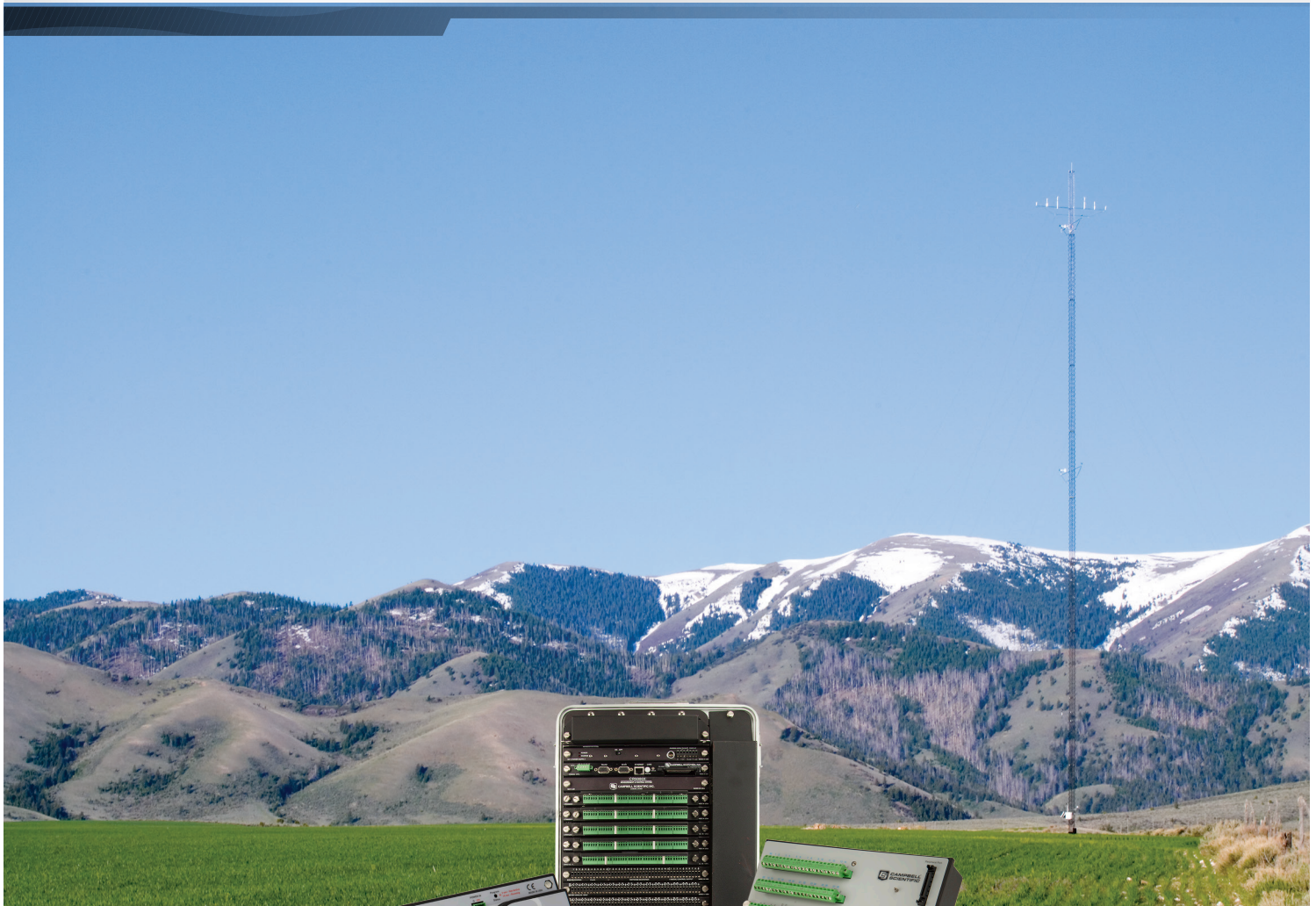




# Datalogger

*Also known as Data Loggers, Data Recorders, and RTUs*



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# Campbell Scientific Datalogger Overview

Campbell Scientific dataloggers are at the center of our rugged, reliable data acquisition systems. They are known for their flexibility, precision measurements, and dependability—even in harsh, remote environments.

