INSTRUCTION MANUAL

CR9000X Measurement and Control System Overview

Revision: 3/07

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CR9000X Overview Table of Contents

Overview

The CR9000X is a modular, multi-processor system that provides precision measurement capabilities in a rugged, battery-operated package. The system makes measurements at a rate of up to 100 K samples/second with 16-bit resolution. The CR9000X Base System includes CPU, power supply, and A/D modules. Up to nine I/O modules are inserted to configure a system for specific applications. The on-board, BASIC-like programming language includes data processing and analysis routines. PC9000 Windows™ Software provides program generation and editing, data retrieval, and realtime monitoring. LoggerNet software can be used for multiple station applications requiring modem communications and/or where schedule data collection to a PC is required.

FIGURE OV1-1. CR9000X Measurement and Control System

OV1. Physical Description

OV1.1 Basic System

CR9032 CPU Module

The CR9032 CPU Module provides system control, processing, and communication to a PC via the built-in 10BaseT/100BaseT Ethernet port or the RS-232 port. The CR9032 also has built-in Serial Device for Measurement (SDM) terminals and a CSI 9-pin port for communication with Campbell Scientific peripherals. The SDM 12 volt supply is current limited to 1.85 amps. The main processor is a 180 MHz Hitachi SH-4 microprocessor. The module has 128 MB SDRAM and 2 MB Flash EEPROM.

MEASUREMENTS:

Analog Output Peripheral (AO4)
CANBus Interface Peripheral (CANBUS)
CSAT3 Sonic Anemometer (CSAT3)
DSP4 Display (DSP4)
I/O Port Peripheral (CD16AC)
Interval Timer Peripheral (INT8)
Output Data to PC Card (CardOut)
Serial Input/Output Peripheral (SIO4)
Switch Closure Measurement Peripheral (SW8A)

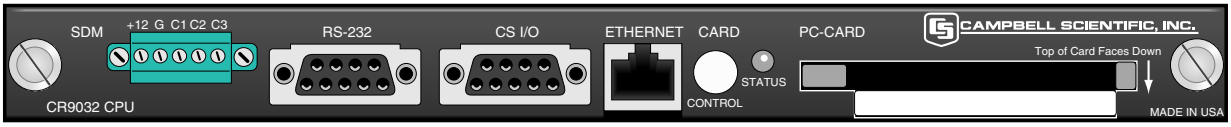


FIGURE OV1-2. CR9032

CR9041 A/D and Amplifier Module

The CR9041 A/D and Amplifier Module provides signal conditioning and 16 bit, 100 kHz A/D conversions.

FIGURE OV1-3. CR9041

CR9011 Power Supply Module and AC Adapter

The CR9011 Power Supply Module provides regulated power to the CR9000X from the internal battery modules. It also regulates battery charging from power supplied by the AC adapter, a DC input, or other external sources. The AC adapter may be used where AC power is available (100 - 240 volts) to provide power to the CR9000X and charge its batteries.

The CR9011 has a relay that allows shutting off power under program control. The Power Up inputs allow an external signal to awaken the CR9000X from a powered down state (PowerOff, Section 9). When the CR9000X is in this power off state the On/Off switch is in the on position but the internal relay is open. The power LED is not lit. If the "<0.5 " input is switched to ground or if the ">2" input has a voltage greater than 2 volts applied, the CR9000X will awake, load the program in memory and run. If the "< 0.5" input continues to be held at ground while the CR9000X is powered on and goes through its 2-5 second initialization sequence, the CR9000X will not run the program in memory. The CR9011's 12VOUT supply is current limited to 300 mA.

MEASUREMENTS:
Battery (voltage and current)

CONTROL:
PowerOff

FIGURE OV1-4. CR9011

OV1.2 Measurement Modules

CR9050 Analog Input Module

The CR9050 Analog Input Module has 14 differential or 28 single-ended inputs for measuring voltages up to ±5 V. Voltages exceeding ±9 V may cause errors on other channels. An on-board PRT provides the reference temperature for thermocouple measurements, while a heavy copper grounding bar and connectors combine with the case design to reduce temperature gradients for accurate thermocouple measurements. Resolution on the most sensitive range is 1.6 μV.

MEASUREMENTS:

Voltage
- Differential Voltage (VoltDiff)
- Single-Ended Voltage (VoltSE)

Thermocouple, Differential Voltage (TCDiff) Thermocouple, Single-Ended Voltage (TCSE)

Bridge measurements (also require CR9060 Excitation Module)
- Full Bridge (BrFull)
- 6 Wire Full Bridge (BrFull6W)
- Half Bridge (BrHalf)
- 3 Wire Half Bridge (BrHalf3W)
- 4 Wire Half Bridge (BrHalf4W)

Module Temperature (ModuleTemp)

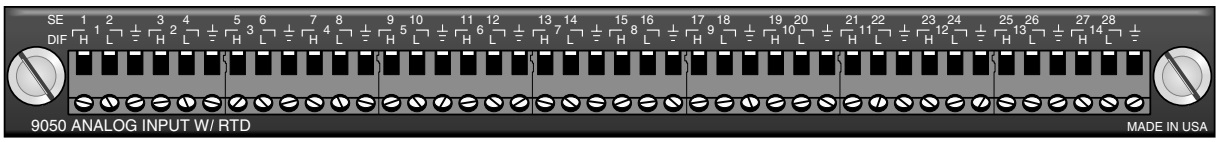


FIGURE OV1-5. CR9050

CR9051E Fault Protected 5 V Analog Input Module

The number of channels and measurements are the same as for the CR9050 Analog Input Module. Each input channel is fault-protected so as to permit over-voltages between +50 V and –40 V without corruption of measurements on other input channels. All the CR9051E input channels become open switches when the CR9000X is powered off. The CR9051E is recommended over the CR9050E for applications where fault voltages beyond ±9 V could come in contact with the inputs, or when the CR9000X could be powered off while still connected to sensors that have power applied to them. The CR9051E supports the same instruction set as the CR9050.

