OPERATOR'S MANUAL

CR5000 Measurement and Control System Overview

Revision: 11/06

CR5000 MEASUREMENT AND CONTROL SYSTEM OVERVIEW TABLE OF CONTENTS

PDF viewers note: These page numbers refer to the printed version of this document. Use the Adobe Acrobat® bookmarks tab for links to specific sections.

CR5000 Overview

The CR5000 provides precision measurement capabilities in a rugged, battery-operated package. The system makes measurements at a rate of up to 5,000 samples/second with 16-bit resolution. The CR5000 includes CPU, keyboard display, power supply, and analog and digital inputs and outputs. The on-board, BASIC-like programming language includes data processing and analysis routines. PC9000 Software provides program generation and editing, data retrieval, and realtime monitoring.

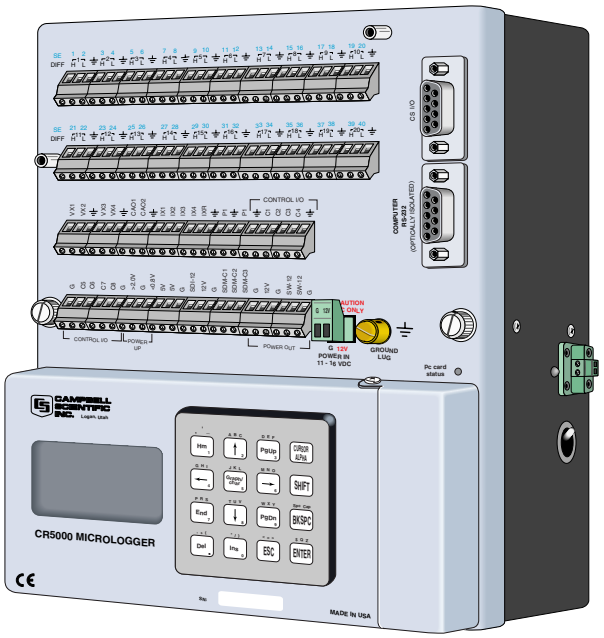


FIGURE OV1-1. CR5000 Measurement and Control System

OV1. Physical Description

Figure OV1-2 shows the CR5000 panel and the associated program instructions. Unless otherwise noted, they are measurement instructions (Section 7).

OV1.1 Measurement Inputs

OV1.1.1 Analog Inputs

There are 20 differential or 40 single-ended inputs for measuring voltages up to ±5 V. A thermistor installed in the wiring panel can be used to measure the reference temperature for thermocouple measurements, and 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 0.67 µV

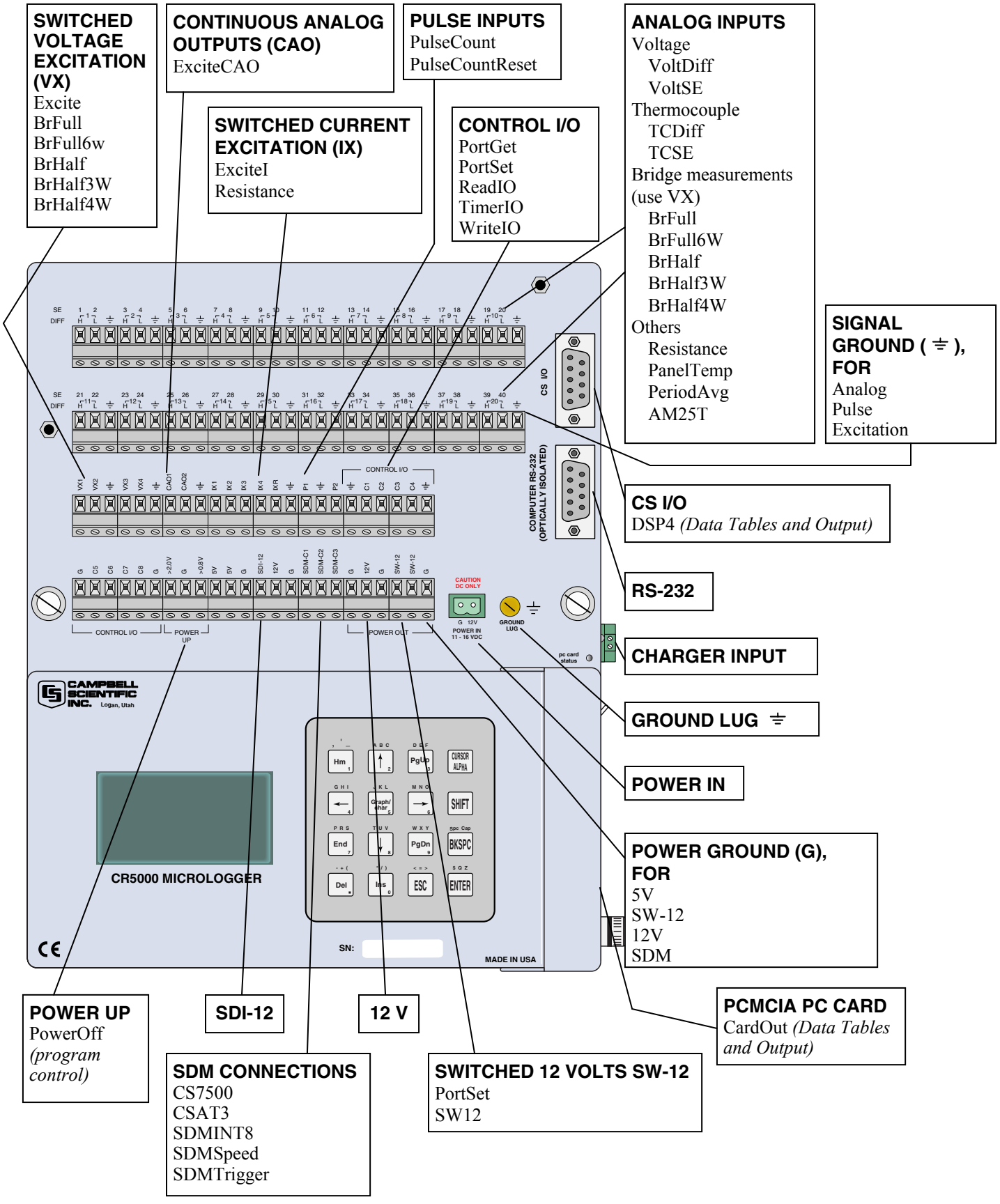


FIGURE OV1-2. CR5000 Panel and Associated Instructions.

OV1.1.2 Signal Grounds (⏚)

The Signal Grounds (⏚) should be used as the reference for Single-ended Analog inputs, Excitation returns, and sensor shield wires.

Signal returns from the CAO and Pulse channels should use the ⏚ terminals located on the CAO and Pulse terminal strip to minimize current flow through the ⏚ grounds on the analog terminal strips.

OV1.1.3 Power Grounds (G)

The Power Grounds (G) should be used as the returns for the 5V, SW12, 12V, and C1-C8 outputs. Use of the G grounds for these outputs with potentially large currents will minimize current flow through the analog section, which can cause Single-ended voltage measurement errors.

OV1.1.4 Ground Lug ⏚

The large ground lug is used to connect a heavy gage wire to earth ground. A good earth connection is necessary fix the ground potential of the datalogger and to send to earth transients that come in on either the G or ⏚ terminals or are shunted to ground via the spark gaps protecting other inputs.

OV1.1.5 Power In

The G and 12V terminals on the unplugable Power In connector are for connecting power from an external battery to the CR5000. These are the only terminals that can be used to input battery power; the other 12V and SW-12V terminals are out only. Power from this input will not charge internal CR5000 batteries. Power to charge the internal batteries (17-28 VDC or 18 VRMS AC) must be connected to the charger input on the side of the LA battery back.

OV1.1.6 Switched 12 Volts SW-12

The SW-12 terminals provide an unregulated 12 volts that can be switched on and off under program control.

