CRYSTAL INSTRUMENTS

DYNAMIC TEST & MEASUREMENT SOLUTIONS

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"We believe in innovation. Innovation leads to higher quality, better solutions, and superior products. Our team's commitment to leading innovation in our industry is a great source of pride for Crystal Instruments."

- James Zhuge, Ph.D.
CEO of Crystal Instruments

Technology & Innovation Drives Our Success

In 1993, only two years after I arrived in the USA, I read about a new technology that was just introduced into the consumer industry. A small start-up company, m-Wave, used an ADC chip which claimed to have a digital (instead of analog) anti-aliasing filter. When I looked at the existing dynamic measurement instruments, I found that the analog circuitry (and its controls) remained bulky, dominating an instrument's packaging. I also noted that high-performance analog anti-aliasing filters occupied a disproportionate amount of an instrument's printed circuit board area.

With the support of my wife, I quit my job and started to develop a measurement system. My partner and I successfully integrated the analog-to-digital-converter (ADC) with this digital anti-aliasing filter into a type-2 PCMCIA card. It was only 5 mm thick but could do everything a HP5420 signal analyzer could. In 1996, Crystal Instruments was officially formed and we introduced the "smallest dynamic signal analyzer in the world". That product was widely used by many companies and was adopted by the US Navy. Years later, an independent company did a survey that concluded: "Crystal Instruments was the first company to adopt the sigma-delta A/D converter in this industry." Nowadays, 100% of dynamic measurement systems use sigma-delta ADCs.

In 1996, I co-founded another company, Dactron Inc. Dactron's vibration controllers grew to take more than 50% of the world market (measured by unit sales). Dactron was then acquired by Bruel & Kjær/LDS.

In 2004, I left Bruel & Kjær/LDS and reactivated Crystal Instruments. The CoCo-80 was a great success as the first product of Crystal Instruments. With two different working modes, one device performs simple route data collection or advanced real-time processing. It speaks to its user in familiar terms which he understands in both cases.

Crystal Instruments developed a unique new algorithm to cross-calibrate multiple ADCs viewing the same signal through different input gains and to "stitch" their time–histories into a single glitch-free high resolution measurement. This technology completely eliminated the need for user operated gain settings in an instrument. This solved a very frustrating problem encountered when using a handheld instrument or a high channel count system.

In 2006, Crystal Instruments became one of the first companies to incorporate IEEE 1588 PTP technology in a networked measurement platform. Measurement devices can now be time synchronized within tens of nanoseconds while separated by hundreds of meters without using a dedicated hardware clock cable.

In 2021, Crystal Instruments was awarded a contract by NASA to provide up to 175 units of Ground Recording Systems (CI-GRS). These systems will be used to measure the noise from an X-59 supersonic aircraft. CI's technology is the first dynamic signal measurement system that is fully integrated with space technology including GPS, ADS-B, and cellular signals.

Crystal Instruments provides innovative solutions in a very traditional marketplace. Our customers delve into the mysteries of acoustics, they solve vibration problems and they keep process machines running smoothly by tracking and diagnosing their signature variables. These are old problems, traditional problems. The joy of our industry is being able to bring exciting new solutions to these problems. We love to craft sharper tools for better measurement!

- James Zhuge, Chief Executive Officer

Timeline of Achievements

www.crystalinstruments.com/about-crystal-instruments

2007: CoCo-80
Dynamic Signal Analyzer
Vibration Data Collector

2011: Spider-81
Fourth-Generation
Vibration Controller

2013: Spider-80X
Scalable Vibration Controller

2015: Spider-20
Handheld Dynamic
Signal Analyzer

2016: CoCo-80X
Touchscreen Dynamic
Signal Analyzer &
Vibration Data Collector

2017: EDM Modal
Complete Modal Testing &
Analysis Sotftware Suite

2018: EDM MIMO VCS &
Spider-80M Controller
Multiple-Input Multiple-Output
Vibration Control

- 1996: Crystal Instruments released the world's smallest dynamic signal analyzer in a type-II PCMCIA form factor. It was the first vibration analyzer in the world using sigma-delta A/D converters.
- 2007: Crystal Instruments introduced the CoCo-80, the first handheld data recorder, real-time dynamic signal analyzer, and vibration data collector that matched the performance of high end lab quality instrumentation.
- November 2007: The US patent office granted Crystal Instruments an important patent, #7302354. This innovation provided an advanced technique that can greatly increase measurement dynamic range and accuracy. All Crystal Instruments products use this patented technology today.
- 2009: Crystal Instruments introduced the Spider-80, a highly scalable network-based dynamic measurement system that can measure up to 512 dynamic input channels with full data recording capability.
- 2011: Crystal Instruments introduced the 4th generation of vibration controllers, the Spider-81.
- 2013: Spider-80X is released, based on the Spider-80 design. Features two additional tachometer channels and the ability to stream data directly to a network attached storage device (Spider-NAS).
- 2014: Spider-80SG strain gage measurement system is introduced. It includes support for quarter-bridge, half-bridge, and full-bridge installations.
- 2015: Spider-20, the first wireless dynamic signal analyzer and data recorder is released. It is battery-powered and palm-sized.
- 2016: CoCo-80X, the LCD touchscreen dynamic signal analyzer, is released following the success of the original CoCo-80.
- 2016: Spider-80Xi, a compact and lightweight high channel count system is released
- 2017: Introduced EDM Modal, a suite of tools for modal test and analysis
- 2018: EDM MIMO VCS Control, software for Multiple-Input Multiple-Output Control
- 2018: Spider-80M Controller is released, based on the Spider-80Xi architecture and is dedicated to MIMO VCS control and MIMO structural testing applications.
- 2019: Released the CoCo-70X, an industrial version of a handheld vibration analyzer
- 2020: Released Spider-80Hi supporting up to 256 kHz sampling rate. Released strain and temperature DAQ products.
- 2021: Awarded by NASA for a major contract: Ground Recording System to be built based on CoCo platform

Machine Condition Monitoring

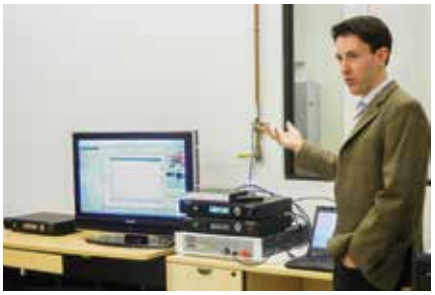
Smooth running process machinery buoys and maintains the world's economy. Products ranging from gasoline and chemicals to paper and steel are produced by continuous manufacturing processes. Nuclear, coal-fired, natural gas fueled, hydroelectric, wind powered or tidal-driven, power generation plants must operate continuously. Unexpected stoppages are the anathema of all these industries and vibration monitoring is a proven means of preventing them. Effectively monitoring the operating health and rapidly diagnosing the occasional mechanical failures of production machines is a vital survival mission in today's competitive business world. Today's monitoring technology has divided to create two equally important strategic paths. Expensive plants and critical machines are continuously monitored by permanently installed systems. Less critical machines (and plants monitored by external contractors) are protected by routed periodic measurements made using handheld data collector/analyzers guided by advanced database and analysis software. Crystal Instruments produces innovative offerings in support of both strategies.

Continuous Condition Monitoring

- Continuous measurement of shaft-to-case gaps
- Continuous measurement of case accelerations
- Track bearing temperatures, lubricant debris
- Share data anywhere, anytime via Internet
- Local recording to solid-state mass memory
- Automatic record-on-alarm operation

Route-Based Periodic Condition Monitoring

- Design and manage monitoring relational database
- Measure consistent error-free data along route
- Make voice-annotated data recordings of problems
- Upload data to PC; generate alarms and reports
- Make at-machine diagnostic measurements
- Perform 1 and 2 plane rotor balancing



Automotive

Automotive applications span a broad range of technology from design through product quality auditing. Manufacturers are under enormous competitive pressure to provide increasingly improved quality, safety, mileage, luxury, and economy. This places a heavy burden on automotive NVH Engineers to accomplish more, faster. Fast-paced development cycles in the modern car, truck, and coach industry demand the use of functionally flexible measurement equipment with friendly intuitive operation to unravel the dynamic and acoustic mysteries of the modern vehicle.

Data Acquisition and Analysis

- In-vehicle data recording and analysis with GPS
- Dynamometer testing and chassis tuning
- Drive-line balance and stability tests
- Component and body-in-white modal tests
- Pass-by acoustic monitoring
- NVH and whole body vibration

Vibration Control

- Component shake tests with road-recorded loads
- Material and component fatigue evaluations
- Component durability testing
- Transport simulation, time waveform replication
- Finite element model verification
- Multi-drive with multi-shaker test

Aerospace

Development of space vehicles, satellites, fixed wing aircraft and helicopters is a technologically leading business calling for the most advanced analysis and control instrumentation. Design verification of hardware and mathematical models is an all important activity. The high cost of aerospace structures and the uniqueness of prototypes demand the most careful conduct of every controlled vibration investigation. Probing the edges of the unknown calls for extreme dynamic range and analysis flexibility in the measurement hardware employed.

Data Acquisition and Analysis

- Ground Vibration Tests (GVT)
- Wind tunnel dynamic studies
- High channel reliable data recording
- Flight stress and vibration recording
- External and internal acoustical surveys
- Engine durability testing

Vibration Control

- Sine, RSTD, Random, SoR
- Durability tests using recorded flight data
- Launch and separation simulation
- Payload dynamic qualification
- Proof-of-performance component stress screening
- MIL-Spec testing

Education

Producing first-rate engineers is a daunting responsibility. More and more, experimental skill and experience with technologically advanced instrumentation is demanded by industry. Today's engineer needs to be both analytically competent and experimentally capable. Leading universities have broadened their curricula and softened the edge between electrical and mechanical studies to serve this need. Economic constraints place a premium on cost-effective instruments that can perform a variety of task by changing software. Flexible licensing that allows hardware modules to be used separately around the campus or to be brought together to form a large channel count system is now essential.

Data Acquisition and Analysis

- Introduction to digital signal processing
- Observing vibration and acoustic phenomena
- Characterizing analog electronic circuits
- Rotating machinery analysis
- Modal testing and analysis
- Real-time digital filters with configurable signal analysis

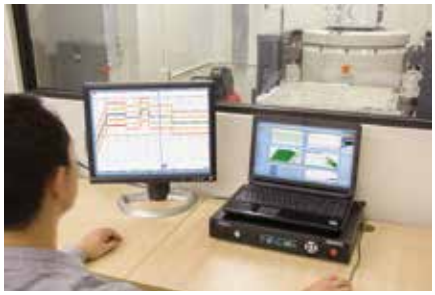
Vibration Control

- Introduction to electro-dynamic shakers
- Introduction to hydraulic shakers
- Concepts in shaker control
- Swept-sine testing
- Random testing
- Shock testing

Military
The military forces of the United States design and acquire a variety of specialized hardware and systems for use on land, in the air and at sea. Military acquisitions range from miniaturized electronics packages to surface ships and aircraft. All of this material is subjected to rigid incoming inspection and testing in accordance with military specifications.

Data Acquisition and Analysis
- Ship and submarine silencing
- Helicopter and jet vibration
- Vehicle dynamic strain recording
- Flight/road test recording
- Engine/driveline analysis
- Route-based vibration data collection

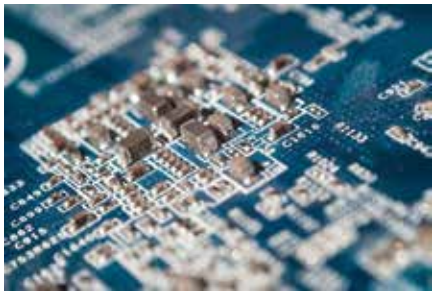
Vibration Control
- Random shake testing
- Swept-sine shake testing
- Classical shock testing
- Drop-table shock testing
- Pyrotechnic shock tests and SRS
- Flight and launch simulations



Testing Labs
Commercial testing laboratories provide capital facilities and in-depth testing expertise to industry. They often represent the least expensive means to qualify a product and prove its compliance to a broad range of specifications and codes. Leading test laboratories have an extensive range of shaker and shock test facilities supported by the most modern control and analysis electronics available.

Data Acquisition and Analysis
- Stress and vibration recording
- CE requirement testing
- Product vibration surveys
- Component modal studies
- Servomechanism verification
- Circuit performance tests

Vibration Control
- Product durability testing
- Random, SoR, RoR shake testing
- Swept-sine, RSTD shake testing
- Shock-on-shaker testing
- Seismic testing and earthquake simulation
- Combined thermal and stress testing



Electronics
The electronics industry spans and affects every aspect of human life. It is an extremely broad industry ranging from military hardware to personal entertainment products and everything in between. Personal computers, tablets and smart phones are part of everyone's life and of many industrial systems. Chronometers, radar, sonar and GPS let us navigate our world precisely. Radios, television and the internet keep us informed and communicating. All of these things have electronic components to be understood and packaging concepts to be qualified.

Data Acquisition and Analysis
- Analog circuit bench testing
- Analog network analysis and tuning
- Characterizing component background noise
- Measuring gain, phase and linearity
- Magnetic field frequency response
- Verifying system poles and zeros
- Automated production test

Vibration Control
- Highly accelerated stress screening (HASS)
- Highly accelerated life-testing (HALT)
- Package design verification
- Spec-qualifying a module, chassis or rack
- Environmental simulations; packaging tests
- Drop-testing shock response analysis
- Sine and dwell test for qualification

Spider-81 Premium Vibration Controller

Spider-81B Basic Vibration Controller

Spider-81

The Spider-81 is the flagship model of Crystal Instruments vibration controllers. This 4th generation hardware is highly modular, distributed and scalable. Each Spider-81 has 8 analog input and 4 analog output channels. Eight digital I/O pairs are provided for custom applications. A bright front panel LCD displays the system status and test information. Users can instantly view real-time status information such as control RMS or sweeping frequency on the LCD panel.

The Spider-81 not only uses Ethernet for data communication, it goes further by employing IEEE 1588v2 time-synchronized Ethernet connectivity. This technology allows (up to 100 meters in distance) remote input modules to be connected solely by Ethernet (with no dedicated “sync” cable required), while still providing sampling and triggering synchronization within an accuracy of 50 ns. The Spider-HUB industrial Ethernet switch can expand the Spider-81 controller up to 512 input channels. All input channels across the system are amplitude matched within 0.1 dB and phase matched within 1° over a 20 kHz bandwidth.

All Spider front-ends contain a 4 GB flash memory for the storage of data and test processing instructions. If longer recording is required, the Spider-NAS (Network Attached Storage) provides 250 GB of solid-state disk (SSD) storage (extendable up to 2 TB) in a removable SATA cartridge. One Spider-NAS records streamed time waveforms for up to eight Spider front-ends at the same speed of 102.4 kHz per channel.

Spider-81B Economical Vibration Controller

The Spider-81B front-end is a smaller, simplified system providing everything needed to run Sine, Random or Shock tests, measuring the control, and up to 3 monitor signals. This smaller system offers a comprehensive solution with the same control quality, safety assurance, measurement precision, expandability and user interface that distinguishes all Crystal Instruments controllers.

Shown here are the Spider-HUB, the Spider-NAS, and Spider-80X.

The Spider-80X is designed for vibration control, machine monitoring, and data acquisition.

The Spider-80Xi is a compact, lightweight, high channel count data acquisition system intended for portable field use.

The Spider-80M is dedicated to MIMO control and MIMO structural testing applications.

Spider-80X

The Spider-80X is a compact package designed for applications in three fields: dynamic data acquisition, vibration control, and machine monitoring. It features eight analog input channels and two channels that can be software selected as analog outputs for vibration control or tachometer inputs for the analysis of rotating machinery. Spider-80X is the most compact form factor in the Spider series.

Spider-80Xi Hardware Platform

The Spider-80Xi is a platform supporting all-purpose data acquisition. Featuring a 64-channel chassis weighing less than 10.5 kg (23 lbs). A single chassis can be carried in one hand and is optimal for field environmental testing where portability is essential.

The Spider-80Xi system consisting of one 64-channel chassis is AC powered at 100 to 240 V. The Spider-80Xi system consisting of one 32-channel chassis is DC powered at 10 V to 22 V.

Spider-80Xi platforms can host various front-ends including voltage, IEPE, strain, temperature or charge measurements. Multiple Spider-80Xi chassis can combine to create a system with up to 512 channels, all simultaneously sampled and synchronized with excellent phase match between all channels on the same front-end, across front-ends, and even across multiple chassis.

The Spider-80Xi is ideal for customers requiring a high channel count system with complete solutions for modal testing, vibration control, data acquisition and dynamic signal measurement.

Spider-80M Hardware Platform

The Spider-80M platform is based on the efficient Spider-80Xi architecture and is dedicated to MIMO VCS control and MIMO structural testing applications. Each Spider-80M chassis features 8 outputs capable of carrying out 6-degree of freedom MIMO testing. One Spider-80M chassis and multiple Spider-80Xi chassis can chain together to form a very large system with up to 504 input channels.

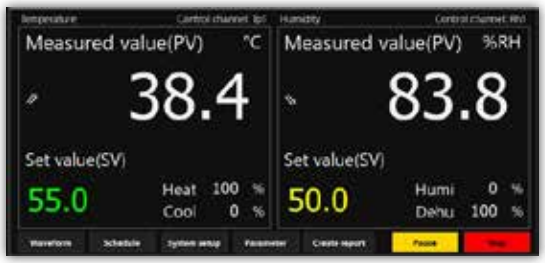
Hardware Platform	Spider-81	Spider-81B	Spider-80X	Spider-80Xi	Spider-80M
Application	VCS, DSA*	VCS, DSA*	VCS, DSA, EMA, RCM*	VCS, DSA, EMA, RCM*	MIMO VCS, MIMO FRF*
Number of Front-ends Per Chassis	1	1	1	8	7
Number of Inputs per Front-end	8	4	8	8	8
Max Number of Inputs Per Chassis	8	4	8	64	56
Max Number of Inputs Per System	512	4	512	512	504
Number of Outputs Per System	4	1	2	2	8
Input Mode	Charge TEDS IEPE Voltage	Charge TEDS IEPE Voltage	Charge (optional) TEDS IEPE Voltage	TEDS IEPE Voltage Strain gage MEMS RTD Thermocouple	TEDS IEPE Voltage Strain gage MEMS RTD Thermocouple
Digital I/O	8 in/out, isolated	4 in/out, isolated	4 in/out, isolated	2 in/out, isolated	2 in/out, isolated
Front Panel LCD	Yes	No	No	Yes	Yes
High Speed Data Port	Yes	No	Yes	Yes	Yes
Notes	Flagship product for VCS line. Input protection up to 220 V. Equipped with Stop/Start button.	Economical solution	Modular at box level.	Modular at board level. Input Mode depends on front-end type. See the following table.	Modular at board level. Input Mode depends on front-end type. See the following table.

** VCS = Vibration Control System*
** DSA = Dynamic Signal Analyzer*
** EMA = Experimental Modal Analysis*
**RCM = Remote Condition Monitoring*
** MIMO VCS = Multi-input Multi-output Vibration Control System*
** MIMO FRF = Multi-input Multi-output FRF analysis in EMA*

The Front-ends of the Spider-80Xi and Spider-80M Platform				
Front-end Types	**Spider-80Hi**	**Spider-80Ci**	**Spider-80SGi**	**Spider-80Ti**
Max Sampling Rate	256 kHz	256 kHz	102.4 kHz	1 kHz
Number of Inputs Per Front-end	8	8	8	16
Connector Type	BNC	BNC	LEMO	Screwed terminal
Input Type	IEPE Voltage TEDS	IEPE Voltage TEDS Charge	Voltage Strain gage Strain gage-based sensors MEMS DC-based sensors IEPE	3-wire RTD K type thermocouple
Input Coupling	AC Differential DC Differential AC Single-ended DC Single-ended	AC Single-ended DC Single-ended	AC Differential DC Differential Bridge-Based Sensor In-line Charge Amplifier	PT 100 (RTD) K-Type input (TC)
Sensor Excitation	4.2 mA at 21 V for IEPE	4.2 mA at 21 V for IEPE	2.5 V, 5 V, 10 V V for IEPE	10 µA to 1.5 mA RTD
Strain Gage Type	-------	-------	Quarter Bridge Type I, II Half Bridge Type I, II Full Bridge Type I, II Excitation voltage: ±2.5, ±5	
Max Input Range	±20 V_{pk}	±20 V_{pk}	±10 V	400 Ohm (RTD) ±80 mV (TC)
Input Protection Voltage	±220 V	±220 V	±40 V	-------
Analog to Digital Converter Per Channel	Dual 24-bit ADC	Dual 24-bit ADC	24-bit ADC	24-bit ADC
Cross Talk	< -100 dB	< -100 dB	< -100 dB	-------
Amplitude Accuracy	±0.1% at 1 kHz 1 V	±0.1% at 1 kHz 1 V	±0.1%	-------
Phase Match	< 1° up to 20 kHz	< 1° up to 20 kHz	< 1° up to 20 kHz	-------

Combined Environmental Testing

www.crystalinstruments.com/temperature-humidity-environmental-controller



Test status page of EDC on a wireless, touchscreen terminal

Parameter page of EDC on a wireless, touchscreen terminal

Create test page of EDC on a wireless, touchscreen terminal

Run log page of EDC on a wireless, touchscreen terminal

The industry trend demands environmental testing conducted in fully integrated environments. Various physical parameters, including vibration (acceleration, velocity and displacement), temperature, humidity, pressure, torque, and electrical signals such as those from a CAN bus should be monitored and controlled by one system. Crystal Instruments made dedicated efforts to achieve this goal.

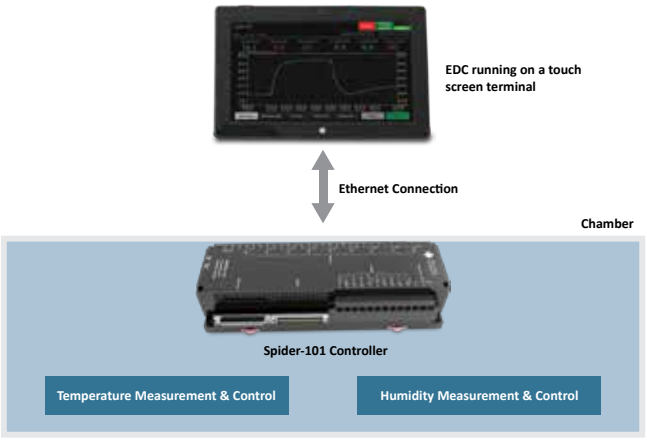
Using the Ethernet network and PTP time synchronization technology, all Spider hardware devices connected to the LAN can be accessed and configured as one integrated system.

The Spider-101i is specifically designed to perform tests subjecting the DUT to simultaneous temperature cycling and variable humidity. The Spider-101i controls both temperature and humidity in a chamber system, which includes external heating/cooling and humidification/dehumidification systems.

When vibration control is required along with temperature and humidity control, the Spider-101i offers a lot of advantages and convenience to access the parameter and schedule setup between all combined physical quantities from one fully integrated user interface. If a THV (temperature, humidity, vibration) system (chamber + shaker) is equipped with a Spider-101i controller, the controller software allows the addition of a Spider vibration controller and operates the two systems as one while providing an integrated user interface. Users can execute vibration tests such as Random, Sine, Shock, SoR, RoR, and other types together with various cycle settings of temperature and humidity.

- One integrated setup
- One clock and schedule
- One user interface
- One testing report
- One vendor to provide technical support

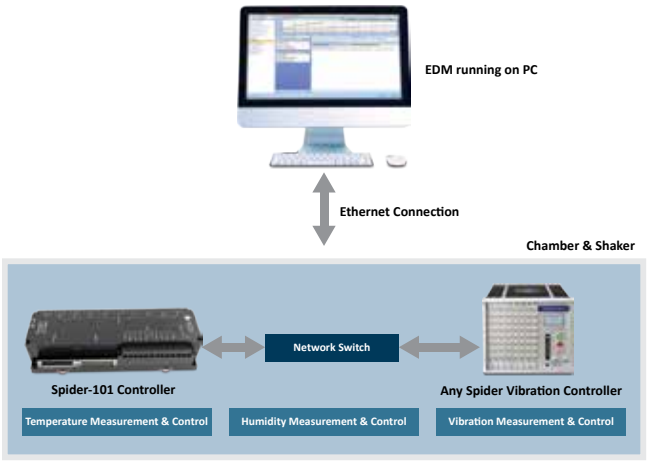
Temperature and Humidity Chamber with a shaker system



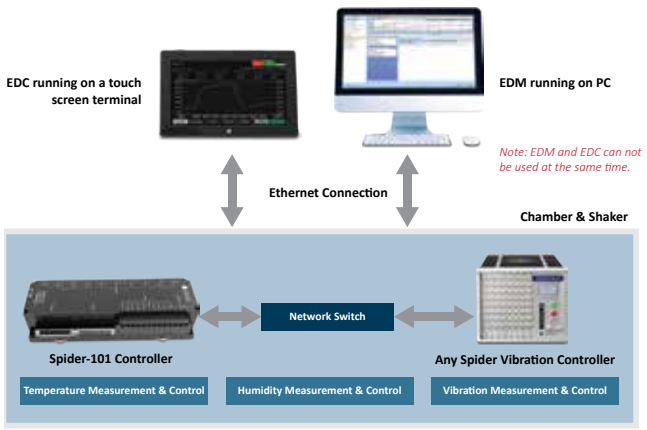
Software Designed for Combined Environmental Testing

EDC (Embedded Device Controller) and EDM THV are two software modules specifically designed for the Spider-101i to perform Temperature/Humidity (TH) or Temperature, Humidity, and Vibration (THV) control tests.

EDC is a lightweight Windows application with an interface designed for touchscreen use. It runs smoothly on both Windows 10 computers and tablets, which can serve as mobile or fixed operation terminals that users can move freely or mount to the testing chamber. In addition, there is a wide selection of Windows tablets offered on the market that fulfill various requirements (such as the IP6X tablet). The Spider-101i controller runs on EDC software to conduct TH testing (without vibration) in independent climate chambers. Users can configure a test, operate a test, review test logs, review signals, and generate reports from the EDC interface.



EDM THV is the THV control software application included in EDM (a PC-based software developed by Crystal Instruments). Use EDM THV with a Spider-101i and a Spider vibration controller when vibration control is required along with temperature and humidity control. EDM THV is a premium and full-featured software product as well as EDM VCS (Vibration Control System) and EDM DSA (Dynamic Signal Analyzer).



When EDM THV is running as the THV control software, EDC can be used to monitor the chamber status.

SOFTWARE ADVANTAGES

- Both temperature and humidity can be display on the same plot
- Both Y-axe (temperature and humidity) can zoom in/out to provide display in detail
- Live Display – display the latest data of the specific duration (X-axis)
- History View – display data of the entire test duration and zoom into any part of the test during operation (X-axis)
- Two cursors can be placed and show delta X and delta Y
- Historical data review on the panel directly
- Fault history and diagnosis with solutions provided
- Report automatically generated at the end of the test
- Customizable contents
- Zoom into screenshots of temperature holding in test
- Supports letter and A4 layouts; supports Word and PDF formats
- Easy to back-up all chamber configuration files
- Easy to download historical data, with or without all chamber configuration files
- Import and view data files or all configurations without connected hardware
- Third-party extension support

Spider-80Ti High Channel Temperature Measurement

www.crystalinstruments.com/spider80ti-temperature-measurement

Spider-80Ti setup

Multi-module setup

The Spider-80Ti is one of the front-ends on the Spider-80Xi hardware platform that enables Temperature measurement. Spider-80Ti supports temperature measurements from Thermocouples and RTD (Resistance Temperature Detector) sensors.

Each Spider-80Ti front-end adds 16 temperature measurement channels to the Spider-80Xi system. A Spider-80Ti front-end is user-configurable to support either a PT100 RTD sensor or a K-type Thermocouple. A combination of RTDs and thermocouples within the same Spider system can also be achieved by combining the front-ends configured as RTDs and Thermocouples.

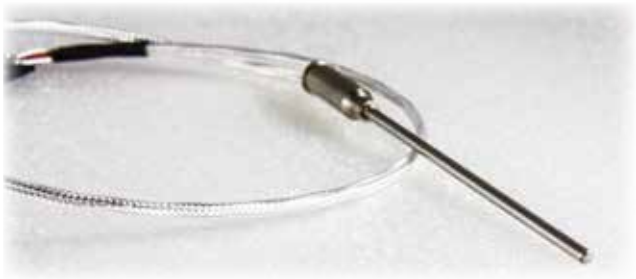
Spider-80Ti is equipped with a 24-bit Sigma-Delta Analog to Digital Converter (ADC) per channel to ensure highly accurate temperature measurements with any type of sensor. Together with the user-configurable non-linearity correction, the accuracy of the measurements is ensured over a wide range of temperature.

The Spider-80Xi chassis can either be configured exclusively for temperature measurements using the Spider-80Ti front-end or can be configured for mixed signal data acquisition by combing the Spider-80Ti with Spider-80Hi, Spider-80Ci, or Spider-80SGi. A choice of Spider-80Xi chassis with 4 front-end slots or 8 front-end slots is available.

The efficient design of the Spider-80Xi chassis eliminates individual enclosures for each modular front-end to minimize the overall dimensions of the system. Its lightweight makes it ideal for applications requiring portability and an efficient size without the need to exchange front-ends during operation.

Multiple chassis consisting Spider-80Ti front-ends or a combination of Spider-80Ti, Spider-80Hi, Spider-80Ci, or Spider-80SGi can be chained together to form a system with up to 1024 channels, all sampled simultaneously.

The Spider-80Xi system is equipped with powerful and flexible data acquisition functions. Users can initiate continuous time data recording or data recording triggered by user configurable events including pre-set run schedule, alarm limit trigger, input trigger, or digital input trigger. A high-performance removable 2.5-inch solid-state drive (SSD) is used as a storage media inside the Spider-80Xi. The default capacity of the SSD is 250 GB and is extendable up to 2 TB. When recorded, data will be written in the NTFS file system format. Data is extracted from the SSD using Crystal Instruments PC software to transfer data to the PC, or the SSD can be physically removed and connected to another PC.



RTD Temperature Measurement Accuracy

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. Having these customizable coefficients also allows the user to use RTD sensors with different alpha values and greatly improves the accuracy of the measurements.

RTD Channel Gain and Offset Calibration

Gain and offset error may be introduced due to the source impedance of the sensor or other factors. Sensors with higher lead resistance may introduce significant errors. Spider-80Ti has an inbuilt function to perform gain correction and offset nulling for each individual channel to negate these errors.

Spider-80Ti with Thermocouples

Each Thermocouple channel is passed through a programable gain amplifier and then sampled by a 24-bit analog-to-digital converter (ADC). Then the cold junction compensation and a user customizable moving linear average is applied to the measurements.

Cold Junction Compensation

Thermocouples have two junctions, namely the Hot and Cold Junction. The hot junction is the measurement junction and is attached to the measurement point. In theory, the cold junction should be maintained at 0 0C. As this is not a practical solution the cold junction is connected to an Isothermal block, the temperature of this block is measured by a high precision internal temperature sensor.

