CR23X MICROLOGGER OVERVIEW

Read the Selected Operating Details and Cautionary Notes at the front of the Manual before using the CR23X.

The CR23X Micrologger combines precision measurement with processing and control capability in a single battery operated system.

Campbell Scientific, Inc. provides three documents to aid in understanding and operating the CR23X:

1. *This Overview*
2. *The CR23X Operator's Manual*
3. *The CR23X Prompt Sheet*

This Overview introduces the concepts required to take advantage of the CR23X's capabilities. Hands-on programming examples start in Section OV4. Working with a CR23X will help the learning process, so don't just read the examples, turn on the CR23X and do them. If you want to start this minute, go ahead and try the examples, then come back and read the rest of the Overview.

- *The sections of the Operator's Manual which should be read to complete a basic understanding of the CR23X operation are the Programming Sections 1-3, the portions of the data retrieval Sections 4 and 5 appropriate to the method(s) you are using (see OV5), and Section 14 which covers installation and maintenance.*

- *Section 6 covers details of serial communications. Sections 7 and 8 contain programming examples. Sections 9-12 have detailed descriptions of the programming instructions, and Section 13 goes into detail on the CR23X measurement procedures.*

The Prompt Sheet is an abbreviated description of the programming instructions. Once familiar with the CR23X, it is possible to program it using only the Prompt Sheet and on-line prompts as a reference, consulting the manual if further detail is needed.

OV1. PHYSICAL DESCRIPTION

The CR23X Micrologger with the alkaline batteries is shown in Figure OV1-1. It is powered with 10 "D" cells and has only the power switch on the base. The rechargeable CR23X has rechargeable lead acid cells. In addition to the power switch, it has a charger input plug and an LED which lights when the charging circuit is active. Rechargeable CR23Xs should always be connected to a solar panel or AC charger. The lead acid batteries provide backup in event of a power failure but are permanently damaged if their voltage drops below 11.76 volts. Campbell Scientific does not warrant batteries.

The 16 character keyboard is used to enter programs, commands and data; these can be viewed on the 24 character x 2 line LCD display.

