CRYSTAL INSTRUMENTS

ELECTRIC BATTERY TESTING SYSTEMS

WWW.CRYSTALINSTRUMENTS.COM

Measure & Record Data

Pack CAN Data

Time Series Data

Dynamic Measurements

Cycling Data Logging (voltage, current, battery, etc.)

Vibration Testing Options

Random, Sine, Shock

EDM Cloud (Test Status & Reports)

Combined Environmental Testing

CRYSTAL INSTRUMENTS

USB CAN adapter

PWR CAN1 CAN2
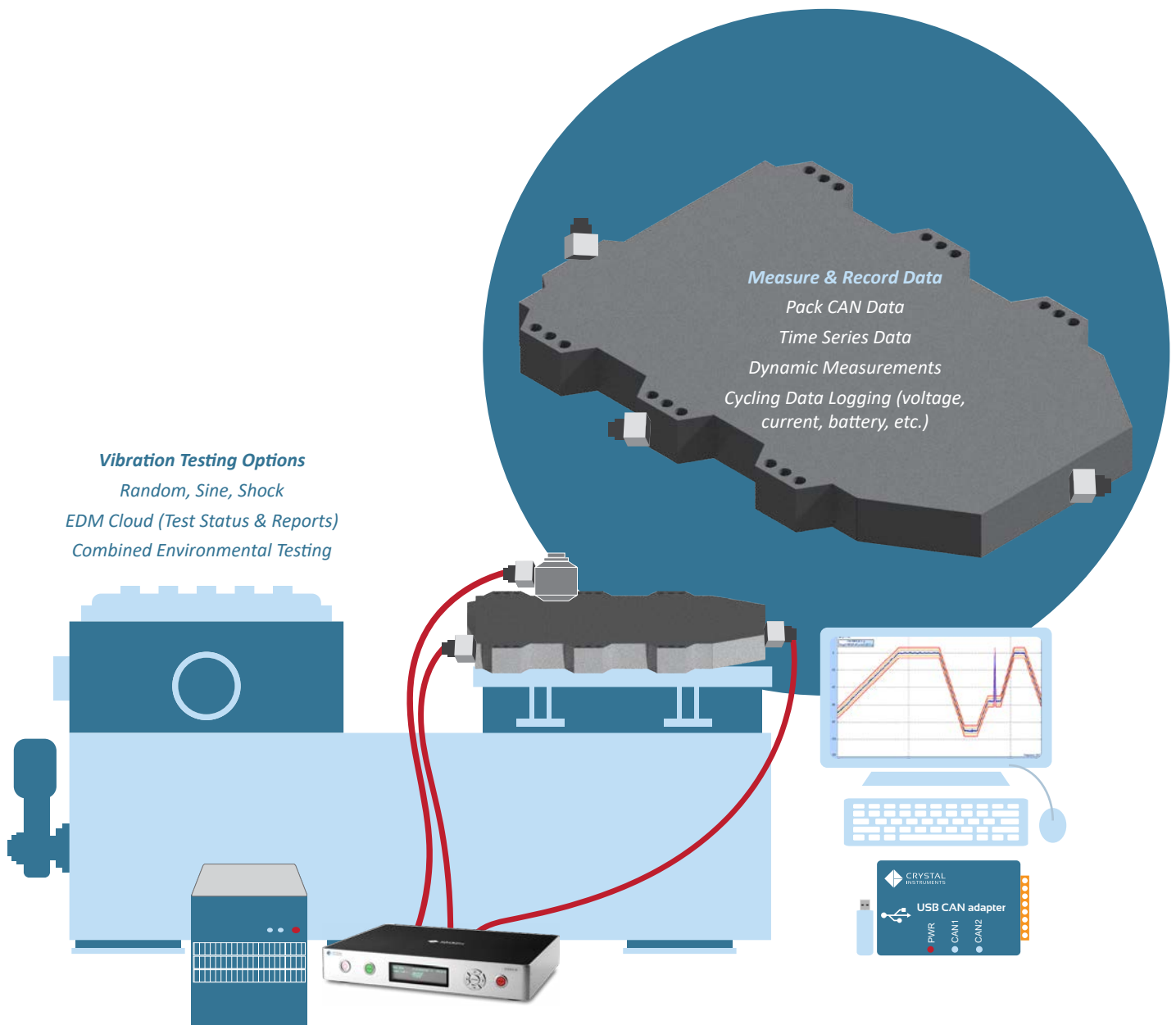
Electric Battery Testing Solutions

Vibration 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.

