



## CR310

Measurement and Control Datalogger with Ethernet

All CR310 dataloggers are tested and guaranteed to meet electrical specifications in a standard  $-40^{\circ}$  to  $+70^{\circ}\text{C}$  non-condensing environment. Datalogger recalibration is recommended every three years. System configuration and critical specifications should be confirmed with Campbell Scientific before purchase.

## ANALOG

Six terminals may be configured to make analog voltage or ratiometric measurements or configured as digital I/O.

## VOLTAGE MEASUREMENTS (SE1 – SE6)

Up to three differential or six single-ended terminals configured for voltage measurements using a 24-bit Adc, one at a time.

INPUT RESISTANCE:  $5\ \text{G}\Omega$  ( $f_{\text{NI}} = 50/60$ ),  $300\ \text{M}\Omega$  ( $f_{\text{NI}} = 4000$ )

INPUT LIMITS:  $-100\ \text{mV}$  to  $+2500\ \text{mV}$

SUSTAINED INPUT VOLTAGE WITHOUT DAMAGE:  $-6\ \text{V}/+9\ \text{V}$  (SE1, SE2),  $\pm 17\ \text{V}$  (SE3 to SE6)

DC COMMON MODE REJECTION:  $> 120\ \text{dB}$  with input reversal ( $\geq 90\ \text{dB}$  without input reversal)

NORMAL MODE REJECTION:  $> 71\ \text{dB}$  @  $50\ \text{Hz}$ ,  $> 74\ \text{dB}$  @  $60\ \text{Hz}$

INPUT CURRENT @  $25^{\circ}\text{C}$ :  $\pm 0.8\ \text{nA}$  ( $f_{\text{NI}} = 50/60$ ),  $\pm 13\ \text{nA}$  ( $f_{\text{NI}} = 4000$ )

RANGE AND RESOLUTION:

Notch Frequency ( $f_{\text{NI}}$ ) (Hz)	Range <sup>1</sup> (mV)	Typical Resolution <sup>2</sup> (Differential w/Input Reversal)		Typical Resolution <sup>2</sup> (Differential w/o Input Reversal)	
		Effective Resolution		Effective Resolution	
		RMS $\mu\text{V}$	bits	RMS $\mu\text{V}$	bits
4000	$-100$ to $+2500$	23	16.8	33	16.3
	$-34$ to $+34$	3.0	14.5	4.2	14.0
400	$-100$ to $+2500$	3.8	19.4	5.4	18.9
	$-34$ to $+34$	0.58	16.8	0.82	16.3
50/60	$-100$ to $+2500$	1.6	20.6	2.3	20.1
	$-34$ to $+34$	0.23	18.2	0.33	17.7

ACCURACY:<sup>4,5</sup>

$0^{\circ}$ to $40^{\circ}\text{C}$	$-40^{\circ}$ to $70^{\circ}\text{C}$
$\pm(0.04\%$ of reading + offset)	$\pm(0.1\%$ of reading + offset)

OFFSETS:

Range (mV)	Differential with Input Reversal ( $\mu\text{V}$ )	Differential without Input Reversal ( $\mu\text{V}$ )	Single-Ended ( $\mu\text{V}$ )
$-100$ to $+2500$	$\pm 20$	$\pm 40$	$\pm 60$
$-34$ to $+34$	$\pm 6$	$\pm 14$	$\pm 20$

MEASUREMENT SPEED: (multiplexed measurement time (ms) \* reps + 0.8 ms)

$f_{\text{NI}}$ (Hz)	Multiplexed Measurement Time (ms)	
	w/Input Reversal	SE or w/o Input Reversal
4000	2.9	1.4
400	14.6	7.3
50/60	103	51.5

DEFAULT SETTling TIME:  $500\ \mu\text{s}$

## RATIOMETRIC MEASUREMENTS (SE1 – SE6)

Resistance measurements for four- and six-wire full bridge and two-, three-, and four-wire half bridge using voltage excitation.

RATIOMETRIC ACCURACY:<sup>4,5</sup>

$0^{\circ}$ to $40^{\circ}\text{C}$	$-40^{\circ}$ to $70^{\circ}\text{C}$
$\pm(0.05\%$ of voltage measurement + offset)	$\pm(0.06\%$ of voltage measurement + offset)

## CURRENT MEASUREMENTS (SE1, SE2)

Two analog inputs may be configured as independent  $0$  to  $20\ \text{mA}$  or  $4$  to  $20\ \text{mA}$  current loop inputs (not isolated) measured one at a time using the 24-bit Adc

ACCURACY:

$0^{\circ}$ to $40^{\circ}\text{C}$	$-40^{\circ}$ to $70^{\circ}\text{C}$
$\pm 0.14\%$ of reading	$\pm 0.26\%$ of reading

## DIGITAL

## PERIOD AVERAGE (SE1 – SE4)

Up to four analog inputs can be used for period averaging, one at a time.

