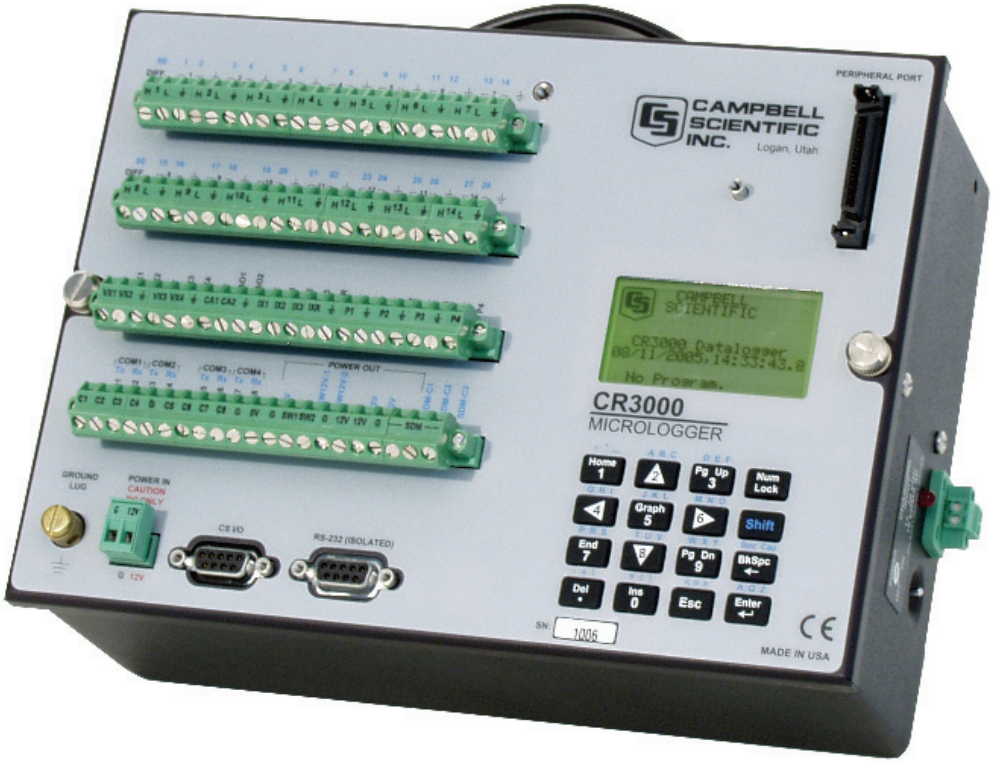
CR3000 Micrologger®

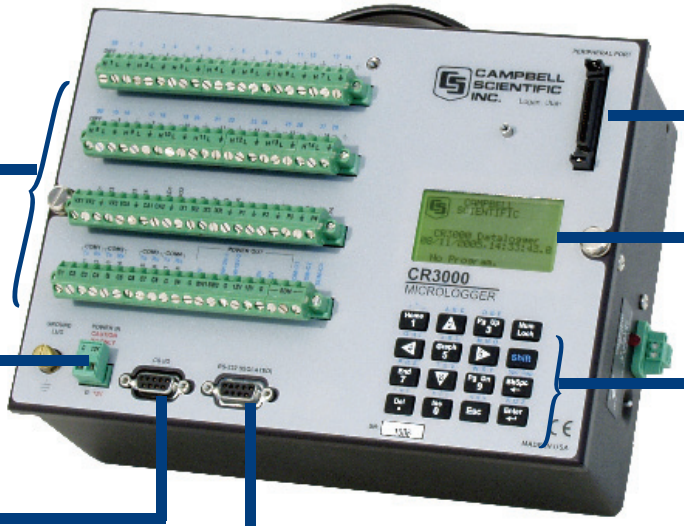
A Portable, Rugged, Powerful Data Acquisition System



CAMPBELL SCIENTIFIC, INC.®
WHEN MEASUREMENTS MATTER

CR3000 Micrologger®

The CR3000 Micrologger® is a compact, rugged, powerful datalogger. Housed in a portable, self-contained package, the Micrologger consists of measurement and control electronics, communication ports, keyboard, display, power supply, and carrying handle. The CR3000's low power requirements allow extended field use from a dc voltage source.



Removable Input/Output Connections—Individually configured for ratiometric resistive bridge, thermocouple, switch closure, high frequency pulse, low-level ac, serial sensors, and more.

Removable Power Terminal—simplifies connection to external power supply.

CS I/O Port—connects to data transfer and storage peripherals such as phone, RF, short-haul, and multidrop modems.

Computer RS-232—provides a 9-pin electrically isolated DCE port.

Peripheral Port—one 40-pin port interfaces with the CFM100 CompactFlash® module, which allows data to be stored on a CompactFlash card.