OV1.1.7 Switched Voltage Excitation (VX)

Four switched excitation channels provide precision programmable voltages within the ±5 Volt range for bridge measurements. Each analog output will provide up to 50 mA between ±5 V.

OV1.1.8 Switched Current Excitation (IX)

Four Switched Current Excitation channels provide precision current excitations programmable within ±2.5 mA for resistance or bridge measurements.

OV1.1.9 Continuous Analog Outputs (CAO)

Two Continuous Analog Outputs (CAO) with individual outputs under program control for proportional control (e.g., PID algorithm) and waveform generation. Each analog output will provide up to 15 mA between ±5 V.

OV1.1.10 Control I/O

There are 8 digital Input/Output channels (0 V low, 5 V high) for frequency measurement, digital control, and triggering.

OV1.1.11 Pulse Inputs

Two Pulse input channels can count pulses from high-level (5 V square wave), switch closure, or low-level A/C signals.

OV1.1.12 Power Up

The CR5000 allows shutting off power under program control. The Power Up inputs allow an external signal to awaken the CR5000 from a powered down state (PowerOff, Section 9). When the CR5000 is in this power off state the ON Off switch is in the on position but the CR5000 is off. If the "<0.5 " input is switched to ground or if the ">2" input has a voltage greater than 2 volts applied, the CR5000 will awake, load and run the “run on power-up” program. If the "< 0.5" input continues to be held at ground while the CR5000 is powered on and goes through its 2-5 second initialization sequence, the CR5000 will not run “run on power-up” program.

OV1.1.13 SDM Connections

The Synchronous Device for Measurement (SDM) connections C1,C2, and C3 along with the adjacent 12 volts and ground terminals are used to connect SDM sensors and peripherals.

OV1.2 Communication and Data Storage

OV1.2.1 PCMCIA PC Card

One slot for a Type I/II/III PCMCIA card. The keyboard display is used to check card status. The card must be powered down before removing it. 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 CR5000 power while the card is present and active.

OV1.2.2 CS I/O

A 9-pin serial I/O port supports CSI peripherals.

OV1.2.3 Computer RS-232

RS-232 Port

OV1.3 Power Supply and AC Adapter

The CR5000 has two base options the low profile without any power supply and the lead acid battery power supply base. The low profile base requires an external DC power source connected to the Power In terminal on the panel.

The battery base has a 7 amp hour battery with built in charging regulator and includes an AC adapter for use where 120 VAC is available (18 VAC RMS output). Charging power can also come from a 17-28 VDC input such as a solar panel. The DCDC18R is available for stepping the voltage up from a nominal 12 volt source (e.g., vehicle power supply) to the DC voltage required for charging the internal battery.

OV2. Memory and Programming Concepts

OV2.1 Memory

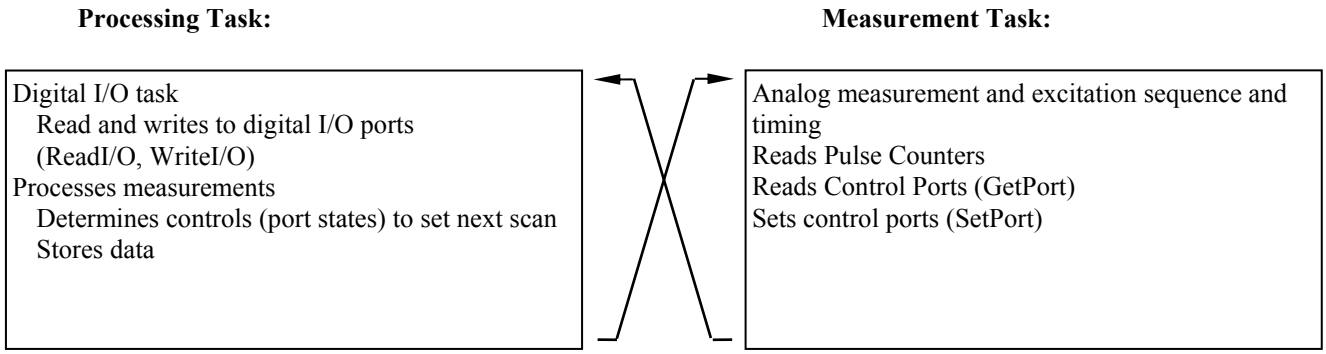
The CR5000 has 2MB SRAM and 1MB Flash EEPROM. The operating system and user programs are stored in the flash EEPROM. The memory that is not used by the operating system and program is available for data storage. The size of available memory may be seen in the status file. Additional data storage is available by using a PCMCIA card in the built in card slot.

OV2.2 Measurements, Processing, Data Storage

The CR5000 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 CR5000 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 CR5000. The software supports CR5000 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 95 or newer
- 30 Meg of Hard Drive Space for software
- 40 Meg of Hard Drive Space for data
- RS232 Serial Port

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
- 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.

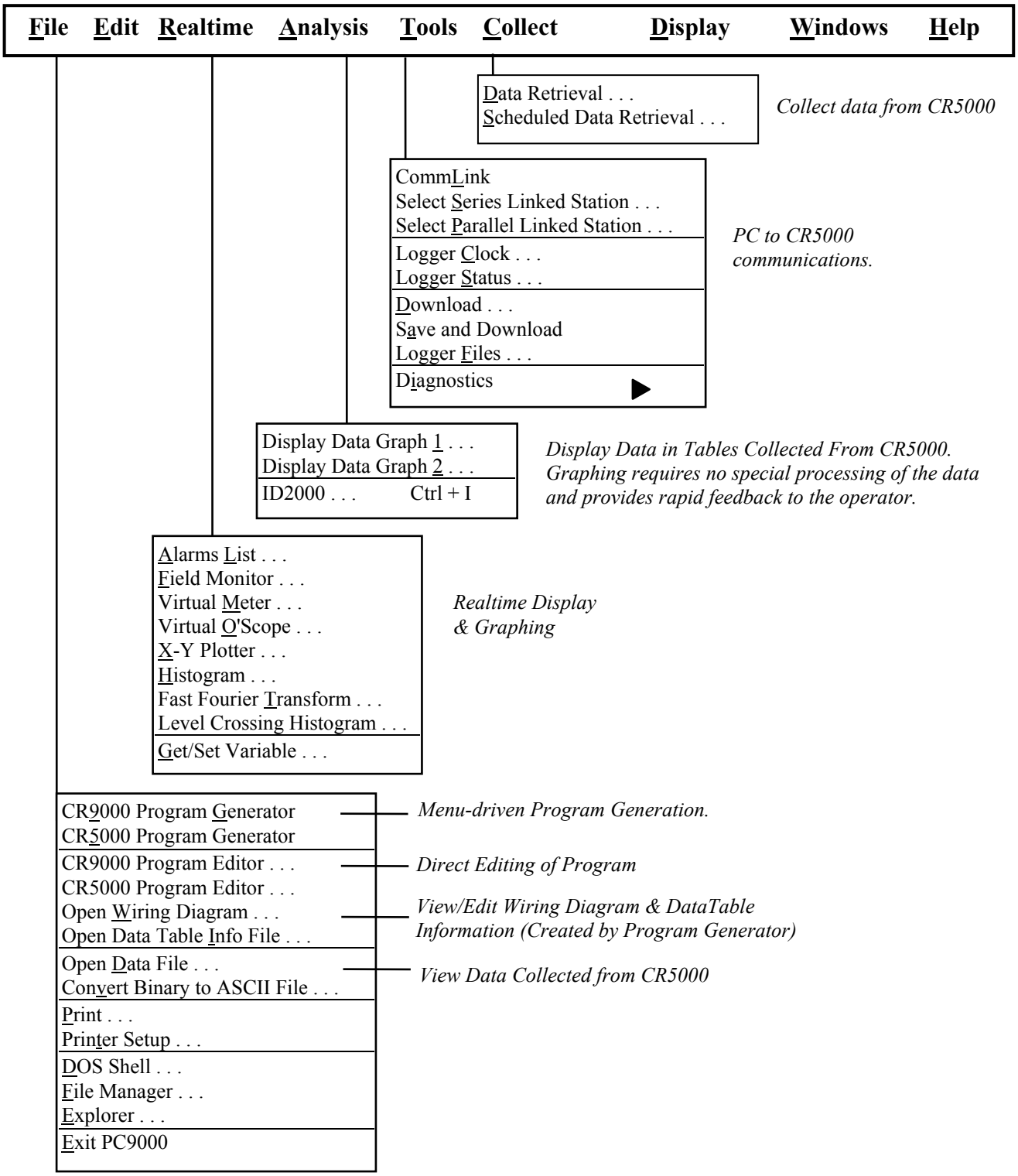
You may use the default directory of PC9000 or install the software in a different directory. The directory will be created for you.