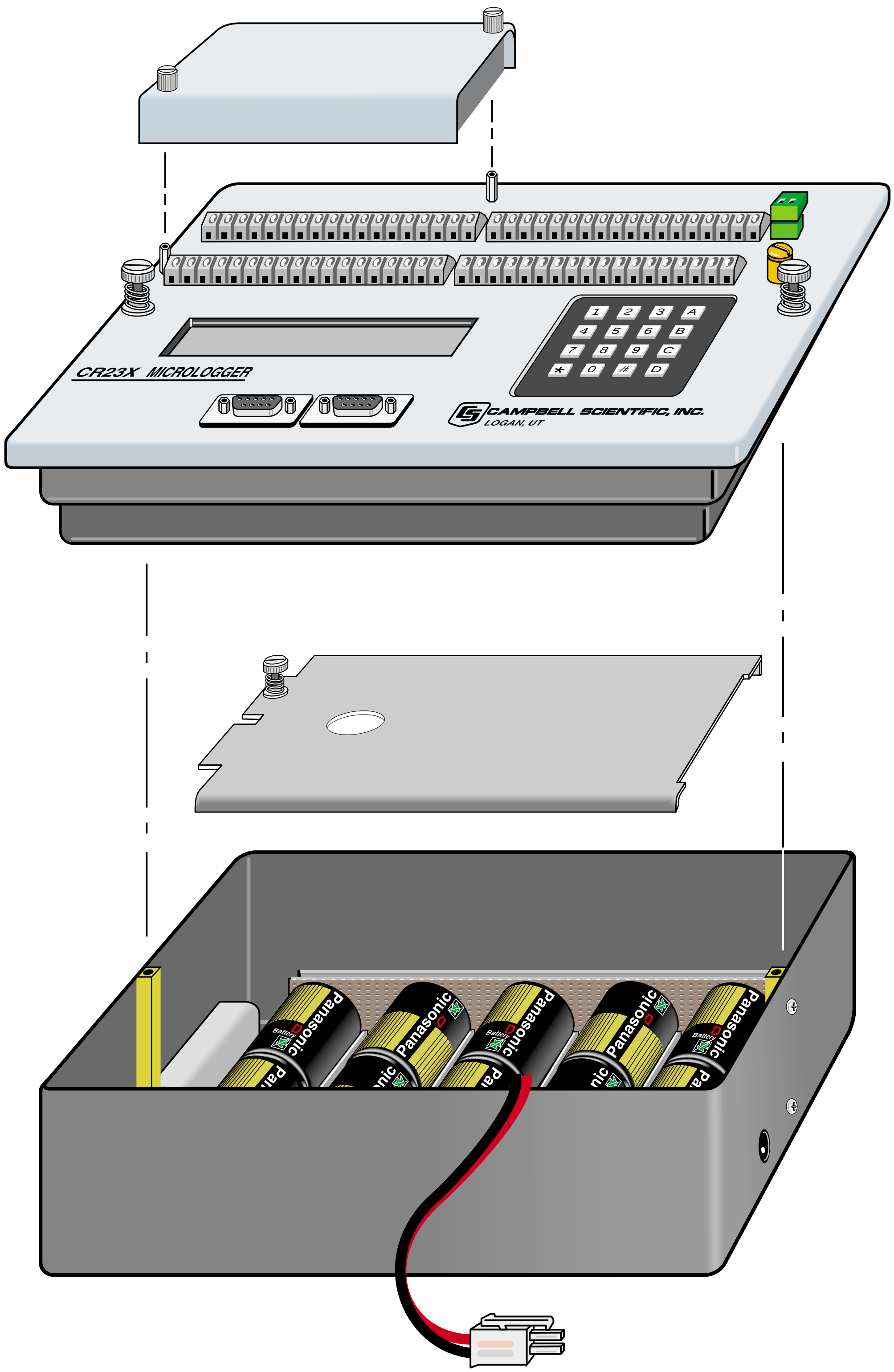


FIGURE OV1-1. CR23X Micrologger

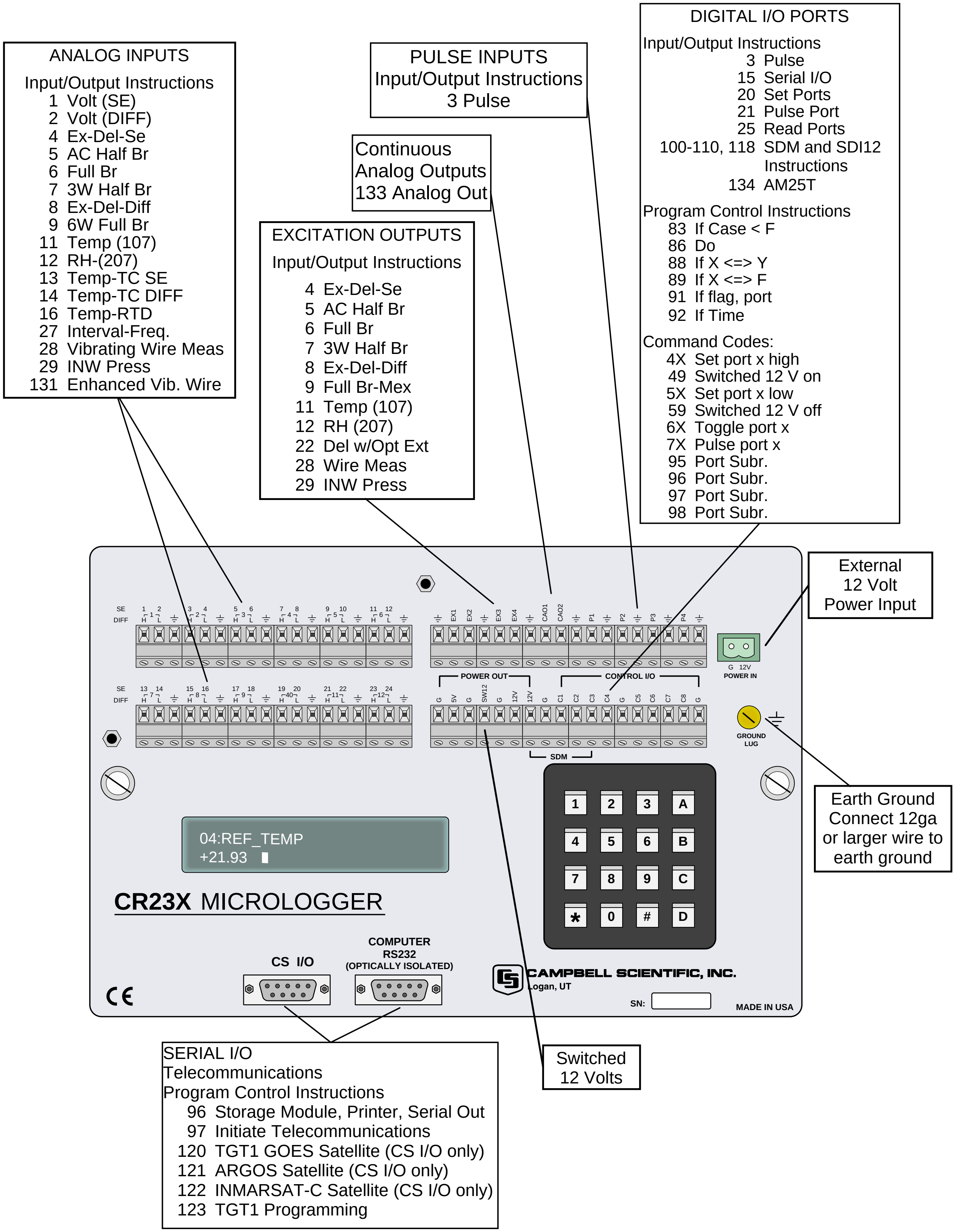


FIGURE OV1-2. CR23X Panel and Associated Programming Instructions

The 9-pin serial CS I/O port provides connection to data storage peripherals, such as the SM192/716 Storage Module, and provides serial communication to computer or modem devices for data transfer or remote programming (Section 6). *This 9 pin port does NOT have the same pin configuration as the 9 pin serial ports currently used on most personal computers*. An SC32A is required to interface the CS I/O port to a PC or other RS-232 serial port (Section 6). An optically isolated computer RS-232 port is also provided for direct connection to PCs and other RS-232 devices.

The panel contains four terminal strips which are used for sensor inputs, excitation, control input/outputs, etc. Figure OV1-2 shows the CR23X panel and the associated programming instructions.

OV1.1 WIRING TERMINALS

Wiring terminals are provided on the CR23X to allow connection of external sensors and other devices.

OV1.1.1 ANALOG INPUTS

The terminals labeled 1H to 12L are analog voltage inputs. These numbers (black) refer to the high and low inputs to the differential channels 1 through 12. In a differential measurement, the voltage on the H input is measured with respect to the voltage on the L input. When making single-ended measurements, either the H or L input may be used as an independent channel to measure voltage with respect to the CR23X analog ground (⏚). The single-ended channels are numbered sequentially starting with 1H (blue); e.g., the H and L sides of differential channel 1 are single-ended channels 1 and 2; the H and L sides of differential channel 2 are single-ended channels 3 and 4, etc.

The analog input terminal strips have an insulated cover to reduce temperature gradients across the input terminals. The cover is required for accurate thermocouple measurements (Section 13.4).

OV1.1.2 EXCITATION OUTPUTS

The terminals labeled EX1, EX2, EX3, and EX4 are precision, switched excitation outputs used to supply programmable excitation voltages for resistive bridge measurements. DC or AC excitation at voltages between -5000 mV and +5000 mV are user programmable (Section 9).

OV1.1.3 CONTINUOUS ANALOG OUTPUTS (CAO)

Two CAO channels supply continuous output voltages under program control, for use with strip charts, x-y plotters, or proportional controllers.

