VIBRATION CONTROL SYSTEMS

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Spider-81 Premium Vibration Controller

Spider-81B Basic Vibration Controller

Vibration Control Systems
Hardware Platforms

Spider-81

The Spider-81 is the flagship model; all other Crystal Instruments controllers have evolved from it. This 4th generation hardware is highly modular, distributed and scalable. Each Spider-81 has 8 analog input and 4 analog output channels. Analog monitoring channels serve an attached oscilloscope. Eight digital I/O pairs are provided for custom applications. The Spider-81 features a bright front panel LCD that displays system status and test information. Real-time status such as control RMS or sweeping frequency is instantly viewed on the LCD.

The Spider-81 does not just use Ethernet for data communication, it employs IEEE 1588v2 time-synchronized Ethernet connectivity. This technology allows (100 meter!) remote input modules to be connected solely by Ethernet (no dedicated "sync" cable required), yet still provides sampling and triggering synchronized within the accuracy of 50 ns. The Spider-80X front-ends and the Spider-HUB industrial Ethernet switch may be used to 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 in a removable SATA cartridge. One Spider-NAS records streamed time waveforms and spectra from up to eight Spider front-ends at the speed of 102.4 kHz per channel. The rapid transfer rate allows continuous recording of all channels at a measurement front-end's highest sample rate.

Multiple Spider-81 front-ends and the Spider-80X front-ends can integrate to construct a higher channel system. The Spider-81B front-ends is not expandable by design.

Spider-81B Economical Vibration Controller

The Spider-81B front-end is a smaller, simplified system featuring 4 input channels and 1 output. This system provides everything needed to run Sine, Random or Shock tests measuring the control and up to 3 monitor signals. The Spider-81B has 4 pairs of DIO. This basic system actually provides a very comprehensive facility with the same control quality, safety assurance, measurement precision, expandability and human interface that distinguish all Crystal Instruments controllers. The Spider-81B is ideal for educational institutions and small R&D laboratories.

Shown here are the Spider-80XA35, the Spider-HUB, the Spider-NAS, and 9 Spider-80X front-ends

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***

Spider-80X

The Spider-80X, a compact package, is designed for application in three fields: dynamic data acquisition, vibration control, and machine monitoring. It features eight analog input channels and two channels that may be software selected as analog outputs for vibration control or tachometer inputs for the analysis of rotating machinery. A single Spider-80X front-end is a complete two-output controller with the same high quality patented dual ADC input technology as the Spider-81 series. The Spider-80X inputs provide absolute/differential and AC / DC / IEPE coupling choices; charge mode is an available option. The Spider-80X provides the same time sync Ethernet connectivity and 4 GB flash memory for data and program storage. Multiple Spider-80X front-ends may be linked together using the (eight-into-one) Spider-HUB module and storage can be increased to 250 GB by adding a Spider-NAS mass storage module.

Spider-80Xi

The Spider-80Xi is a compact version of Spider-80X with an extremely lightweight form factor. Featuring a 64 channel chassis weighing less than 10.5 kg, the Spider-80Xi can be carried in one hand and is optimal for field environment testing where portability is essential.

Like the Spider-80X, multiple chassis combine to create a system up to 512 channels, all sampled simultaneously. A dedicated massive storage hard disk (a solid state hard-drive with a capacity of 250GB) allows the time signals of all input channels to record at up to 102.4 kHz/channel. Accurate time synchronization results in excellent phase match in the frequency domain between all channels, either on the same Spider front-end or across different front-ends. Real time FFT, octave, order tracking or vibration control functions can be enabled. The modular boards of the Spider-80Xi are installed at the factory and are not onsite swappable.

The Spider-80Xi system consisting of the 64 channel chassis is powered by AC power, at 100 to 240 VAC. The Spider-80Xi system consisting of the 32 channel chassis is powered by the DC power, at 10V to 22V. The latter is also easily operable with an external battery pack. With the Spider-Battery, (developed by Crystal Instruments) a 32 channel Spider-80Xi system operates up to 4 hours without interruption.

Spider-100

The Spider-100 is specifically designed to perform all types of tests where the DUT is subjected to simultaneous vibration, temperature cycling, and variable humidity, including Highly Accelerated Stress Screening (HASS) and Highly Accelerated Life Testing (HALT). The Spider-100 controls temperature, humidity, and vibration harmoniously in a chamber and shaker system, which includes external heating/cooling and humidification/dehumidification systems. The communication between numerous devices is optimized by the Spider-100 in an integrated design to achieve high control accuracy. The Spider-100 provides eight input channels and two shaker drive outputs for linear shaker control. When a pneumatic hammer table is used, the controller commands the RMS vibration level via its 4-20 mA current-loop output to the table's pressure control valve. There is a total eight 4-20 mA analog out channels offered on the Spider-100. Additionally, the Spider-100 provides ten 4-20 mA analog input channels for humidity sensors and eight temperature input channels for 3-wire RTD or K-type thermocouples. Thirty relay control channels control the heaters, valves, and fans of the chamber. Thirty-two channels of programmable digital I/O are available for user-defined applications.

