EDM Dynamic Signal Analyzer Mode Software Specifications

Includes the following:

- FFT Spectral Analysis
- Octave Analysis and Sound Level Meters (SLM)
- Real-time Order Tracking and Order Analysis
- Sweep Sine FRF
- Real-time Sine Reduction
- Time Waveform Recording
- Automated Schedule and Limiting Test
- Real-time DIgital Filters
- Shock Response Spectrum (SRS) Analysis
- Remote Condition Monitoring (RCM)
- Monitoring Through EDM Cloud
- Front-end Calibration Tool (FECT)

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EDM DYNAMIC SIGNAL ANALYZER (DSA) MODE SOFTWARE

EDM (Engineering Data Management) is a PC-based software program designed for real-time data management and processing. It contains EDM Testing, EDM Machinery and EDM Utility installation packages.

The Dynamic Signal Analysis (DSA) software is contained in the EDM Testing installation package. It includes basic FFT, FRF, transient capture, octave filter, user-defined digital filter, sound level meter, order analysis, automated alarm limit in both time and frequency domain, and throughput recording. Various time and frequency signals can be played back or post-processed. EDM includes a user interface in multiple languages. Template based report functions provide testing results in seconds. Reports are conveniently generated in Microsoft Office 2007 files, LibreOffice files, and PDF files.

Test Management

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

Spider Hardware System Management

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

User Management and Access Code Control

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

Black Box Mode: Running Without a PC

A supported front-end can operate in Black Box mode, which allows it to acquire data without a PC. In this mode, a PC is used to only configure the system before the test and then to download the data after the test is complete. During the test, the front-end operates according to a preset schedule or through an external device such as a Wi-Fi enabled PDA or an iPad. Hardware versions 7.3 and higher can upload and store up to eight tests on each front-end.

Variable Sampling Rate

High channel count Spider systems support a variable sampling rate, enabling data acquisition at a customizable sampling rate for each Spider front-end. Users can conveniently configure the Spider-80Ti, Spider-80SG/SGi or other Spider-80Xi systems to achieve different sampling rates depending on the application. The modified sampling rates are derived from the Master sampling rate, enabling synchronized data acquisition across all front-ends, even at different sampling rates.

Timestamped Recordings

The Spider hardware architecture now supports timestamped recordings. This allows for timestreams acquired on multiple physically disconnected Spiders to be synchronized with up to a 100-nanosecond accuracy, paving the way for spectral analysis across distributed systems.

IEEE 1588 PTP Timestamps using a Grandmaster Clock

IEEE 1588 timestamps are generated using the IEEE 1588 PTP, a standard designed to synchronize clocks in a network with high precision. A master-slave architecture is employed, where is master clock provides a reference time that Spiders use to discipline their own clocks. Three pieces of hardware are used to accomplish this goal:

1. A Spider with hardware version 8.6 or greater.
2. A Spider-Hub.
3. A grandmaster clock that supports Synchronize Ethernet (SyncE) along with IEEE 1588 PTP.

SyncE is used to ensure all devices on the network are operating at the same lock frequency and PTP handles the time and phase synchronization.

GPS Timestamps

Crystal Instruments was awarded US patent no. 11.611.946 for GPS time synchronization technology. The new Spider hardware supports GPS functionality, allowing the system clock to be synchronized to a GPS time base. Provided the Spiders have a sufficient GPS signal, timestreams can be recorded with a time precision of up to 100 nanoseconds. Use of GPS timestamping allows for front-ends to be synchronized regardless of distance and without physical connection between units. This feature does not place a limit on the number of front-end units that can be synchronized with GPS timestamping.

Record to PC

Time streams can now be recorded directly to a PC via USB, eliminating the need to rely solely on the Spider memory or NAS/NASi for data storage. Data can be recorded at a sampling rate of up to 256 kHz for a 64-channel system.

Time History (Continuous Time Data Recording to PC)

The Time History feature continuously acquires live data, saves it to PC memory, and allows the user to view any part of live or historical data while the test is running. The user has options to view the entire history of the data along with live data updates or view live data for a specified duration or view any part of the historical data. Once the test is complete, the recordings are automatically saved to the PC memory space. Time History signals are currently available for time data with sampling rates less than 100 Hz in addition to the Peak and RMS time data.

Multi-Resolution Spectrum

Most applications require finer frequency resolutions for lower frequencies in a spectrum compared to the higher frequencies. Multi-Resolution spectrum is a unique and innovative way to obtain high resolution for lower frequencies in a spectrum without using a high block size. Processing large block sizes consumes a lot of computational resources and requires a lot more time to acquire the block of data. Using multi-resolution, resolution of low frequencies can be increased by 8 times compared to the higher frequencies without having to increase the block size.

The multi-resolution spectrum can also be used to compute FRF which enables in distinguishing two close resonant frequencies in the low frequencies which a regular spectrum fails to distinguish.

Self-Test

Verifies the condition of the input and output channels using a precise internal signal source. Test validates that the input channels are within the manufacturer's tolerances.

Measurement Quantities

The user has an option to select from a wide range of measurement quantities. Typical measurement quantities include acceleration, velocity, displacement, force, strain, torque, temperature, voltage, angle, phase, resistance, tacho speed, pressure, voltage, time, frequency, angular velocity, current, sound pressure, and mass.

Measurement Data Storage

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

Export Data File Formats

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

Import Data File Formats

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

Languages

English, Russian, Japanese, Simplified and Traditional Chinese are available. Languages can be switched without reinstalling the software.