Combined environmental testing of electric batteries includes electrical, vibration temperature, and humidity tests. Performing these tests simultaneously will better simulate the typical operating conditions experienced by electric vehicles to ensure driver safety.

Spider data acquisition during testing allows users to simultaneously sample up to 512 channels. A massive dedicated storage hard disk (250 GB solid-state drive) records all input channel time signals at up to 256 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. (Option available to expand storage to 2 TB.)

CAN bus Support (automatic abort or notification for status safety)
EDM monitors 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 pre-determined by the tester.
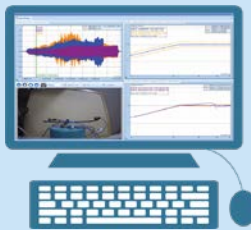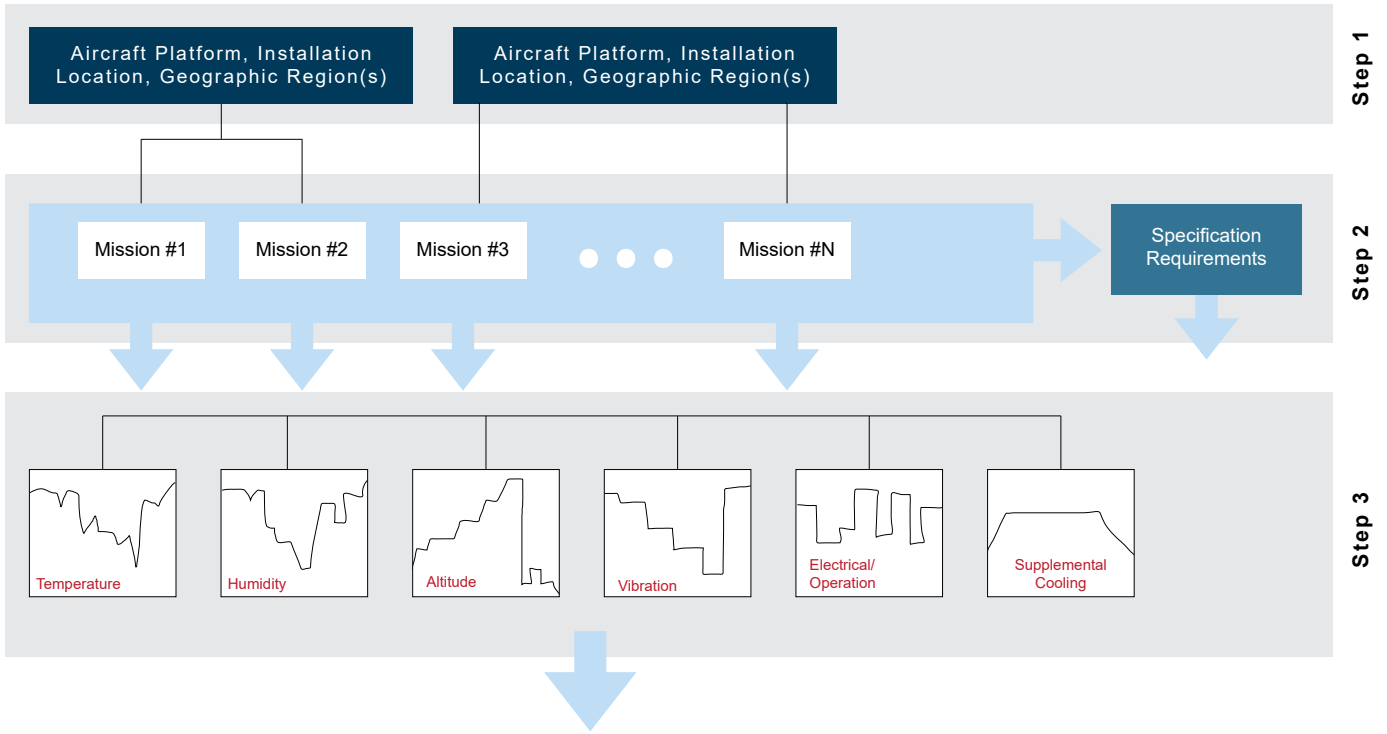
Integration of External Devices
- EDM Camera/Video monitoring
- MQTT Support
- Espec Chamber Control Interface
- UMS 1200 Chamber Control Interface
- Charge Cabinet Control Interface
- Waterchiller Control Interface
- Fluke 2638A and LR8400 DAQ System Start/Stop
- Low voltage source, high voltage source control interface

