

# CR1000 Specifications

Electrical specifications are valid over a -25° to +50°C, non-condensing environment, unless otherwise specified. Recalibration recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

## PROGRAM EXECUTION RATE

10 ms to one day @ 10 ms increments

## ANALOG INPUTS (SE1-SE16 or DIFF1-DIFF8)

8 differential (DF) or 16 single-ended (SE) individually configured input channels. Channel expansion provided by optional analog multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single A/D conversion. A DIFF measurement with input reversal has better (finer) resolution by twice than Basic Res.

Range (mV) <sup>1</sup>	DF Res (μV) <sup>2</sup>	Basic Res (μV)
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

<sup>1</sup>Range overhead of ~9% on all ranges guarantees that full-scale values will not cause over range.

<sup>2</sup>Resolution of DF measurements with input reversal.

## ACCURACY<sup>3</sup>:

±(0.06% of reading + offset), 0° to 40°C

±(0.12% of reading + offset), -25° to 50°C

±(0.18% of reading + offset), -55° to 85°C (-XT only)

<sup>3</sup>Accuracy does not include the sensor and measurement noise. Offsets are defined as:

Offset for DF w/input reversal = 1.5·Basic Res + 1.0 μV

Offset for DF w/o input reversal = 3·Basic Res + 2.0 μV

Offset for SE = 3·Basic Res + 3.0 μV

## ANALOG MEASUREMENT SPEED:

Integration Type/Code	Integration Time	Settling Time	Total Time <sup>4</sup>	
			SE w/ No Rev	DF w/ Input Rev
250	250 μs	450 μs	~1 ms	~12 ms
60 Hz <sup>5</sup>	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz <sup>5</sup>	20.00 ms	3 ms	~25 ms	~50 ms

<sup>4</sup>Includes 250 μs for conversion to engineering units.

<sup>5</sup>AC line noise filter.

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range (digital resolution dominates for higher ranges).

250 μs Integration: 0.34 μV RMS

50/60 Hz Integration: 0.19 μV RMS

INPUT LIMITS: ±5 Vdc

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

INPUT VOLTAGE RANGE W/O MEASUREMENT

CORRUPTION: ±8.6 Vdc max.

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 GΩ typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION

THERMISTOR (for thermocouple measurements):

±0.3°C, -25° to 50°C

±0.8°C, -55° to 85°C (-XT only)

## ANALOG OUTPUTS (VX1-VX3)

3 switched voltage, sequentially active only during measurement.

RANGE AND RESOLUTION:

Channel	Range	Resolution	Current Source/Sink
(VX 1-3)	±2.5 Vdc	0.67 mV	±25 mA

## ANALOG OUTPUT ACCURACY (VX):

±(0.06% of setting + 0.8 mV), 0° to 40°C

±(0.12% of setting + 0.8 mV), -25° to 50°C

±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

VX FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mv square waves for exciting vibrating wire transducers.

## PERIOD AVERAGE

Any of the 16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

Voltage Gain	Input Range (±mV)	Signal (peak to peak)		Min Pulse Width (μV)	Max <sup>8</sup> Freq (kHz)
		Min. (mV) <sup>6</sup>	Max (V) <sup>7</sup>		
1	250	500	10	2.5	200
10	25	10	2	10	50
33	7.5	5	2	62	8
100	2.5	2	2	100	5

<sup>6</sup>Signal centered around Threshold (see PeriodAvg() instruction).

<sup>7</sup>With signal centered at the datalogger ground.

<sup>8</sup>The maximum frequency = 1/(twice minimum pulse width) for 50% of duty cycle signals.

## RATIOMETRIC MEASUREMENTS

MEASUREMENT TYPES: Provides ratiometric resistance measurements using voltage excitation. 3 switched voltage excitation outputs are available for measurement of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Optional excitation polarity reversal minimizes dc errors.

RATIOMETRIC MEASUREMENT ACCURACY:<sup>9,10,11</sup>

±(0.04% of Voltage Measurement + Offset)

<sup>9</sup>Accuracy specification assumes excitation reversal for excitation voltages < 1000 mV. Assumption does not include bridge resistor errors and sensor and measurement noise.