ACCURACY:  $\pm(0.01\%$  of reading + resolution), where resolution is 13 ns divided by the specified number of cycles to be measured.

FREQUENCY RANGE:  $5\ \text{Hz}$  to  $200\ \text{kHz}$

VOLTAGE THRESHOLD: counts cycles on transition from  $<0.9\ \text{Vdc}$  to  $>2.1\ \text{Vdc}$

## DIGITAL I/O (SE1 – SE4, P\_SW)

I/O HIGH STATE:  $3.3\ \text{V}$

I/O LOW STATE:  $0\ \text{V}$

DRIVE CURRENT @  $3.0\ \text{V}$ :  $100\ \mu\text{A}$

MAXIMUM INPUT VOLTAGE:  $-6\ \text{V}/+9\ \text{V}$  (SE1, SE2),  $\pm 17\ \text{V}$  (SE3, SE4, P\_SW)

## DIGITAL I/O (C1, C2)

I/O HIGH STATE:  $5.0\ \text{V}$  (output);  $3.3\ \text{V}$  logic (input)

I/O LOW STATE:  $0\ \text{V}$

DRIVE CURRENT @  $3.5\ \text{V}$ :  $10\ \text{mA}$

MAXIMUM INPUT VOLTAGE:  $-10\ \text{V}/+15\ \text{V}$

<sup>1</sup>Range overhead of  $\sim 10\%$  beyond range guarantees that full-scale values will not cause over range.

<sup>2</sup>Effective resolution (ER) in bits is computed from ratio of full-scale range to RMS resolution.

<sup>3</sup>Accuracy does not include the sensor and measurement noise.

<sup>4</sup>Assumes input reversal for differential measurements not including bridge resistor errors and sensor and measurement noise.

<sup>5</sup>Ratiometric accuracy, rather than absolute accuracy, determines overall measurement accuracy of ratiometric resistance measurements.

More info: 435.227.9120

[campbellsci.com/cr310](http://campbellsci.com/cr310)



## PULSE COUNTING

### SWITCH CLOSURE (P\_SW)

MINIMUM SWITCH CLOSED TIME: 3 ms  
MINIMUM SWITCH OPEN TIME: 3 ms  
MAXIMUM BOUNCE TIME: 1 ms open w/o being counted  
MAXIMUM INPUT FREQUENCY: 150 Hz  
MAXIMUM INPUT VOLTAGE:  $\pm 17$  Vdc

### SWITCH CLOSURE (C1, C2)<sup>6</sup>

MAXIMUM INPUT FREQUENCY: 150 Hz  
MINIMUM SWITCH OPEN TIME: 3 ms

### HIGH-FREQUENCY (C1, C2, SE1 – SE4, P\_SW, P\_LL)

C1-C2: 3 kHz, maximum,  
SE1-SE4: 35 kHz, maximum  
P\_SW: 35 kHz, maximum  
P\_LL: 20 kHz, maximum

### LOW-LEVEL AC (P\_LL)

RANGE (dependent on sine wave input)<sup>7</sup>

Sine Wave (mV RMS)	Range (Hz)
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

INPUT HYSTERESIS: 12 mV @ 1 Hz  
MAXIMUM AC INPUT VOLTAGE:  $\pm 20$  V

## VOLTAGE OUTPUT

### SWITCHED 12 V (BATTERY)<sup>8</sup>

One output provides unregulated 12 V (battery voltage) source under program control. Thermal fuse hold current = 1200 mA @ 0°C, 1100 mA @ 20°C, 830 mA @ 60°C.

### 0.15 TO 5 V ANALOG OUTPUTS (VX1, VX2)<sup>9</sup>

Two terminals configured for 150 to 5000 mV continuous analog output or voltage excitation using 12-bit Dac.