EDM Cloud Online Status Monitoring allows users to monitor the status of environmental tests across multiple Spider controllers. Users can access EDM Cloud through a tablet or mobile device. EDM Cloud can also be deployed on local servers within an organization's network.

Step 1

| Aircraft Platform, Installation Location, Geographic Region(s) | Aircraft Platform, Installation Location, Geographic Region(s) |

Step 2

Mission #1   Mission #2   Mission #3   • • •   Mission #N   →   Specification Requirements

Step 3

| Temperature | Humidity | Altitude | Vibration | Electrical/ Operation | Supplemental Cooling |

Battery Standard Testing
Test according to MIL-STD, SAE, UL, ISO, & more.

Contact the Crystal Instruments team to set up testing projects. Dedicated application engineers are available to assist projects from 6:00 AM to 6:00 PM Pacific time.

| Standards for Battery Testing of Electric Vehicles	
MIL-STD-810H	Released with Method 520.5 added to cover the testing of components in combined environments.
SAE J2380	Durability testing of single batteries
SAE J24964	Electric Vehicle Battery Abuse Testing
ISO-12405-1	Lithium-ion Battery Packs and Systems
UL 2054	Testing and Certification for Battery Packs
UL 2202	Standard for Safety Electric Vehicle (EV) Charging System Equipment
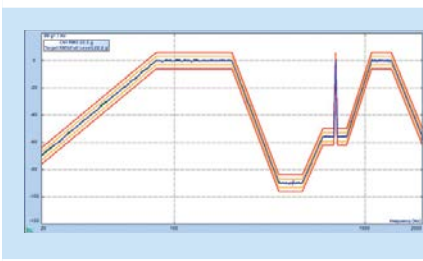
Random Vibration Control

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.
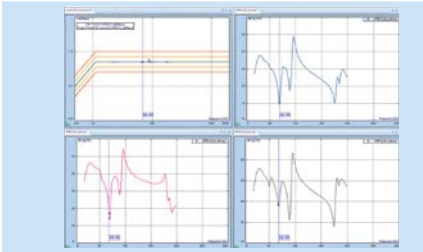
Swept Sine Control

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.
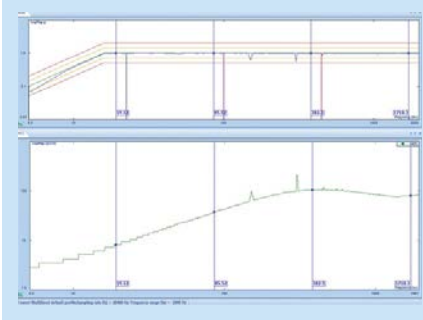
Multi-Sine Control