The thermoelectric voltage across the sensor is measured. The internal sensor measures the isothermal temperature, this is then converted to its corresponding voltage value. This value is used to offset the cold Junction temperature to provide an accurate measurement.

Thermocouple Channel Gain and Offset Calibration

Gain and offset error may be introduced due to the source impedance of the sensor or other factors. Sensors with higher lead resistance may introduce significant errors. The Spider-80Ti has an inbuilt function to perform gain correction and offset nulling for each channel to negate these errors.

Multi-point Sensor Correction

The Spider-80Ti system allows the user to perform multi-point correction if the user has more precise values for the sensor, this data can be entered into the system to provide a linearized offset correction between the temperature breakpoints.

Strain Gage Measurement

www.crystalinstruments.com/spider80sg-general-data-acquisition-with-strain-gage

The Spider-80SG Strain Gage Measurement System

Spider-80SGi in the Spider-80M platform

The Spider-80SG Strain Gage Module

The Spider-80SG/SGi is a front-end in the Spider-80X/Xi hardware family platform. It is a high precision, general purpose data acquisition device featuring strain gage functionality. This device can be used in a variety of physical and measurement tests.

The Spider-80SG can acquire data from a strain gage or a wide range of sensors. With the help of precision excitation voltage, the Spider-80SG/SGi can support strain gage based sensors, MEMS sensors, IEPE and DC sensors (to name a few) thus expanding the scope of the Spider-80Xi hardware platform to support the synchronized acquisition of a wide range of measurement quantities including Force, Torque, Pressure, Acceleration, Velocity and Displacement. It can be used for strain measurement and many other types of sensors that requires external power. EDM-DSA and VCS software fully supports the Spider-80SG front-end in all its testing operations.

In addition to the features shared with the Spider-80Xi hardware platform, the Spider-80SG/SGi offers the following capabilities.

High Channel Count

Named for their networkable ability, the Spider hardware platforms (including the Spider-80X/Xi and the Spider-80SG/SGi) share the flexibility of scaling up in channel count and functionality. The Spider-80SG/SGi can combine with any Spider-80Xi device to create a high channel count system with up to 512 channels.

Spider-80SG

Highlighted Features:

- 8 strain gage/general purpose inputs per front-end
- 24-bit ADC channel
- Supports multiple measurement quantities
- Supports Quarter Bridge, Half Bridge and Full Bridge and Rosette strain gage configurations
- Supports a variety of strain gages based sensors, load cells, pressure transducers, torque sensors, LVDTs, MEMS accelerometers, displacement sensors, velocity transducers and geophones and IEPE sensors
- User configurable synchronized sampling rate
- Remote sensing: measures strain accurately from up to 1000 ft cable length with up to 10 KHz frequency.
- Precision excitation voltage of ±2.5 V and ±5 V
- Power supply voltage of 2.5 V, 5 V and 10 V for sensor excitation
- Shunt calibration
- Offset nulling for any measurement quantity
- Multiple trigger modes
- Compact, portable design
- Scale up to 512 channels using multiple front-ends
- User selectable sampling rate for each front-end in a high channel count system
- DC drift: less than 1.5 µV/V in 48 hours

Dual Modes of Excitation

The Spider-80SG is equipped with dual excitation modes. There is an option for Precision Excitation Voltage of ± 2.5V or ± 5V that can be used to excite a strain gage or a strain gage based sensor and to accurately measure the minute change in resistance. It is also equipped with a user configurable DC power supply of 2.5V, 5V and 10V which can be used as an excitation voltage for a wide variety of sensors.

Strain Measurement

The Spider-80SG/SGi supports Quarter Bridge, Half Bridge and Full Bridge configurations for each input channel. It also supports measuring strain through Rosette configurations by combining the user selected channels in the desired configuration.

Remote Sensing

The Spider-80SG has been tested to work on strain gages up to 1000 ft away from the analyzer using the remote sensing feature. Using an 18AWG 5 conductor cable to measure the excitation voltage using remote sensing and changes in output voltage, the error was measured to be less than 1.5% for signal frequencies up to 10 kHz.

Measurements Quantities and Sensor Types

The Spider-80SG/SGi's user-selectable precision excitation voltage feature enables it to interact with a wide range of sensors, allowing the synchronized acquisition of a wide range of measurement quantities.

Supported Sensor Types: MEMS based Sensors, Strain gage based sensors, Precision Excitation DC Sensors, IEPE and In-line charge amplifiers

Supported Measurement Quantities: Force, Pressure, Torque, Acceleration, Displacement, Velocity, Sound Pressure.

Spider-HUB Industrial Ethernet Switch

Spider-NAS Storage Device

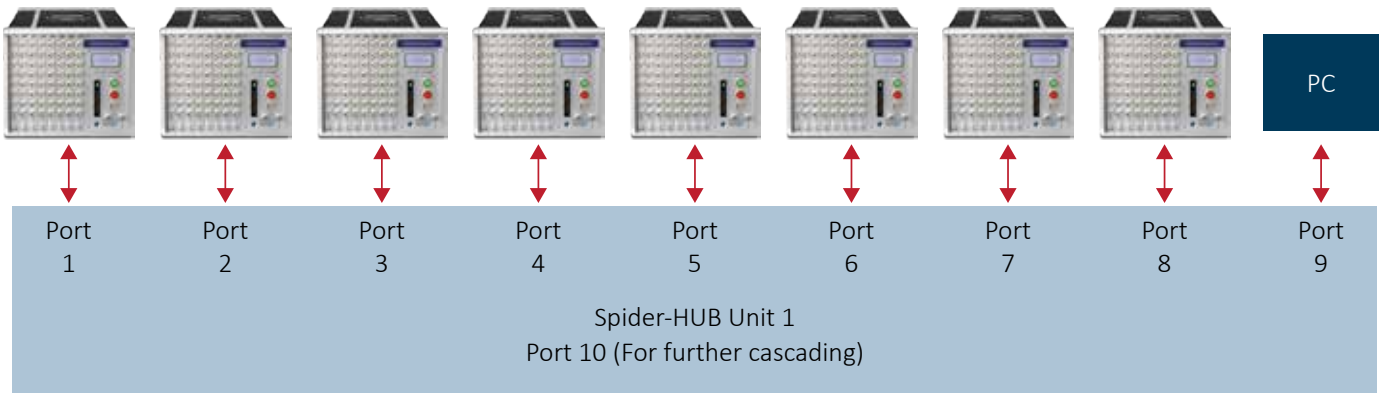
Spider systems use superior Ethernet and time synchronization technology developed by Crystal Instruments which allows modular expansion to support up to 512 input channels. When a system is running multiple front-ends with hundreds of input channels, all data is simultaneously acquired and is accurately phase matched. The phase match accuracy is less than 1 degree within the normal testing frequency range. By providing such high phase match, the frequency response function of cross channel measurement can be used for analyzing the characteristics of the UUT (unit under test), such as modal shape and damping ratio.

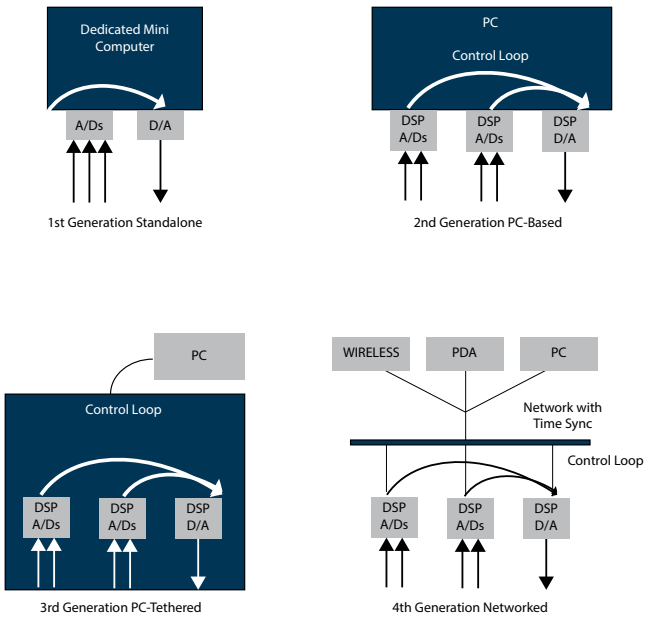
In a Swept Sine test that runs hundreds of input channels, the tracking filter and notching can be applied to any of the input channels. In a Random control test, the monitoring channel, limiting, or Sine-On-Random can all be simultaneously applied to any input channels. In TTH or Shock, data captured among all channels will be acquired simultaneously. CI's Spider system is the only product in the world that fully integrates the DSA and VCS functions to operate with up to 512 channels.

Data recording on Spider systems can be realized via either of two approaches: (1) record the time-stream data into the flash memory on each of Spider front-end or (2) record the time-stream data into an external storage device such as the Spider-NAS.

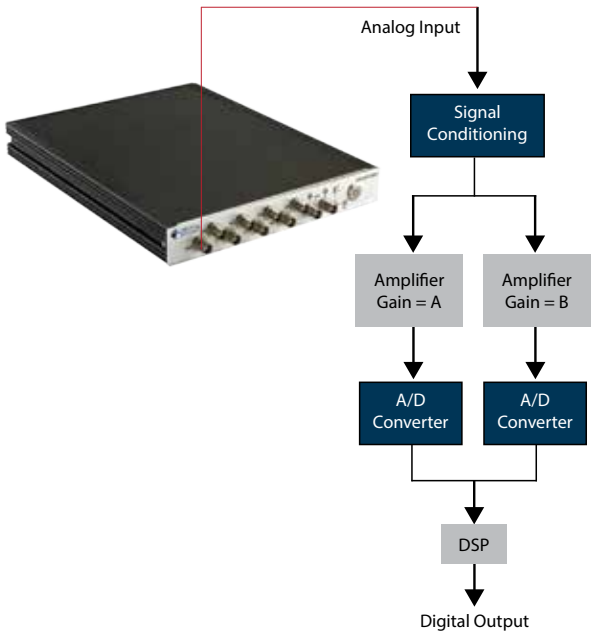
The Spider-NAS can store simultaneous data from all (64 maximum) attached dynamic measurement channels at a sample rate as high as 256 kHz, or as low as a few samples per second. If a system has more than 64 channels, every 64 channels will require one Spider-NAS.

Spider-80Xi System (512 Channel Count)





The Spider platform is based on a fourth generation DSP centralized architecture.



Hardware per US Patent 7,302,354 applies two ADCs to each input channel.

Latest Hardware Design

The Spider front-ends have voltage, IEPE and charge inputs which are ideal for shock, vibration, and acoustic measurement, strain or general-purpose voltage measurement. The internal flash memory stores test configuration data for controlling up to hundreds of channels simultaneously and stores real-time analysis data. Multiple output channels provide various signal output waveforms that are synchronized with the input sampling rate. Ten monitoring connections on each unit are used to read analog input and output signals. There is a built-in isolated digital I/O to interface with other hardware. Our scalable architecture allows users to employ as many as 512 input channels for the utmost spatial resolution. Sampling to 256 kHz provides excellent time resolution while spectra with up to 25,600 lines may be controlled in Random. Data is stored into 4 GB of internal flash memory. Increased storage space is possible with the addition of a 2 TB external disk. Input channels are protected against transient interference of up to 220 V.

Vibration and Various Data Acquisition Inputs

The CI Spider series supports a wide range of measurement types including vibration acceleration, displacement, velocity, strain, temperature, humidity, tachometer, toque, force, charge, current and more. A wide range of compatible sensors can be selected with the Spider hardware.

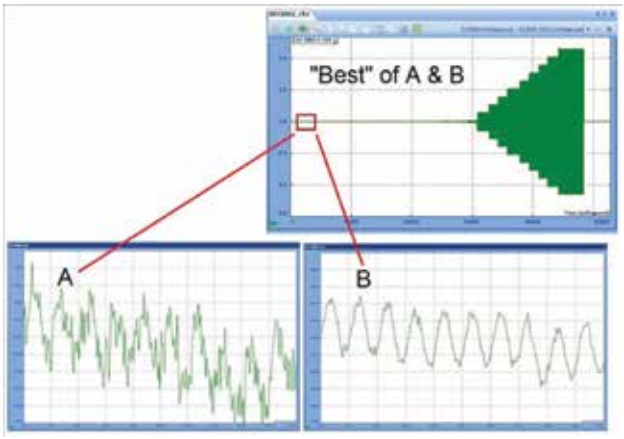
Shaker Compatibility

Spider controllers work with any electrodynamic, servo-hydraulic, or servo-electric shaker with all ranges of force ratings, from tiny desktop to multi-ton water cooled systems. Frequency range can be from sub 1 Hz to 40 kHz. MIMO controllers can drive complex shaker systems with multiple actuators. MIMO controllers can drive complex shaker systems with multiple actuators.

Designed for High Precision and Accuracy

The Spider analog input channels provide extremely high precision measurements. Each channel has single-ended or differential AC or DC input coupling. It can also provide IEPE (ICPTM) input mode (AC coupling with a 4 mA constant current from a 24 VDC source) for use with industry-standard accelerometers with built-in amplifiers. The ability to read TEDS (Transducer Electronic Data Sheet) identification from the attached transducer completes the channel's compliance with IEEE 1451.4.

In some models, built-in charge amplifiers are available. For pyrotechnic and other high-shock applications or tests involving very high DUT temperatures, each input channel can accept a charge-mode piezoelectric sensor input directly without using an expensive external charge amplifier.



DSP knows how to pick the data from either A or B path, and "stitch" them together.

Using our patented parallel dual analog-to-digital converter (ADC) design (U.S. Patent Number 7,302,354), each measurement channel provides an unprecedented dynamic range of 160 dBFS (v7.7 and later) and can detect signals as small as 600 nV and as large as 20 V. This design eliminates the need for the input range or gain settings found on traditional controllers.

Simple Network Connection

Ethernet connectivity allows Spiders to be located far from their host PC. This distributed structure greatly reduces noise and electrical interference in the system. A single PC can monitor and control multiple controllers over a network. Since the control processing and data recording are executed locally inside the controller, the network connection does not affect control reliability. With wireless network routers, a PC connects easily to the Spiders remotely via Wi-Fi.

Time Synchronization between Multiple Hardware Front-ends with only Ethernet Cable

The Spider is built on IEEE 1588 Precision Time Protocol (PTP) time synchronization technology. Spider modules on the same network can be synchronized within 50 ns accuracy, which guarantees ±1° cross-channel phase match up to 20 kHz across the complete system. With this unique technology and high- speed Ethernet data transfer, the distributed components on the network truly act as one integrated system.

Black Box Mode

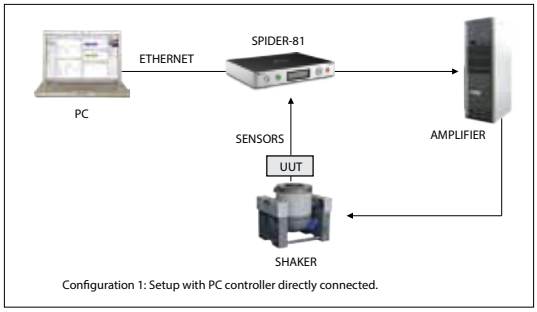
Black Box mode enables Spider operation without a PC. In this mode, a PC is used only to configure the control system before the system starts operation and to download data after the test is completed. During the test, the controller operates autonomously, according to a preset schedule.

LCD Display

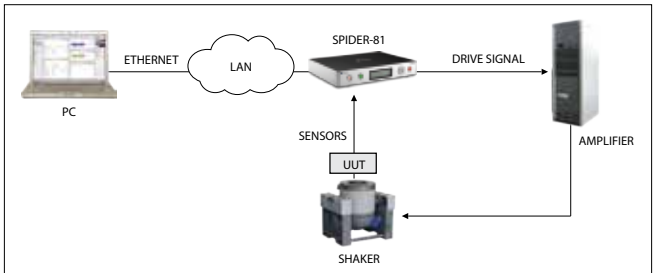
The Spider-81, Spider-80Xi and Spider-80M are equipped with a bright front-panel LCD showing intuitive information alongside the navigation controls. Real-time status such as control RMS or sweeping frequency can be viewed live on the LCD. IP network settings are also viewable on the LCD to help connect the Spider systems to the PC.

Designed for High Reliability

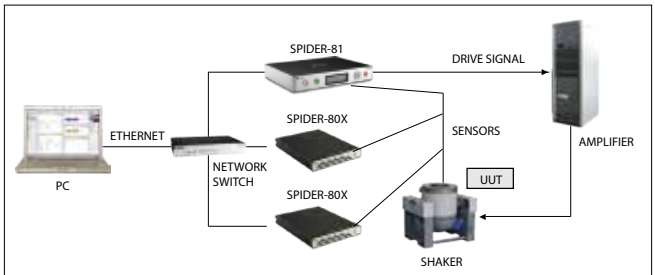
The Spider is the very first vibration control system designed for fail-safe operation even in the event of network or power loss. Advanced safety routines allow sensor failures to be detected within milliseconds. All Spider hardware pass strict environmental tests including EMI, temperature, drop shock, sine and random vibration. The system is built to withstand the rigors of the testing environment with long-lasting durability. The unique floating ground design reduces ground loop problems typically found in testing laboratories. Power backup circuitry based on a super-capacitor is installed to handle any disastrous power loss.



Configuration 1: Setup with PC controller directly connected.



Configuration 2: Spider VCS controlled remotely through a LAN. The network can be wired or wireless.



Configuration 3: High channel count system with one Spider-81 and multiple Spider-80X modules.

Designed for High Performance Control

By using enhanced control algorithms and a simplified DSP architecture, the feedback loop time of Sine and Random control are greatly reduced to a 10 ms latency. Reduced control loop time improves performance for resonance search and tighter control for a structure with high-Q resonances. It also provides faster adaptive responses for better safety protection.

Ease of Use

The Spider software is further improved at the user interface level. More graphical guidance, wizards, and tools are available to simplify test setup. The interface has been reformatted to be more intuitive. Event-Action Rules, Abort-Sensitivity, and numerous other new concepts are introduced in the software to simplify operation. Keyword searching through a large number of tests is easy. A smart network detection tool makes hardware installation very simple.

Admin and User Account Permissions

The controller software provides different account profiles with permissions that can be enabled or disabled (e.g., editing profiles, manually control of run level) to meet the user's role in the organization. An account with disabled features uses a cleaner interface that minimizes confusion.

Variable Sampling Rate

Applications that require measuring several quantities (e.g., acceleration, strain, temperature) may have different requirements for the sampling rate. The Spider product line provides a variety of options that support mixed sampling rates for different quantity measurements.

Cloud Enabled

Cloud service is provided at the customer's request. Test status, software version, hardware status and live data is displayed on the web browser. The data transmission between the controller software and cloud server is fully encrypted. Access Control and file sharing features are available.

CAN Bus Alarm/Aborts

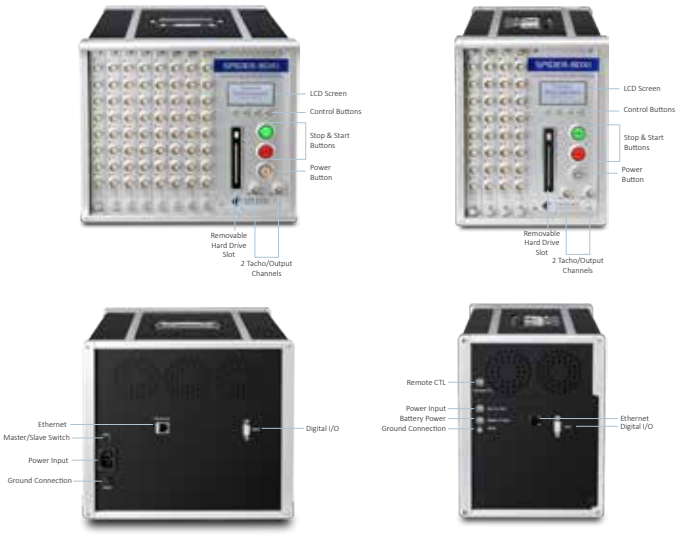
CAN bus data from the DUT now can be monitored by the controller software using a CI custom adapter. Alarm and abort limits can be applied to CAN bus data so that the controller software can stop/pause the vibration test when limits are exceeded. This feature can automate vibration tests by monitoring and reacting to the DUT status in real-time and can be a safety measure for battery testing.

Online Visualization

This feature animates the DUT's deformation during a vibration test from real-time measurements. The animation is based on the 3D model (geometry) of the DUT, which can be imported from a FEA/CAD model or be constructed from a sequence of evenly spaced photos taken around the object with a tool included in the EDM software.

Designed for High Scalability and Expandability

With the Spider architecture, it is possible to make the hardware system scalable and expandable. A testing lab that purchases multiple front-ends of the Spider-81 or Spider-80X can freely move around their units and configure their own systems. For example, if a user purchases 8 Spider-80X front-ends, the user can use it as a 64 channel system, or separate them into two systems each with 32 inputs, or even into eight systems to control eight shakers each with 8 inputs.



KEY FEATURES FOR SHUTDOWN PROTECTION:

- User selectable input channel for COLA input signal
- Customizable bandwidth tracking filters
- Customizable Alarms (raw time/rms time/ frequency domain)
- Digital output signal based on alarm results
- Run log event capture
- Powerful Black Box Mode
- IEEE 1588-time synchronization between front-end modules (50 ns time sync accuracy)
- Measurement dynamic range up to 160 dB
- Frequency resolution as fine as 0.001 Hz
- Measurement strategy: tracking filter, RMS, Mean, peak
- Total time between the onset of an alarm to the change in the state of the digital output: < 10 ms for system no more than 8 channels and <20 ms for more than 8 channels

KEY FEATURES FOR DATA RECORDING:

- Continuously record raw time data for all input channels (up to 512 inputs)
- Storage of continuous recording is up to 16 TB (2 TB per 64 channels)
- IEEE 1588-time synchronization between front-end modules (50 ns time sync accuracy)
- Processed by EDM Post Analysis software

Deploying Spiders as a Shutdown Protection System

Spiders are reputed as excellent products for vibration control applications. The vibration control system typically runs the control algorithms and takes several milliseconds to respond when an abort condition is encountered. The reaction time to shut down the drive may cause severe damage to the Device Under Test (DUT). To protect the DUT, a redundant shutdown protection system must be employed to continuously monitor the abort conditions and to abort the shaker/amplifier or the vibration control system within a small fraction of time.

The Spider platform of products can now provide redundant shutdown protection of a shaker system that is running a valuable DUT. The shutdown is achieved in under 10 ms for single module systems and under 20 ms for high channel count systems.

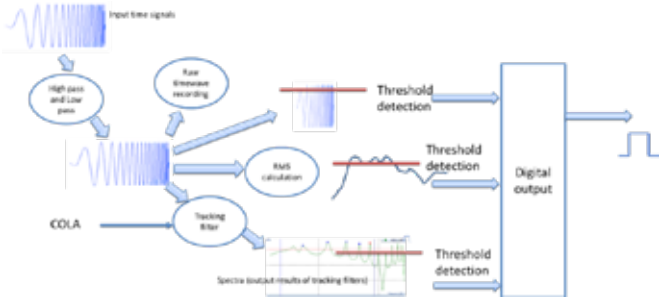
In addition, the Spider system can be attached as a redundant system to any of the current vibration control systems.

Users can define limits for raw time domain signals, RMS time signals, and frequency signals to trigger abort signals.

Event Capture (called Run Log on EDM) keeps track of all the events encountered on the Spider including the time and specific details of the event.

- Captures the time at which alarm is triggered
- Captures the channels for which alarms have triggered
- Captures the time and details of all other events

Channel Status on the other hand gives the status of all the channels in one display. Errors caused on any channel can be easily detected using the Channel Status. It is easy to identify which channel generated an error or triggered an alarm.



EDM (Engineering Data Management) is available in English, Japanese, Simplified Chinese, Traditional Chinese, and Russian.

A Wide Range of Software Functions in Vibration Control and Signal Analysis

The Crystal Instruments vibration control system (VCS) software is designed for a wide range of vibration and shock testing customers. The VCS software suites support Spider hardware systems with as few as two input channels to systems with up to 512 input channels and multiple drive output capabilities. Software solutions for vibration control includes Sine, Resonance Search Track & Dwell (RSTD), Oscillator, Random, Sine-on-Random (SoR), Random-on-Random (RoR), Swept Random-on-Random (SRoR), Classical Shock, Transient, Seismic, Shock Response Spectrum (SRS) Synthesis, Time Waveform Replication, multi-shaker control and a range of MIMO control functions. The VCS software is fully integrated into the combined test environment which includes controls to temperature, humidity, pressure, strain, torque and other quantities.

The same Spider hardware running VCS also supports a wide range of dynamic data acquisition and real-time processing functions including Fast Fourier Transform (FFT), Frequency Response Function (FRF), real-time filters, octave and sound level meters, order tracking, automated limit testing, transducer calibration and a comprehensive suite of modal testing and analysis.

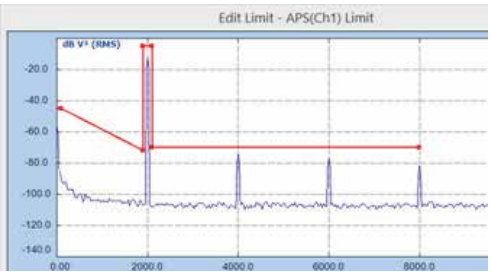
Multi-Language Support

Crystal Instruments' EDM fully supports software interfaces in English, Japanese, Simplified Chinese, Traditional Chinese or Russian. The selected language can be changed without re-installing the software.

Easy Network Configuration

Intelligence has been built into the software so that the hardware devices on the network can be detected and accessed with little effort. A Security Access Code (SAC) is used to protect unauthorized access to the hardware on the network.

Step 1:
EDM sets the alarm limit together with a special message string, such as "Exceeding Limit".



Step 2:
When an alarm event happens, the customized string, "Exceeding Limit" will be sent to the EDM Cloud email service.

Step 3:
User will receive an alarm email

EDM or EDM Cloud Email Service

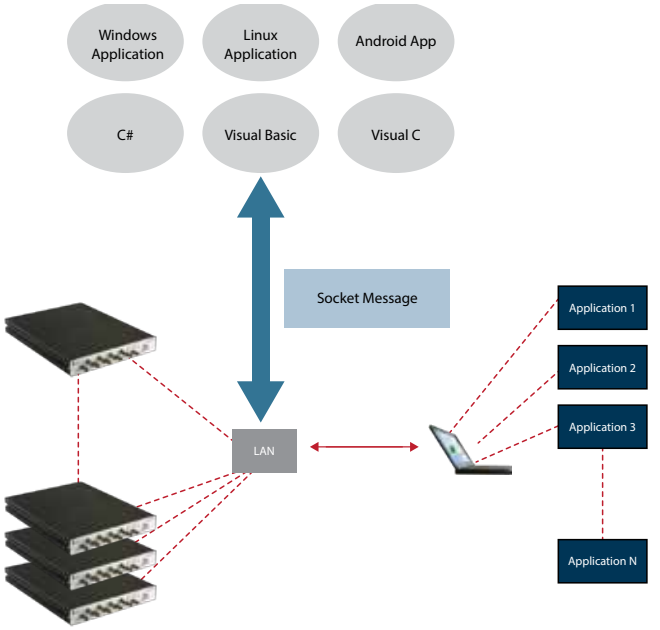
Multi-Tab and Multi-Screen Support
To support the high channel count system that may display up to hundreds of signals, the software is designed to support multiple tabs and multiple screens. The highly flexible online display capabilities are expandable, making monitoring high-channel count systems quicker and easier. Display layouts for each tab and screens can be set up and stored for rapid access.

Safety First
Our software and hardware utilize many safety features to ensure reliable closed-loop vibration control – from pretest checks to abort checking, notching and controlled shutdown during a test. The check-only mode allows checking the connection of sensors and verifies the amplifier status before turning the drive output on. This pretest function is an extremely powerful tool for detecting possible set-up problems before your test is started. During closed-loop control the VCS software performs RMS and line-by-line abort checks, sigma clipping and drive limitation and continuously checks for open channels and overloads. The software carefully checks for open-loop conditions such as failure of a sensor connection and verifies proper response during the initial drive ramp-up. During every test, the shaker limits (peak acceleration, velocity, displacement), maximum drive voltage and sensor connection status are continuously monitored and will initiate an emergency shutdown in case of any deficiency.

Multi-Tasking
With DSP centralized hardware architecture, the real-time measurement and control processes are all run on the front-end hardware; users can utilize all of the capabilities of the host computer for other tasks. This multi-tasking concept guarantees powerful and time efficient vibration testing, even with time critical tests. More importantly, it provides a unique and important safety feature: any computer or network failure will not affect the vibration control.

Test Sequence
A Test Sequence provides the capability to automatically execute a sequence of tests. The user can Run, Pause or Stop the testing at any time and the software keeps a detailed log of the actions and results.

Event-Action Rules
Event-Action Rules is a new way to customize the controller behavior. Many events that can occur during the course of test operation, including certain response levels being reached, limits being exceeded, and user events such as Pause or Stop. Event-Action Rules define the response of the controller to these test events. Many actions are available as custom responses, such as sending an e-mail, sending a digital output signal to the climate chamber or stopping the test.



Spider Vibration Control Systems

Connectivity to Other Software, Hardware and You

Various approaches have been developed to establish the connectivity between the EDM software and other applications, such as climate chamber software or an amplifier controller. Socket messages, a common language that runs on nearly all operating systems and hardware platforms, is used to send and receive messages between EDM and other software. A digital input/output hardware interface is also provided on every Crystal Instruments product, which enables interfacing to other hardware devices. Test status reports can be sent via email or SMS text message to your mobile phone, enabling you to decide whether to return to work or not within minutes of the test stopping.

Continuous Time Data Recording

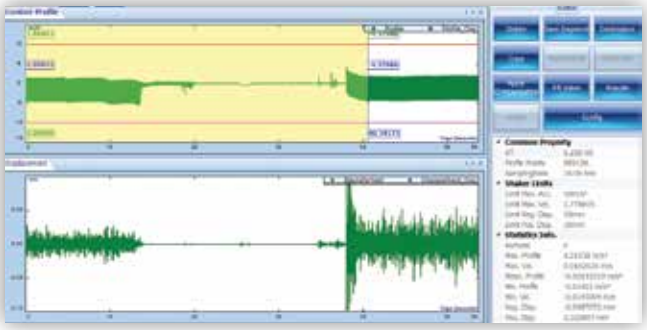
The Spider platform is capable of recording the data of 512 control/monitor input channels sampled at up to 102.4 kHz. The storage can be either internal flash memory or a dedicated solid-state drive. The reliability of the software for such real-time data transfer has been fully validated. Continuous recording happens in parallel with vibration control and neither is affected by the other.

