Datalogger Overview

Campbell Scientific Dataloggers

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
- Control external devices such as pumps, motors, alarms, freezers, and valves
- Operate independently of ac power, computers, and human interaction
- Use our PC support software to program the logger
- 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.

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.

Keyboard Display

The datalogger's keyboard display allows you to manually transfer data and display sensor readings, stored values, or flag/port status. It consists of a 128 x 64 pixel backlit graphical LCD or eight-line numeric display and a 16-character keyboard.

Our CR850, CR3000, and CR5000 have a built-in keyboard display as part of their integrated package. The CR800 and CR1000 dataloggers use the CR1000KD, a portable keyboard display that can be carried from site to site. A keyboard display is not available for our CR200X-series and CR9000X dataloggers.

Programming

Our contemporary dataloggers are programmed with CRBasic. CRBasic stems from the BASIC programming language. It provides special instructions for making measurements and creating tables of output data. CRBasic also supports algebraic and conditional expressions.

Data Storage

Data is stored in multiple tables that can be individually sized and collected. This storage method lets you group and store like-data in separate tables.

Communication Protocols

Traditional

Traditionally, our dataloggers use a connection-based communications protocol.

PakBus®

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 DNP3 protocol supports only long data formats. 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 when a CR1000 or CR3000 is used in conjunction with an NL115, NL120, or third party serial IP device.

Input/Output Connections

Input/Output Connections include analog inputs, continuous analog outputs, pulse counters, switched excitation outputs, and digital I/O ports. These connections measure, communicate with, and power sensors and peripherals.

CS I/O Port connects to most of our data storage, data retrieval, and telecommunications peripherals.

Power & Ground Connections provide power for 12 V or 5 V peripherals and grounding points for sensors and peripherals.

RS-232 Serial I/O Port connects directly to a computer or to smart serial sensors.

Analog Inputs

Analog inputs measure voltage levels. These inputs 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. Voltages must fall within the input voltage range of the datalogger; 2:1 and 10:1 voltage dividers are available. Software selectable voltage ranges let you take full advantage of the datalogger's resolution to measure voltage changes as small as 0.33 µV (depends on datalogger model). Sensors measured by analog inputs include thermocouples, thermistors, resistive bridges, vibrating wires, and 4 to 20 mA outputs.

Continuous Analog Outputs

Several 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 gauges, flow meters, and anemometers.

Digital I/O Ports

Digital I/O ports detect status, read SDM peripherals or SDI-12 sensors, and control external devices. Each port can be configured separately within the datalogger's program.

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 CR5000 also have switched current excitation outputs. These outputs are for resistance measurements and are programmable over a ±2.5 mA range.

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 laptop or PC requires an interface, typically the SC32B Optically Isolated Interface.

The RS-232 port allows the datalogger to be connected to the PC's serial port via an RS-232 cable—no interface required. On the CR200X-series, CR3000, CR5000, and CR9000X, this port is electrically isolated. Isolation is not provided by the RS-232 port on the CR800-series and CR1000 dataloggers.

Our CR1000 and CR3000 have a 20-pin parallel peripheral port for connecting devices that store data on a CompactFlash card and/or communicate via Ethernet.

Datalogger Descriptions (listed from smallest to largest)

CR200X-series Datalogger/Wireless Sensor

The input channel configuration of the CR200X-series dataloggers is optimal for measuring one or two sensors; these dataloggers are not compatible with channel expansion devices or thermocouples. The CR200X series uses an external power supply.

- **Design Features:** These are our smallest and lowest-cost dataloggers. Three of the models include an internal spread spectrum radio, which allows the dataloggers to be used in wireless networks.
- **Ideal Applications:** Wireless sensors, wind energy, rural water, aquaculture, water quality.
- **Models Available:** CR200X (no radio), CR206X (915 MHz radio), CR211X (922 MHz radio), CR216X (2.4 GHz radio), CR295X (supports GOES satellite telemetry).

