Campbell SCIENTIFIC | QUICK DEPLOY GUIDE

Spectrum Series

Spectral Analysis High-Speed Analog Input Module

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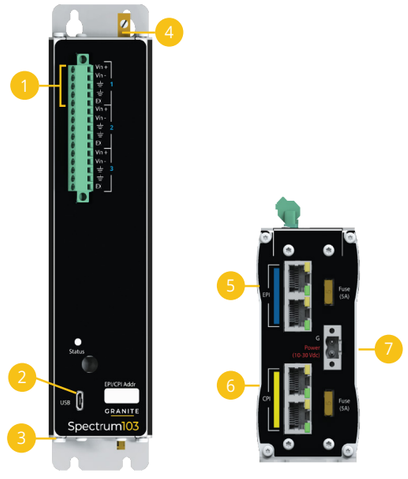
IMPORTANT NOTE: This Quick Deploy Guide is meant to be a general reference to give the installer an overview of the steps required to make this system operational. The product manuals are the definitive source for detailed installation instructions and information.

Diagram

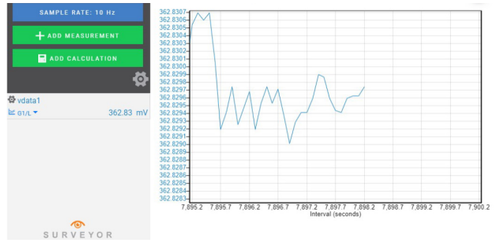
1. Measurement Channel
2. USB Connection
3. Mounting Tab
4. Chassis Ground
5. EPI Network Connection
6. CPI Network Connection
7. Power Connection (10–30 VDC)



Getting Started with Surveyor

Surveyor software enables the Spectrum to stream data directly to the PC, test sensor settings, view wiring diagrams, view live results, record directly to a PC, or create a CRBasic program.

1. Open *Surveyor* software.
2. Connect a USB cable between the Spectrum and the PC.
3. Power the Spectrum (10-30 VDC).
4. Select **Connect Now**.
5. Select the Spectrum from the Communication Port.
6. Configure Device settings as desired, click **Apply**.
7. Select a sample rate.



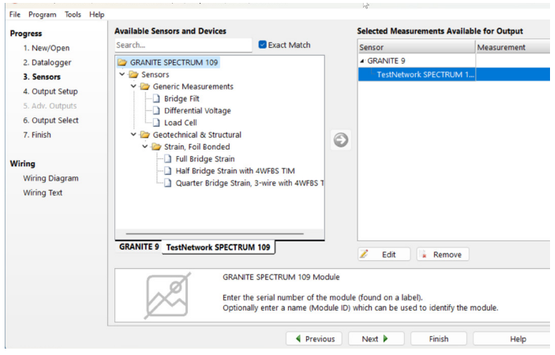
Data Logger Program Export
A CRBasic program can be created based on how a SPECTRUM is configured in Surveyor. Select File to Export a data logger program.

Download Surveyor:
campbellsci.com/cs-surveyor

Getting Started with ShortCut

ShortCut software streamlines the creation of a CRBasic program for reading multiple Spectrum modules. For advanced processing or data management, the CRBasic program can be more fully customized using the CRBasic Editor.

1. Open *ShortCut*.
2. Create a New Program.
3. Select the data logger type (Granite 9 & GRANITE 10 for EPI networks, CR6 and CR1000X for CPI networks).
4. Continue to follow the on-screen prompts through the software.
5. Send the program to the data logger or further modify it using the CRBasic Editor.



Introduction

The Spectrum series offers high-speed synchronous sampling for analog inputs, with dedicated analog input hardware, including amplifiers, filters, and ADCs.

The Spectrum 103 and 109 are 3 or 9 channel analog input modules. These channels offer selectable input ranges of ±200 mV, ±1 V, ±5 V, and 0-10 V, along with a programmable anti-aliasing filter for sample rates up to 10 kHz and 5 Khz bandwidths. These channels are digitized using a 32-bit ADC and offer channel-to-channel sampling synchronization within approximately ±10 ns.

When using the EPI bus for synchronization across multiple modules, module-to-module synchronization is achieved within approximately ±50 ns. Additionally, the Spectrum can perform FFTs on the measured channels.

Connecting the Spectrum to a Campbell Scientific Data Logger With EPI and CPI

Data loggers excel in long-term deployments, syncing multiple Spectrums, and integrating various measurements. Spectrums connect to data loggers via EPI or CPI networks using standard Ethernet cables (Cat 5e, Cat 6, or higher). EPI networks are ideal for SPECTRUM applications, but for smaller channel count setups, a single Spectrum can connect to a traditional CPI-enabled data logger like the CR6 or CR1000X. Data loggers like the GRANITE 9/10, with both EPI and CPI networks, can efficiently manage multiple devices across these networks under the control of the data logger CRBasic program.