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.
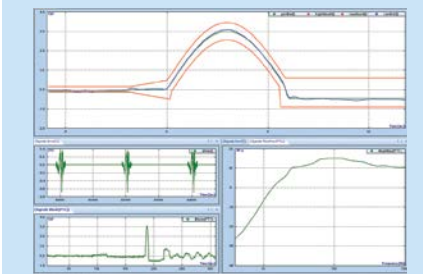
Classical Shock Control

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)
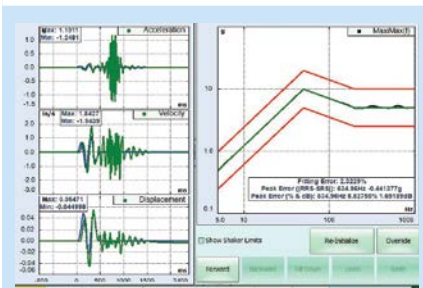
### Shock Response Spectrum (SRS) Synthesis & Control

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.
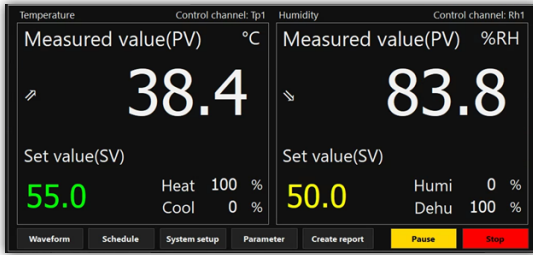
Test status page of EDC on a wireless, touchscreen terminal
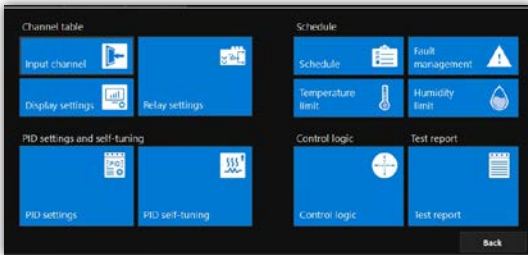
Parameter page of EDC on a wireless, touchscreen terminal

Temperature & humidity signals display

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 CAN bus should be monitored and controlled by one system.

PTP time synchronization technology and Ethernet connectivity to the LAN allows all Spider hardware to 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, it 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 user interface for setting up run schedules for temperature, humidity, vibration, etc.

Fully networked allowing users to connect multiple hardware devices through Ethernet which allows one PC to control all devices at the same time.

Extract battery information through **CAN bus** and take various actions including emergency shutdown.*
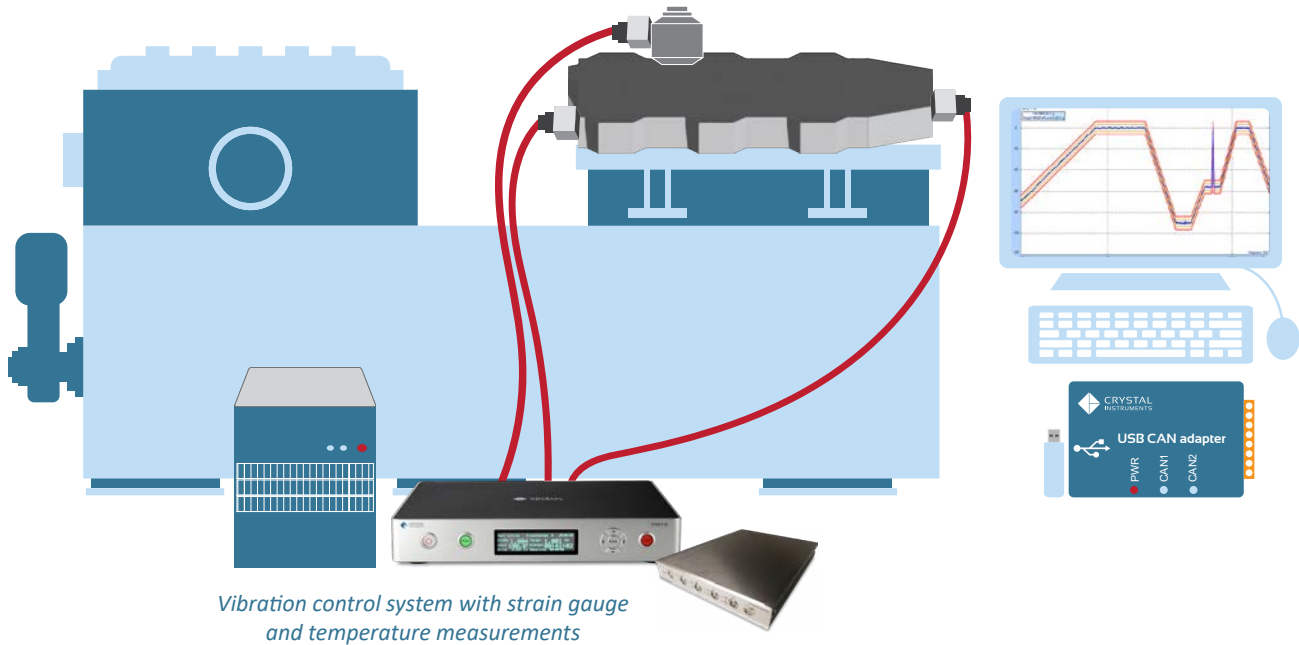
Access and control with one software application.

