Spectrum Specifications

Measurement and Control Peripheral

1. Specifications

All Spectrum units meet electrical specifications in a temperature range of –40 to 70 °C, non-condensing environment. Specifications given are assumed to be valid over this full temperature range unless otherwise noted. Recommended calibration interval is every three years.

1.1 Measurements

1.1.1 Analog inputs

Terminals	
SPECTRUM103:	3 Differential V in, 3 Excitation
SPECTRUM109:	±9 Differential V in, 9 Excitation
Common-mode input voltage (mV):	±10000, ±5000, ±1000, ±200
Common-mode input voltage:	±15 VDC
Absolute max input voltage:	±16 VDC
A/D converters:	32-bit SAR-ADCs
Measurement accuracy @ 20 °C	±(0.04% of Reading ± 130 µV)[1]
Input resistance:	80 MΩ
Input time constant:	230 ns
Input offset current:	5 nA typical, max @ 50 °C

[1] Accuracy specification does not include sensor error or measurement noise.

1.1.2 Analog range and resolution

Table 1-1: Sample ratio 20: signal to noise ratio (SNR) and effective resolution (ER)

Sample ratio = 20	200 mV		1000 mV		500 mV		1000 mV	
Sample rate	SNR dB	ER bits	SNR dB	ER bits	SNR dB	ER bits	SNR dB	ER bits
1	132.6	22.0	133.6	22.2	135.1	22.4	141.2	23.4
10	130.7	21.7	134.2	23.3	134.5	22.3	140.3	23.3
100	131.5	21.8	135.3	22.5	135.6	22.5	139.2	23.1
1000	129.1	21.4	132.8	22.1	133.7	22.2	136.9	22.7
10000	121.6	20.2	127.3	21.2	128.4	21.3	130.6	21.7

Table 1-2: Sample ratio 4: signal to noise ratio (SNR) and effective resolution (ER)

Sample ratio = 4	200 mV		1000 mV		500 mV		1000 mV	
Sample rate	SNR dB	ER bits	SNR dB	ER bits	SNR dB	ER bits	SNR dB	ER bits
1	126.9	21.1	134.1	22.3	136.2	22.6	140.4	23.3
10	127.6	21.2	133.7	22.2	136.0	22.6	139.9	23.2
100	129.0	21.4	133.7	22.2	135.4	22.5	138.3	23.0
1000	126.0	20.9	131.6	21.9	132.5	22.0	135.0	22.4
10000	118.1	19.6	124.8	20.7	125.8	20.9	127.6	21.2

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1.1.3 Anti-aliasing filters

Output sample rate (f samp):	1 to 10,000 sps
Sample ratio (f_samp/f_pass):	4 or 20 (user selected)
End of the pass band (f_pass):	(f_samp/4) or (f_samp/20)
Beginning of the pass band (f_stop):	(f_samp/2) or (f_samp/3.3)
Pass band ripple:	<0.01 dB
Digital filter stop band attenuation:	-90 dB or (1/32000)
Digital filter group delay:	12/f_samp seconds
Analog filter pass band flatness:	<0.005 dB (direct current (0 to 3 kHz)
Analog filter group delay:	66 ±1 µs (0 to 3 kHz)
Linear phase response:	group delay is independent of signal frequency
Ch-Ch sampling simultaneity:	± 10 ns
Module to Module sampling simultaneity over EPI:	± 100 ns

1.1.4 Excitations

10V excitation:
Nominal output: 10,000±5 mV (1 kΩ load)
Load regulation: (350 Ω): 0.005% typical (@25°C relative to 1 kΩ load)
Load regulation: (120 Ω): 0.02% typical (@25°C relative to 1 kΩ load)
Max output current: > 100 mA

5V excitation:
Nominal output: 5000±5 mV (1 kΩ load)
Load regulation: 0.005% typical (@25°C relative to 1 kΩ load)
Load regulation: 0.02% typical (@25°C relative to 1 kΩ load)
Max output current: > 100 mA

10 mA excitation:
Nominal output: 10±0.05 mA (1 kΩ load)
Load regulation: 0.1% typical (@25°C relative to 1 kΩ load)
Load regulation: (120 Ω): 0.02% typical (@25°C relative to 1 kΩ load)
Max output voltage: > 12 V

NOTE:
For bridge measurements, excitation error is canceled out due to the internal ratiometric relationship between the excitation and the input measurement and is corrected with internal calibration. This advantage is realized when the excitation is utilized as part of the integrated CRBasic bridge measurement process. Consequently, excitation accuracy error can be disregarded and should not be included in the calculation of total error alongside input measurement accuracy error. Instead, refer only to the specified input measurement accuracy when performing bridge measurements.

1.2 System

1.2.1 Communications

USB: USB micro-B device only, 2.0 full-speed 12 Mbps, for computer connection.

EPI: Campbell Scientific proprietary interface based on Ethernet and the IEEE 1588 Precision Time Protocol. Provides data communications and device synchronization between Campbell Scientific data loggers, sensors, and GRANITE Modules.

Data logger compatibility: GRANITE 9, 10
EPI max number of Spectrum devices: 10
EPI max measurement sample rate: 10k sample/sec (using subscans)
EPI max sampling synchronization: 50 ηs
EPI max data bit rate: 100 Mbps
EPI max cable length: 100 meters (328 feet) between modules

CPI: CPI works well for slower measurements (< 1,000 Hz) with a single Spectrum module.

Campbell Scientific proprietary interface based on the CAN 2.0 and RS-485 standards.

Data logger compatibility: GRANITE 9, GRANITE 10, GRANITE 6, CR6, CR1000X
CPI max number of devices: 1
CPI max measurement sample rate: 1000 samples/sec (no subscan option)
CPI max data bit rate: 1000 kbps
CPI max total cable length: 850 meters (2800 feet)[1]
[1]See Designing Physical Network Layouts for the CPI Bus.

1.2.2 Hardware

Processor:	Digital Signal Processor 32-bit with floating point units
Processor speed:	400 MHz
Memory:	128 MB SRAM
Onboard oscillator accuracy:	± 50 ppm (-10 to 60°C), active when module is not connected to EPI
EPI master clock accuracy:	± 25 ppm (-40 to 85°C), active when module is connected to EPI

1.2.3 Power requirements

Voltage: 10 to 30 VDC

Table 1-3: Typical current drain				
Model	Power supply			
	@12V without excitation	@12V with excitation	@24V without excitation	@24V with excitation
103	310 mA typical	310 mA + 3.3 *sensor_ current	190 mA	190 mA + 1.7 *sensor_ current
109	680 mA typical	680 mA + 3.3 *sensor_ current	360 mA	360 mA + 1.7 *sensor_ current

NOTE:
Power consumption is independent of measurement speed.

1.2.4 Compliance

View EU Declarations of Conformity at www.campbellsci.com/spectrum.

1.2.5 Physical attributes

Dimensions:	21.6 x 13.7 x 7.6 cm (8.5 x 5.4 x 3.0 in); additional clearance required for cables and wires
Weight:	1.6 kg (3.53 lb)
Operating temperature:	–40 to 70 °C
Storage temperature:	–55 to 85 °C
Passive heat sink thermal resistance w/o air gap:	Max 0.35 °C/W
Air gap clearance for operation w/o heatsink:	Min 4 inches
IP rating:	IP20
Humidity:	0 to 99% Non-condensing
Sensor terminal wire gage:	16-28 AWG
Power terminal wire gage:	2-24 AWG