Report

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

3D Signals (Waterfall and Colormap Display)

- **Maximum Traces in a 3D Signal:** 500
- **Reference Axis:** Time, RPM1, RPM2, RPM1_Up, RPM1_Down, RPM2_Up, RPM2_Down
- **Minimum Time Resolution:** 10 ms
- **Minimum RPM Resolution:** 10
- **Maximum 3D Plots (8 enabled channels) with Maximum Traces:** 32 per module

Digital I/O Interface

Each Spider-81 front-end has 8 isolated digital inputs and 8 isolated digital outputs (Spider-81B, Spider-80X, & Spider-80Xi have 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, capture screen, send socket message, send emails, set digital output signals, start recording, stop recording, save signals in the list, reset average, top the test, limit check on, limit check off

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 or Spider-80Xi only.)

Output Pulse Types: High-Low, Low-High and variations

Live status of Digital inputs and outputs can be viewed.

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 Windows socket message.

Send Emails and Instant Message as Event-Actions

The ability to send emails or instant messages as custom actions in response to a system or user event. Users can customize the content of emails.

Remote Operation Communication Using Socket Messages

Communicate with and control Spider systems remotely with Windows socket messages. Socket messages can transfer over a network or through a serial port connection to communicate with other hardware, such as temperature chambers and tablets. A socket client written by a user may be used as a customized control terminal, test status logger, test monitor, or to configure tests. The socket client can request multiple spider devices' channel data, such as Time Stream, Time Block and APS signals, during a test run from EDM. Please refer to the Socket Message document for more 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:** labels the physical point of UUTs or machines. Location ID is used to name signals.
- **Level Display:** bar graph displays the input level of each channel with 4 grids. Automatic IEPE sensor detection.
- **Sensitivity:** user-defined with engineering unit and input sensitivity setting
- **Input Types:** AC/DC, differential or single-ended, IEPE, charge coupling
- **TEDS:** read TEDS, read all TEDS
- **Integration/Differentiation:** when acceleration is selected as the measurement physical quantity, integration or double integration can be applied to obtain velocity or displacement quantity. When velocity is selected as the measurement quantity, integration or differentiation can be applied to obtain displacement or acceleration.
- **High-Pass Filter:** user-defined cutoff frequency

Event-Action Rules

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

- **Event Type:** system generated events or user-defined events: connection lost, triggered, user-stop, channel overload, output maximum, limit exceeded, average number reached, download complete
- **Actions:** flash screen, beep, create report, capture screen, digital output (user defined pin), start recording, stop recording, save signals, reset average, send email, send message to another program, stop the test, limit check on, limit check off, hold test, continue test

Output Channels

The output channels provide signal sources and generate user determined waveforms. Multiple output channels may generate signals independently or simultaneously. The Spider-80X and Spider-80Xi are equipped with two output channels but only one is enabled. An option (S80-P09) is available to enable the second output.

- **Output Types:** Sine, Triangle, Square, White noise, Pink noise, DC, Chirp, Swept Sine, Arbitrary Waveform, Shaped Random, Playback Signals
- **Arbitrary Waveform:** Outputs a user defined time signal of up to 1 giga points in length at a sampling frequency of 1 KHz. User defined files in ASCII format can also be imported.
- **Shaped Random:** Outputs a random noise signal with a user defined frequency shape. Power spectrum data, in various file formats, can be imported, modified, and used as the spectrum profile. An imported or user defined profile can be created/modified by creating/editing or deleting the breakpoints. Refer to import file formats for signals of available file formats.
- **Playback:** Outputs a time recording file which can be selected by the user. Recording file formats of ASAM-ODS XML, CI-ODS, ASCII, Excel CSV are supported. Supports recording files up to the maximum available memory on Spider flash.

RPM Measurement

Tachometer channels are available to take RPM measurements while performing order tracking, FFT analysis or acoustic analysis. In addition, RPM time trace recording or RPM time stream recording can use the same channels. The new hardware versions (Spider-80X version 7.5 and above, and Spider-80Xi) have output channels that function as dedicated tachometer channels. The older versions of hardware (including the Spider-81) can use any input channel as a dedicated tachometer channel.

Strain Measurement

As an integrated function in DSA mode, users can measure strain with the Spider-80SG or Spider-80SGi hardware. Full, half and quarter bridge configurations are compatible. This integrated design allows FFT spectral analysis to run simultaneously with strain measurement.

- **Shunt Calibration** consists of three convenient steps. (1) Locate the shunt resistor, (2) measure the input, and (3) finalize calibration. The software allows users to switch the location of the shunt resistor between available bridge legs.
- **Offset-Nulling** simplifies the bridge-balancing process. The process can combine with shunt calibration in one step, resulting in a balanced and calibrated strain gage.
- **Remote Sensing** enables long-distance measurements. This function allows users to place the UUT at a further distance from the Spider-80SG or Spider-80SGi system while measuring strain without sacrificing any accuracy.
- **Rosette Configuration** enables computation of principle strain and stress through Rectangular, Delta or custom configurations.

Bridge based sensors

The Spider SG and SGi accept sensors which work based on the Wheatstone Bridge. The sensitivity of these sensors is a function of the excitation voltage supplied between the bridge terminals. DSA accepts the sensitivity of the sensor as mV/V/unit and automatically scales the sensitivity with respect to the voltage supplied.

- **Offset-Nulling** is used to remove any DC or Pre-loading on the sensor.
- **Remote Sensing** enables the precise measurements of the excitation voltage supplied and improves the accuracy of the bridge-based sensors.

Temperature Measurement

Combine a Spider system with a Spider-80Ti front-end to enable temperature measurements in Spider DSA mode. Each Spider-80Ti provides up to 16 channels for temperature measurement using 3 wire RTD as well as J, K, R, S, and T-type thermocouple inputs.

RTD Non-Linearity correction

To provide high accuracy during measurements, the Spider-80Ti directly implements the IEC 751 RTD equations. The user can choose to use the coefficient values as defined by the standard or specify custom coefficients to use RTD sensors with different alpha values.