FIGURE OV1-6. CR9051E

CR9052DC Anti-Alias Filter Module with DC Excitation

The CR9052DC is a high-performance anti-alias filter module that extends the capability of the CR9000X Measurement and Control System. The module includes six anti-aliased analog measurement channels with differential input ranges from ±20 mV to ±5 V. Each input channel has current and voltage excitation options. Measurement rates up to 50 kHz per channel are possible.

MEASUREMENTS:

VoltFilt
FFTFilt

FIGURE OV1-7. CR9052DC

CR9052IEPE Anti-Alias Filter Module with DC Excitation

The The CR9052IEPE module allows direct connection of Internal Electronics Piezo-Electric (IEPE) accelerometers and microphones to CR9000- or CR9000X-series dataloggers. Each CR9052IEPE includes six channels. Each channel has a BNC connector, an open circuit indicator LED, and a short circuit indicator LED which can indicate if the channel is over-or under-driven. Each channel has a built-in constant current source which is software programmable to 0, 2, 4, or 6 mA.

MEASUREMENTS:

VoltFilt
FFTFilt

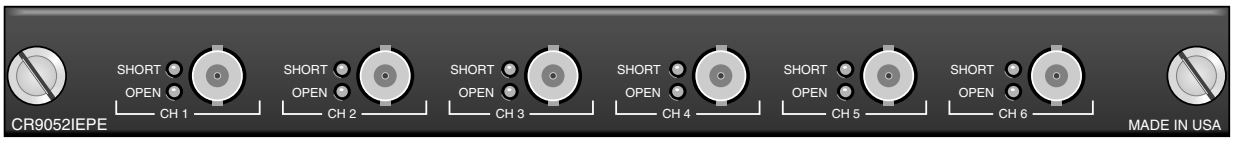


FIGURE OV1-8. CR9052IEPE

CR9058E Isolation Module

The CR9058E is a 10-channel, differential input isolation module. Each channel has a 24-bit A/D converter which supplies input isolation for up to ±60 V continuous common mode voltage conditions. The full-scale ranges available are ±60 V, ±20 V, and ±2 V with a resolution to 2 μVolts. Due to its superb signal to noise ratio, and good resolution, an accurate thermocouple measurement can be made on the 2 Volt range code. An on-board programmable DSP provides digital filtering.

MEASUREMENTS:

VoltDiff
TCDiff

FIGURE OV1-9. CR9058E

CR9055 50-Volt Analog Input Module

The CR9055 50-Volt Analog Input Module has 14 differential or 28 single-ended inputs for measuring voltages up to ±50 V. Resolution on the most sensitive range is 16 μV. The CR9055 has a common mode range of ±50 V.

MEASUREMENTS:

Voltage
  Differential Voltage (VoltDiff)
  Single-Ended Voltage (VoltSE)

Normally thermocouple measurements would be made on the CR9050 Analog Input Module (±5 Volt) because of its greater resolution, however they can be made on the CR9055 if the ±50 V common mode range is necessary.

Thermocouple, Differential Voltage (TCDiff)
Thermocouple, Single-Ended Voltage (TCDiff)

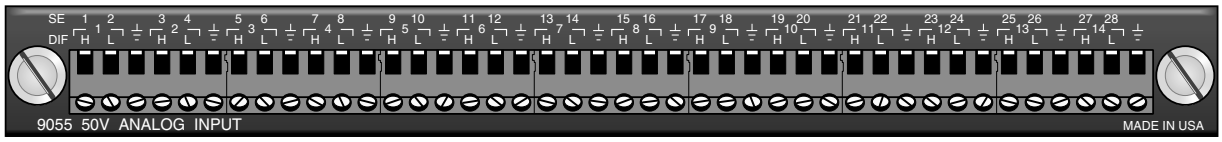


FIGURE OV1-10. CR9055

CR9060 Excitation Module

The CR9060 Excitation Module has six continuous analog outputs with individual digital-to-analog converters for PID Algorithm, waveform generation, and excitation for bridge measurements. Ten switched excitation channels provide precision voltages for bridge measurements. Each analog output will provide up to 50 mA between ±5 V. Also includes eight digital control outputs (0 V low, 5 V high).

MEASUREMENTS:
Excite
PortSet
Full Bridge (BrFull)
6 Wire Full Bridge (BrFull6w)
Half Bridge (BrHalf)
3 Wire Half Bridge (BrHalf3W)
4 Wire Half Bridge (BrHalf4W)

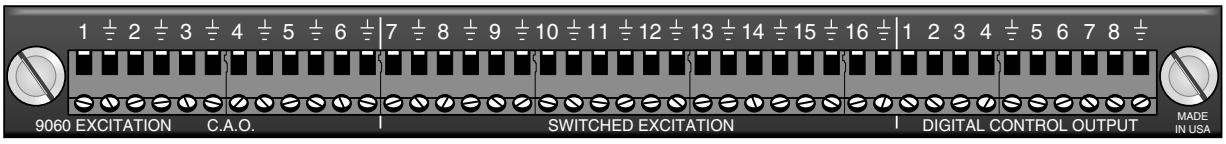


FIGURE OV1-11. CR9060

CR9070 Counter - Timer / Digital I/O Module — Obsolete

Features 12 channels capable of high-level
(5 V square wave) pulse counting at frequencies up to 5 MHz. Four channels can also count switch closures; the other eight can count low-level A/C signals. In addition, there are 16 independent digital I/O channels for digital control, communications, and triggering.