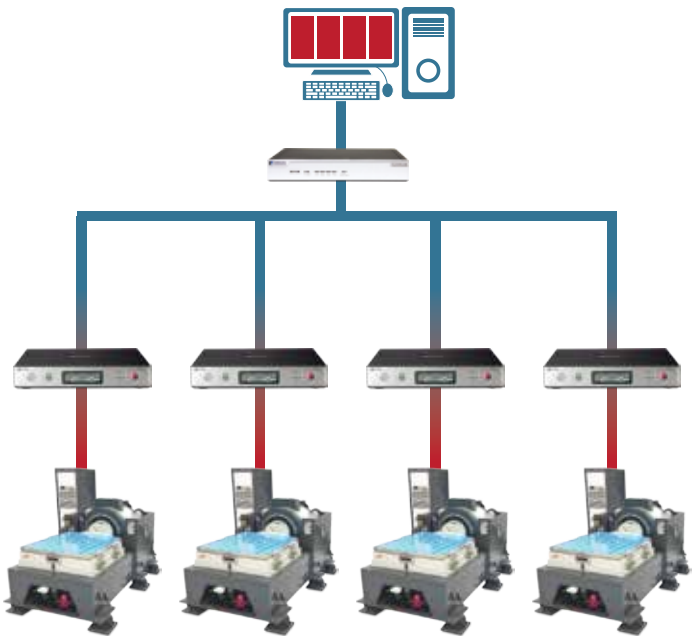
Database Technology

By using the latest database technology, EDM can quickly search, index and organize the testing setup and data. On a single company network, different testing stations can share the same database.

Location ID and Customized Signal Labeling

In EDM, signals can be clearly labeled with names conveying physical meaning, such as “Top” or “Front”. All related signals will be renamed with such labeling automatically.





Check List for the Initial Startup
EDM can show an overview of the critical parameters to be verified before a test is started.

Flexible Math Function
EDM software provides flexible math functions to perform block arithmetic on signals using +, -, *, / or other arithmetic operations. Math functions can be applied in both time and frequency domains.

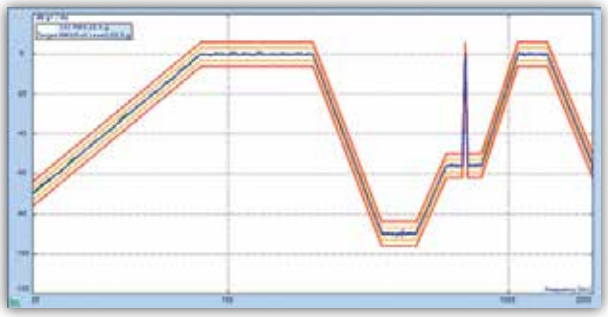
Non-Acceleration Measurements
Any input channel can measure any type of physical signal such as displacement, temperature or pressure.

Remote Operation Communication Using Socket Messages
Socket messages allow communication with other software applications and hardware, such as temperature chambers. With the Socket Message protocol, Crystal Instruments' controller can be accessed from LabView, Matlab or other customized software running on Linux, MacOS, or Windows operating systems. Please refer to the Socket Message Specifications for further details.

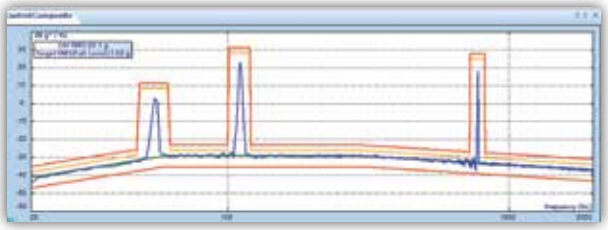
Shaker Parameters
Shaker parameters are saved to the library and used repeatedly in different tests. The library can be imported from or exported to a Microsoft Excel spreadsheet.

Multiple VCS instances
Launch multiple EDM VCS instances on one computer. Each instance of full-featured VCS software connects to one controller that drives one shaker. Each instance runs the vibration control test individually. All instances may run different test types or the same test type. The operator performs the tests and monitors the test status from the same computer, where all reports and signals from multiple instances are saved for better management.

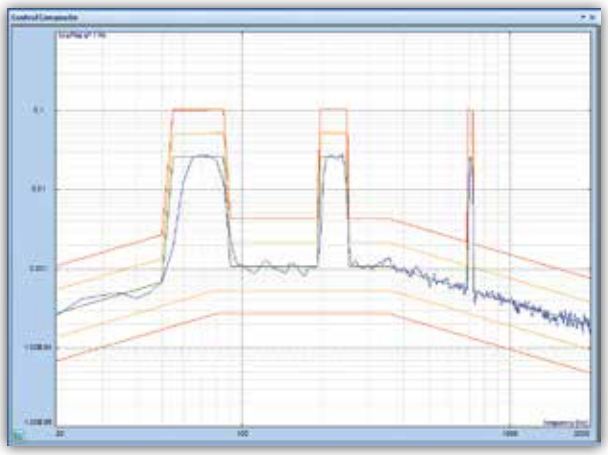
Amplifier Control
The amplifier control software is designed for specific Sentek Dynamics amplifier models. It features a flexible display, a user-friendly UI, and an interlock feature to prevent or stop the controller from running when the amplifier is not in an operating state.



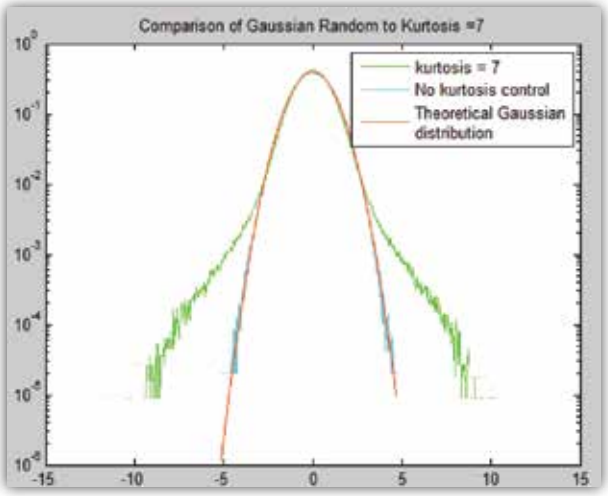
Random Vibration Control (VCS-20-CXX)
Random is the most popular type of excitation. Gaussian or non-Gaussian random signals are generated by the Spider controller to create a broadband excitation to the shaker. Feedback control signal meets most stringent requirements defined by aerospace or military testing standards. Input channels can be set as control, monitor, or limit.



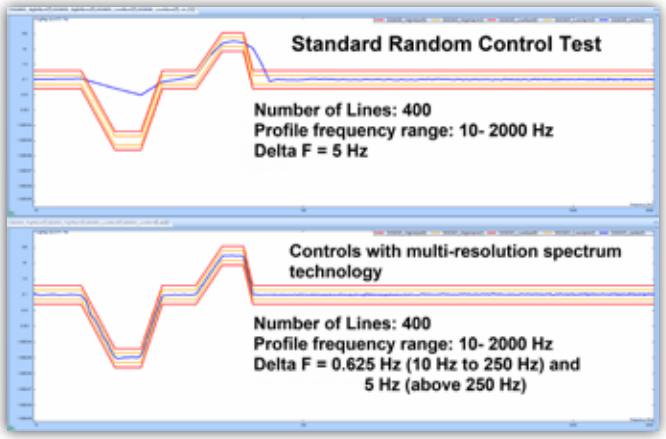
Sine on Random Control (VCS-20-08)
Up to 12 independently sweeping controlled sine tones and up to 32 harmonic sweeping tones may be added to the broadband random signal. Each sine tone has its own sweeping schedule and range. The sweep rate can be fixed or customized to better simulate real-world conditions. Tones can be turned on and off manually or by a predefined schedule. Multi-resolution spectrum technology allows for 8x finer frequency resolution in the lower frequency portion of the spectrum, improving control and display without sacrificing block size and response time.



Random on Random Control (VCS-20-09)
Up to 32 random narrowband signals may be superimposed on the broadband random signal. Each narrowband has its own sweeping schedule and range. They can be turned on and off manually or by a predefined schedule.



Kurtosis Control & Drive Clipping (VCS-20-06)
Kurtosis control can provide a more damaging non-Gaussian random control time history. A unique patented technology can generate a non-Gaussian control time history while precisely maintaining its spectrum shape.



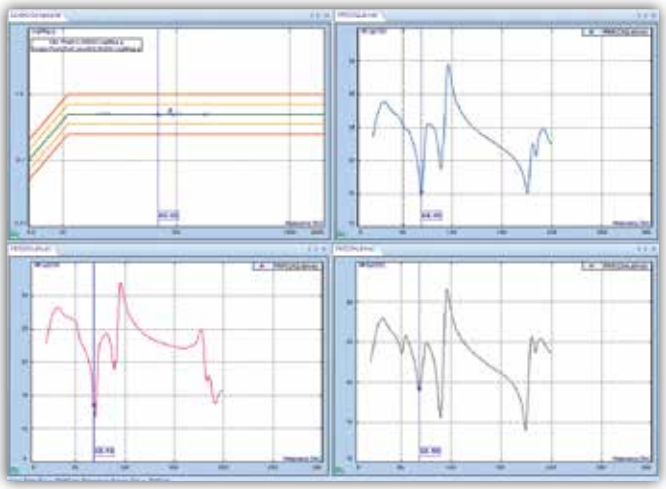
Multi-Resolution Control

The multi-resolution spectrum analysis developed at Crystal Instruments provides 8x finer frequency resolution in the lower portion of the spectrum. This technology maintains the benefits of a fast response time for detecting alarms and aborts while increasing the control accuracy and dynamic range. Supports Random, Sine-on-Random, Random-on-Random.

Fatigue Damage Spectrum (VCS-20-11)

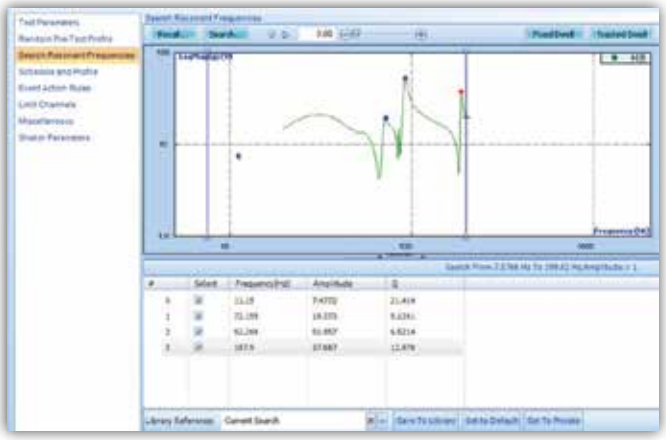
Fatigue Damage Spectrum (FDS) provides a way to reduce testing times by calculating the quickest path to destruction or damage. EDM can generate a Random PSD profile containing the same fatigue damage levels as the imported time stream using the Fatigue Damage theory, with an additional feature to extrapolate the testing time duration to a lifetime duration.

At a high level, the time domain signal data is processed into a Random PSD spectrum. It then converts the spectrum into Damage Potential using the criteria proposed by Henderson and Piersol 95. Multiple time waveform recordings can be combined and then the final spectrum can be scaled to subject the DUT to the same amount of fatigue in the shortened test time compared to its expected lifetime.



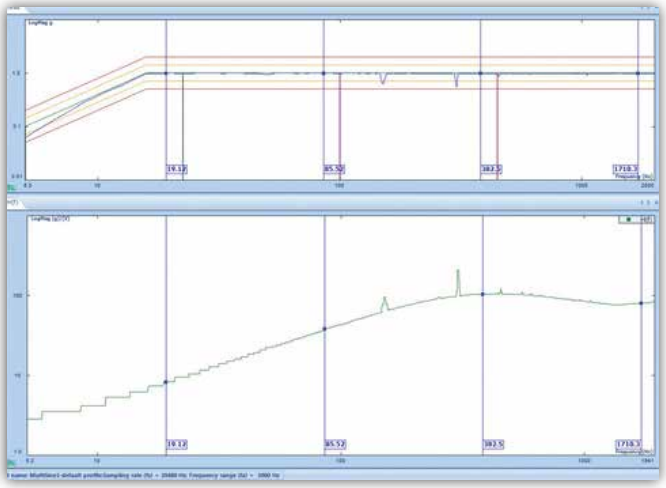
Swept Sine Control (VCS-40-CXX)

Swept Sine Vibration Control provides precise real-time multi-channel control. It provides a spectrally pure and undistorted sine wave and a control dynamic range of up to 100 dB. As many as 512 channels can be enabled for control, notching, or monitoring, while supporting time-data recording.



Resonance Search and Tracked Dwell (RSTD) Control (VCS-40-01)

The resonance search function determines resonant frequencies from the peaks of a transmissibility signal. Dwell type (Fixed dwell, Tracked dwell, Phase tracked dwell) may be specified manually (with a list of resonance frequencies) or automatically executed after a resonance search is done.

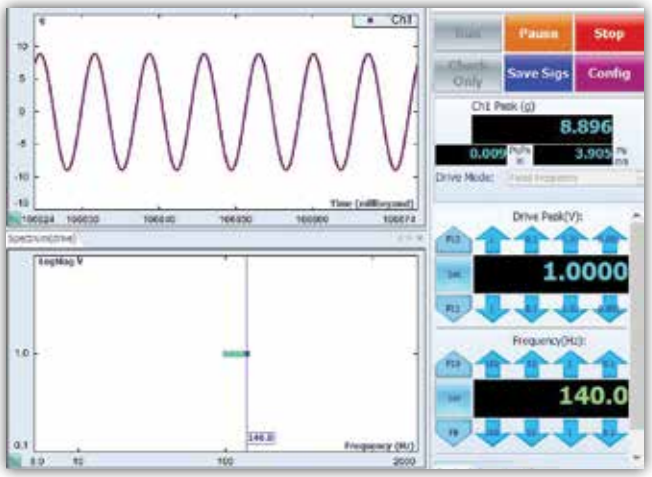


Multi-Sine Control (VCS-40-11)

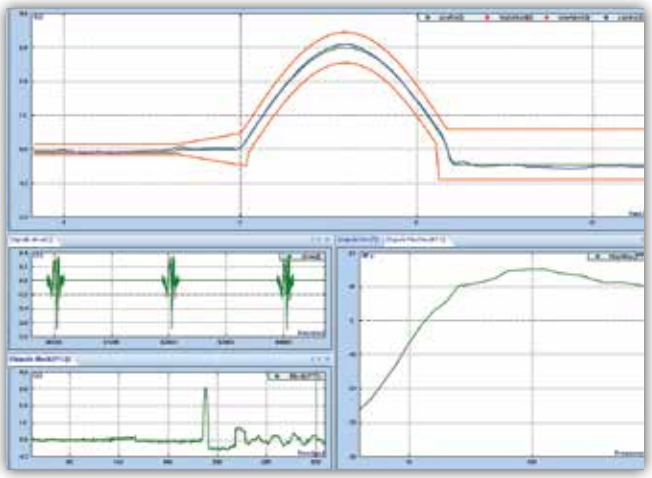
Multi-Sine control enables multiple sine tones sweeping simultaneously and ensures that multiple resonant frequencies of the structure can be excited. With multiple sine tone excitation, the required time duration of sine testing can be reduced significantly.

Total Harmonic Distortion (THD) Measurement for Sine

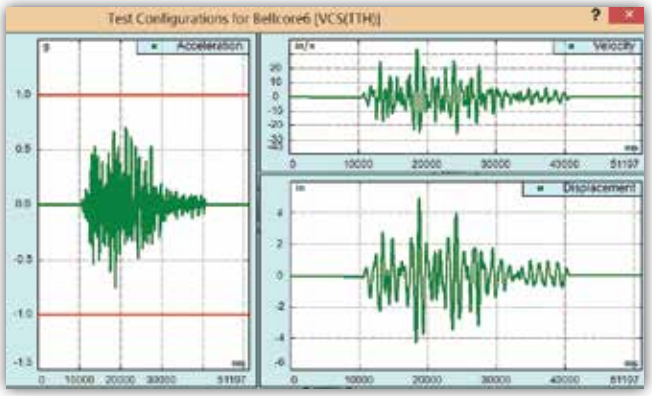
This option adds the ability of computing Total Harmonic Distortion (THD) of the control and Input signals. THD plots can be generated while drive signal either steps through multiple discrete frequencies or a swept sine tone within a predefined range.



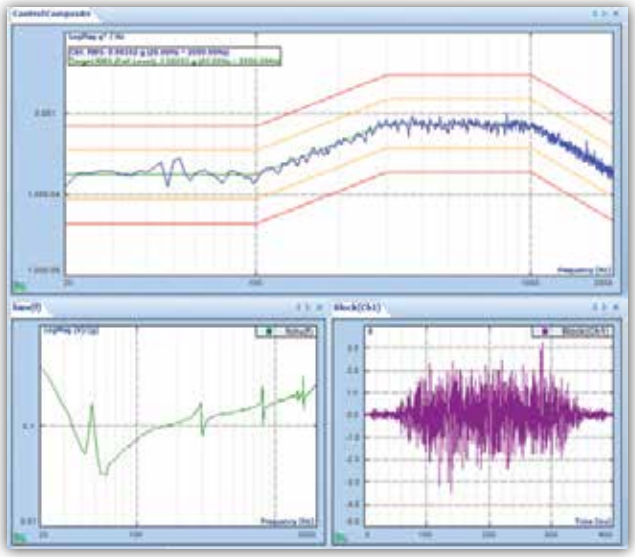
Sine Oscillator (VCS-00-05)
Sine Oscillator is a diagnostic tool providing manual control of the sine output while the system displays various time signals and frequency spectra. Random excitation can be enabled as a checkup function. When the close-loop option is enabled, the Sine Oscillator is essentially a limited sine controller with aug- mented manual control functions.



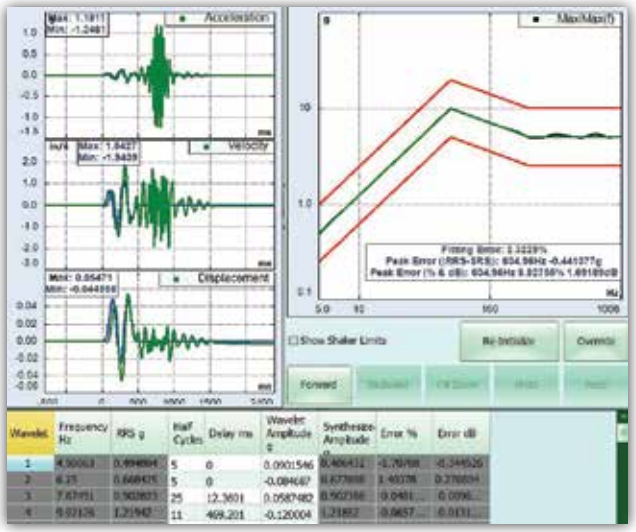
Classical Shock Control (VCS-60-CXX)
Classical Shock Control provides precise, real-time, multi-channel control and analysis of a transient motion in the time domain. Classical pulse shapes include half-sine, haversine, terminal- peak sawtooth, initial-peak saw tooth, triangle, rectangle, and trapezoid. Applicable Test Standards include MIL-STD-810F/G/H, MIL-STD-202F, ISO 9568 and IEC 60068 (plus user-defined specifications).



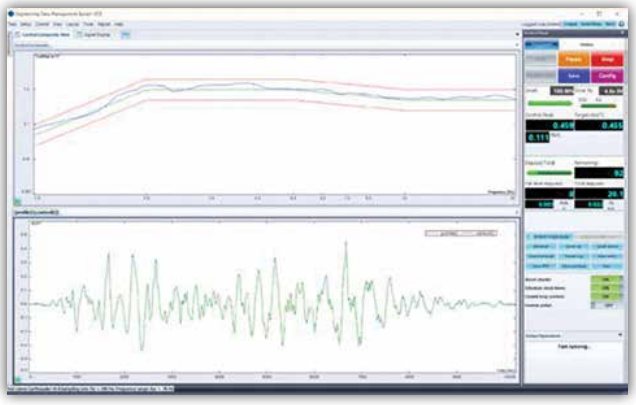
Transient Time History Control (TTH) (VCS-60-01)
Targeting seismic simulation applications, TTH controls shaker motion to match any user defined transient waveform. Time waveforms can be imported to EDM in various formats. Scaling, editing, digital re-sampling, high-pass or low-pass filtering and compensation will tailor the waveform so that it may be duplicated on a particular shaker.



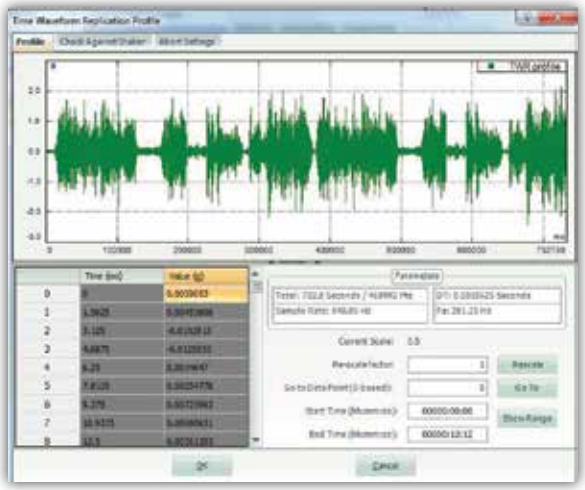
Transient Random Control (VCS-60-12)
Transient Random control applies a chain of pulses with random nature to the shaker. The target profile power spectrum is defined in a same way as Random control, with the addition of defining transient pulse interval. Applications include gunfire simulation and road simulation.



Shock Response Spectrum (SRS) Synthesis & Control (VCS-60-03)
The SRS synthesis and control package provides the means to control the measured SRS of the DUT to match a target SRS, the Required Response Spectrum (RRS). The necessary drive time history is synthesized from damped-sine or sine-beat wavelets. Damped Sine Parameters include frequency, amplitude, critical damping factor, and delay. Waveforms may be automatically synthesized from a user-specified SRS reference profile.

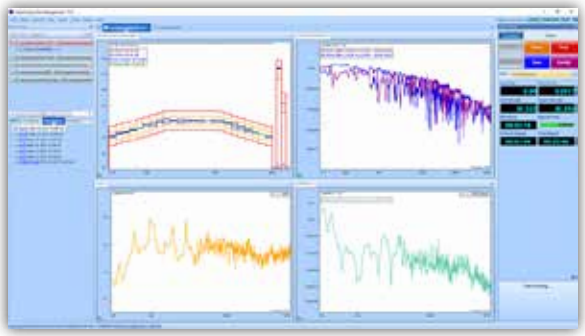


Earthquake Testing Control (VCS-60-13)
The earthquake testing control package provides controls to meet a target a Required Response Spectrum (RRS). Waveforms are automatically synthesized from a user-specified SRS reference profile using random type of wavelets, uniform or shaped. Alarm and Abort tolerances may be applied to any active channel to provide an extra degree of safety for delicate test articles.



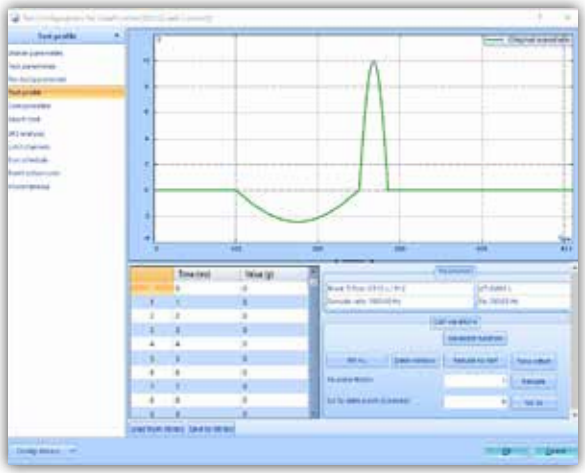
Time Waveform Replication (VCS-80-CXX)

Time Waveform Replication (TWR) provides precise, real-time, multi-channel control for long duration waveform duplication. TWR includes the Waveform Editor, a flexible importing and editing tool for long waveform signals. The Recording option records time stream data at the full sample rate on all input channels.



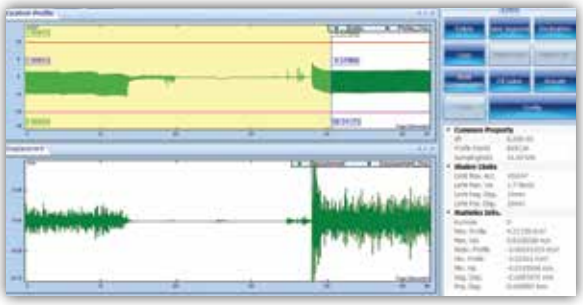
Acoustic Control

Acoustic Control provides accurate control of high-level noise testing for spacecrafts. It can control the noise level in a reverberant acoustic test facility (RATF) chamber or in progressive wave tubes. Acoustic Control is based on the Spider platform and provides quick, reliable control of the noise level to the reference octave spectrum and the overall sound pressure level (OASPL). Multiple outputs support the multiple acoustic noise generators.



Crash Control

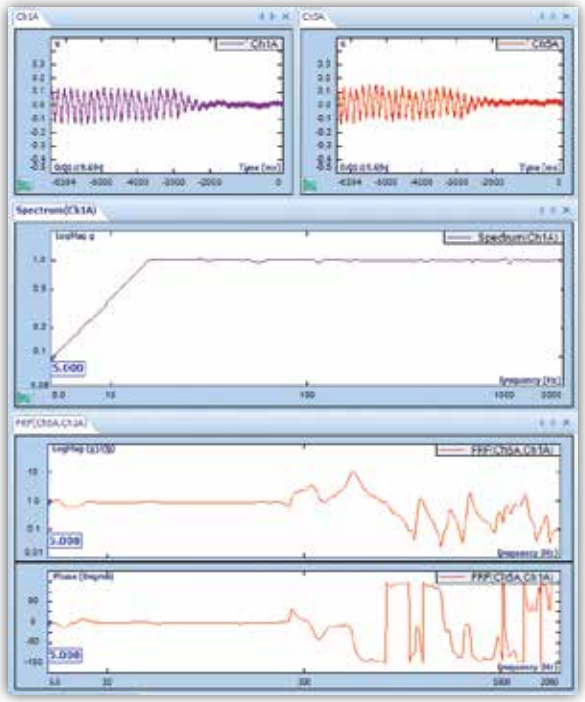
The Crash Control is a specialized version of TTH catering to vehicular incident testing standards to simulate the conditions of a vehicle suddenly braking or crashing. It assumes a specialized long-displacement shaker is being used to run the vibration test. After each pulse, this special shaker armature ends up in a different ending displacement than starting position and can be adjusted back to neutral by the software.



Waveform Editor

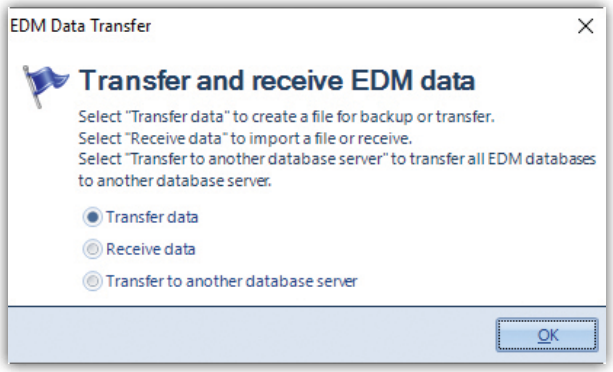
Profile Definition: Any existing signal is treated as a profile and is imported and defined as a control.

Profile Editing: Waveforms with any sampling rate are digitally resampled, re-scaled, filtered, and different compensation techniques may be applied to edit the profile using the EDM–Waveform Editor tool. Options for cropping, appending and inserting parts of a waveform are also provided



Real-time Sine Reduction (DSA-14-CXX)

Real-time sine reduction offers a solution to extend the number of measurement channels of a vibration controller system in a swept sine test. This software is run by a Spider system while an independent vibration controller controls the shaker. The sine reduction application calculates the same time and frequency functions as the controller, but uses its own input signals. This function requires a COLA signal from the vibration controller system for instantaneous frequency, phase detection, and spectrum analysis.



Data Transfer Tool

The Data Transfer Tool is installed with EDM. It transfers all EDM databases (including tests, parameters, and saved files) from a local computer to another over LAN or storage media (e.g. flash drive, DVD, etc.). In addition, databases can be transferred between SQL server instances. The transfer and receive process can also be treated as a backup and recovery process. The step-by-step wizard guides the user through the whole process.

Sensor Calibration (VCS-00-36)

The Sensor Calibration tool is used to calculate the sensitivity of sensors while the measurements of the sensors are compared against referenced sine-wave input signals. The user enters the following information: calibration signal nominal frequency, either RMS reading or dB RMS, and a reference (0 dB) value. The front-end automatically calculates the RMS levels and updates the sensitivity table. The user accepts or rejects the calibration results and views the reports.

Versatile Report Functions

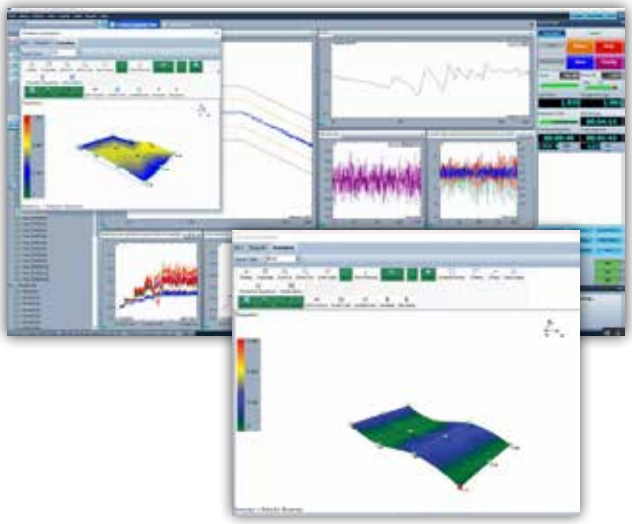
The EDM software generates test reports from pre-defined templates. Users can customize the logo, margins, orientation of the paper, font formats, and contents of the test reports. The reports can export as OpenXML, PDF, or Microsoft Word file types for convenient usage. A word processing program does not need to be installed in order to create reports. With ActiveX reporting, signal displays in the report can be rescaled, analyzed, and zoomed.

- Users can select from various templates for creating reports
- Plot reports can be generated by simply right-clicking the mouse
- Company logos can be inserted into the template header or footer
- Reports can export as WORD, OpenXML or PDF format
- “Active Report” allows the user to zoom in and out like a graph on the report
- Generate typical hardware calibration reports

Front-End Calibration Tool (FECT-30M)

All products are calibrated at the factory prior to shipping and should be recalibrated annually by a factory authorized calibration service. The optional calibration tool existing before EDM 6.1 release is replaced by FECT, which provides a basic adjustment and is operable by the user or a calibration specialist. Reports can be generated from EDM or FECT.

For a more comprehensive calibration report, which provides as found and as left data measured at different frequencies, contact Crystal Instruments or an authorized calibration service provider for more information.



Vibration Visualization (EDM-48)

The EDM Vibration Visualization feature is available in **all test types of EDM VCS software**. This option provides fast and efficient structural model generation and full 3D visualization of the online vibration pattern on the structure under test. There are three tabs to cover the geometry model editing, input channel DOF mapping, and operational deformation shape animation.

