Spider-81 Hardware Specifications



Spider-81 Vibration Controller



Spider-81B Vibration Controller

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APPLICABLE HARDWARE VERSION

This document applies to hardware version 7.7x of the Spider-81 and Spider-81B. Hardware with version 7.3 or lower may have reduced functions and/or performance.

INTRODUCTION

The Spider-81 series is a highly modular, distributed, scalable vibration control system developed by Crystal Instruments. It represents the fourth generation of vibration control systems with advanced technology unavailable in the current generation.

Complete Control Functions

The Vibration Control System (VCS) software in the EDM Testing installation package includes the following control functions that are applicable for single axis shaker testing: Random, Sine-on-Random, Random-on-Random, Swept Sine, Resonance Search and Dwell, Sine Oscillator, Classic Shock, Transient Time History, Shock Response Analysis/ Synthesis, Earthquake Testing, Time Waveform Replication, Transient Random, Multi-Sine, Crash Control and typical environmental testing applications.

DSP Centralized Architecture

Unlike traditional controllers that rely heavily on an external computer for real-time operations, the Spider-81 is the first controller that directly integrates time-synchronized Ethernet connectivity with embedded DSP technology. This greatly increases the control performance, system reliability, and failure protection of the controller. It also allows a large number of channels to be configured without sacrificing system performance.

Latest Hardware Design

The Spider-81 hardware modules have voltage, charge, and IEPE inputs which are ideal for shock, vibration, and acoustic measurement or general purpose voltage measurement. The internal flash memory stores real-time analysis data and test configuration data for simultaneous control of up to hundreds of channels. Multiple output channels provide various signal output waveforms that are synchronized with the input sampling rate. A bright LCD displays testing status information. Ten monitoring connections on each unit are used to read analog input and output signals. The front panel provides intuitive buttons. A built-in isolated digital I/O interfaces with other hardware.

Simple Network Connection

Ethernet connectivity allows the Spider-81 to be located far from the host computer. This distributed structure greatly reduces noise and electrical interference in the system. One computer monitors and controls multiple controllers over the network. Since the control processing and data recording are executed locally inside the controller, the network connection does not affect control reliability.

Spider-81 can be network-connected with other Spider modules, including Spider-80X, Spider-80Xi, Spider-80SG and Spider-80SGi.

Multiple Hardware Time Synchronization

The Spider-81 is built on IEEE 1588 PTP time synchronization technology (PTP-Precision Time Protocol). Spider-81 modules on the same network can be synchronized with up to 100 ns accuracy, which guarantees ±1 degree cross channel phase match of up to 20 kHz. The implementation of such unique technology and high-speed Ethernet data transfer allows the distributed components on a network to operate as one integrated system.

On-Board LCD Display

Each Spider-81 is equipped with a bright front-panel LCD that displays system status and test information. Real-time status such as control RMS or sweeping frequency is instantly displayed on the LCD.

Designed for High Reliability and Durability

The Spider-81 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-81 hardware passes strict environmental tests including EMI, temperature, drop shock, sine, and random vibration testing. The unique floating ground design reduces ground loop problems typically found in testing laboratories. A power-backup circuitry based on a super-capacitor is installed to prevent unexpected power losses.

Designed for High Accuracy

The Spider-81 uses a patented dual parallel A/D design and is the first vibration control system to achieve 160 dBFS input dynamic range. Each measurement channel can detect signals as small as 6 μV and as large as 20 V. This design completely eliminates the need for input range or gain settings found on traditional controllers.

Designed for High Control Performance

The feedback loop time of Sine and Random control are all greatly reduced by using enhanced control algorithms and a simplified DSP architecture. A reduced control loop time provides improved capability for resonance search and dwell or control of structures with high Q resonances. It also provides faster responses for improved safety protection.

Ease of Use

The Spider-81 software is further improved at the user interface level be more intuitive. More graphical guidance, wizards, and tools are added to simplify the setup interface. Event-Action Rules, Abort-Sensitivity, and other features are added to simplify operations. Keyword searches of test data is made convenient for users.

Compatible with Spider Front-ends

Spider-81 is a networked measurement device that fully integrates with other Spider measurement front-ends. Users can configure the Spider-81 with a Spider-80Xi high channel count system, Spider-80X compact dynamic analyzer, Spider-80T temperature measurement system, and a Spider-80G general data acquisition system. EDM software manages and runs the connected Spider hardware as one system.

Integrated with Dynamic Signal Analysis and Data Recording
The Spider-81 is integrated with general signal analysis functions including time stream recording, transient capture, FFT, auto power spectra, and transfer function analysis. Multiple Spider-81 modules work together to form one integrated system. Long waveform data recording is a built-in function.