The Spider-100 Temperature, Humidity, & Vibration Controller

	Spider-81	Spider-81B	Spider-80X	Spider-80Xi
Number of Inputs	8 per front-end expandable to 512	2, 4 not-expandable	8 per front-end expandable to 512	8 per front-end expandable to 512
Number of Outputs	4	1	2	2
Input Mode	Charge TEDS IEPE Voltage	Charge TEDS IEPE Voltage	Charge (optional) TEDS IEPE Voltage	Charge (external) TEDS IEPE Voltage
Digital I/O	8 in/out, isolated	4 in/out, isolated	4 in/out, isolated	4 in/out, isolated
Front Panel LCD	Yes	No	No	No
High Speed Data Port	Yes	No	Yes	Yes
Analog Monitor Channels	Yes	No	No	No
Notes	Flagship product for VCS line. Input protection up to 250V. Equipped with Stop/ Start button	Economical solution	Target at all VCS, Modal and DSA application. Modular at box level.	Compact version of Spider-80X. Target at all VCS, Modal and DSA application. Modular at PCB board level.

8 Strain Gage Inputs

Output Channel

Power

Power Input

Ethernet

Reset Button

Master/Slave Switch

Data Port

RS-485

Digital I/O

The Spider-80SG Strain Gage Measurement System
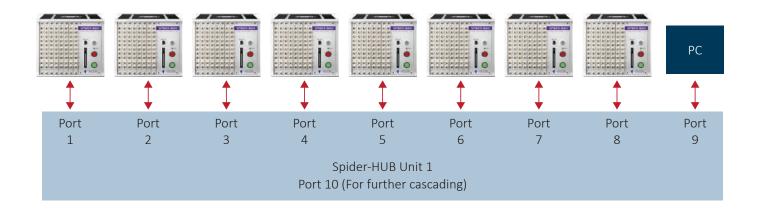

Strain Gage Measurement
The Spider-80SG Strain Gage Module

The Spider-80SG is a front-end in the Spider-80X family. It can be used for strain measurement and many other type of sensors that require external power. VCS software fully supports the Spider-80SG front-end in all its testing types.

Named for their networkable ability, the Spider series as well as the Spider-80SG share the flexibility of scaling up in channel count and functionality. Users can easily couple multiple Spider-80SG front-ends together or combine them with the Spider-80X dynamic signal analyzer or the Spider-81 vibration controller.

■ Support for full-bridge, half-bridge and quarter-bridge

■ Fully integrated, simultaneous strain measurement with any VCS and DSA tests.

■ High channel count supports up to 512 input channels

■ Customizable excitation within the range of -10V to 10V

■ 24-bit ADCs with sampling rate up to 102.4 kHz

■ High precision 7-pin Lemo input channels

■ Input channel adapter to eliminate the need for soldering

■ User-friendly shunt calibration and offset-nulling

■ Customize configuration and set-up independently for each input channel

■ Remote sensing function for distant measurement

■ Expandable units to increase portability

Spider-80Xi System (512 Channel Count)

| Port 1 | Port 2 | Port 3 | Port 4 | Port 5 | Port 6 | Port 7 | Port 8 | Port 9 |

Spider-HUB Unit 1
Port 10 (For further cascading)

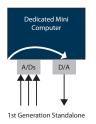*Spider-HUB Industrial Ethernet Switch*

Spider-NAS Storage Device
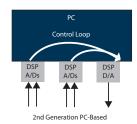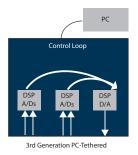
High Channel Count Solution
Using Spider Front-Ends

By using superior Ethernet and time synchronization technology developed by Crystal Instruments, the Spider system can be extended to support up to 512 input channels. When the system is running with multiple module with hundreds of input channels, all data acquired are simultaneous and accurately phase matched. The phase match accuracy can be less than 1 degree within the normal testing frequency range. By have such high phase match, the frequency response function of cross channel measurement can be used for analyzing the characteristics of UUT (unit under test) such as modal shape and damping ratio.
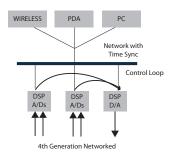
In a Swept Sine test that runs hundreds of input channels, the tracking filter and notching can be applied to any of input channels. In a Random control, monitoring channel, limiting, Sine-On-Random can all be applied to all input channels simultaneously. In TTH or Shock, all data capture among all channels will be acquired simultaneously. CI's Spider system is the only product in the world that fully integrates the DSA and VCS functions that can run up to 512 channels.

