CR23X Micrologger®
A Portable, Rugged, Powerful Data Acquisition System

CAMPBELL SCIENTIFIC, INC.
Design Features
The CR23X measures most sensor types directly, communicates via modems, reduces data, controls external devices, and stores both data and programs in either non-volatile Flash memory or battery-backed SRAM. The standard 2 Mbyte memory stores 1,000,000 data points in two final storage areas. With the 4 Mbyte option, the CR23X can store over 2 million data points.

Two operating system options are available. The array-based operating system stores arrays of data at specified intervals or when some other set condition has been met. The table-based operating system allows you to group and store like data in separate tables.

The CR23X contains a comprehensive set of measurement, processing, and output instructions for programming the datalogger. Measurement instructions specific to bridge configurations, voltage outputs, vibrating wire sensors, SDI-12 sensors, thermocouples, Synchronous Devices for Measurement (SDMs), and multiplexers are standard. Processing instructions support algebraic, statistical, and transcendental functions for on-site processing. Output instructions control external devices and process data over time. These instructions include averages, maximums, minimums, standard deviations, histograms, and FFTs.

The maximum rate the CR23X can execute its program is 100 times per second. The maximum rate a single input can be measured is 1,500 samples per second. A battery-backed clock assures accurate timekeeping.

Cover photos (CR23X applications): From top, Eddy covariance systems, Automotive performance testing, Weather station installation, Geotechnical monitoring.
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 CR23X. The low-profile (no battery) option requires a user-supplied dc source. It is preferred when the system’s power consumption, (e.g. satellite transmitters) needs a user-supplied deep-cycle battery or when it’s advantageous to have a thinner datalogger.

Transient Protection
Rugged gas tubes protect the analog inputs from electrical transients. The CR23X is Compliant under the European Union’s EMC Directive.

Operation in Harsh Environments
Standard operating range is -25° to +50°C; an extended range of -40° to +80°C is available. A CR23X housed in a weather-resistant enclosure with desiccant is protected from humidity and most contaminants.

Peripherals and Software

CR23X-based systems typically include a data retrieval option and may include measurement and control peripherals. Our software supports datalogger programming, communications between the CR23X and PC, and data display.

Data Storage and Retrieval Options
Storage Modules reliably store data and datalogger programs. The data and programs can be downloaded later to a PC.

Direct Links use the CR23X’s RS-232 port to connect the datalogger to a computer. The CR23X can be connected to the computer over distances up to 50 feet.

Short Haul Modems provide local communications between the CR23X and a PC with an RS-232 serial port.

Multidrop Interface permits a PC to address and communicate with one or more dataloggers over a single two-twisted-pair cable.

PDAs can communicate with the CR23X. Palm OS-based PDAs require PConnect software and Pocket PC and Windows® Mobile 2003 devices require PConnectCE software.

Ethernet Communication Peripherals allow the CR23X to communicate over a local network or the Internet.

Radio Frequency (RF) Communications are supported via UHF, VHF, or spread spectrum radios.

Telephone Networks use landlines or cellular transceivers for communications between the datalogger and PC. Our voice-synthesized modem transmits the CR23X’s data by voice.

Satellite Transmitters transmit data via the GOES system.

Channel Expandability
SDMs and multiplexers expand the already formidable measurement and control capabilities of the CR23X. SDMs are addressable peripherals that expand digital control ports, analog output ports, and measurement capabilities. Multiplexers allow sharing of switched excitation channels and analog inputs, thereby increasing the number of sensors that can be measured. Several SDMs or multiplexers can be connected to one datalogger.

Software Packages
PC200W Starter Software allows you to transfer the datalogger’s program and collect data via a direct communications link. PC200W is available at no charge from: www.campbellsci.com/downloads

LoggerNet and PC400 provides more capabilities than PC200W. They support:
- Direct and telecommunications links
- Datalogger programming for most commercially available sensors, SDMs, multiplexers, and relays
- Real-time data display
- Report generation

Real-Time Data Monitor (RTDM) allows experienced users to create custom graphic screens. RTDM supports automatic generation of JPEG output for Internet display. A similar software package, RTDMRT, was developed for customers who require display-only capability. RTDMRT allows you to display screens that were created using RTDM.
Vehicle Testing
This versatile, rugged datalogger is ideally suited for testing cold and hot temperature, high altitude, off-highway, and cross-country performance. The CR23X is compatible with our SDM-CAN interface, GPS16-HVS receiver, and DSP4 Heads Up Display.

The CR23X 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

Process Control
The CR23X can monitor production allowing operators to discard items that don’t meet specifications. Real-time measurements can be displayed for operators and stored for review by quality control personnel. Product and assembly line status can be monitored simultaneously, providing on-line quality control while minimizing production down time.