Cold Junction Compensation

To correct for a non 0°C cold junction, the ambient temperature is measured by a high precision internal temperature sensor based on this a corrective thermoelectric voltage value is computed. This value is used to offset the cold Junction temperature to provide an accurate measurement.

User selectable data rate, measurement range and Average Number

The following parameters can we set by the users:

- **Data rate:** 0.3125, 0.625, 1.25, 2.5 S/sec
- **Temperature Range:** -270 °C to 1250 °C (Thermocouples – K type), -200 °C to 850 °C (RTD – PT 100)
- **Average number:** 1-128

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.

Circular Buffer Recording

This feature provides users with the option to preset a buffer size for recorded data. Long term monitoring and the option to capture long pre trigger data is provided. The Spider system can continuously record and overwrite data until a preset trigger or condition is met which results in capturing and saving all preexisting data, partially overwriting the existing data or completely overwriting with new data.

Circular Buffer can be defined in terms of size (MB) or in terms of recording time (Sec).

Auto Wake and Timer Control (Only Available on the Spider-20 or Spider-20E)

The timer setting function for the Spider-20 and Spider-20E allows users to set up a time to automatically turn the device on and execute one or several sequential tests and turn off at a preset time interval. For long term data monitoring and acquisition, the timer control extends the acquisition time of the Spider-20 or Spider-20E by turning the device off when acquisition is not required.

Automatic Data Management with Data Download

Users can configure tests to automatically record data, download it from internal memory and then delete it from internal storage to free up space. The need for manual actions is eliminated and the user is assisted to set up a long-term, completely autonomous test.

FFT Spectral Analysis (DSA-10)

The FFT Spectral Analysis provides comprehensive data acquisition and FFT analysis. Acquisition Mode controls how the data is acquired block-by-block and processed with the signal analyzer functions. These time blocks can be either gap-free, overlapped, or with gaps, depending on the acquisition mode selection. Users can set Sampling Rates directly from the control panel. 54 sampling rate stages are available. Users can change sampling rate stages without stopping data acquisition. 3D waterfall processing allows data to be acquired and processed in real time with either RPM or time as an additional axis. The output has several signal source types to excite the testing articles.

Frequency Signal Analyzer Functions

- **Maximum Input Channels in a System:** 1024
- **Transient Time Block Size:** up to 256,000 points for 1 channel per Spider front-end, up to 16,000 points for all channels.
- **FFT Block Sizes:** 256 –32,768 for up to 128 channels, 256 –65,536 for 1 channel per Spider front-end, up to 16,384 for 1024 channels
- **FFT Spectral Lines:** 100–14,400 for all input channels, 100 –28,800 for 1 channel per Spider front-end
- **Multi-Resolution Spectra:** Supports two resolutions (one for high frequencies and one for low frequencies),

customizable cut off frequency. 100-7200 for all input channels.

- **Data Window Functions:** Hann, Hamming, Flattop, Uniform, Kaiser-Bessel, Blackman, Force, Exponential, Force-Exponential
- **Averaging:** exponential, linear, peak hold
- **Time Trace:** RMS, Peak, RPM (if enabled) vs. Time
- **Spectrum Types:** linear spectrum, auto power spectrum, frequency response function, coherence, cross power spectrum, phase spectrum
- **PC FRF Function:** H1, H2, H3 and Hv
- **Auto Spectrum Type and Scaling:** linear spectrum with peak or RMS scaling, power spectrum or power spectrum density with RMS scaling (Spectrum Units: EU_{pk}, EU_{rms}, EU_{rms}^2, EU^2/Hz, $EU^2 \cdot s$/Hz), sqrt ($EU^2 \cdot s$/Hz))
- **APS View:** as FFT or Octave of 1/1, 1/3, 1/6, 1/12, 1/24th
- **Overlap Ratio:** free-run, 25%, 50%, 75% or 90%
- **Correlation Functions:** auto and cross correlation functions
- **Display of Complex Spectrum:** bode plot, Nyquist plot
- **Other Graphs:** Orbit plot, Cross Plot
- **Resonance Search and Report for FRF signals:** Includes automatic calculation of user customizable resonance peaks, saving peak values and creating reports on any FRF signals.

Real-Time Processing Performance

- **Real-Time Spectral Bandwidth:** 46 kHz when all inputs are enabled for full spectral analysis (except octave analysis and sound level meter)

Acquisition Mode

- **Mode Selection:** free-run, continuous after trigger, single shot with trigger, single shot without trigger, auto-arm trigger, manual-arm trigger
- **Trigger Conditions:** trigger source > high level (rising edge); trigger source < low level (falling edge); low level < trigger source < high level; trigger source > high level OR trigger source < low level (bi-polar)
- **Trigger Delay:** ±100% of block size
- **Trigger Setup Display:** a special display view is created for trigger setup. User selects the acquisition mode, trigger source, trigger level, trigger delay, and trigger condition
- **Trigger Run-Time Display:** in manual arm-mode, a smaller window will pop up for the user to accept or reject the transient captured signals. Only accepted signals are averaged into the spectra.

Math Functions Applied to the Signals

- **RMS:** apply RMS estimation to an input data stream and generate a continuous output time stream
- **Peak:** extract the peak or peak-peak value over a period of time and generate a time stream. Includes long time PC recording for the Peak and RMS time streams.
- **Math Modules:** abs, +, -, *, /, square, square-root, log, and offset scale.
- **Offset Scale:** apply a multiplier gain and an offset to any input data stream and generate the output stream continuously

Octave Analysis and Sound Level Meters (SLM) (DSA-11)

Both Octave filter and Sound Level Meters are implemented based on high precision real-time filters. Users can execute FFT Spectral Analysis, Octave Analysis, and Sound Level Meter analysis at the same time.

