OVERVIEW

The CR9000 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 CR9000 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.

FIGURE OV1-1. CR9000 Measurement and Control System

OV1. PHYSICAL DESCRIPTION

OV1.1 BASIC SYSTEM

9031 CPU MODULE

The 9031 CPU Module provides system control, processing, and communication to a PC via Transputer Link (TLINK) and fiber optic. The main processor is a 32-bit Inmos T805 Transputer. The module has 2MB static RAM and 2MB Flash EEPROM.

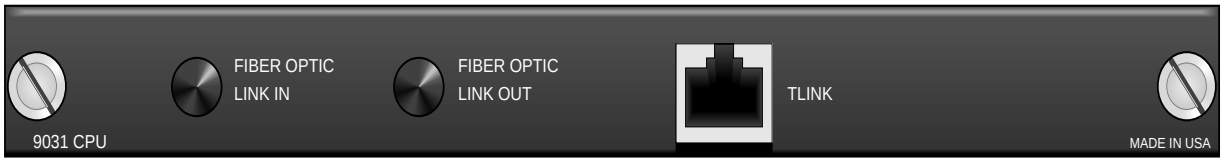


FIGURE OV1-2. 9031

9041 A/D & AMPLIFIER MODULE

The 9041 A/D and Amplifier Module provides signal conditioning and 16 bit, 100 kHz A/D conversions.

FIGURE OV1-3. 9041

9011 POWER SUPPLY MODULE AND AC ADAPTER

The 9011 Power Supply Module provides regulated power to the CR9000 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 CR9000 and charge its batteries.
<<Insert following text in section OV1.1>>

The 9011 has a relay that allows shutting off power under program control. The Power Up inputs allow an external signal to awaken the CR9000 from a powered down state (PowerOff, Section 9). When the CR9000 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 CR9000 will awake, load the program in memory and run. If the "< 0.5" input continues to be held at ground while the CR9000 is powered on and goes through its 2–5 second initialization sequence, the CR9000 will not run the program in memory.

MEASUREMENTS:

Battery (voltage and current)

CONTROL:

PowerOff

FIGURE OV1-4. 9011

OV1.2 MEASUREMENT MODULES

9050 ANALOG INPUT MODULE

The 9050 Analog Input module has 14 differential or 28 single-ended inputs for measuring voltages up to ±5 V. 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 9060 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)

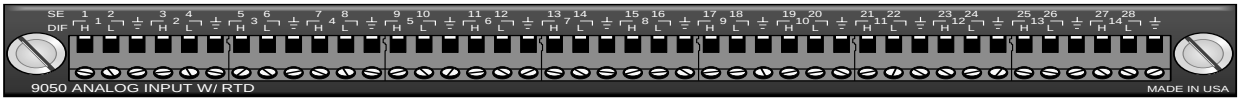


FIGURE OV1-5. 9050

9055 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 9055 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 9050 Analog input module (± 5 Volt) because of its greater resolution, however they can be made on the 9055 if the ± 50 V common mode range is necessary.

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

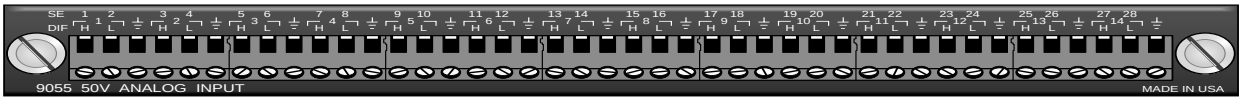


FIGURE OV1-6. 9055

9060 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 OV1-7. 9060

9070 COUNTER - TIMER / DIGITAL I/O MODULE

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)

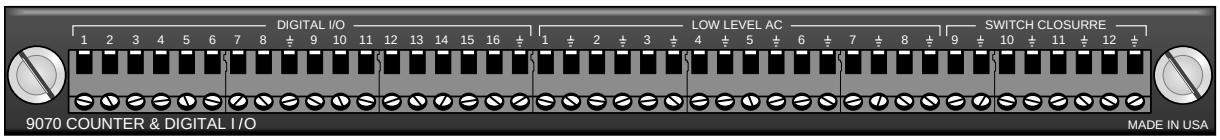


FIGURE OV1-8. 9070

DATA STORAGE PERIPHERAL AND MEMORY MODULE

Contains slots for two Type I/II PCMCIA cards or one type III PCMCIA card. A 9-pin serial I/O port supports CSI peripherals. The LEDs indicate the status of the cards in slots A and B. **Not lit:** no card detected, **green:** present and correctly formatted, **red:** present but corrupt or unrecognized, **orange:** accessing the card. Press the button next to the status LED to power down a card before removing it. The LED will blink green several times then go out for 10 seconds. Remove the card while the LED is not lit. The card will be reactivated if not removed.