Process and control applications:
- Maintain oven/dryer temperature
- Monitor conveyor/belt speed
- Sound alarms for out-of-specification conditions or equipment malfunction
- Maintain liquid or gas levels

HVAC Systems
A CR23X-based system can monitor inside and outside temperatures, flow rates, differential pressures, motor temperatures, and relative humidity. This information can be used by the datalogger to:
- Increase air exchange when conditions are favorable
- Maintain different temperatures in specific areas of the facility
- Reduce HVAC functions when the facility is unoccupied
- Initiate shutdowns, sound alarms, and notify personnel
- Record facility events and conditions

Other Applications
- Laboratory applications
- Mining, mineral extraction, and earth science
- Aerospace/aviation
- Energy management and conservation
- Structural or fatigue analysis
- Machinery testing
Eddy Covariance System
These systems use Eddy Covariance techniques to calculate water vapor, carbon dioxide, and heat flux. Below are the sensors 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 CO₂ and water vapor
- FW05 Fine Wire Thermocouple—temperature

The CR23X measures the above sensors and computes fluxes.

Bowen Ratio Systems
The CR23X is integral to our Bowen Ratio Systems. These systems calculate evapotranspiration (ET) by measuring air temperature, net radiation, soil heat flux, and dew point. The Bowen Ratio Systems measure air temperature at two heights with type E fine-wire thermocouples. To measure dew point, air samples from two heights are forced through mixing volumes and routed to a cooled mirror dew point hygrometer. Every two minutes the air drawn through the cooled mirror is switched from one height to the other. The CR23X also is used in another Bowen Ratio System that measures water vapor and CO₂ concentrations.

Meteorology
The CR23X is ideal for weather stations that require a large number of inputs.

Typical measurements include:

- wind speed
- wind direction
- air temperature and relative humidity
- barometric pressure
- snow depth
- solar radiation
- air and soil temperature
- precipitation
- soil moisture

The CR23X can calculate:

- standard deviations for wind direction
- vapor pressure from wet/dry bulb temperature
- saturation vapor pressure from air temperature

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).

Other Applications

- Water level/stage
- Avalanche control
- Snow science
- Arctic research
- Soil moisture
- Water quality
- Agriculture
- Air Quality
- SCADA/Modbus
CR23X Specifications

PROGRAM EXECUTION RATE
Program is synchronized with real-time up to 100 Hz. Two fast (250 µs) single-ended measurements can write to final storage at 100 Hz. Burst measurements to 1.5 kHz are possible over short intervals.

ANALOG INPUTS
DESCRIPTION: 12 differential or 24 single-ended, individually configured. Channel expansion provided through AM16/32 or AM16/16 Multiplexers and AM25T Thermocouple Multiplexers.

ACCURACY: ±0.25% of FSR, 0° to 40°C ±0.05% of FSR, -25° to 50°C ±0.075% of FSR, -40° to 80°C; (-XT only)
Note: ±5 µV offset voltage error is possible with single-ended (SE) measurements.

RANGES AND RESOLUTION:

<table>
<thead>
<tr>
<th>Input Range (mV)</th>
<th>Resolution (µV)</th>
<th>Accuracy (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±5000</td>
<td>166</td>
<td>±0.00</td>
</tr>
<tr>
<td>±1000</td>
<td>33.6</td>
<td>±1.00</td>
</tr>
<tr>
<td>±200</td>
<td>6.66</td>
<td>±0.20</td>
</tr>
<tr>
<td>±50</td>
<td>1.67</td>
<td>±0.05</td>
</tr>
<tr>
<td>±10</td>
<td>0.33</td>
<td>±0.01</td>
</tr>
</tbody>
</table>

INPUT SAMPLE RATES: Includes the measurement time and conversion to engineering units. Differential measurements incorporate two integrations with reversed input polarities to reduce thermal offset and common mode errors. Fast measurement integrates the signal for 250 µs; slow measurement integrates for one power line cycle (50 or 60 Hz).

Fast single-ended voltage: 2.1 ms
Fast differential voltage: 3.1 ms
Slow single-ended voltage (60 Hz): 18.3 ms
Slow differential voltage (60 Hz): 35.9 ms
Fast differential thermocouple: 6.9 ms

INPUT NOISE VOLTAGE: Typical for ±10 mV Input Range; digital resolution dominates for higher ranges.

Fast differential: 0.60 µV rms
Slow differential (60 Hz): 0.15 µV rms
Fast single-ended: 1.20 µV rms
Slow single-ended (60 Hz): 0.30 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 WITHOUT DAMAGE: 16 V DC max.
INPUT CURRENT: ±2.5 mA typ., ±10 mA max. @ 50°C
INPUT RESISTANCE: 20 Gohms typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):

<table>
<thead>
<tr>
<th>±0.25%</th>
<th>±0.5%</th>
<th>±0.5%</th>
<th>±0.7%</th>
<th>±0.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3°C</td>
<td>4°C</td>
<td>5°C</td>
<td>4°C</td>
<td>1°C</td>
</tr>
</tbody>
</table>

ANALOG OUTPUTS
DESCRIPTION: 4 switched, active only during measurement, one at a time; 2 continuous.