EPI Overview

An EPI network is the preferred connection for a Spectrum due to superior time synchronization, higher bandwidth and multi-module support. A GRANITE 9 or GRANITE 10 can be used to link up to 10 Spectrums on an EPI network.

EPI Basics

- EPI networks offer 100 times greater throughput than CPI.
- Devices are daisy-chained, with a 100-meter cable limit between EPI devices.
- A GRANITE 9/10 supports one EPI network with two ports.
- Each Spectrum has two EPI ports for signal reception and regeneration, extending the network and resetting the 100-meter limit.
- A maximum of 10 EPI modules can be connected to a single EPI network.
- When using multiple Spectrums on an EPI network, assign a unique EPI address (1-120) to each module.
- Monitor EPI network capacity (percentage) in the host data logger EPI status table.

CPI Overview

Data loggers such as the CR6, CR1000X, or GRANITE6 can connect to a Spectrum using their CPI network. A CPI network works well for slower measurements (less than 1,000 Hz) with a single Spectrum module. Note: when a Spectrum is on a CPI network, no other CPI devices can be present.

CPI Basics

- Only one Spectrum can be on a CPI network.
- A CPI terminator may improve the network performance for long distance or high-speeds.
- The CPI network speed can be optimized for data speed or cable distance.
- The CPI Calculator (a downloadable Excel file from Campbell Scientific) can help determine CPI network capacity.
- Monitor the CPI network capacity (percentage) in the host data logger CPI status table.

Physical Deployment

The GRANITE series, including the Spectrum, can be mounted in a standard environmental enclosure, distributed across a site in different enclosures, or in a GRANITE Chassis. The GRANITE Chassis is a rugged housing offering portability or a mounting option in a server cabinet.

GRANITE equipment installed in the GRANITE Chassis

Modules connected using an EPI network allow connections between multiple modules in an enclosure and connections between modules in multiple enclosures.

CRBasic Tips & Tricks

The CRBasic Editor is a programming tool for data logger and Spectrum setup, measurement configuration, and data storage. Additionally, it can configure CPI, EPI devices, or CPI network settings. Surveyor and ShortCut can be used to generate CRBasic programs.

The following CRBasic instructions are used in the Spectrum:

Instruction	Function
CPIAddModule()	Configure the address of a Granite module.
CDM_VoltFilt()	Measure voltage with an antialias filter.
CDM_BridgeFilt()	Measure a resistive bridge with an antialias filter.
CDM_FFTFilt()	Perform a real-time Fast Fourier Transform (FFT).

CRBasic Tip: When using a CPI or EPI device, improve data logger performance by adjusting the CRBasic SCAN() BufferOption. Set it to approximately 400 for networks operating slower than 10 Hz and 1500 for networks measuring faster than 10 Hz. This allocates extra memory for the data logger to process incoming data from GRANITE modules while handling other tasks.

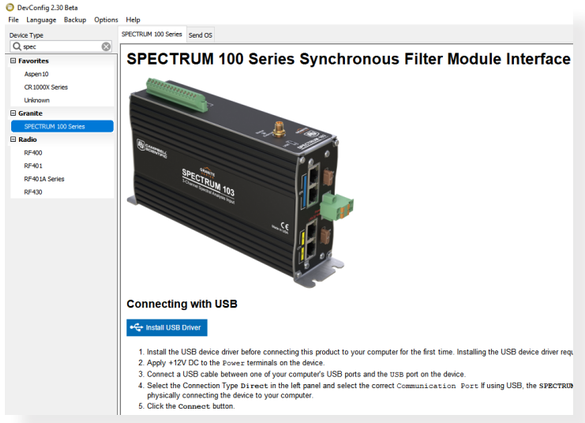
Example Program:
The following program highlights two Spectrums connected to a GRANITE 9/10. The program is measuring and recording all 12 sensors (a Spectrum 109 with 9 sensors and a Spectrum 103 with 3 sensors) using a 5 mSec (200 Hz) scan rate.

Lines 1-2: Declare variable names to be associated with the measurements.
Lines 4-7: Create a table called “All_Data” to store the measurements.
Lines 10-11: Add the Spectrums to the EPI network on the data logger.
Line 12: Measure every 5 milliseconds.
Lines 13-14: Perform the measurements on each module.
Line 15: Store data to the “All-Data” table.

```
1  Public Module1(9)                    'Declare 9 variables for voltage measurements on Spectrum 1
2  Public Module2(3)                    'Declare 3 variables for voltage measurements on Spectrum 2
3
4  DataTable(All_Data,True,-1)
5    Sample(9,Module1(1),IEEE4)                                  'Store Module 1 measurements
6    Sample(3,Module2(1),IEEE4)                                  'Store Module 2 measurements
7  EndTable
8
9  BeginProg
10   CPIAddModule(SPECTRUM109,1234,"Spectrum #1",EPI_BUS+1)      'Add Module 1 to the EPI Network
11   CPIAddModule(SPECTRUM103,1235,"Spectrum #2",EPI_BUS+2)      'Add Module 2 to the EPI Network
12   Scan(5,mSec,400,0)                                          'Main Scan at 5 miliseconds
13     CDM_VoltFilt(SPECTRUM109,EPI_BUS+1,Module1(),9,mV200,1,4,0,1,0)   'Measure 9 sensors, Module 1
14     CDM_VoltFilt(SPECTRUM103,EPI_BUS+2,Module2(),3,mV200,1,4,0,1,0)   'Measure 3 sensors, Module 2
15     CallTable All_Data                                        'Store measurements
16   NextScan
17 EndProg
```