Data acquisition is accurately time-synchronized.

One combined test report – *If test reports are generated separately from several apps, the time clock and schedules will not be coordinated, unlike the integrated test report generated by EDM THV Software.*

Vibration control system with strain gauge and temperature measurements

Spider Data Acquisition

Can bus data

Peak CAN data

Time data

Dynamic measurements (APS, FRF, frequency domain data, etc.)

Cycling data logging (voltage, current, battery, etc.)

Combine a Spider vibration controller with a Spider-80SG unit to 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.

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 to perform data acquisition during vibration tests. A dedicated massive storage hard disk (a 250 GB solid-state drive) allows the time signals of all input channels to record at up to 256 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.
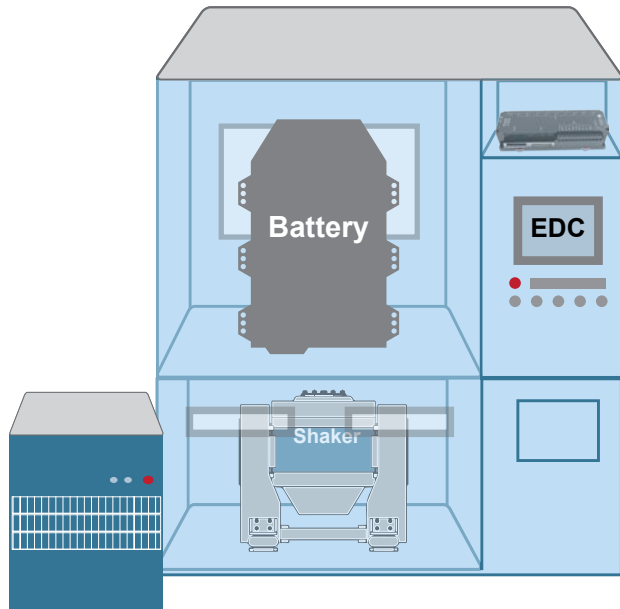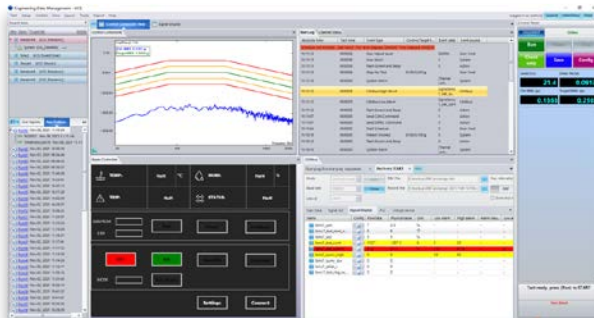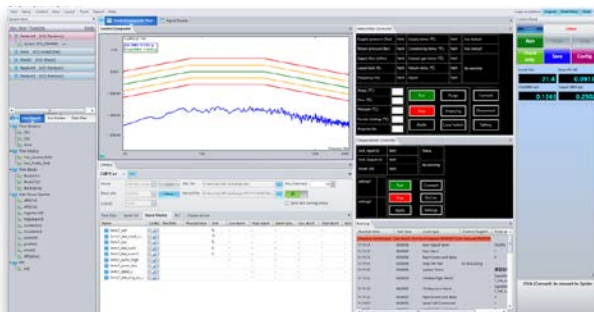
Spider-101i Temperature and Humidity Control
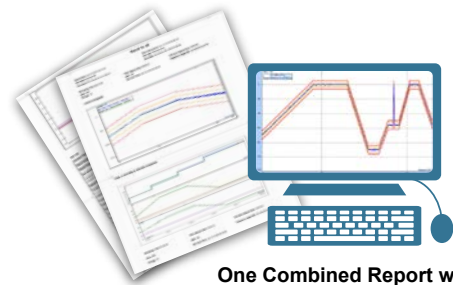
One Combined Report with CAN bus data

