CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CR1000X

Measurement and Control Datalogger

All CR1000X dataloggers are tested and guaranteed to meet electrical specifications in a standard -40° to +70°C or extended -55° to +85°C non-condensing environment. Datalogger recalibration is recommended every three years. System configuration and critical specifications should be confirmed with Campbell Scientific before purchase.

ANALOG (SE1 – SE16, DIFF1 – DIFF8)

16 single-ended (SE) or 8 Differential (DIFF) inputs individually configurable for voltage, thermocouple, ratiometric, and period average measurements, using a 24-bit ADC and performed one at a time.

VOLTAGE MEASUREMENTS

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: ±1 nA typical @ 25°C

FILTER FIRST NOTCH FREQUENCY (f_{N1}) RANGE: 0.5 Hz to 31.25 kHz

RANGE AND TYPICAL EFFECTIVE RESOLUTION:

Notch Frequency (f_{N1})[1] (Hz)	Range[2] (mv)	Typical Resolution, µV RMS (DIFF w/Input Reversal)	Typical Resolution, µV RMS (SE or DIFF w/o Input Reversal)
15000	±5000	8.2	11.8
	±1000	1.9	2.6
	±200	0.75	1.0
50/60[3]	±5000	0.6	0.88
	±1000	0.14	0.2
	±200	0.05	0.08
5	±5000	0.18	0.28
	±1000	0.04	0.07
	±200	0.02	0.03

ACCURACY (does not include sensor or measurement noise):

0° to 40°C	-40° to 70°C	-55° to 85°C
±(0.04% of reading + offset)	±(0.06% of reading + offset)	±(0.08% of reading + offset)

OFFSETS:

Range (mV)	DIFF w/Input Reversal (µV)	SE or DIFF w/o Input Reversal (µV)
±5000	±0.5	±2
±1000	±0.25	±1
±200	±0.15	±0.5

MULTIPLEXED MEASUREMENT TIME: (450 µs + settling time + ($1/f_{N1}$)) * reps

Example f_{N1} (Hz)[4]	Multiplexed Measurement Time (ms) w/ 500 µs settling time	
	DIFF w/Input Reversal	SE or DIFF w/o Input Reversal
15000	2.04	1.02
60	35.24	17.62
50	41.9	20.95
5	401.9	200.95

MEASUREMENT SETTLING TIME: 20 µs to 600 ms; 500 µs default

RATIOMETRIC MEASUREMENTS

Resistance measurements for four- and six-wire full bridge and two-, three-, and four-wire half bridge using voltage excitation. Excitation polarity reversal available to minimize dc error.

ACCURACY:[5,6]

±(0.01% of reading + offset) , 0° to 40°C
±(0.015% of reading + offset), -40° to 70°C
±(0.02% of reading + offset , -55° to 85°C

PERIOD AVERAGE MEASUREMENTS

Up to 16 analog inputs can be used for period averaging.

ACCURACY: ±(0.01% of reading + resolution), where resolution is 130 ns divided by the specified number of cycles to be measured.

RANGE DEPENDENT ON INPUT

Gain Code	Minimum peak-to-peak Signal (mV)[7]	Maximum peak-to-peak Signal (V)[8]	Minimum Pulse Width (µs)	Maximum Frequency (kHz)[9]
0	500	10	2.5	200
1	50	2	10	50
2	10	2	62	8
3	2	2	100	5

VOLTAGE EXCITATION (VX1 – VX4)

Four independently configurable voltage sources that can operate in one of two modes: Switched Excitation mode or Switched Regulated Voltage Supply. In Switched Excitation mode, a single 16-bit digital-to-analog converter (DAC) shared by all VX outputs produces a user-specified voltage during measurement only. In Switched Regulated Voltage Supply mode, the port can continuously provide either 3.3 Vdc or 5 Vdc.

	Range (V)	Resolution	Accuracy[5,10]	Maximum Source/Sink Current (mA)[11]
Voltage Excitation	±4	0.06 mV	±(0.1% of setting + 2 mV)	±40
Switched, Regulated	+3.3 or 5	+3.3 or 5 V	±5%	50

PULSE COUNTING (P1, P2)

Two inputs individually configurable for switch closure, high-frequency pulse, or low-level AC measurements. Independent 32-bit counter for each input. See also C1 - C8 for additional switch closure and high-frequency measurement inputs.

