CRYSTAL INSTRUMENTS

SPIDER-81
HARDWARE SPECIFICATIONS (v7.7)

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APPLICABLE HARDWARE VERSION

This document applies to hardware version 7.6x 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.

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 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. A bright LCD displays testing status information. Ten monitoring connections on each unit are used to read signals of analog input and output. The front panel has intuitive buttons. There is a built-in isolated digital I/O to interface with other hardware.

Simple Network Connection

Ethernet connectivity allows the Spider-81 to be located far from the host PC. This distributed structure greatly reduces noise and electrical interference in the system. One PC 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. With wireless network routers, a PC connects easily to the Spider-81 remotely via Wi-Fi.

Time Synchronization between Multiple Hardware Modules

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 up to 20 kHz. With such unique technology and high-speed Ethernet data transfer, the distributed components on the network truly act as one integrated system.

Black Box Mode: Operate without PC

The Spider-81 in Black Box mode enables 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 according to a preset schedule or from a connected iPad. Black Box mode is included with every Spider-81/81B.

For hardware with version 5.8 and lower, up to 4 tests are uploaded and stored on each module. For hardware with version 7.3 and higher, up to 8 tests are uploaded and stored on each module.

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 viewed on the LCD.

Designed for High Reliability

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. 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. A power-backup circuitry based on super-capacitor is installed to prevent the unexpected power loss.

Designed for High Accuracy

Using a patented dual parallel A/D design, the Spider-81 is the first vibration control system that achieves 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 the input range or gain settings found on traditional controllers.

Designed for High Control Performance

By using enhanced control algorithms and a simplified DSP architecture, the feedback loop time of Sine and Random control are all greatly reduced. A reduced control loop time gives much better capability for resonance search and dwell or control for a structure with high Q resonances. It also provides faster responses for better safety protection.

Ease of Use

The Spider-81 software is further improved at the user interface level. More graphical guidance, wizards, and tools are available to simplify 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.

ASAM-ODS Data and File Model

ASAM is an international organization supported by more than 150 companies in the test and measurement industry. The Spider-81 is fully compliant with the ASAM-ODS data and file model. With ASAM-ODS, the engineering unit, user control, testing article description, and data exchange of the Spider-81 are all governed by the ASAM standard. The Spider-81 data is read by the software of LMS, Bruel & Kjaer, BBM, and many other providers.

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 front-ends work together to form one integrated system. Long waveform data recording is a built-in function.

iPad Control
The iPad app is available from the Apple App Store. The software runs on the iPad and accesses the Spider-81 hardware when operating in Black Box mode. The iPad app enables users to access preloaded tests to run and control when they are mobile but within the range of the wireless network. Display window can show one or multiple signals. The user can print or email screen shots. For hardware versions 7.x and higher, up to 8 tests can be uploaded to the hardware for selection while running the iPad app.

Spider-81B, the 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 have less DIO ports than the Spider-81.

HARDWARE SPECIFICATIONS

Analog Input Channels

- **Input Channels per Spider-81 Front-End:** 4,6, 8
- **Max Input Channels per Spider-81 System:** 512
- **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
- **Input Range:** ±20 Vpk
- **Input Impedance:** 1MΩ for differential and 500 kΩ for single-end
- **Input Protection Voltage:** ±220V (For hardware version 7.6.x)
- **AC Coupling:** analog high-pass filter, -3 dB @ 0.3 Hz and -0.1 dB @ 0.7 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:** -95 dBfs (DC to 1 kHz)
- **Amplitude Channel Match (1 kHz, 1V input):** 0.02 dB
- **Channel Phase Match:** better than ±1.0 degree, up to 20 kHz
- **Crosstalk:** less than -100 dB
- **Frequency Accuracy:** ±250 ppm (typically ±0.25Hz margin at 1 kHz)
- **Common Mode Range:** ±20 Vpk
- **Amplitude Accuracy (1 kHz, 1V input):** ± 0.1%

Analog Output Channels

- **Spider-81 Output Channels:** 2 (Additional 2 outputs reserved for future expansion)
- **Spider-81B Output Channels:** 1
- **Connector Type:** isolated BNC
- **D/A Resolution:** 24 bit
- **Sampling Rate:** up to 102.4 kHz per channel, synchronized with input channels
- **Output Dynamic Range:** 100 dB
- **Maximum Output Current:** 250 mA (HW 7.4 and earlier: 25mA)
- **Amplitude Accuracy (1 kHz,1Vrms):** ±0.2%
- **Anti-Imaging Filter:** 160 dB/oct digital and analog filters
- **Digital Filters:** high-pass and low-pass digital filters
- **Output Range:** ± 10 Volts
- **Frequency Accuracy:** ±250 ppm (typically ±0.25Hz margin at 1 kHz)

Isolated Digital Input and Output

- **Connector:** 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
- *Inputs*
  - **Input Format:** opto-isolated input (compatible with current-sink output)
  - **Spider-81 Channels:** 8
  - **Spider-81B Channels:** 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).