Vibration Control System

CAN bus alarm and abort rules can be configured during a vibration test with a customer's DBC file and a custom-built Crystal Instruments USB CAN adapter. For example, a user running vibration tests on an EV battery can configure EDM to monitor the battery's temperature and stop or pause the test in response to the temperature matching or exceeding a particular value.

EDM supports the custom-built Crystal Instruments USB CAN adapter as well as the PCAN-USB adapter developed by Peak Systems.

While performing vibration or THV (temperature/humidity/vibration) tests on a battery pack, the accelerometers, temperature, and humidity sensors can measure the external environment of the battery pack. The Battery Management System (BMS) monitors the internal battery pack status and communicates with external components using CAN bus. The integrated CAN bus support allows EDM to monitor the internal and external status of a battery pack and take actions according to pre-defined conditions. Supports multiple CAN Bus channels and records data simultaneously to a solid-state drive. Expand data storage to 2 TB with the addition of a Spider-NAS.

EDM Video Monitoring

Closely monitor the UUT status.

Share videos during an online meeting.

Align video images with recorded signals.

MQTT Client/Broker Support

The most popular standard for IoT applications.

Supports both MQTT and MQTT sparkplug.

Provides both broker and server roles.

MQTT client may connect to a MQTT server on the Internet.

Espec Chamber Control Interface

On/Off, set temperatures/humidity, show temperatures/humidity

UMS 1200 Chamber Control Interface

On/Off, set temperatures/humidity, show temperatures/humidity

Charge Cabinet Control Interface
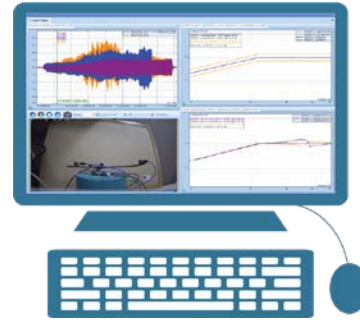
Show charge cabinet status

Charge or discharge

Waterchiller Control Interface
Show status of water chiller
Set temperature

Acquire data with Fluke 2638A and LR8400 DAQ system

Low voltage source, high voltage source control interface: on/off, set voltage

EDM Extensions integrates third party products to work with EDM software and Spider hardware to display and save collected data related to each other to provide a complete picture of the testing environment.

Video Capture is a new EDM Extension that works with IP cameras for vibration test monitoring and data acquisition. This feature provides real-time video monitoring and video or photo recording of the test process or any object of interest along with data acquisition. Dome or box type IP cameras using the ONVIF protocol are supported by the video capture feature.

