CR1000X Specifications

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: 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)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Current Limit (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>−40°</td>
<td>4.53</td>
</tr>
<tr>
<td>0°</td>
<td>3.00</td>
</tr>
<tr>
<td>70°</td>
<td>1.83</td>
</tr>
<tr>
<td>85°</td>
<td>1.56</td>
</tr>
</tbody>
</table>

1 Limited by self-resetting thermal fuse

### 12V and SW12V 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.

<table>
<thead>
<tr>
<th>SW12 current limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
</tr>
<tr>
<td>−40°</td>
</tr>
<tr>
<td>0°</td>
</tr>
<tr>
<td>20°</td>
</tr>
<tr>
<td>50°</td>
</tr>
<tr>
<td>70°</td>
</tr>
<tr>
<td>80°</td>
</tr>
</tbody>
</table>

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<sub>Ω</sub>): 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

### Analog measurements 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 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<sub>N1</sub>) Range: 0.5 Hz to 31.25 kHz

#### Analog Range and Resolution:

<table>
<thead>
<tr>
<th>Notch Frequency (f&lt;sub&gt;N1&lt;/sub&gt;) (Hz)</th>
<th>Differential with Input Reversal</th>
<th>Single-Ended and Differential without Input Reversal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range (mV)</td>
<td>RMS (µV)</td>
</tr>
<tr>
<td>15000</td>
<td>±5000</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>±1000</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>±200</td>
<td>0.75</td>
</tr>
<tr>
<td>50/60&lt;sup&gt;3&lt;/sup&gt;</td>
<td>±5000</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>±1000</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>±200</td>
<td>0.05</td>
</tr>
<tr>
<td>5</td>
<td>±5000</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>±1000</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>±200</td>
<td>0.02</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Range (mV)</th>
<th>Typical Offset (µV RMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Differential with Input Reversal</td>
</tr>
<tr>
<td>±5000</td>
<td>±0.5</td>
</tr>
<tr>
<td>±1000</td>
<td>±0.25</td>
</tr>
<tr>
<td>±200</td>
<td>±0.15</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Example fN1 (Hz)</th>
<th>Time2 (ms)</th>
<th>Time2 (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15000</td>
<td>2.04</td>
<td>1.02</td>
</tr>
<tr>
<td>60</td>
<td>35.24</td>
<td>17.62</td>
</tr>
<tr>
<td>50</td>
<td>41.9</td>
<td>20.95</td>
</tr>
<tr>
<td>5</td>
<td>401.9</td>
<td>200.95</td>
</tr>
</tbody>
</table>

1 Notch frequency (1/integration time).
2 Default settling time of 500 µs used.

Resistance measurements 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: SE terminals 1-16
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

<table>
<thead>
<tr>
<th>Gain Code Option</th>
<th>Voltage Gain</th>
<th>Minimum Peak to Peak Signal (mV)</th>
<th>Maximum Peak to Peak Signal (V)</th>
<th>Minimum Pulse Width (µs)</th>
<th>Maximum Frequency (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>500</td>
<td>10</td>
<td>2.5</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>2.5</td>
<td>50</td>
<td>10</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>12.5</td>
<td>10</td>
<td>2</td>
<td>62</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>2</td>
<td>2</td>
<td>100</td>
<td>5</td>
</tr>
</tbody>
</table>

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: 2³²
Maximum Counts Per Scan: 2³²
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
Resistance: Configurable in terminal pairs with 100 kΩ pull-up or pull-down
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:

<table>
<thead>
<tr>
<th>Sine wave (mV RMS)</th>
<th>Range (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1.0 to 20</td>
</tr>
<tr>
<td>200</td>
<td>0.5 to 200</td>
</tr>
<tr>
<td>2000</td>
<td>0.3 to 10,000</td>
</tr>
<tr>
<td>5000</td>
<td>0.3 to 20,000</td>
</tr>
</tbody>
</table>

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

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, UART1, RS-2322, RS-4853, SDM4, SDI-121, I2C2, and SPI3 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(), SD112Recorder(), WaitDigTrig()). For example, if C1 is used for SD112Recorder(), C2 cannot be used for TimerInput(), PulseCount(), or WaitDigTrig().

Terminals: C1-C8
Maximum Input Voltage: ±20 V
Logic Levels and Drive Current:

<table>
<thead>
<tr>
<th>Terminal Pair Configuration</th>
<th>5 V Source</th>
<th>3.3 V Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic low</td>
<td>≤ 1.5 V</td>
<td>≤ 0.8 V</td>
</tr>
<tr>
<td>Logic high</td>
<td>≥ 3.5 V</td>
<td>≥ 2.5 V</td>
</tr>
</tbody>
</table>

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
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, DNS, DHCP, SLAAC, Telnet, HTTP(S), FTP(S), POP3/TLS, NTP, SMTP/TLS, SNMPv3, CS I/O IP

1Universal Asynchronous Receiver/Transmitter for asynchronous serial communications.
2Recommended 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.
3Recommended Standard 485. A standard defining how two computing devices can communicate with each other.
4Synchronous 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.

1Serial Data Interface at 1200 baud. Communication protocol for transferring data between the data logger and SDI-12 compatible smart sensors.
2Inter-Integrated Circuit is a multi-master, multi-slave, packet switched, single-ended, serial computer bus.
3Serial Peripheral Interface - a clocked synchronous interface, used for short distance communications, generally between embedded devices.
**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.

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

**SDI-12** (C1, C3, C5, C7): Four independent SDI-12 compliant terminals are individually configured and meet SDI-12 Standard v1.4.

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

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

**Standards compliance specifications**

View EU Declarations of Conformity at www.campbellsic.com/cr1000x.

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

**EMI and ESD protection:**

- **Immunity:** Meets or exceeds following standards:
  - **ESD:** per IEC 61000-4-2; ±8 kV air, ±4 kV contact discharge
  - **RF:** per IEC 61000-4-3; 3 V/m, 80-1000 MHz
  - **EFT:** per IEC 61000-4-4; 1 kV power, 500 V I/O
  - **Surge:** per IEC 61000-4-5; 1 kV power and I/O
  - **Conducted:** per IEC 61000-4-6; 3 V 150 kHz-80 MHz

- Emissions and immunity performance criteria available on request.

**Warranty**

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

**Extended (optional):** An additional four years. against defects in materials and workmanship, bringing the total to 7 years.

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1CPI is a proprietary interface for communications between Campbell Scientific dataloggers and Campbell Scientific CDM peripheral devices. It consists of a physical layer definition and a data protocol. CDM devices are similar to Campbell Scientific SDM devices in concept, but the use of the CPI bus enables higher data-throughput rates and use of longer cables. CDM devices require more power to operate in general than do SDM devices.
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