128 x 64 Backlit LCD—provides a graphical or 8-line numeric data display to view labeled real-time and historical data, program instructions, and help menus.

Keyboard—allows on-site program editing and command entries.

Features

- Program execution rate of up to 100 Hz
- 16-bit analog to digital conversions
- 16-bit microcontroller with 32-bit internal CPU architecture
- Temperature compensated real-time clock
- Background system calibration for accurate measurements over time and temperature changes
- Gas Discharge Tube (GDT) protected inputs
- Data values stored in tables with a time stamp and record number
- 4 Mbytes data storage memory
- Battery-backed SRAM and clock that ensure data, programs, and accurate time are maintained while the CR3000 is disconnected from its main power source
- Measures SDI-12 or serial sensors with four independent COM ports

Sensor Connections

Analog Inputs: Twenty-eight single-ended (14 differential) channels measure voltage levels with 16-bit resolution on five software selectable voltage ranges.

Pulse Counting Channels: Four 24-bit pulse channels measure switch closures, high frequency pulses, or low-level ac.

Digital Control Ports: Eight ports have multiple functions including digital control output, interrupt, pulse counting, switch closure, frequency/period measurements, edge timing, SDI-12 communication, or serial sensor communication at rates up to 115.2 kbps. Three additional ports are dedicated for measuring SDM devices.

Continuous Analog Outputs: Two continuous analog outputs provide voltage levels to displays or proportional controllers.

Switched Excitation Outputs: Four switched voltage and three switched current outputs provide precision excitation for ratiometric sensor/bridge measurements.

Power Connections: The continuous 5 V and 12 V terminals are for connecting sensors and non-Campbell Scientific peripherals. Two switched 12 V terminals are program controlled.

Operation in Harsh Environments

The standard operating range is -25° to +50°C; an extended range of -40° to +85°C is available. A CR3000 housed in an environmental enclosure with desiccant is protected from humidity and most contaminants.

Data Storage Capacity

The CR3000 provides 2 Mbyte of FLASH memory for the Operating System and 4 Mbytes of battery-backed SRAM for CPU usage, program storage, and data storage. Data is stored in a table format. The storage capacity of the CR3000 can be increased by using a CompactFlash® card.

Datalogger Programming

The CR3000 is programmed using the CRBasic language. CRBasic programs can be created using the Short Cut program generator or the CRBasic Editor. Short Cut generates CR3000 programs and wiring diagrams in four easy steps and supports almost all of Campbell Scientific sensors. The CRBasic Editor uses the flexible programming structure of Basic to create more complex CR3000 programs. Short Cut generated programs can be imported into the CRBasic Editor to add instructions, or for functionality not supported by Short Cut. Short Cut and the CRBasic Editor are available in both LoggerNet and PC400 Datalogger Support Software. LoggerNet includes the Transformer application that converts existing CR23X Edlog programs to CR3000 CRBasic programs.

Communication Protocols

The CR3000 supports the PakBus® communication protocol. PakBus 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.

Communications

Compatible telecommunication options include Ethernet, phone modems (land-line and cellular), radios, short haul modems, GOES satellite transmitters, and multi-drop modems. Real-time and historical data can be displayed using the on-board graphical display or a PC. The PC connects to the CR3000 via an RS-232 cable or the CS I/O port and SC32B interface.

Customers can transport programs/data to a PC via CompactFlash® cards. The CFM100 module is used to store the programs/data on the card, and a SanDisk® ImageMate® card reader or CF1 module is used to download the programs/data to the PC.

Channel Expansion

Synchronous Devices for Measurement (SDMs)

SDMs are addressable peripherals that expand the CR3000's measurement and control capabilities. For example, SDMs are available to add control ports, analog outputs, pulse count channels, interval timers, or even a CANbus interface to your system. Multiple SDMs can be connected to one CR3000 datalogger on its dedicated SDM ports.

Multiplexers

Multiplexers increase the number of analog sensors that can be measured by a CR3000 by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single CR3000. The CR3000 is compatible with the AM16/32 and AM25T multiplexers.

Battery Base Options

The alkaline base option includes 10 D-cell batteries with a 10 Ahr rating at 20°C. The rechargeable base option provides an internal 7 Ahr sealed rechargeable battery that can be trickle-charged via vehicle power, solar panels, or ac power. For charging the battery via ac power, a 110 Vac wall charger is offered for US customers or other countries with 110 Vac outlets. A 100 to 240 Vac wall charger is also available. When using vehicle power, our DCDC18R Boost Regulator is used to increase the vehicle's supply voltage to charging levels required by the CR3000.

The low-profile (no battery) option requires a user-supplied dc source. It is preferred when the system's power consumption needs a larger capacity battery or when it's advantageous to have a thinner, lighter datalogger.