- *Outputs*
  - **Output Format:** opto-isolated input (current sink output)
  - **Spider-81 Channels:** 8
  - **Spider-81B Channels:** 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 interfacing to Spider-NAS
Not available on Spider-81B

- **Connector Type:** 5-pin LEMO
- **Maximum Distance of Cable:** 2 meters
- **Data Transfer Speed:** Higher than 819.2ksample/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 102.4kHz 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 user customizable
- **LCD Control Buttons:** five buttons: 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 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 the measurement channels will be synchronized and the phase match across different Spider modules 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 Front-ends:** ±100 ns or better (Multiple Spider-81 front-ends 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
- **Power Consumption:** less than 18 watts

Environmental and General Specifications
- **Enclosure:** metal box compliant with CE electrical safety and EMI shielding standards
- **Spider-81 Dimension:** 440 x 66 x 330 mm (W x H x D)
- **Spider-81B Dimension:** 220 x 66 x 276 mm (W x H x D)
- **Weight:**
  - **Spider-81:** 4.8kg
  - **Spider-81B:** 2.56kg
- **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:** -10 °C to +55 °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

APPENDIX 1: SPIDER SERIES COMPARISON

	Spider-81	Spider-81B	Spider-80X	Spider-80Xi
Number of Inputs	8 per module expandable to 512	2, 4 not-expandable	8 per module expandable to 512	8 per module 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
Notes	Flagship product for VCS line. Input protection up to 220V. 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.

APPENDIX 2: TYPICAL SYSTEM CONFIGURATIONS

The Spider hardware platform can operate in two working modes: Black Box and PC Tethered mode. When Spider runs in Black Box mode, preset projects are executed based on a user defined schedule. In PC tethered mode, the PC 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 your PC and LAN is either wired or wireless.

PC Tethered with One Spider Front-End

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

PC Tethered with Multiple Spider Front-Ends

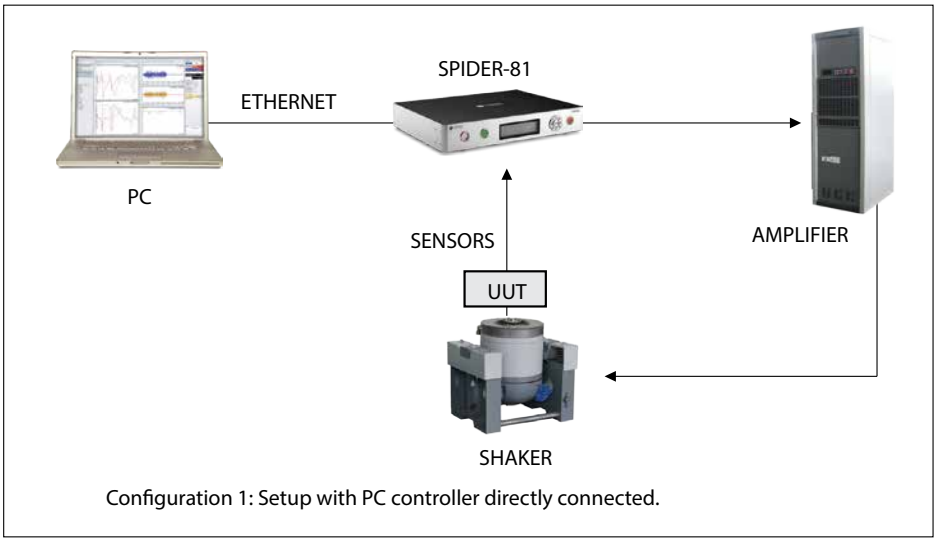
Multiple Spider modules are connected to form a high channel count system. Multiple switches are cascaded to extend the number of modules. For example, to make a 64 channel system, a Spider-81 and 7 Spider-80X's can be used. The PC is used as a control and monitoring terminal via the EDM software.

