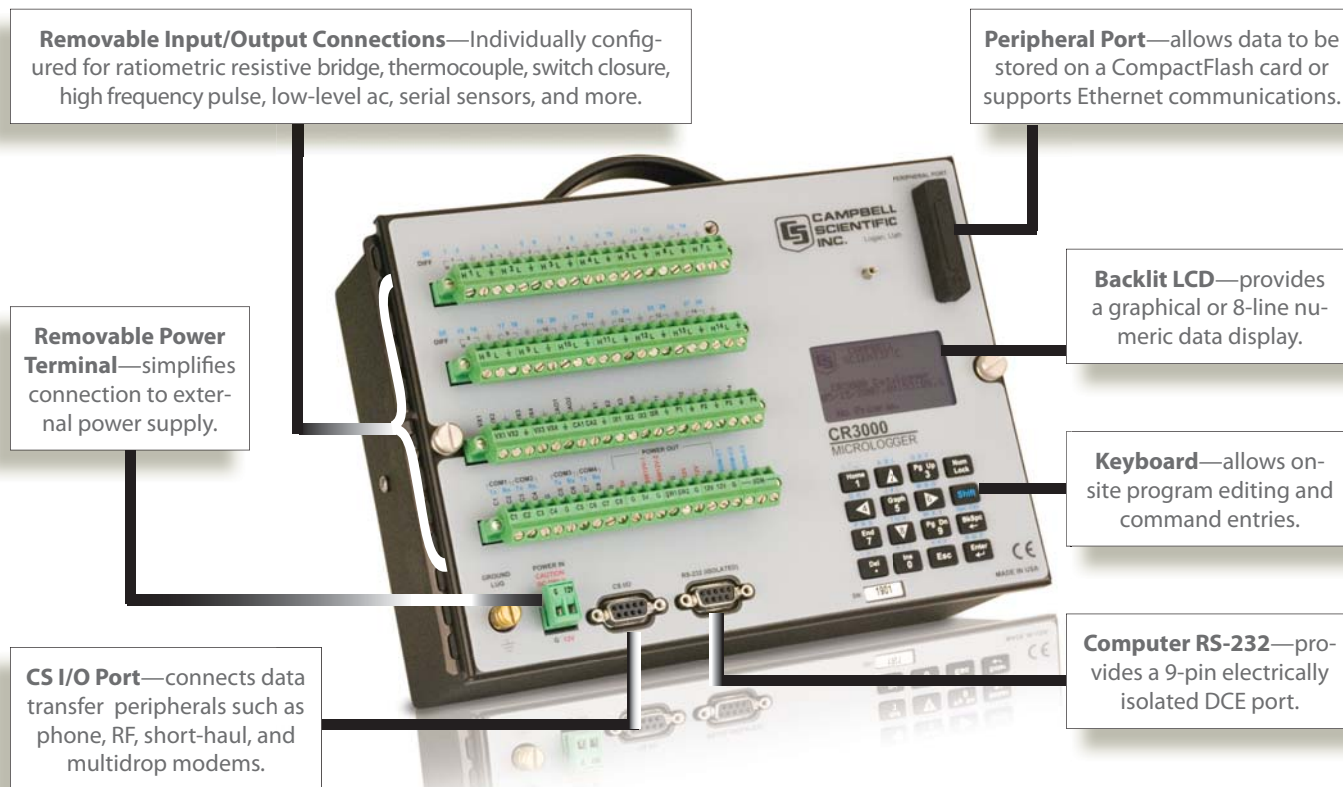# CR3000 Micrologger®

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.

Peripheral Port—allows data to be stored on a CompactFlash card or supports Ethernet communications.

Removable Power Terminal—simplifies connection to external power supply.

Backlit LCD—provides a graphical or 8-line numeric data display.

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

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

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

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
- Serial communications with serial sensors and devices supported via I/O port pairs
- PakBus, Modbus, and DNP3 protocols supported

Operating System/Logic Control

The on-board operating system includes measurement, processing, and output instructions for programming the datalogger. The programming language, CRBasic, uses a BASIC-like syntax. Measurement instructions specific to bridge configurations, voltage outputs, thermocouples, and pulse/frequency signals are included. Processing instructions support algebraic, statistical, and transcendental functions for on-site processing. Output instructions process data over time and control external devices.

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.

Input Output Terminals

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

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

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

Digital I/O Ports
Eight ports have multiple functions including digital control output, interrupt, pulse counting, switch closure, frequency/period measurements, edge timing, or SDI-12 communication. Three additional ports are dedicated for measuring SDM devices.

The I/O ports can be paired as transmit and receive. Each pair has 0 to 5 V UART hardware that allows serial communications with serial sensors and devices. An RS232-to-logic level converter may be required in some cases.