Octave Filter Analysis

- **Maximum Input Channels in a System:** 1024
- **Standards:** conforms to ANSI std. S1.11:2004, Order 3 Type 1-D and IEC 61260-1995
- **Filter Implementation:** real-time digital filters
- **Frequency Weighting:** A, C, Z comply with IEC 61672-2002 class 1. B complies with IEC 60651-1979 type 0.
- **Octave Fractional Resolution:** 1/1, 1/3, 1/6, 1/12, 1/24
- **Frequency Range (Band Centers):** Up to 20 kHz
- **Mid-band Frequencies:** base 10 complies with ANSI std. S1.11:2004 Annex A
- **Average Type:** linear, exponential, peak hold, time linear, time exponential
- **Time Weighting:** fast, slow, impulse
- **Accuracy:** < 0.2 dB (1 second stable average, single tone at band center)
- **Dynamic Range:** from typical noise floor to maximum level for a pure tone signal at 1 kHz: -23 – 111 dB (1/3 Octave, 2 second stable average) per ANSI S1.11:2004
- **VC Curves:** Vibration Criteria Curves are available for 1/3 Octaves
- **NC Curves:** Noise Criteria Curves are available for 1/1 Octave.
- **Maximum Tachometer Channels:** 2
- **Tracking RPM Range:** 1 – 300,000 RPM (0.016 Hz – 5 kHz)
- **RPM Resolution:** 10 – 10,000 RPM

Sound Level Meter Analysis

- **Maximum Input Channels in a System:** 1024
- **Standards:** conforms to IEC 61672-1 2002
- **Filter Implementation:** real-time digital filters
- **Frequency Weighting:** A, C, Z comply with IEC 61672-2002 class 1. B complies with IEC 60651-1979 type 0
- **Time Weighting:** fast, slow, impulse (complies with IEC 61672-2002)
- **Average Time Interval:** from 0.125 seconds to 24 hours. Unique moving linear averaging method allows independent setting averaging time interval and time trace update rate.
- **Linear Operating Range:** 110 dB
- **Inherent Noise:** A: -10 dB or less, B: -13 dB or less, C: 1 dB or less, Z: 16 dB or less
- **Measurement Range:** A: 0 to 110 dB, B: 0 to 110 dB, C: 5 to 110 dB, Z: 20 to 110 dB
- **Measurement Types:** time-weighted sound level (L), time-averaged sound level (L_{eq}), sound exposure level (L_E), peak sound level (L_{peak}), peak C sound level (L_{Cpeak}), maximum time-weighted sound level (L_{max}), minimum time-weighted sound level (L_{min}), maximum time-averaged sound level (L_{eqmax}), minimum time-averaged sound level (L_{eqmin}), statistical sound level (L_N) and statistical sound level distribution (dB Histogram).

	Time Weighting	Frequency Weightings			
		Z	A	B	C
Time-Weighted Sound Level (L)	**F (Fast)**	L_{ZF}	L_{AF}	L_{BF}	L_{CF}
	S (Slow)	L_{ZS}	L_{AS}	L_{BS}	L_{CS}
	I (Impulse)	L_{ZI}	L_{AI}	L_{BI}	L_{CI}
	User-Defined	L_{ZU}	L_{AU}	L_{BU}	L_{CU}
Time-Averaged Sound Level (L_{eq})		L_{eq}	L_{Aeq}	L_{Beq}	L_{Ceq}
Sound Exposure Level (L_E)		L_{ZE}	L_{AE}	L_{BE}	L_{CE}
Statistical Level (L_N)		L_1	L_5	L_{50}	L_{95}
Peak Sound Level		L_{peak}		L_{CPeak}	

- **Measure Time Control:** free run, user-defined
- **Decay Time Constant for F and S time-weighted Sound Levels:** 34.7 dB/s (by standard, >25 dB/s) and 4.34 dB/s (by standard, between 3.4 – 5.3 dB/s)

Signal Type

- **Octave Analysis:** time trace, octave spectrum,
- **Sound Level Meter:** SLM time trace, analysis result, dB histogram

RPM Measurement

Tachometer channels are available to take RPM measurements while performing order tracking, FFT analysis or acoustic analysis. In addition, RPM time trace recording or RPM time stream recording can use the same channels. The new hardware versions (Spider-80X version 7.5 and above, and Spider-80Xi) have output channels that function as dedicated tachometer channels. The older versions of hardware (including the Spider-81) can use any input channel as a dedicated tachometer channel.

Real-time Order Tracking and Order Analysis (DSA-12)

Real-time Order tracking and Order Analysis is available across all Spider hardware systems manufactured by Crystal Instruments. The Spider-80X and Spider-80Xi hardware have a special capability and are equipped with two tacho channels in addition to eight analog inputs. The Order Tracking option was developed and based on a precise tachometer measurement of rotating speed, using fast digital re-sampling at the rotating speed and a proprietary DFT method to acquire any required fractional orders of interest at a fast slew rate. The following measurements are made in the Order Tracking option: raw time streams, real-time order tracks, order spectra, and constant band frequency spectra.

- **Maximum Input Channels in a System:** 1024
- **Maximum Tachometer Channels:** 2

Real-Time Order Tracks and Order Spectra

Real-Time Order Tracks are frequency amplitude signals graphed against an RPM variable. Multiple order tracks are measured, displayed, and saved. Order spectra are auto power spectra that are normalized to orders.

All Order Tracks can have optional phase, which is phase measurement relative to the tachometer signals as a reference. Order tracks with phase can be displayed as Bode, Polar, or Nyquist plots.

Order tracks and Order Spectra can use one of the tachometer channels' RPM as reference.