Users are often required to monitor critical operations related to vibration testing activities or to simply monitor the UUT in motion. If the test operator is unable to clearly observe the UUT in motion (with some distance), a video camera always provides a clear view and even audio of the environment. If a test aborts due to an issue, the real-time video provides a first hand observation of the event in addition to information received by the controller software for users to assess and resolve the issue.

After completing a test, viewing recorded signals along with the saved video relates the UUT movement corresponding to the measured signals.

Recording photos and videos can be integrated to the test schedule as part of an automated test procedure. At the end of a test, recorded videos and photos can be inserted to a test report with signals and other test information. These files are stored in the same folder with test data for convenient management.

EDM Cloud Online Status Monitoring
https://cloud.go-ci.com/
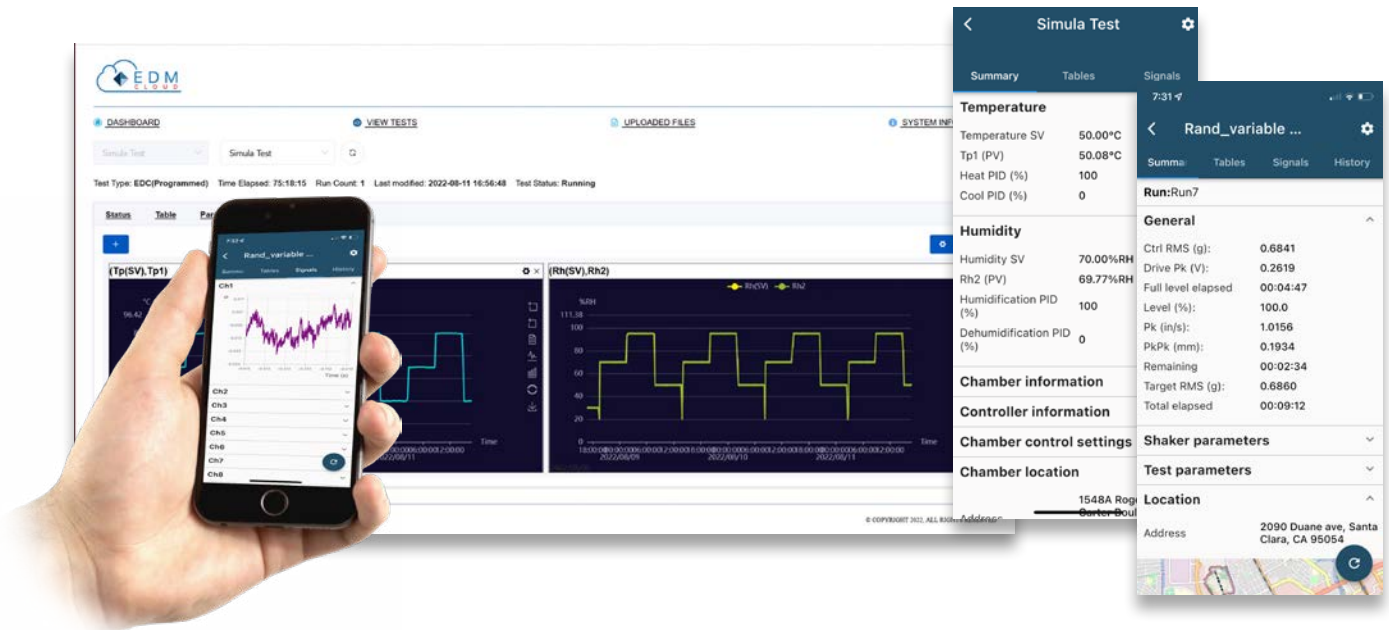
Provided for users to monitor the status of vibration tests across multiple Spider controllers. Allows access to multiple users according to customized account privileges to view data and status of Spider systems. Lab administrators can simultaneously monitor multiple tests from anywhere in the world using EDM Cloud.

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

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. Visit https://cloud.go-ci.com/ to register and log on.

EDM Cloud allows users to:
Create email address accounts and invite others to form a team with groups underneath.
Share tests with group members 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.

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 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.