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 of Spider front-end or, 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 102.4 kHz, or as low as a few samples per second.
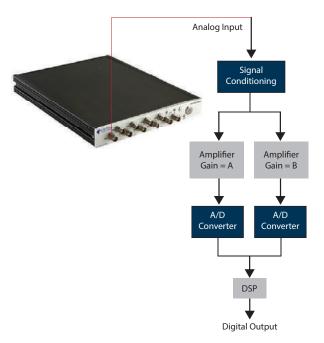
1st Generation Standalone

2nd Generation PC-Based

3rd Generation PC-Tethered

4th Generation Networked

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.

Vibration Control Systems
Unique Features

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 102.4 kHz provides excellent time resolution while spectra with up to 12,800 lines may be controlled. Data is stored into 4 GB of internal lash memory. Increased storage space is possible with the addition of a 250 GB external unit.
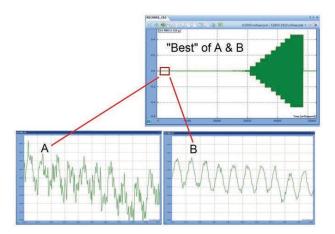
Shaker Compatibility
Spider controllers work with any electrodynamic, servo-hydraulic, or servo-electric shaker with all ranges of force ratings, from tiny desktop to multi-ton water cooled systems. Frequency range can be from sub 1Hz to 40kHz.

High Precision Front-End Design
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 (ICP™) 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.

It is unnecessary to adjust the input sensitivity of any channel; these are fixed at ±20 volts. Each channel provides an unprecedented dynamic range of 150 dBFS, detecting voltages as small as 600 nV. This is accomplished by applying two 24-bit analog-to-digital converters to each channel and combining their outputs in accordance with our United States Patent number 7,302,354.

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

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 or in response to a connected iPad.
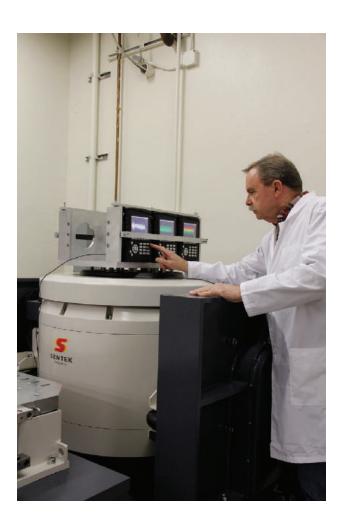
On-Board LCD Display

The Spider-81 is equipped with a bright front-panel LCD and intuitive information navigation controls. Real-time status such as control RMS or sweeping frequency is instantly viewed on the LCD.

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.

Designed for High Accuracy

Using our patented parallel dual analog-to-digital converter (ADC) design, each measurement channel can detect signals as small as 600 nV and as large as 20 V. This design completely eliminates the need for the input range or gain settings found on traditional controllers. Crystal Instruments engineers have also raised many related hardware specifications to establish new industry performance standards. These include total harmonic distortion (THD), cross-channel phase match, frequency flatness, linearity, cross-talk and frequency accuracy

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.

Complete Software Solutions
The Spiders have complete software solutions available for vibration control, including Sine, RSTD, Oscillator, Random, SoR, RoR, SRoR, Classical Shock, Transient, Seismic, Shock Response Spectrum analysis and SRS Synthesis, Time Waveform Replication, HALT/HASS and multi-drive control. They cover testing to virtually all current environmental test standards. Customizable report templates allow the user to generate reports in XML, OpenOffice, PDF or MS-Word with one click. With the Application Programming Interface, Crystal Instruments' controller can be directly accessed from LabView, Matlab or other customized software. The Spiders can operate from Linux and iOS in addition to Windows.

Integrated Control and Dynamic Signal Analysis
With appropriate software, the same Spider-80X hardware used for vibration control can also be used for dynamic signal analysis including machine monitoring, order tracking, modal analysis, and acoustic analysis. Multiple Spider front-ends can work together to form one integrated system. Long waveform data recording is a built-in function. An optional hardware front-end (Spider-80SG) integrates monitoring of strain gages and thermocouples.

Designed for High Scalability and Expandability
With the Spider architecture, it is possible to make the hardware system ultimately 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.