- **Maximum Input Channels in a System:** 1024
- **Max Order Tracks:** 16 on each front-end
- **Max Order of Interest:** 200
- **Maximum Tachometer Channels for RPM Measurement:** 2
- **Maximum Reference Tachometer Signals for Order Analysis:** 1
- **Spectrum Units:** EU_{pk}, EU_{rms}, EU_{rms}^2
- **Tracking RPM Range:** 1 – 300,000 RPM (0.016 Hz – 5

kHz)

- **RPM Resolution:** 10 – 10,000 RPM
- **Minimum Delta Order of Order Spectrum:** 0.025
- **Maximum Delta Order of Order Spectrum:** 1
- **Acquisition Mode:** Free Run, Run Up, Run Down, Run Up and Down, Run Down and Up

Constant Band Frequency Spectra

Constant band frequency spectrum displays the auto power spectrum of the selected fixed band of frequencies and is computed using the FFT analysis within the fixed band of interest.

Tachometer Processing

Two tachometer channels are available. Utilize one or both channels simultaneously to calculate the RPM of each respective tachometer channel.

Users have the option to view the original time signal for the Tachometer 1 and the RPM trace for both tachometer channels. Users can dedicate one of the tachometer channels to generate order tracks and order spectrum.

Tachometer/Output Channels

Users have the option to use one or two tachometer channels. At least one tachometer channel must be configured. An unused tachometer channel can operate as an output channel (only on Spider-80X and Spider-80Xi systems).

Limiting and Alarms (Included with DSA -24)

Users can set limits on order tracks, order spectra, constant band frequency spectra, and RPM signals to trigger a function when the signals go beyond or below a preset value. (Only input channels on the master front-end support this function.)

Sweep Sine FRF (DSA-13)

Sweep Sine FRF allows users to manually control the sine output while the system displays various time signals and frequency spectra. Users can enable Random excitation as a checkup function. Tracking filters are applied to each input channel to extract the signals at sweeping frequency. When the close-loop option is enabled, Sweep Sine FRF is essentially a limited sine controller with more manual control functions.

- **Frequency Range:** 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

Real-Time Sine Reduction and Shutdown Protection (DSA-14)

The real-time sine reduction function offers a solution to extend the number of measurement channels of a vibration controller system in a swept sine test. When a Spider dynamic measurement system is running in Sine Reduction Mode while an independent vibration controller controls a shaker, the Sine Reduction application will calculate all time and frequency spectra available in the controller. Users could enable up to 128 alarm channels to monitor time and frequency limits and send digital output to shut down the controller when the limit exceeds.

Sine Reduction function requires a COLA signal from the vibration controller system for instantaneous frequency, phase detection, and spectrum analysis. Applications involving a comparison of amplitudes for only the driving frequency require a tracking filter to attenuate all other frequencies in proximity to the driving frequency. The Shutdown Protection System uses a single input channel (COLA channel) to measure and track the driving frequency and subsequently implements a bandpass filter with a center frequency that matches the driving frequency to all measurement channels. The resulting amplitudes are compared against user defined thresholds and abort signals are sent through digital outputs. A shutdown signal can be generated within 10 milliseconds from the time a threshold has exceeded user defined limits.

Time Waveform Recording (DSA-20) can be used in conjunction of Real-Time Sine Reduction, which enables the system recording the continuous raw data with ”infinite” length.

Analysis Parameters:

- **Maximum Input Channels in a System:** 1024
- **Frequency Range:** up to 46 kHz analysis frequency range of the COLA signal
- **Spectrum Display Resolution:** 256 to 4096
- **Spectrum Average:** Linear (User configurable between 1 to 2000 frames)
- **Measurement Dynamic Range:** Up to 160 dB
- **Measurement Strategy:** tracking filter, RMS, Mean, Peak (multiple strategies allowed for each channel signal)
- **Frequency Resolution:** as fine as 0.001 Hz
- **Sweep Type:** Log, Linear
- **COLA Channel:** can set any channel from Master front-end as COLA channel.

- **Maximum number of Alarm Channels:** 128
- **Types of Alarms:** Time domain and Frequency domain

Tracking Filter:

Tracking filter can be Enabled / Disabled and customized for each channel. When enabled, options for Tracking filter are:

- **Proportional Filter:** The bandwidth is proportional to the tracking frequency. User settable with options of 7%, 12%, 25%, 50% and 100% of the tracking frequency.
  - Amplitude Accuracy and Harmonic Attenuation using a 100% Proportional Filter:
    - **Amplitude of 1st harmonic:** -0.03 dB at 10 Hz; -0.02 dB at 100 Hz
    - **Amplitude of 2nd harmonic:** -99.5 dB at 10 Hz; -94.7 dB at 100 Hz
  - **Reaction Time using a 100% Proportional Filter:** 63 ms at 10 Hz, 12 ms at 100 Hz (from the time a threshold has exceeded user defined limits to a shutdown signal generated)
- **Fixed Bandwidth Filter:** An infinite impulse response fixed bandwidth filter. A choice of 2nd order or a 4th order filter is available.
  - Amplitude Accuracy and Harmonic Attenuation using a 2nd Order 10 Hz Fixed Bandwidth IIR Filter
    - **Amplitude of 1st harmonic:** -0.05 dB at 10 Hz; -0.0081 dB at 100 Hz
    - **Amplitude of 2nd harmonic:** -12.09 dB at 10 Hz; -54.44 dB at 100 Hz
  - **Reaction Time Using a 2nd Order IIR 10 Hz Fixed Bandwidth Filter:** 79 ms at 10 Hz, 83 ms at 100 Hz
  - **Reaction Time Using a 4th Order IIR 10 Hz Fixed Bandwidth Filter:** 129 ms at 10 Hz, 128 ms at 100 Hz
- **Proportional + Fixed Bandwidth (IIR) Tracking Filter:** A proportional filter cascaded with an infinite impulse response fixed bandwidth filter. Various options consisting of the combinations of the user settable bandwidths of the proportional and fixed filter are available.
  - Amplitude Accuracy and Harmonic Attenuation using a 100% Proportional + 2nd Order 10 Hz fixed Bandwidth IIR Filter
    - **Amplitude of 1st harmonic:** -0.02 dB at 10 Hz; -0.01 dB at 100 Hz
    - **Amplitude of 2nd harmonic:** -91.13 dB at 10 Hz; -99.37 dB at 100 Hz
  - **Reaction Time Using a 100% proportional + 2nd Order IIR 10 Hz Fixed Bandwidth Filter:** 142 ms at 10 Hz, 86 ms at 100 Hz