OV1.1.4 PULSE INPUTS

The terminals labeled P1, P2, P3, and P4 are the pulse counter inputs for the CR23X. They are programmable for high frequency pulse, low level AC, or switch closure (Section 9, Instruction 3).

OV1.1.5 DIGITAL I/O PORTS

Terminals C1 through C8 are digital Input/Output ports. On power-up they are configured as input ports, commonly used for reading the status of an external signal. High and low conditions are: 3 V < high < 5.5 V; -0.5 V < low < 0.8 V.

Configured as outputs the ports allow on/off control of external devices. A port can be set high (5 V ± 0.1 V), low (<0.1 V), toggled or pulsed (Sections 3, 8.3, and 12).

Ports C5 through C8 can be configured as pulse counters for switch closures (Section 9, Instruction 3) or used to trigger subroutine execution (Section 1.1.2).

Built in Zener diodes on the eight control ports limit input voltage to acceptable levels of < = 5.6 VDC. Do not apply voltages greater than 16 VDC. A voltage of 5.0 VDC is preferred.

OV1.1.6 GROUNDS

The CR23X has ground terminals marked ⏚ and G. Signal returns of analog inputs and their associated shields along with excitation voltage returns are to be tied to the ⏚ terminals located in the analog input terminal strips. The G terminals (Power Grounds) are intended to carry return currents from the 5 V, SW12, 12 V, and C1-C8 outputs. Tying these potentially large return currents to G terminals keeps these currents from flowing through and corrupting analog measurements. Offset voltage errors in single-ended measurements can occur for large (50 mA) currents flowing into the ⏚ terminals in the analog input terminal strips. Return currents from the CAO and pulse-counter channels should be tied to the ⏚ terminals in the CAO and pulse-counter terminal strip to prevent them from flowing through the analog measurement section.

The ground lug is also marked ⏚ and provides a rugged ground path from the individual ⏚ and G terminals to earth or chassis ground for ESD protection.

Review Section 14.7 for complete grounding recommendations.

OV1.1.8 5V OUTPUTS

The 5 V (±4.0%) output is commonly used to power peripherals such as the QD1 Incremental Encoder Interface, AVW1 or AVW4 Vibrating Wire Interface.

The 5 V output is common with pin 1 on the CS I/O 9 pin connector; 200 mA is the maximum combined output.

OV1.1.9 CS I/O

The 9 pin CS I/O port contains lines for serial communication between the CR23X and external devices such as computers, printers, Campbell modems, Storage Modules, etc. **This port does NOT have the same configuration as the 9 pin serial ports currently used on most personal computers**. It has a 5 VDC power line which is used to power peripherals such as Storage Modules. The same 5 VDC supply is used for the 5 V output on the lower right terminal strip. It has a 12 VDC power line used to power other peripherals such as the COM200 phone modem. Section 6 contains technical details on serial communication.

OV1.1.10 COMPUTER RS-232 PORT

This port is an optically isolated standard 9 pin RS-232 DCE/DTE port. It can be connected directly to the serial port of most personal computers. A 6 foot 9 to 9 pin serial cable and a 9 to 25 pin adapter are included with the CR23X to connect this port to a PC serial port.

OV1.1.11 SWITCHED 12 VOLT

The switched 12 volt output can be used to power sensors or devices requiring an unregulated 12 volts. The output is limited to 600 mA at 50°C (360 mA at 80°C) current. The switched 12 volt port is addressed as “Port 9” in a datalogger program.

When the port is set high, the 12 volts is turned on; when the port is low, the switched 12 volts is off (Section 8.12).

OV1.2 CONNECTING POWER TO THE CR23X

The CR23X should be powered by any clean, battery backed 12 VDC source. The green power connector on the wiring panel is a plug in connector that allows the power supply to be easily disconnected. The power connection is reverse polarity protected. The datalogger should be earth or chassis ground during routine operation. See Section 14 for details on power supply connections and grounding.

When primary power falls below 11.0 VDC, the CR23X stops executing its programs. The Low Voltage Counter (*B window 9) is incremented by one each time the primary power falls below 11.0 VDC and E10 is displayed. A double dash (--) in the 9th window of the *B mode indicates that the CR23X is currently in a low primary power mode. (Section 1.6)

The datalogger program and stored data remain in memory, and the clock continues to keep time when power is disconnected. The clock and SRAM are powered by an internal lithium battery. (Section 14.11.2)

OV2. MEMORY AND PROGRAMMING CONCEPTS

OV2.1 INTERNAL MEMORY

The standard CR23X has 512 Kilobytes of Flash Electrically Erasable Programmable Read Only Memory (EEPROM), 128 Kilobytes Static Random Access Memory (SRAM), and 1 Megabyte of Flash RAM. As an option, the CR23X can be purchased with 4 Megabyte Flash for final storage. Operating system EEPROM stores the operating system, user programs, and labels. SRAM is used for final storage data and running the user program. Final Storage Flash is used for data storage. The use of the Input, Intermediate, and Final Storage in the measurement and data processing sequence is shown in Figure OV2.1-2. The five areas of SRAM are:

1. **System Memory** - used for overhead tasks such as compiling programs, transferring

data, etc. The user cannot access this memory.

2. **Active Program Memory** - available for user entered programs.

3. **Input Storage** - Input Storage holds the results of measurements or calculations. The * 6 Mode is used to view Input Storage locations for checking current sensor readings or calculated values. Input Storage defaults to 64 locations. Additional locations can be assigned using the * A Mode.

4. **Intermediate Storage** - Certain Processing Instructions and most of the Output Processing Instructions maintain intermediate results in Intermediate Storage. Intermediate storage is automatically accessed by the instructions and cannot be accessed by the user. The default allocation is 64 locations. The number of locations can be changed using the * A Mode.