Spider-81B Basic Version

The Spider-81B is designed to meet the requirements of basic vibration testing applications. It has 4 inputs, 1 output, and 4 pairs of digital I/O. Available software includes Random, Sine, Shock, and RSTD testing bundles.

The Spider-81B does not have an LCD display, cannot be extended to more than one module, and has less DIO ports than the Spider-81.

HARDWARE SPECIFICATIONS

Analog Input Channels

- **Number of input channels per Spider-81 front-end:** 4, 6, 8 (software configurable)
- **Max input channels per Spider-81 system:** 512
- **Number of input channels per Spider-81B:** 2, 4
- **Connector type:** isolated BNC
- **TEDS:** IEEE 1451.4 compliant
- **Coupling:** AC Voltage, DC Voltage, Charge, or IEPE (ICP®)
- **IEPE DC Offset voltage and current:** 21 V at 4.2 mA
- **Charge input:** 1,000 pC and 10,000 pC
- **Voltage input range**: ±20 V
- **Input impedance:**
  - **Differential:** 1 MΩ || 3.2 nF
  - **Single-End:** 500 kΩ || 1.8 nF
- **Input protection voltage:** ±220 V
- **AC coupling:** analog high-pass filter (-3 dB @ 0.375 Hz and -0.1 dB @ 2.45 Hz)
- **A/D resolutions:** 2 x 24-bit (per input channel)
- **Anti-aliasing filter:** analog anti-aliasing low-pass filters in addition to sigma-delta converters
- **Digital filter:** high-pass and low-pass filters (user programmable)
- **Input dynamic range:** 160 dBFS
- **Sampling rate:** 0.48 Hz to 102.4 kHz, with 54 stages
- **Maximum useful bandwidth:** 46.08 kHz
- **THD:**
  - -101 dB @ 1 kHz, 2 V (-20 dBFS)
- **Amplitude accuracy (1 kHz, 1 V):** ±0.01 dB (0.115%)
- **Amplitude channel match (1 kHz, 1 V):** < 0.04 dB
- **Channel phase match:** better than ±1.0 degree, up to 20 kHz
- **Crosstalk:** less than -100 dB
- **Frequency accuracy:** ±250 ppm (typically ±0.25 Hz margin at 1 kHz)
- **Common mode range:** ±20 V

Analog Output Channels

- **Number of output channels on Spider-81:** 2 (additional 2 outputs reserved for future expansion)
- **Number of output channels on Spider-81B:** 1
- **Connector type:** isolated BNC
- **D/A resolution:** 24-bit
- **Sampling rate:** up to 102.4 kHz per channel, synchronized with input channels
- **Output impedance:** 50 Ω
- **Output dynamic range:** 120 dB
- **Maximum output current:** 250 mA (HW 7.4 and earlier: 25 mA)
- **Amplitude accuracy:**
  - ±0.05 dB at 1 kHz
- **Anti-imaging filter:** 160 dB/oct digital and analog filters
- **Digital filters:** high-pass and low-pass digital filters
- **Output voltage range:** ±10 V
- **Frequency accuracy:** ±250 ppm (typically ±0.25 Hz margin at 1 kHz)

Isolated Digital Input and Output

- **Connector type:** 25-pin female D-SUB
- **External circuit power supply:** 3.3 – 12 VDC (±10%)
- **Internal power:** 12 VDC 400 mA (For Spider-81B, only V7.5.x provide internal power)
- **Maximum allowable distance of signal extension:** 50 meters

Digital Inputs

- **Input format:** opto-isolated input (compatible with

current-sink output)

- **Number of digital inputs on Spider-81:** 8
- **Number of digital inputs on Spider-81B:** 4
- **Input resistance:** 6.1 kΩ
- **Input on current:** 2.0 mA or more
- **Input off current:** 0.16 mA or less
- **Interrupt:** 8 input signals are arranged into a single interrupt output signal. An interrupt is generated either at the rising edge (HIGH-to-LOW transition) or falling edge (LOW-to-HIGH transition).

Digital Outputs

- **Output format:** opto-isolated input (current sink output)
- **Number of digital outputs on Spider-81:** 8
- **Number of digital outputs on Spider-81B:** 4
- **Output rating:** output voltage 12 VDC max, output current 100 mA per channel max
- **Residual voltage with output On:** 1.0 V or less (output current < 100 mA)
- **Pulse width:** 47 ms
- **Rise time:** 250 µs
- **Fall time:** 50 µs

High Speed Data Port Interface to Spider-NAS

Not available on Spider-81B

- **Connector type:** 5-pin LEMO
- **Maximum cable distance:** 2 meters
- **Data transfer speed:** Higher than 819.2 k samples/second. Data saved in 32-bit single precision floating point. (Data from all input channels can be streamed to the Spider-NAS at rate of 102.4 kHz per channel.)