MAXIMUM INPUT VOLTAGE: ±20 Vdc

ACCURACY: ±(0.02% of reading +1/scan)

SWITCH CLOSURE INPUTS

PULL-UP RESISTANCE: 100 kΩ to 5 V

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

MINIMUM SWITCH CLOSED TIME: 5 ms

MINIMUM SWITCH OPEN TIME: 6 ms

MAXIMUM BOUNCE TIME: 1 ms open without being counted

HIGH-FREQUENCY INPUTS

PULL-UP RESISTANCE: 100 kΩ to 5 V

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

INTERNAL PULL-UP RESISTANCE: 100 kΩ to 5 V

MAXIMUM INPUT FREQUENCY: 250 kHz

LOW-LEVEL AC INPUTS

MINIMUM RESISTANCE: 10 kΩ to G

DC-OFFSET REJECTION: Internal AC coupling eliminates DC-offset voltages up to ±0.5 Vdc

INPUT HYSTERESIS: 12 mV @ 1 Hz

RANGE:

Sine Wave (mV RMS)	Input Frequency 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 (C1 – C8)

Eight ports configurable for digital input and output including status high/low, pulse width modulation, external interrupt, edge timing, switch closure pulse counting, high-frequency pulse counting, UART, RS-232, RS-485, SDM, SDI-12, I2C, and SPI function. Ports are configurable in pairs for 5 V or 3.3 V logic for some functions.

MAXIMUM INPUT VOLTAGE: ±20 Vdc

LOGIC LEVELS AND DRIVE CURRENT:

Terminal Pair Configuration	Logic Low	Logic High	Current Source
5 V	≤ 1.5 V	≥ 3.5 V	10 mA @ 3.5 V
3.3 V	≤ 0.8 V	≥ 2.5 V	10 mA @ 1.85 V

SWITCH CLOSURE INPUTS

ACCURACY: ±(0.02% of reading + 1/scan)
RESISTANCE: Port pair configurable with 100 kΩ pull-up or pull-down
SOFTWARE DEBOUNCE TIME: 3 ms
MAXIMUM BOUNCE TIME: 1 ms open without being counted
MAXIMUM INPUT FREQUENCY: 150 Hz

HIGH-FREQUENCY INPUTS

ACCURACY: ±(0.02% of reading + 1/scan)
RESISTANCE: Port pair configurable with 100 kΩ pull-up or pull-down
MAXIMUM INPUT FREQUENCY: 1 MHz

EDGE TIMING

MAXIMUM INPUT FREQUENCY: ≤ 2.3 KHz
RESOLUTION: 500 ns

RESISTIVE GROUND (RG1 – RG2)

Two resistance-to-ground inputs that can be used for non-isolated 0-20 mA and 4-20 mA current loop measurements or for terminating the ground reference of an RS-485 serial connection.

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
CURRENT MEASUREMENT RESOLUTION: ≤ 20 nA
CURRENT MEASUREMENT ACCURACY: ±(0.1% of reading + 100 nA) @ -40° to 70°C

5V OUTPUT (5V)

One regulated 5V output (±5%) with a current limit of 230 mA. Output is shared with CS I/O DB9 5V output. See also VX1 – VX4 for additional regulated voltage outputs.

12V OUTPUT (12V, SW12-1, SW12-2)

Three unregulated 12 Vdc outputs with voltage equal to the Power Input supply voltage. Two levels of thermal fuses regulate current sourcing. In total (12V + SW12-1 + SW12-2) the hold current is limited to 2.68 A @ -40°C, 0.96 A @ 80°C. SW12-1 and SW12-2 can be independently set under program control. Each SW12 has a hold current limited to 1.3 A @ -40°C, 0.47 A @ 80°C.

DEDICATED COMMUNICATION INTERFACES

USB: Micro-B device for computer connectivity

CS I/O: 9-pin D-sub multidrop interface to Campbell Scientific CS I/O peripherals

RS-232/CPI: A single RJ-45 interface that can operate in one of two modes, RS-232 or CPI. RS-232 used to connect computer, sensor, or communication devices serially. CPI used to interface to Campbell Scientific CDM measurement expansion modules and sensors.

ETHERNET PORT: RJ-45, 10/100 Mbps, full or half duplex, Auto-MDIX, magnetic isolation and TVS surge protection

PROTOCOLS

INTERNET PROTOCOLS: Ethernet, PPP, CS I/O IP, RNDIS, ICMP/Ping, Auto-IP(APIPA), IPv4, IPv6, UDP, TCP, TLS, DNS, DHCP, SLAAC, SNMPv2, NTP, Telnet, HTTP(S), FTP(S), SMTP/TLS, POP3/TLS

ADDITIONAL PROTOCOLS: PakBus, PakBus Encryption, CPI, SDM, SDI-12, Modbus RTU / ASCII / TCP, DNP3, NTCIP, NMEA 0183, I2C, SPI, Custom user definable over serial, TCP, and UDP

DATA FILE FORMATS: CSV, XML, JSON, binary, encrypted, custom user definable

POWER REQUIREMENTS

PROTECTION: Reverse polarity protected; overvoltage protected up to 30 Vdc

VOLTAGE INPUT: 10 to 16 Vdc

INPUT CURRENT LIMIT @ 12 VDC: 4.35 A @ -40°C, 1.56 A @ 85°C

AVERAGE CURRENT DRAIN @ 12 VDC:
IDLE: <1 mA
ACTIVE 1 HZ SCAN: 1 mA
ACTIVE 20 HZ SCAN: 55 mA
SERIAL ACTIVE (RS-232/RS-485): Active + 25 mA
ETHERNET POWER MODE 1 MINUTE: Active + 1 mA
ETHERNET LINK ACTIVE: Active + 48 mA

