CR1000X Specifications

Datalogger

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.

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

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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[1] (A)
–40°	4.53
20°	3.00
70°	1.83
85°	1.56
[1] 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 [1] (mA)**
–40°	1310
0°	1004
20°	900
50°	690
70°	550
80°	470
[1] Thermal fuse hold current.	

5 V and 3.3 V

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 Ω
  - **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[1]
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
[1] 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 GΩ 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_{N1}) (Hz)	Range[1] (mV)	RMS (µV)	Bits[2]	RMS (µV)	Bits[2]
15000	±5000 ±1000 ±200	8.2 1.9 0.75	20 20 19	11.8 2.6 1.0	19 19 18
50/60[3]	±5000 ±1000 ±200	0.6 0.14 0.05	24 23 22	0.88 0.2 0.08	23 23 22
5	±5000 ±1000 ±200	0.18 0.04 0.02	25 25 24	0.28 0.07 0.03	25 24 23

[1] Range overhead of ~5% on all ranges guarantees that full-scale values will not cause over range

[2] Typical effective resolution (ER) in bits; computed from ratio of full-scale range to RMS resolution.

[3] 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:

	Typical Offset (µV RMS)	
Range (mV)	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[1] (Hz)	Time[2] (ms)	Time[2] (ms)
15000	2.04	1.02
60	35.24	17.62
50	41.9	20.95
5	401.9	200.95

[1] Notch frequency (1/integration time).

[2] 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^{32}

Maximum Counts Per Scan: 2^{32}

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[1], RS-232[2], RS-422[3], RS-485[4], SDM[5], SDI-12[6], I2C[7], and SPI[8] 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

Edge timing

Terminals: C1-C8

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[1]Universal Asynchronous Receiver/Transmitter for asynchronous serial communications.

[2]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 communication with smart sensors are flexible.

[3]Communications protocol similar to RS-485. Most RS-422 sensors will work with RS-485 protocol.

[4]Recommended Standard 485. A standard defining how two computing devices can communicate with each other.

[5]Synchronous Device for Measurement. A processor-based peripheral device or sensor that communicates with the data logger via hardwire over a short distance using a protocol proprietary to Campbell Scientific.

[6]Serial Data Interface at 1200 baud. Communication protocol for transferring data between the data logger and SDI-12 compatible smart sensors.

[7]Inter-Integrated Circuit is a multi-controller, multi-peripheral, packet switched, single-ended, serial computer bus.

[8]Serial Peripheral Interface - a clocked synchronous interface, used for short distance communications, generally between embedded devices.

Maximum Input Frequency: ≤ 1 kHz

Resolution: 500 ns

Edge counting

Terminals: C1-C8

Maximum Input Frequency: ≤ 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 µs or 32 kHz

Pulse-width modulation

Maximum Period: 36.4 seconds

Resolution:

- **0 – 5 ms**: 83.33 ns
- **5 – 325 ms**: 5.33 µs
- **> 325 ms**: 31.25 µs

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[1]

Additional Protocols: CPI, PakBus, PakBus Encryption, SDM, SDI-12, Modbus RTU / ASCII / TCP, DNP3, custom user definable over serial, UDP, 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 µS. 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, Irridium

Standards compliance specifications

View EU Declarations of Conformity at 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; ±15 kV air, ±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.

[1]Message Queuing Telemetry Transport - a messaging protocol for the Internet of Things (IoT)

Terminal functions

Analog input terminal functions																		
SE DIFF	1 2 ┌1┐ H L		3 4 ┌2┐ H L		5 6 ┌3┐ H L		7 8 ┌4┐ H L		9 10 ┌5┐ H L		11 12 ┌6┐ H L		13 14 ┌7┐ H L		15 16 ┌8┐ H L		RG1	RG2
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[1]	VX1-VX4	5V	12V	SW12-1	SW12-2
5 VDC	✓	✓	✓			
3.3 VDC	✓	✓				
12 VDC				✓	✓	✓

[1] 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	SDA	SCL	SDA	SCL	SDA	SCL	SDA	SCL	
SPI	MOSI	SCLK	MISO		MOSI	SCLK	MISO		
SDM[1]	Data	Clk	Enabl		Data	Clk	Enabl		
CPI/CDM									✓

[1] 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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Campbell Scientific Regional Offices

Australia

Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

India

Location: New Delhi, DL India
Phone: 91.11.46500481.482
Email: info@campbellsci.in
Website: www.campbellsci.in

South Africa

Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Spain

Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

Thailand

Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: info@campbellsci.asia
Website: www.campbellsci.asia

UK

Location: Shepshed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA

Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com