MEASUREMENTS:
Count Pulses or Frequency (PulseCount)
Read State of I/O Channels (ReadI/O)
Write to I/O Channels (WriteI/O)

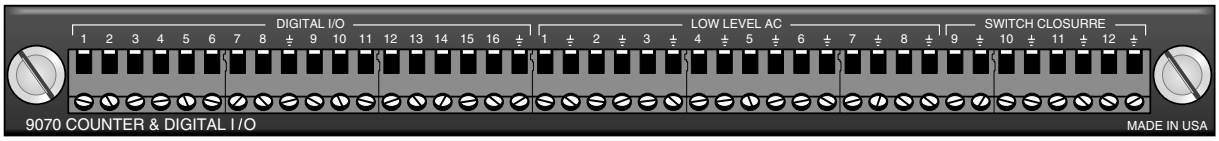


FIGURE OV1-12. 9070

CR9071E Counter and Digital I/O Module

Features 12 channels capable of high-level (5 V square wave) pulse counting at frequencies up to 1 MHz. The pulse channels can also do interval timing measurements with 40 ηs resolution. Four channels can also count switch closures; the other eight can count low-level A/C signals. In addition, there are 16 independent digital I/O channels for digital control, communications, and triggering.

MEASUREMENTS:

Count Pulses or Frequency (PulseCount)
Read State of I/O Channels (ReadI/O)
Write to I/O Channels (WriteI/O)
Interval and Timing Measurements (TimerI/O)

FIGURE OV1-13. CR9071E

OV1.3 Communication Interfaces

The CR900X's CPU module (CR9032) has built-in RS-232 and Ethernet ports, thus eliminating the need for expensive external communication interfaces.

Any terminal emulator program can be used to set up the CR9000X's IP address parameters. Hyper Terminal is an example of an available terminal emulator. The port settings should be:

Bits per Second:	115,200
Data bits:	8
Parity:	None
Stop bits:	1
Flow control:	Hardware

PC9000's Terminal Mode can also be used. Set the Comm window to your computer's Comm port and set the baud rate to 115200. With a serial cable hooked between your PC's and CR9000X's RS-232 ports, press the test button to ensure that you have established communications. Close the Comm window and open PC9000's terminal emulator (Tools/Diagnostics/Terminal Mode). Click in the Low Level I/O box. Press enter a few times until a CR9000> prompt is returned. Press C and enter. The IP port configuration options will be shown. See Sections QS1.5 and QS1.6 for additional information about setting up the IP Port for the CR9000X and for your computer.

OV2. Memory and Programming Concepts

OV2.1 Memory

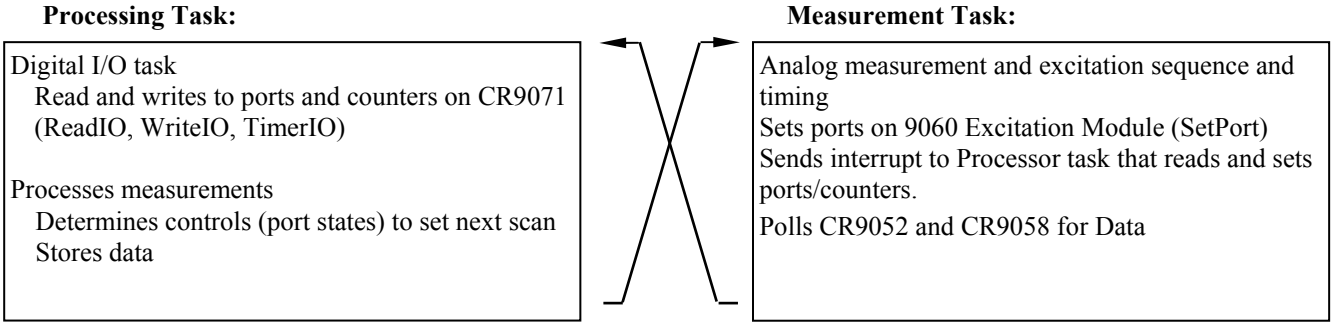
The CR9032 CPU Module in the CR9000X base system has 128 MB SDRAM and 2 MB Flash EEPROM. The operating system, user program listing(s), and calibration files are stored in the flash EEPROM. When the CR9000X is powered up, the operating system, the compiled program, and any calibration files are uploaded into SDRAM. The size of available memory may be seen in the status file. Additional data storage is available through the use of a PCMCIA memory card in the built-in card slot.

OV2.2 Measurements, Processing, Data Storage

The CR9000X divides a program into two tasks. The **measurement task** manipulates the measurement and control hardware on a rigidly timed sequence. The **processing task** processes and stores the resulting measurements and makes the decisions to actuate controls.

The measurement task stores raw Analog to Digital Converter (ADC) data directly into memory. As soon as the data from a scan is in memory, the processing task starts. There are at least two buffers allocated for this raw ADC data (more under program control), thus the buffer from one scan can be processed while the measurement task is filling another.

When a program is compiled, the measurement tasks are separated from the processing tasks. When the program runs, the measurement tasks are performed at a precise rate, ensuring that the measurement timing is exact and invariant.



OV2.3 Data Tables

The CR9000X can store individual measurements or it may use its extensive processing capabilities to calculate averages, maxima, minima, histograms, FFTs, etc., on periodic or conditional intervals. Data are stored in tables such as listed in Table OV2-1. The values to output are selected when running the program generator or when writing a datalogger program directly.