Applications

- Eddy covariance systems
- Wireless sensor/datalogger networks
- Mesonet systems
- Wind profiling
- Water quality
- Avalanche forecasting, snow science, polar, high altitude
- Long-term climatological monitoring, meteorological research, routine weather measurement
- Air quality
- Agriculture, agriculture research
- Soil moisture, Time Domain Reflectometry
- Water level/stage
- Vehicle testing
- Aerospace/aviation
- Stuctural or fatigue analysis

The CR3000 can be used in networks of dataloggers that continuously monitor air quality.

CR3000 Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; non-condensing environment required. To maintain electrical specifications, Campbell Scientific recommends recalibrating dataloggers every two years. We recommend that you confirm system configuration and critical specifications with Campbell Scientific before purchase.

ANALOG INPUTS *(SE1-SE28 or DIF1-DIF14)*

14 differential (DF) or 28 single-ended (SE) voltage measurements individually configured. Ratiometric resistive bridge, thermocouple, and period average (frequency) measurements also supported on all analog input channels. Channel expansion provided by AM16/32 and AM25T multiplexers.

RANGES, RESOLUTION: 16-bit basic resolution (Basic Res). **Resolution of DF measurements with input reversal is half the Basic Res (17-bits).**

Input Range (mV)[1]	DF Res (µV)[2]	Basic Res (µV))
±5000	83.33	167
±1000	16.67	33.3
±200	3.33	6.67
±50	0.83	1.67
±20	0.33	0.67

[1]Range overhead of ~9% exists on all ranges to guarantee that the full-scale range values will not cause overrange.

[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.04% of reading + offset), 0° to 40°C
±(0.07% of reading + offset), -25° to 50°C
±(0.09% of reading + offset), -40° to 85°C (-XT only)

[3]Accuracy does not include 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 + 5.0 µV

MEASUREMENT SPEED: Time includes 250 µs for conversion to engineering units. For voltage measurements, the CR3000 integrates the input signal.

Integration Type	Integration Time	Settling Time	Measurement Total Time Standard	Input Rev.
250	250 µs	200 µs	~0.7 ms	~1.4 ms
60 Hz filter	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz filter	20.00 ms	3 ms	~23 ms	~46 ms

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±20 mV input range; digital resolution dominates for higher ranges.

250 µs Integration: 0.4 µV RMS
50/60 Hz Integration: 0.19 µV RMS

COMMON MODE RANGE: ±5 V

DC COMMON MODE REJECTION: >100 dB

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

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

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±120 nA @ 85°C

INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C;
±0.8°C, -40° to 85°C (-XT only)

PERIOD AVERAGE MEASUREMENTS: Any of the 28 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution) where resolution is 96 ns divided by the specified number of cycles to be measured.

Input Amplitude & Frequency:

Volt. Gain	Range Code	Signal (peak to peak) Min (mV)	Max (V)[4]	Pulse W. Min. (µs)	Max. Freq. (kHz)[5]
1	mV1000	200	10	2.5	200
5	mV200	20	2	5.0	100
20	mV50	5	2	10.0	50
50	mV20	2	2	25.0	20

[4]Maximum signal must be centered at datalogger ground.
[5]Assuming 50% duty cycle.

ANALOG OUTPUTS *(Vx1-Vx4, Ix1-Ix3, CAO1, CAO2)*

4 switched voltage and 3 switched current outputs for ratiometric sensor/bridge excitation and 2 continuous voltage outputs. Switched outputs active only during measurement, one at a time.

	Range	Res	Current Source/Sink	Compliance Voltage
Vx:	±5 V	0.17 mV	±50 mA	N/A
CAO:	±5 V	0.17 mV	±15 mA	N/A
Ix:	±2.5 mA	0.08 µA	N/A	±5 V

Vx & CAO ACCURACY:
±(0.04% of setting + 0.5 mV), 0° to 40°C
±(0.07% of setting + 0.5 mV), -25° to 50°C
±(0.09% of setting + 0.5 mV), -40° to 85°C (-XT only)

Ix ACCURACY:
±(0.1% of setting + 0.5 µA), 0° to 40°C
±(0.13% of setting + 0.5 µA), -25° to 50°C
±(0.15% of setting + 0.5 µA), -40° to 85°C (-XT only)

Vx FREQUENCY SWEEP FUNCTION: The switched outputs provide a programmable swept frequency, 0 to 5 V square wave for exciting vibrating wire transducers.

RESISTANCE MEASUREMENTS

MEASUREMENT TYPES: The CR3000 provides ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation for voltage or current excitations eliminates DC errors. Offset values are reduced by a factor of 2 when excitation reversal is used.

