

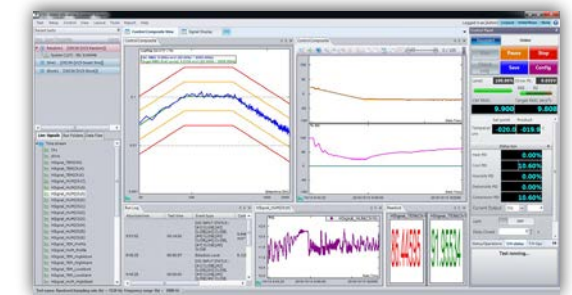


SENTEK
DYNAMICS

TEMPERATURE | HUMIDITY AND VIBRATION ENVIRONMENTAL TEST SYSTEMS

WORLD CLASS SUPPLIER OF ENVIRONMENTAL TEST SYSTEMS

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Environmental & Reliability Testing Solutions

Sentek Dynamics supplies vibration test equipment and environmental test chambers to simulate real-world environmental conditions for a wide-variety of aerospace, automotive, medical, commercial and independent test lab applications.

Located in the heart of California's Silicon Valley, Sentek Dynamics is dedicated to testing and measurement technology. With its comprehensive product line, Sentek

Dynamics is able to offer turn-key solutions for today's demanding environmental and reliability test requirements.

Sentek Dynamics is currently in the process of establishing a local team in North Carolina to produce systems that are tested and assembled in the USA from globally sourced parts. The establishment of our local North Carolina facility furthers our commitment to providing high quality testing solutions.

The Sentek Dynamics Team is committed to customer satisfaction and developing the right solution through delivery and quality initiatives that form an integral part of the Sentek Dynamics culture. This enables Sentek Dynamics to consistently deliver a wide-variety of standard and custom-engineered products that exceed customer expectations and the specifications of other manufacturers.

High / Low Temperature, Humidity and Low Air Pressure Test Chamber

Walk-in High / Low Temperature and Humidity Test Chambers

High / Low Temperature and Humidity Test Chamber

AGREE Chambers Combined Temperature, Humidity and Vibration

Rapid Temperature Change ESS Test Chamber

Temperature and Vacuum Test Chamber

SENTEK DYNAMICS

THV Series Environmental Test Systems*

Sentek Dynamics' THV Series environmental test systems offer a turn-key solution for product development and reliability improvement. This combined testing method, also known as The Department of Defense's AGREE (Advisory Group on Reliability of Electronic Equipment) method of testing, combines three testing environments (temperature, humidity and vibration) in one chamber. The Spider-101i controller by Crystal Instruments is standard with all THV Series environmental test chambers and is specifically designed for precise temperature and humidity control. The Spider-101i, along with a proven Crystal Instruments' Spider vibration controller, precisely controls all aspects of a combined temperature, humidity and vibration test regime.

Sentek Dynamics' THV Series is comprised of thirteen test chambers with volumes ranging from 600 to 24,000 L, a standard and extended temperature range (-45 to +150°C and -70 to +150°C) and temperature change (ramp) rates of 2, 5, 10 and 15°C/min. Temperature only and temperature/humidity configurations are available. The THV Series provides a quality, complete and integrated environmental test system to meet ever-changing reliability, qualification and ESS (Environmental Stress Screening) test requirements for a wide-range of industries including aerospace, automotive, electronics and medical.