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

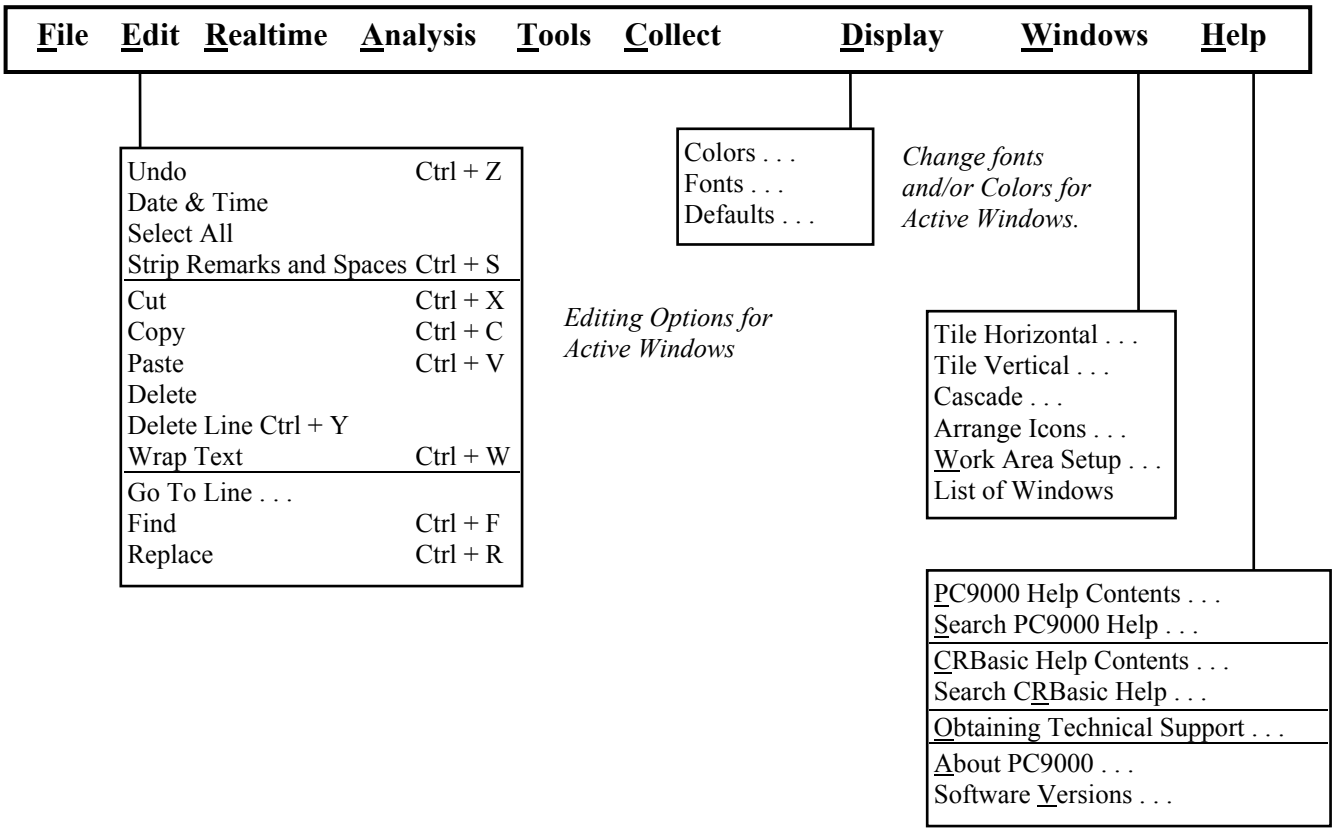
OV3.3 PC9000 Software Overview

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 CR5000 is not necessary to try out the programming and real time display options; a demo uses canned data for viewing. Without a CR5000, 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

OV3.3.1 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 CR5000 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 CR5000. Provides context-sensitive help for the CR5000's BASIC-like language.

OV3.3.2 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.

OV3.3.3 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.

OV3.3.4 Tools

Control and Communications
Supports PC to CR5000 communications: clock read/set, status read, program download, and program retrieval.

OV3.3.5 Collect

Collect data from CR5000 data tables

OV3.3.6 Display

Configure the font and color scheme in an active window.

OV3.3.7 Windows

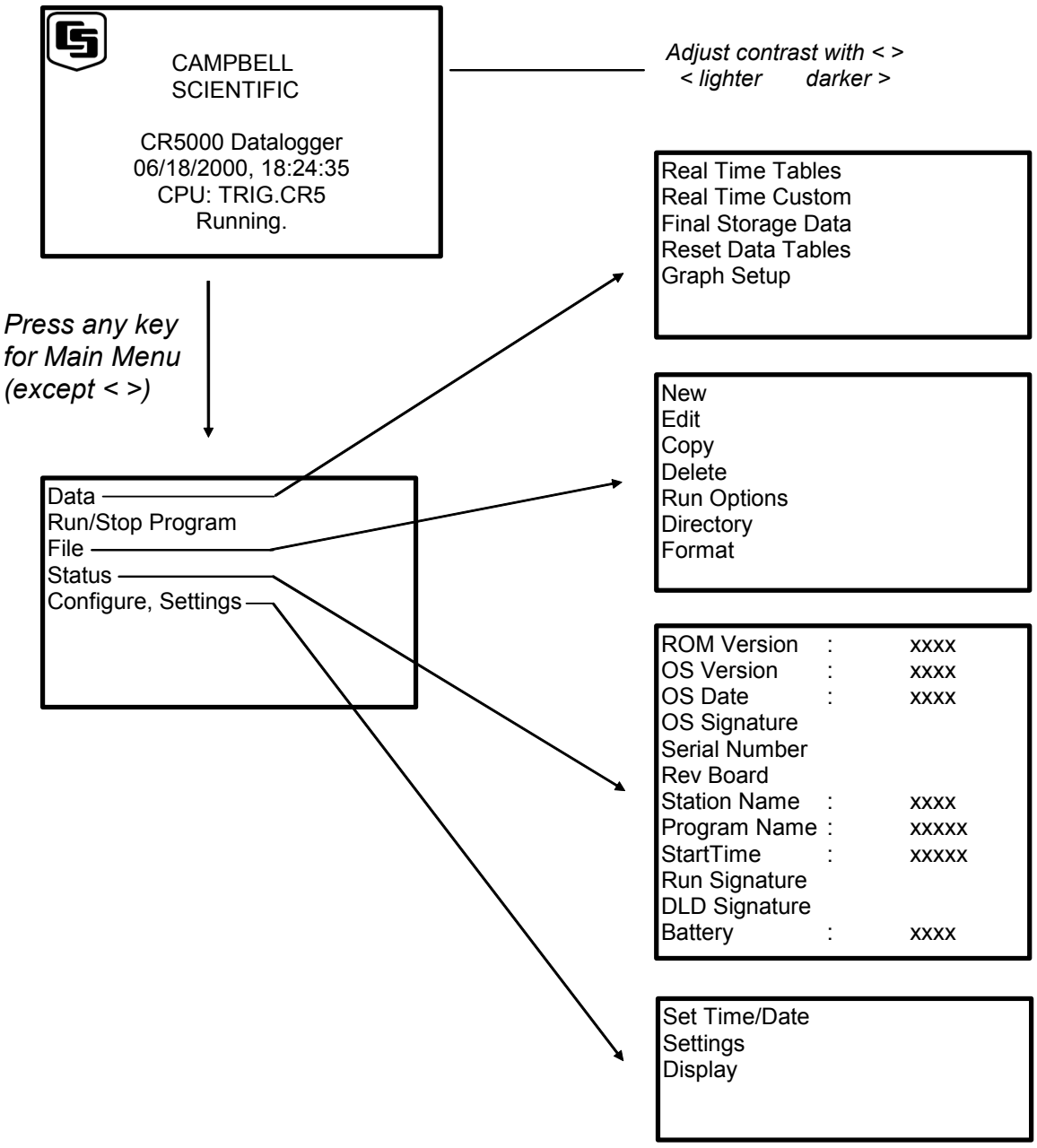
Size and arrange windows.