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

Vibration Control Systems
Software Solutions

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 same software suites support from as few as two inputs up to 512 input channels with multiple drive output capability. Software solutions for vibration control include Sine, Resonance Search Track & Dwell (RSTD), Oscillator, Random, Sine-on-Ransom (SoR), Random-on-Random (RoR), Swept Random-on-Random (SRoR), Classical Shock, Transient, Seismic, Shock Response Spectrum (SRS) Synthesis, Time Waveform Replication, Highly Accelerated Life-Testing/Stress-Screening (HALT/HASS) and multi-drive control. These suites facilitate testing to virtually all current environmental test standards. Customizable report templates allow the user to generate reports in XML, OpenOffice, PDF or Microsoft Word with a single click. With the Application Programming Interface (API), Crystal Instruments' controller can be directly accessed from LabView, Matlab or other customized software. Spider front-ends run on Linux, iOS, and Windows operating systems. The VCS software 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 more.

Common User Interface

Our Engineering Data Management (EDM) software comes with each system. EDM provides a common user interface for both VCS and Dynamic Signal Analysis (DSA) applications. A single interface with the same look and feel means that test specifications can be transferred from engineering to production without change or error and test data can be compared directly between one system and another. EDM provides a consistent user interface regardless of the application and independent of the number of hardware channels.
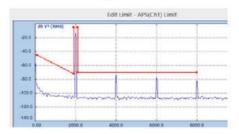
Multi-Language Support

We work in a multi-lingual world. Crystal Instruments' EDM fully supports operations using English, Japanese, Simplified Chinese, Traditional Chinese or Russian (others on request) user interfaces. The selected language can be changed at any time with one mouse click.

Versatile Report Functions

The advanced report function allows users to create a report in several formats including OpenOffice, XML, Microsoft Word, ActiveX and PDF. The report is template-based. Users can customize the logo, margins, orientation of the paper, font, and the content. Microsoft Word/Office is not required to be installed to create reports. In the Review Mode, batch report can generate reports for the signals saved in multiple runs. With ActiveX reporting, signal displays in the report can be rescaled, analyzed, and zoomed.

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

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.

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 utilizes 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.
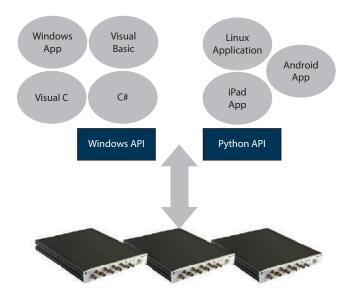
Multi-Tasking
With DSP centralized hardware architecture, the real-time measurement and control processes are all run on the front-end hardware; users can utilize all of the capabilities of the host computer for other tasks. This multi-tasking concept guarantees powerful and time efficient vibration 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.
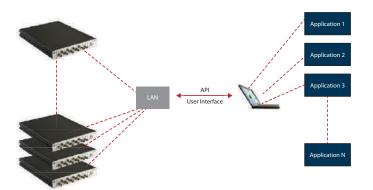
Test Sequence
A Test Sequence provides the capability to automatically execute a sequence of tests. The user can Run, Pause or Stop the testing at any time and the software keeps a detailed log of the actions and results.

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, send a digital output signal to the climate chamber or stopping the test.

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. You can also automatically control the power amplifier - shut it down at a test's end and switch it on when a new vibration test is to be started. When the system is left running but unattended (e. g. for an overnight or weekend run), you still remain in control. 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 SATA hard-disk. 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 latest database technology, EDM can quickly search, index and organize the testing setup and data. On the company network different testing stations can share the same database.

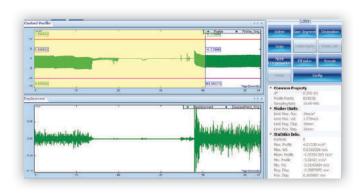## Application Programming Interface (API)

Crystal Instruments' Spider Application Programming Interface (API) is a collection of Windows Dynamic-Linked Libraries (DLL) or Python API providing an easy path for external applications to access and control the Spider-80X hardware.

If Windows OS is used, the user can develop their own applications in Windows App, VC, VB or C# languages. If Linux, iOS or Android is used, a Python API serves as the control interface.
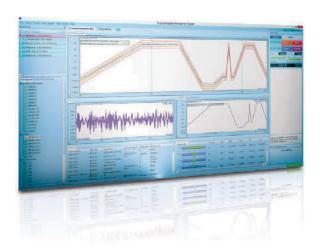
The Spider API defines a set of command structures based on character strings. This implementation is widely compatible with various connection tools such as APIs, scripts, socket messages and handheld devices, facilitating future technical support.

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 actually started.