As for functionality, all of our dataloggers:

- › Measure sensors
- › Process data onboard
- › Initiate measurement and control functions based on time or event
- › Store data in multiple tables that can be individually sized and collected
- › Control external devices such as pumps, motors, alarms, freezers, and valves
- › Operate independently of ac power, computers, and human interaction
- › Use our support software to program the datalogger
- › Consume minimal power from a 12 Vdc source
- › Interface with on-site and telemetry devices
- › Perform reliably under adverse conditions



We manufacture a complete line of dataloggers that range in size and complexity. Dataloggers vary in the supported scan rates, number and type of input/output channels, analog resolution, and analog voltage accuracy. All of our dataloggers have a three year warranty.

To help customers choose the best datalogger for their application, this document describes the different components of the datalogger, provides a brief summary of each datalogger model available, and includes charts that compare the datalogger specifications and list the compatible devices.

## Communication Protocols

### *PakBus*<sup>®</sup>

With the PakBus protocol, networks have the distributed routing intelligence to continually evaluate links. Continually evaluating links optimizes delivery times and, in the case of delivery failure, allows automatic switch over to a configured backup route.

### *Modbus*

The Modbus RTU protocol supports both floating point and long formats. The datalogger can act as a slave and/or master.

### *DNP3*

The dataloggers are level 2 slave compliant, with some of the operations found in a level 3 implementation.

### *TCP/IP, FTP, and SMTP*

These protocols provide TCP/IP functionality on the CR6 or CR1000X or, when a CR3000 is used in conjunction with an NL116, NL121, or third party serial IP device.

## Keyboard Display

The datalogger's keypad display which allows you to display current and recorded data and manually communicate with the datalogger. It consists of a 128-by-64 pixel backlit graphical LCD or with-line numeric display and 16-character keyboard. The CR850 and CR3000 have a built-in keyboard display as part of their

integrated package. The CR6, CR800, and CR1000X use the CR1000KD, a portable keyboard display that can be carried from site to site. The CR3000-series datalogger does not have a keyboard display.



## Programming

Our family of contemporary dataloggers are programmed using Short Cut, a simple point-and-click software, for most basic applications. For more complex programming, CRBasic provides

special instruction for making measurements and creating tables of output data. CRBasic also supports complex algebraic and conditional expressions.

# Input/Output Connections

## Switched Excitation Outputs

Provides programmable excitation for resistive bridge measurements

## Pulse Counters

For measuring switch closures, low-level ac sine waves, or high frequency pulses

## Analog Inputs

For differential, single-ended, and period averaging measurements

## 5 V Terminal

For sensor or modem power

## Switched 12 V Terminal

For switching power to sensors or communication devices

## 12 V Terminal

For continuous sensor or modem power

## Digital I/O Ports

For controlling external devices, reading SDI-12 sensors or SDM peripherals

## CPI Port

For terminal expansion using Campbell Distributed Modules (CDMs) (CR6 and CR1000X only)

## Removable Power Terminal

Simplifies connection to external power supply.