<sup>10</sup>Estimated accuracy, ΔX (where X is value returned from the measurement with Multiplier = 1, Offset = 0):

**BrHalf()** instruction:  $\Delta X = \Delta V_x / V_x$

**BrFull()** instruction  $\Delta X = 1000 \cdot \Delta V_x / V_x$ , expressed as mV·V<sup>-1</sup>.

ΔV<sup>-1</sup> is calculated from the ratiometric measurement accuracy. See Resistance Measurements Section in the manual for more information.

<sup>11</sup>Offsets are defined as:

Offset for DIFF w/input reversal = 1.5·Basic Res + 1.0 μV

Offset for DIFF w/o input reversal = 3·Basic Res + 2.0 μV

Offset for SE = 3·Basic Res + 3.0 μV

Excitation reversal reduces offsets by a factor of two.

## PULSE COUNTERS (P1-P2)

2 inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7x10<sup>6</sup>

SWITCH CLOSURE MODE:

Minimum Switch Closed Time: 5 ms

Minimum Switch Open Time: 6 ms

Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:

Maximum Input Frequency: 250 kHz

Maximum Input Voltage: ±20 V

Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 μs time constant.

LOW-LEVEL AC MODE: Internal ac coupling removes ac offsets up to ±0.5 Vdc.

Input Hysteresis: 12 mV RMS @ 1 Hz

Maximum ac Input Voltage: ±20 V

Minimum ac Input Voltage:

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 I/O PORTS (C1-C8)

8 ports software selectable, as binary inputs or control outputs. Provide on/off, pulse width modulation, edge timing, subroutine interrupts / wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UARTs), and SDI-12 communications. SDM communications are also supported.

LOW FREQUENCY MODE MAX: <1 kHz

HIGH-FREQUENCY MODE MAX: 400 kHz

SWITCH-CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 Ω with inputs <6.2 Vdc

220 Ω with inputs ≥6.2 Vdc

SERIAL DEVICE/RS-232 SUPPORT: 0 to 5 Vdc UART

## SWITCHED 12 VDC (SW-12)

1 independent 12 Vdc unregulated source is switched on and off under program control. Thermal fuse hold current = 900 mA at 20°C, 650 mA at 50°C, 360 mA at 85°C.

## CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

## COMMUNICATIONS

RS-232 PORTS:

DCE 9-pin: (not electrically isolated) for computer connection or connection of modems not manufactured by Campbell Scientific.

COM1 to COM4: 4 independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART

Baud Rates: selectable from 300 bps to 115.2 kbps.

Default Format: 8 data bits; 1 stop bits; no parity

Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with telecommunications peripherals manufactured by Campbell Scientific.

SDI-12: Digital control ports C1, C3, C5, and C7 are individually configured and meet SDI-12 Standard v 1.3 for datalogger mode. Up to 10 SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, AES-128 Encrypted PakBus, Modbus, DNP3, FTP, HTTP, XML, HTML, POP3, SMTP, Telnet, NTCIP, NTP, Web API, SDI-12, SDM.

## SYSTEM

PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core running at 7.3 MHz)

MEMORY: 2 MB of flash for operating system; 4 MB of battery-backed SRAM for CPU usage and final data storage; 512 kB flash disk (CPU) for program files.

REAL-TIME CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

REAL-TIME CLOCK RESOLUTION: 10 ms

## SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc

INTERNAL BATTERIES: 1200 mAh lithium battery for clock and SRAM backup that typically provides three years of backup

EXTERNAL BATTERIES: Optional 12 Vdc nominal alkaline and rechargeable available. Power connection is reverse polarity protected.

TYPICAL CURRENT DRAIN at 12 Vdc:

Sleep Mode: < 1 mA

1 Hz Sample Rate (1 fast SE meas.): 1 mA

100 Hz Sample Rate (1 fast SE meas.): 6 mA

100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 20 mA

Active external keyboard display adds 7 mA (100 mA with backlight on).

## PHYSICAL

DIMENSIONS: 23.9 x 10.2 x 6.1 cm (9.4 x 4 x 2.4 in); additional clearance required for cables and leads.

MASS/WEIGHT: 1 kg / 2.1 lb

## WARRANTY

3 years against defects in materials and workmanship.



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