Instant Color and Style Change of UI
EDM provides a wide selection range of colors and styles for text, signals and backgrounds.

Complex FRF/Transmissibility
EDM software has a very flexible setup to measure the matrix of complex motion/force FRF (or g/g transmissibility's) which are critical for modal analysis,

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
Communicate with and control Spider systems remotely with Window socket messages. Socket messages also allow communication with other hardware, such as temperature chambers. Please refer to document for Socket Message for detail specs. The ability to send emails or instant messages as custom actions in response to a system or user event. Content of emails can be customized.
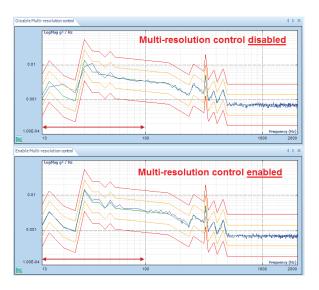
Shaker Parameters
Shaker limits are calculated from the shaker parameters and the weight of the Unit Under Test (UUT). Shaker Parameters include maximum amplifier input voltage, shaker acceleration, velocity, displacement, force, drive frequency, and mass of UUT. Shaker library settings are saved to a library and used repeatedly in different tests. Shaker parameters are imported from or exported to a Microsoft Excel spreadsheet.

Random control dynamic range of up to 90dB
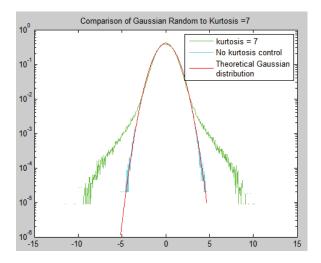
Random Vibration Control

Random Vibration Control provides precise multi-channel control in real time. The device under test is subjected to true random noise with a precisely shaped spectrum with either Gaussian or non-Gaussian amplitude statistics. With a control dynamic range up to 90 dB, up to 512 channels can be enabled for Control, Notching, Monitoring and time data recording. The recording option records time-stream data at the full sample rate on all input channels. A unique hardware/firmware/software design featuring spectral overlapping provides a fast loop time of less than 15 ms in a typical test.

Compare control(f) with Multi-resolution control disabled and enabled. (profile range: 13~2000Hz)

Multi-Resolution Control

The Multi-Resolution function applies the selected resolution in the high-frequency range and 8 times of the resolution in the low-frequency range. It perfectly fulfils the requirements of many Random profiles having details in the low frequency range and up to 2 kHz. Adequate loop time, spectrum refresh rate, and storage are maintained without using high resolution (large block size) that is not needed in the high frequency.
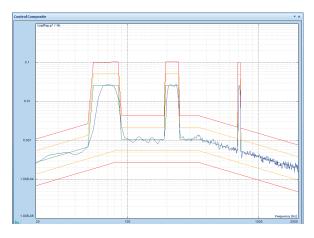

Kurtosis Control & Drive Clipping

Kurtosis control can provide a more damaging non-Gaussian random control time history. A unique patent pending technology can generate a non-Gaussian control time history while precisely maintaining its spectrum shape. Drive clipping clamps the drive signal to maximize the power rating of the power amplifier.
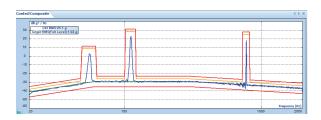
Non-linear Control

Non-linear control provides improved performance at frequencies near sharp resonances by using a unique error correction algorithm.
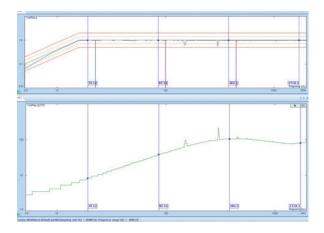
Up to 32 independent random narrow band signals

Random on Random Control

Up to 32 independent (stationary or sweeping) random narrow-band signals may be superimposed on the broadband random signal. Each narrow-band has its own sweeping schedule and range. They can be turned on and off by a predefined schedule or manually.
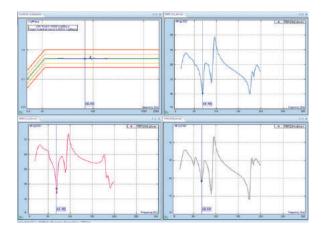

Sine on Random Control

Up to 32 independently sweeping sine tones may be controlled in addition to the broadband random signal. Each sine tone has its own sweeping schedule and range. Tones can be turned on and off manually or by a predefined schedule.