Table OV2-1. Typical Data Table

TOA4 TIMESTAMP TS	StnName RECORD RN	Temp RefTemp_Avg DegC Avg	TC_Avg(1) DegC Avg	TC_Avg(2) DegC Avg	TC_Avg(3) degC Avg	TC_Avg(4) degC Avg	TC_Avg(5) degC Avg	TC_Avg(6) degC Avg
2004-02-16 15:15:04.61	278822	31.08	24.23	25.12	26.8	24.14	24.47	23.76
2004-02-16 15:15:04.62	278823	31.07	24.23	25.13	26.82	24.15	24.45	23.8
2004-02-16 15:15:04.63	278824	31.07	24.2	25.09	26.8	24.11	24.45	23.75
2004-02-16 15:15:04.64	278825	31.07	24.21	25.1	26.77	24.13	24.39	23.76

OV3. PC9000 Application Software

PC9000 is a Windows™ application for use with the CR9000X. The software supports CR9000X program generation, real-time display of datalogger measurements, graphing, and retrieval of data files.

OV3.1 Hardware and Software Requirements

The following computer resources are recommended:

- IBM PC, portable or desktop
- 64 MB RAM
- VGA monitor
- Windows 2000, Windows XP, Windows NT, or Windows 4.0
- 60 Meg of hard drive space for software
- 400 Meg of hard drive space for data
- RS-232 serial port, a 10BaseT or 100BaseT Ethernet port

The following computer resources are recommended:

- 128 MB RAM
- 233 MHz 486 or faster
- Mouse

OV3.2 PC9000 Installation

To install the PC9000 software:

- Start Microsoft Windows 2000, NT, or XP
- Insert CD
- From the Program Manager, select **F**ile menu and choose **R**un
- Type (disk drive):\setup and press Enter , e.g., a:\setup<Enter>
- The setup routine will prompt for disk 2

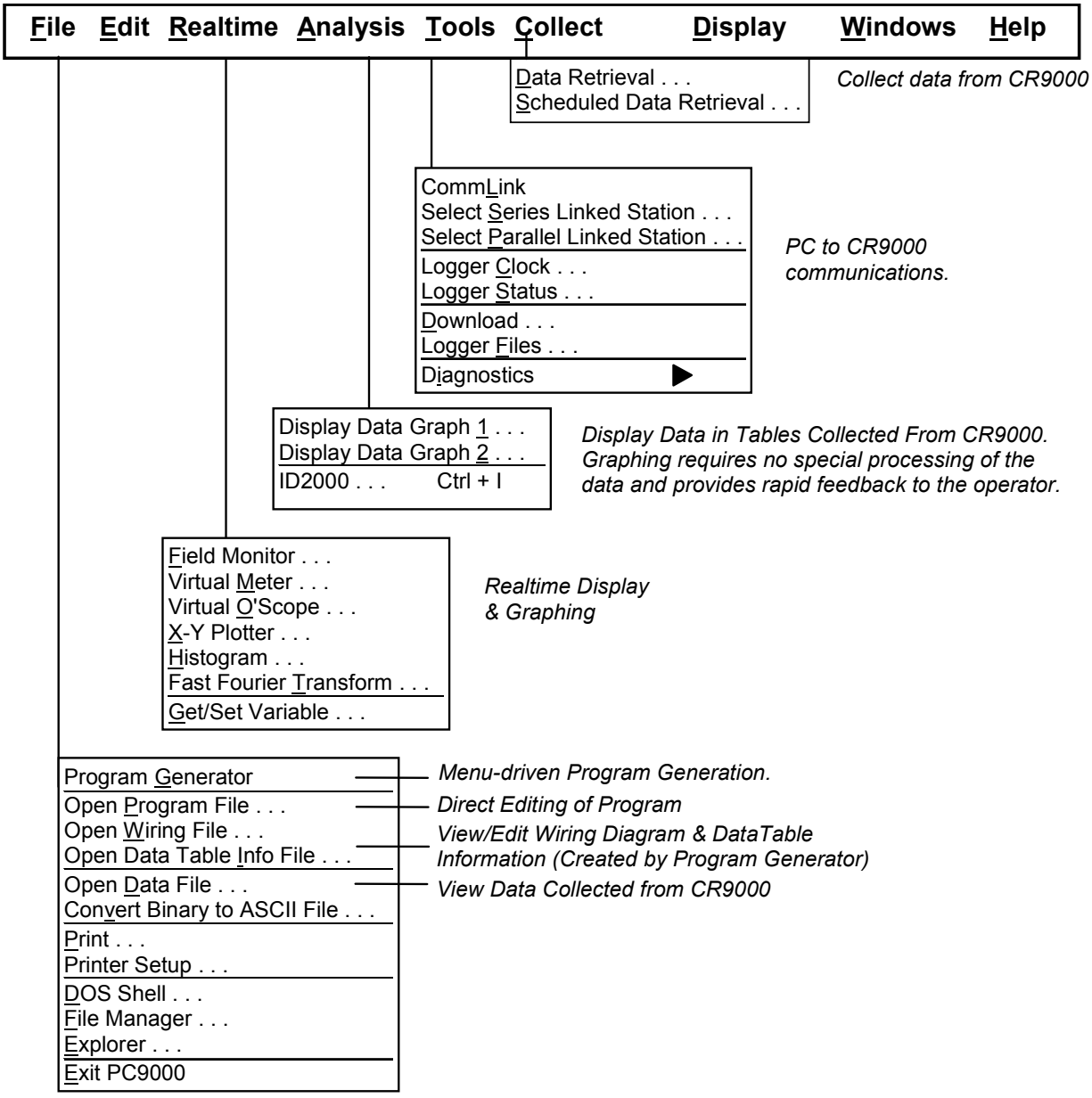
You may use the default directory of PC9000 or install the software in a different directory. The directory will be created for you.