> **CAUTION:** Removing a card while it is active can cause garbled data and can actually damage the card. Do not switch off the power (9011 Module) while the cards are present and active.

MEASUREMENTS:

Output data to PAM (PAMOut)
DSP4 Display (DSP4)
CSAT3 Sonic Anemometer (CSAT)

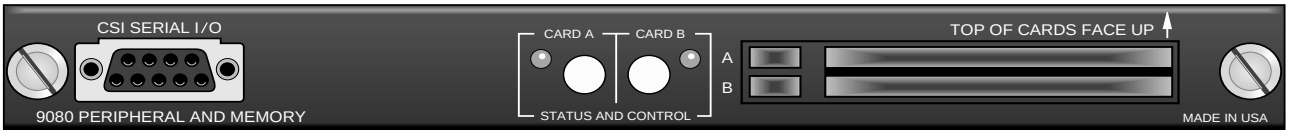


FIGURE OV1-9. 9080

OV1.3 COMMUNICATION INTERFACES

TL925 RS232-TLINK INTERFACE

The TL925 CR9000 to Computer Interface converts RS232 signals from the computer into a transputer link for the CR9000. The TLINK cable can be up to 30 meters long.

FIGURE OV1-10. TL925

BLC100 BUS LINK CARD & FIBER OPTIC LINK INTERFACE

The BLC100 is an interface board that plugs into a half length card slot (AT bus) in the user's computer. It can be used for either TLINK (8 wire, up to 30 meters) or for fiber optic (separate transmit and receive) communications. The communication rate is 10 MBPS.

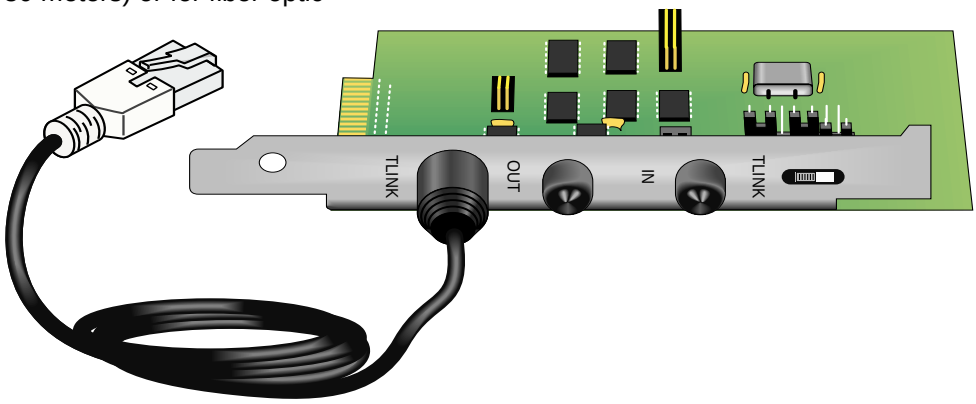


FIGURE OV1-11. BLC100 Bus Link Card

PLA100-L PARALLEL LINK INTERFACE

The PLA100-L converts a parallel port on a computer to a TLINK for communication with the CR9000.

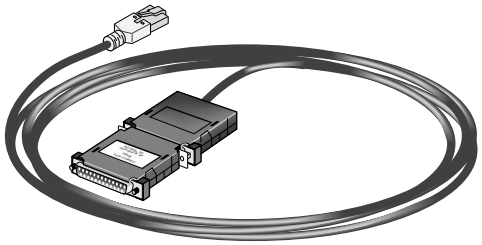


FIGURE 0V1-12. PLA100-L Parallel Link Interface

OV2. MEMORY AND PROGRAMMING CONCEPTS

OV2.1 MEMORY:

The 9031 CPU Module in the CR9000 base system has 2MB static RAM and 2MB Flash EEPROM. The static RAM allows fast read

write cycles (150 ηs). The Flash EEPROM is much slower to write to (15µs *minimum*) but it retains its information when power is shut off. The operating system and user program listing(s) are stored in the flash EEPROM. When the CR9000 is powered up, the operating system and the compiled program are loaded into RAM. The memory that is not used by the operating system and program is available for data storage. The size of available memory may be seen in the status file. Additional data storage is available with the 9080 PAM Module.