CR800-series Measurement and Control System

The CR800 series consists of measurement electronics encased in a plastic shell and an integrated wiring panel. The CR800 series uses an external power supply—typically the BPALK Alkaline Battery Pack or PS100 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 are compatible with channel expansion peripherals and thermocouples, and support serial communications with serial sensors and devices via I/O port pairs.
- **Ideal Applications:** Wind profiling, weather stations, ETo/agriculture, air quality, soil moisture, water level/stage, aquaculture, vehicle testing, Time Domain Reflectometry, SCADA, water quality.
- **Models Available:** CR800 uses the portable CR1000KD keyboard display; CR850 includes a keyboard display as part of its integrated package.

CR1000 Measurement and Control System

The CR1000 consists of a measurement and control module and a detachable wiring panel. It uses an external power supply, usually the BPALK or PS100, and a portable keyboard display, the CR1000KD.

- **Design Features:** Besides providing all of the design features for the CR800-series dataloggers, the CR1000 has more channels and includes a 40-pin parallel peripheral port. The peripheral port interfaces with the NL115 Ethernet Interface & CompactFlash Module, the NL120 Ethernet Interface, or the CFM100 CompactFlash® Module.
- **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 all of the CR1000's design features, as well as more channels, programmable switched current outputs, and removable terminal strips.
- **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, alkaline batteries, or low-profile (no-battery) base.

CR5000 Measurement and Control System

The CR5000 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 CR5000 has a sampling rate of up to 5000 Hz, an onboard PC-card slot for expanding its storage capacity, and programmable switched current outputs.
- **Ideal Applications:** Eddy covariance, Bowen ratio, weather stations, vehicle testing, HVAC, process monitoring and control, structural or fatigue analysis, machinery testing, energy management and conservation.
- **Base Options:** Sealed rechargeable battery or low-profile (no-battery) base.

CR9000X Measurement & Control Systems

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

- **Design Features:** The CR9000X supports a measurement rate of up to 100,000 Hz, provides 180 MHz clock speed, has an onboard PC-card slot for expanding its storage capacity, and includes an onboard 10baseT/100baseT port. Also, the CR9000X 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.
- **Models Available:** 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.

Comparison Table for Smaller Dataloggers

FEATURE	CR200X Series	CR800/CR850	CR1000
Max. Scan Rate (Hz)	1	100	100
Analog Inputs	5 SE (no diff) (see note 1)	6 SE or 3 diff	16 SE or 8 diff
Pulse Counters	2	2	2
Switched Excitation Channels	2 voltage	2 voltage	3 voltage
Digital Ports (see note 2)	2 I/Os	4 I/Os or 2 RS-232 COM (see note 3)	8 I/Os or 4 RS-232 COM (see note 3)
Continuous Analog Outputs	0	0	0
Communications/ Data Storage Ports	1 RS-232 (see note 4)	1 CS I/O, 1 RS-232	1 CS I/O, 1 RS-232 1 Parallel Peripheral
Input Voltage Range (Vdc)	0≤ V < 2.5	±5	±5
Analog Voltage Accuracy	±(0.25% of reading +1.2 mV offset), -40° to +50°C	±(0.06% of reading + offset), 0° to 40°C	±(0.06% of reading + offset), 0° to 40°C
Analog Resolution	to 0.6 mV	to 0.33 µV	to 0.33 µV
A/D Bits	12	13	13
Temperature Range (°C)	-40 to +50	-25 to +50 (standard) -55 to +85 (extended, CR800) -30 to +80 (extended, CR850)	-25 to +50 (standard) -55 to +85 (extended)
Memory (bytes)	up to 19.6 k (compiled program), 512 k (data storage), 106 k (operating system)	2 M Flash (operating system) 4 M (CPU usage, program storage, and data storage)	2 M Flash (operating system) 4 M (CPU usage, program storage, and data storage)
Power Requirements (Vdc)	7 to 16	9.6 to 16	9.6 to 16
Typical Current Drain (mA)	~0.2 (quiescent, no radio) ~3 (active, no radio)	~0.6 (sleep mode) 1 to 16 (w/o RS-232 comm) 17 to 28 (w/RS-232 comm.)	~0.6 (sleep mode) 1 to 16 (w/o RS-232 comm.) 17 to 28 (w/RS-232 comm.)
Dimensions (inches)	5.5 x 3.0 x 1.9	9.5 x 4.1 x 2	9.4 x 4.0 x 2.4
Weight (lbs)	0.5 (CR200X, CR295X) 0.6 (CR206X, CR211X, CR216X)	1.5	2.1
SDI-12 Supported	yes	yes	yes
PakBus Supported	leaf node only	yes	yes
Modbus Supported	yes	yes	yes
DNP3 Supported	no	yes	yes
CE Compliant	CR200X, CR206X, CR211X, CR216X	yes	yes
Warranty	3 year	3 years	3 years