To abort the installation, type Ctrl-C or Break at any time.

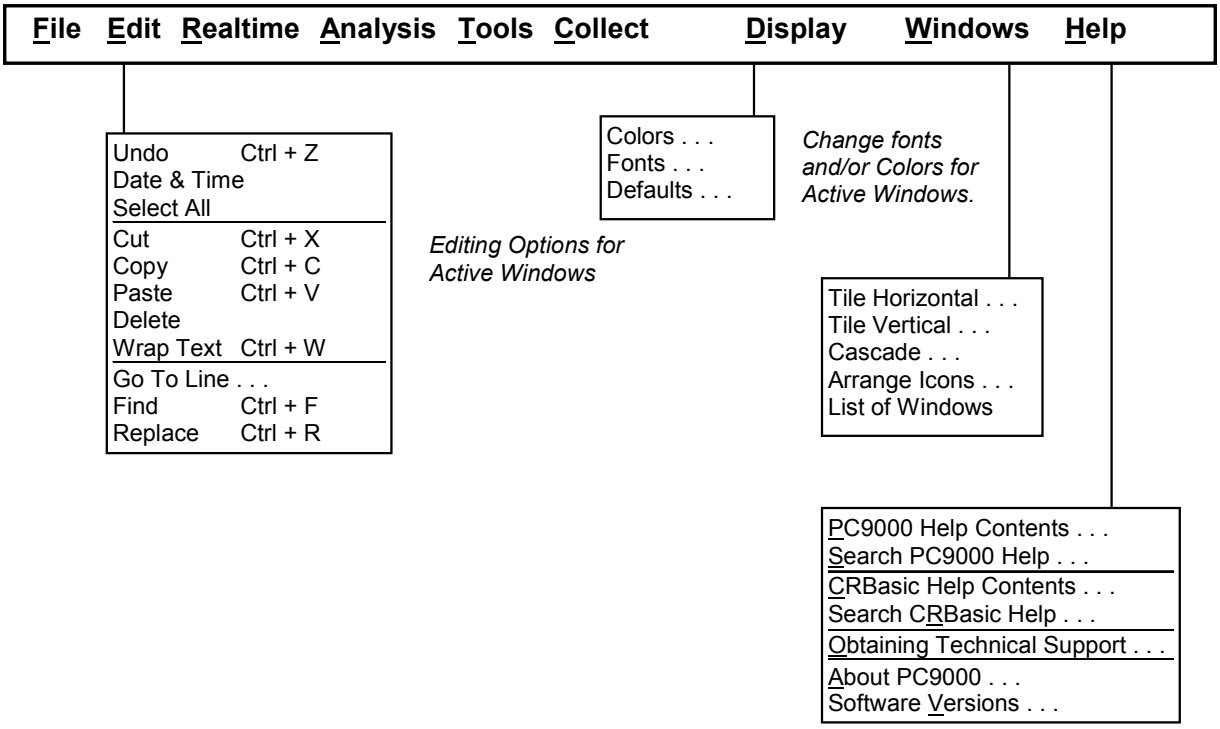
OV3.3 PC9000 Software Overview

This overview points out the main PC9000 functions and where to find them. PC9000 has extensive on-line help to guide the user in its operation. Install PC9000 to get the details. A CR9000X is not necessary to try out the programming and real-time display options; the demo uses canned data for viewing. Without a CR9000X, there are no communications with the datalogger; operations such as downloading programs and retrieving data will not function.

Figures OV3-1 and OV3-2 show the main PC9000 menus. The primary functions of PC9000 are accessed from the File, Comm, Realtime, and Analysis selections on the main menu (Figure OV3-1).



OV3-1. PC9000 Primary Functions



OV3-2. PC9000 Editing, Help, and User Preferences

File

Program Generator
Guides the user through a series of menus to configure the measurement types: thermocouple, voltage, bridge, pulse counting, frequency, and others. Creates a CR9000X program, wiring diagram, output table, description, and configuration file.

Program Editor
Create programs directly or edit those created by the program generator or retrieved from the CR9000X. Provides context-sensitive help for the CR9000X's BASIC-like language.

RealTime

Alarms List
Allows the display of up to 20 fields from a single data table. Two alarm conditions can be created for each field by double clicking the left mouse button while the cursor is held over the field number. After the alarm parameters are set-up, they can be saved to and subsequently loaded from an .alm file. The .alm file can be edited using the program editor.

Field Monitor
Allows the display of up to three different tables at a time. Each table module may display any of the available fields from any of the available tables.

Virtual Meter
Allows the display of up to five different meters at a time. Each meter may display any of the available fields from any of the available tables. Each meter may be independently ranged and scaled as desired. In addition, each meter may have two independent alarms that are visual and/or audible as desired. Each meter may be displayed as a vertical or horizontal bar graph or as an analog gauge. If Cal-On-Site is selected from the Program Generator, each meter can provide access to the sensor calibration facility.

Trend Monitor
Allows the display of up to 20 different traces on a single trend or strip chart. Each trace may display any of the available fields from any of the available tables. You can invoke multiple iterations of the Trend Chart window for viewing additional variable traces.

Virtual Oscilloscope
Allows the display of up to 20 different traces on a single scope. Each trace may display any of the available fields from any of the available tables. You can invoke multiple iterations of the Virtual O'Scope window for viewing additional variable traces.

X-Y Plotter
Allows the plotting of 20 different fields against one field from the same table in an X-Y configuration. You can invoke multiple iterations of the XY Plot window.

Spatial Plot
Allows the display of values from multiple fields in a Trend plot. Useful for displaying data from various sensors in a histogram format. Can also be used to pick a selection of bins from a histogram or FFT to display. You can invoke multiple iterations of the Spatial Plot window.