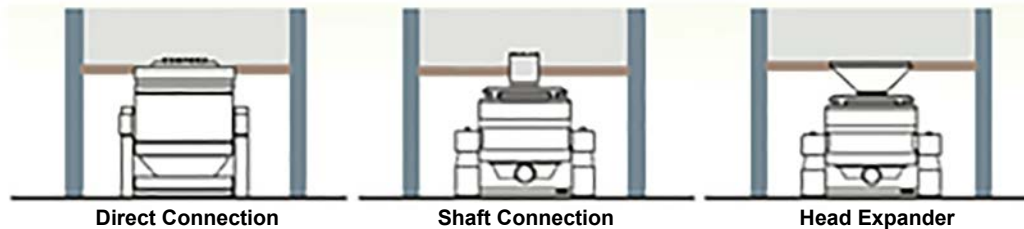


** Systems tested & assembled in the USA coming soon. Contact Sentek Dynamics for availability.*

THV Series AGREE Chambers

| Model | THV-600 | THV-1200 | THV-2200 | THV-3300 | THV-4500 | THV-6000 | THV-8000 | THV-10000 | THV-12000 | THV-16000 | THV-18000 | THV-20000 | THV-24000 |
|---|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Internal Volume (L) | 600 | 1200 | 2200 | 3300 | 4500 | 6000 | 8000 | 10000 | 12000 | 16000 | 18000 | 20000 | 24000 |
| Interior Dimensions WxDxH (mm) | 800x800x950 | 1100x1100x1000 | 1100x1100x1000 | 1500x1500x1500 | 1500x1500x2000 | 2000x2000x1500 | 2000x2000x2000 | 2000x2000x2500 | 2200x2200x2500 | 2800x2800x2200 | 3000x3000x2000 | 2800x2800x2500 | 3000x3000x2600 |
| Exterior Dimensions WxDxH (mm) | 1570x3820x2300 | 1870x4040x2300 | 2000x4500x2500 | 2400x4600x2560 | 2400x4600x2560 | 2850x5900x2570 | 2850x5900x3570 | 3000x6200x3800 | 3000x6200x4000 | 3800x6700x3800 | 4100x7600x3760 | 4100x7600x3760 | 4100x7600x4360 |
| Air-Cooled Option Available | Yes | | | | | | No | | | | | | |
| 5°C/Min Temperature Ramp Rate | | | | | | | | | | | | | |
| Temperature Range (°C) | -70 to +150 | | | | | | | | | | | | |
| Temperature Fluctuation (°C) | ± 0.5 | | | | | | | | | | | | |
| Temperature Uniformity (°C) | ≤ 2 | | | | | | | | | | | | |
| Temperature Deviation (°C) | ± 2 | | | | | | | | | | | | |
| Temperature Ramp Rate (°C/Min) Average (-40 to +80°C) | 5 | | | | | | | | | | | | |
| Humidity Range (%RH) | 20 to 98 | | | | | | | | | | | | |
| Humidity Deviation (%RH) | ± 5 | | | | | | | | | | | | |
| Maximum Connector Size (mm) | 600x600 | 800x800 | 1200x1200 | 1200x1200 | 1200x1200 | 1500x1500 | 1500x1500 | 1500x1500 | 1800x1800 | 2020x2020 | 2525x2525 | 2525x2525 | 2525x2525 |
| Maximum Slip Table Size (mm) | 600x600 | 800x800 | 1200x1200 | 1200x1200 | 1200x1200 | 1500x1500 | 1500x1500 | 1500x1500 | 1800x1800 | 2020x2020 | 2525x2525 | 2525x2525 | 2525x2525 |
| Rated Power (kW) | 18 | 25 | 40 | 40 | 42 | 45 | 50 | 60 | 65 | 68 | 72 | 80 | 90 |
| Cooling Water Flow Rate @+27°C (m³/h) | 5 | 6 | 8 | 10 | 12 | 15 | 20 | 25 | 25 | 30 | 35 | 38 | 28 |
| Noise Level (dB) | ~80 | | | | | | | | | | | | |
| Maximum Shaker Force (kN) | 22 | 32 | 80 | 100 | 120 | 300 | 400 | | | | | | |
| 10°C/Min Temperature Ramp Rate | | | | | | | | | | | | | |
| Rated Power (kW) | 23 | 30 | 45 | 50 | 50 | 60 | 75 | 85 | 90 | 95 | 110 | 130 | 135 |
| Cooling Water Flow Rate @+27°C (m³/h) | 6.5 | 8.5 | 10 | 12 | 18 | 23 | 25 | 28 | 28 | 30 | 35 | 70 | 70 |
| Temperature Ramp Rate (°C/Min) Average (-40 to +80°C) | 10 | | | | | | | | | | | | |
| 15°C/Min Temperature Ramp Rate | | | | | | | | | | | | | |
| Rated Power (kW) | 35 | 40 | 80 | 120 | 130 | 160 | 180 | 250 | 250 | 250 | 280 | 320 | 390 |
| Cooling Water Flow Rate @+27°C (m³/h) | 8 | 10 | 15 | 20 | 20 | 22 | 25 | 35 | 40 | 48 | 70 | 90 | 110 |
| Temperature Ramp Rate (°C/Min) Average (-40 to +80°C) | 15 | | | | | | | | | | | | |

The THV Series environmental test chambers are designed to work with Sentek Dynamics' air and water-cooled ED (electrodynamics) shakers in vertical only, mono-base and multi-axis configurations, and can accommodate other manufacturer's shakers using one of the following interfaces:



The environmental chamber and vibration shaker interface is established by direct connection with the armature, with the use of a shaft or a plug between the chamber floor and the armature, and by interaction between a head expander with the chamber.

Model Selection*



The following table identifies all possible configurations of chamber sizes (internal chamber volume), maximum force shaker model and maximum slip table size. The maximum force shaker model and slip table size represent the largest/highest capacity vibration system that can be combined with the listed chamber model. For more details on ED shaker specifications in general and/or the process of choosing an adequate THV chamber for specific needs, please contact Sentek Dynamics' sales department.

| Chamber Model | Volume L (ft ³) | Internal Dimensions | Maximum Force Shaker Model | Rated Force kN (lbf) | Maximum Slip Table Size mm (in) |
|---------------|-----------------------------|---------------------|----------------------------|----------------------|---------------------------------|
| THV-600 | 600 (21) | 800x800x950 | M2232A | 21 (4840) | 600 (23.6) |
| THV-1200 | 1200 (42) | 1100x1100x1000 | M3240A | 31(7030) | 800 (31.5) |
| THV-2200 | 2200 (77) | 1100x1100x1000 | H8044A | 78 (17,600) | 1200 (47.2) |
| THV-3300 | 3300 (116) | 1500x1500x1500 | H8044A | 78 (17,600) | 1200 (47.2) |
| THV-4500 | 4500 (158) | 1500x1500x2000 | H10056A | 98 (22,000) | 1200 (47.2) |
| THV-6000 | 6000 (211) | 2000x2000x1500 | H12056A | 117 (26,400) | 1500 (59.1) |
| THV-8000 | 8000 (282) | 2000x2000x2000 | H12056A | 117 (26,400) | 1500 (59.1) |
| THV-10000 | 10,000 (353) | 2000x2000x2500 | E30076A | 294 (66,000) | 1500 (59.1) |
| THV-12000 | 12,000 (423) | 2200x2200x2500 | E40086A | 392 (88,100) | 1800 (70.9) |
| THV-16000 | 16,000 (565) | 2800x2800x2200 | E40086A | 392 (88,100) | 2500 (98.4) |
| THV-18000 | 18,000 (635) | 3000x3000x2000 | E40086A | 392 (88,100) | 2500 (98.4) |
| THV-20000 | 20,000 (706) | 2800x2800x2500 | E40086A | 392 (88,100) | 2500 (98.4) |
| THV-24000 | 24,000 (847) | 3000x3000x2600 | E40086A | 392 (88,100) | 2500 (98.4) |