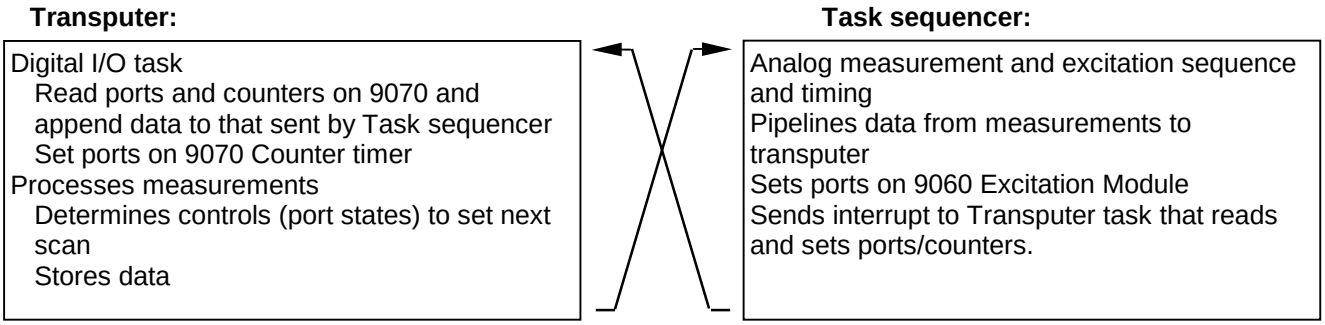
OV2.2 MEASUREMENTS, PROCESSING, DATA STORAGE.

The CR9000 divides datalogging and control between two entities. The **task sequencer** manipulates the measurement and control hardware on a rigidly timed sequence. The main processor, an Inmos T805 **Transputer,** processes and stores the resulting measurements and makes the decisions to actuate controls.

The **Transputer** is a 32 bit processor that has parallel processing capabilities. Four communication links allow rapid transfer of data with little processor time. One link is used to transfer data to and from intelligent modules in the CR9000 (e.g., the PAM module). One link is used for TLINK communications and another for the fiber optic link. The forth link gives the task sequencer direct memory access (DMA) to store raw Analog to Digital Converter (ADC) data directly into transputer memory. As soon as the data from a scan is in memory, the transputer starts processing it. There are two buffers allocated for this raw ADC data, thus the transputer can be busy full time processing one scan of data while the task sequencer is filling the other.

The transputer directly controls the 9070 Counter and Digital I/O Module.

The **task sequencer** is a combination of components that include memory, a Xylinx Programmable Gate Array (i.e., a CSI customized chip), and the digital bus. When a program is compiled by the transputer, it loads the task sequencer memory with a series of instructions that define the sequence and timing of the measurements. This control includes channel and gain switching and ADC control that is done in our other dataloggers by the CPU When the program runs, the task sequencer steps through the instructions at a precise rate, ensuring that the measurement timing is exact and invariant.



OV2.3 DATA TABLES

The CR9000 can store individual measurements or it may use its extensive processing capabilities to calculate averages, maxima, minima, histogams, 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
1995-02-16 15:15:04.61	278822	31.08	24.23	25.12	26.8	24.14	24.47	23.76
1995-02-16 15:15:04.62	278823	31.07	24.23	25.13	26.82	24.15	24.45	23.8
1995-02-16 15:15:04.63	278824	31.07	24.2	25.09	26.8	24.11	24.45	23.75
1995-02-16 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 CR9000. The software supports CR9000 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 necessary:

- IBM PC, Portable or Desktop
- 8 Meg of Ram
- VGA Monitor
- Windows 3.1
- 30 Meg of Hard Drive Space for software
- 40 Meg of Hard Drive Space for data
- Parallel port and a PLA100-L, RS232 Serial Port and TL925, or BLC100 Bus Link Card

The following computer resources are recommended:

- 16 Meg of Ram
- 33 MHz 486 or faster
- Mouse

OV3.2 PC9000 INSTALLATION

To install the PC9000 Software:

- Start Microsoft Windows 3.1
- Insert diskette 1 (marked 1 of 2) in a disk drive.
- 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.