5. **Final Storage** - Final processed values are stored here for transfer to printer, solid state Storage Module or for retrieval via telecommunication links. Values are stored in Final Storage only by the Output Processing Instructions and only when the Output Flag is set in the user's program. Approximately 570,000 locations are allocated to Final Storage from SRAM on power up. This number is reduced if Input or Intermediate Storage is increased.

   While the total size of these three areas remains constant, memory may be reallocated between the areas to accommodate different measurement and processing needs (* A Mode, Section 1.5).

6. **Alphanumeric Labels** - The CR23X can be programmed through EDLOG (PC208W software) to assign alphanumeric labels to Input Storage and Final Storage locations. Labels must consist of letters, numbers, or the underscore (_), and must not begin with a number.

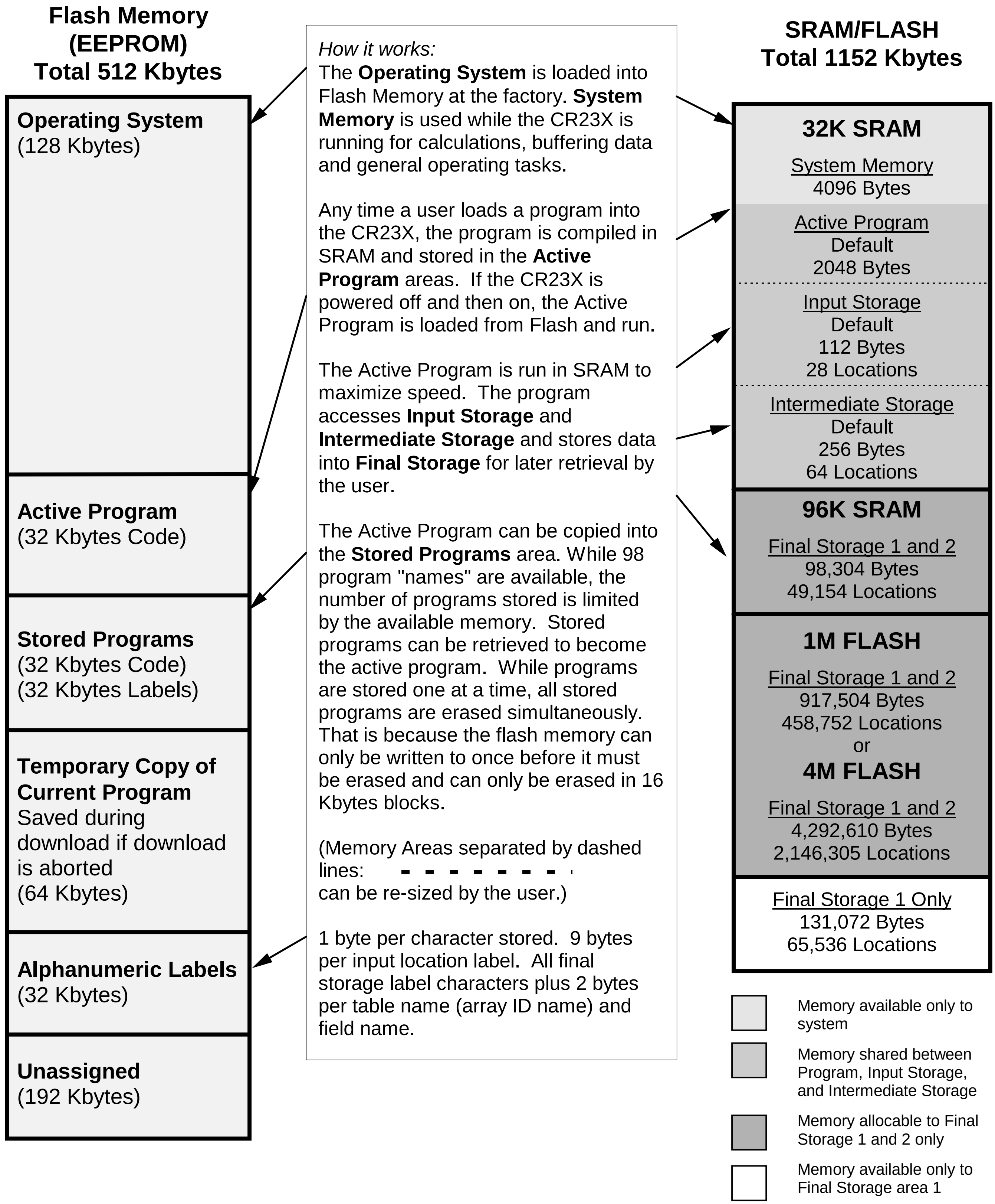


FIGURE OV2.1-1. CR23X Memory

OV2.2 PROGRAM TABLES, EXECUTION INTERVAL AND OUTPUT INTERVALS

The CR23X must be programmed before it will make any measurements. A program consists of a group of instructions entered into a **program table**. The program table is given an **execution interval** which determines how frequently that table is executed. When the table is executed, the instructions are executed in sequence from beginning to end. After executing the table, the CR23X waits the remainder of the execution interval and then executes the table again starting at the beginning.

The interval at which the table is executed generally determines the interval at which the sensors are measured. The interval at which data are stored is separate from how often the table is executed, and may range from samples every execution interval to processed summaries output hourly, daily, or on longer or irregular intervals.

Programs are entered in Tables 1 and 2. Subroutines, called from Tables 1 and 2, are entered in Subroutine Table 3. The size of program memory can be fixed or automatically allocated by the CR23X (Section 1.5).

Table 1 and Table 2 have independent execution intervals, entered in units of seconds with an allowable range of 1/100 to 6553.5 seconds. Subroutine Table 3 has no execution interval, since it is called from Table 1, Table 2, or an interrupt subroutine.

OV2.2.1 THE EXECUTION INTERVAL

The execution interval specifies how often the program in the table is executed, which is usually determined by how often the sensors are to be measured. *Unless two different measurement rates are needed, use only one table*. A program table is executed sequentially starting with the first instruction in the table and proceeding to the end of the table.