Software Supported			
Short Cut	yes	yes	yes
PC200W	yes	yes	yes
PC400	1.0 or higher	1.4 or higher	1.2 or higher
LoggerNet	2.1 or higher	3.3 or higher	3.0 or higher
RTDAQ	no	yes	yes
PConnect	3.0 or higher	3.3 or higher	3.1 or higher
PConnectCE	2.0 or higher	2.2 or higher	2.0 or higher

Notes:
1. The single-ended analog inputs on the CR200X-series dataloggers can also be used as control ports.
2. Certain digital ports can be used to count switch closures.
3. For the CR800, CR850, and CR1000, the I/O ports can be paired as transmit and receive for measuring smart serial sensors.
4. The CR295X has an additional RS-232 port for satellite communications.
5. We recommend you confirm system configuration and critical specifications with Campbell Scientific before purchase.

Comparison Table for Larger Dataloggers

FEATURE	CR3000	CR5000	CR9000X (see note 1)
Max. Scan Rate (Hz)	100	1667	100,000
Analog Inputs	28 SE or 14 diff	40 SE or 20 diff	28 SE or 14 diff per CR9050, CR9051E, or CR9055(E)
Pulse Counters	4	2	12 per CR9071
Switched Excitation Channels	4 voltage, 3 current	4 voltage, 4 current	10 voltage per CR9060
Digital Ports (see note 2)	3 SDM, 8 I/Os or 4 RS-232 COM (see note 3)	8 I/Os, 1 SDM	1 SDM; 8 outputs per CR9060 or 16 I/Os per CR9071
Continuous Analog Outputs	2	2	6 per CR9060
Communications/ Data Storage Ports	1 CS I/O, 1 RS-232 1 Parallel Peripheral	1 CS I/O, 1 RS-232	1 CS I/O, 1 RS-232, 1 10baseT/100baseT
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℃	±0.05% FSR, 0° to 40℃	±(0.07% of reading + 4 A/D counts), -25° to +50℃
Analog Resolution	to 0.33 µV	to 0.33 µV	to 1.6 µV
A/D Bits	16	16	16
Temperature Range (℃)	-25 to +50 (standard) -40 to +85 (extended)	-25 to +50 (standard) -40 to +85 (extended)	-25 to +50 (standard) -40 to +70 (extended)
Memory (bytes)	2 M Flash (operating system), 4 M (CPU usage, program, storage, and data storage)	128 k (program), 2 M (data storage)	128 k (program), 128 M (data storage)
Power Requirements (Vdc)	10 to 16	11 to 16	9.6 to 16
Typical Current Drain (mA)	2 (sleep mode), 3 (1 Hz sample rate), 10 (100 Hz sample rate)	1.5 (sleep mode) 4.5 (1 Hz sample rate) 200 (5 kHz sample rate)	750 to 1000 (processing), 750 to 4000 (analog meas.)
Dimensions (inches)	9.5 x 7.0 x 3.8	9.8 x 8.3 x 4.5	15.75 x 9.75 x 8 (lab enclosure), 18 x 13.5 x 9 (field enclosure), 10 x 11 x 9 (CR9000XC)
Weight (lbs)	10.7 (rechargeable battery), 8.3 (alkaline battery), 3.6 (w/o battery)	12.2 (w/battery), 4.5 (w/o battery)	~30 (lab enclosure), ~40 (field enclosure), ~27 (CR9000XC)
SDI-12 Supported	yes	yes	no
PakBus Supported	yes	no	no
Modbus Supported	yes	no	no
DNP3 Supported	yes	no	no
CE Compliant	yes	yes	yes
Warranty	3 year	3 years	3 years