## 10/100 Ethernet

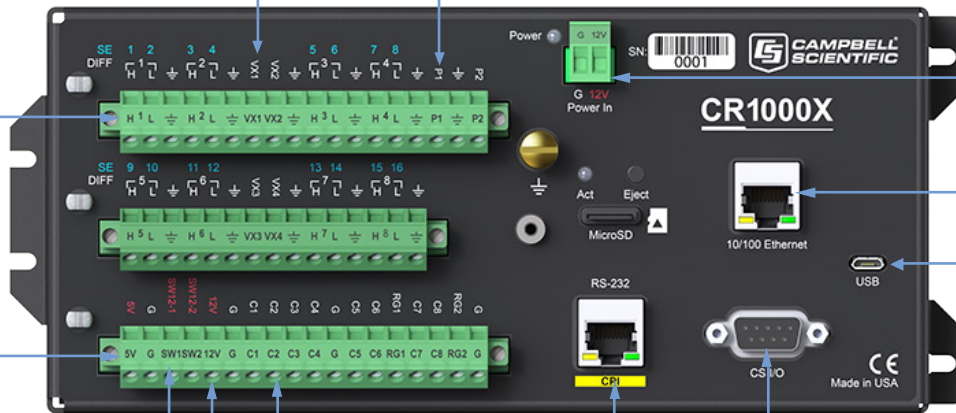
RJ-45 for LAN connection

## USB

For direct connection to the computer

## CS I/O Port

For connecting to Campbell Scientific peripherals



## Analog Inputs

Analog inputs measure voltage levels, and can be configured to make single-ended (a voltage measurement compared to ground) or differential (the high side of a voltage output compared to the low side) measurements. Sensors measured by analog inputs include thermocouples, thermistors, resistive bridges, vibrating wire, and 4 to 20 mA outputs. The CR300-series, CR6, and CR1000X dataloggers can measure the 4 to 20 mA sensors, natively.

## Continuous Analog Outputs

Some datalogger models have continuous analog outputs, which provide voltage levels to displays or proportional controllers.

## Pulse Counters

Pulse counters measure switch closures, low level ac sine waves, or high frequency pulses. They sum the number of counts over each execution interval (scan rate), and allow the determination of variables such as rpm, velocity, flow, and rainfall intensity. Sensors that use pulse counters include tipping bucket rain gages, flow meters, and anemometers.

## Digital I/O Ports

Digital I/O ports detect status, read SDI-12 sensors or synchronous devices for measurement (SDMs), and control external devices. Each port can be configured separately within the datalogger's program.

## CPI Port

Our CR6 and CR1000X dataloggers have a port for directly connecting Campbell Distributed Modules (CDMs) without using an SC-CPI interface.

## Power and Ground Inputs

Power and ground inputs allow easy connection of an energy source, typically 12 Vdc nominal, to energize the datalogger. Switched 12 V terminals allow the datalogger to supply power to a peripheral only when the peripheral is being measured, thus reducing power consumption.

## Switched Excitation Outputs

All of our dataloggers have switched voltage excitation outputs. These outputs provide programmable excitations for resistive bridge measurements by switching voltage on and off. Bridge measurements are the ratio of the bridge output to the excitation voltage, eliminating any errors in the excitation voltage. The CR3000 and CR6 also have switched current excitation outputs that are for resistance measurements.

## Communications/Data Storage Ports

The CS I/O 9-pin port is used to connect most of our data storage and retrieval peripherals. Connection to a computer requires an interface, typically the SC32B Optically Isolated Interface.

The USB and/or RS-232 port allows the datalogger to be connected to the computer. On the CR300-series, CR3000, and CR9000X, the RS-232 port is electrically isolated. Isolation is not provided by the RS-232 port on the CR800-series dataloggers.

Other communication ports available on some dataloggers include the 10/100 Ethernet port, microSD card slot, and 20-pin parallel peripheral port. The peripheral port allows connection of devices that store data on a CompactFlash card and/or communicate using Ethernet.

## Datalogger Descriptions

### CR300-Series Dataloggers

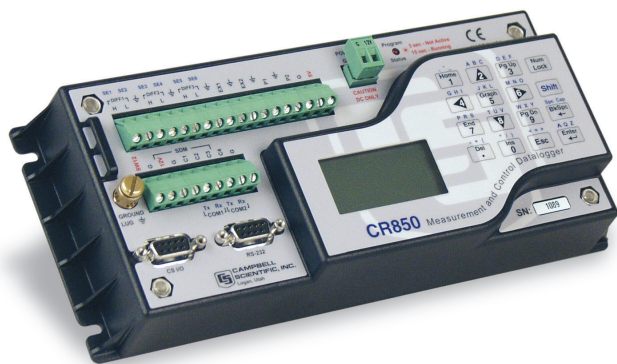
The input channel configuration of the CR300-series dataloggers is optimal for measuring two or three sensors. The CR300-series dataloggers have an integrated dc/dc charge regulator for an external battery.