Table 1.	Table 2.	Table 3.
Table 1. Execute every x sec. $0.01 \le x \le 6553.5$	Table 2. Execute every y sec. $0.01 \le y \le 6553.5$	Table 3. Subroutines
Instructions are executed sequentially in the order they are entered in the table. One complete pass through the table is made each execution interval unless program control instructions are used to loop or branch execution.	*Table 2 is used if there is a need to measure and process data on a separate interval from that in Table 1.*	*A subroutine is executed only when called from Table 1 or 2.*
Normal Order: MEASURE PROCESS CHECK OUTPUT COND. OUTPUT PROCESSING		Subroutine Label Instructions End
		Subroutine Label Instructions End
		Subroutine Label Instructions End

FIGURE OV2.2-1. Program and Subroutine Tables

Each instruction in the table requires a finite time to execute. If the execution interval is less than the time required to process the table, an execution interval overrun (table overrun) occurs; the CR23X finishes processing the table and waits for the next execution interval before initiating the table. When a table overrun occurs, $^{T}{}_{o}$ appears in the lower right corner of the display in the Running Table mode ([*] [0]). Overruns and table priority are discussed in Section 1.1.

OV2.2.2. THE OUTPUT INTERVAL

The interval at which output occurs must be an integer multiple of the execution interval (e.g., a table cannot have a 10 minute execution interval and output every 15 minutes).

A single program table can have many different output intervals and conditions, each with a unique data set (Output Array). Program Control Instructions are used to set the Output Flag. The Output Processing Instructions which follow the instruction setting the Output Flag determine the data output and its sequence. Each additional Output Array is created by another Program Control Instruction checking a output condition, followed by Output Processing Instructions defining the data set to output.

OV2.3 CR23X INSTRUCTION TYPES

Figure OV2.3-1 illustrates the use of three different instruction types which act on data. The fourth type, Program Control, is used to control output times and vary program execution. Instructions are identified by numbers.

1. **INPUT/OUTPUT INSTRUCTIONS** (1-29, 100-110, 113-118, 130-134; Section 9) control the terminal strip inputs and outputs (Figure OV1.1-2), storing the results in Input Storage (destination). Multiplier and offset parameters allow conversion of linear signals into engineering units. The Digital I/O Ports and CAO analog output ports are also addressed with I/O Instructions.

2. **PROCESSING INSTRUCTIONS** (30-68, Section 10) perform numerical operations on values located in Input Storage and store the results back in Input Storage. These instructions can be used to develop high level algorithms to process measurements prior to Output Processing.

3. **OUTPUT PROCESSING INSTRUCTIONS** (69-82, Section 11) are the only instructions which store data in Final Storage. Input Storage values are processed over time to obtain averages, maxima, minima, etc. There are two types of processing done by Output Instructions: **Intermediate** and **Final**.

   Intermediate processing normally takes place each time the instruction is executed. For example, when the Average Instruction is executed, it adds the values from the input locations being averaged to running totals in Intermediate Storage. It also keeps track of the number of samples.

   Final processing occurs only when the Output Flag is high (Section 3.7.1). The Output Processing Instructions check the Output Flag. If the flag is high, final values are calculated and output. With the Average, the totals are divided by the number of samples and the resulting averages sent to Final Storage. Intermediate locations are zeroed and the process starts over. *The Output Flag, Flag 0, is set high by a Program Control Instruction which must precede the Output Processing Instructions in the user entered program.*

4. **PROGRAM CONTROL INSTRUCTIONS** (83-98, 111, 120-123, 220; Section 12) are used for logic decisions, conditional statements, and to send data to peripherals. They can set flags and ports, compare values or times, execute loops, call subroutines, conditionally execute portions of the program, etc.