Software Supported			
Short Cut	yes	yes	no
PC200W	yes	yes	no
PC400	1.3 or higher	1.0 or higher	1.0 or higher
LoggerNet	3.2 or higher	2.0 or higher	2.0 or higher
RTDAQ	yes	yes	yes
PConnect	3.2 or higher	no	no
PConnectCE	2.1 or higher	no	no

Notes:

1. For the CR9000X, the current drain, weights, and specific number of input/output channels depend on the I/O modules chosen.

2. Certain digital ports can be used to count switch closures.

3. For the CR3000, the I/O ports can be paired as transmit and receive for measuring smart serial sensors.

4. We recommend you confirm system configuration and critical specifications with Campbell Scientific before purchase.

Sensor and Peripheral Compatibility Table

Device	CR200X-series	CR800/CR850	CR1000	CR3000	CR5000	CR9000X
Sensors						
Anemometers (cup or propeller)	X	X	X	X	X	X
Anemometers (2-D sonic)	see note 2	X	X	X	see note 2	
Anemometers (3-D sonic)		X	X	X	X	X
Barometers	X	X	X	X	X	X
GPS		X	X	X	see note 3	see note 3
Pyranometers	CS300 only	X	X	X	X	X
Reflectometers	CS625 only	X	X	X	X	
Relative humidity	X	X	X	X	X	X
Shaft encoders	X	X	X	X	X	X
Strain gages	SDI-12 gages only	X	X	X	X	X
Tipping buckets	X	X	X	X	X	X
Thermistors	109 & 109SS only	X	X	X	X	X
Thermocouples		X	X	X	X	X
Vibrating wire		X	X	X	X	
Wind vanes	X	X	X	X	X	X
Communications Peripherals						
CompactFlash®			X	X	X	X
Direct Connect	X	X	X	X	X	X
Ethernet	X	X	X	X	X	X
Multidrop Modems	X	X	X	X	X	
PCMCIA Cards (type I, II, or III)					X	X
PDAs (see note 4)	X	X	X	X		
Phone Modems (cellular)	X	X	X	X	X	see note 5
Phone Modems (land-line)		X	X	X	X	see note 5
Radios (narrowband UHF/VHF)		X	X	X		
Radios (spread spectrum)	X	X	X	X	X	see note 5
Satellite Transmitters (GOES)	CR295X only	X	X	X	X	
Satellite Transmitters (Argos)		X	X	X		
Satellite Transmitters (Meteosat)		X	X	X		
Short-Haul Modems		X	X	X	X	see note 5
Measurement and Control Peripherals						
Multiplexers		X	X	X	X	see note 6
SDM Devices		X	X	X	X	see note 6

Notes:
1. 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 a Campbell Scientific applications engineer.
2. Our CR200X-series and CR5000 dataloggers are only compatible with the 2-D sonic anemometer that outputs an SDI-12 signal (the WindSonic4). Although the WindSonic4 is not listed on our price lists, it may be purchased from Campbell Scientific.
3. Contact Campbell Scientific about configuration requirements for using these dataloggers with our GPS sensor.
4. User-supplied PDAs with a Palm OS require PConnect software; user-supplied PDAs with a Windows Pocket PC/Windows Mobile OS require PConnectCE software.
5. Although compatible, phone modems, spread spectrum radios, and short haul modems do not support the CR9000X's maximum communication rate.
6. Measurement and control devices typically used with the CR9000X are the AM25T multiplexer, SDM-CAN, SDM-INT8, and SDM-SIO4. Although compatible, the AM16/32B multiplexer, SDM-CD16AC, and SDM-CVO4 do not support the CR9000X's maximum communication rate and are not practical for most CR9000X applications.