

# CR1000X Specifications



Data Logger

Electrical specifications are valid over a -40 to +70 °C, non-condensing environment, unless otherwise specified. Extended electrical specifications (noted as XT in specifications) are valid over a -55 to +85 °C non-condensing environment. Recalibration is recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

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## System specifications

**Processor:** Renesas RX63N (32-bit with hardware FPU, running at 100 MHz)

### Memory:

- Total onboard: 128 MB of flash + 4 MB battery-backed SRAM
  - Data storage: 4 MB SRAM + 72 MB flash (extended data storage automatically used for auto-allocated Data Tables not being written to a card)
  - CPU drive: 30 MB flash
  - OS load: 8 MB flash
  - Settings: 1 MB flash
  - Reserved (not accessible): 10 MB flash
- Data storage expansion: Removable microSD flash memory, up to 16 GB

**Program Execution Period:** 1 ms to 1 day

### Real-Time Clock:

- Battery backed while external power is disconnected
- **Resolution:** 1 ms
- **Accuracy:** ±3 min. per year, optional GPS correction to ±10 µs

**Wiring Panel Temperature:** Measured using a 10K3A1A BetaTHERM thermistor, located between the two rows of analog input terminals.

## Physical specifications

**Dimensions:** 23.8 x 10.1 x 6.2 cm (9.4 x 4.0 x 2.4 in); additional clearance required for cables and wires.

**Weight/Mass:** 0.86 kg (1.9 lb)

**Case Material:** Powder-coated aluminum

## Power requirements

**Protection:** Power inputs are protected against surge, over-voltage, over-current, and reverse power. IEC 61000-4 Class 4 level.

### Power In Terminal:

- **Voltage Input:** 10 to 18 VDC
- **Input Current Limit at 12 VDC:**
  - 4.35 A at -40 °C
  - 3 A at 20 °C
  - 1.56 A at 85 °C
- 30 VDC sustained voltage limit without damage.

**USB Power:** Functions that will be active with USB 5 VDC include sending programs, adjusting data logger settings, and making some measurements. If USB is the only power source, then the CS I/O port and the 5V, 12V, and SW12 terminals will not be operational.

**Internal Lithium Battery:** AA, 2.4 Ah, 3.6 VDC (Tadiran TL 5903/S) for battery-backed SRAM and clock. 3-year life with no external power source.

## Average Current Drain:

Assumes 12 VDC on POWER IN terminals.

- **Idle:** <1 mA
- **Active 1 Hz Scan:** 1 mA
- **Active 20 Hz Scan:** 55 mA
- **Serial (RS-232/RS-485):** Active + 25 mA
- **Ethernet Power Requirements:**
  - **Ethernet 1 Minute:** Active + 1 mA
  - **Ethernet Idle:** Active + 4 mA
  - **Ethernet Link:** Active + 47 mA

**Vehicle Power Connection:** When primary power is pulled from the vehicle power system, a second power supply OR charge regulator may be required to overcome the voltage drop at vehicle start-up.

## Power output specifications

### System power out limits (when powered with 12 VDC)

Temperature (°C)	Current limit <sup>1</sup> (A)
-40°	4.53
20°	3.00
70°	1.83
85°	1.56

<sup>1</sup> Limited by self-resetting thermal fuse

### 12 V and SW12 V power output terminals

12V, SW12-1, and SW12-2: Provide unregulated 12 VDC power with voltage equal to the Power Input supply voltage. These are disabled when operating on USB power only.

SW12 current limits	
Temperature (°C)	Current limit <sup>1</sup> (mA)
-40°	1310
0°	1004
20°	900
50°	690
70°	550
80°	470

<sup>1</sup> Thermal fuse hold current.

### 5 V fixed output

5V: One regulated 5 V output. Supply is shared between the 5V terminal and CS I/O DB9 5 V output.