OV3.3.8 Help

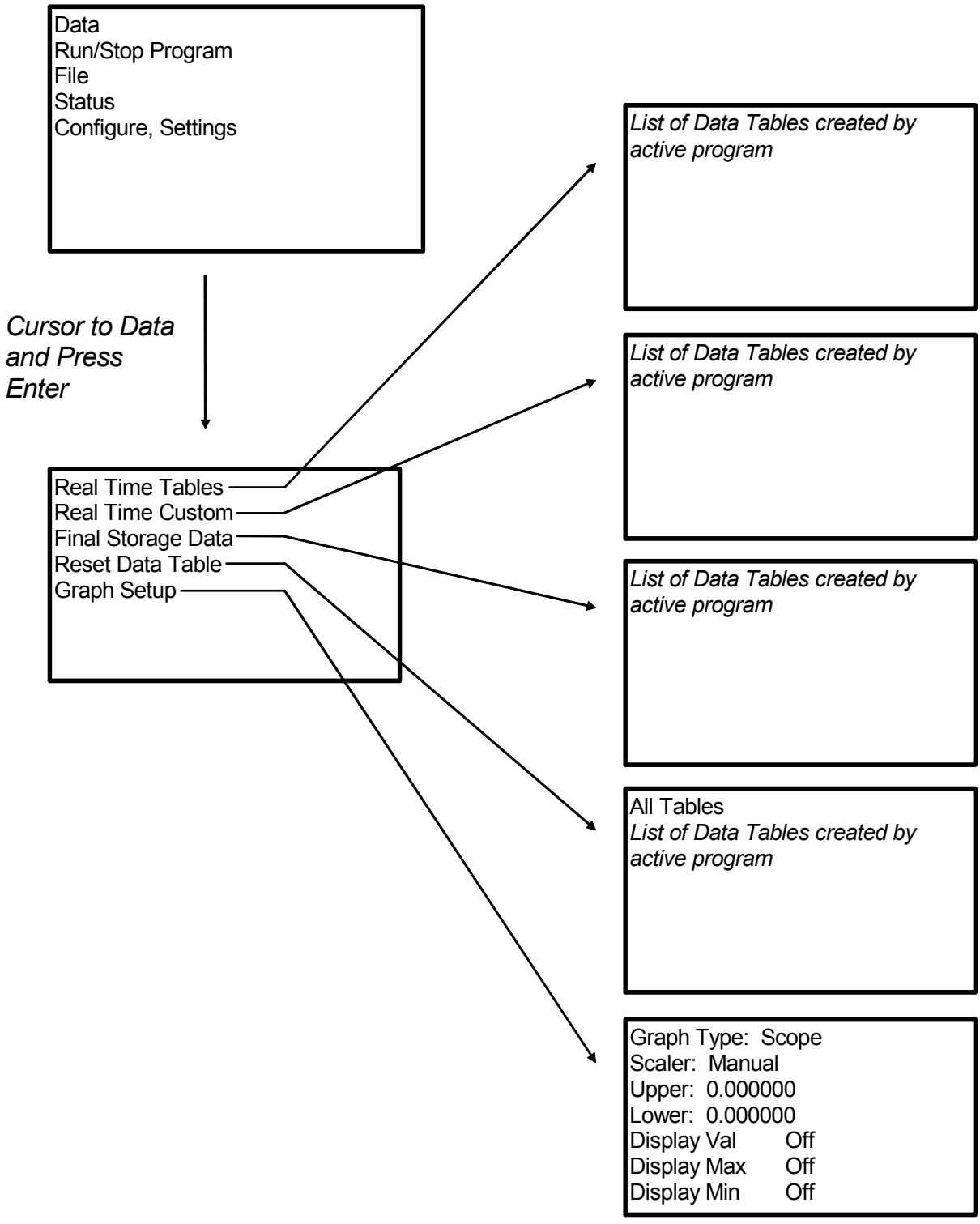
On-line help for PC9000 software.