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Temperature | Humidity System

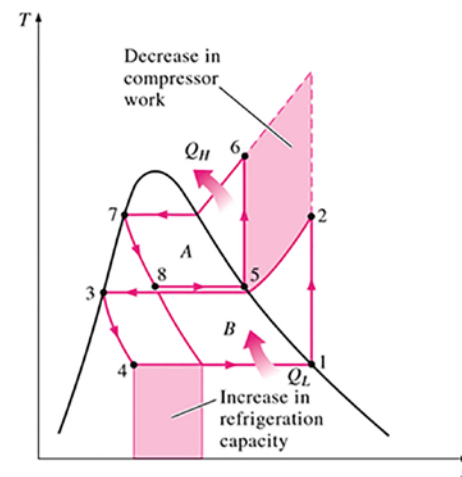
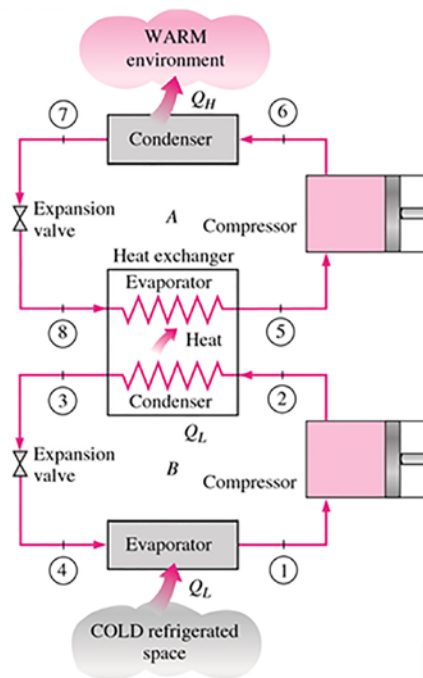
Temperature

Temperature regulation is established via two temperature cooling sub-systems and a heating system. For cooling, mechanical cascade vapor-compression refrigeration and liquid nitrogen cooling are utilized. This provides three methods of cooling, cascade vapor-compression refrigeration and liquid nitrogen independently, or both of these solutions used in conjunction. The heating system consists of high-power resistance wire heating.

These heating/cooling methods are applied to an optimized high-volume airflow system for improved controllability within the chamber to minimize temperature gradients of the device under test. Additionally, advanced heating/cooling methods combined with better airflow accelerates temperature changes rates while maintaining excellent temperature control.

Cascade Refrigeration

A single stage refrigeration cycle is used for most refrigeration applications. However, for improved efficiency and applications requiring wide temperature ranges, cascade refrigeration is used. The THV chamber incorporates a two-stage cascade refrigeration cycle (two combined cycles). The two cycles are connected through the heat exchanger which serves as the evaporator for the topping cycle and the condenser for the bottoming cycle. Cascade refrigeration allows for increased refrigeration capacity with reduction in individual compressor work to improve the coefficient of performance (COP) of the system.



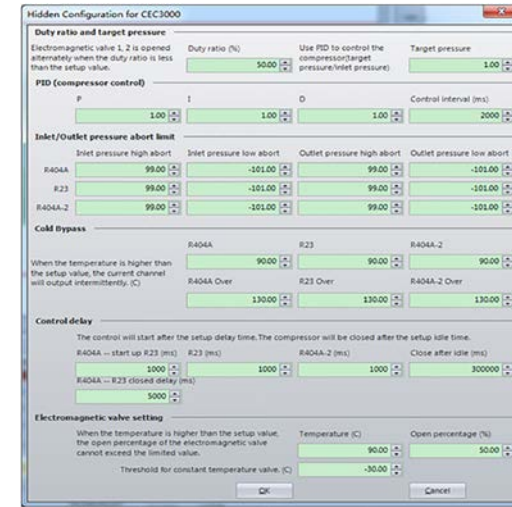
Liquid Nitrogen Cooling

Liquid nitrogen cooling is used to produce extremely low temperatures. Incorporated to work in conjunction with the cascade refrigeration system, liquid nitrogen cooling assists in providing enhanced chamber temperature performance.

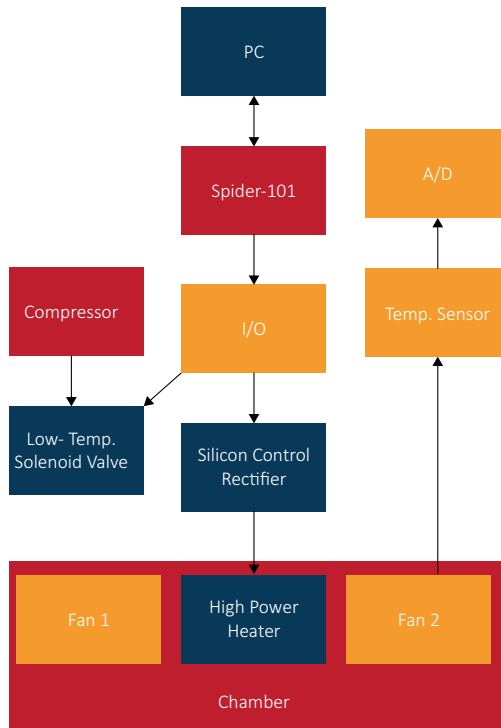
Cooling Unit

THV chamber cooling is highly efficient and reliable due its advanced design and application of cascade refrigeration along with liquid nitrogen cooling. Features include low-noise compressors, environmentally friendly refrigerants (R404a, R23), nitrogen protected oxidation-free welding, and pneumatic, hydraulic and evaporation temperature adjustment for extended life span. Main mechanical components include a water-cooled condenser, BITZER or Copeland semi-hermetic compressors, expansion valves, an evaporator and a heat exchanger.