The first tab (**Editor**) is designed to help users create the geometric models for viewing the operational deflection shapes of the test structure. The second tab (**Channels**) allows the user to assign the corresponding DOF information to each enabled input channel. The third tab (**Animation**) displays the deformation animation of the operational deflection shapes of the structure under test. **Block** and **RMS** data from the input channels can be used for the vibration visualization of the operational deflection shapes.

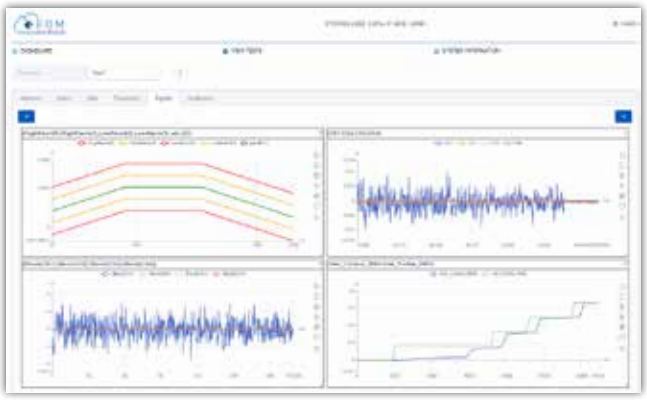
EDM-Vibration Utilities Mobile App

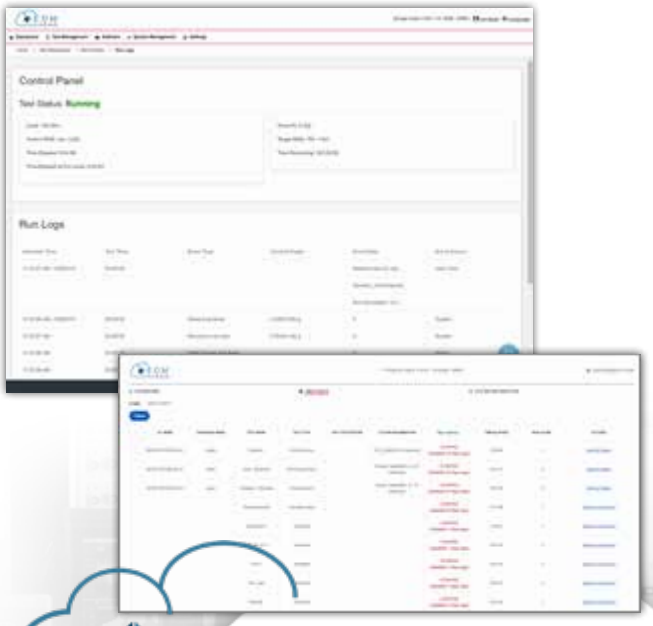
Crystal Instruments in partnership with our sister shaker company Sentek Dynamics announces the release of the Vibration Utilities mobile app on iOS and Android. This app provides calculation features for sizing your vibration profile (Random, Sine or Shock) and searches through the catalogue of shakers and controllers for the best fit.

Enter a vibration profile into the Vibration Utilities app to calculate the projected force, acceleration, velocity, and displacement needs. Add in the mass of the test object and the app will search through its catalogue of shakers for the most appropriate one. Attributes such as the shaker force rating, velocity and displacement limits, and armature mass will be accounted for in the calculation.

EDM Cloud – Cloud-based Test Monitoring and Storage

Visit https://cloud.go-ci.com/



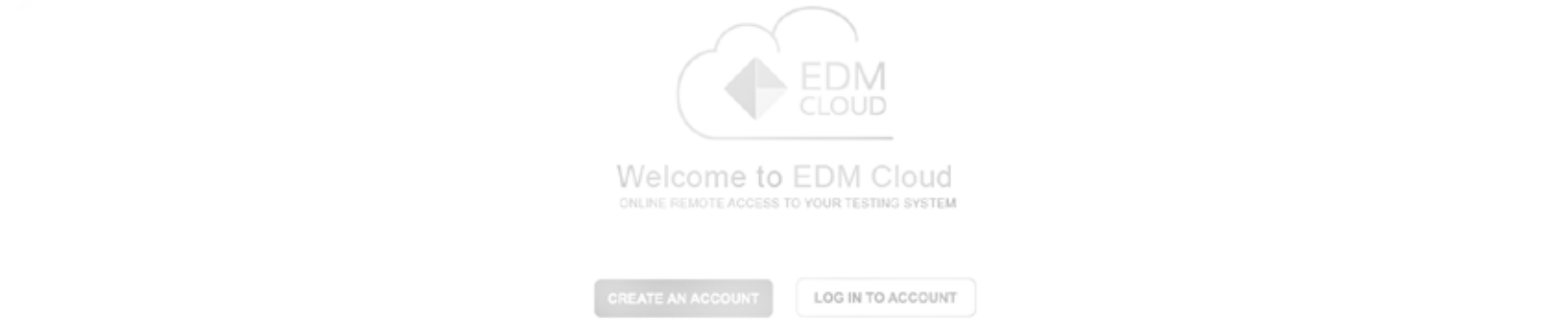


EDM Cloud is a premium web-hosted service provided for users to monitor the status of vibration tests across multiple Spider controllers. EDM Cloud allows access to multiple users according to customized account privileges to view the data and status of Spider systems. Lab administrators can simultaneously monitor multiple tests from anywhere in the world using EDM Cloud.

EDM Cloud supports:
EDM Vibration Control Testing
EDC Temperature/Humidity Testing

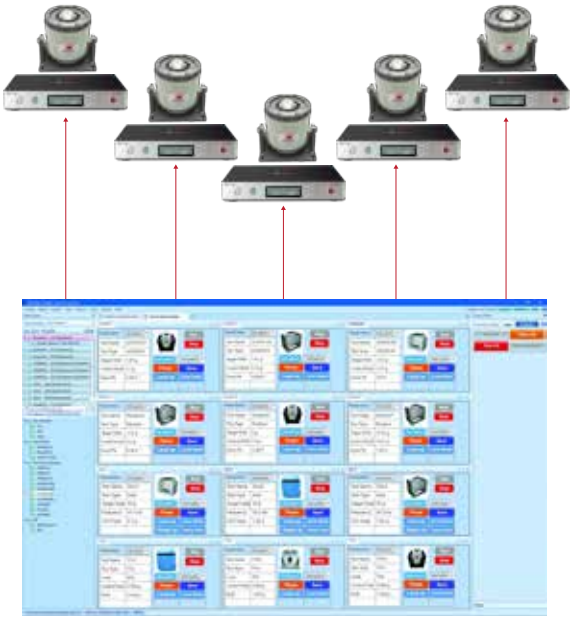
EDM Cloud allows users to:
Create email address accounts and invite others to form a team with groups underneath.
Share tests among members of the same group after configuring the upload parameters in the EDM VCS application.
Save and share several aspects of the test, including Status, Run Log, and Test Reports.

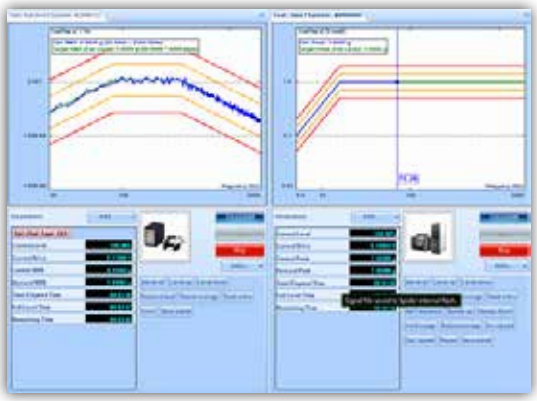
EDM Cloud can also be deployed on local servers within an organization's network. This allows an organization to limit the scope of information exchange and data sharing to users within their network to ensure data security. This feature is useful for monitoring the progress and status of environmental tests with classified information.



Multi-Shaker Control from One Application

www.crystalinstruments.com/multiple-shaker-control-software





Multi-Shaker Control from One Application

The EDM MSC function enables users to view and monitor multiple shaker tests from one PC station. The user can observe the testing status, view individual signals from different shaker systems, and send commands to each controller from one centralized application. The MSC feature is especially useful for production applications, increasing efficiency and simplifying control process. For practical reasons we limit the number of controllers that EDM can access to 12.

Run Different Type of Tests

Different types of tests can be mixed and loaded into this application together. Random, Sine, etc. can run in the same test duration. The status display for each individual shaker controller can be customized. For example, users can display the Peak value for a Sine controller and the RMS value for the random. Users can also show the composite view for one test and show test status view for another test.

Customizable Individual Command Panel

Commands for each controller are customized. Some panels can have Start/Stop/Pause, and other panels can show Sweep Up/Down. Users can add/remove testing related command item, such as Increase Level, Reset Average, etc.

Common Commands

Several common commands have been implemented – these commands can be applied to all controllers at once from the main control panel. All the tests can be started or stopped by pressing one button.

Robust Tolerant Design

Robust software design allows for tests to be run without being interrupted by the failure of other tests. If one test failed for any reason, the other tests will continue, until the operator wants to stop them.

Multiple-Input Multiple-Output (MIMO) Vibration Control System

www.crystalinstruments.com/mimo-vibration-control-overview

MIMO Vibration Control Overview

MIMO Testing has gained a lot of momentum in the past decade with the development of multiple shaker table systems, the availability of Multiple-Input Multiple-Output (MIMO) controllers, and the readiness of the standards (e.g., Mil STD 810G method 527 and IEST DTE 022 working group recommendation).

In the real world, structural vibrations are excited from sources in all directions. To simulate a real-world vibration environment, testing must be performed simultaneously in multiple directions. MIMO testing with simultaneous multiple direction excitation reduces the overall testing time and eliminates the time needed to change the fixing of the DUT to the table and to change shaker orientations (e.g., from vertical to horizontal).

The multi-shaker system ranges from Multiple Exciter Single Axis (MESA), to Multiple Exciter Multiple Axis (MEMA), with 2 to 6 shakers involved, for single axis, three axis translational shaker table, 6 DOF Multi Axis Shaker Table (MAST) table, etc.

Multi-Exciter Single-Axis (MESA) is a type of application in which multiple exciters provide dynamic input to the test item along a single axis. For cases in which the two exciters are driven to a common specification with respect to both phase and amplitude, the output may be effectively described in one axis of excitation.

Three axis shaker tables are available for Multiple-Exciter Multiple-Axis (MEMA) test arrangements. Many testing applications require testing the DUT simultaneously in all three directions. With a three- axis shaker table system, the overall testing time is reduced by two-thirds over single-axis testing along each axis.

The automotive industry has been running tests on their vehicles for decades using four poster testing systems. Nowadays, with the availability of sophisticated MIMO control, testing with four posters is raised to a whole new level. Users can accurately reproduce time waveforms recorded from the testing tracks or real road conditions inside the lab.

The vibration environment is incomplete without rotation. The MEMA Type 6 DOF Shaker Tables are available for this type of testing. The arrangement of shakers among all three axes allows the roll, pitch, and yaw to be achieved along with the three-dimensional translation motions from the table.

MIMO Vibration Control Software

MIMO Vibration Control has always been a challenge for testing engineers. With Spider MIMO Control software, it is now possible to perform accurate and precise MIMO testing using multiple shakers to reproduce real-world complex vibration environments. Spider MIMO Control software covers the complete range of multi-shaker test requirements.

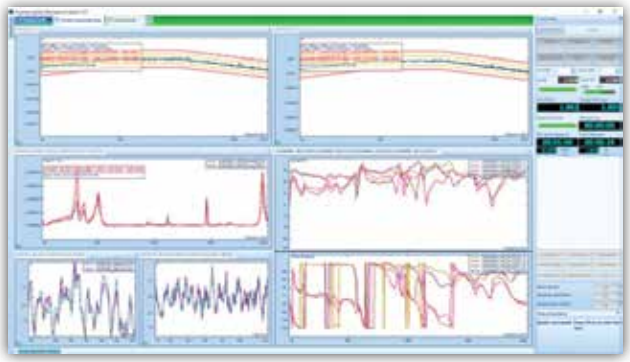
The Spider MIMO Control System uses multiple shakers and multiple control channels with defined profiles. The MIMO Control process is expanded into a Matrix fashion compared to the Scalar fashion of single shaker control.

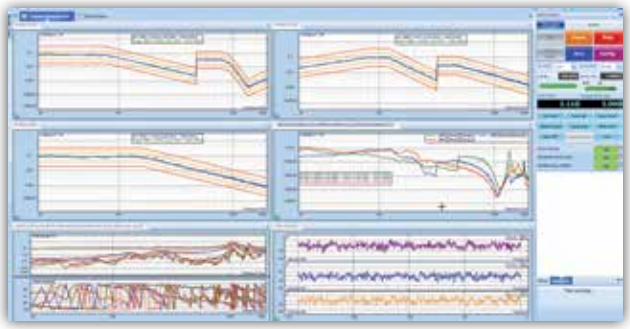
For a multiple shaker system with the number of drive X equals to m, and the number of Control Y equal to n, it will follow the system equation,

$$\{Y\}_{nx1} = [H]_{nxm} \{x\}_{mx1}$$

The $[H]_{nxm}$ is the system transfer function matrix, which is typically evaluated during the pretest stage. {Y} is the linear spectrum vector of the responses (controls), and {X} is the linear spectrum vector of the drives.

MIMO Random Control, like MIMO Sine Control, can control the phase between shakers and between axes. By maintaining a multi-dimensional system matrix, the Spider system is always capable of determining the contribution from each shaker to the overall response and properly differentiating for each shaker so that proper, accurate, and safe control is assured.





MIMO Random Control

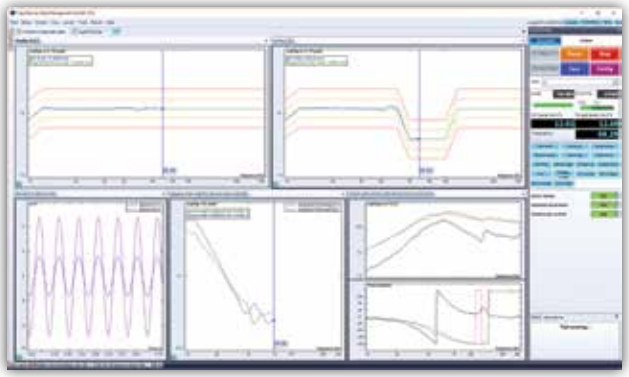
MIMO Random control is one of the more commonly used multiple shaker control methods, which provides precise control in real time. The device under test is subjected to true random noise with a precisely shaped spectrum and Gaussian amplitude statistics.

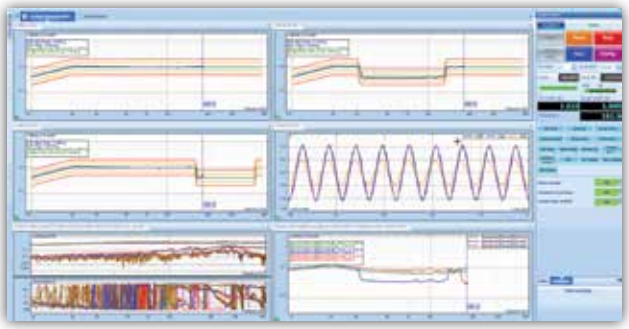
For MIMO Random control, multiple random profiles are defined for each control channel. The relationship among these controls can be defined and controlled, or not. This results in different MIMO random control modes: Magnitude only control, or Mag and Phase control.

Depending on the test requirements, users can update or keep a system FRF matrix the same for the duration of a test. The non-linear control will correct control errors. The Minimum energy option can handle the non-linearity issue at the low frequency end and provide fast control. Limit of alarm, abort and notching is also available.

Control null is a unique feature to handle the single axis testing on 3-axis shaker table. By setting the off-axis control to be Control-null, the shaker will try to suppress the vibration along that axis.

The first MIMO Random control screenshot illustrates identical profiles within phase control on a dual shaker setup. The second screenshot shows a MIMO Random test that ran on a three-axis shaker table with three different profiles uncorrelated.





MIMO Sine Control

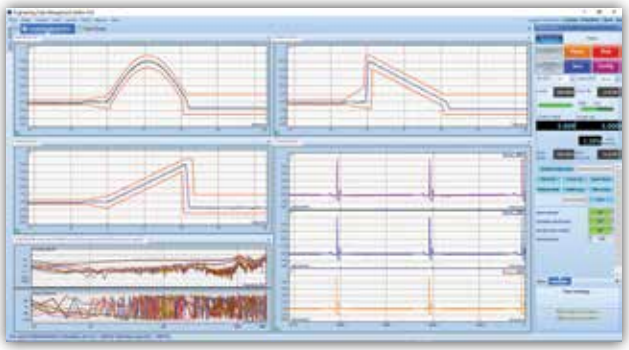
MIMO Sine control is another commonly used multiple shaker control method that provides precise control in real time. It controls multiple sine waves with a control dynamic range of up to 100 dB. With MIMO Sine control, the linear spectrum profiles of Mag, or Mag/Phase are defined and assigned to multiple control channels. With the sweep rate defined, the sine waveform in the time domain is determined.

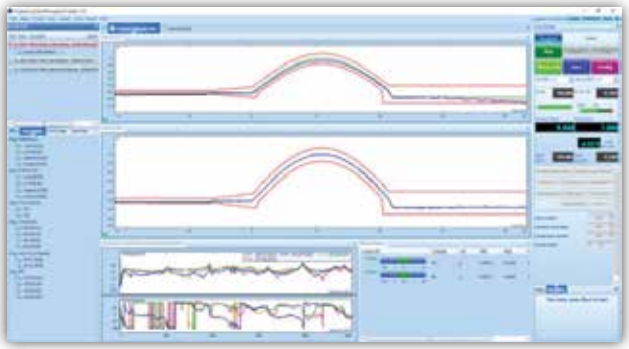
Random signals are applied during the pretest to identify the system FRF matrix. The Multi-Resolution technique can be used during pre-test to produce a better system FRF matrix. This will improve the control result.

Also available in MIMO Sine is the limit of alarm, abort and notching which provides more protection of the UUT, e.g., Satellite.

During the control, the closed loop control will correct the errors from all control channels. Tracking filters are more often used to control channels as well as measurement channels to calculate the sine signal amplitude and phase.

The screenshots to the left illustrate tests with dual shaker and three-axis shaker table, respectively.





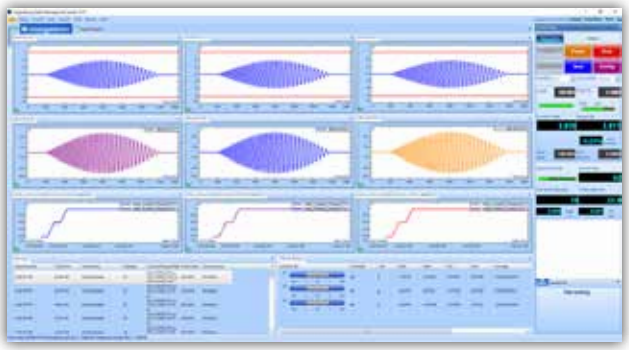
MIMO Classical Shock Control

EDM MIMO Classical Shock Control tests are used to measure the reliability and durability of the object under test. It is a multiple shaker system control method that provides precise, real-time, multi-channel analysis of classical shock waveforms in the time domain. The MIMO Shock control process is essentially a time-domain waveform replication process that uses an FFT based algorithm to correct the test system dynamics.

A MIMO shock test outputs a series of pulses to test the structure. The responses are measured at multiple locations on the structure and spectral analysis is used to determine its frequency characteristics. The Fourier transform of the impulse response is the Frequency Response Function (FRF) of the system.

A dual shaker test is carried out and shown in the screenshot on the bottom left, with the same shock profile defined.

On the three-axis shaker table, three different types of classical shock waveforms are defined, as shown in upper left screenshot.

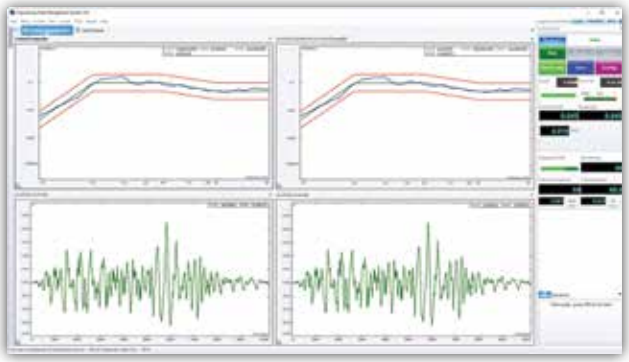


MIMO Transient Time History (TTH) Control

The MIMO Transient Time History (TTH) Control tests output pre-defined, transient type waveforms. The closed-loop control algorithm ensures that the control signal inputs match the specified waveform shapes. The outputs are repeated in a set interval.

The shape can be any of the usual waveform shapes, such as sinusoidal, triangular, and trapezoidal, or white noise. Pre-stored profiles include: Bellcore Z1 & Z2, Bellcore Z3, Bellcore Z4, (Burst) Sine, Triangle, Chirp, Burst Chirp, White Noise (Burst Random), Sine Beat, Sine Beat (multiple frequency), Door Slam (Ford), Decay sine (linear/angular frequency), and Sine Burst.

Customized waveforms can also be added to be used as a profile for the MIMO TTH Test type for test articles.

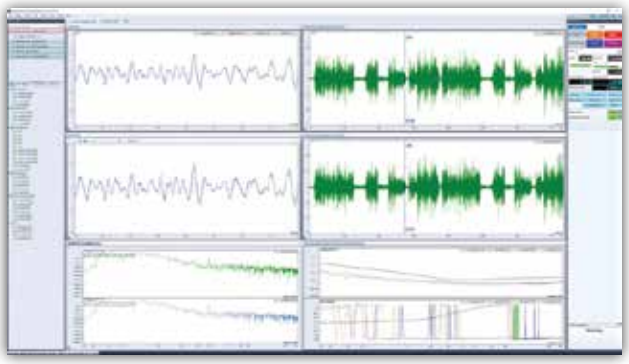


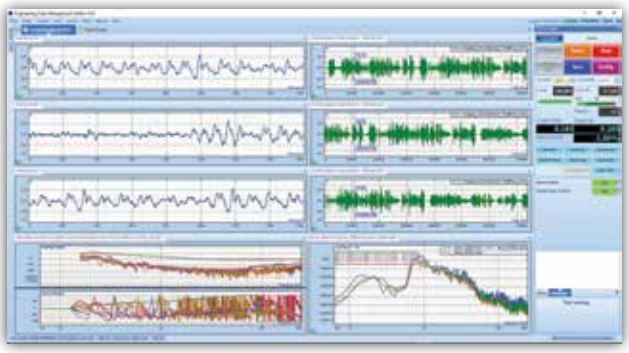
MIMO Shock Response Spectrum (SRS) Control

The MIMO Shock Response Spectrum (SRS) control package provides controls of multiple shakers to meet multiple targeted Required Response Spectrum (RRS). Time waveforms are automatically synthesized from a user-specified SRS reference profile using different types of wavelets. Sine beats and damped sine are commonly used types of wavelets.

Each control channel is assigned with one RRS and to the synthesized time waveform accordingly. Users can apply high frequency waveforms and alarm and abort tolerances to any active channel to provide an extra degree of safety for delicate test articles.

The analysis SRS span can expand to be higher than the control SRS band upper frequency. This gives the user an opportunity to check the SRS spectrum above the control frequency range.





MIMO TWR Control

MIMO Time Waveform Replication (TWR) is very popular method to use when field recorded data needs to be reproduced on a multiple shaker table in the lab. With MIMO TWR control, a time waveform profile containing multiple channels of data can be imported, pre-processed (such as bandpass filtered, etc.), and selected as the control profile.

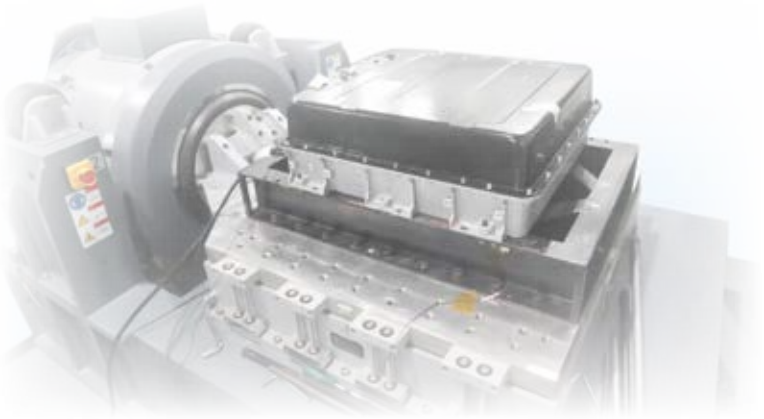
Each channel of time waveform in the profile is of the same sample rate and length. The MIMO TWR control is carried out based on consecutive blocks of data. Users can select from two control algorithms. One algorithm keeps the system FRF matrix measured from the pretest stage while updating the drive to correct the error from one block to the next. The other control algorithm updates the system FRF matrix online as the test is operating.

A dual shaker test result is shown in the screenshot to the left (top), with the same profile defined for both control channels.

On the three-axis shaker table, three different waveforms are defined, as shown in the screenshot to the left (bottom).

Battery Testing of Electric Vehicles

www.crystalinstruments.com/battery-testing-for-electric-vehicles



The global demand for electric vehicles has increased the need for battery testing. Batteries must be tested to withstand the harsh conditions resulting from shipping and everyday usage to ensure their safe operation. Environmental hazards can range from extreme temperatures to repeated shocks and vibrations resulting from transportation.

Testing the batteries includes a combination of electrical, vibration and environmental tests. Performing these tests simultaneously would better simulate the conditions electric vehicles typically operate in to ensure safety for the drivers.

The Spider platform of products provides one integrated software interface to perform combined vibration and environmental tests while monitoring CAN bus information through one system.

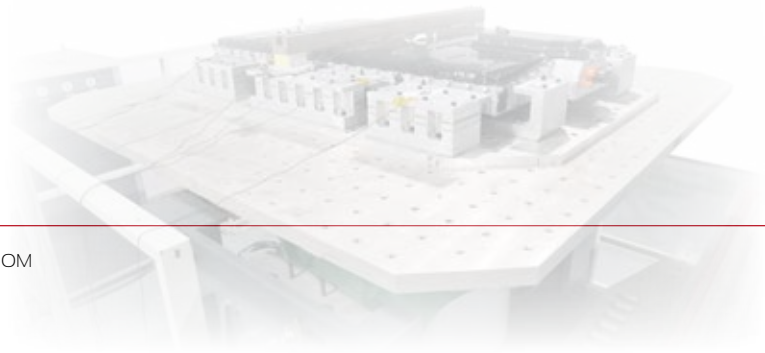
Users can add CAN bus to their Spider system to monitor received data and display data through EDM software. EDM monitors the real-time battery information received from CAN bus and applies a threshold. When the threshold is exceeded, EDM will stop the test or execute pre-defined actions (e.g. send email to the operator or DIO message) to automate safety reactions that were pre-determined by the tester.

The combination of features in addition to the flexibility in using multiple Spider products together not only accurately mimics the environment of electric vehicles, but also provides battery condition monitoring and automatic reactions to ensure the testing safety and frees the tester from continuous monitoring. The overall and integrated solution makes the Spider system the best choice for performing battery tests.

Crystal Instruments offers the following battery testing solutions:

- **Complete Shock and Vibration Testing** (Software, hardware, USA-based product support)
- **Combined Environmental Testing** (Temperature/Humidity/Vibration)
- **Testing with CAN bus integration** (Automatic and customizable safety reactions)
- **Data Acquisition Solutions** (Handheld, Tabletop, to High Channel Count up to 512, High Sample Rate up to 256 kHz)

Standards for Battery Testing of Electric Vehicles	
IEC 62133	Safety Requirements for Portable Sealed Secondary Cells & Batteries made from them
SAE J2464	Electric Vehicle Battery Abuse Testing
UL 2054	Testing & Certification for Battery Packs
UL 2202	Standard for Safety Electric Vehicle (EV) Charging System Equipment
UL 2231-2	Standard for Safety Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems
UN 38.3	Transport of dangerous goods
ISO 12405-1	Lithium-ion traction battery packs & systems
SAE J2380	Durability testing of single batteries
GMW16390	General Motors manufacturer standard



CoCo-80X Handheld System

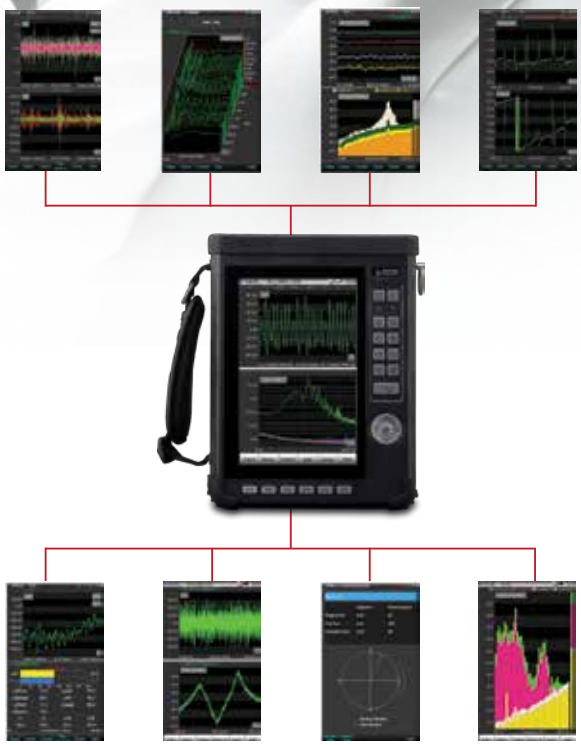
www.crystalinstruments.com/coco80x-dynamic-signal-analyzer

CoCo-80X

Highlighted Features:

- 2-8 inputs with IEPE
- Full speed recording
- Battery powered (portable)
- **CAN bus**, USB, HDMI, **GPS**, Audio, and Wi-Fi*
- Patented dual-AD technology
- Large touchscreen with vivid color display
- 150 dBFS input dynamic range
- SD card for mass data storage
- 20 volt input range
- Hard keys for quick access
- 102.4 kHz sampling

**Non Wi-Fi & Non GPS Options Available*

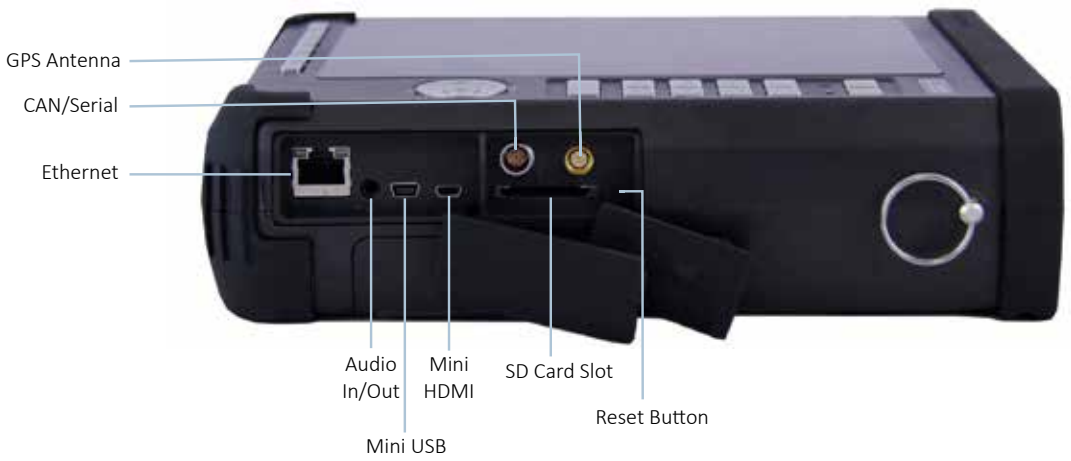


CoCo-80X Dynamic Signal Analyzer

The CoCo-80X is a rugged, lightweight, battery-powered handheld system with unparalleled performance and accuracy. Combined with hard keys, the multi-point functionality touchscreen is designed for an intuitive user interface that provides a wide variety of analysis functions.