Basic 2-D Histogram
Allows the display of two-dimensional histograms in real-time. You can invoke multiple iterations of the Histogram window. An understanding of the Histogram instruction for the data logger is required to make use of this window.

Basic 3-D Histogram
Allows the display of histograms in a real-time 3D format. The 3rd dimension is based on the record number. You can set the number of histogram records that you wish to monitor in a single histogram graph.

Rainflow Histogram
Allows the display of RainFlow Histograms in real-time. An understanding of the Rainflow Histogram instruction for the data logger is required to make use of this window. You can invoke multiple iterations of the Histogram window.

Level Crossing Histogram
Allows the display of Level Crossing Histograms in real-time. An understanding of the LevelCrossing Histogram instruction for the data logger is required to make use of this window. You can invoke multiple iterations of the Histogram window.

2-D Fast Fourier Transform
Allows the display of FFT's in a 2 dimensional real-time format. An understanding of the FFT instruction for the datalogger is required to make use of this window.

3-D Fast Fourier Transform
Allows the display of FFT's in a 3 dimensional real-time format. The third dimension is based on the record number. You can set the number of FFT records that you wish to monitor in a single plot.

Analysis

Data Graphing
Displays up to 16 fields simultaneously as strip charts or two multi-charts with up to 8 traces each. Includes 2D/3D bars, line, log/linear, area, and scatter. Line statistics available for max/min, best fit, mean, and standard deviation. Handles files of unlimited size. Historical graphing requires no special processing of the data and provides rapid feedback to the operator.

Tools

Control and Communications
Supports PC to CR9000X communications: clock read/set, status read, program download, and program retrieval.

Collect

Data Collection
Collect data from CR9000X data tables.

Options

PC9000 Setup Options
Configure the font and color scheme in an active window.

Windows

C9000 Setup Options
Size and arrange windows. Select window to bring to the for-ground. Save Window setup options to file.

Help

C9000 Help Files
On-line help for PC9000 software.

OV4. Specifications

General CR9000X & CR9000XC Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; testing over -40° to +70°C available as an option, excluding batteries. Non-condensing environment is required. To maintain specifications, Campbell Scientific recommends recalibrating dataloggers every two years.

CR9032 CPU MODULE

PROCESSORS: 180 MHz Hitachi SH-4

MEMORY: 128 Mbytes of internal SDRAM for program and data storage. Expanded data storage with PCMCIA type I, type II or type III cards.

SERIAL INTERFACES: RS-232
9-pin interface for computer or modem. CS I/O 9-pin interface for CSI peripherals and SDM devices.

ETHERNET INTERFACE: 10baseT/100baseT port for communications over a local network or the Internet.

CR9011 POWER SUPPLY MODULE

VOLTAGE: 9.6 to 18 Vdc

TYPICAL CURRENT DRAIN: Base system with no modules is 500 mA active; 300 mA standby. Current drain of individual I/O modules varies. Refer to specifications for each I/O module for specific values. Power supply module can place the system in standby mode by shutting off power to the rest of the modules.

DC CHARGING: 9.6 to 18 Vdc input charges internal batteries at up to 2 A rate. Charging circuit includes temperature compensation.

INTERNAL BATTERIES: Sealed rechargeable with 14 Ahr (7 Ahr for the CR9000XC) capacity per charge.

EXTERNAL BATTERIES: External 12 V batteries can be connected.

CR9041 A/D and AMPLIFIER MODULE

A/D Conversions: 16-bit, 100 kHz

TRANSIENT PROTECTION

All analog and digital inputs and outputs use gas discharge tubes and transient filters to protect against high-voltage transients. Digital I/Os also have over-voltage protection clamping.

PHYSICAL

Size

LAB ENCLOSURE:	15.75"L x 9.75"W x 8"D (40 x 24.8 x 20.3 cm)
FIBERGLASS ENCLOSURE:	18"L x 13.5"W x 9"D (45.7 x 34.3 x 22.9 cm)
CR9000XC:	10"L x 11"W X 9"D (25.4 x 27.9 x 22.9 cm)

Weight

LAB ENCLOSURE: 30 lbs including modules (13.6 kg)

FIBERGLASS ENCLOSURE: 42 lbs including modules (19.1 kg)

CR9000XC: 27 lbs including modules (12.3 kg)

REPLACEMENT BATTERIES: 6.4 lbs (2.9 kg)

ADDITIONAL MODULES: 1 lb each (0.5 kg)

WARRANTY

Three years against defects in materials and workmanship.

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

CR9000X & CR9000XC I/O Module Specifications

CR9050(E) and CR9051E ANALOG INPUT MODULE with RTD

INPUT CHANNELS PER MODULE: 14 differential or 28 single-ended.

RANGE AND RESOLUTION:

Input Range (mV)	Resolution (1 A/D count) (µV)	Input Noise (µV RMS)	Max Sample Rates (kHz)
±5000	158.0	105	100
±1000	32.0	35	100
±200	6.3	7	50
±50	1.6	4	50

Input Range (mV)	Input Noise CR9050(E)	(µV RMS) CR9051E
±5000	105	130
±1000	35	35
±200	7	7
±50	4	4

Note: Measurement averaging provides lower noise and better resolution.