- › **Design Features:** These are our smallest and lowest-cost dataloggers. They have a built-in USB port and can measure 0-to-20 mA or 4-to-20 mA sensors, natively. They are compatible with multiplexers, but are not compatible with SDMs nor CDMs.
- › **Ideal Applications:** Rural water, aquaculture, water quality, water level/stage, SCADA, weather stations, and OEM application specific where the small form factor and channel count customized to reduce cost
- › **Models Available:** Unlike the CR300, the CR310 (picture not shown) includes a built-in Ethernet port and removable terminal strips.
- › **Options Available:** both models can include an on-board cellular modem, spread spectrum radio, or Wi-Fi.

### CR800-series Measurement and Control Dataloggers

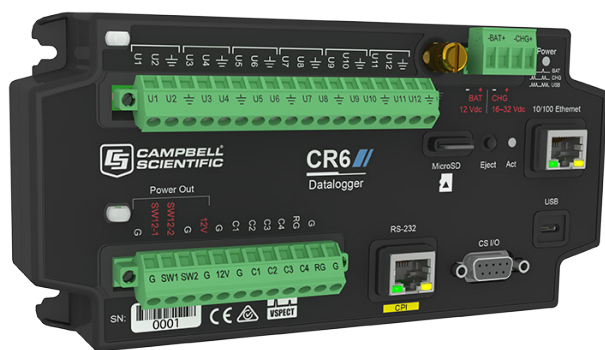
The CR800-series dataloggers consist of measurement electronics encased in a plastic shell and an integrated wiring panel. These dataloggers use an external power supply—typically the BPALK Alkaline Battery Pack or PS200 or PS150 Rechargeable Power Supply.



- › **Design Features:** These research-grade dataloggers have a custom ASIC chip that expands pulse count, control port, and serial communications capabilities. They support serial communications with serial sensors and devices using I/O port pairs. Measurement and control can be expanded with multiplexers, SDMs, and CDMs (requires the SC-CPI interface).
- › **Ideal Applications:** Wind profiling, weather stations, air quality, ETo/agriculture, soil moisture, water level/stage, aquaculture, vehicle testing, Time Domain Reflectometry, SCADA, water quality.
- › **Models Available:** CR800 uses the portable CR1000KD keyboard display; CR850 has a keyboard display as part of its integrated package.

### CR6 Measurement and Control Datalogger

Innovative U terminals featuring high accuracy analog measurements with unsurpassed sensor interface flexibility define the CR6. It also boasts fast processing, low power, and offers an integrated charger regulator.

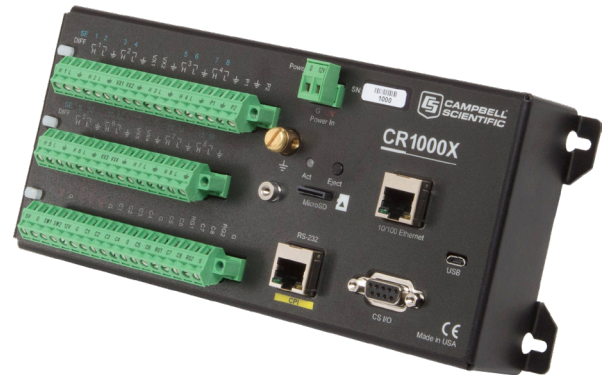


- › **Design Features:** The CR6 includes 12 universal (U) terminals allowing virtually any sensor, analog digital or smart, to be connected to any U terminal. It can measure static vibrating-wire sensors and 0-to-20 mA or 4-to-20 mA sensors, natively. The CR6 also provides faster communications, built-in USB and 10/100baseT ports, microSD card slot, compact size, and improved analog input accuracy and resolution. Measurement and control can be expanded as the CR6 is compatible with all Campbell Scientific multiplexers, SDMs, and CDMs. An RS-232/CPI port allows CDM connection without using the SC-CPI interface.
- › **Ideal Applications:** Structural health monitoring, solar and wind assessment and power performance, SCADA, vehicle testing, Mesonet systems, weather stations, air quality, ETo/agriculture, soil moisture, eddy covariance, aquaculture, avalanche forecasting, water quality.
- › **Options Available:** CR6 can include an on-board spread spectrum radio or Wi-Fi.