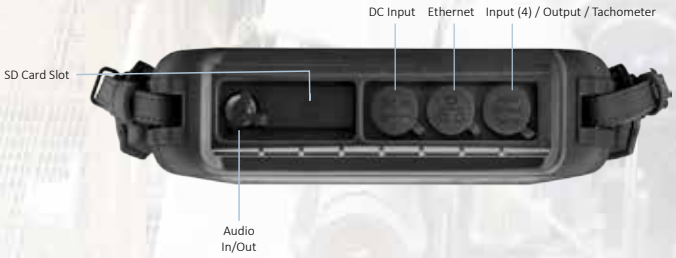
The CoCo-80X is equipped with 8 software-enabled channels. Measured time histories can be recorded in 32-bit single precision floating point format and all subsequent signal processing is performed using floating-point arithmetic. 54 sample rates from 0.48 Hz to 102.4 kHz are provided with better than 150 dB of dynamic range.

CoCo-80X Hardware Diagram



CoCo-70X Vibration Analyzer

The CoCo-70X is Crystal Instruments' latest handheld vibration analyzer, featuring an improved user interface and redesigned chassis. The CoCo-70X is a four-channel vibration analyzer with an IP-67 rating, designed specifically for the machinery Predictive Maintenance (PdM) community. The CoCo-70X offers powerful processing capabilities and an intuitive user-interface, providing users with an easy-to-use data collection experience. The newly designed chassis is lighter and more ruggedized, making the CoCo-70X a perfect device for route-based measurements.

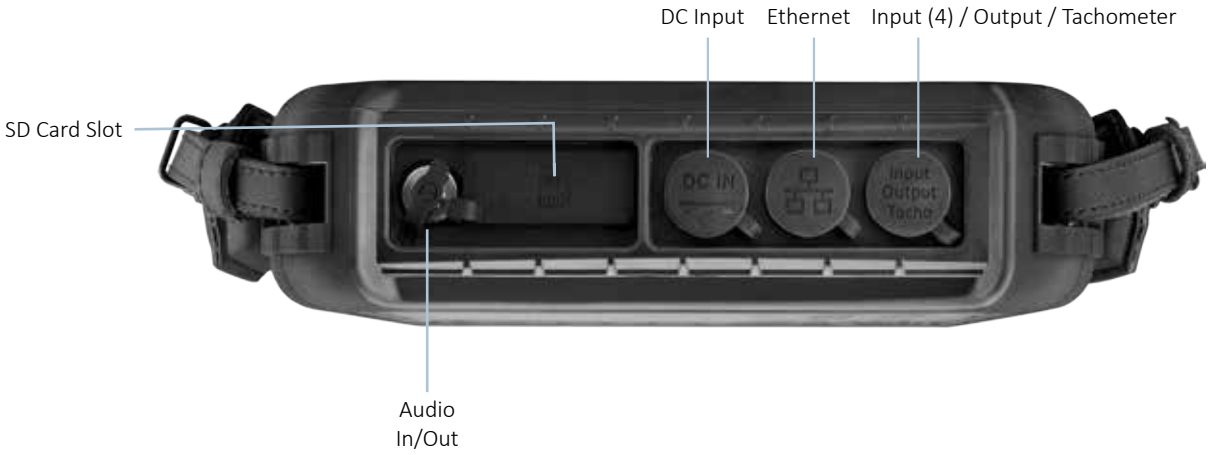


CoCo-70X

Specifications:

- 4 Inputs with IEPE plus tach
- Sampling rates up to 102.4 kHz
- 150 dBFS dynamic range
- Audio via headphones
- SD Card for mass data storage
- Waterproof IP-67 rating
- Data recording & real-time measurement

CoCo-70X Hardware Diagram



CoCo-90X

www.crystalinstruments.com/coco-90x-dynamic-signal-analyzer

16 Channel Configuration of CoCo-90X

CoCo-90X Specifications

Input Channels: 16 inputs with IEPE LEMO connectors. One 24-bit A/D converter per unit.

Input Modes: Single-ended

Coupling: AC- or DC-coupling

Ports: 100 Base-T Ethernet, Wi-Fi, GPS, Mini-USB, SD Card, Audio Input and Output, CAN bus

7” Touchscreen LCD Display

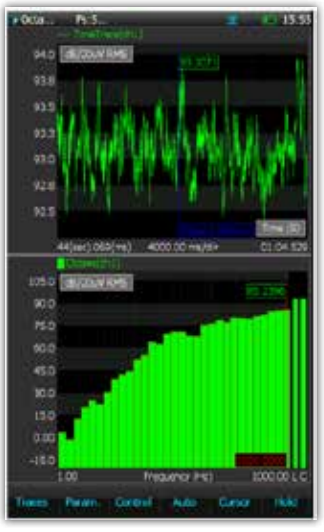
Max Sampling Rate: 102.4 kHz

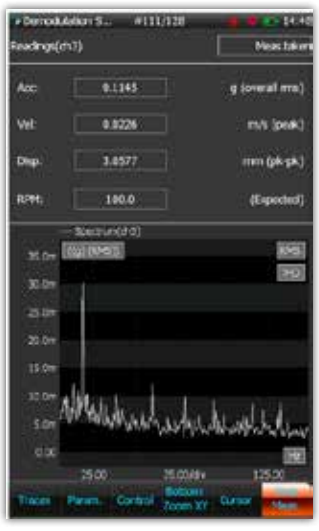
CoCo Dynamic Signal Analysis Software

www.crystalinstruments.com/dynamic-signal-analyzers

Dynamic Signal Analysis (DSA) Features:

- FFT Analysis
- Order Tracking
- Octave Analysis
- Rotor Balancing
- Vibration Intensity
- Modal Data Acquisition (MDA)
- Automated Test and Limit Check
- Shock Response Spectrum (SRS)
- Power System Stabilizer
- Sound Power Analysis





Spider-20 Handheld Dynamic Signal Analyzer

www.crystalinstruments.com/spider-20-dynamic-signal-analyzer

Handheld Field Testing Solution

The Spider-20 series of products are compact yet powerful data acquisition and dynamic measurement systems. These units provide four 24-bit precise high-fidelity input channels, and a unique software-selectable tachometer-input/signal-source output channel. Each input is individually programmable to accept AC or DC voltage or output from an IEPE (ICP) sensor with built-in electronics. Input channels can be programmed to sample up to a rate of 256 kHz.

The Spider-20E is a small scale (5 ⁵/16 x 4 ⁵/16 x 1 ⁵/16 inch) device weighing only 18 ounces. This handheld unit features three push-button controls and five LED status indicators. This little powerhouse can run over 6 hours, on its internal rechargeable battery, and can be deployed in the field with a backup battery.

The compact battery-less version with industrial grade enclosure makes the Spider 20i suitable for deployment in rugged industrial environments. Without any buttons, it is suitable to be deployed in remote locations enabling operation and monitoring entirely through software applications.

The Spider-20 series of products communicates with the world through an Ethernet interface. Link the Spider to your laptop or tablet running Windows and enjoy the full suite of functionality provided by our EDM (Engineering Data Management) software, including spectral analysis and frequency response functions, 1/nth octave acoustic functions, order tracking for rotating machinery, shock response spectra for drop testing, or digital filtering for special purpose analysis.

The Spider-20E can chain systems together to construct a high channel count system with up to 256 input channels while simultaneously sampling all input data. Crystal Instruments' unique PTP (Precision Time Protocol) technology ensures better than 1° phase match up to 20 kHz.

The Spider-20 series of products are equipped with built-in 4 GB of flash memory. Raw time signals can be recorded with sampling rates of up to 256 kHz with a push of a button or through an automated schedule. It is also capable of periodically saving processed time and frequency signals. A unique Black Box mode enables Spiders to run without being connected to a host PC.

Spider-20E Analyzer

Spider-20i Industrial Grade

SPIDER-20 & SPIDER-20E

Features:

- Weighs only 18 ounces
- Built-in Ethernet (Spider-20E)
- 4 GB Flash Memory
- 4 Input Channels
- 1 Tachometer Channel
- PC Independent
- iPad Compatible
- 6 Hour Battery Life

Spider-20 Industry & Product Applications

Machinery Diagnosis

Four inputs and a tachometer channel are the perfect size for many machinery monitoring tasks. Simultaneously measure two perpendicular proximity probes or horizontal and vertical bearing cap accelerations at both ends of a machine. Record this along with a 1/rev tachometer during startups and shutdowns to plot waterfalls and Campbell diagrams identifying resonances, critical speeds and unusual forcing functions. Use the same signal inputs to balance the machine. Place accelerometers on either side of a coupling to aid alignment.

Machine/Process Monitoring

Load a custom monitoring program employing our Automated Schedule and Limiting software and leave your Spider-20 to monitor speed and four dynamic inputs. Upon detecting an alarm-level limit (in the time or frequency domain), it can send you an email reporting the finding and make an immediate recording for more detailed analysis. For longer stays, leave the accessory AC power unit plugged in. This allows Spider-20 to draw power (6 Watts, maximum) from any 100 to 240 VAC (50/60 Hz) power line. Alternatively, you can provide a battery backup of 15 VDC (±10%) for more remote applications.

Octave Analysis & Sound Level Meter

www.crystalinstruments.com/acoustics-measurement

Acoustic Measurements with the Spider Series

Acoustics measurements are performed for a variety of reasons, including: product design, production testing, machine performance, and process control. Crystal Instruments' Spider series has capable acoustic measurement facilities including real-time octave, 1/3 octave filters, and sound level meter functions. Crystal Instruments provides an easy to use yet powerful toolbox for acquiring and viewing acoustic signals. Digital octave band filters and raw time data recording can be performed simultaneously for a detailed investigation of noise problems.

The Spider series meets the requirements for measurements from 4 input channels going up to 512 channels!

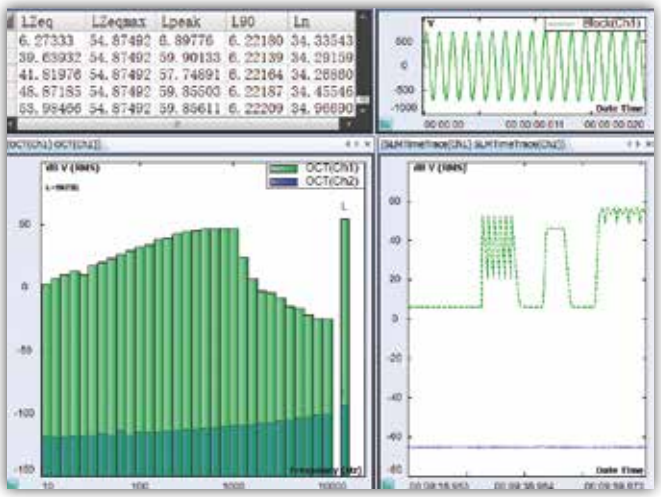
Onboard IEPE (ICP®) transducer power capability allows for direct connection to pre-polarized microphones when used with an ICP microphone preamplifier. Traditional condenser microphones are also easily accommodated by connecting the direct voltage signal from the microphone power supply into an input channel. White and pink noise signals can be produced using the waveform generator. This feature is very useful when performing absorption measurements using a speaker.

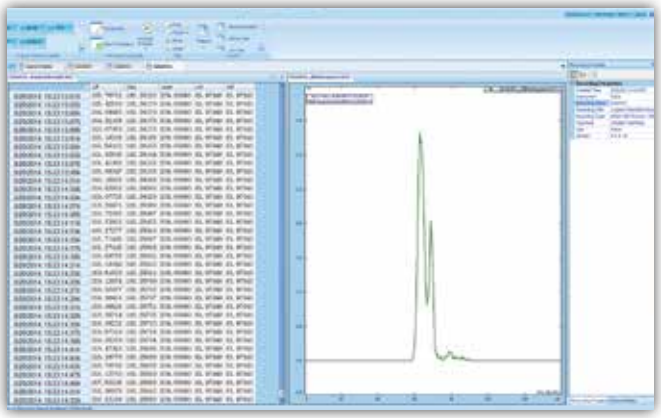
Real-time Octave Analysis

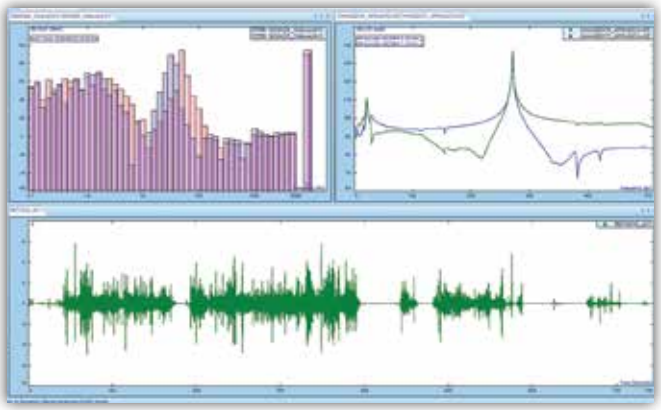
The acoustic data acquisition software option for Spider hardware includes real-time octave filters, sound level meters, and microphone calibration functions. These three operations allow users to perform many acoustic measurement operations.

The octave analysis option applies a bank of real-time filters with 1/1, 1/3rd, 1/6th, or 1/12th octave resolution. The input time stream is split into fractional frequency-band signals (octave bands) which can be saved. Frequency weighting can be applied to the octave bands to simulate human hearing, and time weighting can be applied to adjust sensitivity to short duration events. The resulting octave spectra can be saved periodically and displayed on a waterfall plot to observe how the spectrum changes in time. The RMS time history can also be saved as a time trace of a given octave band.

The 1/1 and 1/3 octave analysis are implemented using a real-time band-pass filtering with decimation technique. The data stream is processed continuously, and fed into a bank of decimation filters. Band-pass filters are then applied to the output of each stage of the decimation filters. This provides extremely accurate filter shapes that comply with worldwide acoustic standards: ANSI std. S1.11:2004, Order 3 Type 1-D and IEC 61260-1995.







Acoustic Measurement: Sound Level Meter
The Sound Level Meter (SLM) is a related application in the acoustic data acquisition software. This module is also referred to as an Overall Level Meter. The SLM applies a frequency weighting filter to the input signal and time weighting to the filter's output. Various acoustic measurements are then extracted from both the input and output signals of this frequency weighting filter.

All of the features that you would expect from an acoustic measurement device are present…and then some! A, B, C, and linear weighting functions; fast, slow, impulse, and peak detectors; and user selectable high and low-pass filtering. The tremendous dynamic range that all Crystal Instruments products offer take the worry out of setting voltage ranges precisely to avoid under-range or overload conditions.

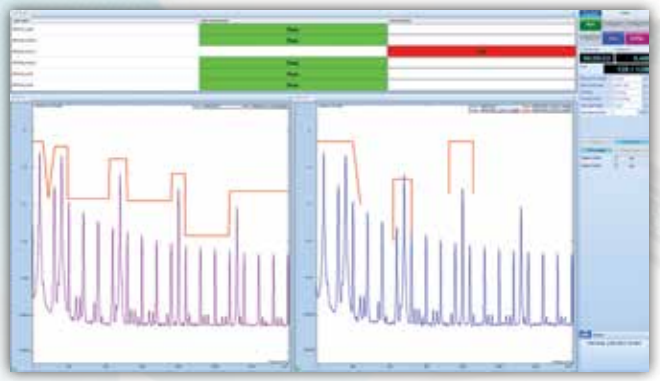
Built-in Microphone Calibration
Microphone calibration is easily handled by using a traditional microphone calibrator together with the online calibration feature. Simply define the frequency and amplitude of the reference signal, and the Crystal Instruments system will automatically detect the input channel that the calibration signal is applied to and then calculate the necessary calibration constants. Offsets are calculated and stored for later reference.

Simultaneous Recording and Octave Analysis
The Spider series is designed with simultaneous time-stream recording capability. While the acoustic analysis is processed in real time, the raw time data of the Spider can be recorded into internal flash memory or an external dedicated Spider-NAS storage device.

The raw time data of all input channels can be recorded at full analysis frequency band. After recording, the saved files can be processed by using EDM Post Analyzer which provides identical analysis algorithms to those available in the real time mode.

Automated Production Testing

www.crystalinstruments.com/automated-production-testing

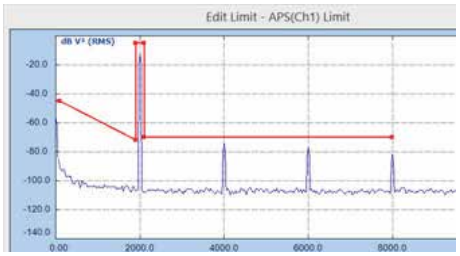


Automated production testing is critical in today's competitive manufacturing environment. Companies can no longer rely on variable costs, non-uniformity, and potential health hazards that come with a labor-based manufacturing line. This is no less true for sound and vibration tests , ranging from in-process burn- in tests to product validation and verification tests. The measurement tools and intelligence behind present day manufacturing include data acquisition equipment as well as closed-loop control. While these systems may not take part in the assembly of any goods, they are just as important to ensure quality control for both components coming into an assembly line and products going out.

Crystal Instruments has evolved a synergistic solution to such testing involving custom hardware and application-focused software. The Spider-80X and Spider-80Xi systems are complete multi-channel analyzers and controllers with IEEE 1588 Precision Time Protocol (PTP) Ethernet communication. The Spider systems can be programmed to accomplish multiple complex measurement tasks using a workstation or PC running Engineering Data Management (EDM) software. Through EDM, the user can create custom interfaces and greatly simplified operating interfaces for specific product tests. Users can also generate custom reports using XML, OpenOffice, PDF, and Microsoft Word templates.

The PC can (optionally) be disconnected and tests run in "Black Box" mode without an attached computer.

Step 1:
EDM sets the alarm limit together with a special message string, such as "Exceeding Limit".



Step 2:
When an alarm event happens, the customized string, "Exceeding Limit" will be sent to the EDM Cloud email service.

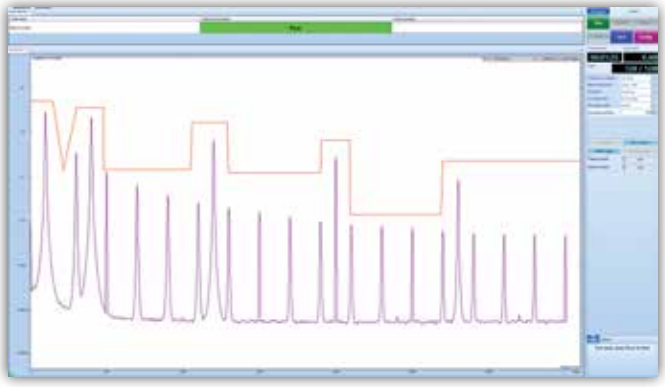
Step 3:
User will receive an alarm email

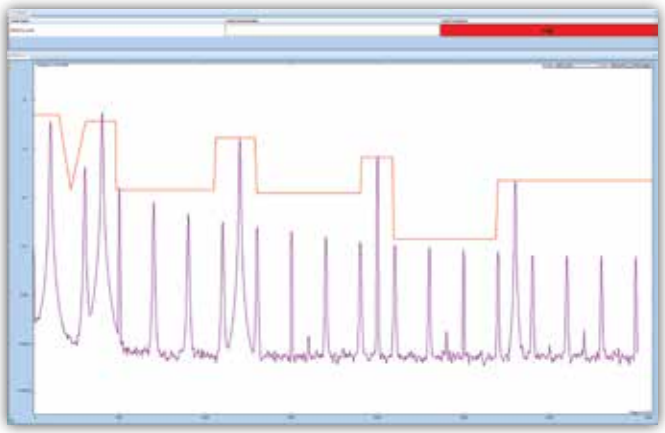
EDM or EDM Cloud Email Service

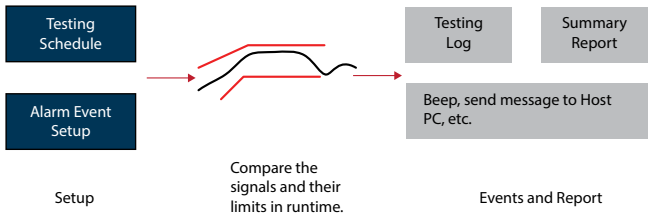
Black Box mode provides the ability to run Spiders without an attached computer. Control of the Spider may be accompanied through an Apple iPad tablet using the EDM App for iPad. The Spider API, when used along with Black Box mode, is the gateway to integration with LabView, Mat-lab and other scripting software. Spider front-ends operate from Android, Linux and iOS in addition to Microsoft Windows. A single iPhone, tablet or PC can control multiple Spider front-ends at distributed locations running unique tests from a single control screen.

Limit Configuration
Alarm limits could be defined independently and multiple limits could be defined to each channel and may be applied to a Time Block, Auto Spectrum, FRF, Coherence, Octave Spectrum, Sound-Level Measurements, RMS, or Peak value. Spectra and time histories are tested by comparing against a custom test signal; a template which must bound the measured signal. Each test signal may be either an upper or lower limit and may contain up to 64 segments. Up to 64 test signals may be applied to a single measurement.

Customize Actions for Specific Events
Event-Action Rules (EAR) allows users to customize the system's response to every test event. User defined events include signal exceeds a limit profile, signal is less than a limit profile, normal end-of-test, loss-of-signal or any number of events encountered during a VCS test. Responses include halting a test, starting a different test, flashing the control screen, initiating a recording, sending a screen message, sending a text message, or sending an email. Users can program loops using EAR. Every event is logged on a cloud server and is identified by the text of a customized event string (only on EDM Cloud).







An illustration of the automatic testing process.

Auto Failure Detection

Defining the limits on either time or spectral data enables the Spider system to compare the input signal with the defined Pass/Fail tolerances and instantaneously display the status on the EDM. This feature is particularly useful during burn-in tests. For example, consider cell phones, a consumer product produced in the millions which contains both a microphone and a speaker. These two audio components almost always need to be run through a burn-in test, which is easily automated using the Spider platform of products. The Spider provides a stimulating programmable function generator using the output channel and data is collected from the input channels which is then compared with the tolerances to detect the failed products.

However, burn-in tests are not the only type of automated production tests performed with sound and vibration instrumentation. Product validation and verification are also an important part of production line testing. Such tests range from validating incoming components to verifying a finished product assembled from them.

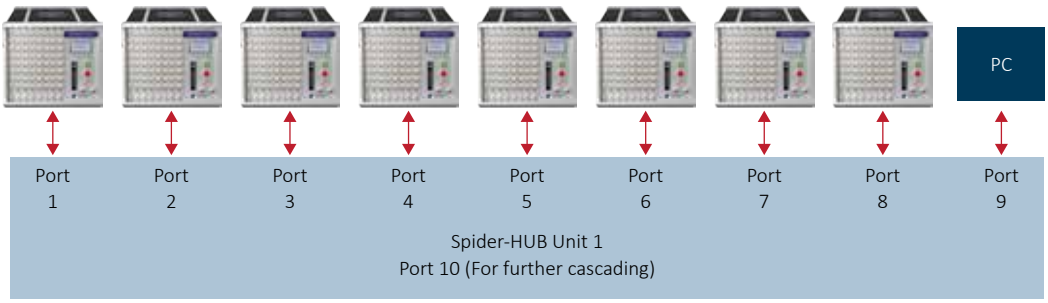
Virtually all turbine manufacturers carefully match tune the component blades of their steam and gas turbines. This involves accurately measuring the natural frequency of one or more vibration modes of each blade individually, while the blade is root-restrained by a standardized fixture. Different manufacturers implement such tests in various manners, but all rely upon measuring the forced vibration response of the blade. The most accurate frequency determinations are made from frequency response functions (FRF), wherein both the stimulating force and resulting vibration are simultaneously measured.

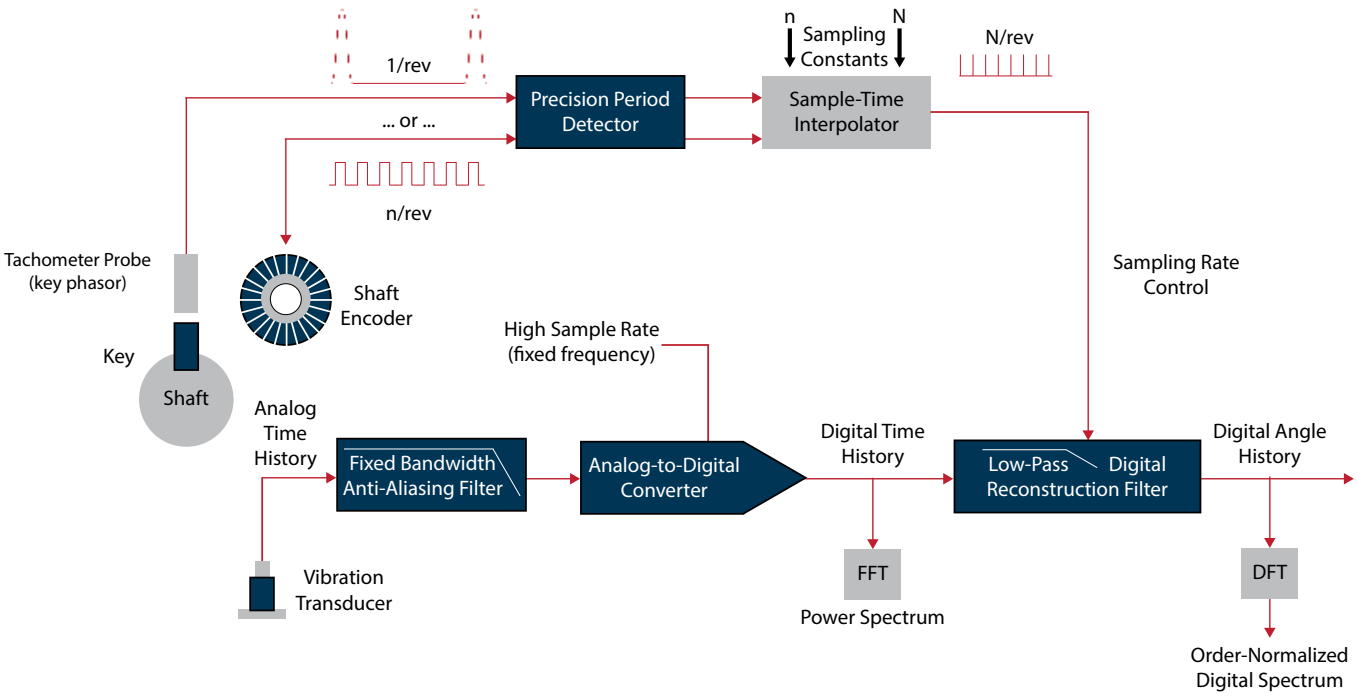
Frequency response functions characterize the linear relationship between a measured input and output and conveys an enormous amount of information. An accompanying two-channel measurement, the coherence function, determines if two signals are linearly related. It is an ideal indicator of throughput linearity, an important characteristic of most electronic circuits and many mechanical structures.

Scalability

Scalability is one of the benefits of automation and this is why the Spider-80X/Xi is designed as a networked device. With an Ethernet connection on the Spider-80X/Xi, multiple front-ends can be connected to test hundreds of products simultaneously.

Spider-80Xi System (512 Channel Count)





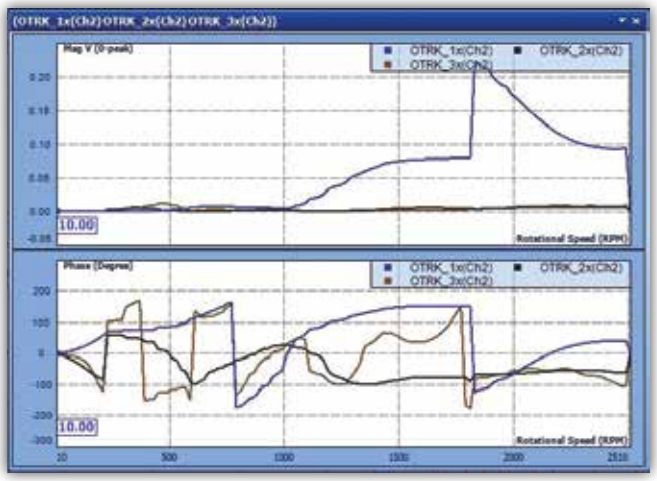
Providing Real-Time Order Tracking

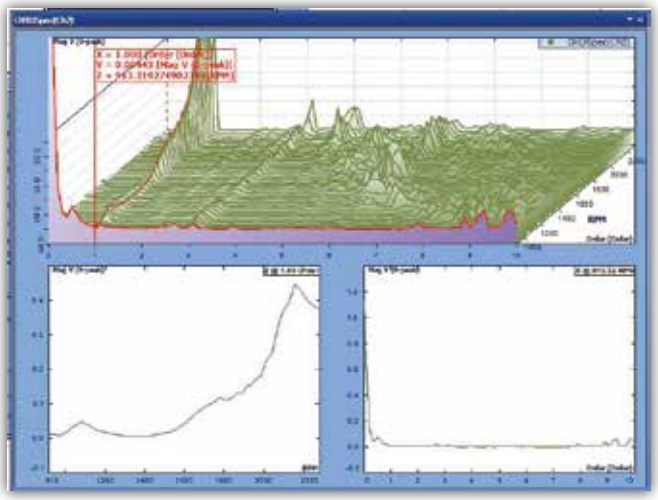
The high channel count Spider systems provide a wide range of real-time order tracking capability to understand the noise and vibration induced within rotating and reciprocating machines Fixed and variable speed machines are accommodated as are both structural vibration and condition monitoring diagnostics. Multiple tachometer inputs can be processed for accurate speed tracking during analysis. Spectral mapping, order tracking, time history and orbit data analysis are all available.

Additionally, Crystal Instruments provides post processing order tracking capability in its Post Analyzer (PA) that generates the same analysis results as real-time order tracking. The user can simply record the raw data together with tachometer signals and process them later.

