180 to +180 degrees.

**Coherence specification** From 0.0 to 0.99.

**Alarm and abort limits** Independent positive and negative alarm and abort tolerances for each break point's PSD value and relative phase in applicable units.

**Frequency range** DC to 40, 50, 80, 100, 200, 400, 800, 1K & 2K Hz.

**Frequency resolution** 100, 200, 400, 800, 1600 or 3200 lines.

**Imported SDM** A reference spectral density matrix may be imported from an ASCII UFF file or spreadsheet file.

**Re-scale reference** Re-scale the reference spectra based on user specified overall RMS levels.

**Units** Acceleration (g or  $m/s^2$ ),  $rad/s^2$  or user defined.

**Limit profiles** Defined using up to 40 frequency breakpoints and slopes. May use reference spectrum as default.

**Control Parameters**

**Control channels** Any channel may be selected as control; up to the number of installed output channels.

**Mode of operation** Manual (interactive) or automatic (non-interactive).

**Test duration** User defined up to 999:59:59 (h:m:s).

**Degrees of freedom** User defined from 8 to 10000.

**Output level control** Automatic or manual (up/down/full level).

**Limit channels** Limit profiles override defined control method on spectral line by line basis to prevent over-test. Any non-control channel may be a limit channel.

**Control Strategy**

**Pre-stored [Z(f)]** Select equalized impedance from previous tests.

**Adaptive gain** Z(f) update rate; selectable from 0.0 to 1.0.

**Singularity threshold** Specifies when pseudo-inversion is used for Z(f).

**Equalization method** Adaptive inverse frequency response matrix. May specify frequency range for PSD level control.

**Characterization** Random signals with flat power spectral density.

**Startup Parameters**

**Characterization level** -30 to 0 dB (relative to maximum reference rms). System increases drive rms until one of the control channels has an rms equal to or greater than specified characterization level. Charge amplifier sensitivities and characterization levels need to be chosen such that the least responsive control channel response voltage is at least 50 mV rms.

**Level increase** Manual or automatic 0 to 10000 seconds or loops.

**Level increment** 0.1 to 10 dB.

**Time to full level** 0 to 10000 seconds.

**Safety Features**

**Shaker limits** Pretest verification that spectrum dynamic limits are within shaker operational limits (acceleration, velocity, displacement and voltage).

**Loop check** Selectable, 10 to 1000 mVrms maximum drive.

**Alarm/Abort limits** RMS acceleration limit in dB or EU. Number of lines or percent of lines within specified range. An independent profile for each limit channel. Continuous automatic detection. Graphical and keyboard abort buttons.

**Limit profiles** Independently selectable from 0.1 to 50 dB/sec.

**Control signal loss**

**Manual abort**

**Startup/shutdown rates**

**Channel Setup**

**Channel type** Control, auxiliary, limit or inactive.

**Sensitivity** 0.01 to 10,000 mV/(units).

**Channel loop check** Enabled or disabled (per channel).

**Channel labels** Two labels for each channel (30 & 15 characters).

**On-Line Displays**

**Simultaneous displays** Up to 12 windows, each with up to 4 grids.

**Waveforms per grid** Up to 4 (up to 192 on 48 grids).

**Auxiliary monitor** Optional second monitor for test displays.

**On-Line Analysis**

**SDM functions** Reference, control and drive with magnitude, phase and coherence. Z(f) with magnitude and phase.

**PSD functions** Error, monitor, limit and auxiliary measurements.

**MIMO H(f)** True MIMO [H(f)] magnitude and phase.

**Partial Coherence** Check coherence between drive and control signals for adequacy of the system setup/design.

**Spectra averaging** Auxiliary measurement channels processed with linear or exponential averaging and user defined DOF (separate from control loop).

**Cursors** X and Y value readout, peak search, trace tagging and multi-window locked positioning.

**Scaling (x-y)** Log, linear or mixed. Automatic or fixed scale.

**Host Data Storage & Review**

**Setup & format** Automatic timed (any level) or timed at full level or manual mode. Binary files converted to UFF or Ascii spreadsheet formats.

**Playback** Scan forward or backward through the entire test data file, with adjustable delay.

**Test overlay** Select files from multiple tests for overlay.

**Annotation** Test name, test time & level for each record.

**Documentation**

**Test summary** Documented post-test summary; easily printed or incorporated into documents using standard word processing software.

**Message log** Text file records all system status messages that were displayed during the test.

**Batch plots** Automatic plot generation at test completion. Plot modes for sending all displays to the printer with single or multiple grids per page.

**Throughput Disk (TPD)**

**General description** Store all time domain data to disk during a test. Data may be replayed to recreate spectral test displays or replayed via Signal Analysis or imported into MIMO Waveform Replication. See separate TPD data sheet.

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S P E C T R A L  
D Y N A M I C S

**Spectral Dynamics Inc.**  
2730 Orchard Parkway  
San Jose, CA 95134-2012  
Tel 408 678-3500  
Fax 408 678-3580