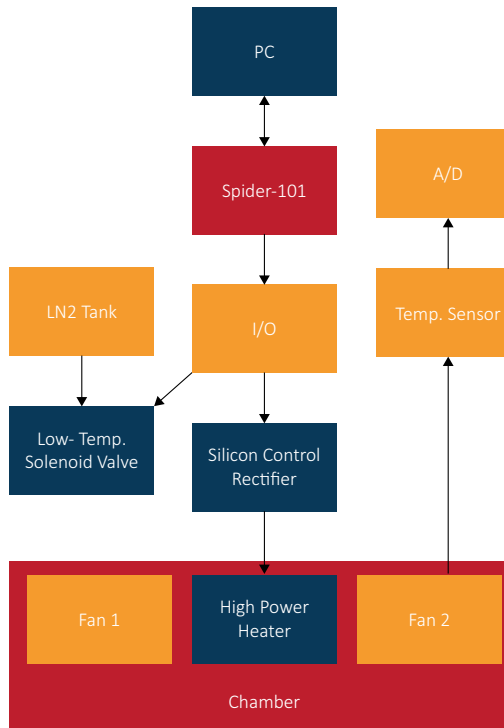
Compressor Configuration Settings



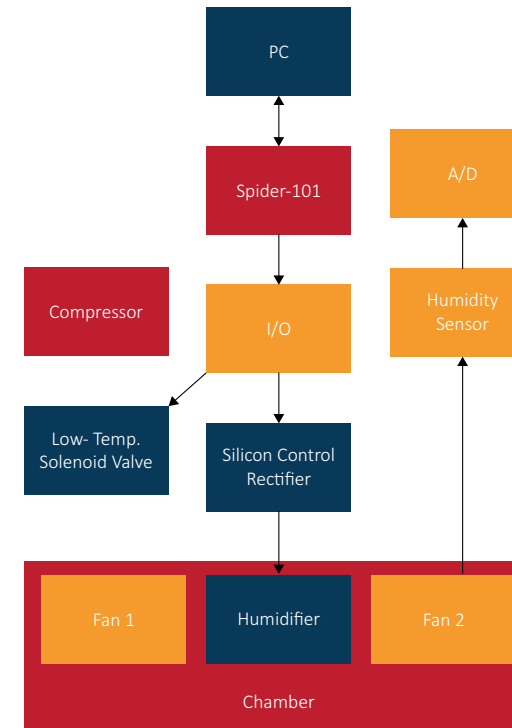
Method 1: Compressor Cooling



Method 2: Liquid N₂ for Cooling

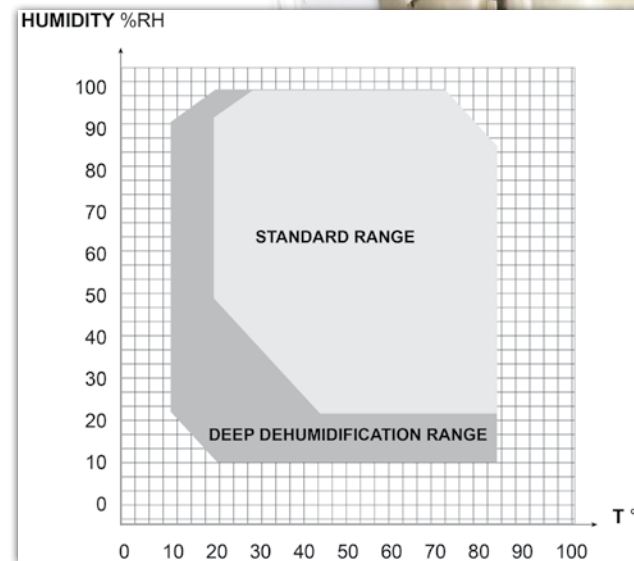


Method 3: Liquid N₂ & Compressor Hybrid



Humidity

The innovative design of the stainless steel armored humidifier and air duct combined with solid-state sensors assure high-accuracy and reduced maintenance. The design includes humidification and dehumidification sub-systems for optimal humidity control. The humidification system achieves humidity rise by injecting steam into the chamber. This steam is generated when the humidification water tank is heated by a wire heating furnace. A water level interlock and automatic water control delivery system is also part of the humidification sub-system. Dehumidification results from application of the desiccation principle, where air is cooled to a temperature below the dew point so that the moisture content is greater than the saturated water vapor condensation precipitation, thus lowering the humidity. Water purification and water softening is provided by a water purifier for these processes as well.



Chamber Features

Air Circulation System

Consisting of a centrifugal fan to produce forced air driven by external long axes motors, a heating device and control and fin heat sinks for heat dissipation, THV chambers provide exceptional air circulation and balancing of temperature and humidity.