Advanced Digital Processing

All measurements in the order domain are derived from an advanced digital resampling method. High speed DSP processing allows synchronization of the analyzer's sampling rate to a tachometer signal. The analyzer's sampling rate continuously adjusts to track variation in shaft speed. After data sampling, a flexible radix FFT converts the time/angle data into the frequency/order domain. The flexible radix algorithm provides a much broader choice of resolutions and spans than does a power-of-2 FFT for extraction of the order amplitude values as a function of RPM.





Order tracking extracts the amplitude at a single order and plots it against machine speed (RPM). Real-time order tracking offers advantages over fixed sample rate techniques. It provides better tracking performance when the RPM varies quickly. Additionally, it provides precise control over the order resolution of the measurement. For instance, users can specify that the order resolution be 1/10 of an order for all measurements.

There are also significant benefits in order amplitude estimation provided by the real-time order tracking method. Since the sampling rate is synchronized to the tachometer signal, the data in each frame is always exactly periodic with respect to the fundamental speed. That is, there are always an integer number of cycles for the fundamental and its harmonics in each data frame. Because of this periodicity, there is no need to use a spectral window, such as a Hann window, in the tracking calculation. This results in a more accurate estimate of the amplitude for each order.

Real-Time Order Tracks and Order Spectra

Real-Time order tracks are the amplitude history signals of certain "rotational orders" graphed against the machine's RPM. Multiple order tracks can be measured, displayed, and saved. Order spectra are auto power spectra that are normalized to orders. All order tracks can have the optional phase which is phase measurement relative to the tachometer signal.

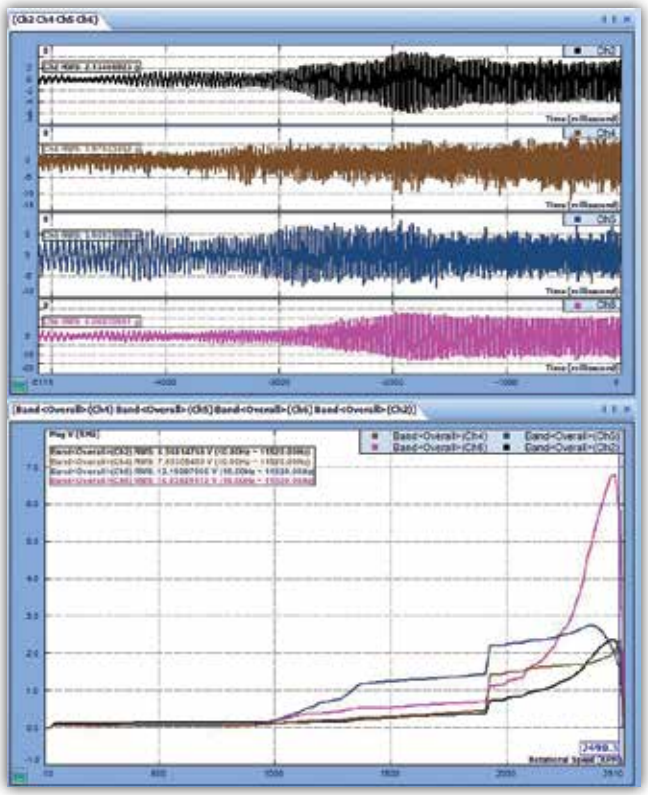
The RPM range can be from 10 to 10,000. The acquisition modes include: Free Run, Run Up, Run Down, Run Up and Down, Run Down and Up order tracks can be scaled with linear peak, linear RMS, or power scaling.

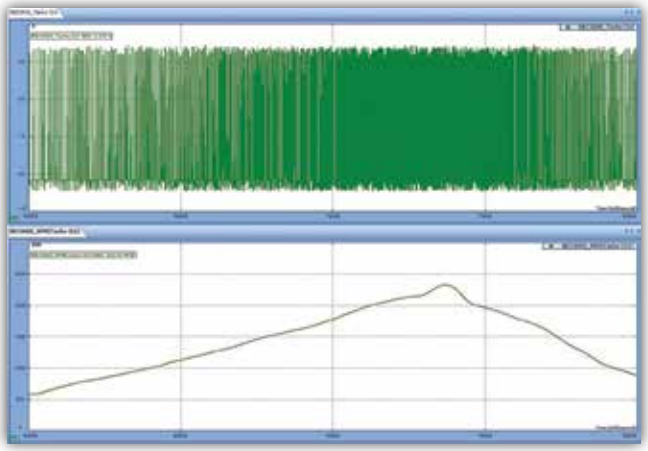
Constant Band Frequency Spectra

Constant band frequency spectrum displays the auto power spectrum of the selected fixed band of frequencies and is computed using FFT analysis within the fixed band of interest. 3D plots using time or RPM as the reference are available along with 3D extractions of desired orders of interest. The available spectrum amplitude units includes EU_{pk}, EU_{rms}, EU^2_{rms}, EU^2/Hz, and $EU^2 \cdot s/Hz$

Order Tracks with Phase

Order tracks with phase are order spectra with the associated phase measurement relative to the tachometer signal. All the measurement specifications are the same as real-valued order tracks, except that order tracks with phase can also be displayed as Bode, Polar, or Nyquist plots. Furthermore, with this option the orbit display can be enabled for any two data channels.





Tachometer Processing

The tachometer is stored as a time history. The user may view either the original tachometer input waveform or the resulting RPM-versus-time translation. A tachometer channel can be used to extract the order track of any input channel or channels. Tachometer signal processing automatically eliminates any “glitches” in the tachometer pulse train and reconstructs the best estimate pulse signal for phase measurement.

Orbit Analysis

Online orbits can be displayed and monitored on a standard two-channel orbit diagram chart. For advanced analysis a throughput recording including a tachometer or vibration signal can be post processed using the orbit analysis tool in Post Analyzer. This provides averaging, filtering and order based orbit displays with a replay feature for visualizing changes over a change in machine speed.

Display Flexibility

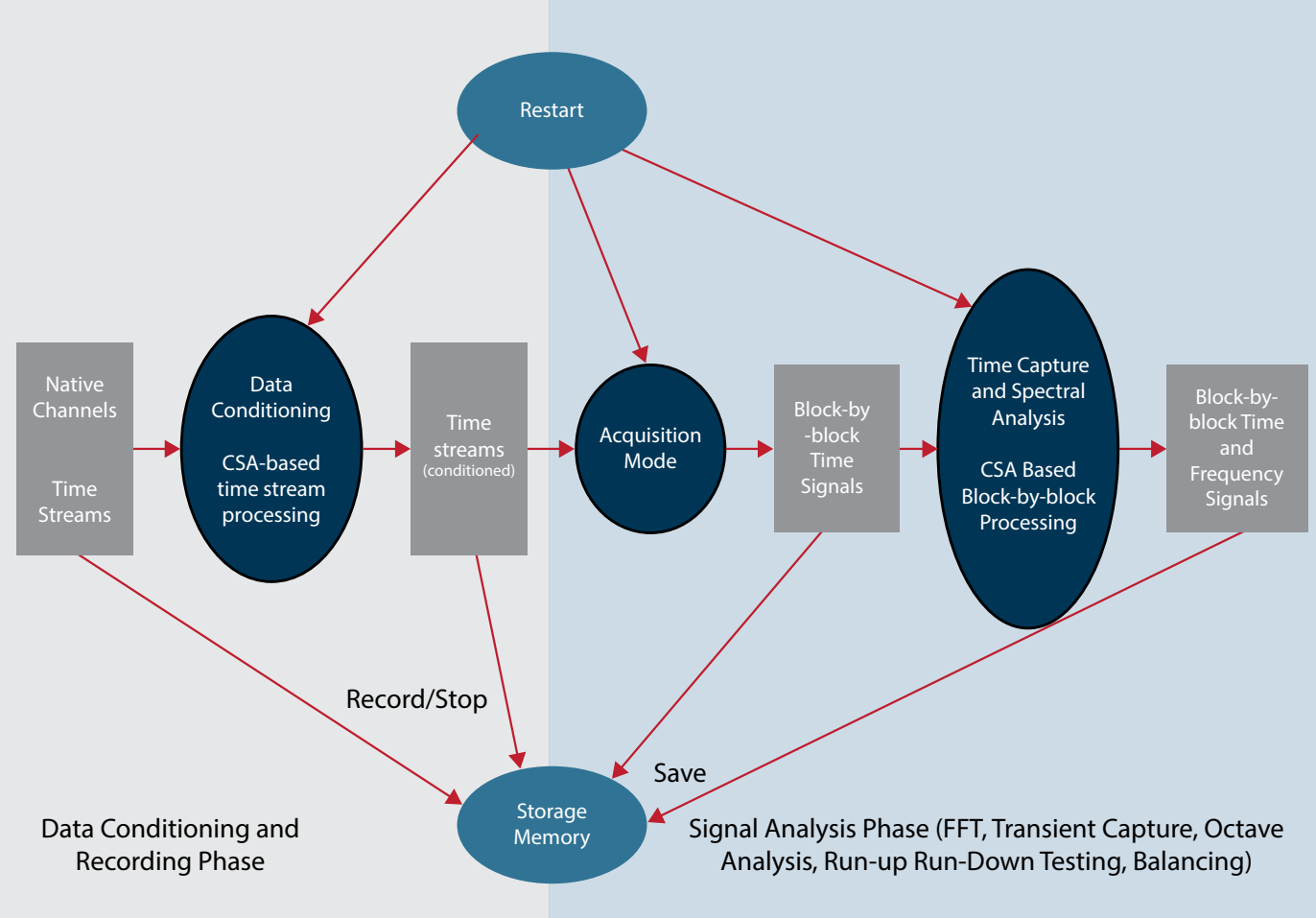
Measurements can be viewed in real time as the data is being acquired and analyzed. On line displays include the time histories, orbit plots, order spectra, order tracks, waterfalls, spectrograms, and contour plots. Users can also view the instantaneous RPM as a function of time.

Waterfall displays provide a good overview of an entire run-up or run-down measurement. To better understand the measurement results, users can easily change the viewing angle so that effects of order related excitation and structural resonance excitation are immediately obvious.

Waterfall displays include a “slice” mode that provides a plot of a cut across the order or RPM axes. To view a particular slice, simply position the 3D cursor. Users can view the order track for a given order, or fractional order, or view the amplitude-versus-order spectrum at a given RPM. This capability allows the user to quickly zero in on the problem’s root cause.

Color map presentations further enhance problem diagnosis capabilities. For example, spectrograms, or color intensity plots make it very easy to differentiate order related responses from excitation due to a structural resonance. Color contour, or topographic maps, also provide added graphic insight into the nature of a vibration or acoustic response.

A full complement of cursors – single, dual, peak, valley, harmonic and sideband provide precise numeric readout of critical data features. Users also have complete and easy control of the orientation, scaling, colors, etc., enabling the creation of insightful data visualizations.



Introduction

In a time-critical test, it is highly desirable to record the raw time data continuously, so that the data can be analyzed later when more time is available for a complete review. Integral raw data recording eliminates the need for a separate recording device that was necessary just a few years ago.

The Spider platform simultaneously performs both real-time processing and continuous data recording. In most real-time applications, the raw data can be recorded at any desired sampling rate with full 32-bit floating point precision. To increase the reliability of data recording, a special check sum algorithm is always applied to the measurements.

For example in a typical FFT process, the raw data time streams (full bandwidth, sampled at the instrument's highest sample rate) and/or the continuous output of a bandwidth-reducing data conditioning process can be recorded at a lower sample rate on the system's storage media while the real-time filtering and spectral analysis is in progress. This same design philosophy is incorporated in the Spider high channel count systems.

While being recorded, the measured values can be graphically displayed as y/t or y/x diagrams, as bar charts, as waterfalls, FFT, PSD, tachometer speed, or numerical statistical displays with a simple mouse-click. EDM software allows users to design an individual graphical visualization for each desired real-time measurement.

The recording system processes virtually every physical quantity, including: temperature, voltage, stress, strain, pressure, force, acceleration and frequency. Even high channel count applications using hundreds of channels can be configured within a very short time and are handled safely and efficiently.

The recording function is driven by user-defined events. On Spider front-ends the recording "action" can be initiated via various events, including: hard button press, user software command, defined trigger-condition event, digital input event, third party software command, defined alarm limit event, fixed timer, etc.

Typical Data Storage on the Spider-NAS	
General Functions	• NTFS file system: Supports single large data file (2 TB max) • Data format: ASAM ODS data format • Data samples are in 32-bit single precision floating point • Data file access: EDM, FTP, removable disk • Configuration Tool: EDM software from Crystal Instruments
Storage Speed	• Up to 64 channels, each sampled at up to 204.8 kHz sampling rate retained with 32-bit floating point format (per IEEE 754-2008) • Aggregate speed is greater than 26 MB/second
Typical Storage Duration for a 250 GB Disk	• 4 channel at 1 kHz/ch sampling rate: 4660 hours • 8 channel at 5 kHz/ch sampling rate: 466 hours • 8 channel at 102.4 kHz/ch sampling rate: 23 hours • 64 channel at 102.4 kHz/ch sampling rate: 3 hours
Management	• Wake-on LAN, Keyboard Power-on, Timer Power-on • System power management, AC power failure recovery • Watch Dog Timer

The Spider-NAS features eight dedicated high-speed data buses and a removable 250 GB serial ATA (SATA) Solid State Disk (SSD).

High Channel Count Solution Using Spider Front-ends

For high channel count applications, the data recording can be realized on Spider systems via either of two approaches: record the time-stream data into the flash memory on each Spider front-end, or record the time-stream data into an external storage device, such as the Spider-NAS (one Spider-NAS can service up to eight Spider-80X data acquisition front-ends simultaneously). Either way, the data recording path does not involve the system's Ethernet connection. This provides robust recording while preserving network communication bandwidth.

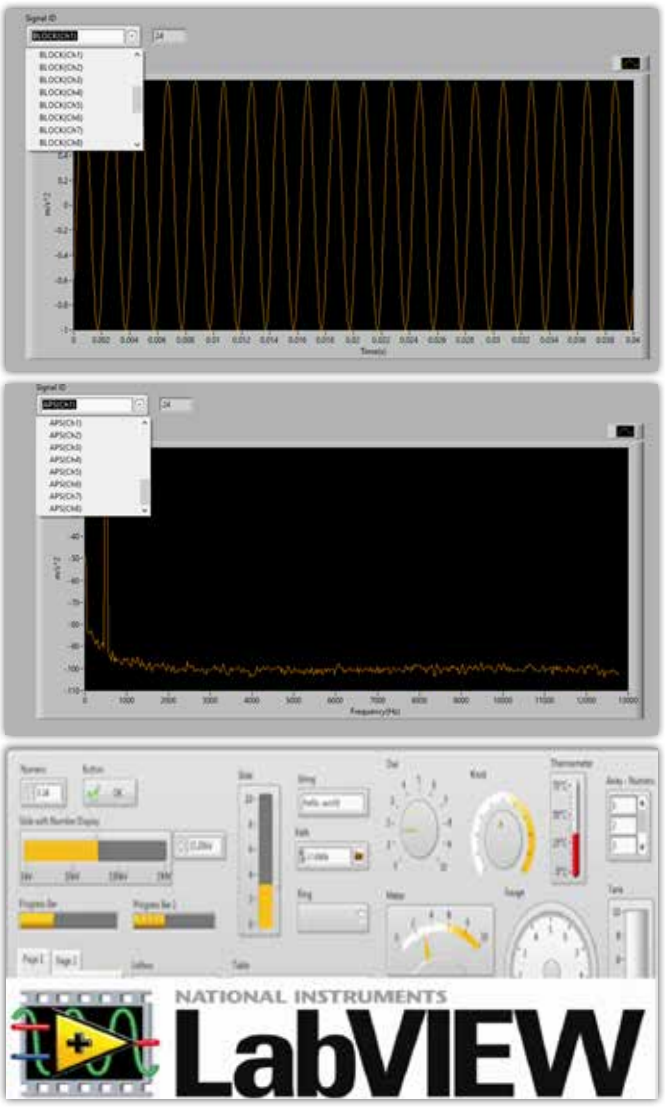
The Spider-NAS (Network Attached Storage) is a dedicated storage device that works with front-end modules from Crystal Instruments, including the Spider-80X, Spider-80SG, Spider-81, and Spider-DAQ. Eight dedicated high-speed data buses interface directly with each Spider front-end. Each Spider-NAS dedicated data port communicates at speeds up to 480 MB/second. The Spider-NAS can store simultaneous data from all (64 maximum) attached dynamic measurement channels at a sample rate as high as 256 kHz, or as low as a few samples per second. An Ethernet port is used to configure and control the Spider-NAS.

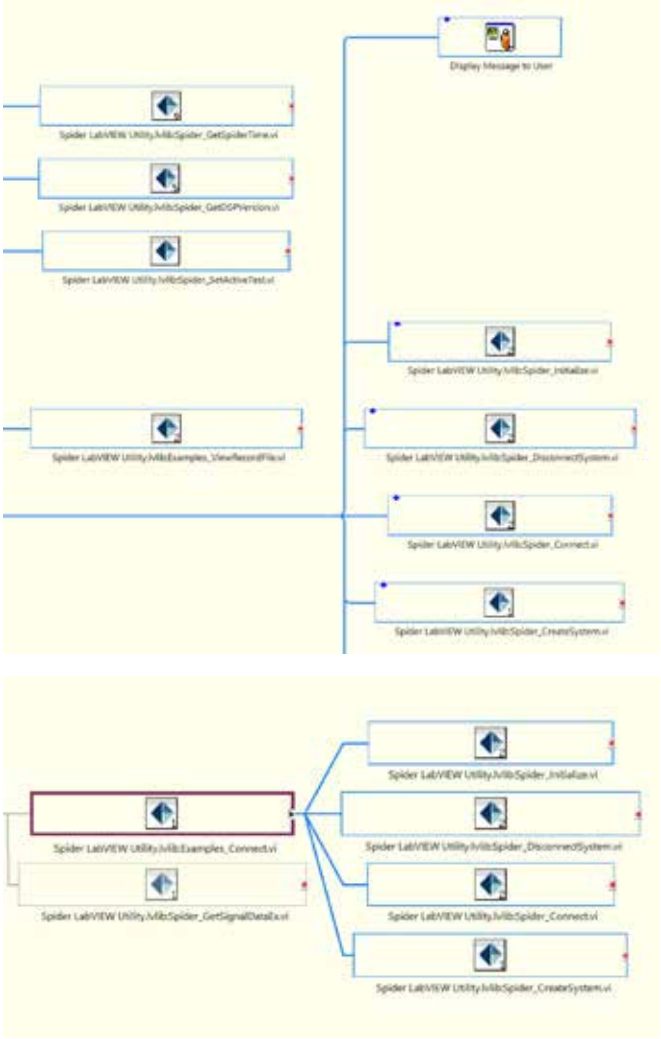
Remote Operation on Recorded Data

The recorded data can be remotely accessed and downloaded to an authorized PC anywhere in the world. This feature is particularly useful for remote machine monitoring or structure health monitoring. Multiple Spider front-ends can be installed throughout a processing factory or at a single machine location. The vibration signals and their extracted characteristic values can be recorded continuously.

Spider LabVIEW Utility

www.crystalinstruments.com





LabVIEW is a registered trademark of National Instruments.

Spider products are equipped with a DSP core processor that handles data acquisition and processing. Users can configure the analysis parameters of a Spider using LabVIEW. Raw data along with processed data can be visualized or saved through LabVIEW.

EDM now supports the FFT Analysis test through LabVIEW.

Available Functions
Create a new test
Set up the input channel table
Retrieve live data
Initiate recording commands
Download recorded raw time data

Spider LabVIEW Utility provides several examples and virtual instruments (vi) to help users configure the Spider to receive or visualize data.

LabVIEW helps users control a wide range of industrial equipment through the status of sensors read by Crystal Instruments' Spider systems.

Supported Spider Front-ends
Spider-80X, Spider-80Xi & Spider-80Hi
Spider-80M: MIMO Vibration Controller
Spider-80SG: Wide range of sensors including strain gages
Spider-80Ti: RTD and Thermocouples

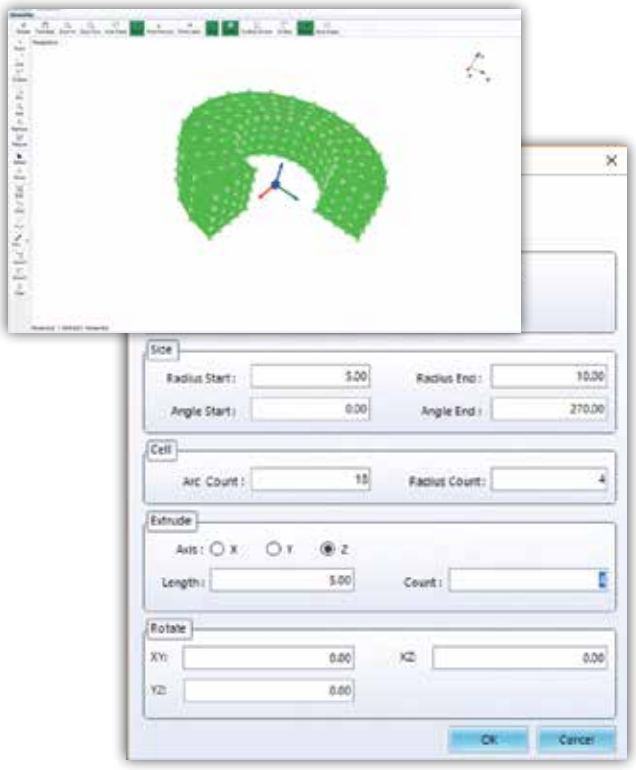
EDM Modal: Complete Modal Testing & Analysis Software

www.crystalinstruments.com/edm-modal-testing-and-analysis-software

Overview

EDM Modal is a complete Testing and Analysis suite for Experimental Modal Analysis (EMA). An intuitive interface allows users to manage highly complicated tests that can involve hundreds of measurement points and multiple excitations to be conducted quickly and with little effort.

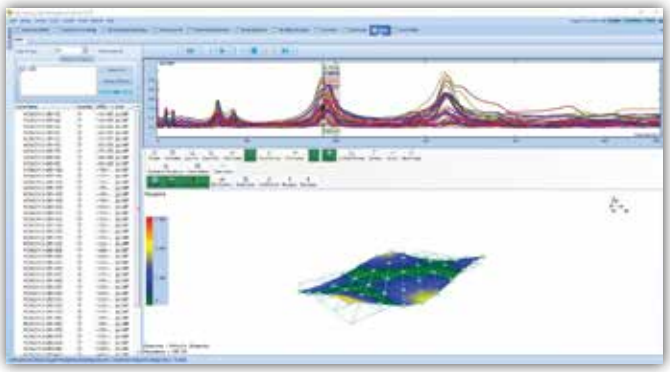
- Geometry Editor: Handles structure modeling and supports all types of coordinate systems.
- Experimental & Operational Modal Analysis: Hammer impact testing or modal shaker(s) testing to acquire FRF signals. OMA makes use of ambient excitation or machinery operating status.
- Modal Playback Analysis: Makes use of the recorded data files and allows analysis with detailed settings to calculate the FRF/ spectrum signals.
- Curve-Fitting Techniques: Least-Squares Complex Exponential (LSCE), Poly-Reference Time Domain (PTD), Poly-X (based on p-LSCF), Stochastic Subspace Identification (SSI) fitters are available.
- Animation & ODS: Simulate mode shapes of device under test. Also, Operational Deflection Shapes (ODS) can be displayed using measured time or spectrum operating responses.
- Correlation Analysis: Bridges the EMA and FEA results



Geometry

EDM Modal Geometry is the primary EDM Modal software module and is required for every EDM Modal system. This option provides fast and efficient structural model generation and full 3D visualization of test and analysis results.

- Basic Elements: point, line, surface; editing graphically or through editor table entry
- Coordinate System: cartesian, cylindrical, spherical
- Component Entry: origin, direction (Euler angle)
- Built-in Component Library: line, plane, cube, sphere, cylinder and circle
- Geometry model decimation
- 3D geometry model reconstruction from 2D photos
- Geometry Model Import: UFF (.unv), CAD (.dxf, .stl, .obj, .3ds), Nastran (.nas), and .xml
- Geometry Model Export: .xml, .obj, .stl, .unv
- Geometry Model Display: point, line, surface; point directions, point number; surface norm; origin
- Geometry View: Perspective, Quad (perspective, top, side, front)



Operational Deflection Shape

EDM Modal Operational Deflection Shape (ODS) is a feature that allows users to better visualize the deformation of the structure under test. Time domain data and spectrum data can be animated using the animation feature of the geometry model. It is an integrated feature with the Geometry and works for all types of EDM Modal testing.

- Data management of time domain and frequency domain
- Supported time data: block, recorded time data
- Sweep control of forward/backward
- Sweep speed control: -, +
- Animation amplitude normalization
- Animation of 3D geometry model with frame or contour
- Animation equation editor and animation with interpolation
- Animation amplitude control
- Animation image and video file saving

Hammer Impact Testing

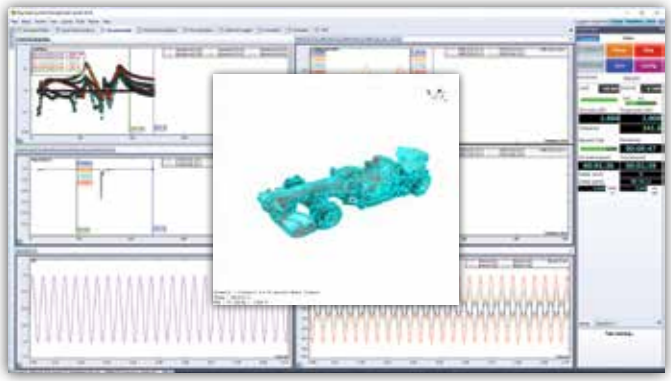
EDM Modal Hammer Impact Testing provides the necessary features for a single-operator experimental modal test. The Hammer Impact GUI features an intuitive step-by-step process, allowing a user to easily go through the setup and testing.

- Testing plan for the process and status
- Roving hammer or response
- Auto or manual point/direction increment
- Manual/auto trigger arming
- Auto trigger level; suggested block size
- Resizable preview window for DOFs, frame counts, impact/response waveforms
- Double hit detection on/off, auto/manual reject
- Driving point selection
- Audio/graphic feedback of test status
- H1, H2, H3, and Hv estimation

SIMO/MIMO FRF Testing

EDM Modal MIMO FRF Testing includes a dedicated test setup and operation process flow using single or multiple simultaneous shakers to acquire FRF signals. Using a large channel count data acquisition system (i.e., Spider- 80X or Spider-80Xi), this shaker excitation method provides much higher efficiency and accuracy for the FRF measurements while minimizing local stresses on the test article.

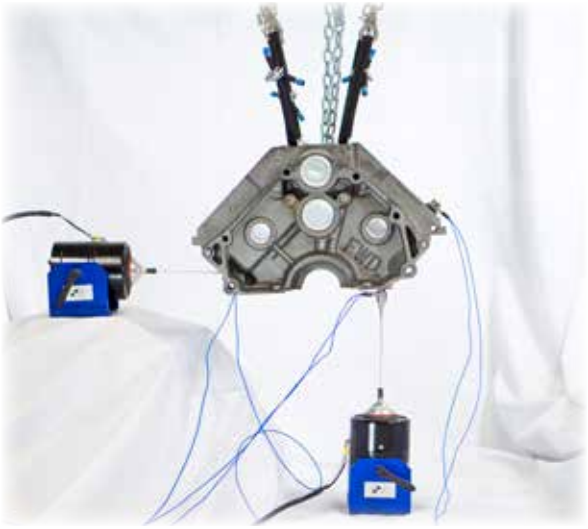
- Point/direction auto/manual increment
- One or multiple synchronized and uncorrelated excitation(s) (reference)
- Testing plan for the process and status
- Source trigger mode for synchronized acquisition and source random, burst random, shaped random, burst shaped random, pseudo random, period random, chirp/burst chirp output types
- Delay block and cyclic block number setting for pseudo/periodic random
- Supports Multi-Resolution Spectrum Analysis
- Scope tab to view channel data before measurement
- H1, H2, H3, and Hv estimation



SIMO/MIMO Stepped Sine Testing

EDM Modal SIMO/MIMO Stepped Sine Testing includes a dedicated test setup and operation process flow using single or multiple shakers outputting sine wave to acquire FRF signals. The Source Output type is Stepped sine tones. The step mode can be linear or logarithmic. The FRF signals of each measurement DOFs with respect to defined reference channels will be constructed. The output drive level can be defined to operate the test in an open loop, or the response of a control channel can be specified to operate the test in a closed loop.

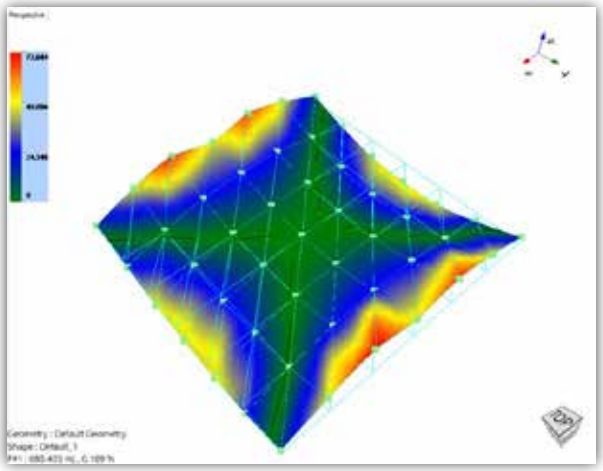
- Point/direction auto/manual increment
- One or multiple sine excitation with sine tone (reference(s))
- Single or multiple number of sweeps
- Different initial phase conditions for each sweep: +/- or random
- Testing plan for the process and status
- Specify source output level profiles; or control the amplitude of input channels
- Linear, logarithmic sweep mode
- Filter, RMS, mean or peak for measurement strategy
- Fixed or proportional tracking filter, with user defined bandwidth
- User defined start/end frequency; number of points; delta F (or points/oct); transition speed



SIMO/MIMO Swept Sine Testing

EDM Modal SIMO/MIMO Swept Sine Testing includes a dedicated test setup and operation process flow using a single or multiple shakers outputting sine waves to acquire FRF signals. The source output type is swept sine. The sweep mode can be linear or logarithmic. The FRF signals of each measurement DOFs with respect to defined reference excitation DOF will be constructed.

- Point/direction auto/manual increment
- One or multiple sine excitation with sine tone (reference(s))
- Single or multiple number of sweeps
- Different initial phase conditions for multiple sweep: +/- or random
- Testing plan for the process and status
- Specify source output level profiles; or control the amplitude of input channels
- Linear, logarithmic sweep mode
- Filter, RMS, mean or peak for measurement strategy
- Fixed or proportional tracking filter, with user defined bandwidth
- User defined start/end frequency; number of points; delta F (or points/oct); transition speed



Operational Modal Testing

EDM Modal Operational Modal Testing (OMA Testing) includes a dedicated test setup and operation process flow using ambient vibration data. Using a large channel count data acquisition system (e.g., Spider- 80X or Spider-80Xi), the excitation method provides a much higher efficiency and accuracy for FRF measurements while minimizing local stresses on the test article.

