CR1000Xe 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.

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:

- **Supply Voltage**: 10 to 36 VDC
- **Sustained Supply Voltage without Damage**: 38 VDC

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.

USB Power: Functions that will be active with USB 5 VDC applied 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.

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Average Current Consumption (typ. at 20 °C):

Operating state	12 V Supply voltage	24 V Supply voltage
Idle	<1.9 mA	<1.0 mA
Active 1 Hz Scan	2.0 mA	1.1 mA
Active 20 Hz Scan	57 mA	36 mA
Serial (RS-232/RS-485)	Active + 25 mA	Active + 16 mA
Ethernet Power Requirements:		
Ethernet 1 Minute	Active + 1 mA	Active + 0.7 mA
Ethernet Idle	Active + 4 mA	Active + 2.6 mA
Ethernet Link	Active + 47 mA	Active + 31 mA

power output specifications

System power output current limits

Temperature (°C)	12 V Supply voltage Current limit[1] (A)	24 V Supply voltage Current limit[1] (A)
–55°	3.4	4.4
–40°	3.4	4.4
20°	3.4	4.4
70°	2.5	4.2
85°	2.1	4.0

[1] Limited by self-resetting thermal fuse and maximum regulator output current.

Shared 12 V and SW12 power output

12V, SW12-1, and SW12-2 provide regulated 12 VDC power. These outputs are disabled when operating on only USB power.

Temperature (°C)	12 V Supply voltage Current limit[1] (A)	24 V Supply voltage Current limit[1] (A)
–55°	3.3	3.3
–40°	3.3	3.3
20°	3.3	3.3
70°	2.5	3.3
85°	2.1	3.3

[1] Limited by self-resetting electronic and thermal fuses.

Individual maximum current for 12 V and SW12 output terminals

Regulated 12 V output. System power output current limits may override one or more of these individual limits. These outputs are disabled when operating on only USB power.

- **Voltage Output**: Regulated 12 V output (±5%)
- **Current Limit**: 2000 mA

5 V fixed output

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

Control port 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 fixed output

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

CS I/O pin 8: 12 V switched output

Regulated 12 V output. Power output shared with system power output. This output is disabled when operating on only USB power.

- **Voltage Output**: Regulated 12 V output (±5%)
- **Current Limit**: 800 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	0.12 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 =

Setup Time + ((Settling Time + 1/fN1) × M × Repetitions)

Where:

M = 1 (default)
M = 2 if reverse differential or measurement offset is used
Setup Time = 150 µs

	Differential with input reversal	Single-ended or differential without input reversal
Example fN1[1] (Hz)	**Time[2] (ms)**	**Time[2] (ms)**
15000	1.28	0.717
60	34.48	17.31
50	41.15	20.65
5	401.15	200.65

[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

Sustained Input Voltage without Damage: ±13.1 V

Resistance to Ground: 101 Ω

Current Measurement Shunt Resistance: 10 Ω

Maximum Current Measurement Range: ±80 mA

Sustained Maximum Current without Damage: ±130 mA

Resolution:

- **±1000 mV range**: ≤ 20 nA
- **±200 mV range**: ≤ 7.5 nA

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

Pulse measurement specifications

Terminals individually configurable for switch closure, high-frequency pulse, or low-level AC measurements. Each terminal has its own independent 24-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()`.

Sustained Input Voltage without Damage: (P1-P2): ±20 VDC

Sustained Logic Input Voltage without Damage: (C1-C8): +16/-12 VDC

Maximum Counts Per Scan: 2^{24}

Input Resistance: 5 kΩ

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

Low-level AC input

Terminals: P1-P2

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

Switch closure input

Terminals: C1-C8, P1-P2

Pull-Up Resistance: 100 kΩ to 5 V

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

Maximum Input Frequency: 100 Hz

Minimum Switch Closed Time: 5 ms

Minimum Switch Open Time: 5 ms

Maximum Bounce Time: 1 ms open without being counted

High-frequency input

Terminals: C1-C8, P1-P2

Pull-Up Resistance: 100 kΩ to 5 V

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

Maximum Input Frequency: 250 kHz

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, plus UART[1], RS-232[2], RS-422[3],

[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 communications with smart sensors are flexible.

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

RS-485[1], SDM[2], SDI-12[3], I2C[4], and SPI[5] serial-communications functions. 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

Sustained Logic Input Voltage without Damage: +16/-12 VDC

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

Edge timing

Terminals: C1-C8

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

Minimum Pulse Width: 10 µs

Pulse-width modulation

Terminals: C1-C8

Maximum Period: 128 seconds

Resolution:

- **0 – 5 ms**: 83.33 ns
- **5 – 300 ms**: 5.33 µs
- **> 300 ms**: 1.95 ms

[1]Recommended Standard 485. A standard defining how two computing devices can communicate with each other.
[2]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.
[3]Serial Data Interface at 1200 baud. Communications protocol for transferring data between the data logger and SDI-12 compatible smart sensors.
[4]Inter-Integrated Circuit is a multi-controller, multi-peripheral, packet switched, single-ended, serial computer bus.
[5]Serial Peripheral Interface - a clocked synchronous interface, used for short distance communications, generally between embedded devices.

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: Type C 2.0. Full speed: 12 Mbps. Operates as:

- Device for computer communications

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 (C1 to C8): Up to two full duplex or four half duplex

RS-422 (C1 to C8): Up to two full duplex or four 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 compliance and conformity documents at www.campbellsci.com/cr1000x.

Test	Applied standard	Description
Shock and vibration:	MIL-STD 810G methods 516.6 and 514.6	
Protection:		
Wiring panel	IP40	
Measurement module when connected to wiring panel	IP65	

Test	Applied standard	Description
EMI and ESD immunity:		
ESD	IEC 61000-4-2	±15 kV air, ±8 kV contact discharge
Radiated RF	IEC 61000-4-3	10 V/m, 80-1000 MHz
EFT	IEC 61000-4-4	4 kV power, 4 kV I/O
Surge	IEC 61000-4-5	4 kV power, 4kV I/O
Conducted RF	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 ┌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	SW12-CSIO
5 VDC	✓	✓	✓				
3.3 VDC	✓	✓					
12 VDC				✓	✓	✓	✓

[1]C terminal voltage levels are configured in pairs. The default voltage output from C terminals is 5 V. Use the `PortPairConfig` instruction in CRBasic to configure a C terminal pair to output 3.3 V.

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[1]	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
LVTTL 0-3.3 V[1]	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
RS-232	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	✓

Communications terminal functions									
	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI
RS-485 (Half Duplex)	A-	B+	A-	B+	A-	B+	A-	B+	
RS-485[2] (Full Duplex)	Tx-	Tx+	Rx-	Rx+	Tx-	Tx+	Rx-	Rx+	
I2C	SCL	SDA	SCL	SDA	SCL	SDA	SCL	SDA	
SPI	SCLK	COPI	CIPO		SCLK	COPI	CIPO		
SDM[3]	Data	Clk	Enabl		Data	Clk	Enabl		
CPI/CDM									✓

[1] TTL and LVTTL are configured with the CommsMode option of the `SerialOpen` instruction in CRBasic.

[2] RS-422 compatible.

[3] 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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