Front Panel LCD Display

Not available on Spider-81B

- **Display area:** 115.05 x 28.65 mm
- **Color:** blue-green
- **Technology:** VFD, 8 level brightness, font size is user customizable
- **LCD control buttons (5):** left, right, up, down and enter

Ground Connection

- **Purpose:** connect to common ground of power amplifier to reduce ground-loop interference
- **Connector type:** 0.166-inch (4.23 mm) jack connector for standard 0.166-inch banana plug

System Specifications

- **On-board memory:** 4 GB non-volatile flash memory, 32 MB DRAM
- **Ethernet:** 100Base-T, RJ45 female connector
- **Internal clock:** maintains date and time
- **Cooling:** no cooling fan required

Network Protocols and IEEE 1588 Time Synchronization

Multiple Spider-81 and Spider front-ends are synchronized through the IEEE 1588 protocol. The synchronization accuracy is better than ±100 ns when using a certified network switch, such as the Spider-HUB. Data acquired by all measurement channels will be synchronized and the phase match across different Spider front-ends is within 1.0 degree of 20 kHz.

- **IPv4 protocol stack:** ICMP, IP, UDP, TCP, IGMP
- **IPv4 configuration:** manual or via DHCP
- **IEEE 1588v2 protocol:** PTP ordinary clock, with both E2E and P2P synchronization supported and hardware level timestamp for PTP event messages. Not available on Spider-81B
- **Time sync accuracy for sampling clocks between modules:** ±100 ns or better (Multiple Spider-81 modules connected by specified switch)

Power Specifications

- **Power supply:** external DC power
- **External DC power:** AC adaptor accepts 100 to 240 VAC (50/60 Hz), DC power 15 V (±10%)/3A
- **Backup super capacitor:** 8 seconds for emergency shutdown
- **Power consumption:** less than 18 W

Environmental and General Specifications

- **Enclosure:** metal box compliant with CE electrical safety and EMI shielding standards
- **Spider-81 dimensions:** 440 x 66 x 330 mm (W x H x D)
- **Spider-81B dimensions:** 220 x 66 x 276 mm (W x H x D)
- **Weight:**
  - **Spider-81:** 4.8 kg
  - **Spider-81B:** 2.56 kg
- **Safety standards:** electromagnetic compatibility and sensitivity:
  - EN 61326:1997+A1:1998+A2:2001
  - EN61000-3-2: 2000
  - EN61000-3-3: 1995+A1:2001

- **Operating temperature:** -20 °C to +55 °C
- **Relative humidity:** up to 95% RH non condensing at 23 deg.C and 50% at 45 deg.C
- **Storage temperature:** -20 °C to +70 °C
- **Shock:** 50 g's, 315 in/sec, tested at 6 sides, non-operational test
- **Vibration:** 5 – 500 Hz, 0.3 g, tested at 3 sides, operational test
- **Vibration:** 5 – 500 Hz, 2.42 g, tested at 3 sides, non-operational test

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APPENDIX 1: SPIDER FRONT-END HARDWARE COMPARISON

	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 (external) 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
Notes	Flagship product for VCS line. Input protection up to 220 V. Equipped with Stop/Start button	Economic 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.

APPENDIX 2: TYPICAL SYSTEM CONFIGURATIONS

The Spider hardware platform can operate in two working modes: Black Box and PC Tethered mode. When a Spider runs in Black Box mode, preset projects are executed based on a user defined schedule. In PC tethered mode, the computer is used as a control terminal to access the Spider through an Ethernet network. The Spider can switch between the two modes during tests. The PC Tethered mode is ideal for applications such as structural testing in a laboratory environment. The Black Box mode is ideal for remote monitoring. The connection between the computer and LAN is either wired or wireless.

PC Tethered with One Spider Front-End

One Spider-81 is directly connected to a computer or to a LAN network through Ethernet. No switch is needed. The computer is used as a control and monitoring terminal via the EDM software.