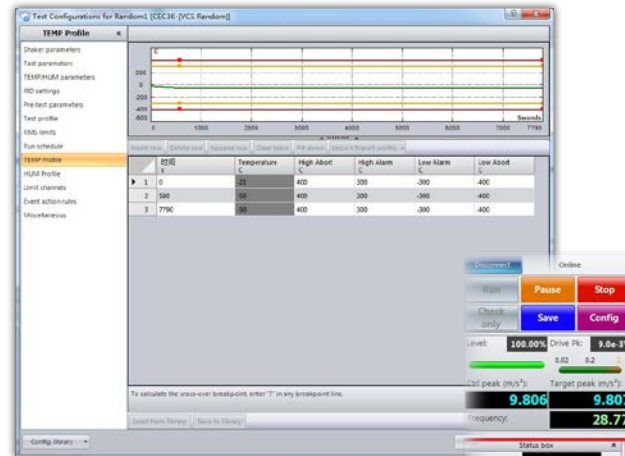
Reduced Maintenance

THV chambers contain many features to reduce maintenance such as a drawer-type water reservoir located in the front of the chamber. The reservoir contains a water valve at the bottom and also has a low-water level warning indication. Additionally, a nylon dust-proof filter located in the front of the condenser (removable for cleaning), and a centralized drainage for condensate water facilitate cleaning and reduce maintenance costs for the user.

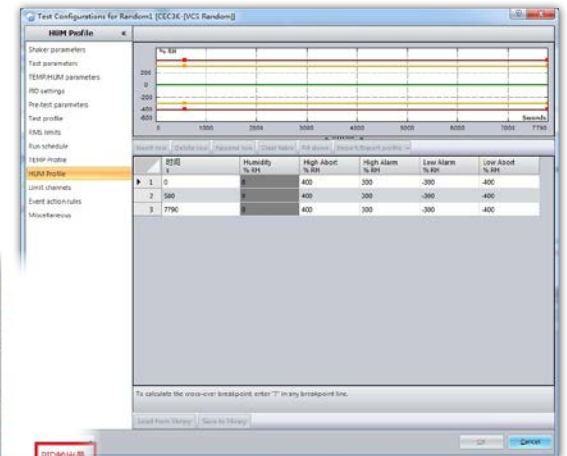


Control System

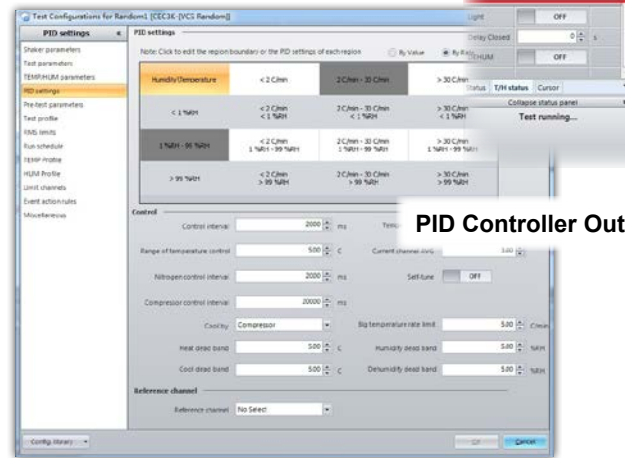
Control for temperature, humidity and vibration utilizes closed-loop control. Signal acquisition from a sensor (temperature, humidity, accelerometer) provides feedback to the controller. The measured signals are compared to user-defined environmental test conditions (programmed prior to testing) to recognized deviations between the actual and targeted value. Upon recognition of discrepancies (signal analysis), the control system sends control signals based on adaptive PID control algorithms to activate or deactivate environment-adjusting mechanical components for a calculated period of time to better match the targeted environmental condition. Control activation/deactivation of mechanical components for heating, refrigeration, liquid nitrogen cooling and vibration correspond to a heat switch for the furnace, runtime and performance of the refrigeration compressors, opening of the nitrogen tank valve, and adjusted voltage/current inputs, respectively. For humidification, a heating wire furnace produces steam by heating an open water tank, while dehumidification results when a dehumidifier compressor is triggered for designated amount of time.