ACCURACY OF VOLTAGE MEASUREMENTS:
Single-Ended & Differential:
±(0.07% of reading + 4 A/D counts) -25° to +50°C
±(0.14% of reading + 4 A/D counts) -40° to +70°C

Dual Differential:
(two measurements with input polarity reversed)
±(0.07% of reading + 1 A/D count) -25° to +50°C
±(0.14% of reading + 1 A/D count) -40° to +70°C

COMMON MODE RANGE: ±5 V

DC COMMON MODE REJECTION: >120 dB

INPUT RESISTANCE: 2.5 gigaohms typical

MAXIMUM INPUT VOLTAGE WITHOUT DAMAGE: ±20 V CR9050(E), -40 to +50 V CR9051E

TYPICAL CURRENT DRAIN: 25 mA active

Resistance & Conductivity Measurements
(Also requires 9060 Excitation Module)

ACCURACY: ± (0.04% of reading + 2 A/D counts) limited by accuracy of external bridge resistors.

MEASUREMENT TYPES: 6-wire and 4-wire full bridge, 4-wire, 3-wire, and 2-wire half bridge. Uses excitation reversal to remove thermal EMF errors.

CR9052DC ANTI-ALIAS FILTER MODULE

Refer to the CR9052DC documentation

CR9055(E) 50 V-ANALOG INPUT MODULE

INPUT CHANNELS PER MODULE: 14 differential or 28 single-ended.

RANGE AND RESOLUTION:

Input Range (V)	Resolution (1 A/D count) (µV)	Input Noise (µV RMS)	Max Sample Rates (kHz)
±50	1580	1050	100
±10	320	350	100
±2	63	85	50
±0.5	16	60	50

Note: Measurement averaging provides lower noise and better resolution.

ACCURACY OF VOLTAGE MEASUREMENTS:
Single-Ended & Differential:
±(0.1% of reading + 4 A/D counts) -25° to +50°C
±(0.2% of reading + 4 A/D counts) -40° to +70°C

Dual Differential:
(two measurements with input polarity reversed)
±(0.1% of reading + 1 A/D count) -25° to +50°C
±(0.2% of reading + 1 A/D counts) -40° to +70°C

COMMON MODE RANGE: ±50 V

DC COMMON MODE REJECTION: >62 dB

INPUT RESISTANCE: 100 kohms typical

MAXIMUM INPUT VOLTAGE WITHOUT DAMAGE: ±150 V

TYPICAL CURRENT DRAIN: 15 mA active

CR9058E ISOLATION MODULE

INPUT CHANNELS PER MODULE: 10 isolated, differential; each channel has its own isolation ground for shielded cable connection.

RANGE, RESOLUTION, AND INPUT RESISTANCE:

Input Range (Vdc)	Resolution w/o Averaging (µV)	Resolution w/ Averaging (µV)	Input Resistance (kohms)
±2	±10	±2	10,000
±20	±100	±20	88.9
±60	±300	±60	269

ACCURACY: ±0.02% of Full Scale Range over -40° to +70°C

MINIMUM SCAN TIME PER MODULE:
VoltDiff: 1285 µs (778 samples per second) + integration time for no input reversal (RevDiff=0); or 2990 µs (334 samples per second) + integration time with input reversal (RevDiff=1)

TCDiff (range parameter set to V2C): 2570 µs (389 samples per second) + integration time for no input reversal (RevDiff=0); or 4275 µs (233 samples per second) + integration time with input reversal (RevDiff=1).

MAXIMUM CONTINUOUS VOLTAGE W/O DAMAGE:

Input Range (Vdc)	H to L (Vdc)	H or L to ISO Ground (Vdc)	ISO Ground to Systm Ground (Vdc)	H or L to Systm Ground (Vdc)
±2	±208	±109	±360	±469
±20	±223	±121	±360	±481
±60	±448	±233	±360	±593

MAXIMUM ESD VOLTAGE ON INPUTS: ±5000V

TYPICAL CURRENT DRAIN: 360 mA

CR9060 EXCITATION MODULE

TYPICAL CURRENT DRAIN:
108 mA quiescent, 125 mA active

Analog Outputs

ANALOG OUTPUTS PER MODULE:
10 switched, 6 continuous

SWITCHED: Provides excitation for resistance measurements. Only one output can be active at a time.

CONTINUOUS: All outputs can be active simultaneously.

RANGE: ±5 V

ACCURACY: ± (0.2% of output ±4 mV)

RESOLUTION: 12-bit A/D (2.4 mV)

OUTPUT CURRENT: ±50 mA

Digital Control Outputs

CONTROL CHANNELS PER MODULE: 8

OUTPUT VOLTAGES (no load):
High: 5.0 V ±0.2 V
Low: < 0.2 V

OUTPUT RESISTANCE: 100 ohms

CR9071E COUNTER & DIGITAL I/O MODULE

Counter Channels

COUNTER CHANNELS PER MODULE: 12

MAXIMUM COUNTS PER INTERVAL: 2^{32} Maximum counts per interval will never be reached because with a maximum input frequency of 1 MHz, the 32-bit counter will go 71.58 minutes before it rolls over. The maximum CR9000X scan rate is 1 minute.

SWITCH CLOSURE MODE (4 channels)
Minimum switch closed time: 5 ms
Minimum switch open time: 6 ms
Maximum bounce time: 1 ms open without being counted

HIGH FREQUENCY MODE (all channels)
Minimum pulse width: 500 ns
Maximum input frequency: 1 MHz
Thresholds: Pulse counted on transition from below 1.5 V to above 3.5 V
Maximum input voltage: ±20 V

LOW LEVEL AC MODE (8 channels)
Input hysteresis: 10 mV
Minimum ac voltage: 25 mV RMS
Maximum input voltage: ±20 V
Frequency range:

(mV RMS)	RANGE (Hz)
25 mV	1 to 10,000
≥50 mV	0.5 to 20,000

TYPICAL CURRENT DRAIN: 35 mA

Digital Inputs/Outputs

I/O CHANNELS PER MODULE: 16

OUTPUT VOLTAGES (no load)
High: 5.0 V ±0.2 V
Low: < 0.2 V

OUTPUT RESISTANCE: 320 ohms

Input State
High: 3.5 to 5 V
Low: -0.5 to 1.2 V

Input Resistance: 100 kOhms

Interval Measurement
I/O CHANNELS:
Resolution is the scan rate

PULSE CHANNELS
Maximum interval: 1 minute
Resolution: ±40 ns

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

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Printed May 2004

CR9052DC Specifications

Operating temperature range is -40° to +70°C (specifications valid over this range unless otherwise specified). Non-condensing environment required. To maintain specifications, yearly recalibrations are recommended.