## CR1000X Measurement and Control Datalogger

The CR1000X is our flagship datalogger that provides measurement and control for a wide variety of applications. It uses an external power supply, usually the BPALK, PS200, or PS150, and a portable keyboard display, the CR1000KD.

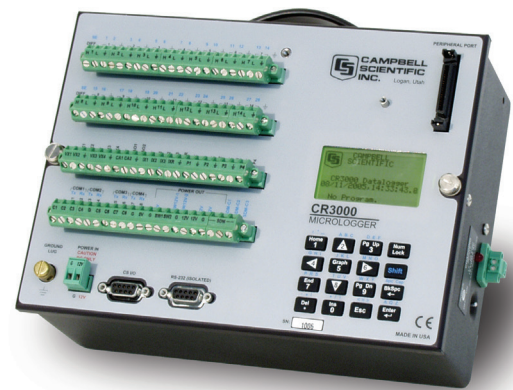
- › **Design Features:** This world-class environmental datalogger has similar communication speed, analog input accuracy, and resolution as the CR6. The CR1000X includes built-in USB and 10/100baseT ports and a microSD card slot. It measures 0-to-20 mA or 4-to-20 mA sensors, natively. Measurement and control can be expanded as the CR1000X is compatible with all Campbell Scientific multiplexers, SDMs, and CDMs. An RS-232/CPI port allows CDM connection without using the SC-CPI interface.
- › **Ideal Applications:** Fire weather, mesonet systems, wind profiling, weather stations, air quality, ETo/agriculture, soil moisture, water level/stage, aquaculture, avalanche forecasting, Time Domain Reflectometry, vehicle testing, SCADA, water quality.



## CR3000 Micrologger

The CR3000 consists of a compact, integrated package with a built-in power supply, a 128 x 64 pixel backlit graphical or eight-line numeric display, and a 16-character keyboard.

- › **Design Features:** The CR3000 provides more channels, programmable switched current outputs, and a 40-pin parallel peripheral port. The peripheral port interfaces with the NL116 Ethernet Interface and CompactFlash® Module, the NL121 Ethernet Interface, or the CFM100 CompactFlash Module. Measurement and control can be expanded with multiplexers, SDMs, and CDMs (requires the SC-CPI interface).
- › **Ideal Applications:** Eddy covariance, wind profiling, HVAC, weather stations, vehicle testing, air quality, process control, Mesonet systems, agriculture, soil moisture, Time Domain Reflectometry, water quality.
- › **Base Options:** Sealed rechargeable battery or low-profile (no-battery) base.



## CR9000X and CR9000XC Measurement and Control Dataloggers

The CR9000X and CR9000XC are large modular dataloggers that consists of a base system and slots for user-specified I/O modules.

- › **Design Features:** The CR9000X and CR9000XC support a measurement rate of up to 100,000 Hz, provides 180 MHz clock speed, have an onboard PC-card slot for expanding the storage capacity, and include an onboard 10baseT/100baseT port. Also, these dataloggers can provide anti-aliasing and real-time FFT capabilities by using a CR9052IEPE or CR9052DC module.
- › **Ideal Applications:** Vehicle testing, structural or seismic monitoring, or other applications that require rapid sampling or a large number of high resolution channels.
- › **Base Options:** Standard CR9000X includes the base system and slots for up to nine I/O modules; the user chooses either the lab or environmental enclosure. The CR9000XC includes the base system, slots for up to five I/O modules, and an environmental enclosure.