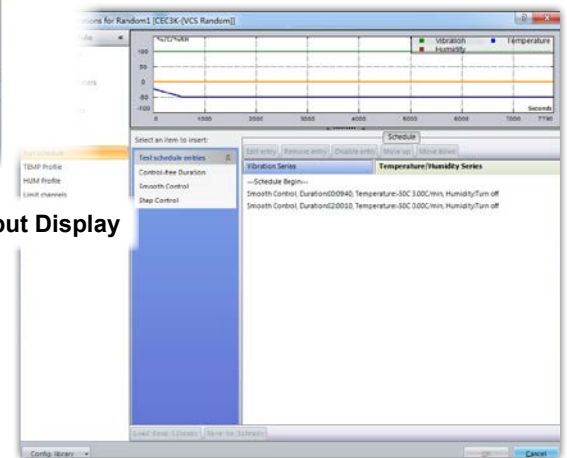
Temperature Profile



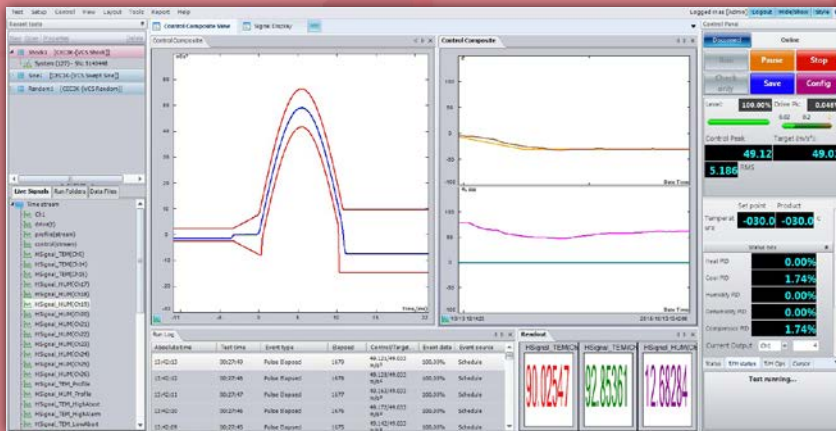
Humidity Profile



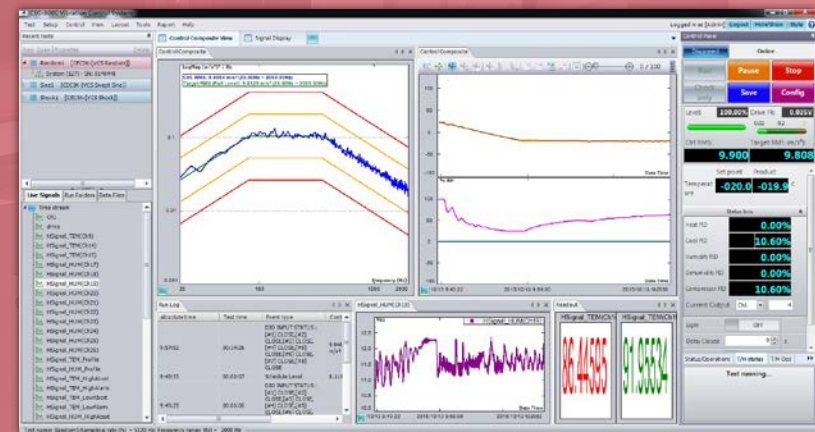
PID Controller Output Display



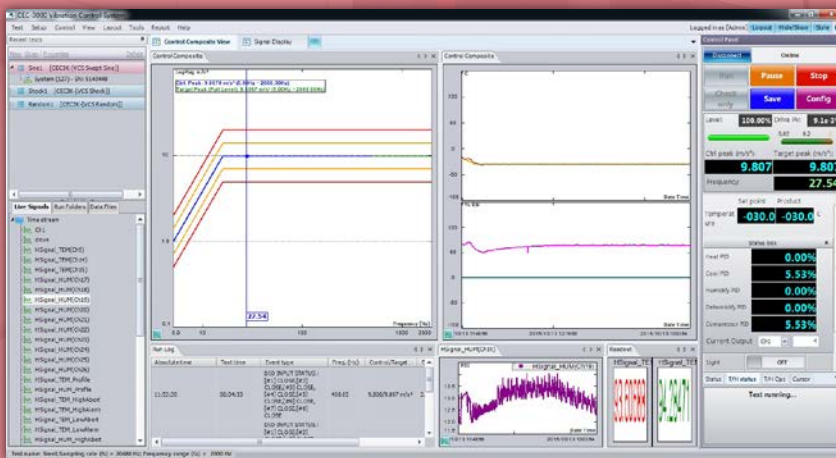
Temperature/Humidity Run Schedule



Shock

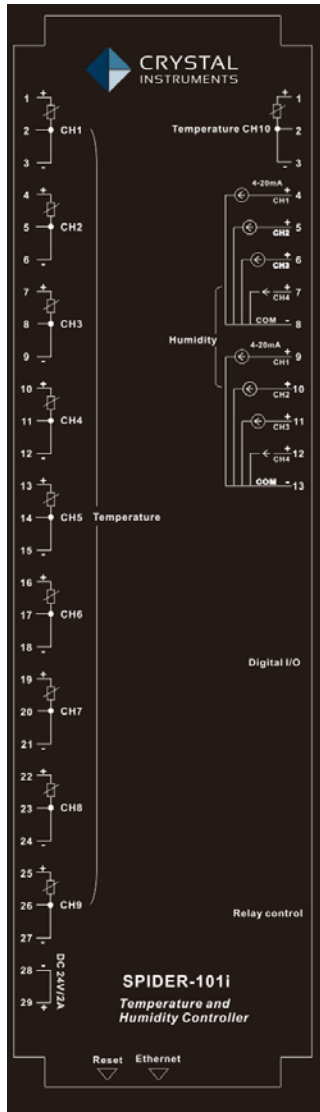


Random Vibration



Sine Vibration

THV Series environmental test systems allows for simultaneous and integrated control of temperature, humidity and vibration from a single user interface



Spider-101i Controller

Designed and manufactured by Crystal Instruments, the Spider-101i controller is a key element of the Sentek Dynamics THV Series chambers. The Spider-101i is the world's first controller that supports combined temperature, humidity and vibration testing and reporting. Crystal Instruments' EDM (Engineering Data Management) software, along with one of their proven vibration controllers, is used to control the combined temperature, humidity and vibration test environment. For tests involving only temperature and humidity control, Crystal Instruments' EDC (Embedded Device Controller) software is required.

The unique capability of simultaneous control for combined testing is made possible by excellent control design which allows for control of a shaker, refrigeration units, electric heating elements and humidification components.

The Spider-101i provides ten input channels using either RTD or K-type thermocouple for temperature measurement and eight 4-20 mA input channels for humidity sensors. There are 32 configurable relay control outputs to control compressors and other mechanical systems, as well as digital I/O channels for alarm/status monitoring.