Isolated Digital Input and Output

- **External Circuit Power Supply:** 3.3 – 12 V_{DC} (±10%)
- **Internal Power:** 12 V_{DC} 400 mA
- **Maximum Allowable Distance of Signal Extension:** 50 meters

Digital Inputs

- **Input Format:** opto-isolated input (compatible with current-sink output)
- **Max Number of Channels:** 2 – 8 (Depends on choice of hardware)
- **Input Resistance:** 6.1 kΩ
- **Input On Current:** 2.0 mA or more
- **Input Off Current:** 0.16 mA or less
- **Interrupt:** An interrupt is generated either at the rising edge (HIGH-to-LOW transition) or falling edge (LOW-to-HIGH transition).

Digital Outputs

- **Output Format:** opto-isolated input (current sink output)
- **Max Number of Channels:** 2 – 8 (Depends on choice of hardware)
- **Output Rating:** output voltage 12 VDC max, output current 100 mA per channel max
- **Residual Voltage with Output On:** 1.0 V or less (Output current < 100 mA)
- **Output Type:** LOW-HIGH-LOW (With configurable pulse width), HIGH-LOW-HIGH (With configurable pulse width), Transition to LOW, Transition to HIGH, Invert State
- **Rise Time:** 250 µs
- **Fall Time:** 50 µs

Measured Signals and Display Status

Measured Signals: Input time stream of all channels, 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. 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, run log window, large numerical value display window, channel status window, recording status, search resonance, vibration visualization

Run log: a test log continuously records real-time status changes and user commands. This includes start / stop time

of test and recording, abort conditions, triggered system events and associated actions.

Alarms (Time and Frequency Domain) and Trigger

Alarms can be optionally enabled on all channels simultaneously. Three types of triggers are available in Sine Reduction: Raw time data alarms, RMS time data alarms, Frequency domain alarms.

As a consequence of a trigger, actions specific to each type of trigger (Frequency, Raw Time, RMS Time) can be defined by the user. The most often used action is sending a digital output signal.

Raw Time Alarm Trigger

Raw time alarm trigger function checks each point of the input time data after applicable tracking filter. When a time domain point exceeds the threshold, actions corresponding to the event are triggered.

- **Alarm Trigger Threshold:** Negative threshold and Positive threshold
- **Alarm Configuration:** User configurable thresholds for each channel
- **Additional Options:** “Fill down” to “Fill to” provides options to copy defined thresholds to selected channels or all channels

RMS Time Alarm Trigger

RMS time alarm trigger function checks each block of user defined size and user defined overlap. When the RMS value of the block exceeds user set threshold, actions corresponding to the event are triggered.

- **RMS computation block:** User defined block size (ms) and Overlap (ms)
- **Alarm Threshold:** High limit
- **Alarm Configuration:** User configurable high limit for each channel
- **Additional Options:** “Fill down” to “Fill to” provides options to copy defined thresholds to selected channels or all channels

Frequency Domain Alarm Trigger

Frequency Domain alarm trigger function checks the output of tracking filters. When the amplitude at current frequency exceeds the defined threshold, actions corresponding to the events are triggered.

- **Alarm Trigger Threshold:** Alarm Limit and Abort Limit
- **Alarm Setup:** Definable as breakpoint table for single frequency, different ranges of frequencies or entire frequency range
- **Import / Export Options:** Import from csv
- **Alarm Configuration:** User configurable thresholds for each channel
- **Additional Options:** “Fill down” to “Fill to” provides options to copy defined thresholds to selected channels or all channels

Alarm Trigger Response Time

The alarm trigger response time is the time delay between the analog input signal that sets the trigger event AND the time at which actions are executed.

Configuration	1 to 8 Channels	9 to 64 Channels	65 to 128 Channels
Raw Time Alarm Trigger	< 10 ms	< 20 ms	< 20 ms
RMS Time Alarm Trigger	< 10 ms	< 20 ms	< 20 ms

Event Actions for Alarms

Actions for each event can be defined by the user. Any of the below actions or multiple actions can be defined by the user which will be executed in the order of selection.

Digital Outputs

For detailed specifications on Digital Output, refer to “Digital Output” section of “Isolated Digital Input and Output”

Transient Recording

Captures the alarm with user defined pre-transient duration and user defined post transient duration

- **Pre-Transition Recording Time:** User defined time (ms) from 0ms to 5000 ms
- **Post Transition Recording Time:** User defined time (s) or indefinite time

Start Recording / Stop Recording

Start Recording for user defined time (s) or indefinite time or Stop an ongoing recording. Detailed specifications are included in Time Waveform Recording (DSA-20)

Save Results to PC

Save user defined results including block signal data (time and frequency) to PC.

Save signals to Internal Storage

Save block signal data (time and frequency) to Spider’s internal storage.

Create Report

Generate a report with user-configured template.

Capture Screen
Capture screenshot of the software

Send Email
Send a user configurable email

Stop / Pause Test
The Sine-reduction test will be stopped or paused

Safety
Abort criteria in time or frequency domain could be optionally configured using limit channels and by configuring limit actions to send Digital Output to shut down the primary controller or the amplifier assembly.

Add-Ons
- Time Waveform Recording (DSA-20)
- Monitoring through EDM Cloud (EDM-Cloud)

Time Waveform Recording (DSA-20)

The Spider front-end can perform long time waveform recording during real-time data processing. Data is saved to either the internal flash memory or continuously to an external Spider-NAS. The data recording speed is independent of the number of channels. Recording on a high channel count system in Black Box mode is supported.