Range	Resolution	Maximum Source/Sink Current
150 to +5000 mV	4.5 mV	50 mA total, concurrent or individually

## COMMUNICATIONS

### ETHERNET PORT:

RJ45/ jack  
10/100Base-TX, full and half duplex Auto-MDIX  
Magnetic isolation and TVS surge protection

### INTERNET PROTOCOLS:

Ethernet, PPP, ICMP/Ping, Auto-IP(APIPA), IPv4, IPv6, UDP, TCP, TLS, DHCP, SLAAC, DNS Client, SNMP, NTP, Telnet, HTTP/HTTPS, FTP/FTPS, SMTP/TLS, POP3/TLS

### ADDITIONAL PROTOCOLS SUPPORTED:

PakBus, PakBus Encryption, SDI-12, Modbus RTU/ASCII/TCP, DNP3/TCP, NTCIP, NMEA 0183. Custom user definable over serial, TCP, and UDP

### DATA FILE FORMATS:

CSV, XML, JSON, binary

### USB:

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

### RS-232:

female RS-232, 9-pin interface

### SERIAL (C1, C2):

0 to 5 V output, 1200 to 115.2k bps

### SDI-12 (C1, C2):

Two independent SDI-12 V1.3 compliant terminals configurable as sensor or recorder

<sup>6</sup> Requires an external 100 k $\Omega$  resistor connected from the terminal to BAT+.

<sup>7</sup> AC coupling removes ac offsets up to  $\pm 0.05$  V.

<sup>8</sup> Not operational under USB power only.

<sup>9</sup> Range reduced to 0 to 2500 mV when under USB power.

## ON-BOARD RADIO

RADIO TYPE:

CR310-RF407, CR310-RF412	CR310-RF422
Frequency Hopping Spread Spectrum Radios (FHSS)	SRD860 Radio with Listen before talk (LBT) and Automatic Frequency Agility (AFA)

TRANSMIT:

	CR310-RF407	CR310-RF412	CR310-RF422
Output Power	5 to 250 mW, user selectable		2 to 25 mW, user selectable
Frequency	902 to 928 MHz (US, Canada)	915 to 928 MHz (Australia, New Zealand)	863 to 870 MHz (European Union)
Channel Capacity	Eight 25-channel hop sequences sharing 64 available channels	Eight 25-channel hop sequences sharing 31 available channels	Ten 30-channel hop sequences
RF Data Rates	200 kbps		10 kbps

RECEIVE SENSITIVITY:

CR310-RF407, CR310-RF412	CR310-RF422
-101 dBm	-106 dBm

ANTENNA CONNECTOR: Reverse Polarity SMA (RPSMA)

## WLAN (CR310-WIFI only)

MAXIMUM POSSIBLE THROUGHPUT: 30 Mbps  
MAXIMUM POSSIBLE OVER-THE-AIR DATA RATES:

802.11b	802.11g	802.11n
up to 11 Mbps	up to 54 Mbps	up to 72 Mbps

OPERATING FREQUENCY: 2.4 GHz, 20 MHz bandwidth

ANTENNA CONNECTOR: Reverse Polarity SMA (RPSMA)

SUPPORTED STANDARDS: IEEE 802.11 b/g/n, IEEE 802.11d/e/i, 802.1X, WEP, WPA/WPA2-Personal and Enterprise

OPERATIONAL MODES: Client or Access Point

TRANSMIT POWER: 7 to 18 dBm

Rx SENSITIVITY: -97 dBm

## SYSTEM

PROCESSOR: ARM Cortex M4 running at 144 MHz

### MEMORY

CPU DRIVE / PROGRAMS: 80 MB flash

DATA: 30 MB flash

OPERATING SYSTEM (OS): 2 MB flash

CLOCK ACCURACY:  $\pm 1$  min. per month

CLOCK RESOLUTION: 1 ms

PROGRAM EXECUTION: 100 ms to one day

## POWER REQUIREMENTS

CHARGER INPUT (CHG): 16 to 32 Vdc, current limited at 0.9 A.  
Power converter or solar panel input.

EXTERNAL BATTERIES (BAT): 12 Vdc, lead-acid 7 Ah battery, typical

INTERNAL LITHIUM BATTERY: 3 V coin cell CR2016 (Energizer) for battery-backed clock. 6 year life with no external power source.

### TYPICAL POWER REQUIREMENTS

SLEEP: 1.5 mA

ACTIVE 1 HZ SCAN WITH ONE ANALOG MEASUREMENT: 5 mA

ACTIVE PROCESSOR ALWAYS ON: 23 mA

ETHERNET:

Idle	Active
32 mA	51 mA