Inputs

Number of differential input channels: 6

Programmable anti-aliasing implemented with finite-impulse-response filters

Output sample rate	f_{SAMPLE}	programmable: 50 ksamples s^{-1} to 5 samples s^{-1}
Sample ratio	f_{SAMPLE}/f_{PASS}	programmable: 2.5, 5, 10, or 20
Top of the pass band	f_{PASS}	
Bottom of the stop band	f_{STOP}	
Transition band rolloff	f_{PASS}/f_{STOP}	

Sample Ratio	f_{PASS}	f_{STOP}	f_{PASS}/f_{STOP}
2.5	$f_{SAMPLE}/2.5$	$f_{SAMPLE}/2.01$	1.24
5	$f_{SAMPLE}/5$	$f_{SAMPLE}/3.37$	1.48
10	$f_{SAMPLE}/10$	$f_{SAMPLE}/5.08$	1.97
20	$f_{SAMPLE}/20$	$f_{SAMPLE}/6.81$	2.94

Linear phase response: group delay is independent of frequency
Pass band ripple: ≤ 0.01 dB
Stop band attenuation: ≥ 90 dB
Group delay: 36 / f_{SAMPLE}
Channel-to-channel sampling simultaneity: ≤ 100 nsec

CR9052 measurement rates

Non-burst: 15 ksamples s^{-1}, aggregate*
Bursting to PC FLASH card: 50 ksamples s^{-1}, aggregate*
Bursting to rotating media PC card: 100 ksamples s^{-1}, aggregate*
Bursting to 8-Msample buffer on filter module: 300 ksamples s^{-1}, aggregate per module**

**The aggregate rate is the sum of the measurement rates on all channels*
***The aggregate per module rate is the sum of measurement rates on all channels of a single filter module*

Analog Input Full-Scale Differential Ranges		Noise Performance	Dynamic Range (f_{PASS}=10 Hz)	CMRR◆
±5000 mV	50	µV + 600 nV * sqrt (f_{PASS})	106 dB	-70 dB
±1000 mV	10	µV + 150 nV * sqrt (f_{PASS})	106 dB	-70 dB
±200 mV	2	µV + 30 nV * sqrt (f_{PASS})	106 dB	-83 dB
±50 mV	0.5	µV + 12 nV * sqrt (f_{PASS})	106 dB	-95 dB
±20 mV	0.25	µV + 8 nV * sqrt (f_{PASS})	103 dB	-103 dB

◆CMRR = common-mode rejection ratio = common-mode gain / differential-mode gain. CMRR specified from dc to 500 Hz.

Gain accuracy: ± 0.03 percent of reading
Offset accuracy: ± 0.03 percent of full-scale input range

Input resistance: 1 x 10^9 Ω
Input time constant: 1 kΩ x 100 pF = 100 nsec
Input offset current: ≤ 35 nA

Common-mode input range: +15 to -5 V

Channel-to-channel crosstalk: ≤ -120 dB

CR9052DC Specifications (continued)

FFT Spectrum Analyzer

Fourier transforms applied to anti-aliased inputs described above

Number of channels:	6
Time series sample rates:	programmable from 50 ksamples s^{-1} to 5 samples s^{-1}
FFT length:	programmable from 32 to 65,536 samples
Real-time spectral throughput	
for six channels:	50-kHz or slower, 2048-point or smaller, seamless snapshots
for two channels:	50-kHz or slower, 65536-point or smaller, seamless snapshots
Optional time series windows:	Hanning, Hamming, Blackman
Spectrum options:	Real and imaginary, Amplitude and phase, Amplitude, Amplitude rms, Power, Power spectral density, dB

Optional spectral binning to reduce final spectrum length

Linear spectral binning:	$2 \le m \le$ (FFT_length/2) where programmable m adjacent bins are combined into a single bin
Logarithmic spectral binning:	$1 \le n \le 12$ where exponentially increasing spectral bin width gives 1/n Octave Analyses

Excitations

Number of continuous excitation channels: 6

Programmable Excitation Levels	Compliance	Accuracy
10 V	85 mA	± 0.03 percent of setting, -25° to 50° C ± 0.05 percent of setting, -40° to 70° C
5 V	85 mA	± 0.03 percent of setting, -25° to 50° C ± 0.05 percent of setting, -40° to 70° C
10 mA	12 V	± 0.06 percent of setting, -25° to 50° C ± 0.08 percent of setting, -40° to 70° C

General

Over-voltage protection on all inputs and outputs:	+ 50 V, -40 V
Current consumption (at 12 V input):	500 mA + 1.5*[I_{ex}] where I_{ex} is the sum of excitation currents provided by all channels
Current consumption for complete CR9000 system:	must be less than 4 A

Sensor connections use CR9052EC Easy Connectors for CR9052DC. The Easy Connectors consist of a terminal strip that is easily disconnected from the CR9052. Customers needing to monitor several locations intermittently have found it useful to buy several CR9052ECs and simply move the CR9000 and on-board CR9052DC(s) between monitoring locations.

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Printed April 2001

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