

CR1000 *Measurement and Control System*

A Rugged Instrument with Research-Grade Performance



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CR1000 Measurement and Control System

The CR1000 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control module and a wiring panel.

Features

- 2 Mbytes standard memory; 4 Mbytes optional memory
- Program execution rate of up to 100 Hz
- CS I/O and RS-232 serial ports
- 13-bit analog to digital conversions
- 16-bit H8S Hitachi Microcontroller with 32-bit internal CPU architecture
- Temperature compensated real-time clock
- Background system calibration for accurate measurements over time and temperature changes
- Single DAC used for excitation and measurements to give ratio metric measurements
- Gas Discharge Tube (GDT) protected inputs
- Data values stored in tables with a time stamp and record number
- Battery-backed SRAM memory and clock ensuring data, programs, and accurate time are maintained while the CR1000 is disconnected from its main power source
- Measures intelligent serial sensors without using an SDM-SIO4

Storage Capacity

The CR1000 has 1 Mbyte of FLASH memory for the Operating System. The standard CR1000 provides 2 Mbytes battery-backed SRAM for CPU usage, program storage, and data storage; an optional version provides 4 Mbytes of SRAM. Data is stored in a table format. The storage capacity of the CR1000 can be increased by using a CompactFlash® card.

12-Volt Powered

Any 12 Vdc source can power the CR1000; it typically uses our BPALK or PS100 power supply. The BPALK consists of eight D-cell batteries, and the PS100 includes a sealed rechargeable battery that can be float-charged with a solar panel or ac power.

Datalogger Programming

The onboard, BASIC-like programming language supports data processing and analysis routines. Compatible software includes Short Cut, PC400, and LoggerNet. Short Cut generates straightforward datalogger programs in four steps. PC400 and LoggerNet software support datalogger program creation/editing, data retrieval, and real-time monitoring.



The CR1000's power consumption and packaging are optimized for unattended network applications.

Input Output Terminals

Analog Inputs: Eight differential (16 single-ended) channels measure voltage levels. Resolution on the most sensitive range is 0.67 μ V.

Pulse counters: Two pulse channels can count pulses from high level (5 V square wave), switch closure, or low level ac signals.

Switched voltage excitations: Three outputs provide precision excitation voltages for resistive bridge measurements.

Digital I/O ports: Eight ports are provided for frequency measurements, digital control, and triggering. Three of these ports can also be used to measure SDM devices.

Switched 12 Volt: This terminal provides unregulated 12 V that can be switched on and off under program control.

RS-232 port: A PC or laptop can be connected to this 9-pin port via an RS-232 cable.

CS I/O port: Data transfer peripherals that require power from the datalogger can be connected to this port via a cable. This port is also used for connecting the datalogger to a PC via an SC32B interface when optical isolation is required.

Peripheral Port: One 40-pin port interfaces with the CFM100 CompactFlash® module.

Operation in Harsh Environments

The standard operating range is -25° to $+50^{\circ}\text{C}$; an extended range of -55° to $+85^{\circ}\text{C}$ is available. A CR1000 housed in an environmental enclosure with desiccant is protected from humidity and most contaminants.

Communication Protocols

The CR1000 supports three communication protocols: traditional, PAKBUS®, and Modbus. The traditional communication protocol is connection-based.

The PAKBUS® communication protocol improves upon traditional communications for datalogger networks. 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.

The Modbus protocol allows the CR1000 to work with “off the shelf” Modbus software packages.

Communications

Compatible telecommunication options include Ethernet, phone modems (land-line and cellular), radios, short haul modems, GOES satellite transmitters, and multidrop modems. Real-time and historical data can be displayed on-site using a Palm OS-based PDA (requires PConnect 3.1), the CR1000KD Keyboard/Display, or a PC. The PC connects to the CR1000 via an RS-232 cable, or if optical isolation is required, via 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 is used to download the programs/data to the PC.

Channel Expansion

Synchronous Devices for Measurement (SDMs)

SDMs are addressable peripherals that expand the CR1000'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, in any combination, can be connected to one CR1000 datalogger.

Multiplexers

Multiplexers increase the number of sensors that can be measured by a CR1000 by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single CR1000. The CR1000 is compatible with the AM16/32 and AM25T.

Applications

- Eddy covariance systems
- Wireless sensor/datalogger networks
- Mesonet systems
- Wind profiling
- Vehicle testing
- Long-term climatological monitoring, meteorological research, routine weather measurement
- Air quality
- Agriculture, agriculture research
- Soil moisture, Time Domain Reflectometry
- Water level/stage
- Aquaculture
- Water quality
- Avalanche forecasting, snow science, polar, high altitude
- Fire weather
- Geotechnical
- Historic preservation



The CR1000 is compatible with the LLAC4 Low-Level AC Conversion Module. Use of the LLAC4 allows more wind sensors to be measured for wind profiling applications. Wind profiling helps customers determine if a site is a good candidate for harvesting wind.

CR1000 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.

PROGRAM EXECUTION RATE

10 ms to 30 min. @ 10 ms increments

ANALOG INPUTS

8 differential (DF) or 16 single-ended (SE) individually configured. Channel expansion provided by AM16/32 and AM25T multiplexers.

RANGES, RESOLUTION AND TYPICAL INPUT NOISE:

Basic resolution (Basic Res) is the A/D resolution of a single conversion. **Resolution of DF measurements with input reversal is half the Basic Res.** Noise values are for DF measurements with input reversal; noise is greater with SE measurements.