Device Configuration Utility

Device Configuration Utility (DevConfig) is a tool for updating the Operating System (OS) and adjusting Spectrum settings. It can also set the module address, eliminating the need for the CPIAddModule() instruction in the CRBasic program.



Measurement Speed and Filter Options

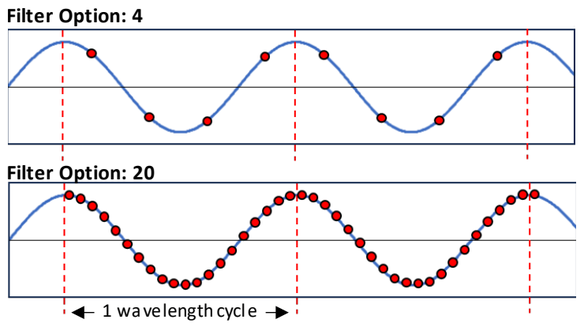
STEP 1 Determine the Fastest Signal:
Determine the highest expected frequency in the signal or system. For example, if measuring a structure like a bridge with an expected resonant frequency of 1-3 Hz, consider 3 Hz as the fastest signal. Specifying a measurement frequency that significantly exceeds the maximum bandwidth will increase noise in the signal.

STEP 2 Determine the Filter Option:
To prevent aliasing and ensure accurate signal reconstruction, the sample rate should be at least double the highest signal frequency (Nyquist theorem).

The Filter option, available in 4 and 20, represents oversampling. Filter Option 4 captures at least 4 points within a wavelength cycle of the fastest frequency. Filter Option 20 captures 20 points for a higher resolution visualization of the signal, but fundamentally does not contain more information about a sinusoidal signal than filter option 4.

Benefits of higher resolution (Filter Option 20) may include a smoother wave reconstruction during post processing or improved edge computing with a data logger program determining the minimum and/or maximum signal amplitude.

STEP 3 Determine the Scan Rate:
Calculate the minimum sample rate in the data logger program by multiplying the fastest sensor or system scan rate by the selected filter option.



Example:
Step 1: Determine the fastest frequency possible (fPass).
A user wants to measure a signal and determines the fastest frequency response possible is 25 Hz.
Step 2: Determine the filter option.
The user wants the highest fidelity signal possible to enable edge computing in the data logger program to monitor the maximum amplitudes of the signal. The desired Filter Option is chosen to be 20.
Step 3: Calculate the Scan rate (a.k.a. sample rate, or fSample)

- $\text{Scan Rate} = \frac{1}{(f_{Pass})(\text{Filter Option})} = \frac{1}{(25\text{Hz})(20)} = \frac{1}{500\text{Hz}} = 2\text{mSec}$

- This is how the scan rate is applied in a CRBasic program: Scan(2,mSec,1500,0)

Managing High Speed Data

Given the fast data collection of the Spectrum, effective data management is vital. Here are some tips:

1. **Streamline Data Collection**: Only keep necessary data. Adjust measurement or recording speeds to capture what is needed without excess.
2. **Use Event-Based Triggers**: They help filter and store relevant data.
3. **Local Data Processing**: Employ the data logger real-time tools like Rainflow histograms, averaging, statistics, or the FFT function with the Spectrum CRBasic instruction CDM_FFTFilt() to reduce large data volumes.
4. **Efficient Data Transfer**: For high-speed applications, use the integrated Ethernet port for fast and cost-effective data transfer. Ethernet may reduce concerns with cellular costs, Wi-Fi bandwidth, or USB throughput.
5. **FTP for Remote Transfers**: Use FTP to send data from the data logger to a remote server. FTP is reliable, automated, and ensures easy access to the data on the server.

Troubleshooting Tips

- Are the OS versions up to date on all devices within an EPI or CPI network, including the data logger, Spectrum, and other Granite modules?
- Is LoggerNet updated to the most recent version?
- Are all devices properly powered?
- Are all devices properly grounded?
- Ensure that the Spectrum Chassis ground is locally grounded. Avoid connecting the Chassis ground to distant ground locations.
- Is the addressing between modules and the CRBasic program accurate, with no duplicate addresses on the same network?
- Is the correct cable being used and are all connections secure?