RANGE: Programmable between ±5 V

RESOLUTION: 333 µV

ACCURACY: ±5 mV; ±2.5 mV (0° to 40°C)

CURRENT SOURCING: 50 mA for switched; 15 mA for continuous

CURRENT SINKING: 50 mA for switched, 5 mA for continuous (15 mA for continuous with Boost selected in menu)

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 CR23X 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 4 switched outputs eliminates dc errors. Conductivity measurements use a dual polarity 0.75 ms excitation to minimize polarization errors.

ACCURACY: ±0.02% of FSR (±0.015%, 0° to 40°C) plus bridge resistor error.

PERIOD AVERAGING MEASUREMENTS
DESCRIPTION: The average period for a single cycle is determined by measuring the duration of a specified number of cycles. Any of the 24 SE analog inputs can be used. Signal attenuation and ac coupling are typically required.

INPUT FREQUENCY RANGE:

<table>
<thead>
<tr>
<th>Signal peak-to-peak¹</th>
<th>Min.</th>
<th>Max.</th>
<th>Pulse w.</th>
<th>Freq.²</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 mV</td>
<td>10.0 V</td>
<td>2.5 µs</td>
<td>200 kHz</td>
<td></td>
</tr>
<tr>
<td>40 mV</td>
<td>2.0 V</td>
<td>10 µs</td>
<td>50 kHz</td>
<td></td>
</tr>
<tr>
<td>5 mV</td>
<td>0.2 V</td>
<td>62 µs</td>
<td>8 kHz</td>
<td></td>
</tr>
<tr>
<td>2 mV</td>
<td>0.1 V</td>
<td>100 µs</td>
<td>5 kHz</td>
<td></td>
</tr>
</tbody>
</table>

¹Signals centered around datalogger ground
²Assuming 50% duty cycle

RESOLUTION: 12 ns divided by the number of cycles measured
ACCURACY: ±0.01% of reading

PULSE COUNTERS
DESCRIPTION: Four 8-bit or two 16-bit inputs selectable for switch closure, high frequency pulse, or low-level AC. Counters read at 10 or 100 Hz.

MAXIMUM COUNT RATE: 2.5 kHz and 25 kHz, 8-bit counter read at 10 Hz and 100 Hz, respectively; 400 kHz, 16-bit counter.

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Maximum Bounce Time: 1 ms open without being counted

HIGH FREQUENCY PULSE MODE:
Minimum Pulse Width: 1.2 µs
Maximum Input Frequency: 400 kHz
Voltage Thresholds: Count upon transition from below 1.5 V to above 3.5 V at low frequencies. Larger input transitions are required at high frequencies because of input filter with 1.2 µs time constant. Signals up to 400 kHz will be counted if centered around +2.5 V with deviations ±2.5 V for ±1.2 µs.

Input Hysteresis: ±0.5 V

LOW LEVEL AC MODE:
Internal ac coupling removes dc offsets up to ±0.5 V.
Input Hysteresis: 15 mV

Minimum Input Voltage: ±20 V

DIGITAL I/O PORTS
DESCRIPTION: 8 ports selectable as binary inputs or output controls. Ports C5-C8 capable of counting switch closures and high frequency pulses.

HIGH FREQUENCY MAX: 2.5 kHz

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

OUTPUT RESISTANCE: 500 ohms

INPUT STATE: high 3.0 to 5.5 V; low -0.5 to +0.8 V

SYSTEM POWER REQUIREMENTS
VOLTAGE: 11 to 16 Vdc

TYPICAL CURRENT DRAW: 2 mA quiescent with display off (2.5 mA max), 7 mA quiescent with display on, 45 mA during processing, and 70 mA during analog measurement.

INTERNAL BATTERIES: 10 Ahr alkaline or 7 Ahr rechargeable base. 1800 mAh lithium battery for clock and SRAM backup typically provides 10 years of service.

EXTERNAL BATTERIES: Any 11 to 16 Vdc battery may be connected; reverse polarity protected.

PHYSICAL SPECIFICATIONS
SIZE: 9.5” x 7.0” x 3.8” (24.1 cm x 17.8 cm x 9.6 cm).
Terminal strips extend 0.4” (1.0 cm) and terminal strip cover extends 1.3” (3.3 cm) above the panel.
WEIGHT: 3.6 lbs (1.6 kg) with low-profile base 8.5 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.

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