Multi-Sine Control

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

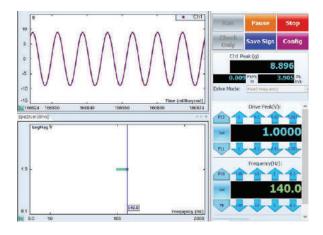*Sine: Provides precise multi-channel control in real time.*

Swept Sine Control

Swept Sine Vibration Control provides precise multi-channel control in real time. It provides a spectrally pure undistorted sine wave and a control dynamic range of up to 100 dB. As many as 512 channels can be enabled for Control, Notching, Monitoring and time-data recording. The recording option records a time-stream at the full sample rate on all input channels. A unique hardware design and spectral overlapping provides a fast loop time of less than 10 ms.

A random signal can be applied during pretest for checking the loop. Precise tracking filters are often applied to each channel with either fixed or proportional bandwidth. Spectral display resolution is from 256 to 4096 lines. Linear and logarithmic Sweep-speeds can be defined in Oct/Min, Hz/Sec, Dec/Min, Sweeps/Min, Sweep Time/Sweep or Cycles/Min. Non-acceleration control allows measuring and controlling on velocity or displacement sensors in lieu of acceleration. Multi-Drive control can drive more than one shaker. FRF measurement allows measuring the transmissibility between any channel-pair with high phase match. The standard frequency range is up to 4,900 Hz (up to 46 kHz optional). Notching, Alarm or Abort criteria can be set on each channel.
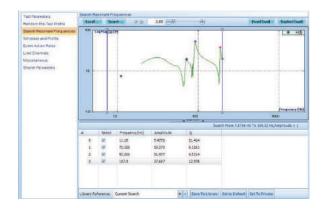
Step Sine Control

Step Sine uses a sequence of short dwells within a frequency range. The steps are uniformly distributed in a log or linear frequency scale. Step Sine Entry in Run Schedule includes user defined frequency range, step resolution and dwell duration (or cycles) at each frequency.
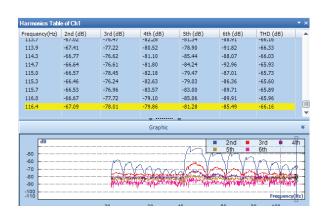

Sine Oscillator

Sine Oscillator is a diagnosis tool with 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 more manual control functions.
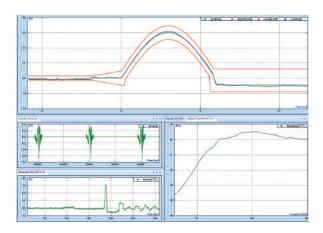
Resonance Search and Tracked Dwell (RSTD) Control

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. Under real-time control, the tracked dwell entry tracks each resonant frequency as it shifts with time, temperature or damage. Phase Tracked Dwell allows tracking the resonance frequency by seeking both a peak transmissibility and a specified phase angle. Dwelling continues until time duration is reached or the resonance frequency changes outside of specified limits.
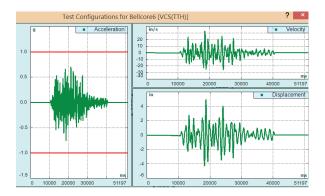

Total Harmonic Distortion (THD) Measurement for Sine

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.

Classical Shock Control

Classical Shock Control provides precise, real-time, multi-channel control and analysis of transient time domain motion. Classical pulse shapes include half-sine, haversine, terminal-peak sawtooth, initial-peak saw tooth, triangle, rectangle, and trapezoid. The recording option records time stream data at the full sample rate on all input channels. Shock response spectrum (SRS) analysis can be applied to any input signal; optionally control of the DUT's SRS may be executed. Applicable Test Standards include MIL-STD-810F, MIL-STD-202F, ISO 9568 and IEC 60068 (plus user-defined specifications).
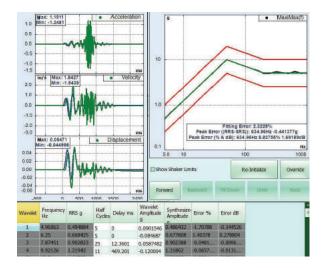
Controls shaker motion to match a defined transient waveform

Transient Time History Control (TTH)

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, low-pass filtering and compensation will tailor the waveform so that it may be duplicated on a particular shaker. Compensation varies the waveform so that it does not exceed the maximum shaker displacement. Methods include pre-pulse, post-pulse, pre & post-pulse, DC removal and high-pass filters. Pre-stored profiles include Bellcore Z1, Z2, Z3 and Z4; Sine; Chirp; Burst Sine and others. An option is available to run profiles requiring sampling frequency lower than 120 Hz. Large block sizes up to 64,000 samples are provided.

Shock Response Spectrum analysis can be applied to any input time signals to generate SRS instantaneously. SRS Type includes maxi-max, primary, residual and composite. A low frequency option supports imported profiles with a sampling rate lower than a few Hz.