OV4. Keyboard Display

Power Up Screen

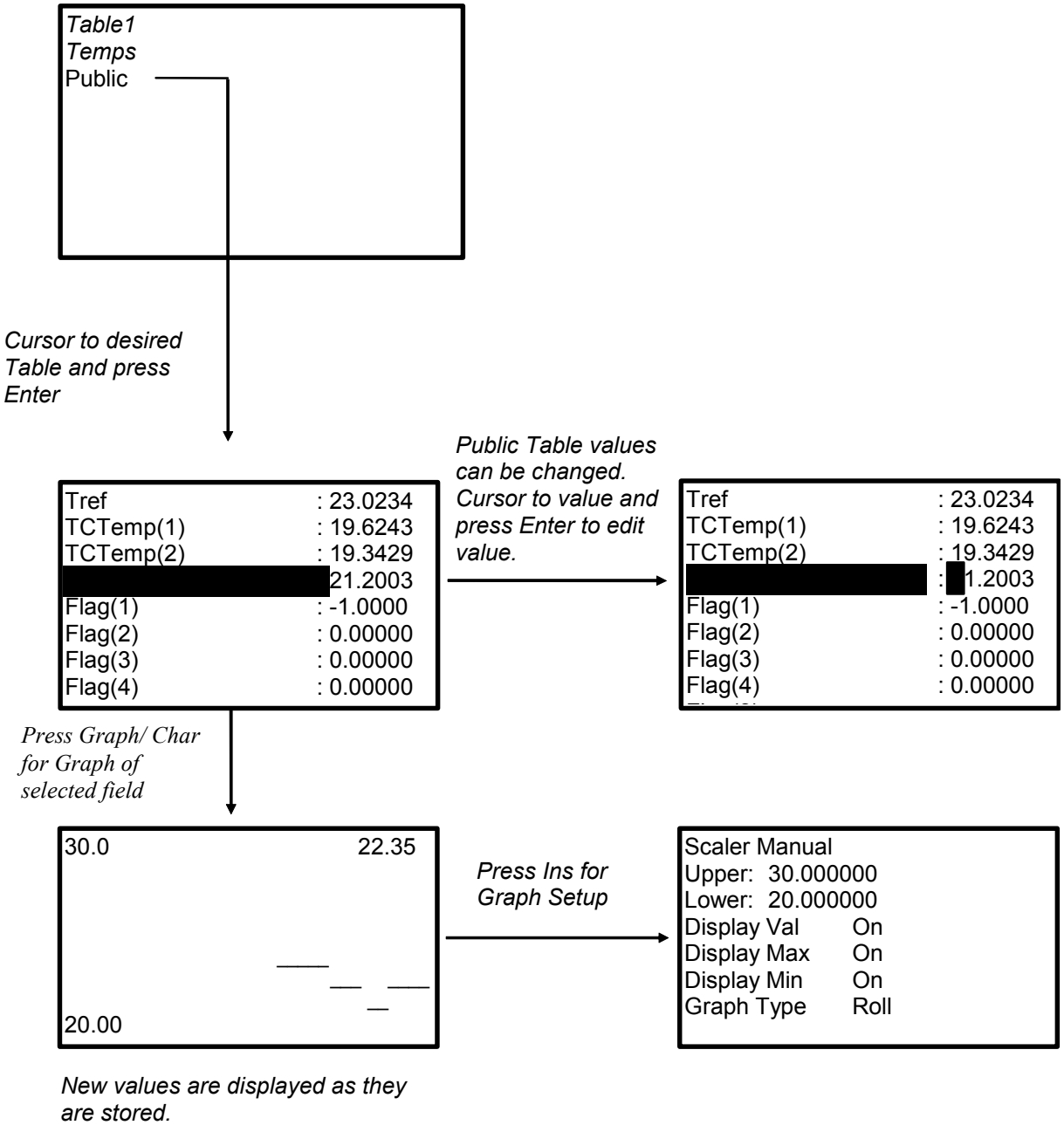


OV4.1 Data Display

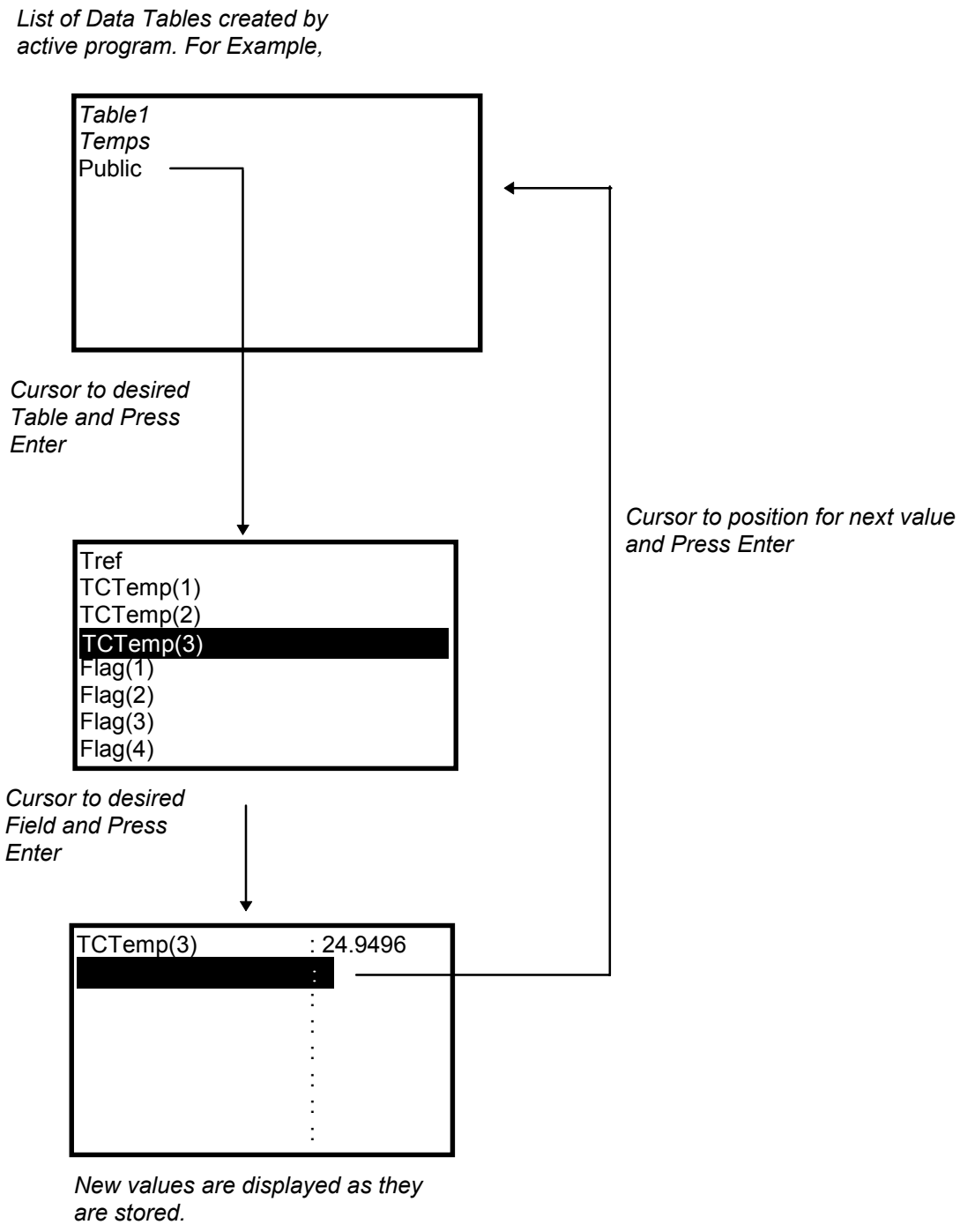


OV4.1.1 Real Time Tables

List of Data Tables created by active program. For Example,