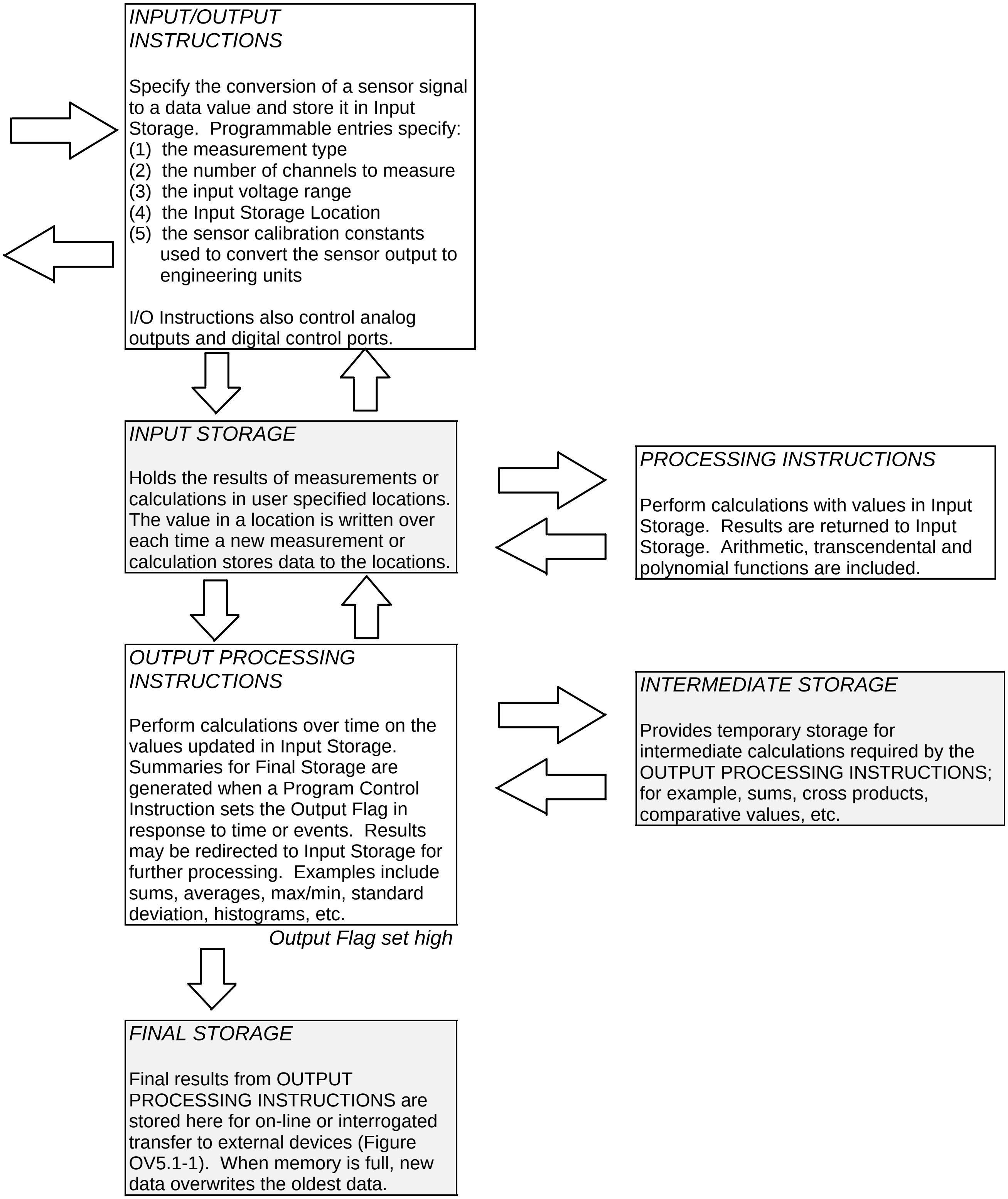


FIGURE OV2.3-1. Instruction Types and Storage Areas

OV3. COMMUNICATING WITH CR23X

The user can communicate with the CR23X through either the integral keyboard and two line LCD display, or through a telecommunications link with a terminal or computer. The preferred method for routine operation is through a telecommunications link with a personal computer running Campbell Scientific's PC208 or PC208W Datalogger Support Software. These packages contain a program editor (EDLOG), datalogger communications, automated telecommunications data retrieval, a data reduction program (SPLIT), and programs to retrieve data from Campbell Scientific Storage Modules.

Some situations, however, require an alternate communications method. The integral keyboard is convenient for cursory on-site inspection of datalogger functions. It can also be used when becoming familiar with the dataloggers functional modes as outlined in Sections OV3.1 through OV5 and Section 1.

A third communications alternative is through a dumb terminal or a computer terminal emulator program through a telecommunications link. Several arcane commands are used in this mode as outlined in Section 5. The most useful command to most CR23X users is the **7H** command, which places the CR23X in the Remote Keyboard Mode. This mode uses the same commands as when communicating on-site through the integral keyboard and display. A common way to use this mode is to enter it through the terminal emulator program in PC208 or PC208W. Once the telecommunications link is established, CR-LF (carriage return - line feed) is issued from the PC by hitting the <Enter> key several times while in the terminal emulator. The CR23X will respond by sending an asterisk (*) to the PC screen. At the *, 7H followed by a CR-LF is issued. The CR23X will respond with a greater-than symbol (>). From the >, the functional modes can be entered as outlined in Section 1.

OV3.1 CR23X KEYPAD/DISPLAY

On power-up, the "HELLO" message is displayed while the CR23X checks memory. The total size of memory is then displayed (1664 K bytes of memory).

Using the keypad, work through the direct programming examples in this overview in addition to using EDLOG and you will have the basics of CR23X operation as well as an appreciation for the help provided by the software and the CR23X on-line help.

The display will turn off automatically if not continuously updated. The display will stay on if continuously updated such as occurs in the * 5 and * 6 modes. Otherwise, it will turn off automatically to save 4 mA of power. Time to display shut off is 3 minutes if left in the * 0 mode, or 6 minutes if left in other modes not continuously updating the screen. While in the * 0 mode, the screen can be manually turned off by pressing the #. Press any other key to turn it back on.

OV3.1.1 FUNCTIONAL MODES

CR23X/User interaction is broken into different functional MODES (e.g., programming the measurements and output, setting time, manually initiating a block data transfer to Storage Module, etc.). The modes are referred to as Star (*) Modes since they are accessed by first keying *, then the mode number or letter. Table OV3.1-1 lists the CR23X Modes.

Because the display uses approximately 4 mA when active, it is automatically turned off if not updated for three minutes, except in the * 6 mode, where it is left on indefinitely. The display can be turned off from the keypad in the * 0 mode by pressing #. Pressing any key except the # key will cause the display to be turned back on after it has been turned off.

TABLE OV3.1-1. * Mode Summary

Key	Mode
* 0	Compile program, log data and indicate active Tables
* 1	Program Table 1
* 2	Program Table 2
* 3	Program Table 3, subroutines only
* 4	Parameter Entry Table
* 5	Display/set real time clock
* 6	Display/alter Input Storage data, toggle flags or control ports.
* 7	Display Final Storage data
* 8	Final Storage data transfer to peripheral
* 9	Storage Module commands
* A	Memory allocation/reset
* B	Signature/status
* C	Security
* D	Save/load program, set display contrast, power up settings, ID, etc.
* #	Used with TGT1 satellite transmitter

OV3.1.2 KEY DEFINITION

Keys and key sequences have specific functions when using the keypad or a computer/terminal in the remote keyboard state (Section 5). Table OV3.1-2 lists these functions. In some cases, the exact action of a key depends on the mode the CR23X is in and is described with the mode in the manual.

TABLE OV3.1-2 Key Description/Editing Functions

Keys A, B, C, and D repeat when continuously pressed. Repetitions occur slowly at first and then speed up.