Input Range (mV)	Basic Res (µV)	250 µs Int. (µV RMS)	50/60 Hz Int. (µV RMS)
±5000	1330	385	192
±2500	667	192	95.9
±250	66.7	19.2	19.2
±25	6.7	2.3	1.9
±7.5	2	0.62	0.58
±2.5	0.67	0.34	0.19

Offset for DF w/input reversal = Basic Res + 1.0 µV
Offset for DF w/o input reversal = 2 Basic Res + 2.0 µV
Offset for SE = 2 Basic Res + 3.0 µV

ACCURACY¹:

±(0.07% of reading + offset), 0° to 40°C
±(0.14% of reading + offset), -25° to 50°C
±(0.2% of reading + offset), -55° to 85°C (-XT only)

MINIMUM TIME BETWEEN VOLTAGE MEASUREMENTS:

Includes the measurement time and conversion to engineering units. For voltage measurements, the CR1000 integrates the input signal for 0.25 ms or a full 16.66 ms or 20 ms line cycle for 50/60 Hz noise rejection. DF measurements with input reversal incorporate two integrations with reversed input polarities to reduce thermal offset and common mode errors and therefore take twice as long.

250 µs Analog Integration: ~1 ms SE
1/60 Hz Analog Integration: ~20 ms SE
1/50 Hz Analog Integration: ~25 ms SE

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; ±90 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, -55° to 85°C (-XT only)

ANALOG OUTPUTS

3 switched voltage, active only during measurement, one at a time.

RANGE AND RESOLUTION: Voltage outputs programmable between ±2.5 V with 0.67 mV resolution.

ACCURACY: ±(0.07% of setting + 0.8 mV), 0° to 40°C
±(0.14% of setting + 0.8 mV), -25° to 50°C
±(0.2% of setting + 0.8 mV), -55° to 85°C (-XT only)

CURRENT SOURCING/SINKING: ±25 mA

RESISTANCE MEASUREMENTS

MEASUREMENT TYPES: The CR1000 provides ratiometric measurements of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Precise, dual polarity excitation using any of the 3 switched voltage excitations eliminates dc errors.

RATIO ACCURACY¹: Assuming excitation voltage of at least 1000 mV, not including bridge resistor error.
±(0.04% of reading + Offset/V_{ex})

Offset values are reduced by a factor of 2 when excitation reversal is used.

Offset for DF w/input reversal = Basic Res + 1.0 µV
Offset for DF w/o input reversal = 2 Basic Res + 2.0 µV
Offset for SE = 2 Basic Res + 3.0 µV

PERIOD AVERAGING MEASUREMENTS

The average period for a single cycle is determined by measuring the average duration of a specified number of cycles. The period resolution is 192 ns divided by the specified number of cycles to be measured; the period accuracy is ±(0.01% of reading + resolution).¹ Any of the 16 SE analog inputs can be used for period averaging. Signal limiting are typically required for the SE analog channel.

INPUT FREQUENCY RANGE:

Input Range	Signal (peak to peak) ²	Min. Pulse W.	Max ³ Freq.
±2500 mV	500 mV	10 V	2.5 µs
±250 mV	10 mV	2 V	10 µs
±25 mV	5 mV	2 V	62 µs
±2.5 mV	2 mV	2 V	100 µs

²Signal centered at datalogger ground.

³Maximum frequency = 1/(Twice Minimum Pulse Width) for 50% duty cycle signals.

PULSE COUNTERS

Two 24-bit inputs selectable for switch closure, high frequency pulse, or low-level ac.

MAXIMUM COUNTS PER SCAN: 16.7x10⁶

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:

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

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 I/O PORTS

8 ports software selectable, as binary inputs or control outputs. C1-C8 also provide edge timing, subroutine interrupts/wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UART), SDI-12 communications, and SDM communications.

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

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

SDI-12 INTERFACE SUPPORT

Control ports 1, 3, 5, and 7 may be configured for SDI-12 asynchronous communications. Up to ten SDI-12 sensors are supported per port. It meets SDI-12 Standard version 1.3 for datalogger mode.

CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED: BS EN61326:2002

CPU AND INTERFACE

PROCESSOR: Hitachi H8S 2322 (16-bit CPU with 32-bit internal core)

MEMORY: Battery-backed SRAM; 2 Mbytes, 16 kbytes for program storage; 4 Mbytes optional

SERIAL INTERFACES: COM1 (CS I/O, used to interface with Campbell Scientific peripherals), COM2 (standard RS-232 communication port)

PARALLEL INTERFACE: 40-pin interface for attaching data storage or communication peripherals such as the CFM100 module

BAUD RATES: Selectable from 300 to 115.2 kbps. ASCII protocol is one start bit, one stop bit, eight data bits, and no parity.

CLOCK ACCURACY: ±3 min. per year (-30° to 85°C); ±15 min. per year (-55° to 85°C, -XT only)

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc

TYPICAL CURRENT DRAIN:

Sleep Mode: ~0.5 mA
1 Hz Sample Rate (one fast SE meas.): ~0.6 mA
100 Hz Sample Rate (one fast SE meas.): ~7.0 mA
100 Hz Sample Rate (one fast SE meas. w/RS-232 communications): <7.0 mA

EXTERNAL BATTERIES: 12 Vdc nominal; reverse polarity protected.

PHYSICAL SPECIFICATIONS

MEASUREMENT & CONTROL MODULE SIZE: 8.5" x 3.9" x 0.85" (21.6 x 9.9 x 2.2 cm)

CR1000WP WIRING PANEL SIZE: 9.4" x 4" x 2.4" (23.9 x 10.2 x 6.1 cm); additional clearance required for serial cable and sensor leads.

WEIGHT: 2.1 lbs (1 kg)

WARRANTY

Three years against defects in materials and workmanship.

¹Sensor and measurement noise not included