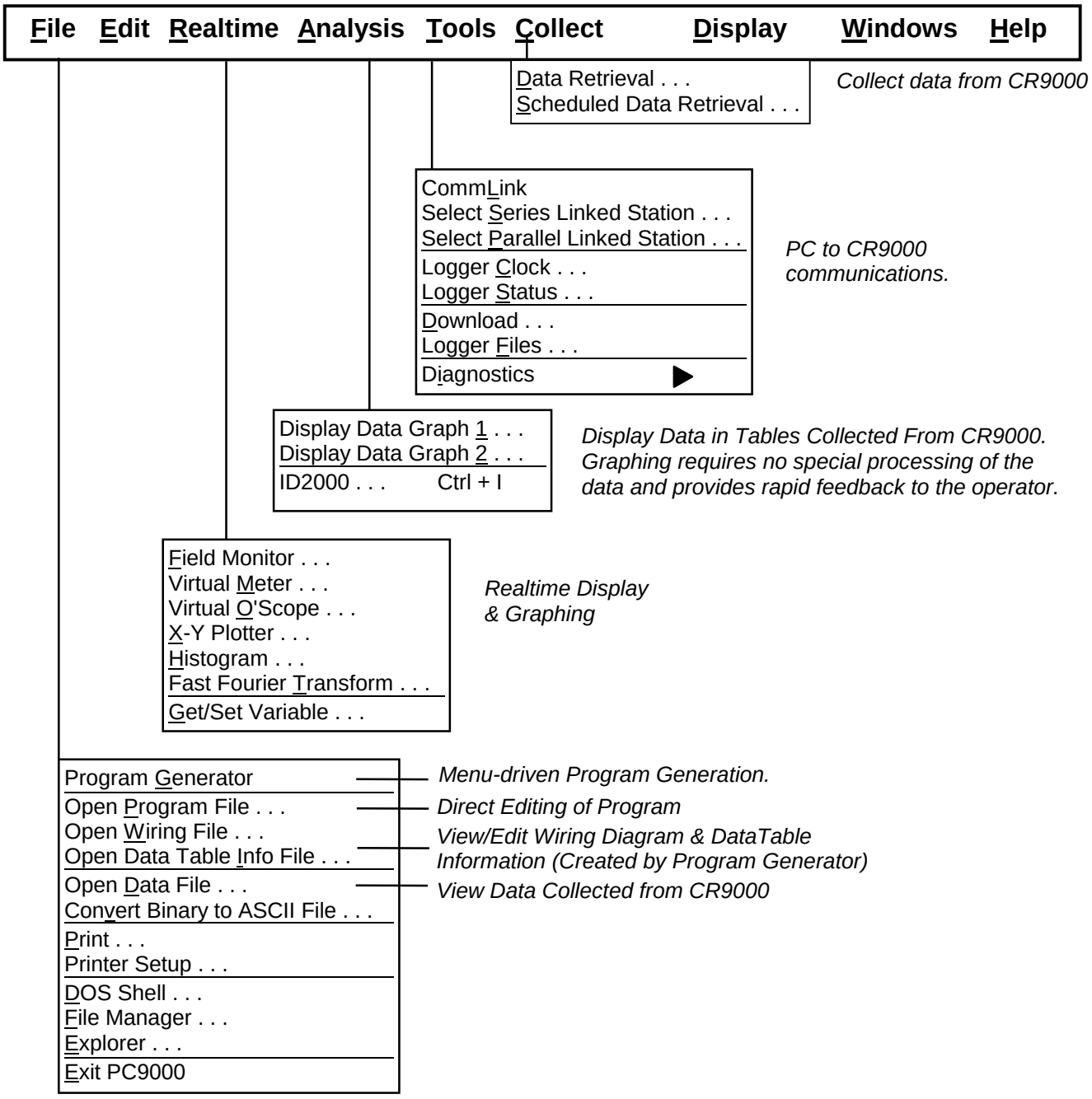
You may use the default directory of PC9000 or install the software in a different directory. The directory will be created for you.