- **Voltage Output:** Regulated 5 V output (±5%)
- **Current Limit:** 230 mA

## C as power output

- C Terminals:
  - **Output Resistance ( $R_o$ ):** 150  $\Omega$
  - **5 V Logic Level Drive Capacity:** 10 mA @ 3.5 VDC
  - **3.3 V Logic Level Drive Capacity:** 10 mA @ 1.8 VDC

## CS I/O pin 1

5 V Logic Level Max Current: 200 mA

## Voltage excitation

**VX:** Four independently configurable voltage terminals (VX1-VX4). When providing voltage excitation, a single 16-bit DAC shared by all VX outputs produces a user-specified voltage during measurement only. VX terminals can also be used to supply a selectable, switched, regulated 3.3 or 5 VDC power source to power digital sensors and toggle control lines.

	Range	Resolution	Accuracy	Maximum source/sink current <sup>1</sup>
Voltage Excitation	±4 V	0.06 mV	±(0.1% of setting + 2 mV)	±40 mA
Switched, Regulated	+3.3 or 5 V	3.3 or 5 V	±5%	50 mA

<sup>1</sup> Exceeding current limits causes voltage output to become unstable. Voltage should stabilize when current is reduced to within stated limits.

## Analog measurement specifications

16 single-ended (SE) or 8 differential (DIFF) terminals individually configurable for voltage, thermocouple, current loop, ratiometric, and period average measurements, using a 24-bit ADC. One channel at a time is measured.

## Voltage measurements

**Terminals:**

- **Differential Configuration:** DIFF 1H/1L – 8H/8L
- **Single-Ended Configuration:** SE1 – SE16

**Input Resistance:** 20 G $\Omega$  typical

**Input Voltage Limits:** ±5 V

**Sustained Input Voltage without Damage:** ±20 VDC

**DC Common Mode Rejection:**

- > 120 dB with input reversal
- ≥ 86 dB without input reversal

**Normal Mode Rejection:** > 70 dB @ 60 Hz

**Input Current @ 25 °C:** ±1 nA typical

**Filter First Notch Frequency ( $f_{N1}$ ) Range:** 0.5 Hz to 31.25 kHz (user specified)

## Analog Range and Resolution:

		Differential with input reversal		Single-ended and differential without input reversal	
Notch frequency (f <sub>N1</sub> ) (Hz)	Range <sup>1</sup> (mV)	RMS (μV)	Bits <sup>2</sup>	RMS (μV)	Bits <sup>2</sup>
15000	±5000	8.2	20	11.8	19
	±1000	1.9	20	2.6	19
	±200	0.75	19	1.0	18
50/60 <sup>3</sup>	±5000	0.6	24	0.88	23
	±1000	0.14	23	0.2	23
	±200	0.05	22	0.08	22
5	±5000	0.18	25	0.28	25
	±1000	0.04	25	0.07	24
	±200	0.02	24	0.03	23

<sup>1</sup> Range overhead of ~5% on all ranges guarantees that full-scale values will not cause over range

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

<sup>3</sup> 50/60 corresponds to rejection of 50 and 60 Hz ac power mains noise.

**Accuracy** (does not include sensor or measurement noise):

- 0 to 40 °C: ±(0.04% of measurement + offset)
- 40 to 70 °C: ±(0.06% of measurement + offset)

**Voltage Measurement Accuracy Offsets:**

Range (mV)	Typical offset (μV RMS)	
	Differential with input reversal	Single-ended or differential without input reversal
±5000	±0.5	±2
±1000	±0.25	±1
±200	±0.15	±0.5

**Measurement Settling Time:** 20 μs to 600 ms; 500 μs default

**Multiplexed Measurement Time:**

Measurement time = INT(multiplexed measurement time • (reps+1) + 2ms

		Differential with input reversal	Single-ended or differential without input reversal
Example fN1 <sup>1</sup> (Hz)	Time <sup>2</sup> (ms)	Time <sup>2</sup> (ms)	Time <sup>2</sup> (ms)
15000	2.04	1.02	
60	35.24	17.62	

	Differential with input reversal	Single-ended or differential without input reversal
Example fN1 <sup>1</sup> (Hz)	Time <sup>2</sup> (ms)	Time <sup>2</sup> (ms)
50	41.9	20.95
5	401.9	200.95

<sup>1</sup> Notch frequency (1/integration time).

<sup>2</sup> Default settling time of 500 μs used.

## Resistance measurement specifications

The data logger makes ratiometric-resistance measurements for four- and six-wire full-bridge circuits and two-, three-, and four-wire half-bridge circuits using voltage excitation. Excitation polarity reversal is available to minimize dc error.