- **Maximum Input Channels in a System:** 1024
- **Maximum Data Recording Rate:**
  - **Single Front-end System:** all channels can continuously record simultaneously at a maximum rate of 102.4 kHz and 1 channel up to 512 kHz.
  - **Multiple Front-end Systems:**
    - **Record to Flash:** up to 81.92 kHz for 1024 channels
    - **Record to Spider-NAS:** up to 81.92 kHz for 1024 channels
- **Typical Continuous Recording Time:** Records to the built-in 4 GB flash memory, the recording times are:
  - 14 hours for 4 input channels with a frequency range of 2,000 Hz
  - 21 minutes for 8 input channels with sampling rate of 102.4 kHz
  - 3 hours and 30 minutes for 8 input channels with sampling rate of 10.24 kHz
  - 37 hours for 8 input channels with sampling rate of 1 kHz
  - If the Spider-NAS is installed, the typical recording time for a 250 GB disk is: 4660 hours for 4 channels at 1 kHz/ch; 2 hours and 45 minutes for a system with 64 inputs at 102.4 kHz/ch.
- **Begin Recording On:** Manually start recording by pushing buttons (default); when measurement starts; when input signal is triggered according to trigger condition; when digital input is received from input #; when limit is exceeded; when time status exceeds the limit.
- **Stop Recording On:** when digital input is received from input #; when limit is exceeded; when time status exceeds the limit
- **Recording Duration:** user specified, or until stopped by user; repeat # can be specified per defined event ("begin recording when input signal is triggered" currently available only on the 8 channels of master front-end)

Automated Schedule and Limiting Test (DSA-24)

The automated limit test function allows the Spider front-end to conduct automated limit checking for time or frequency signals. This function is supported in both PC tethered mode and Black Box mode. Limiting signals are designed using the EDM software on a host PC. There are four elements in a limiting test: signals being tested, upper or lower limits applied, testing schedule, and testing log.

- **Maximum Input Channels in a System:** 1024, up to 8 channels with limiting
- **Test Signals:** raw time stream signals, peak time stream signals, RMS time stream signals, time block signals, auto spectrum, frequency response function, octave spectrum
- **Limit Signals:** user defined upper or low limit signals. For spectra signal, the spectrum type will also be assigned. Limit signals will be bound to testing signals. Maximum segments of each limit signal: 64; Maximum number of limit signals: 64.
- **Limit Editor:** breakpoint table, envelope of imported signal
- **Testing Schedule:** automatically controls the test duration and automates the operation. Users can develop multiple testing schedules and execute one at a time. Testing schedule event entries: loop/end-loop, run duration, hold, limit check on, limit check off, start recording, stop recording, save signals, turn signal source on and turn signal source off, user defined entries.
- **Testing Log and Summary Report:** a log file is automatically created for each run of the schedule to record up to 512 major events. A summary report is provided for the limiting check status for the last scheduled run.
- **Limit Check Alarm Events:** beep, screen flashing, add event to testing log, send message to host PC, save signals, and send emails or text messages
- **User Defined Event Strings:** the user can define the

message strings of each alarm event. The message strings can be displayed in the run log, EDM Cloud user interface, and the report.

Barcode Scanner Support for Limit Functions (DSA)
The barcode scanner support is added to the limit function in DSA. It supports up to two barcode scanners.

Real-Time Digital Filters (DSA-25)

Real-time digital filters are applied in the data conditioning phase. The user designs the filter model with a provided graphic design tool and uploads the filter design parameters to the front-end for real time calculation. The graphic design tool draws the filter performance in the vertical axis with the dB unit and horizontal axis in relative frequency.

- **Maximum Input Channels in a System:** 1024
- **Filter Design Display (in EDM):** user enters cutoff frequencies, criteria of attenuation, ripple, and filter orders. The design tool provides the frequency response of the filter in a graphic format.
- **FIR Filter Using Window Method:** FIR filter designed based on the data window applied to the sinc function. Data window types: Hanning, Hamming, Flattop, Uniform, Kaiser-Bessel, and Blackman. The user selects one of low-pass, high-pass, band-pass or band-stop types; sets one or two cut-off frequencies (either relative to the sampling rate or in fixed value); and sets the filter length between 3 and 127 (number of FIR taps).
- **FIR Filter Using Remez Method:** The Remez FIR Filter design block implements the Parks-McClellan algorithm to design and apply a linear-phase filter with an arbitrary multi-band magnitude response. The user selects low-pass, high-pass, band-pass or band-stop types; sets one or two cut-off frequencies either relative to the sampling rate or in fixed value; and sets the filter length between 4 and 127 (number of FIR taps).
- **IIR Filters:** Butterworth, Chebyshev I, and Elliptic. The user selects one of the filter types, selects low-pass, high-pass, band-pass or band-stop types; sets one or two cut-off frequencies (either relative to the sampling rate or in fixed value); and sets the filter length between 2 and 21.

Time history statistics like Peak, RMS, Avg and St. Dev can be computed on any filtered signal.

Shock Response Spectrum (SRS) Analysis (DSA-27)

Compute the SRS for all channels using maxi-max, maximum negative, and maximum positive analysis techniques. Reference profile is available.

- **Maximum Input Channels in a System:** 1024
- **Maximum Block Size:** 262144 (256K)
- **Filter Implementation:** real-time digital filters that simulate single Degree-of-Freedom system.
- **Octave Fractional Resolution:** 1/1, 1/3, 1/6, 1/12, 1/24, 1/48
- **Filter Damping Ratio (1/2Q):** set by percentage 0.01 – 100%
- **Filter Center Frequencies:** controlled by low frequency, high frequency and reference frequency
- **SRS Spectrum Type:** maximum positive, maximum negative, maxi-max.