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## Datalogger Comparison Table

FEATURE	CR300-Series	CR800/CR850	CR6 (see note 1)
Max. Scan Rate (Hz)	10	100	1000
Analog Inputs	6 SE or 3 diff (see note 2)	6 SE or 3 diff	up to 12 SE or 6 diff
Pulse Counters	2	2	up to 16
Switched Excitation Channels	2 voltage	2 voltage	up to 12 voltage or 12 current
Digital Ports (see notes 3, 4)	2 I/Os 1 TX/RX pair RS-232	4 I/Os or 2 TX/RX pair RS-232	up to 16 I/Os, 2 RS-232, 2 RS-485, 8 TX/RX pair RS-232, or 8 SDI-12
Continuous Analog Outputs	0	0	0
Communications/ Data Storage Ports	1 RS-232, 1 USB, 1 10/100baseT (CR310 only)	1 CS I/O, 1 RS-232	1 USB, 1 CS I/O, 1 CPI/RS-232, 1 MicroSD, 1 10/100baseT
CPI Port	0	0	1
Input Voltage Range (Vdc)	-0.1 to +2.5	±5	±5
Analog Voltage Accuracy	±(0.04% of reading + offset), 0° to +40°C	±(0.06% of reading + offset), 0° to +40°C	±(0.04% of reading + offset), 0° to +40°C
Analog Resolution	to 0.23 µV	to 0.33 µV	to 0.05 µV
A/D Bits	24	13	24
Temperature Range (°C)	-40 to +70	-25 to +50 (standard) -55 to +85 (extended, CR800) -30 to +80 (extended, CR850)	-40 to +70 (standard) -55 to +85 (extended)
Memory (B)	10 M flash for data storage 5 M flash for CPU drive / programs 2 M flash for operating system	2 M Flash (operating system) 4 M (CPU usage, program storage, and data storage)	6 M flash (operating system), 6 M (CPU usage, program, storage, and data storage)
Power Requirements (Vdc)	16 to 32 CHS, 9.6 to 16 BAT	9.6 to 16	16 to 32 CHS, 9.6 to 16 BAT
Typical Current Drain (mA)	1.5 (sleep, no radio) 5 (active, 1 Hz scan with analog measurement, no radio)	~0.7 (sleep mode) 1 to 16 (w/o RS-232 comm) 17 to 28 (w/RS-232 comm)	~0.8 (sleep mode) 3 (1 Hz sample rate), 67 (20 Hz sample rate)
Dimensions (inches)	5.5 x 3.0 x 2.0	9.5 x 4.1 x 2	8 x 4 x 2.4
Weight (lb)	0.5 (CR300) 0.6 (CR310, CR300-CELL2XX/RF4XX/WIFI) 0.7 (CR310-CELL2XX/RF4XX/WIFI)	1.5	0.9 (CR6) 1.0 (CR6-/RF4XX/WIFI)
SDI-12 Supported	yes	yes	yes
PakBus Supported	yes	yes	yes
Modbus Supported	yes	yes	yes
DNP3 Supported	yes	yes	yes
Compliance Information	Available at: <a href="http://www.campbellsci.com/cr300">www.campbellsci.com/cr300</a> <a href="http://www.campbellsci.com/cr310">www.campbellsci.com/cr310</a>	Available at: <a href="http://www.campbellsci.com/cr800">www.campbellsci.com/cr800</a> <a href="http://www.campbellsci.com/cr850">www.campbellsci.com/cr850</a>	Available at: <a href="http://www.campbellsci.com/cr6">www.campbellsci.com/cr6</a>

### SOFTWARE SUPPORTED

Short Cut	3.2 or higher	yes	yes
PC200W	4.4 or higher	yes	yes
PC400	4.4 or higher	1.2 or higher	4.3 or higher
LoggerNet	4.4 or higher	3.0 or higher	4.3 or higher
RTDAQ	no	yes	yes

#### Notes:

1. The CR6 has 12 universal (U) and four control (C) terminals that can be programmed for a variety of functions. The number of analog inputs, switched excitations, and digital ports assume all of the ports are configured the same.
2. On the CR300-series, two analog inputs can measure 4 to 20 mA or 0 to 20 mA, natively, and four analog inputs can provide pulse/digital I/O functions.
3. Certain digital ports can be used to count switch closures.
4. I/O ports can be paired as transmit and receive for measuring smart serial sensors.
5. We recommend you confirm system configuration and critical specifications with Campbell Scientific before purchase.

