# 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<br>±1000<br>±200 | 8.2<br>1.9<br>0.75 | 20<br>20<br>19 | 11.8<br>2.6<br>1.0 | 19<br>19<br>18 |
| 50/60[3] | ±5000<br>±1000<br>±200 | 0.6<br>0.14<br>0.05 | 24<br>23<br>22 | 0.88<br>0.2<br>0.08 | 23<br>23<br>22 |
| 5 | ±5000<br>±1000<br>±200 | 0.18<br>0.04<br>0.02 | 25<br>25<br>24 | 0.28<br>0.07<br>0.03 | 25<br>24<br>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<br>DIFF | 1 2<br>┌1┐<br>H L | | 3 4<br>┌2┐<br>H L | | 5 6<br>┌3┐<br>H L | | 7 8<br>┌4┐<br>H L | | 9 10<br>┌5┐<br>H L | | 11 12<br>┌6┐<br>H L | | 13 14<br>┌7┐<br>H L | | 15 16<br>┌8┐<br>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 | | | | | | | | | ✓ |

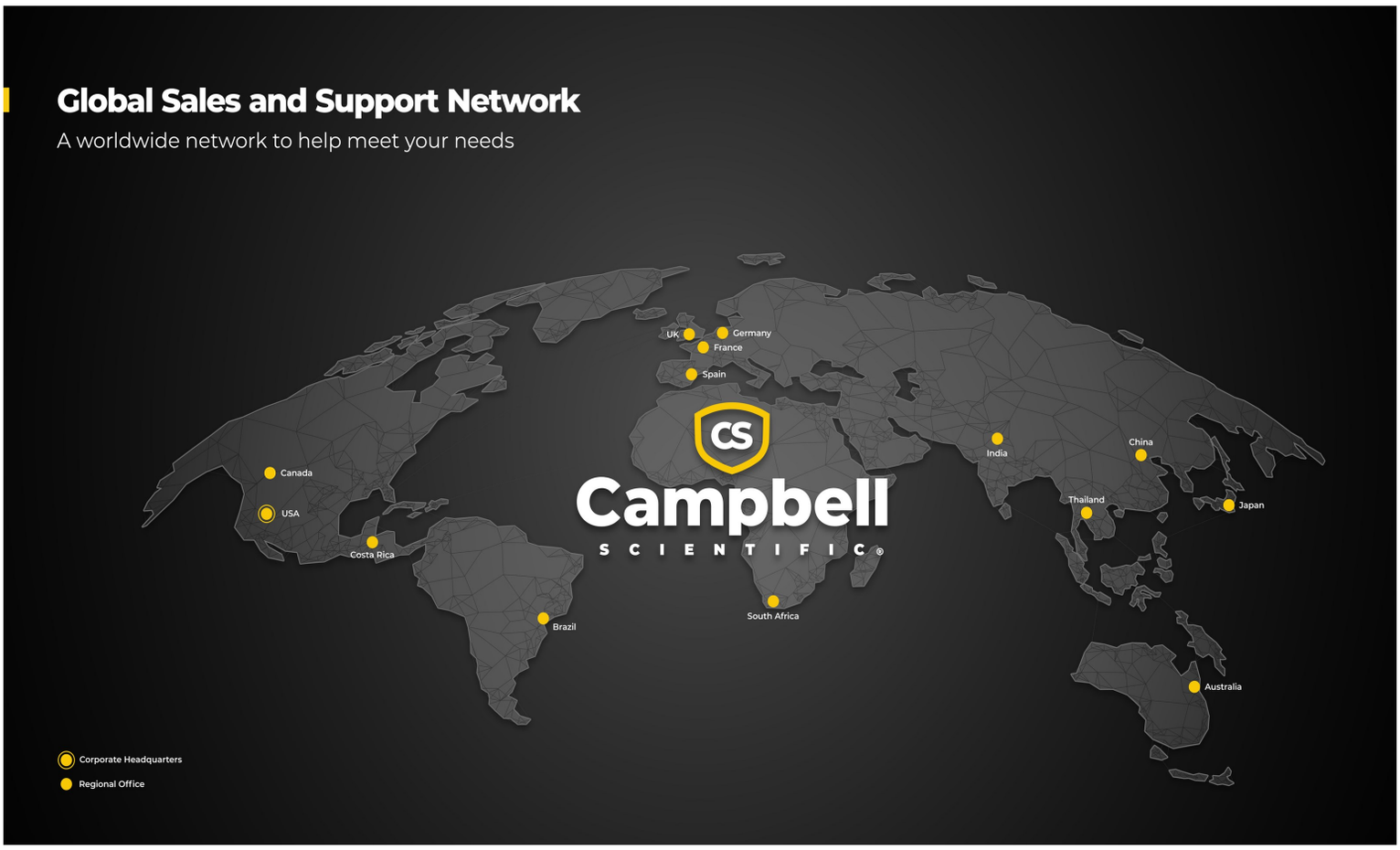
[1] TTL and LVTTL are configured with the CommsMode option of the `SerialOpen` instruction in CRBasic.

[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 | ✓ |




## 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:* Montrouge, 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

### *Japan*

*Location:* Kawagishi, Toda City, Japan
*Phone:* 048.400.5001
*Email:* jp-info@campbellsci.com
*Website:* www.campbellsci.co.jp

### *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