VOLTAGE RATIO ACCURACY[1]: Assuming excitation voltage of at least 500 mV, and not including bridge resistor errors

±(0.02% of voltage reading + offset)/V_x, 0° to 40°C
±(0.025% of voltage reading + offset)/V_x, -25° to 50°C
±(0.03% of voltage reading + offset)/V_x, -40° to 85°C

[1]Accuracy does not include 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 + 5.0 µV

ACCURACY WITH CURRENT EXCITATION[1]: Assuming excitation current of at least 500 µA.

±(0.02% of voltage reading + offset)/I_x, 0° to 40°C
±(0.025% of voltage reading + offset)/I_x, -25° to 50°C
±(0.03% of voltage reading + offset)/I_x, -40° to 85°C

[1]Accuracy does not include 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 + 5.0 µV

DEDICATED PULSE COUNTERS *(P1-P4)*

Four inputs individually selectable for switch closure, high frequency pulse, or low-level AC. Independent 24-bit counters (16.8 x 10^6 counts) for each input.

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:
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.
Maximum Input Voltage: ±20 V
Maximum Input Frequency: 250 kHz

LOW LEVEL AC MODE: Internal AC coupling removes DC offsets up to ±0.5 V.
Input Hysteresis: 16 mV @ 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 CONTROL PORTS *(C1-C8, SDM)*

8 digital control ports (C1-C8) having multiple function capability including digital control outputs, digital control interrupts, pulse counting, switch closure, frequency/period measurements, edge timing, and SDI-12 communication. Independent asynchronous communication ports (UARTs) paired on control port pairs C1-C2, C3-C4, C5-C6, and C7-C8 resulting in four independent Tx/Rx pair for serial sensors.

INPUT STATE: high 3.8 to 5.3 V; low -0.3 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kohms

HIGH FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

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

OUTPUT RESISTANCE: 330 ohms

ADDITIONAL DIGITAL PORTS: SDM-C1, SDM-C2, SDM-C3 are dedicated for measuring SDM devices.

SWITCHED 12 V *(SW12V)*

Two independent 12 V unregulated sources switched on and off under program control. Thermal fuse hold current = 900 mA @ 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

CE COMPLIANCE

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

COMMUNICATION

RS-232 PORTS:
9-pin: DCE (electrically isolated) for computer or non-CSI modem connection
COM1 to COM4: Four independent Tx/Rx pairs on control ports (non-isolated)
Baud Rate: Selectable from 300 to 115.2 kbps.
Format: 7, 8 data bits; 1, 2 stop bits; odd, even, or no parity

CS I/O PORT: Interface with CSI peripherals.

SDI-12: Digital Control ports 1, 3, 5, and 7 are individually configurable and meet Standard version 1.3 for datalogger mode. Up to ten SDI-12 sensors are supported per port.

SDM PORT: Interface with CSI Synchronous Devices for Measurement

PERIPHERAL PORT: Interface with CFM100 CompactFlash Module

SYSTEM

PROGRAM EXECUTION INTERVALS: 10 ms to 30 min. @ 10 ms increments

PROCESSOR: Renesas H8S 2674 (16-bit CPU with 32-bit internal core)

MEMORY: 2 Mbytes of Flash for operating system; 4 Mbytes of battery-backed SRAM for CPU usage, program storage and data storage

CLOCK ACCURACY: ±3 min. per year

SYSTEM POWER REQUIREMENTS

VOLTAGE: 10 to 16 VDC

TYPICAL CURRENT DRAIN: Sleep Mode: 2 mA
1 Hz Sample Rate (one fast SE meas.): 3 mA
100 Hz Sample Rate (one fast SE meas.): 10 mA
100 Hz Sample Rate (one fast SE meas. w/RS-232 communications): 38 mA
Display on: add 1 mA to current drain
Backlight on: add 42 mA to current drain

INTERNAL BATTERIES: 10 Ahr alkaline or 7 Ahr rechargeable base. 1200 mAhr lithium battery for clock and SRAM backup typically provides 3 years of back-up.

EXTERNAL BATTERIES: 12 VDC nominal; reverse polarity protected.

PHYSICAL SPECIFICATIONS

SIZE: 9.5" x 7.0" x 3.8" (24.1 x 17.8 x 9.6 cm). Terminal strips extend 0.875" (2.2 cm) and terminal strip cover extends 1.575" (4.0 cm) above the panel.

WEIGHT: 3.6 lbs (1.6 kg) with low profile base; 8.3 lbs (3.8 kg) with alkaline base; 10.7 lbs (4.8 kg) with rechargeable base.

WARRANTY

Three years against defects in materials and workmanship.

815 W. 1800 N. | Logan, Utah 84321-1784 | USA | phone (435) 753-2342 | www.campbellsci.com
Australia | Brazil | Canada | England | France | Germany | South Africa | Spain | USA (headquarters)

Printed February 2007