## Datalogger Comparison Table Continued

FEATURE	CR1000X	CR3000	CR9000X (see note 1)
Max. Scan Rate (Hz)	1000	100	100,000
Analog Inputs	16 SE or 8 diff (see note 2)	28 SE or 14 diff	28 SE or 14 diff per CR9050, CR9051E, or CR9055(E)
Pulse Counters	2	4	12 per CR9071
Switched Excitation Channels	4 voltage	4 voltage, 3 current	10 voltage per CR9060
Digital Ports (see note 3,4)	8 I/Os, 4 TX/RX pair RS-232, or 4 SDI-12	3 SDM, 8 I/Os or 4 TX/RX pair RS-232	8 outputs per CR9060 or 16 I/Os per CR9071; 1 SDM
Continuous Analog Outputs	0	2	6 per CR9060
Communications/ Data Storage Ports	1 USB, 1 CS I/O, 1 CPI/RS-232, 1 MicroSD, 1 10/100baseT	1 CS I/O, 1 RS-232 1 parallel peripheral	1 CS I/O, 1 RS-232, 1 10/100baseT
CPI Port	1	0	0
Input Voltage Range (Vdc)	±5	±5	±5 w/CR9050 or CR9051E, ±50 w/CR9055(E), ±60 w/CR9058E
Analog Voltage Accuracy	±(0.04% of reading +offset), 0° to +40°C	±(0.04% of reading +offset), 0° to +40°C	±(0.07% of reading+4 A/D counts), -25° to +50°C
Analog Resolution	to 0.05 µV	to 0.33 µV	to 1.6 µV
A/D Bits	24	16	16
Temperature Range (°C)	-40 to +70 (standard) -55 to +85 (extended)	-25 to +50 (standard) -40 to +85 (extended)	-25 to +50 (standard) -40 to +70 (extended)
Memory (bytes)	128 MB Flash + 4 MB SRAM (battery backed)	2 M Flash (operating system), 4 M (CPU usage, program, storage, and data storage)	128 k (program), 128 M (data storage)
Power Requirements (Vdc)	10 to 16	10 to 16	9.6 to 16
Typical Current Drain (mA)	<1 (idle) 1 (1 Hz sample rate), 55 (20 Hz sample rate)	2 (sleep mode), 3 (1 Hz sample rate), 10 (20 Hz sample rate)	750 to 1000 (processing), 750 to 4000 (analog meas.)
Dimensions (inches)	9.4 x 4.0 x 2.4	9.5 x 7.0 x 3.8	15.75 x 9.75 x 8 (lab enclosure), 18 x 13.5 x 9 (field enclosure), 10 x 11 x 9 (CR9000XC)
Weight (lb)	1.9	10.7 (rechargeable battery), 3.6 (w/o battery)	~30 (lab enclosure), ~40 (field enclosure), ~27 (CR9000XC)
SDI-12 Supported	yes	yes	no
PakBus Supported	yes	yes	no
Modbus Supported	yes	yes	no
DNP3 Supported	yes	yes	no
Compliance Information	Available at: <a href="http://www.campbellsci.com/cr1000x">www.campbellsci.com/cr1000x</a>	Available at: <a href="http://www.campbellsci.com/cr3000">www.campbellsci.com/cr3000</a>	CE compliant
<b>SOFTWARE SUPPORTED</b>			
Short Cut	yes	yes	no
PC200W	yes	yes	no
PC400	4.5 or higher	1.3 or higher	1.0 or higher
LoggerNet	4.5 or higher	3.2 or higher	2.0 or higher
RTDAQ	yes	yes	yes

### Notes:

1. For the CR9000X, the current drain, weights, and specific number of input/output channels depend on the I/O modules chosen
2. On the CR1000X, two analog inputs can measure 4 to 20 mA or 0 to 20 mA, natively, and four analog inputs can provide pulse/digital I/O functions..
3. Certain digital ports can be used to count switch closures.
4. For the CR1000X and CR3000, the I/O ports can be paired as transmit and receive for measuring smart serial sensors.
5. We recommend you confirm system configuration and critical specifications with Campbell Scientific before purchase.