SYSTEM

PROCESSOR: Renesas RX63N (32-bit with hardware FPU, running at 100 MHz)

MEMORY: 128 MB Flash + 4 MB SRAM (battery backed)
DATA STORAGE: 4 MB SRAM + 72 MB flash
DATA STORAGE EXPANSION: removable microSD flash memory; up to 8 GB

PROGRAM EXECUTION: 1 ms to one 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

INTERNAL LITHIUM BATTERY: AA, 2.4 Ah, 3.6 Vdc (Tadiran TL 5903/S) for battery-backed memory and clock only. 3 year life with no external power source

WIRING PANEL TEMPERATURE: A 10K3A1A BetaTHERM thermistor, located between the two rows of analog input channels, is measured when reporting wiring panel temperature.

COMPLIANCE INFORMATION

VIEW EU DECLARATION OF CONFORMITY AT:

www.campbellsci.com/cr1000x

PHYSICAL

DIMENSIONS: 23.8 cm x 10.1 cm x 6.2 cm (9.4 in x 4.0 in x 2.4 in); additional clearance required for cables and leads

WEIGHT/MASS: 0.86 kg (1.9 lb)

WARRANTY

Three years against defects in materials and workmanship.

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[1] Valid notch frequencies: 0.5 Hz to 31.25 kHz.

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

[3] 50/60 correspond to rejection of 50 and 60 Hz ac power mains noise.

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

[5] Assumes input reversal for differential measurements along with excitation reversal for excitation voltage <1000 mV, not including bridge resistor errors or sensor and measurement noise.

[6] Ratiometric accuracy, rather than absolute accuracy, determines overall measurement accuracy of ratiometric resistance measurements.

[7] Minimum signal centered around specified period average threshold.

[8] Maximum signal centered around datalogger ground.

[9] The maximum frequency = 1/(twice minimum pulse width) for 50% duty cycle signals.

[10] Valid over -55 to +85 °C temperature range.

[11] Exceeding current limits causes voltage output to become unstable. Voltage should stabilize when current is reduced to within stated limits.

TERMINALS

Analog Input Function	SE1	SE2	SE3	SE4	SE5	SE6	SE7	SE8	SE9	SE10	SE11	SE12	SE13	SE14	SE15	SE16	RG1	RG2	Max
Single Ended	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			16
Differential	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L			8
Ratiometric Bridge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			16
Thermocouple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			16
Current Loop																	✓	✓	2
Period Average	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			16

Analog Output Function	VX1	VX2	VX3	VX4	5 V	12V	SW12V-1	SW12V-2	Max
Switched-Voltage Excitation	✓	✓	✓	✓					4
5 V Source	✓	✓	✓	✓	✓				5
3.3 V Source	✓	✓	✓	✓					4
12 V Source						✓	✓	✓	3

Communication Function[12]	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI	USB	Ethernet	CS I/O	Max
SDI-12	✓		✓		✓		✓						4
GPS Time Sync	PPS	Rx											1
TTL (0 to 5 V)	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx					4
LVTTL (0 to 3.3 V)	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx					4
RS-232					Tx	Rx	Tx	Rx	✓				3
RS-485 (Half Duplex)					A(-)	B(+)	A(-)	B(+)					2
RS-485 (Full Duplex)					Tx-	Tx+	Rx-	Rx+					1
I2C	SCL	SDA	SCL	SDA	SCL	SDA	SCL	SDA					4
SPI	SCLK	MOSI	MISO		SCLK	MOSI	MISO						2
SDM[13]	DATA	CLK	ENABLE		DATA	CLK	ENABLE						1
CPI/CDM									✓				1
USB										✓			1
Ethernet											✓		1
CS I/O												✓	1

Digital I/O Function[12]	C1	C2	C3	C4	C5	C6	C7	C8	Max
General I/O Pair	✓	✓	✓	✓	✓	✓	✓	✓	8
Pulse-Width Modulation Output	✓	✓	✓	✓	✓	✓	✓	✓	8
Timer Input	✓	✓	✓	✓	✓	✓	✓	✓	8
Interrupt	✓	✓	✓	✓	✓	✓	✓	✓	8

Pulse Counting Function[12]	C1	C2	C3	C4	C5	C6	C7	C8	P1	P2	Max
Switch Closure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
High Frequency	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
Low Level AC									✓	✓	2

[12] Triggering conflicts can occur when companion control ports are used for different triggering instructions (TimerInput, PulseCount, SDI12Recorder, WaitDigTrig). For example, if C3 is used for the SDI12Recorder instruction, C4 cannot be used in the TimerInput, PulseCount, or WaitDigTrig instructions.

[13] SDM can be on either C1-C3 or C5-C7, but not both at the same time.

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