- Point/direction auto/manual increment
- User defined reference channel
- Scope tab to view channel data before measurement
- Expanded cross power spectrum for all input channel vs. reference channel
- Cross power spectrum vector(S) smoothing, multiple times or cancel

CoCo Handheld Analyzers & Data Acquisition

Spider-20 Series Dynamic Signal Analyzers

Spider-80SG/SGi Strain Measurement Device

Spider-80M MIMO Vibration Controller

Hardware Systems

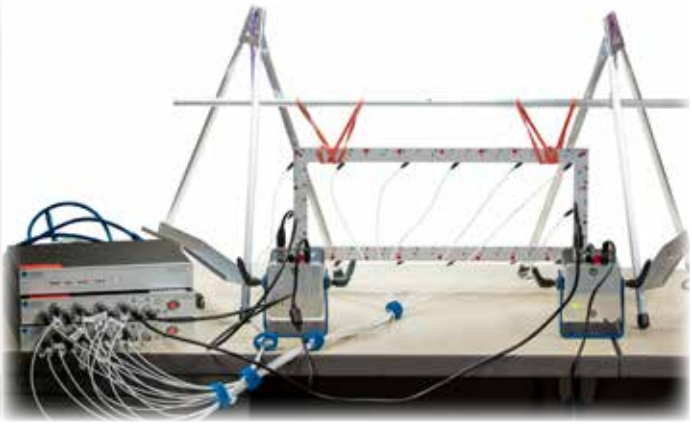
Different hardware systems from the Coco and Spider platforms can be used to execute experimental modal testing and acquire modal data which can be further post-processed in the EDM Modal software suite.

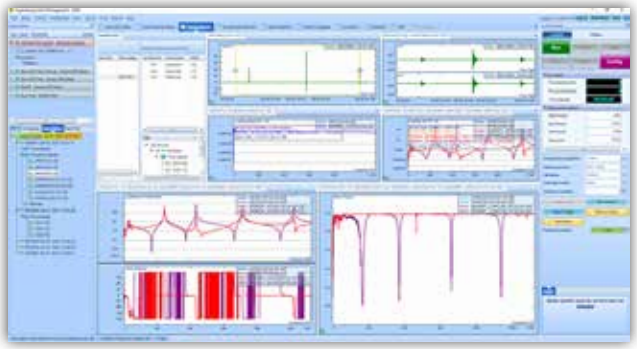
Handheld hardware systems to medium sized hardware systems can be used to execute modal measurements. Furthermore, these systems can be scaled up and combined as a high-channel count system to record and measure modal data in the field. Processing and analyzing the measurements in EDM Modal guides users in studying the structural properties of the device under test.

The different hardware systems shown here can be deployed to record, measure, analyze modal test measurements.

For a quick and simple modal test like a modal hammer impact test or a single modal shaker excitation test, the CoCo-80, CoCo-80X, CoCo-90 and CoCo-70 hardware systems or the Spider-20, Spider-20Hi, Spider-20E systems can be used to reduce the instrumentation and setup times. Based on the testing method of interest, a roving excitation and roving response test can be executed to collect the data using the small channel systems.

For a more complex test involving larger numbers of sensors where multiple modal shaker systems are needed for testing the structure, a Spider-80X, Spider-81, Spider-81B or the highly efficient Spider-80Xi and Spider-80M can be used to acquire large amounts of data in a single effort. The testing times can be significantly reduced using the high-channel count systems.

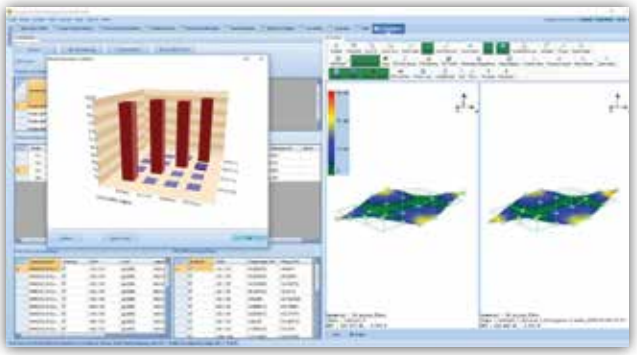




Playback Analysis

Modal Playback Analysis takes use of the recorded data files and allows the analysis with detailed settings to calculate the FRF signals. This is extremely useful for the field testing cases. The recorded data files can be recalled and the structural spectrum signals, i.e., FRF or CPS, can be re-calculated with any valid setup parameters.

- Record and data file management through Testing plan
- Available in Hammer Impact, SIMO/MIMO FRF and OMA testing types
- Simple playback mode switch from online analysis
- Same setup as that for online analysis
- Repeatable and complete analysis for the spectrum required

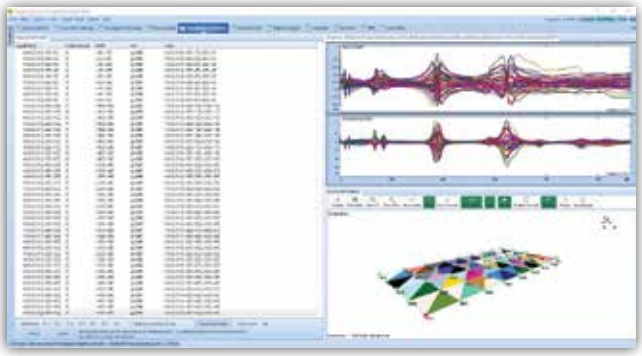


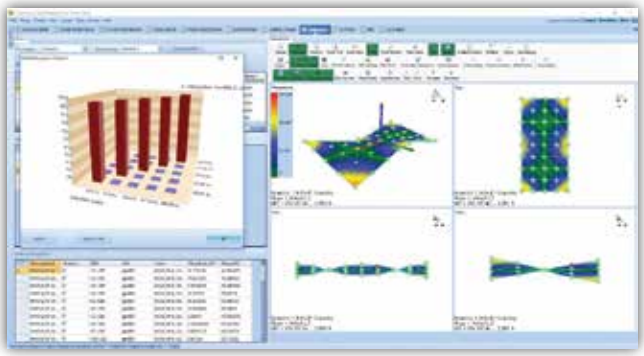
Correlation Analysis

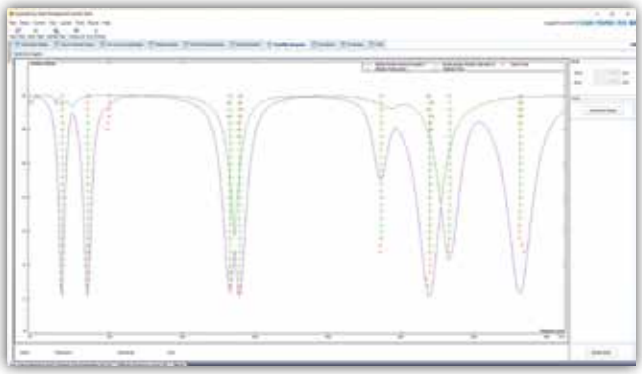
EDM Modal Correlation Analysis allows the user to correlate two modal models. The modal models can be EMA model, and/or FEA model. Comparing the experimental data with that acquired through finite element analysis helps in validating the test results. The geometry model and mode shape data from the FEA software or another set of mode shape data from EMA can be imported. A modal mapping procedure is executed to match the EMA and FEA models. After this matching procedure, the new mode shape information from FEA is interpolated and the FEA modal parameters are displayed alongside with EMA results. Finally, to observe the correlation between the results from two methods, a Cross-MAC matrix is calculated and shown.

- Import Model: .xml, .unv, .nas
- Import Mode Shape: .unv
- Modal Mapping: Manually pair 3 points from each model (or more), Auto-Match
- Cross-MAC calculation and display
- Animation Comparison: Left/Right, Upper/Lower

Function	Standard Modal Analysis	Advanced Modal Analysis	Premium Modal Analysis
Modal Data Selection	√	√	√
Band selection, MIF functions	√	√	√
Stability Diagram	√	√	√
Animation, MAC, FRF Synthesis	√	√	√
LSCE (single reference time domain)	√	√	√
PTD (Poly-reference time domain)		√	√
Poly-X (Poly-reference frequency domain)			√







Modal Analysis

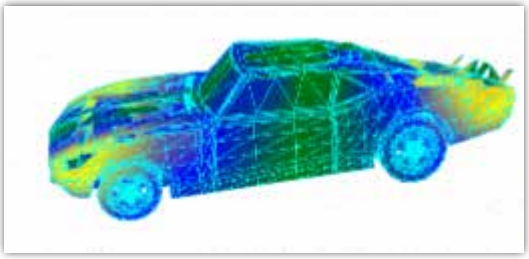
Upon completion of the Modal testing, the set of FRF data is made available for the next step of Modal Analysis which provides the user with a complete arsenal of tools, from FRF data selection and parameter identification to results validation and mode shape animation.

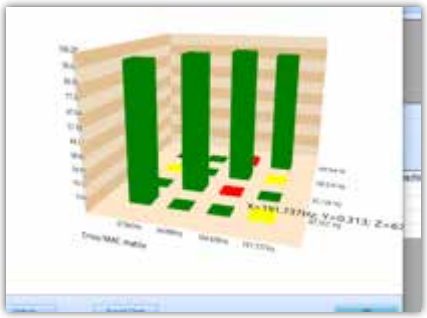
Mode Indicator Functions (MIFs) available in Band Selection aide in identifying repeated roots and closely-spaced distinct modes. The curve-fitters available in Stability Diagram facilitate in obtaining the modal parameters. Tools like Modal Assurance Criterion (MAC) and FRF synthesis provide means for validation of the modal parameters.

- Modal Data Selection: Review measured FRFs, Signal Smoothing with Deconvolution (for OMA testing only)
- Band Selection: Multivariate MIF, Complex MIF, Real MIF, Imag sum MIF with Auto pole selection
- Stability Diagram: Curve fitting method: LSCE, PTD, Poly-X, SSI
- Least square frequency domain (LSFD) algorithm for mode shape calculation
- Save/append modes to the shape table
- Auto/Cross MAC calculation and display
- Import/Export Modes: UFF format
- Animation equation editor for unmeasured DOFs
- Mode Shape Animation: wireframe, surface contour, FFD, animation with interpolation
- Contour edit, Contour value
- Animation smoothing
- Node lines
- Animation with un-deformed elements
- Mode Shape Animation speed control (fast, slow), magnitude control (increase, decrease)
- Animation Format: Single, Left/Right, Upper/Lower
- Modal Shape video saving, graph saving
- Synthesized FRF vs. measured FRF, with Correlation and Error values

EDM Post Analyzer Software

www.crystalinstruments.com/edm-post-analyzer-software





Crystal Instruments offers EDM Post Analyzer software (EDM-PA), a powerful post processing addition to the CoCo or Spider-based analysis tool kit, allowing users to analyze Time Stream recordings made using a Dynamic Signal Analyzer, Vibration controller or external datasets. Post Analyzer's true power shines through when users analyze, reanalyze, or digitally condition recorded data to meet their precise testing needs.

To offer a complete package of both real-time analysis and post processing, Crystal Instruments developed three separate but related software modules: Post Analyzer, Waveform Editor, and File Converter. Post Analyzer (PA) contains many powerful post processing tools with batch processing capability. Post Analyzer is an independent Windows application that analyzes recorded data files on a computer using various algorithms. Most of the algorithms implemented in PA are identical to those used in the real-time DSP of the Spider hardware.

Post Analyzer offers a selection of different test types to choose from.

FFT Spectral

FFT Spectral tests can perform spectral analysis on all recorded data, with live or accelerated data playback. This allows the user to setup run time conditions such as specific number of averages or even a condition-based trigger on any channel. PA can simultaneously process 100s of channels per recording. In addition to numerous channels per recording, it can also process several recordings together in the powerful and versatile batch processing function.

Basic Signal Conditioning

Basic Signal Condition greatly expands on the already powerful spectral analysis tests to provide the user with options to perform basic math functions, offset/scaling, statistic signals (RMS, Peak, histograms), and Integration/Differentiation (Accel/Vel/Disp) calculations. The user can then choose to process both the original as well as the conditioned data together to obtain either spectral signals or a new conditioned time stream signal which can be exported to various universal formats such as .mat, .wav, .csv etc. for further processing.

Octave Analysis and Sound Level Meter (SLM)

The Octave Analysis option applies a real-time filter bank in 1/1, 1/3rd, 1/6th, or 1/12th octaves. The input time stream is split into fractional frequency-band signals (octave bands) which can be saved. Frequency weighting can be applied to the octave bands to simulate human hearing, and time weighting can be applied to adjust sensitivity to short duration events. The resulting octave spectra can be saved and displayed on a waterfall plot to observe how the spectrum changes in time. The 1/1 and 1/3 octave analysis are implemented using a real-time band-pass filtering with decimation technique. The octave filters are designed in accordance ANSI std. S1.11:2004, Order 3 Type 1-D and IEC 61260-1995.

The Sound Level Meter (SLM) is a related application in the acoustic data acquisition software. This module is also referred to as an Overall Level Meter. The SLM applies a frequency weighting filter to the input signal and time weighting to the filter's output. Various acoustic measurements are then extracted from both the input and output signals of this frequency weighting filter.

All of the features that are expected from an acoustic measurement device are present…and then some! A, B, C, and Linear weighting functions; Fast, Slow, Impulse, and Peak detectors; and user selectable high and low-pass filtering. The tremendous dynamic range that all CI instruments offer take the worry out of setting voltage ranges precisely to avoid under-range or overload conditions.

Shock Response Spectrum
PA can perform SRS tests on time stream data, with live or accelerated data playback. This allows the user to setup test parameters such as custom damping ratios, octave resolution or even a condition-based trigger on any channel. The results can be saved and a report with all the specified graphs and data can be automatically generated in just a few clicks.

Order Tracking
PA can perform Order Tracking and Order Domain Analysis on tachometer-based time signals. PA resamples all the data in the order domain to provide an accurate order track. In addition to this PA can also track the FFT-based PSD spectra, a fixed band or an octave band versus RPM. All the processed signals can be saved and displayed in 3D waterfall plots or color maps.

Fatigue Damage Spectrum - SoR Accelerated Testing Profile
This powerful feature takes tachometer-based time waveform signals from rotating machines and processes them in the order domain to extract dominant sine tones (orders) and random broadband signals. The user can then define the target life for the product to be tested. PA then calculates and adjusts the extracted signals to match the expected fatigue from life testing. The user can decide to 'accelerate' testing and PA will calculate the new profile for a faster testing time.

This new profile is a sine on random signal simulating both the periodic vibrations from the rotating parts as well as the random vibrations from external sources. Users can easily export this profile to EDM Vibration Control software (VCS) and the DUT can be tested. This feature integrates the DSA, PA and VCS software into one seamless workflow - from data collection and post processing to vibration controller profile and testing.

Vibration Intensity
Vibration Intensity or Whole-Body Vibration (WBV) testing is a type of vibration analysis geared towards estimating the effects on the operator. There are three categories of concern for the operator: health and comfort, perception, and motion sickness. The goal for any WBV test is to ensure that under normal operating conditions there is no significant or lasting effect of the vibration experienced by the operator.

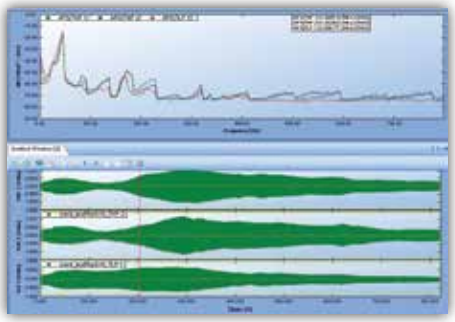
This data can be collected over 8 hours or more of triaxial data and then PA can process the data in a fraction of that time to establish baselines and produce a vibration intensity analysis and report according to ISO standards.

Highlights
Easy and intuitive data import of 100s of channels from internal and external data sources
Use normal or accelerated data playback to generate same results as real-time analysis
Ability to refine and rerun analysis with different user-defined parameters
Unique storage structure and algorithm to browse very large files with millions of data points and review older runs.
Payback GPS tagged data in real-time with satellite map overlays
Simultaneously review CAN bus and vibration data
Produce accelerated fatigue testing profiles with PA FDS
Create test reports, waterfall plots and color maps with ease.
Easily export results to popular data formats such as .mat, .csv, .wav .uff, etc.

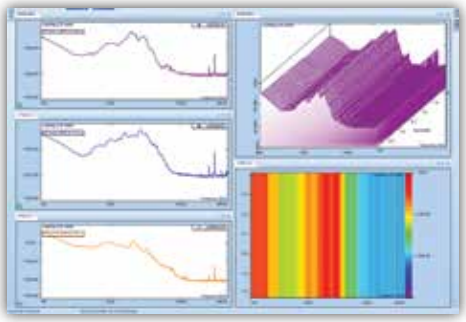
Waveform Editor and File Convertor
Waveform Editor is an independent Windows application that allows the user to cut, edit or merge time waveforms. File Converter is an independent Windows application that converts files in various data formats to standard ATFX format.

For the convenience of ordering, three bundles of PA are provided: PA Viewer allows the user to view data and create reports; PA Basic has FFT spectral analysis, curve fitting, demodulation spectrum and 3D signal display functions; PA Premium has more advanced functions including Waveform Editor, File Converter, offline sine reduction, real-time filters, octave filters and order tracking. Users can also choose to add individual modules that they require to meet specific testing requirements.

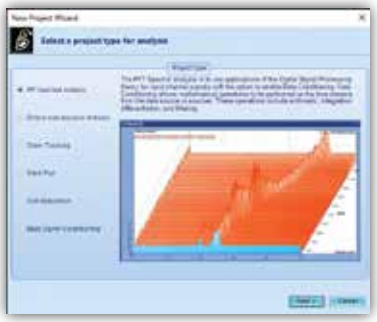
Engineering Data Management (EDM) is a complete suite of turn-key solutions for both real-time processing and post analysis. Shown in the next page are typical screen shots of EDM PA functions, in the following order: Post Processing, PA Spectra, and PA Projects.



Post Processing

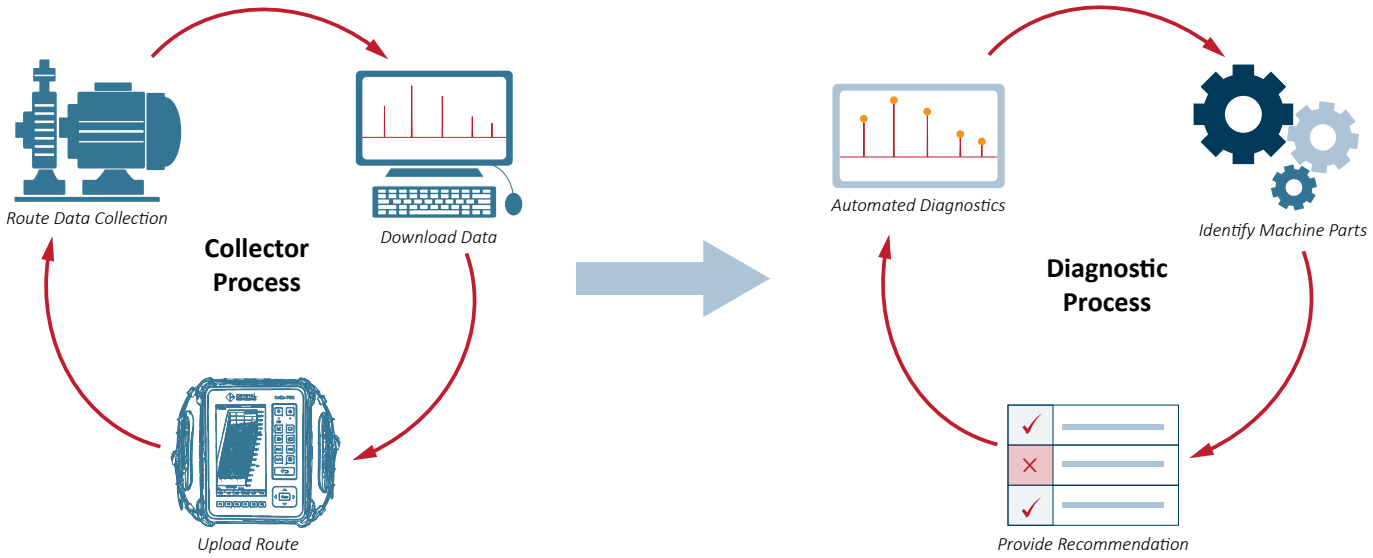


PA Spectra



PA Projects

Function	PA Viewer	PA Basic	PA Premium
Browse, display, and edit long waveform files	√	√	√
Signal display with different spectrum unit and X-Y scale	√	√	√
Signal annotation, cursor, play sound, calculate RMS, THD, ZOOM-in, ZOOM-out, auto scaling	√	√	√
Create template-based report in HTML, Excel, Word or PDF	√	√	√
Engineering unit conversion, dB reference	√	√	√
Export to standard formats including ASAM-ODS, UFF, BUFF, MATLAB, user-defined ASCII, and wave files	√	√	√
3D Display: waterfall, colormap	√	√	√
Import user-defined ASCII file, wave file, Pacific Instrument file		√	√
Acceleration, velocity and displacement conversion		√	√
FFT Spectral Analysis: FFT, auto power spectra, cross power spectra, frequency response function		√	√
Math Functions: abs, +, -, *, /, square, square root, log, integration, differentiation, RMS, peak, offset and scale			√
User defined data conditioning modules (PA-05)			√
Digital Filters: IIR, FIR, Low-pass, High-pass, Band-pass (PA-06)			√
Shock Response Spectra (SRS) (PA-07)			√
Fractional Octave Filters and SLM: 1/1, 1/3, 1/6, 1/12 (PA-08)			√
Order Tracking: RPM Spectra, Order Spectra (PA-09)			√
Offline Sine Data Reduction (PA-10)			√
Vibration Intensity (PA-11)			√



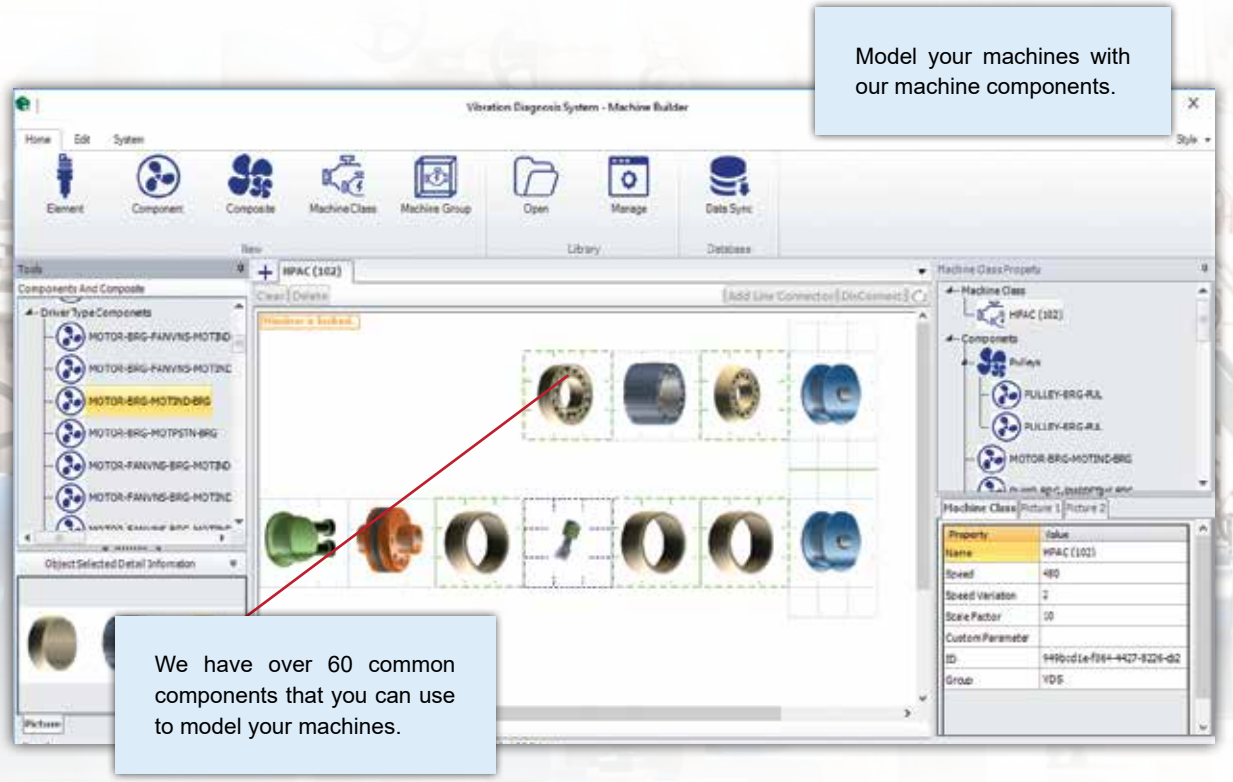
Route Data Collection
The CoCo can take field measurements and upload the data to the Vibration Diagnostic System (VDS) software. Create and maintain a database of machines and data for condition monitoring.

Quick Analysis Functions
Troubleshoot machine problems using embedded Quick Analysis functions. Routines are designed to tackle tough monitoring jobs like coast down, order tracking and bump tests.

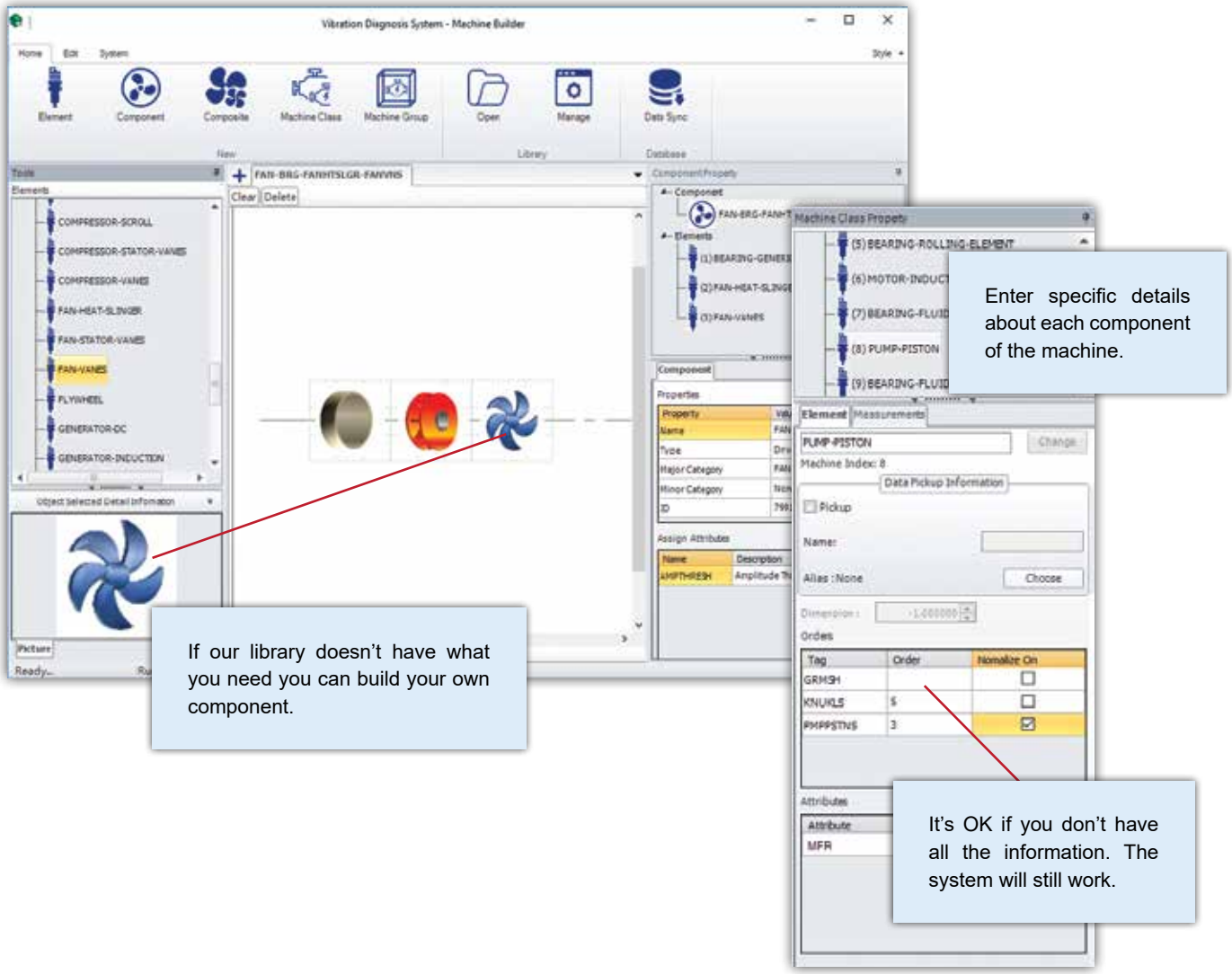
Job Management
Off Route measurements are linked to machines in the database using a system called Job Management. When taking Off Route data, the measurements are stored under jobs and each job is assigned to a machine. When the CoCo is synced with VDS the measurements are automatically placed under the appropriate machine.