## Sensor and Peripheral Compatibility Table

DEVICE	CR300-Series	CR800/CR850	CR6	CR1000X	CR3000	CR9000X
<b>SENSORS</b>						
Anemometers (cup or propeller)	✓	✓	✓	✓	✓	✓
Anemometers (2-D sonic)	✓	✓	✓	✓	✓	
Anemometers (3-D sonic)	✓	✓	✓	✓	✓	✓
Barometers	✓	✓	✓	✓	✓	✓
Ceilometers	✓	✓	✓	✓	✓	
GPS	✓	✓	✓	✓	✓	see note 2
Present Weather	✓	✓	✓	✓	✓	✓
Pyranometers	✓	✓	✓	✓	✓	✓
Reflectometers	✓	✓	✓	✓	✓	
Relative humidity	✓	✓	✓	✓	✓	✓
Shaft encoders	✓	✓	✓	✓	✓	✓
Strain gages	✓	✓	✓	✓	✓	✓
Tipping buckets	✓	✓	✓	✓	✓	✓
Thermistors	✓	✓	✓	✓	✓	✓
Thermocouples	✓	✓	✓	✓	✓	✓
Vibrating wire		✓	✓	✓	✓	
Visibility	✓	✓	✓	✓	✓	✓
Wind Vanes	✓	✓	✓	✓	✓	✓
<b>COMMUNICATIONS PERIPHERALS</b>						
MicroSD			✓	✓		
CompactFlash®					✓	✓
Direct Connect	✓	✓	✓	✓	✓	✓
Ethernet	✓	✓	✓	✓	✓	✓
Multidrop Modems	✓	✓	✓	✓	✓	
PCMCIA Cards (type I, II, or III)						✓
Phone Modems (cellular)	✓	✓	✓	✓	✓	see note 3
Phone Modems (land-line)		✓	✓	✓	✓	see note 3
Radios (narrowband UHF/VHF)	✓	✓	✓	✓	✓	
Radios (spread spectrum/SRD860)	✓	✓	✓	✓	✓	see note 3
Satellite Transmitters (GOES)	✓	✓	✓	✓	✓	
Satellite Transmitters (Argos)	✓	✓	✓	✓	✓	
Satellite Transmitters (Iridium)	✓	✓	✓	✓	✓	
Short-Haul Modems		✓	✓	✓	✓	see note 3
<b>MEASUREMENT AND CONTROL PERIPHERALS (see note 4)</b>						
Multiplexers	see note 5	✓	✓	✓	✓	✓
SDM Devices		✓	✓	✓	✓	✓
CDM Devices (see note 6)		✓	✓	✓	✓	

### Notes:

- To determine compatibility with devices not offered by Campbell Scientific or devices not listed on this chart, refer to the device's product brochure or manual, or contact Campbell Scientific.
- Contact Campbell Scientific about configuration requirements for using the CR9000X with our GPS sensor.
- Although compatible, phone modems, spread spectrum radios, and short haul modems do not support the CR9000X's maximum communication rate.
- Measurement and control devices typically used with the CR9000X are the AM25T and SDM-CAN. Although compatible, the AM16/32B, SDM-CD16AC, and SDM-CVO4 do not support the CR9000X's maximum communication rate and are not practical for most CR9000X applications.
- Early CR300-series operating systems did not support multiplexers.
- Our CR6 and CR1000X dataloggers support CDMs natively through their CPI port. The CR800, CR850, and CR3000 must use an SC-CPI interface.



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