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

Peripheral Port
One 40-pin port interfaces with the NL115 Ethernet Interface & CompactFlash Module, the NL120 Ethernet Interface, or the CFM100 CompactFlash Module.

RS-232 Port
The RS-232 port is for connecting a PC, serial sensor, or RS-232 modem. The PC attaches to the CR3000 via an RS-232 cable—no interface required. This port isolates the PC's electrical system from the datalogger, thereby protecting against ground loops, normal static discharge, and noise.

CS I/O Port
Many communication peripherals connect with the CR3000 via this port. A PC may also connect with this port, but an SC32B or SC-USB interface is required.

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.

Transient Protection
Gas Discharge Tube (GDT) protects the inputs from electrical transients. The CR3000 is CE compliant under the European Union's EMC Directive, meeting ESD, EMC, Fast Transient standards.

Communication Protocols
The CR3000 supports the PakBus, Modbus, and DNP3 communication protocols. 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.

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

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.

Enclosures
The CR3000 can be housed in an ENC12/14, ENC14/16 and ENC16/18 enclosure. A CR3000 housed in a weather-resistant enclosure can collect data under extremely harsh conditions. The enclosure protects the CR3000 from dust, water, sunlight, or pollutants.

Battery Base Options

Alkaline Base
The alkaline base option includes 10 D-cell batteries with a 10 Ahr rating at 20°C.

Rechargeable Base
The rechargeable base includes an internal 7-Ahr sealed rechargeable battery that can be charged from vehicle power, solar panels, or ac power.

When using vehicle power, our DCDC18R Boost Regulator is used to increase the vehicle's supply voltage to charging levels required by the CR3000.
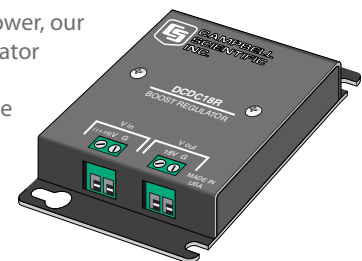
Low-Profile Base (no battery)
The low-profile (no battery) option requires a user-supplied dc source. It is preferred when the system's power consumption needs a larger capacity battery or when it's advantageous for the Micrologger to be thinner and lighter.

Communication Options

To determine the best option for an application, consider the accessibility of the site, availability of services (e.g., cellular phone or satellite coverage), quantity of data to collect, and desired time between data-collection sessions. Some communication options can be combined—increasing the flexibility, convenience, and reliability of the communications.

CompactFlash®
A CFM100 or NL115 module attached to a CR3000 can store data on a CompactFlash (CF) card. The PC reads the CF card using either the CF1 CompactFlash Adapter or a 17752 USB Reader/Writer. Please note that the CF card should be industrial-grade with a storage capacity of 2 Gbytes or less.

Campbell Scientific offers 64 Mbyte, 256 Mbyte, 1 Gbyte (shown), and 2 Gbyte industrial-grade CompactFlash cards.

Direct Links
A PC or laptop can be connected directly to the data-logger's RS-232 port (no interface required). This port provides electrical isolation. Alternatively, the PC or laptop can be connected to the CR3000's CS I/O port via an SC32B or SC-USB interface.

Keyboard Display
The CR3000's integrated keyboard display is used to program the datalogger, manually initiate data transfer, and display data. It displays 8 lines x 21 characters (64 x 128 pixels) and has a 16-character keyboard. Custom menus are supported allowing customers to set up choices within the datalogger program that can be initiated by a simple "toggle" or "pick list"

CD295 DataView II Display
This two-line, 32-character LCD displays one real-time value, a description, and units. It is typically mounted in an enclosure lid, which allows customers to view the CR3000's data on-site without opening the enclosure.

Ethernet
Use of an NL120, NL115, or NL100 interface enables the CR3000 to communicate over a local network or a dedicated Internet connection via TCP/IP. The NL115 can also store data on a CompactFlash card.

Multidrop Interface
The MD485 intelligent RS-485 interface permits a PC to address and communicate with one or more data-loggers over a single CABLE3CBL cable. Distances up to 4000 feet are supported.

Short Haul Modems
The SRM-5A RAD Short Haul Modem supports communications between the CR3000 and a PC via a four-wire unconditioned line (two twisted pairs).

PDAs
Customers can set the CR3000's clock, monitor real-time data, retrieve data, graph data, and transfer CR3000 programs via a PDA. PDAs with a Palm™ OS require PConnect software (purchased separately); PDAs with a Windows® Pocket PC/Windows Mobile OS require PConnectCE software (purchased separately).