Shock Response Spectrum (SRS) Synthesis & Control

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. The Transient Control option allows control using imported transient files. High frequency waveforms, Alarm and Abort tolerances may be applied to any active channel to provide an extra degree of safety for delicate test articles.
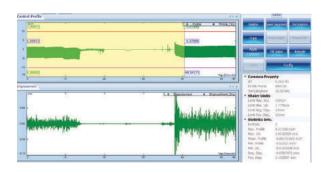
Provides precise, real-time, multi-channel control for long waveform duplication

Time Waveform Replication

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

Multiple waveform recordings can be available in the same test to automatically run, one after the other on the test specimen. The maximum number of points is subject to the internal flash memory space available for storing profile data (currently 3.7 GB), which corresponds to approximately 1 billion data points. At a sampling rate of 200 samples/second it can replicate a waveform of about 50 days.
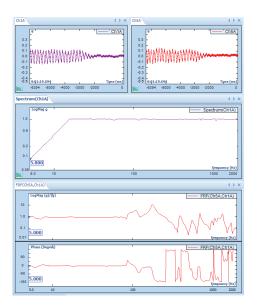

Waveform Editing for TTH and TWR

This convenient tool provides the editing functions for any type of waveform so they can be accurately duplicated on the shaker systems. First, the user will import the data files into the Waveform Editor. The Editor can import UFF, ASCII UFF Binary, CI-ODS and other twenty types of data files. Waveforms with any sampling rates shall be digitally re-sampled, rescaled, filtered, and different compensation techniques are applied to edit the profile. It also has the options for cropping, appending and inserting parts of waveforms.

Non-acceleration Control

With this option, a non-acceleration measurement quantity can be applied to the target profile and the control signal. This provides an option of choosing from multiple quantities including force, sound pressure, and voltage to be controlled when appropriate sensors are used. Angular acceleration can be controlled in sine and random tests using the appropriate selection. The controller is also capable of using mixed displacement, velocity and acceleration sensors to synthesize a control signal in the acceleration domain.

Real-time Sine Reduction

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 using 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

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, …). In addition, databases can be transferred between SQL server instances. The transfer and receive process can also be seen as a backup and recovery process. The step by step wizard guides through the whole process and make it easy to use.

Sensor Calibration

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.
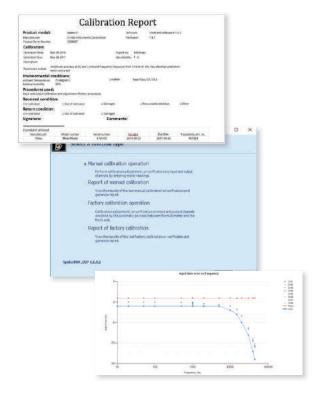
Versatile Report Functions

In the EDM software, the report function allows users to create a report in several formats including OpenOffice, XML, Microsoft Word, ActiveX and PDF. The report is template-based and completely customizable.

Users can customize the logo, margins, orientation of the paper, font, and the content. Microsoft Word/Office does not need to be installed in order to create reports. In Review Mode, batch reports can be made for the signals saved in multiple runs. Using ActiveX reporting, signal displays in the report can be rescaled, analyzed, and zoomed.
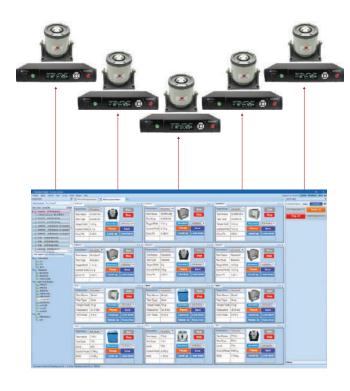
- User can select from various templates for creating reports
- Plot reports can be generated by simply right-clicking the mouse
- Company logos can be inserted into the template header or footer
- Reports can be in WORD, XML or PDF format
- "Active Report" allows the user to ZOOM in and out like a graph on the report
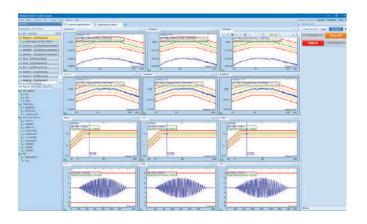- Generate typical hardware calibration reports

Front-End Calibration Tool (FECT)

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 includes manual calibration and factory calibration functions. The manual calibration provides basic adjustment and is operatable by either the user or a calibration specialist. The factory calibration provides as found and as left data measured at different frequencies and the report includes more comprehensive information about the calibration. The factory calibration requires designated meter model and should be performed by a calibration specialist.