Key	Action
Any key	Turn on display (except #)
0 - 9	Key numeric entries into display
*	Enter Mode (followed by Mode Number)
A	Enter/Advance
B	Back up
C	Change the sign of a number or index a parameter
D	Show Help when "?" is on display Enter the decimal point
#	Turns off display in * 0 Shows output table name in * 7 Clear the rightmost digit keyed into the display
# A	Advance to next instruction in program table (* 1, * 2, * 3) or to next Output Array in Final Storage (* 7)
# B	Back up to previous instruction in program table or to previous Output Array in Final Storage
# D	Delete entire instruction
# 0	(then A or CR) Back up to the start of the current array.

When using a computer/terminal to communicate with the CR23X (Telecommunications remote keyboard state) there are some keys available in addition to those found on the keypad. Table OV3.1-3 lists these keys.

TABLE OV3.1-3. Additional Keys Allowed in Telecommunications

Key	Action
-	Change Sign, Index (same as C)
CR	Enter/advance (same as A)
S or ^S	Stops transmission of data (10 second time-out; any character restarts)
C or ^C	Aborts transmission of Data

OV3.2 USING COMPUTER WITH DATALOGGER SUPPORT SOFTWARE

Direct datalogger communication programs in the datalogger support software (PC208W) provide menu selection of tools to perform the datalogger functions (e.g., set clock, send program, monitor measurements, and collect data). The user also has the option of directly entering keyboard commands via a built-in terminal emulator (Section OV3.3).

When using the support software, the computer's baud rate, port, and modem types are specified and stored in a file for future use.

The simplest and most common interface is to connect the optically isolated 9 pin "Computer RS-232" port to a 9 pin PC RS-232 port. An adapter is supplied with the CR23X for connection to a 25 pin PC RS-232 port. Otherwise, an SC32A can be used on the CS I/O port. The SC32A converts and optically isolates the voltages passing between the CR23X and the external terminal device.

The SC12 Two Peripheral cable which comes with the SC32A is used to connect the CS I/O port of the CR23X to the 9 pin port of the SC32A labeled "Datalogger". Connect the "Terminal/Printer" port of the SC32A to the serial port of the computer with a straight 25 pin cable or, if the computer has a 9 pin serial port, a standard 9 to 25 pin adapter cable.

OV3.3 ASCII TERMINAL OR COMPUTER WITH TERMINAL EMULATOR

Devices which can be used to communicate with the CR23X include standard ASCII terminals and computers programmed to function as a terminal emulator. See Section 6.7 for details.

To communicate with any device, the CR23X enters its Telecommunications Mode and responds only to valid telecommunications commands. Within the Telecommunications Mode, there are 2 "states"; the Telecommunications Command state and the Remote Keyboard state. Communication is established in the Telecommunications command state. One of the commands is to enter the Remote Keyboard state (Section 5).

The Remote Keyboard state allows the keyboard of the computer/terminal to act like the CR23X keypad. Various datalogger modes may be entered, including the mode in which programs may be keyed in to the CR23X from the computer/terminal.

OV4. PROGRAMMING THE CR23X

A datalogger program is created on a computer using EDLOG. A program can also be entered directly into the datalogger using the keypad. Section OV4.3 describes options for loading the program into the CR23X.

OV4.1 PROGRAMMING SEQUENCE

In routine applications, the CR23X measures sensor output signals, processes the measurements over some time interval and stores the processed results. A generalized programming sequence is:

1. Enter the execution interval. In most cases, the execution interval is determined by the desired sensor scan rate.
2. Enter the Input/Output instructions required to measure the sensors.
3. If processing in addition to that provided by the Output Processing Instructions (step 5) is required, enter the appropriate Processing Instructions.
4. Enter the Program Control Instruction to test the output condition and set the Output Flag when the condition is met. For example, use

   Instruction 92 to output based on time.

   Instruction 86 to output every execution interval.

   Instruction 88 or 89 to output based on a comparison of values in input locations.

   This instruction must precede the Output Processing Instructions which store data in Final Storage. Instructions are described in Sections 9 through 12.
5. Enter the Output Processing Instructions to store processed data in Final Storage. The order in which data are stored is determined by the order of the Output Processing Instructions in the table.
6. Repeat steps 4 and 5 for additional outputs on different intervals or conditions.

NOTE: The program must be executed for output to occur. Therefore, the interval at which the Output Flag is set must be evenly divisible by the execution interval. For example, with a 2 minute execution interval and a 5 minute output interval, the output flag will only be set on the even multiples of the 5 minute intervals, not on the odd. Data will be output every 10 minutes instead of every 5 minutes.

Execution intervals and output intervals set with Instruction 92 are synchronized with real time starting at midnight.

OV4.2 INSTRUCTION FORMAT

Instructions are identified by an instruction number. Each instruction has a number of parameters that give the CR23X the information it needs to execute the instruction.

The CR23X Prompt Sheet has the instruction numbers in red, with the parameters briefly listed in columns following the description. Some parameters are footnoted with further description under the "Instruction Option Codes" heading. The CR23X also has on-line help available when a “?” appears on the display. Help is accessed by pressing [D].

For example, Instruction 73 stores the maximum value that occurred in an Input Storage location over the output interval.

```
P73  Maximum
     1:    Reps
     2:    TimeOption
     3:    Loc
```

The instruction has three parameters (1) REPetitionS, the number of sequential Input Storage locations on which to find maxima, (2) TIME, an option of storing the time of occurrence with the maximum value, and (3) LOC, the first Input Storage location operated on by the Maximum Instruction. The codes for the TIME parameter are listed in the "Instruction Option Codes".

The repetitions parameter specifies how many times an instruction's function is to be repeated. For example, four 107 thermistor probes may be measured with a single Instruction 11, Temp-107, with four repetitions. Parameter 2 specifies the input channel of the first thermistor (the probes must be connected to sequential channels). Parameter 4 specifies the Input Storage location in which to store measurements from the first thermistor. If location 5 were used and the first probe was on channel 1, the temperature of the thermistor on channel 1 would be stored in input location 5, the temperature from channel 2 in input location 6, etc.

Detailed descriptions of the instructions are given in Sections 9-12. Entering an instruction into a program table is described in OV5.