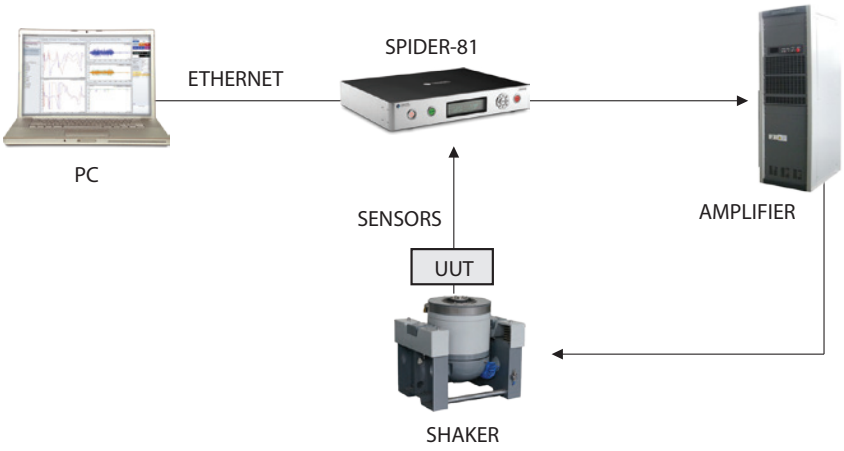
PC Tethered with Multiple Spider Front-Ends

Multiple Spider front-ends are connected to form a high channel count system. Multiple switches are cascaded to extend the number of front-ends. For example, a 64-channel system can consist of one Spider-81 front-end and seven Spider-80X front-ends. An EDM software installed computer is used as a control and monitoring terminal.

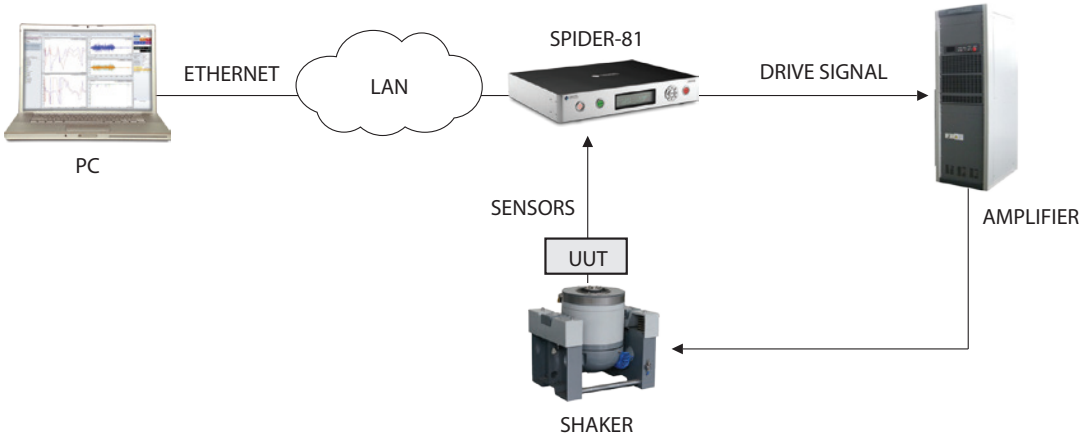
Black Box Mode with One Spider Front-End

This is the same as Configuration 1 except a computer is not required during operation. A computer is required to install the Spider Black Box engine, to configure the Spider, and to download data files.

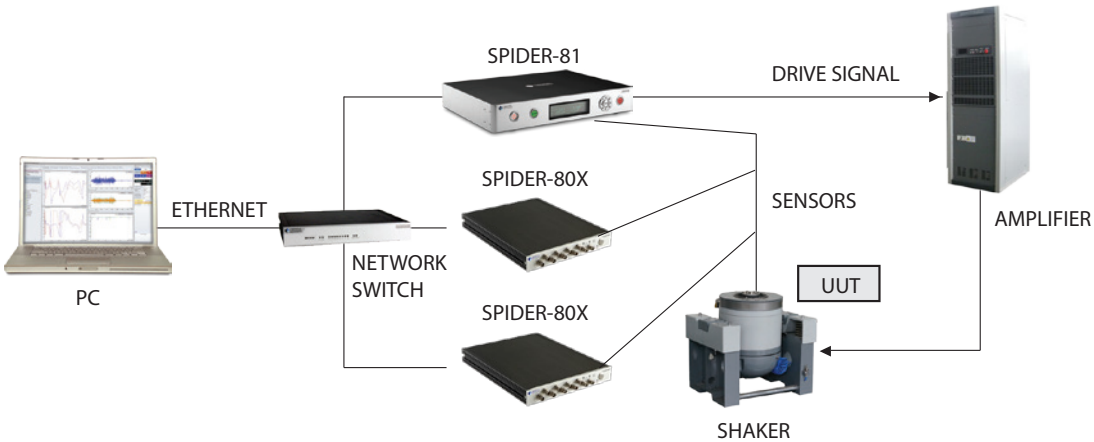
The following figures illustrate some of the many configurations that are possible with the Spider system.



Configuration 1: Setup with PC controller directly connected.



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



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