**Accuracy:**

Assumes input reversal for differential measurements **RevDiff** and excitation reversal **RevEx** for excitation voltage <1000 mV. Does not include bridge resistor errors or sensor and measurement noise.

- 0 to 40 °C: ±(0.01% of voltage measurement + offset)
- 40 to 70 °C: ±(0.015% of voltage measurement + offset)
- 55 to 85 °C (XT): ±(0.02% of voltage measurement + offset)

## Period-averaging measurement specifications

**Terminals:** SE1-SE16

**Accuracy:** ±(0.01% of measurement + resolution), where resolution is 0.13 μs divided by the number of cycles to be measured

**Ranges:**

- Minimum signal centered around specified period average threshold.
- Maximum signal centered around data logger ground.
- Maximum frequency = 1/(2 \* [minimum pulse width]) for 50% duty cycle signals

Gain code option	Voltage gain	Minimum peak to peak signal (mV)	Maximum peak to peak signal (V)	Minimum pulse width (μs)	Maximum frequency (kHz)
0	1	500	10	2.5	200
1	2.5	50	2	10	50
2	12.5	10	2	62	8
3	64	2	2	100	5

## Current-loop measurement specifications

The data logger makes current-loop measurements by measuring across a current-sense resistor associated with the RS-485 resistive ground terminal.

**Terminals:** RG1 and RG2

**Maximum Input Voltage:** ±16 V

**Resistance to Ground:** 101 Ω

**Current Measurement Shunt Resistance:** 10 Ω

**Maximum Current Measurement Range:** ±80 mA

**Absolute Maximum Current:** ±160 mA

**Resolution:** ≤ 20 nA

**Accuracy:** ±(0.1% of reading + 100 nA) @ -40 to 70 °C

## Pulse measurement specifications

Two inputs (P1-P2) individually configurable for switch closure, high-frequency pulse, or low-level AC measurements. See also [Digital input/output specifications](#) (p. 4). Each terminal has its own independent 32-bit counter.

### NOTE:

Conflicts can occur when a control port pair is used for different instructions ([TimerInput\(\)](#), [PulseCount\(\)](#), [SDI12Recorder\(\)](#), [WaitDigTrig\(\)](#)). For example, if C1 is used for [SDI12Recorder\(\)](#), C2 cannot be used for [TimerInput\(\)](#), [PulseCount\(\)](#), or [WaitDigTrig\(\)](#).

**Maximum Input Voltage:** ±20 VDC

**Maximum Counts Per Channel:** 2<sup>32</sup>

**Maximum Counts Per Scan:** 2<sup>32</sup>

**Input Resistance:** 5 kΩ

**Accuracy:** ±(0.02% of reading + 1/scan)

## Switch closure input

**Terminals:** C1-C8

**Pull-Up Resistance:** 100 kΩ to 5 V

**Event:** Low (<0.8 V) to High (>2.5 V)

**Maximum Input Frequency:** 150 Hz

**Minimum Switch Closed Time:** 5 ms

**Minimum Switch Open Time:** 6 ms

**Maximum Bounce Time:** 1 ms open without being counted

## High-frequency input

**Terminals:** C1-C8

**Pull-Up Resistance:** 100 kΩ to 5 V

**Event:** Low (<0.8 V) to High (>2.5 V)

**Maximum Input Frequency:** 250 kHz

## Low-level AC input

**Minimum Pull-Down Resistance:** 10 kΩ to ground

**DC-offset rejection:** Internal AC coupling eliminates DC-offset voltages up to ±0.05 VDC

**Input Hysteresis:** 12 mV at 1 Hz

**Low-Level AC Pulse Input Ranges:**

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

## Digital input/output specifications

Terminals configurable for digital input and output (I/O) including status high/low, pulse width modulation, external interrupt, edge timing, switch closure pulse counting, high-frequency pulse counting, UART<sup>1</sup>, RS-232<sup>2</sup>, RS-422<sup>3</sup>, RS-485<sup>4</sup>, SDM<sup>5</sup>, SDI-12<sup>6</sup>, I2C<sup>7</sup>, and SPI<sup>8</sup> function. Terminals are configurable in pairs for 5 V or 3.3 V logic for some functions.