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

Multi-Shaker Control from One Application

The multi-shaker control function is specifically designed for production applications, where the operator wants to observe and command multiple shaker tests from one PC station. The operator can manage the entire testing configuration from one EDM instance at their workstation – this includes observing the testing status, viewing individual signals from different shaker systems, and sending commands to each controller. Spider systems are not limited by bandwidth in their number of controllers – the ethernet connectivity of Spider systems allows for any number of connections. For practical reasons we limit the number of controllers that EDM can access to 12.

Customizable Status Display
The status display for each individual shaker controller can be customized. For example, you can display the Peak value for a Sine controller and the RMS value for the Random. These can be displayed on one screen.

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.

Run Different Type of Tests
Different types of tests can be mixed and loaded into this application together. Random, Sine, TTH or Shock can run in the same test duration.
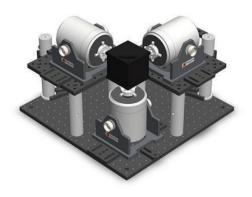
Common Commands
Several common commands have been implemented – these commands can be applied to all controllers at once. All the tests can be started or stopped by pressing one button.

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.

$$
\begin{Bmatrix} c_1(f) \\ c_2(f) \\ c_3(f) \\ c_4(f) \end{Bmatrix} = \begin{bmatrix} h_{11}(f) & h_{12}(f) & h_{13}(f) & h_{14}(f) \\ h_{21}(f) & h_{22}(f) & h_{23}(f) & h_{24}(f) \\ h_{31}(f) & h_{32}(f) & h_{33}(f) & h_{34}(f) \\ h_{41}(f) & h_{42}(f) & h_{43}(f) & h_{44}(f) \end{bmatrix} \begin{Bmatrix} d_1(f) \\ d_2(f) \\ d_3(f) \\ d_4(f) \end{Bmatrix}
$$

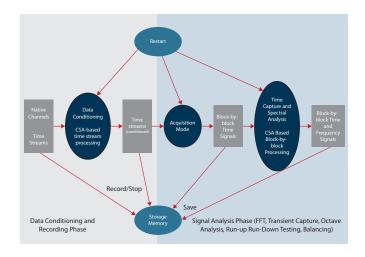## Multi-Input and Multi-Output (MIMO) Control

Spider system recreates multiple degree of freedom environments in the laboratory. Applications include the dual shaker setup to either push-and-pull or simultaneous excitation in the same direction, or a complex system shaking a large structure in 3 axes simultaneously, or those driving a very heavy structure in one axis while sharing the load over many shakers.
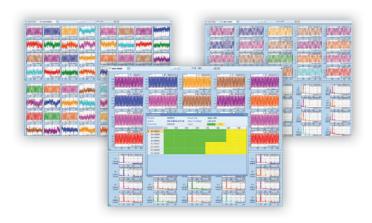
In a Random test, MIMO produces true Random with one control per actuator or averaged control points per actuator. The same quality of control offered by MISO Random is inherent to MIMO Random control. Adaptive control guarantees rapid equalization and accurate control in the face of non-linear response. It also reduces the time required to achieve full level testing, which reduces the exposure to low level energy for the test article.

MIMO Sine, like MIMO Random, can control phase between actuators and between axes.

By maintaining a multi-dimensional impedance matrix, Spider system is always capable of determining the contribution from each shaker to the overall response and properly differentiating for each actuator so that proper, accurate, safe control is assured. The complex issue of singularities is addressed with an elegant solution that permits intricate tests to be performed without having to resort to test segmentation in an attempt to avoid the singularity.

For detail availability of MIMO control product line, please contact CI sales office.

Data Conditioning and Recording Phase

Signal Analysis Phase (FFT, Transient Capture, Octave Analysis, Run-up Run-Down Testing, Balancing)

Dynamic Signal Analysis and Post Processing Functions

EDM DSA, a comprehensive the dynamic signal analysis function, and EDM PA, the Post Analyzer, can be included in any of purchasing of VCS software. Real-time DSA functions include basic FFT, frequency response function, coherence, phase, transient capture, octave filter, user-defined digital filter, sound level meter, order analysis, automated alarm limit in both time and frequency domain, and throughput recording. Various time and frequency signals can be played back or post-processed.

Crystal Instruments offers EDM Post Analyzer software, a powerful adjunct to your real-time analysis EDM-DSA, allowing users to analyze Time Stream recordings made with a Spider system. The beauty of this approach is that it lets you analyze and re-analyze digitally recorded data after the recording event.

For details of EDM DSA and EDM PA, please refer to their respective brochures.

Premier Technology Support 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 "Premier 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 QMS 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 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.

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.

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