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

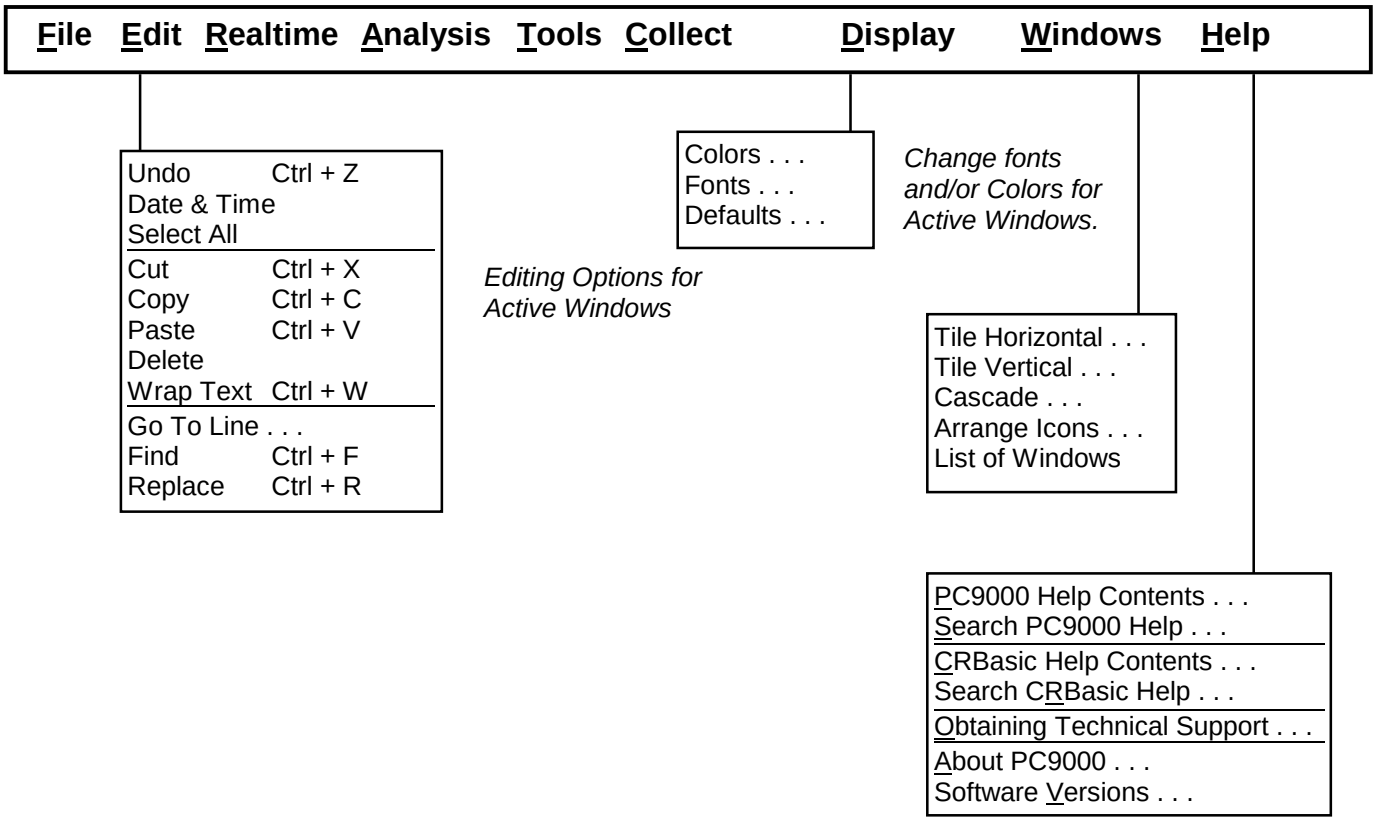
OV3.3 PC9000 SOFTWARE OVERVIEW

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, run PC9000 to get the details. A CR9000 is not necessary to try out the programming and real time display options; a demo uses canned data for viewing. Without a CR9000, 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 CR9000 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 CR9000. Provides context-sensitive help for the CR9000's BASIC-like language.

Edit

REALTIME

Virtual Meter
Updates up to five displays simultaneously. Choices include analog meter, horizontal and vertical bars, independent scaling/offset, multiple alarms, and rapid on-site calibration of sensors

Virtual Oscilloscope
Displays up to six channels. Time base variable from milliseconds to hours.

X-Y Plotter
Allows comparison of any two measurements in real time.

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 CR9000 communications: clock read/set, status read, program download, and program retrieval.

COLLECT

Collect data from CR9000 data tables

DISPLAY

Configure the font and color scheme in an active window.

WINDOWS

Size and arrange windows.

HELP

On-line help for PC9000 software.

OV4. SPECIFICATIONS

The following specifications are valid for a temperature range of -25° to +50°C, unless otherwise specified.