### NOTE:

Conflicts can occur when a control port pair is used for different instructions ([TimerInput\(\)](#), [PulseCount\(\)](#), [SDI12Recorder\(\)](#), [WaitDigTrig\(\)](#)). For example, if C1 is used for [SDI12Recorder\(\)](#), C2 cannot be used for [TimerInput\(\)](#), [PulseCount\(\)](#), or [WaitDigTrig\(\)](#).

**Terminals:** C1-C8

**Maximum Input Voltage:** ±20 V

**Logic Levels and Drive Current:**

Terminal pair configuration	5 V source	3.3 V source
Logic low	≤ 1.5 V	≤ 0.8 V
Logic high	≥ 3.5 V	≥ 2.5 V
C1 - C8	10 mA @ 3.5V	10 mA @ 1.85V

<sup>1</sup>Universal Asynchronous Receiver/Transmitter for asynchronous serial communications.

<sup>2</sup>Recommended Standard 232. A loose standard defining how two computing devices can communicate with each other. The implementation of RS-232 in Campbell Scientific data loggers to computer communications is quite rigid, but transparent to most users. Features in the data logger that implement RS-232 communications with smart sensors are flexible.

<sup>3</sup>Communications protocol similar to RS-485. Most RS-422 sensors will work with RS-485 protocol.

<sup>4</sup>Recommended Standard 485. A standard defining how two computing devices can communicate with each other.

<sup>5</sup>Synchronous Device for Measurement. A processor-based peripheral device or sensor that communicates with the data logger via hardware over a short distance using a protocol proprietary to Campbell Scientific.

<sup>6</sup>Serial Data Interface at 1200 baud. Communications protocol for transferring data between the data logger and SDI-12 compatible smart sensors.

<sup>7</sup>Inter-Integrated Circuit is a multi-controller, multi-peripheral, packet switched, single-ended, serial computer bus.

<sup>8</sup>Serial Peripheral Interface - a clocked synchronous interface, used for short distance communications, generally between embedded devices.

## Edge timing

**Terminals:** C1-C8

**Maximum Input Frequency:**  $\leq 1$  kHz

**Resolution:** 500 ns

## Edge counting

**Terminals:** C1-C8

**Maximum Input Frequency:**  $\leq 2.3$  kHz

## Quadrature input

**Terminals:** C1-C8 can be configured as digital pairs to monitor the two sensing channels of an encoder.

**Maximum Frequency:** 2.5 kHz

**Resolution:** 31.25  $\mu$ s or 32 kHz

## Pulse-width modulation

**Maximum Period:** 36.4 seconds

**Resolution:**

- 0 – 5 ms: 83.33 ns
- 5 – 325 ms: 5.33  $\mu$ s
- > 325 ms: 31.25  $\mu$ s

## Communications specifications

**Ethernet Port:** RJ45 jack, 10/100Base Mbps, full and half duplex, Auto-MDIX, magnetic isolation, and TVS surge protection.

**Internet Protocols:** Ethernet, PPP, RNDIS, ICMP/Ping, Auto-IP (APIPA), IPv4, IPv6, UDP, TCP, TLS (v1.2), DNS, DHCP, SLAAC, Telnet, HTTP(S), SFTP, FTP(S), POP3/TLS, NTP, SMTP/TLS, SNMPv3, CS I/O IP, MQTT

**Additional Protocols:** CPI, PakBus, PakBus Encryption, SDM, SDI-12, Modbus RTU / ASCII / TCP, DNP3, custom user definable over serial, NTCIP, NMEA 0183, I2C, SPI

**USB Device:** Micro-B device for computer connectivity

**CS I/O:** 9-pin D-sub connector to interface with Campbell Scientific CS I/O peripherals.

**SDI-12 (C1, C3, C5, C7):** Four independent SDI-12 compliant terminals are individually configured and meet SDI-12 Standard v 1.4.

**RS-485 (C5 to C8):** One full duplex or two half duplex

**RS-422 (C5 to C8):** One full duplex or two half duplex

**RS-232/CPI:** Single RJ45 module port that can operate in one of two modes: CPI or RS-232. CPI interfaces with Campbell Scientific CDM measurement peripherals and sensors. RS-232 connects, with an adapter cable, to computer, sensor, or communications devices serially.