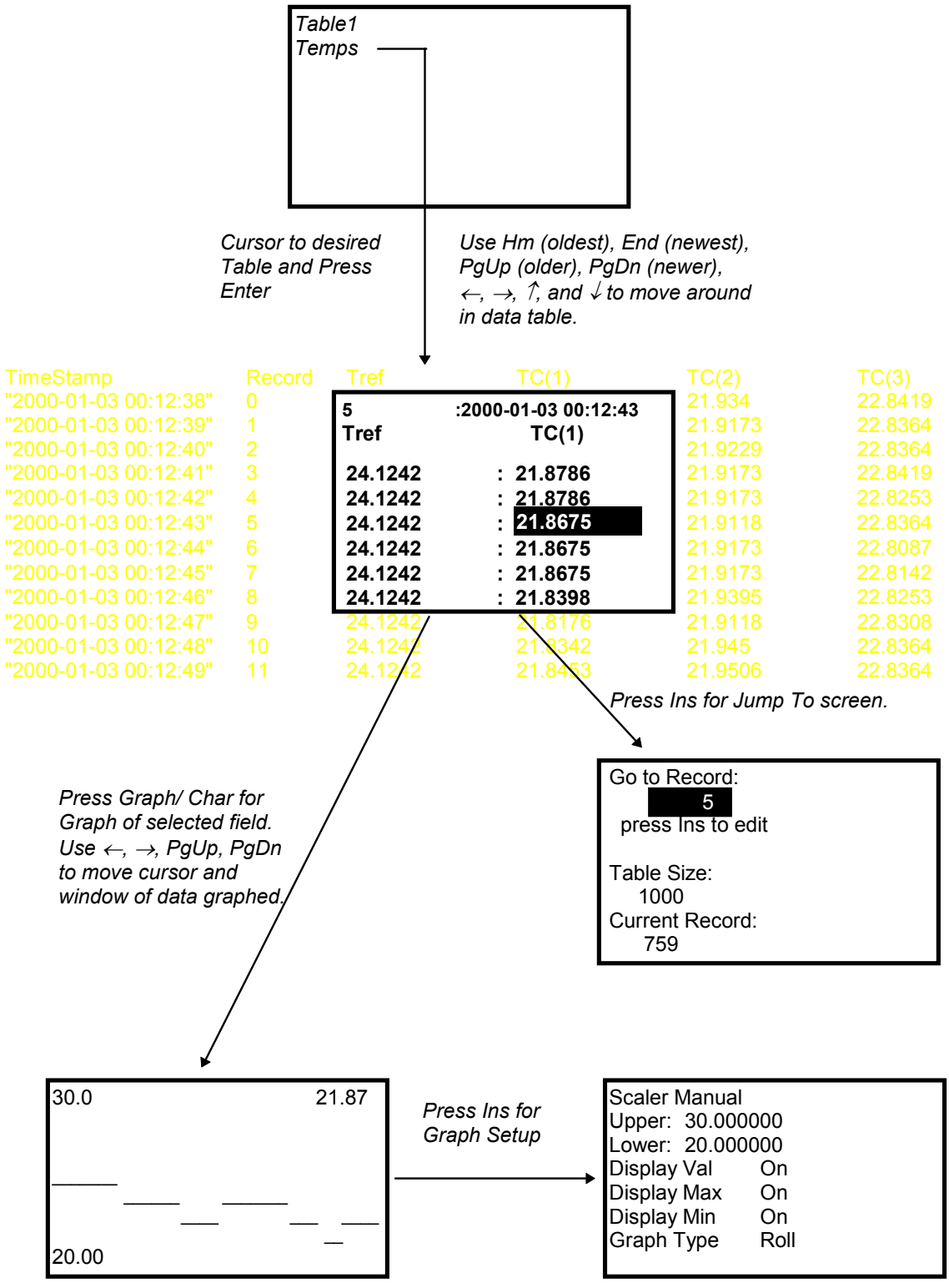


OV4.1.2 Setting up Real Time Custom Display



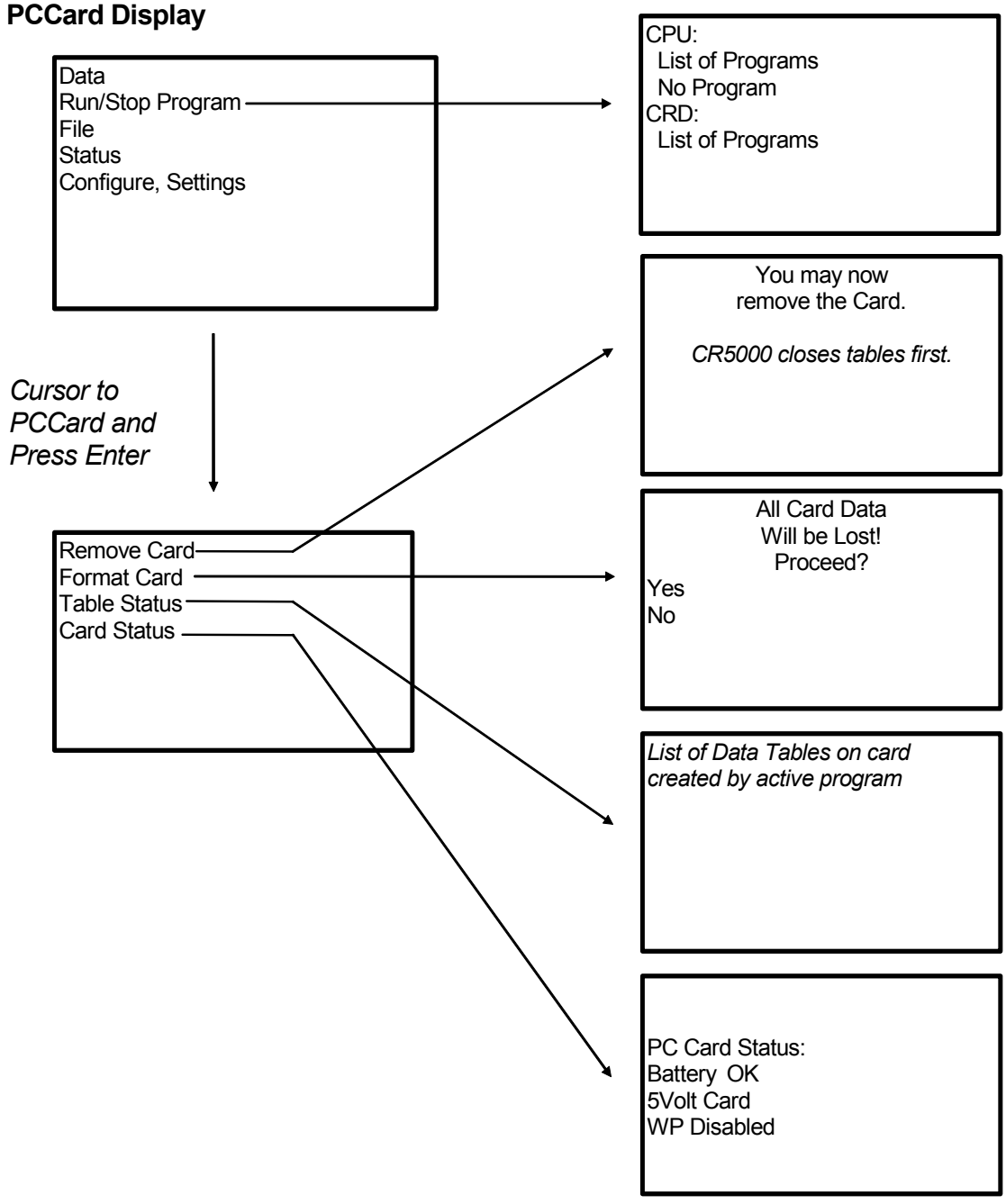
OV4.1.3 Final Storage Tables

List of Data Tables created by active program. For Example:

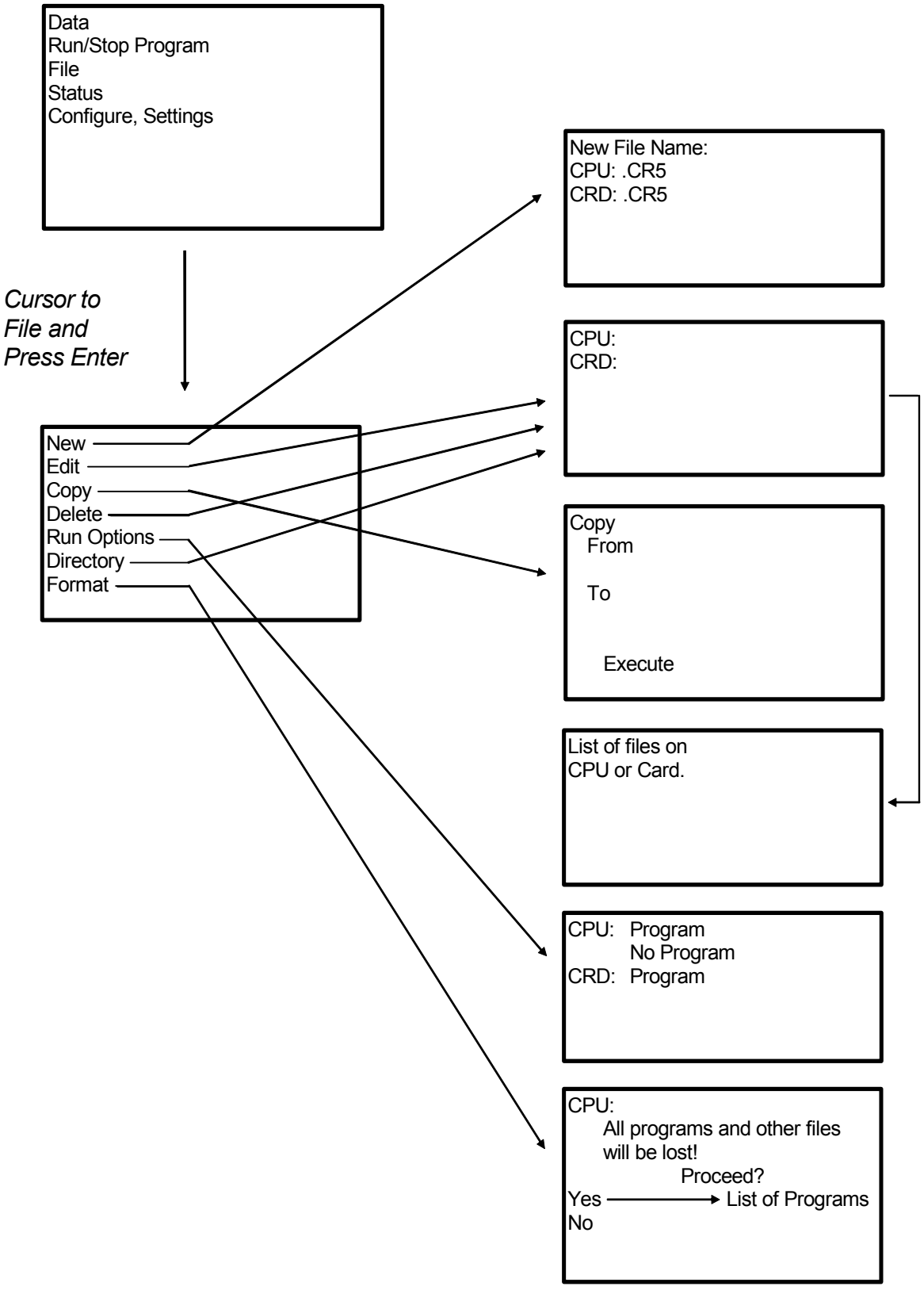


OV4.2 Run/Stop Program

PCCard Display

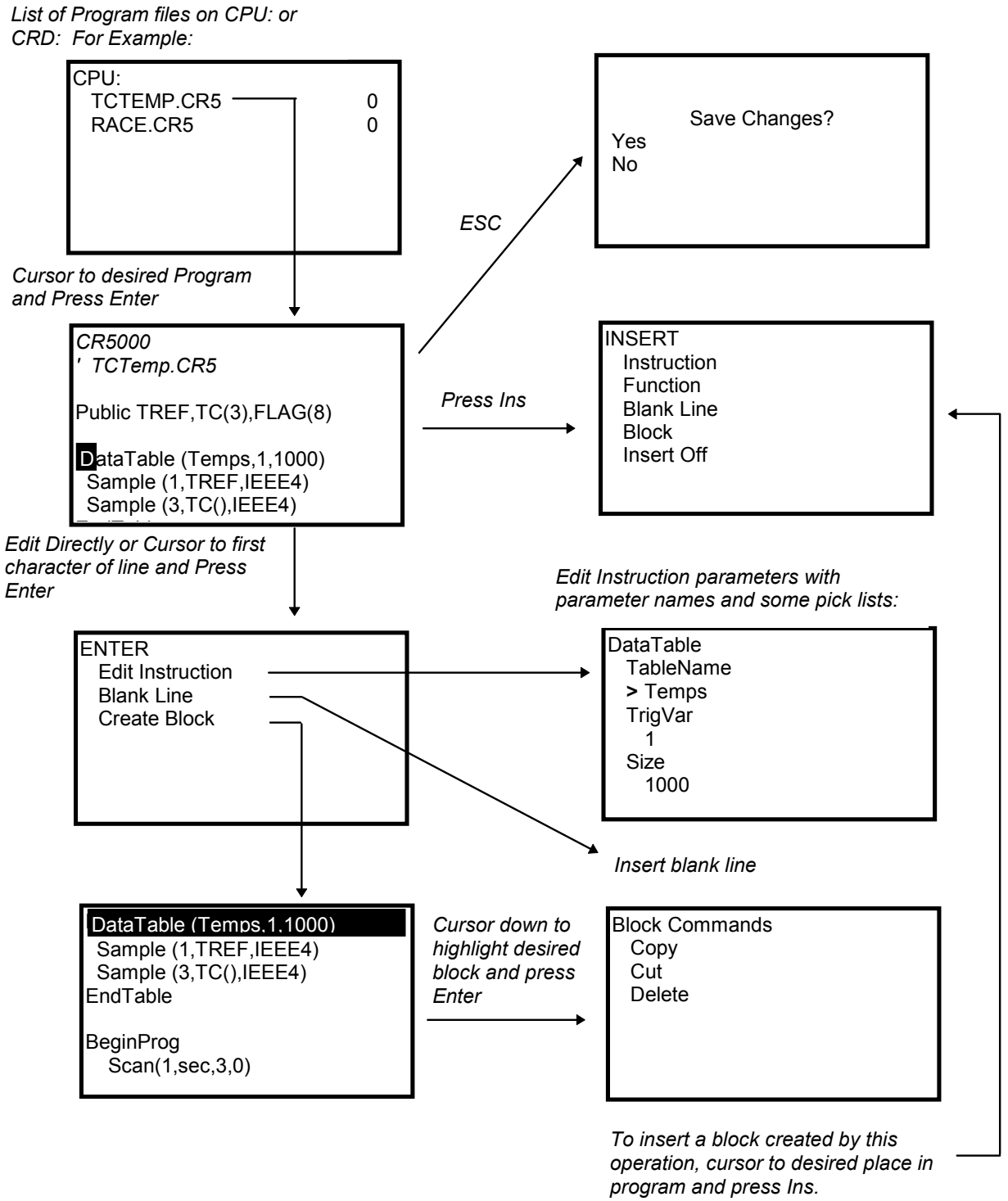


OV4.3 File Display

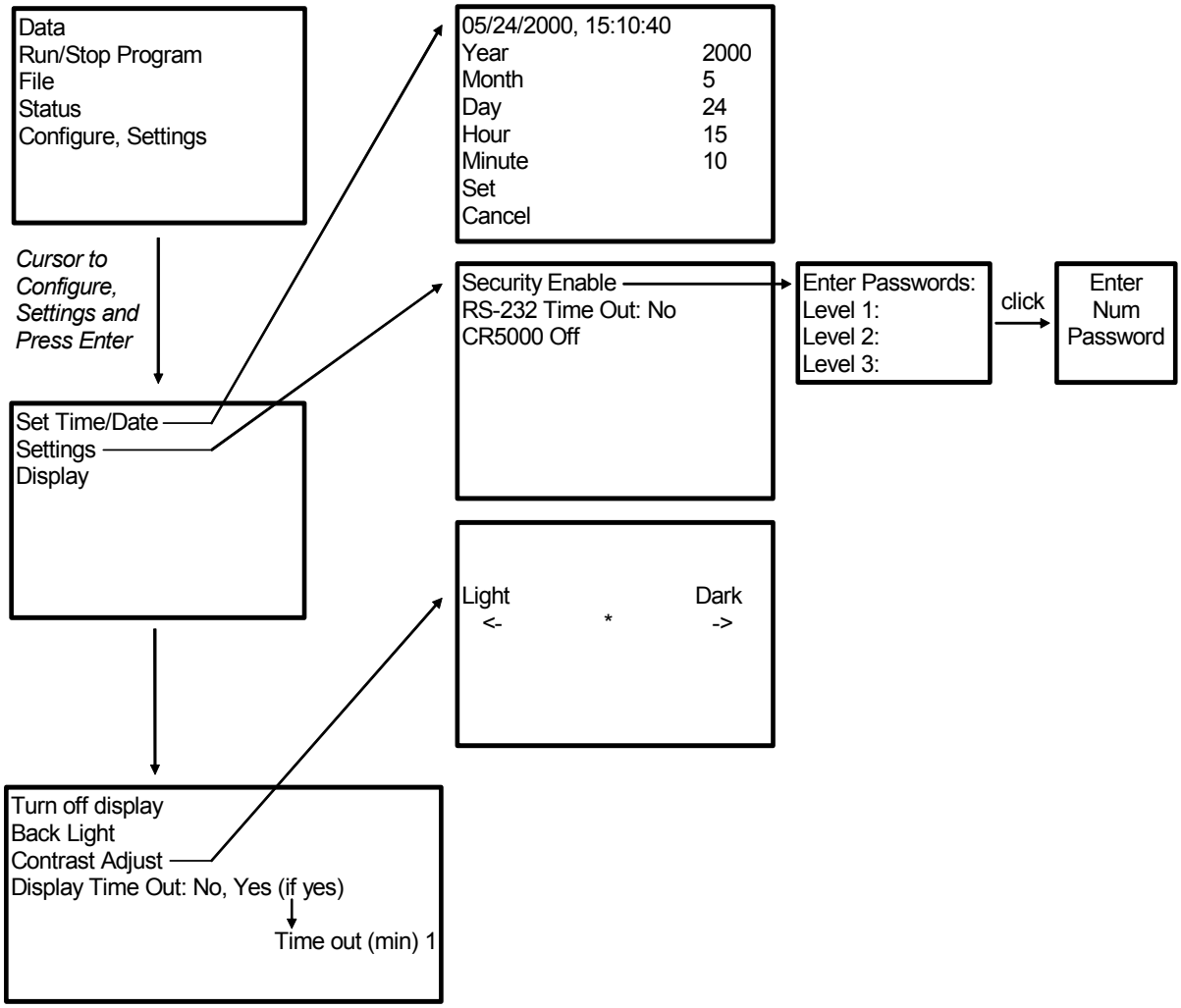


OV4.3.1 File: Edit

The Program Editor in PC9000 is recommended for writing and editing datalogger programs. Changes in the field can be made with the keyboard display.