Satellite Transmitters
Our NESDIS-certified GOES satellite transmitter provides one-way communications from a Data Collection Platform (DCP) to a receiving station. We also offer an Argos transmitter that is ideal for high-altitude and polar applications and a METEOSAT transmitter for European applications.

Radios
Radio frequency (RF) communications are supported via narrow-band UHF, narrow-band VHF, spread spectrum, or meteor burst radios. Line-of-sight is required for all of our RF options.

Telephone Networks
The CR3000 can communicate with a PC using land-lines, cellular CDMA, or cellular GPRS transceivers. A voice synthesized modem enables anyone to call the CR3000 via phone and receive a verbal report of real-time site conditions.

Meteorological conditions measured at Lake Louise, Alberta, Canada are telemetered via phone-to-RF link to a base station.

Channel Expansion

4-Channel Low Level AC Module
The LLAC4 is a small peripheral device that allows customers to increase the number of available low-level ac inputs by using control ports. This module is often used to measure up to four anemometers, and is especially useful for wind profiling applications.

Synchronous Devices for Measurement (SDMs)
SDMs are addressable peripherals that expand the data-logger'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 the system. Multiple SDMs, in any combination, can be connected to one datalogger.

Multiplexers
Multiplexers increase the number of sensors that can be measured by a datalogger by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single datalogger.

The CR3000 is compatible with the AM16/32B (shown above) and AM25T multiplexers.
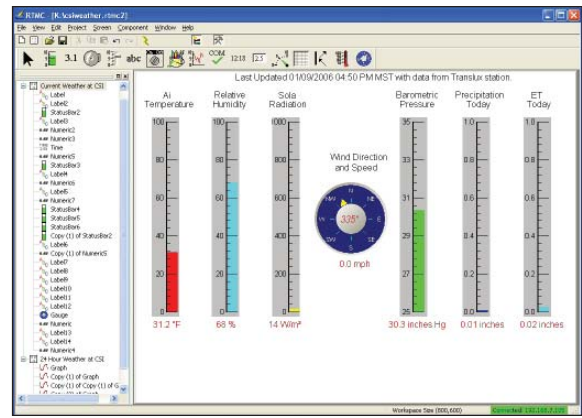
Software

Starter Software
Our easy-to-use starter software is intended for first time users or applications that don't require sophisticated communications or datalogger program editing. SCWin Short Cut generates straight-forward CR3000 programs in four easy steps. PC200W allows customers to transfer a program to, or retrieve data from a CR3000 via a direct communications link.

At www.campbellsci.com/downloads, you can download starter software at no charge. Our Resource CD also provides this software as well as PDF versions of our brochures and manuals.

Datalogger Support Software
Our datalogger support software packages provide more capabilities than our starter software. These software packages contains program editing, communications, and display tools that can support an entire datalogger network.


RTMC, a program for displaying the datalogger's data, is bundled with LoggerNet and RTDAQ. Customers may also purchase the RTMCRT and RTMC Web Server clients, which use forms created in the developer mode of RTMC.

PC400, our mid-level software, supports a variety of telemetry options, manual data collection, and data display. For programming, it includes both Short Cut and the CRBasic program editor. PC400 does not support combined communication options (e.g., phone-to-RF) or scheduled data collection.

RTDAQ is an ideal solution for industrial and real-time users desiring to use reliable data collection software over a single telecommunications medium, and who do not rely on scheduled data collection. RTDAQ's strength lies in its ability to handle the display of high speed data.

LoggerNet is Campbell Scientific's full-featured datalogger support software. It is referred to as "full-featured" because it provides a way to accomplish almost all the tasks you'll need to complete when using a datalogger. LoggerNet supports combined communication options (e.g., phone-to-RF) and scheduled data collection.
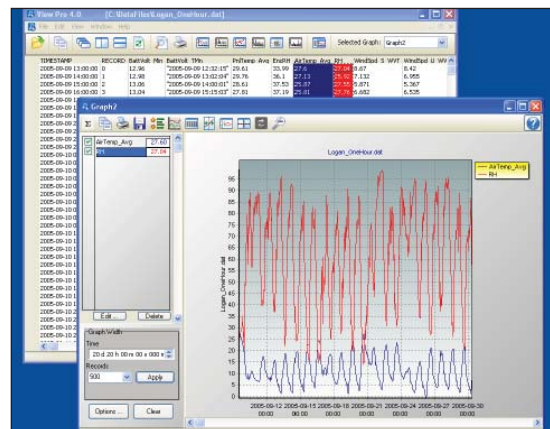
RTDAQ includes View Pro which will display historical data in a tabular or graphical format.