**CPI:** One CPI bus. Up to 1 Mbps data rate. Synchronization of devices to 5  $\mu$ s. Total cable length up to 610 m (2000 ft). Up to 20 devices. CPI is a proprietary interface for communications between Campbell Scientific data loggers and Campbell Scientific CDM peripheral devices. It consists of a physical layer definition and a data protocol.

**Hardwired:** Multi-drop, short haul, RS-232, fiber optic

**Satellite:** GOES, Argos, Inmarsat Hughes, Iridium

## Standards compliance specifications

View compliance and conformity documents at [www.campbellsci.com/cr1000x](http://www.campbellsci.com/cr1000x).

**Shock and Vibration:** MIL-STD 810G methods 516.6 and 514.6

**Protection:**

- Wiring panel: IP40
- Measurement module when connected to the wiring panel: IP65

**EMI and ESD protection:**

- **Immunity:** Meets or exceeds following standards:
  - **ESD:** per IEC 61000-4-2;  $\pm 15$  kV air,  $\pm 8$  kV contact discharge
  - **Radiated RF:** per IEC 61000-4-3; 10 V/m, 80-1000 MHz
  - **EFT:** per IEC 61000-4-4; 4 kV power, 4 kV I/O
  - **Surge:** per IEC 61000-4-5; 4 kV power, 4kV I/O
  - **Conducted RF:** per IEC 61000-4-6; 10 V power, 10 V I/O
- Emissions and immunity performance criteria available on request.

## Warranty

**Standard:** Three years against defects in materials and workmanship.

**Extended (optional):** An additional four years, bringing the total to seven years.

## Terminal functions

### Analog input terminal functions

SE DIFF	1 2		3 4		5 6		7 8		9 10		11 12		13 14		15 16		RG1	RG2
	$\overline{1}$ H L	$\overline{2}$ H L	$\overline{3}$ H L	$\overline{4}$ H L	$\overline{5}$ H L	$\overline{6}$ H L	$\overline{7}$ H L	$\overline{8}$ H L	$\overline{9}$ H L	$\overline{10}$ H L	$\overline{11}$ H L	$\overline{12}$ H L	$\overline{13}$ H L	$\overline{14}$ H L	$\overline{15}$ H L	$\overline{16}$ H L		
Single-Ended Voltage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Differential Voltage	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L		
Ratiometric/Bridge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Thermocouple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Current Loop																	✓	✓
Period Average	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

### Pulse counting terminal functions

	P1	P2	C1-C8
Switch-Closure	✓	✓	✓
High Frequency	✓	✓	✓
Low-level AC	✓	✓	

### Analog output terminal functions

	VX1-VX4
Switched Voltage Excitation	✓

### Voltage Output

	C1-C8 <sup>1</sup>	VX1-VX4	5V	12V	SW12-1	SW12-2
5 VDC	✓	✓	✓			
3.3 VDC	✓	✓				
12 VDC				✓	✓	✓

<sup>1</sup> C terminals have limited drive capacity. Voltage levels are configured in pairs.

### Communications terminal functions

	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI
SDI-12	✓		✓		✓		✓		
GPS	PPS	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
TTL 0-5 V	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
LVTTL 0-3.3 V	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
RS-232					Tx	Rx	Tx	Rx	✓
RS-485 (Half Duplex)					A-	B+	A-	B+	

Communications terminal functions									
	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI
RS-485 (Full Duplex)					Tx-	Tx+	Rx-	Rx+	
I2C	SCL	SDA	SCL	SDA	SCL	SDA	SCL	SDA	
SPI	SCLK	COPI	CIPO		SCLK	COPI	CIPO		
SDM <sup>1</sup>	Data	Clk	Enabl		Data	Clk	Enabl		
CPI/CDM									✓
<sup>1</sup> SDM can be on either C1-C3 or C5-C7, but not both at the same time. Communications functions also include Ethernet and USB.									

Digital I/O terminal functions	
	C1-C8
General I/O	✓
Pulse-Width Modulation Output	✓
Timer Input	✓
Interrupt	✓
Quadrature	✓

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