OV4.4 Configure Display



OV5. Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; testing over -40° to +85°C available as an option, excludes batteries. Non-condensing environment required. Yearly calibrations are recommended to maintain electrical specifications.

PROGRAM EXECUTION RATE

The CR5000 can measure one channel and store the result in 500 µs; all 40 SE* channels can be measured in 8 ms (5 kHz aggregate rate).

ANALOG INPUTS

DESCRIPTION: 20 DF* or 40 SE, individually configured. Channel expansion provided through AM16/32, AM416, and AM25T Multiplexers.

RANGES, RESOLUTION, AND TYPICAL INPUT NOISE: Basic Resolution (Basic Res) is the A/D resolution of a single conversion. **Resolution of DFM* with input reversal is half the Basic Res**. Noise values are for DFM with input reversal; noise is greater with SEM.*

Input Rng (mV)	Basic Res (µV)	0 Int. (µV RMS)	250 µs Int. (µV RMS)	20/16.7 ms Int. (µV RMS)
±5000	167	70	60	30
±1000	33.3	30	12	6
±200	6.67	8	2.4	1.2
±50	1.67	3.0	0.8	0.3
±20	0.67	1.8	0.5	0.2

ACCURACY†:

±(0.05% of Reading + Offset) 0° to 40°C

±(0.075% of Reading + Offset) -25° to 50°C

±(0.10% of Reading + Offset) -40° to 85°C

Offset for DFM w/input reversal = Basic Res +1 µV

Offset for DFM w/o input reversal = 2Basic Res + 2 µV

Offset for SEM = 2Basic Res + 10 µV

MINIMUM TIME BETWEEN MEASUREMENTS:

Zero Integration:	125 µs
250 µs Integration:	475 µs
16.7 ms Integration:	19.9 ms
20 ms Integration:	23.2 ms

COMMON MODE RANGE: ±5 V

DC COMMON MODE REJECTION: >100 dB with input reversal (>80 dB without input reversal)

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

SUSTAINED INPUT VOLTAGE WITHOUT DAMAGE: ±16 Vdc

INPUT CURRENT: ±2 nA typ., ±10 nA max. @ 50°C

INPUT RESISTANCE: 20 GΩ typical

ACCURACY OF INTERNAL THERMOCOUPLE REFERENCE JUNCTION:

±0.25°C, 0° to 40°C
±0.5°C, -25° to 50°C
±0.7°C, -40° to 85°C

ANALOG OUTPUTS

DESCRIPTION: 4 switched voltage; 4 switched current; 2 continuous voltage; switched outputs active only during measurements, one at a time.

RANGE: Voltage (current) outputs programmable between ±5 V (±2.5 mA)

RESOLUTION: 1.2 mV (0.6 µA) for voltage (current) outputs

ACCURACY: ±10 mV (±10 µA) for voltage (current) outputs

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

CURRENT SINKING: 50 mA for switched voltage; 5 mA for continuous (15 mA w/selectable option)

COMPLIANCE VOLTAGE: ±5 V for switched current excitation

RESISTANCE MEASUREMENTS

Provides voltage ratio measurements of 4- and 6-wire full bridges, and 2-, 3-, 4-wire half bridges. Direct resistance measurements available with current excitation. Dual-polarity excitation is recommended.

VOLTAGE RATIO ACCURACY†: Assumes input and excitation reversal and an excitation voltage of at least 2000 mV.

±(0.04% Reading + Basic Res/4) 0° to 40°C

±(0.05% Reading + Basic Res/4) -25° to 50°C

±(0.06% Reading + Basic Res/4) -40° to 85°C

ACCURACY† WITH CURRENT EXCITATION: Assumes input and excitation reversal, and an excitation current, I_x, of at least 1 mA.

±(0.075% Reading + Basic Res/2I_x) 0° to 40°C

±(0.10% Reading + Basic Res/2I_x) -25° to 50°C

±(0.12% Reading + Basic Res/2I_x) -40° to 85°C

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 40 SE analog inputs can be used; signal attenuation and ac coupling may be required.

INPUT FREQUENCY RANGE:

Input Rng (mV)	Signal (peak to peak) Min.	Max.[1]	Min. Pulse W.	Max. Freq
±5000	600 mV	10 V	2.5 µs	200 kHz
±1000	100 mV	2.0 V	5.0 µs	100 kHz
±200	4 mV	2.0 V	25 µs	20 kHz

[1]Maximum signals must be centered around datalogger ground.

RESOLUTION: 70 ns/number of cycles measured

ACCURACY: ±(0.03% of Reading + Resolution)

PULSE COUNTERS

DESCRIPTION: Two 16-bit inputs selectable for switch closure, high frequency pulse, or low-level ac.

MAXIMUM COUNT: 4 x 10^9 counts per scan

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:
Maximum Input Frequency: 400 kHz
Maximum Input Voltage: ±20 V
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 1.2 µs time constant filter.

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

Input Hysteresis: 15 mV
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage (sine wave):

(mV RMS)	Range (Hz)
20	1.0 to 1000
200	0.5 to 10,000
1000	0.3 to 16,000

DIGITAL I/O PORTS

DESCRIPTION: 8 ports selectable as binary inputs or control outputs.

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

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.0 to 5.3 V; low -0.3 to 0.8 V

INPUT RESISTANCE: 100 kΩ

EMI and ESD PROTECTION

The CR5000 is encased in metal and incorporates EMI filtering on all inputs and outputs. Gas discharge tubes provide robust ESD protection on all terminal block inputs and outputs. The following European CE standards apply.

EMC tested and conforms to BS EN61326:1998.

Details of performance criteria applied are available upon request.

Warning: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to correct the interference at the user's own expense.

CPU AND INTERFACE

PROCESSOR: Hitachi SH7034

MEMORY: Battery-backed SRAM provides 2 Mbytes for data and operating system use with 128 kbytes reserved for program storage. Expanded data storage with PCMCIA type I, type II, or type III card.

DISPLAY: 8-line-by-21 character alphanumeric or 128 x 64 pixel graphic LCD display w/backlight.

SERIAL INTERFACES: Optically isolated RS-232 9-pin interface for computer or modem. CSI/O 9-pin interface for peripherals such as CSI modems.

BAUD RATES: Selectable from 1,200 to 115,200 bps. ASCII protocol is eight data bits, one start bit, one stop bit, no parity.

CLOCK ACCURACY: ±1 minute per month

SYSTEM POWER REQUIREMENTS

VOLTAGE: 11 to 16 Vdc

TYPICAL CURRENT DRAIN: 400 µA software power off; 1.5 mA sleep mode; 4.5 mA at 1 Hz (200 mA at 5 kHz) sample rate.

INTERNAL BATTERIES: 7 Ahr rechargeable base (optional); 1650 mAhr lithium battery for clock and SRAM backup, 10 years of service typical, less at high temperatures.

EXTERNAL BATTERIES: 11 to 16 Vdc; reverse polarity protected.

PHYSICAL SPECIFICATIONS

SIZE: 9.8" x 8.3" x 4.5" (24.7 cm x 21.0 cm x 11.4 cm) Terminal strips extend 0.4" (1.0 cm).

WEIGHT: 4.5 lbs (2.0 kg) with low-profile base; 12.2 lbs (5.5 kg) with rechargeable base

WARRANTY

Three years against defects in materials and workmanship.

*SE(M): Single-Ended (Measurement)

*DF(M): Differential (Measurement)

† Sensor and measurement noise not included.

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

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