The Spider-101i controller can connect to the control PC or tablet via Ethernet ports or wirelessly for test setup and/or test monitoring. When combined temperature, humidity and vibration testing is required, the Spider-101i can combine with any dedicated Crystal Instruments vibration controller (Spider-81/81B, Spider-80Xi, etc.) through a network switch for accurate synchronized **combined temperature, humidity and vibration testing.**

Major Benefits of the Spider-101i Platform

- A controller fully integrated with any shaker controller from Crystal Instruments
 - One integrated setup
 - One clock and schedule
 - One user interface
 - One testing report
 - One vendor to provide support
- Two user interfaces:
 - EDC: Embedded Device Control, a touch screen user interface running on Windows 10 tablet
 - EDM, PC software to control T, H and V



Spider-80X
Modular DAQ/DSA/VCS



Spider-80SG
Modular DAQ/DSA/VCS



Spider-80Xi
Modular DAQ/DSA/VCS



Spider-81
Premium Vibration Controller



Spider-81B
Basic Vibration Controller

Ease of Use

The Spider-101i's EDM/EDC software contains attractive user interface interactions. Graphical guidance, wizards and tools are available to simplify the test setup. The interface has been formatted to be intuitive to the user. Event-Action Rules, Abort-Sensitivity, and numerous other concepts are introduced in the EDM/EDC software to simplify operation. Keyword searching through a large number of tests is made easy, and the smart network detection tool makes hardware installation very simple as well.

Simple Network Connection

Ethernet connectivity allows the Spider-101i controller to be located far from the touch screen tablet or host PC. This distributed structure greatly reduces the noise and electrical interference in the system. One PC can monitor and control multiple Spider-101i 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, the tablet or PC easily connects to the Spider-101i via Wi-Fi.

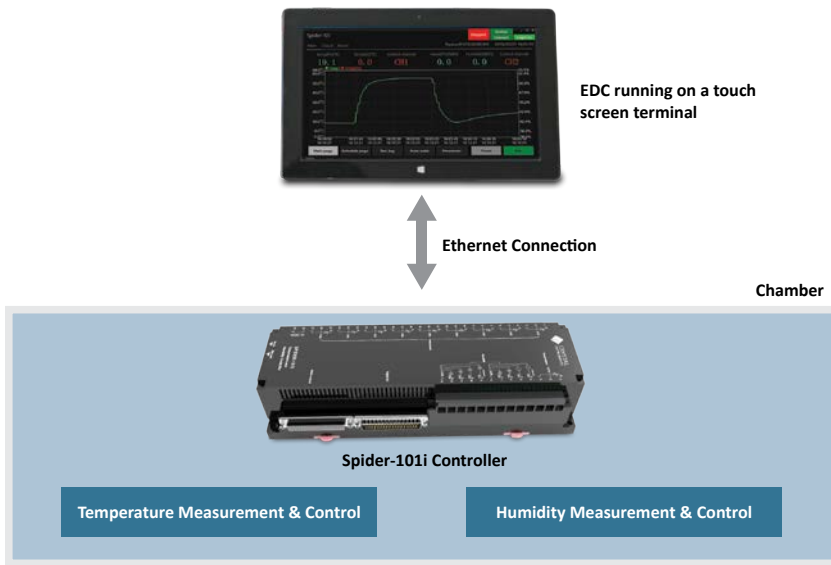
Designed for High Control Performance

By using enhanced control algorithms and a simplified DSP architecture, the feedback loop time for temperature and humidity is greatly reduced. Advanced adaptive PIO algorithms are developed to suit into various temperature profiles. It also provides faster responses for superior safety protection.

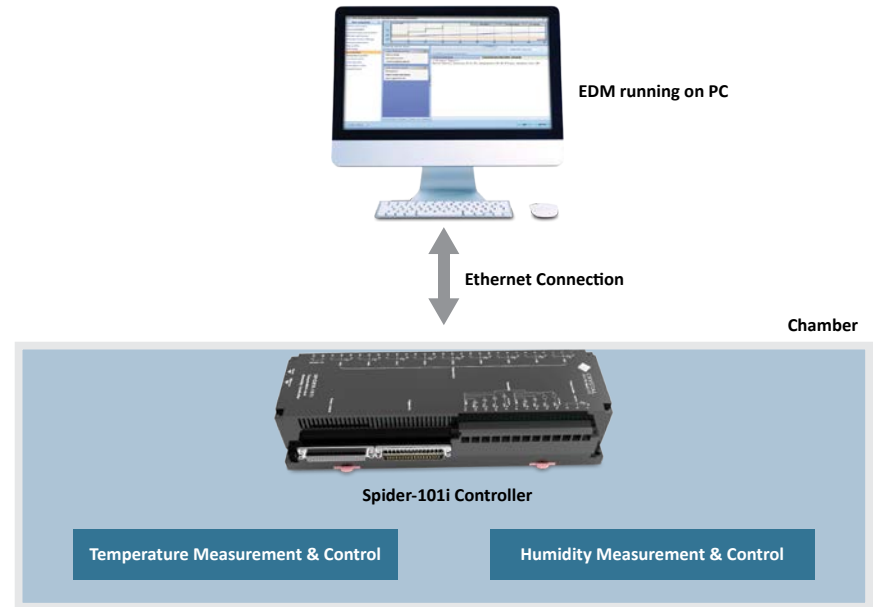
Common User Interface

Crystal Instruments' Engineering Data Management (EDM) software comes with each Spider-101i controller and THV Series chamber. EDM provides a common user interface for both Vibration Control System (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.