Applications

Open Path Eddy Covariance Systems

These systems use eddy covariance techniques to calculate water vapor, carbon dioxide, and heat flux.

For eddy covariance applications, the CR3000 can measure the LI7500 Open-Path CO_2 Analyzer, CSAT3 Sonic Anemometer, and KH20 Krypton Hygrometer then compute fluxes.

Below are the sensors used and their measurements:

- CSAT3 Sonic Anemometer—absolute wind and sonic temperature fluctuations
- KH20 Hygrometer—fluctuations of atmospheric water vapor
- LI7500 Infrared Gas Analyzer—both absolute CO_2 and water vapor
- FW05 Fine Wire Thermocouple—absolute temperature

The CR3000 measures the above sensors and computes fluxes on-line. The raw time-series data can be saved to a CompactFlash card, along with processed data for later analysis. A PC at the site is not required. The CR3000's storage capacity can be increased using CompactFlash cards.

Meteorology

The CR3000 is used in long-term climatological monitoring, meteorological research, and routine weather measurement applications.

Sensors the CR3000 can measure include:

- RH sensors
- cup, propeller, and sonic anemometers
- wind vanes
- tipping bucket rain gages
- pyranometers
- ultrasonic ranging sensor
- thermistors, RTDs, and thermocouples
- barometers
- cooled mirror hygrometers

Wind Profiling

Our data acquisition systems can monitor conditions at wind assessment sites, at producing wind farms, and along transmission lines. The CR3000 makes and records measurements, controls electrical devices, and can function as PLCs or RTUs. Because the Micrologger has its own power supply (batteries, solar panels), it can continue to measure and store data and perform control during power outages.

Typical sensors for wind assessment applications include, but are not limited to:

- cup, propeller, and sonic anemometers (up to 10 anemometers can be measured by using two LLAC4 peripherals)
- wind vanes
- thermistors, RTDs, and thermocouples
- barometers
- pyranometers

Photo courtesy RADTech Ltd. UK

A Campbell Scientific datalogging system monitors this offshore wind farm located between Rhyl and Prestatyn in North Wales at about 7 to 8 km out to sea.

Agriculture and Agricultural Research

The versatility of the CR3000 allows measurement of agricultural processes and equipment in applications such as:

- plant water research
- canopy energy balance
- machinery performance
- plant pathology
- crop management decisions
- food processing/storage
- frost prediction
- irrigation scheduling
- integrated pest management

Air Quality

The CR3000 can monitor and control gas analyzers, particle samplers, and visibility sensors. It can also automatically control calibration sequences and compute conditional averages that exclude invalid data (e.g., data recorded during power failures or calibration intervals).

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

Road Weather/RWIS

Our fully NTCIP-compliant Environmental Sensor Stations (ESS) are robust, reliable weather stations used for road weather/RWIS applications. A typical ESS includes a tower, CR3000, two road sensors, remote communication hardware, and sensors that measure wind speed and direction, air temperature, humidity, barometric pressure, solar radiation, and precipitation.

Soil Water

The CR3000 is compatible with soil water blocks, matric water potential sensors, Time-Domain Reflectometery (TDR) systems, self-contained water content reflectometers, and tensiometers. These soil water instruments are used extensively to monitor water content and matric potential in applications requiring knowledge of soil water inventory or movement.

Vehicle Testing

This versatile, rugged datalogger is ideally suited for testing cold and hot temperature, high altitude, off-highway, and cross-country performance. The CR3000 is compatible with our SDM-CAN interface and GPS16X-HVS receiver.

Vehicle monitoring includes not only passenger cars, but airplanes, locomotives, helicopters, tractors, buses, heavy trucks, drilling rigs, race cars, and motorcycles.

The CR3000 can measure:

- Suspension—strut pressure, spring force, travel, mounting point stress, deflection, ride
- Fuel system—line and tank pressure, flow, temperature, injection timing
- Comfort control—ambient and supply air temperature, solar radiation, fan speed, ac on and off, refrigerant pressures, time-to-comfort, blower current
- Brakes—line pressure, pedal pressure and travel, ABS, line and pad temperature
- Engine—pressure, temperature, crank position, RPM, time-to-start, oil pump cavitation
- General vehicle—chassis monitoring, road noise, vehicle position and speed, steering, air bag, hot/cold soaks, wind tunnels, traction, CANbus, wiper speed and current, vehicle electrical loads

Other Applications

- Stuctural or fatigue analysis
- Wireless sensor/datalogger networks
- Water quality
- Water level/flow
- Mesonet systems
- Avalanche forecasting, snow science, polar, high altitude
- HVAC Systems
- Aerospace/aviation

The CR3000 can monitor and control pumps, fans, and starter motors in an HVAC system.