ANALOG INPUTS

(9050 Analog Input Module)

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)*	*Sample Rates (kHz)*
±5000	158.0	90	100
±1000	32.0	30	100
±200	6.3	7	50
±50	1.6	4	50

Note: Measurement averaging provides lower noise and higher resolution.

ACCURACY OF VOLTAGE MEASUREMENTS: (Excluding noise)

Single-Ended & Differential:
±0.07% of reading + 4 A/D counts

Dual Differential (two measurements with input polarity reversed):
±0.07% of reading + 1 A/D count

COMMON MODE RANGE: ±5 V; ±50 V with 9055 Module

DC COMMON MODE REJECTION: 120 dB

INPUT RESISTANCE: 2.5 gigaohms typical

MAXIMUM INPUT VOLTAGE WITHOUT DAMAGE: ±20 V; ±150 V with 9055 Module

RESISTANCE AND CONDUCTIVITY MEASUREMENTS

(Uses measured excitation from 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.

ANALOG OUTPUTS

(9060 Excitation Module)

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: ±0.08% of output ±4 mV

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

OUTPUT CURRENT: ±50 mA

DIGITAL CONTROL OUTPUTS

(9060 Excitation Module)

CONTROL CHANNELS PER MODULE: 8

OUTPUT VOLTAGES (no load):
High: 5.0 volts ±0.1 volt
Low: ±0.1 volt

OUTPUT RESISTANCE: 100 ohms

COUNTERS

(9070 Counter & Digital I/O Module)

COUNTER CHANNELS PER MODULE: 12

MAXIMUM COUNTS PER INTERVAL: 65536

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: 100 ns

MAXIMUM INPUT FREQUENCY: 5 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: 20 mV RMS

MAXIMUM INPUT VOLTAGE: ±20 V

FREQUENCY RANGE:

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

DIGITAL INPUTS/OUTPUTS

(9070 Counter & Digital I/O Module)

I/O CHANNELS PER MODULE: 16

OUTPUT VOLTAGES (no load):
High: 5.0 V ±0.1 volt
Low: ±0.1 volt

OUTPUT RESISTANCE: 125 ohms

MAXIMUM INPUT VOLTAGE: ±20 V

TRANSIENT PROTECTION

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

CPU MODULE

(9031 CPU module)

PROCESSORS: Main CPU is a 32-bit Inmos T805 Transputer with on-chip floating point unit. 30 MIPS (peak) instruction rate. 4.3 Mflops (peak) instruction rate. Measurements timing and setup done by hardware task sequencer with DMA type transfer to Transputer memory.

MEMORY: 2 MB Flash EEPROM, 2 MB Static RAM

COMMUNICATION OPTIONS

BLC100: PC ISA bus to CR9000 via either of two interfaces.

TLINK: 8-pin differential interface. Transfer rate to 2 Mpbs. Cable length to 30 meters.

FIBER OPTIC: Dual fiberoptic interface. Transfer rate to 2 Mbps. Cable length to 1000 meters.

PLA100 PARALLEL LINK: PC Parallel port to CR9000 via TLINK interface as described above. Transfer rate to 1 Mbps.

TL925 SERIAL LINK: PC Serial port to CR9000 via TLINK interface. Transfer rate to 115,200 bps.

PERIPHERAL & MEMORY MODULE

(9080 Peripheral & Memory Module)

PCMCIA CARD INTERFACE: Accepts two Type I/II cards or one Type III card.

SERIAL I/O: Allows serial communications with CSI peripherals at up to 115,200 baud.

SYSTEM POWER REQUIREMENTS

(9011 Power Supply Module)

VOLTAGE: 9.6 to 18 VDC

TYPICAL CURRENT DRAIN: Base system with no modules is 500 mA active; 300 mA standby. Modules use from 25 mA (9050) to 300 mA (9080) each. 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 capacity per charge.

EXTERNAL BATTERIES: External 12 V batteries can be connected.

PHYSICAL SPECIFICATIONS

SIZE: ENC 9L: 15.75" L x 9.75" W x 8" D (40 x 24.8 x 20.3 cm)
ENC 9F: 18" L x 13.5" W x 9"D (45.7 x 34.3 x 22.9 cm)

WEIGHT: ENC 9L: 22 lbs (includes 6 modules) (10.0 kg)
ENC 9F: 34 lbs (includes 6 modules) (14.8 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.