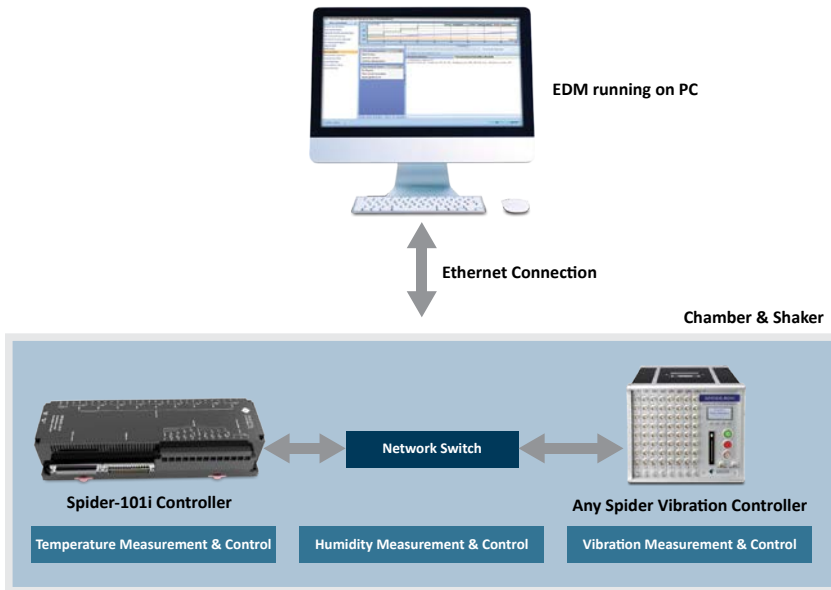
SPIDER-101i TYPICAL CONFIGURATION 1: TH CONTROL WITH EDC



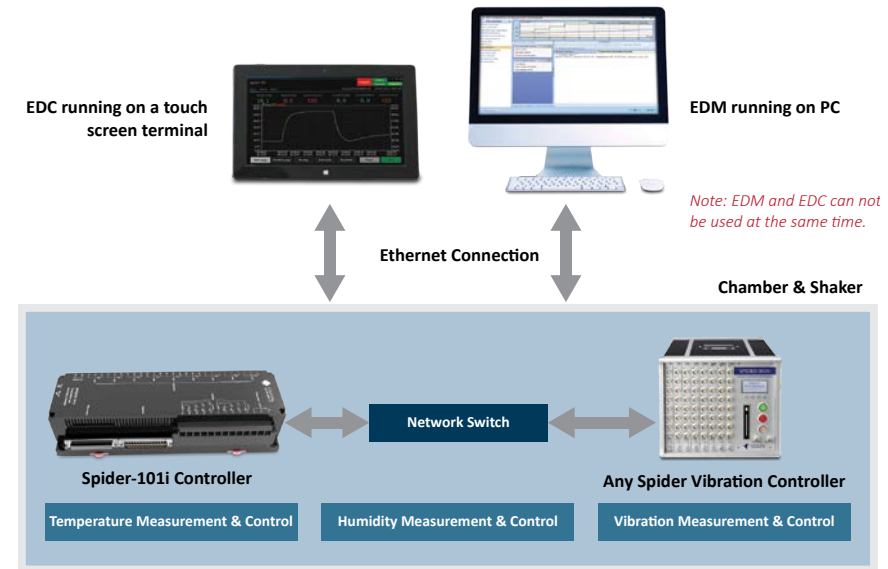
SPIDER-101i TYPICAL CONFIGURATION 2: TH CONTROL WITH EDM ON A PC



SPIDER-101i TYPICAL CONFIGURATION 3: THV CONTROL WITH EDM ON A PC



SPIDER-101i TYPICAL CONFIGURATION 4: THV CONTROL WITH EDM (ON PC) & EDC (ON TOUCH SCREEN TERMINAL)



Available EDM Vibration Control System (VCS), Dynamic Signal Analyzer (DSA) Software and Hardware Expansion



| Option Designation | Description (EDM Part Number) |
|-------------------------------------|--|
| 20 | Random Vibration Control (VCS-20-C08) |
| 20-06 | Kurtosis Control (VCS-20-06) |
| 20-08 | Sine on Random Control (VCS-20-08) |
| 20-09 | Random on Random Control (VCS-20-09) |
| 20-11 | Fatigue Damage Spectrum (VCS-20-11) |
| 40 | Swept Sine Control (VCS-40-C08) |
| 40-01 | Resonance Search and Tracked Dwell (RSTD) Control (VCS-40-01) |
| 60 | Classic Shock Control (VCS-60-C08) |
| 60-01 | Transient Time History (TTH) Control (VCS-60-01) |
| 60-03 | Shaker Response Spectrum (SRS) Synthesis and Control (VCS-60-03) |
| 60-12 | Transient Random Control (VCS-60-01) |
| General VCS Software Options | |
| 00-05 | Sine Oscillator (VCS-00-05) |
| 00-12 | Non-Acceleration Control (VCS-00-12) |
| 00-60 | Spider Front-End Calibration Software (SPIDER-CAL) |
| 10-C08 | Premium FFT Spectral Analysis (DSA-10-C08) |
| CEC4 | Spider-101 4-Channel Expansion |

Software Functions in Vibration Control and Signal Analysis

VCS software is designed for a wide range of vibration and shock testing applications. The same software suites support from as few as two inputs to 512 input channels with multiple drive output capability. Software solutions for vibration include Sine, Resonance Search Track and 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, Highly Accelerated Life-Testing/Stress-Screening (HALT/

HASS) and multi-drive control. 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), the Spider-101i can be directly accessed from LabView, Matlab or other customized software. The VCS software runs on Linux, iOS and Windows operating systems. Additionally, it 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.



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