Remote Condition Monitoring (RCM) (DSA-40)

Remotely monitor multiple Spider systems in any location using the EDM Remote Condition Monitoring tool. Users should run Spiders in Black Box mode while using the specifically designed EDM-RCM tool to monitor the status and alarms for each system. Users can communicate with remotely located Spider system(s) that are connected through a wireless gateway to a mobile data network using a public IP address. Users can configure EDM-RCM mode to connect multiple Public IPs to simultaneously monitor multiple Spider front-ends.

Users can configure EDM-RCM software to simultaneously monitor up to 64 Spider systems. A Spider system can consist of single or multiple Spider front-ends.

Key Features

- **Remote Installation and Operation:** Users can perform remote installations of Spider front-ends without connecting to a computer at that location. Users can configure Spider systems, continuously or periodically check status, and download data as needed with just a personal computer (PC), EDM-RCM software, and an internet connection.
- **Project Status:** Overview status of all operating Spider front-ends. Updates running status, running time and location of each Spider front-end in the project.
- **Alarm Status:** Overview of number of alarms triggered for each Spider front-end in the project.
- **Real-time FFT analysis:** All analysis functions available in FFT mode are available, such as spectrum or FRF analysis.
- **Live Data:** View live data, including live time streams, processed time streams (Peak and RMS) and spectral data for any Spider front-end in the project.
- **Continuous Waveform/Processed Waveform Recording:** Can perform continuous recording of raw time data or processed data (Peak/RMS) on Spider front-ends. The recordings are stored in the Spider internal flash memory.

- **Alarm and Limiting/Trigger:** Users can set multiple alarms on each Spider system based on user specified event(s). Users can define multiple actions to capture and provide notification of events. EDM keeps track of all alarms and alerts the user defines for each Spider system.
- **Remote Downloads:** Users can remotely download saved spectral data or recorded time data for any specific Spider system or all systems without stopping the test.
- **Email:** Users can configure emails for each Spider front-end to send alerts based on specific events.

EDM Cloud (cloud.go-ci.com)

EDM Cloud allows users to continuously monitor input channels and status information. Crystal Instruments provides user accounts with convenient cloud storage space for uploading data. All tests in EDM-DSA support status are checked through EDM Cloud. FFT Spectral Analysis is widely used for monitoring applications.

The EDM Cloud website is located at https://cloud.go-ci.com/ and provides convenient access from anywhere in the world to check the status of current or past tests. A secure log-in ensures only authorized personnel with credentials are able to access the account and check the test status. The option to create multiple usernames for access to the same EDM Cloud account is also available.

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

Front-End Calibration Tool (FECT)

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 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 details, please refer to the FECT specifications document.

EDM Extensions

EDM Extensions is a set of features that integrates external devices with EDM VCS software. An EDM Extension establishes the connection between EDM and an external device over a computer IO to allow EDM VCS software to operate the external device, display data from the external device, monitor the status of the external device, or automate a vibration test according to the data or the state of the external device.

CAN bus (EDM-CANBUS)

CAN bus is the abbreviation for the Controller Area Network Bus which is a communication protocol allowing peer to peer (usually the microcontrollers and devices) communication without the host control. EDM integrates this feature to receive and record raw data from the CAN bus adapter, decipher the raw data to signals, and apply alarm and abort limits to those signals. The necessary safety actions can be executed automatically when a CAN bus signal triggers its alarm or abort limits. Alternatively, alarm and aborts can be triggered by matching specified values.

- **Supported Hardware:** Crystal Instruments CAN USB adapter, Peak Systems PCAN USB adapter
- **Working Mode:** normal, listen-only, self-test, PCAN-USB
- **Data Display:** raw data, signal values
- **Configurable Limits:** High Abort, High Alarm, Low Abort, Low Alarm, Abort Values, Alarm Values
- **Event-action Rules:** CAN-Bus Abort, CAN-Bus Alarm, sending digital output
- **Search Feature:** search for signals whose name include the given string
- **Channel Number:** all channels on the same CAN bus adapter

Amplifier Control Software

The amplifier control software is designed for the specific amplifier models of Sentek Dynamics. It is an alternative control interface and status display of the amplifier.

- **Interlock:** stops controller software from generating signals when the amplifier is not in a running state
- **User Interface:** mimics the control panel of the amplifier with clear layout and button status
- **Display:** real-time status display
- **Run Log:** integrated in the vibration control run log and report

Scanivalve Sensor

Data measured by Scanivalve sensors on the same network as the vibration controller is displayed and saved in real-time.

- **Signal Display:** real-time display of signals from all 64 channels of each sensor
- **Signal Save:** data of signals from all 64 channels of each sensor is saved in real-time

Video Capture (EDM-52)

- **Default Supported Camera Models:** LILIN UFG1122E (ONVIF), LILIN PZD6422EX3 (ONVIF)
- **Compatible Camera:** Camera supports ONVIF protocol
- **Maximum number of cameras:** up to the number of CPU cores

Features

- Real-time Video View with taking snapshots, recording video, and PTZ control
- One button to take snapshots from all cameras at a time
- One button to start or stop video recording from all cameras at a time
- Taking snapshots with signals saved
- Taking snapshots triggered by an event or a schedule entry
- Start or stop video recording when signal recording starts or stops
- Start or stop video recording triggered by an event or a schedule entry
- Viewing video on EDM
- Synchronized display of video and signals
- Adjustable offset between video and signals
- Adjustable playback speed
- Set Camera Date and Time: sync with an NTP server, PC, any custom time
- Selectable media profile for each camera
- Pre-record

Supported Hardware Devices

- Spider-81/81B
- Spider-80X/80Xi
- Spider-80SG/80SGi
- Spider-80Ti
- Spider-20/20E

PC Requirements for EDM Software

Minimum System Requirements:

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

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

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

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