Vibration Diagnostics System

Powered with Artificial Intelligence | www.crystalinstruments.com/vibration-diagnostics-system

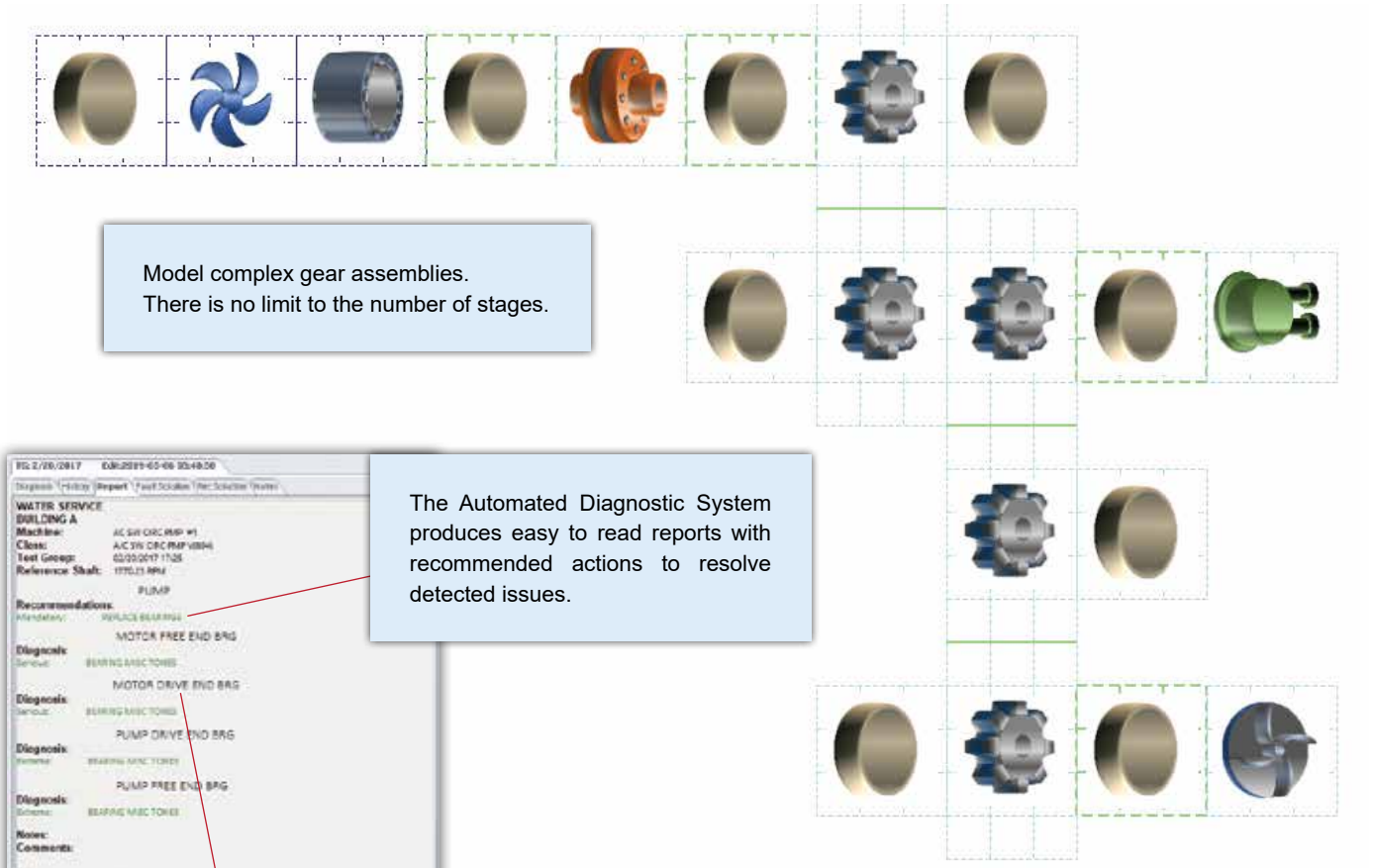


The Vibration Diagnostic System (VDS) is a vibration data management system designed specifically for the machinery Predictive Maintenance (PdM) community. It harnesses the graphic display capabilities of Crystal Instruments EDM Software for the work of machinery vibration analysts. It allows the user to quickly get to the data for a machine of interest and display that data in the familiar Tri-axial or Single Axis view. It lets users quickly compare to other data from the same machine, quickly navigate back into the historical data of the machine, and quickly compare the data to that of other machines in the database. The software supports the construction of Average (a.k.a. baseline) data for a class of machines and allows easy comparison to that data as well. When users interact with the data they will have access to a full suite of cursors designed specifically for PdM analysis.



In addition to great graphics, Crystal Instruments has developed an extensible machine modeling system specifically for vibration analysis. It allows users to model machines based on the elements of the machine that can contribute to the vibration energy of the whole. Model bearings, rotors such as motor bars, couplings such as flexible and fluid couplings, account for slip in things like fluid couplings, model gears and pulley systems, and model turbines by accounting for each stage. It's wide open, users can create new elements to use in their system.

Not all users may want to do all of that, and for those users we're including a comprehensive library of machine components such as AC and Induction Motors, Couplings, Gears, Pulleys, Pumps, and other components. With our single and double gear shafts, users will be able to model many kinds of gear boxes with an unlimited number of stages. This ability alone lets you model your machines to view and use to keep track of vibration pickup locations, record the forcing frequencies of each part of the system, and attach attributes such as manufacturer and other part information.



Model complex gear assemblies.
There is no limit to the number of stages.

The Automated Diagnostic System produces easy to read reports with recommended actions to resolve detected issues.

The Automated Diagnostic System shows the detected machinery faults.

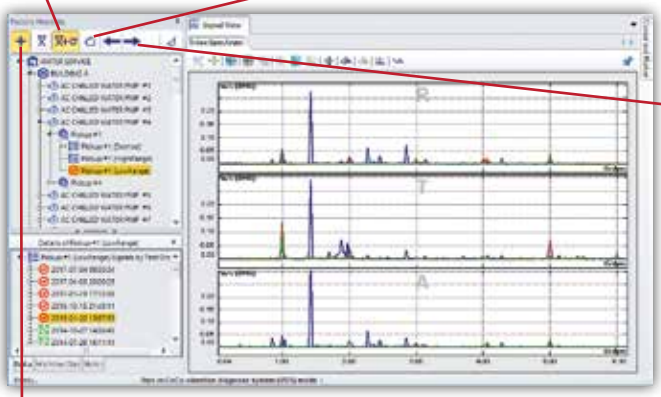
The Machinery Modeling system provides the structure for our narrow band automated diagnostic system. VDS provides the following features in support of an automated diagnosis system:

- The Machine Modeling System, which allows us to model machine components and to know the relative rotational speeds of all the shafts of the system.
- A method to organize Machine Class Average (baseline) data for each designated pickup location.
- Associate a physical machine with a Machine Class.
- A diagnostic rule processing system based on a forward chaining, probabilistic, inference engine.
- A method to define machinery faults.
- A method to define recommended actions based on recognized faults.
- Provide functions to support basic vibration analysis that takes care of all the mundane details such as extracting dominant peaks from each data set, matching the extracted peaks to forcing frequencies defined by the Machine model, comparing individual datasets with the appropriate Average data and returning the difference in amplitude between the two.

In essence, VDS takes care of all the math and accounting to let the rule writer focus on applying their knowledge of machine condition analysis.

Overlay baseline data.

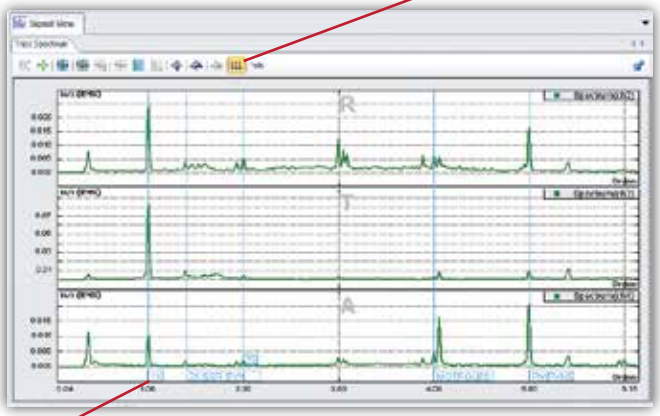
Easily cycle through the machine's data.



Navigate back through previous data.

Turn Forcing Order markers on and off.

Overlay data from the same Machine or other Machines.



Forcing order marker values are from the Machine Class setup. Users can customize which ones are displayed.

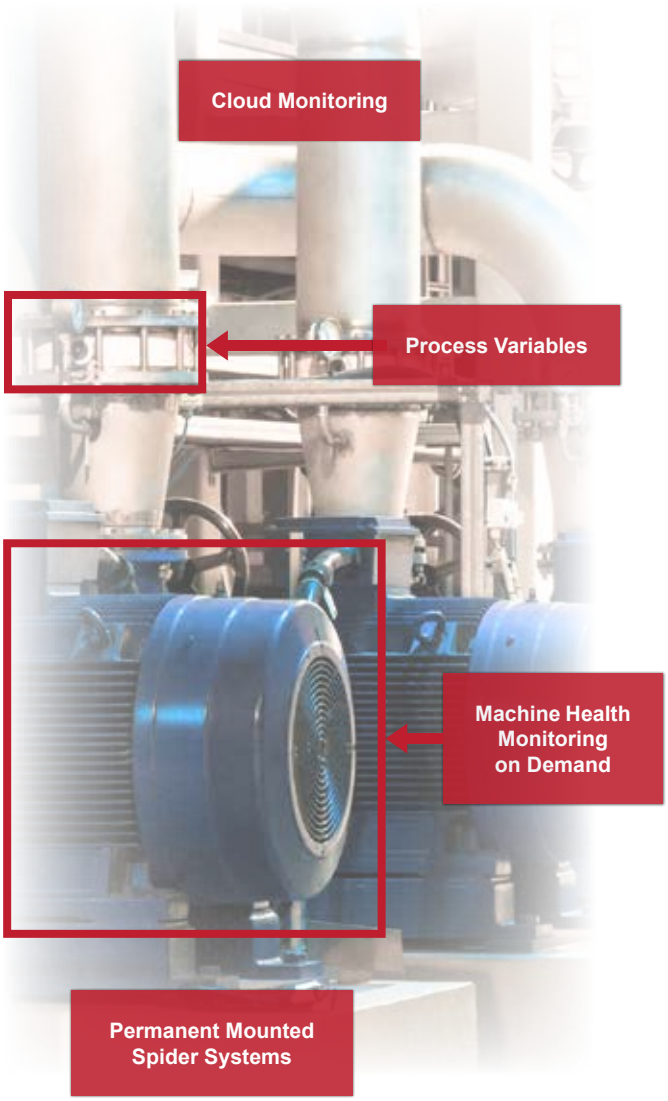
We know that most analysts don't have the time or desire to write their own rules for identifying machinery faults so we hired an expert to write a comprehensive set of rules for all of the machine components in our component library. When you model your machines with our component library you will get the benefit of **Artificial Intelligence (AI)** that will find many common machine problems.

Because our inference engine is based on a well-known open source scripting language called Lua, those that do want to build their own rule base or add to our rules will be able to do so. Using our low level, documented API, and open source tools, anyone could attempt to build or add to the knowledge base. But keep in mind that this is not for the faint of heart, it can be a challenging task. Entities that may want to do this include:

- Predicative Maintenance organizations that specialize in a certain kind of machine and have years of detailed knowledge about these machines, could encode their knowledge with rules, thus extending our system to meet their needs.
- University Engineering departments may want to work with our system to teach and experiment with machine vibration analysis.

Remote Condition Monitoring

www.crystalinstruments.com/remote-condition-monitoring-software



Continuous Condition Monitoring

Critical assets, by nature, require continuous monitoring. Only an online system can handle the task of 24/7 monitoring. As soon as a measurement crosses the threshold, condition monitoring software sends an alert to technicians. A Crystal Instruments Spider system remotely deployed can be wirelessly linked to a PC in an office which is running EDM-RCM (Remote Condition Monitoring Software).

Crystal offers software solutions for monitoring a variety of signal types and applications.

General Data Acquisition and FFT Spectral Analysis
Octave Analysis & Sound Level Meter
Rotational Dynamic Acquisition and Analysis
Automated Production Test Solutions
Continuous Recording & Post Analysis

Parallel Execution

CI Remote monitoring systems can cover many machines simultaneously. The system communicates with all devices in parallel. Additional data acquisition devices can be added to the system to provide greater throughput and to add coverage.

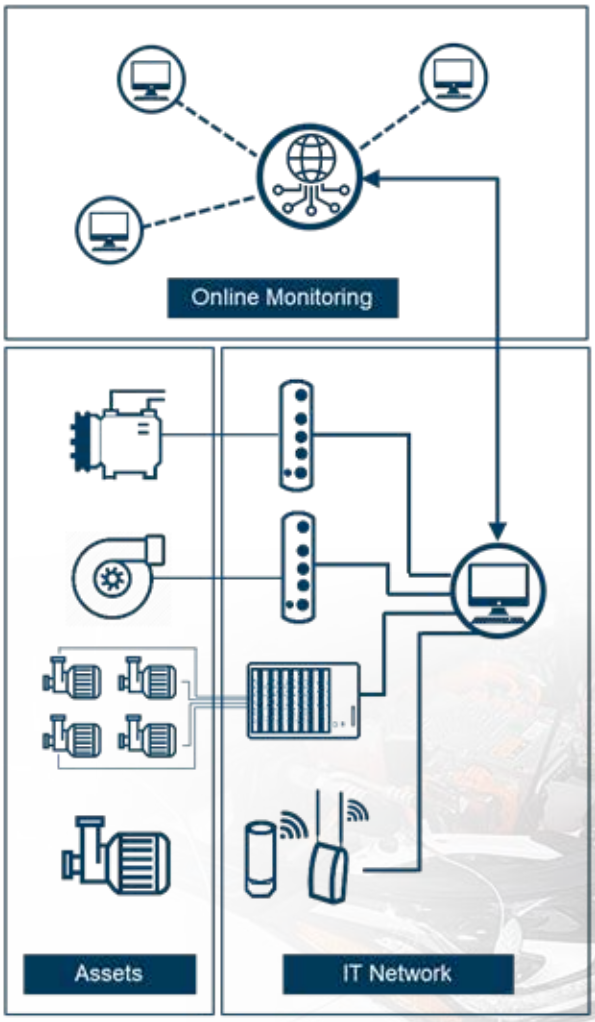
Permanent Mounted Data Acquisition

Crystal offers several hardware solutions for permanently mounted data collection.

Expandable Systems	Spider-80X & Spider-80Xi
Strain Gage Measurement	Spider-80SG
Temperature Measurement	Spider-80Ti
Compact Systems	Spider-20/20E/20i

Remote Condition Monitoring Features

- Simultaneouly monitor status of multiple Spider systems
- Simulanously download data from all Spider systems
- View generated alarms across all Spiders
- Low Power Consumption
- 160 dbFS Dynamic Range
- “Black Box” Mode (No PC Required)
- Reliable in All Circumstances



Connection Reliability

All types of Spider platforms support Black Box mode, which allows Spider systems to function as a standalone data recording system without requiring a live computer connection. This hardware design eliminates connection reliability issues between the PC during real-time data acquisition application.

Monitoring over LAN

Using the capabilities of the Spider’s Black Box mode together with the ability of EDM-RCM to efficiently monitor multiple Spider systems simultaneously, the Spider systems could be deployed in a plant or factory where continuous monitoring of several machines are needed.

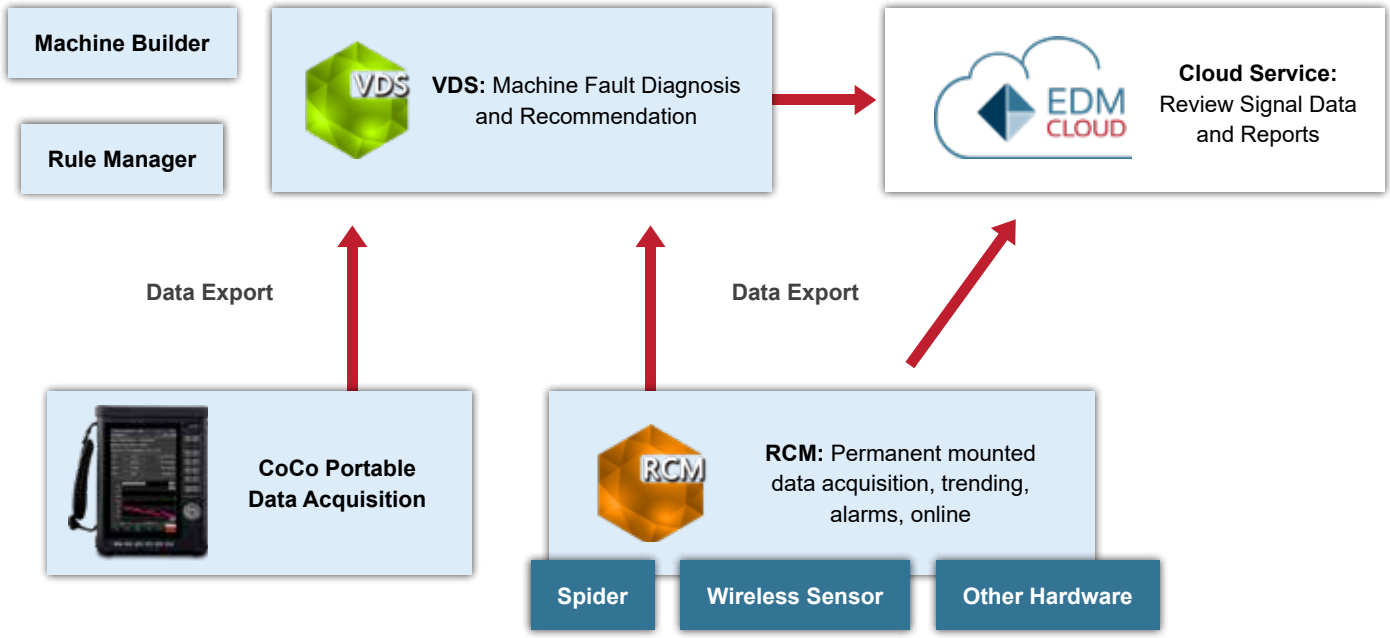
Each Spider front-end is configurable to continuously monitor the input channels and can be set to save data or generate specific events when certain user defined limits on time or spectral data is exceeded. The generated alarms are then passed to the EDM-RCM software for the user to diagnose.

Monitoring Using Cellular Networks

Crystal Instruments has developed several competitive features that help its line of Spiders succeed at wireless remote condition monitoring.

Using the “Black-Box” mode feature of the Spider, the PC merely acts as a terminal to view the status. If the connection fails or slows due to limitations in the transmission, such as the wireless connection failing, neither the data acquisition nor the monitoring functions on the Spider system will be interrupted.

This means that a Spider system placed in a moving car can be remotely monitored and controlled by a PC with an internet connection running EDM-RCM software. The Mobile Gateway modem makes the remote in-vehicle operation of Spider system possible.



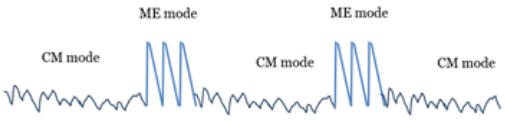


Figure 1: Spider systems can operate in both CM mode and ME mode

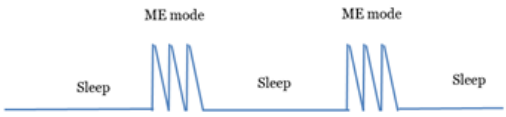


Figure 2: Wireless Sensors can only run in ME mode

Continuous Monitoring or Periodic Measurements

Spider systems provide a direct connection between the permanently mounted sensors and the vibration monitoring software. This gives the ability to operate in Continuous Monitoring (CM) mode. It also can operate in a periodic data acquisition mode called Measurement Entry.

Remotely Manage Power to a Spider System

The active power consumption of one 8 channel Spider front-end is less than 10 Watts. It is feasible to use battery power, or solar assisted power source to power the units.

If a Spider needs to save power, the system can switch to a power saving mode using an intelligent power control module developed by Crystal Instruments. The power module uses Ethernet messages which can transmit to the Spider using a local network or over the internet. The power module can also be used to remotely power cycle the Spider.

Predictive Maintenance

The purpose of Predictive Maintenance (PdM) programs is to identify machinery faults as they are developing. CI's Vibration Diagnostic System (VDS) provides automated diagnostic capabilities that can detect the development of failure and mitigate system risk. Experts can identify the problem with plenty of time to schedule downtime to occur when it doesn't impact operations.

The Remote Condition Monitoring (RCM) software is one of several CI products designed for machine condition monitoring applications. RCM is responsible for communicating with permanently mounted devices and managing the signal data. The database is shared between RCM and VDS, so the two software programs can work jointly to provide an automated machine fault diagnostic solution.

Comprehensive Technology Service Agreement

www.crystalinstruments.com/technology-service-agreement

Crystal Instruments understands the enormous investment our clients put into our products. We match their investment by offering the most comprehensive technical support agreement in the industry. From support calls to staff training, Crystal Instruments provides solutions to our customers' needs.

The "Comprehensive Technology Support Agreement" offered by Crystal Instruments is fairly priced as a small percentage of the total purchase value. The services offered and included in the agreement are for the duration of 1 year. The agreement is renewable at a locked in rate as a subscription. Rates are subject to increase if a subscription is not continued at the time of renewal and signed up for at a later time. Please contact Crystal Instruments for pricing information.

Services offered are:

- Annual software upgrade program - accessible by convenient online downloads
- Annual hardware calibration
- Priority phone/email/live video support from highly trained engineers
- Temporary replacement unit for hardware in 48 hours
- Data recovering services
- Hardware repair when the total service hours required is less than 4 hours per incident

Annual Hardware Calibration

Crystal Instruments DMS is certified by ISO:9001. Hardware calibrations are also performed at the customer's site upon request. Customers with a Premier Technology Service Agreement will receive standard annual hardware calibration services at no additional cost (a $1500 value).

Annual Software Upgrades

Crystal Instruments provides convenient solutions for software upgrades. Users are able to download the latest versions of Crystal Instruments' Engineering Data Management (EDM) software through the support website.

Other options include emailed links to download software updates, physical CD-ROMs or USB drives sent to your location, and installation instructions provided over the phone by our highly qualified Applications Engineers. Customers with a Premier Technology Service Agreement will receive standard software update services at no additional cost.

Temporary Replacement Units

Crystal Instruments strives to minimize any inconvenience to our customers' operations. Temporary replacement units are often provided to customers as a solution. Units will usually be assigned to customers within 48 hours or less.

Live Product Support

Crystal Instruments support staff is based in Santa Clara, CA at our corporate headquarters. Our support staff provides phone and email support from 8am to 5pm PST, Monday through Friday. All support is provided by highly trained engineers, not technicians. After hours support is also available upon request.

Crystal Instruments' highly diverse staff provides native language support in English, Spanish, Mandarin, Cantonese, Japanese, Taiwanese, Persian, Hindi, and Vietnamese.

Hardware Repair Services

Crystal Instruments provides hardware repair for units estimated to have a 4 hour or less repair service period. Additional hours required for repairs are charged at an hourly rate. Replacement parts are discounted by 30% under the Premier Technology Support Agreement. All hardware repair takes place at Crystal Instruments headquarters in Santa Clara, CA. Our highly trained technicians will accurately and efficiently repair your equipment in our ISO:9001 certified facilities.

Data Recovery Services

Crystal Instruments understands the importance of recovering any lost data safely and securely. Our staff is ready and available to assist you through any data loss crisis.

Crystal Instruments Product List	
CoCo-80X Dynamic Signal Analyzer (DSA) One output, tacho, sampling up to 102.4 kHz, 150 dBFS, 128 GB SD card, Wi-Fi, CAN-Bus, 7" touch screen color LCD. Includes C80X-01 (DSA) software option.	
C80X-P02	Two inputs
C80X-P04	Four inputs
C80X-P06	Six inputs
C80X-P08	Eight inputs
C80X-P02NW	Two inputs (Excludes GPS and Wi-Fi hardware modules)
C80X-P04NW	Four inputs (Excludes GPS and Wi-Fi hardware modules)
C80X-P06NW	Six inputs (Excludes GPS and Wi-Fi hardware modules)
C80X-P08NW	Eight inputs (Excludes GPS and Wi-Fi hardware modules)
CoCo-80X Vibration Data Collector (VDC) One output, tacho, sampling up to 102.4 kHz, 150 dBFS, 128 GB SD card, Wi-Fi, CAN-Bus, 7" touch screen color LCD. Includes C80X-02 (VDC) software option.	
C80X-P02V	Two inputs
C80X-P04V	Four inputs
C80X-P02VNW	Two inputs (Excludes GPS and Wi-Fi hardware modules)
C80X-P04VNW	Four inputs (Excludes GPS and Wi-Fi hardware modules)
CoCo-90X One 24 bit output, simultaneous sampling up to 102.4 kHz, input dynamic range 130 dB, floating point DSP, 4 GB data flash, and 5.7" color LCD. Application Software includes Dynamic Signal Analysis software, Calibration software.	
C90X-P16	Sixteen 24 bit inputs
C90X-P16NW	Sixteen 24 bit inputs (Excludes GPS and Wi-Fi hardware modules)
CoCo-70X Portable Machinery Vibration Analyzer: sampling up to 102.4 kHz, 150 dBFS, 128 GB SD card, 6.5" color LCD.	
C70X-P02	Two inputs, one output, tacho. Requires C70X-40 Software.
C70X-P04	Four inputs, one output, tacho
C70X-G15	Four 24 bit inputs, one 24 bit output, Ethernet, and keypad.
Spider-20 One 24 bit output, 4 GB data flash, BNC connectors, built-in Wi-Fi connection. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output enabled.	
S20-P02	Two 24 bit inputs (Voltage, IEPE) enabled *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S20-P04	Four 24 bit inputs (Voltage, IEPE) enabled
S20-P02B	Two inputs. Wireless Connectivity. Basic FFT Analysis Software, Battery not included.
Spider-20E One 24 bit output, 4 GB data flash, BNC connectors, Ethernet connection. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output enabled.	
S20E-P02	Two 24 bit inputs (Voltage, IEPE) enabled. *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S20E-P04	Four 24 bit inputs (Voltage, IEPE) enabled
S20E-P02B	Two inputs. Ethernet Connectivity. Basic FFT Analysis Software, Battery not included.
Spider-20H 256 kHz Sampling Rate: One 24 bit output, 4GB data flash, BNC connectors, built-in Wi-Fi connection. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output enabled.	
S20H-P02	Two 24 bit inputs (Voltage, IEPE) enabled. *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S20H-P04	Four 24 bit inputs (Voltage, IEPE) enabled
Spider-20HE 256 kHz Sampling Rate: One 24 bit output, 4 GB data flash, BNC connectors, Ethernet connection. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output enabled.	
S20HE-P02	Two 24 bit inputs (Voltage, IEPE) enabled. *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S20HE-P04	Four 24 bit inputs (Voltage, IEPE) enabled
Spider-20i 256 kHz Sampling Rate: One 24 bit output, 4 GB data flash, BNC connectors, Ethernet connection. Includes Basic FFT Analysis Software (DSA-10-C08), one output enabled (DSA-30). No battery.	
S20i-P02	Two 24 bit inputs (Voltage, IEPE) enabled. *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S20i-P04	Four 24 bit inputs (Voltage, IEPE) enabled
Spider-80X 256 kHz sampling, 4 GB data flash. BNC connectors. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output/tachometer channel.	
S80X-P04	Four 24 bit inputs (Voltage, IEPE). *Note: the product will be shipped with 8 input channels installed but with only 4 inputs enabled. The remaining four channels can be remotely enabled.*
S80X-P06	Six 24 bit inputs (Voltage, IEPE). *Note: the product will be shipped with 8 input channels installed but with only 6 inputs enabled. The remaining two channels can be remotely enabled.*
S80X-P08	Eight 24 bit inputs (Voltage, IEPE)
Spider-80XC 256 kHz sampling, 4 GB data flash. BNC connectors. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output/tachometer channel.	
S80XC-P04	Four 24 bit inputs (Voltage, IEPE). *Note: the product will be shipped with 8 input channels installed but with only 4 inputs enabled. The remaining four channels can be remotely enabled.*

S80XC-P06	Six 24 bit inputs (Voltage, IEPE). *Note: the product will be shipped with 8 input channels installed but with only 6 inputs enabled. The remaining two channels can be remotely enabled.*
S80XC-P08	Eight 24 bit inputs (Voltage, IEPE)
Spider-80Xi	
S80Xi-P08	Eight 24 bit inputs (Voltage, IEPE), 102.4 kHz sampling. 4 GB data flash, BNC connectors. Includes Dynamic Signal Analysis (DSA) Software (DSA-10-C08), one output/tachometer channel. Order it with S80Xi-A35-5N or S80Xi-A35-8N.
Spider-80Hi	
S80Hi-P08	Eight 24 bit inputs (Voltage, IEPE), 256 kHz sampling rate. 4 GB data flash, BNC connectors. Order it with S80Xi-A35-5N or S80Xi-A35-8N. Includes FFT Analysis Software (DSA-10), one output/tachometer channel.
Spider-80Ci	
S80Ci-P08	Eight 24 bit inputs (Voltage, IEPE, Charge), 256 kHz sampling rate. 4 GB data flash, BNC connectors. Order it with S80Xi-A35-5N or S80Xi-A35-8N. Includes FFT Analysis Software (DSA-10), one output/tachometer channel.
Spider-80SG	
S80SG-P08	Eight 24 bit strain Inputs, 102.4 kHz sampling, 4 GB data flash, LEMO connectors for strain inputs. Includes 8 LEMO to Breakout boxes (S80SG-A08). Includes Time Data Acqusition (TDA-10) software module.
Spider-80SGi	
S80SGi-P08	Eight general purpose measurement inputs (Strain, Voltage, IEPE), 102.4 kHz sampling, 4 GB data flash, LEMO connectors for strain inputs. Includes 4 LEMO to Breakout boxes (S80SGi-A08). Includes Time Data Acqusition (TDA-10) software module.
Spider-16G	
S80SGi-P16	Sixteen strain measurement inputs, 20 kHz sampling, 4 GB data flash, D-SUB connectors for strain inputs. Includes two D-SUB break-out boxes (S16Gi-A08). Includes Time Data Acqusition (TDA-10) software module.
Spider-80Ti	
S80Ti-P16	16 Temperature measurements inputs with three wire RTD/K type thermocouples, three pins screwed terminal connectors. Includes Time Data Acqusition (TDA-10) software module. Required S80Xi or S80SGi front-end.
Spider-80M Eight 24 bit inputs (Voltage, IEPE), 102.4 kHz sampling, 4 GB data flash, BNC connectors.	
S80M-P08	Eight Inputs
S80M-P08_O2	Eight Inputs Two Outputs
S80M-P08_O3	Eight Inputs Three Outputs
S80M-P08_O4	Eight Inputs Four Outputs
S80M-P08_O6	Eight Inputs Six Outputs
S80M-P08_O8	Eight Inputs Eight Outputs
Spider-81 Two 24 bit outputs, BNC connectors, LCD display, Ethernet connection, and Black Box engine. Can be expanded to 64 channels with other Spider-81 or Spider-80X front-ends.	
S81-P04	Four 24 bit IEPE/Voltage/Charge inputs enabled. *Note: the product will be shipped with 8 input channels installed but with only 4 inputs enabled. The remaining four channels can be remotely enabled.*
S81-P06	Six 24 bit IEPE/Voltage/Charge inputs enabled. *Note: the product will be shipped with 8 input channels installed but with only 6 inputs enabled. The remaining four channels can be remotely enabled.*
S81-P08	Eight 24 bit IEPE/Voltage/Charge inputs enabled
Spider-81B One output, BNC connectors, Ethernet connection and Black Box Engine.	
S81B-P02	Two 24 bit IEPE/Voltage/Charge inputs enabled. *Note: the product will be shipped with 4 input channels installed but with only 2 inputs enabled. The remaining two channels can be remotely enabled.*
S81B-P04	Four 24 bit IEPE/Voltage/Charge inputs enabled
Spider-101i (Only operates with a Sentek Dynamics chamber.)	
S101i-P00	Spider-101i Temperature/Humidity Front-end, DIO Relay Board, Industrial touchscreen PC (UI), EDC software included (S101-EDC, S101-A25 or S101-A26)
S101-A25	Digital I/O and Relay Out Expansion board for Chambers (General)
S101-A26	Digital I/O and Relay Out Expansion board for Shanghai Electric Chambers
Additional Hardware	
Spider-HUB	10 Port Ethernet Switch. Supports IEEE 1588v2
Spider-NAS	High Speed Network Storage Device. Includes high capacity SATA Disk
Spider-Battery	External Battery Pack for Spider front-end
CA-08A	External Charge Amplifier

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