Black Box Mode with One Spider Front-End

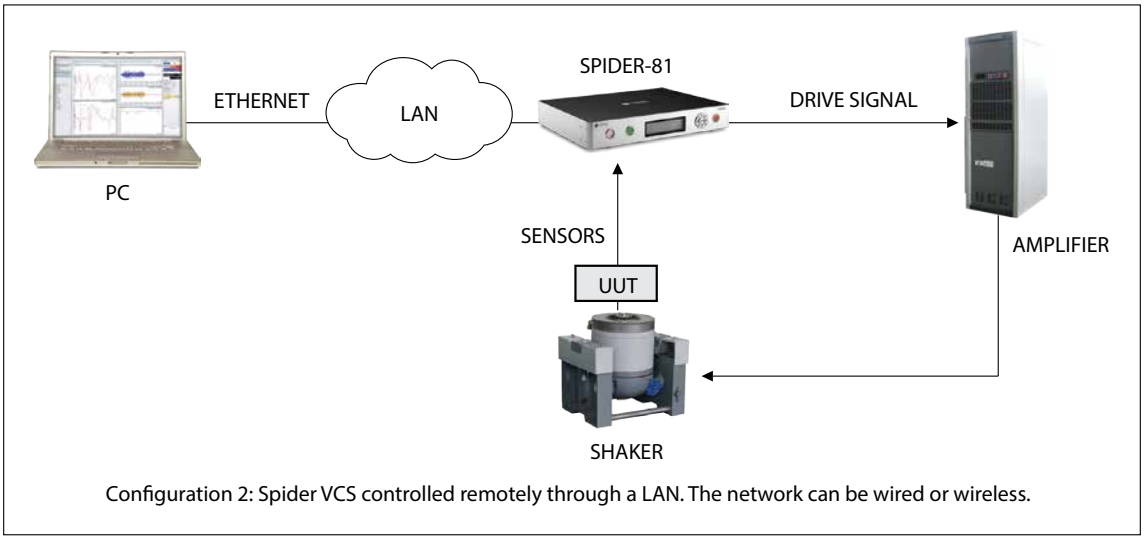
This is the same as Configuration 1 except that the PC is not required during run time. A PC is required to install the Spider Black Box engine to the Spider module, and is used to configure the Spider and to download data files.

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

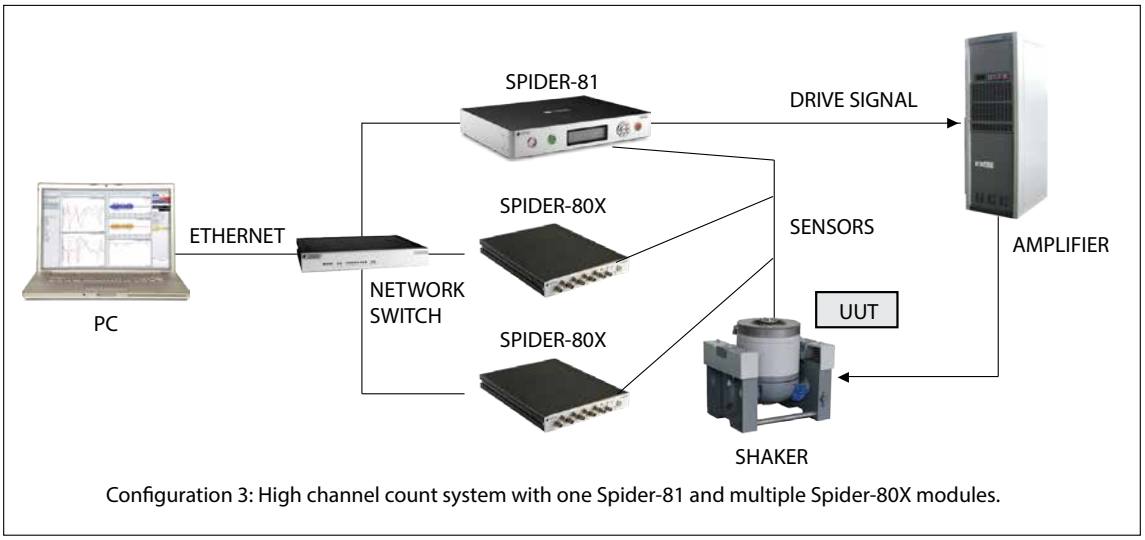
(see next page.)



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.