OV4.3 ENTERING A PROGRAM

Programs are entered into the CR23X in one of three ways:

1. Keyed in using the CR23X keypad.
2. Loaded from a pre-recorded listing using the * D Mode. There are 2 types of storage/input:
   a. Stored on disk/sent from computer.
   b. Stored/loaded from Storage Module.
3. Loaded from internal Flash Memory or Storage Module upon power-up.

A program is created by keying it directly into the datalogger as described in Section OV5, or on a PC using PC208W.

Program files (.DLD) can be downloaded directly to the CR23X using PC208W. Communication via direct wire, telephone, cellular phone, or Radio Frequency (RF) is supported.

Programs on disk can be copied to a Storage Module with the appropriate software. Using the * D Mode to save or load a program from a Storage Module is described in Section 1.8.

Once a program is loaded in the CR23X, the program will be stored in flash memory and will automatically be loaded and run when the datalogger is powered-up.

The program on power up function can also be achieved by using a Storage Module. Up to 8 programs can be stored in the Storage Module, the programs may be assigned any of the numbers 1-8. If the Storage Module is connected when the CR23X is powered-up the CR23X will automatically load program number 8, provided that a program 8 is loaded in the Storage Module (Section 1.8). The program from the Storage Module will replace the active program in flash memory.

OV5. PROGRAMMING EXAMPLES

The following examples stress direct interaction with the CR23X using the keypad. At the beginning of each example is an EDLOG listing of the program. You can also participate in the example by entering the program in EDLOG and sending it to the CR23X and viewing measurements with PC208W. (See the PC208W manual for guidance.) You can also work through the examples with the 16 key keypad. You will learn the basics of CR23X operation as well as an appreciation for the help provided by the software.

We will start with a simple programming example. There is a brief explanation of each step to help you follow the logic. When the example uses an instruction, press D on parameters marked with "?" for parameter descriptions. Alternatively, find the instruction on the Prompt Sheet and follow through the description of the parameters. Using the Prompt Sheet or on-line help while going through these examples will help you become familiar with their respective formats. Sections 9-12 have more detailed descriptions of the instructions.

Turn on the CR23X. The programming steps in the following examples use the keystrokes possible on the keypad. With a terminal, some responses will be slightly different.

When the CR23X is powered up, the display will show:

Display	Explanation
HELLO	On power-up, the CR23X displays "HELLO" while it checks the memory

after a few seconds delay

1664 Kbytes memory	The size of the machine's total memory

When the CR23X is turned on, it tests the FLASH memory and loads the current program to RAM. After the program compiles successfully, the CR23X begins executing the program. If a key is pressed while the CR23X is testing memory (“HELLO” is on the display), there will be a 128 second delay before compiling and running the program. This can be used to edit or change the program before it starts running.

In order to ensure that there is no active program in the CR23X, load an empty program using the [*] [D] Mode:

Key	Display Will Show: (ID:Data)	Explanation
[*]	Mode	Enter mode
[D]	13:Enter Command 00	Enter [*] [D] Mode
[7]	13: 00 7	7 is command to load program from flash
[A]	07:Program ID 00	Execute command 7, CR23X is ready for program number
[0]	07:Program ID 00 00	Load Program 0 (empty program)
[A]		Execute program load, after a short wait, the display will show
	Prog. operation complete	Indicating that the command is complete.

OV5.1 SAMPLE PROGRAM 1

EDLOG Listing Program 1:

```
*Table 1 Program
01:          5.0        Execution Interval (seconds)

1: Panel Temperature (P17)
  1:         1          Loc [ CR23XTemp ]

2: Do (P86)
  1:        10          Set Output Flag High

3: Sample (P70)
  1:         1          Reps
  2:         1          Loc [ CR23XTemp ]
```

In this example the CR23X is programmed to read its panel temperature (using a built in thermistor) every 5 seconds and to send the results to Final Storage.

Key	Display Will Show: (ID:Data)	Explanation
[*]	Mode	Enter mode.
[1]	Mode 01 Go To 0000	Enter Program Table 1.
[A]	Scan Interval +0000	Advance to execution interval (In seconds)
[5]	Scan Interval +0.0000 5	Key in an execution interval of 5 seconds.
[A]	01:P00	Enter the 5 second execution interval and advance to the first program instruction location.
[1] [7]	01:P00 17	Key in Instruction 17 which directs the CR23X to measure the panel temperature in degrees C. This is an Input/Output Instruction.
[A]	Panel Temp 01:Loc 0000	Enter Instruction 17 and advance to the first parameter.
[1]	01:Loc 0000 1	The input location to store the measurement, location 1.

A	02:P00	Enter the location # and advance to the second program instruction.

The CR23X is now programmed to read the panel temperature every 5 seconds and place the reading in Input Storage Location 1. The program can be compiled and the temperature displayed (note that it is not yet storing data).

Key	Display Will Show: (ID:Data)	Explanation
* 0	Running Table 1	Exit Table 1, enter * 0 Mode, compile table and begin logging.
* 6	Mode 06 Enter Loc 0001	Enter * 6 Mode (to view Input Storage).
A	0001: 21.234	Advance to first storage location. Panel temp. is 21.234°C (display shows actual temperature so exact value will vary).

Wait a few seconds:

	01:21.423	The CR23X has read the sensor and stored the result again. The internal temp is now 21.423 °C. The value is updated every 5 seconds when the table is executed. At this point the CR23X is measuring the temperature every 5 seconds and sending the value to Input Storage. No data are being saved. The next step is to have the CR23X send each reading to Final Storage. (Remember, the Output Flag must be set first.)
* 1	Mode 01 Go To	Exit * 6 Mode. Enter 0000 program table 1.
2 A	02:P00	Advance to 2nd instruction location (this is where we left off).
8 6	02:P00 86	This is the DO instruction (a Program Control Instruction).
A	Do 01:CMD 00	Enter 86 and advance to the first parameter (which will specify the command to execute).
1 0	01:CMD 00 10	This command sets the Output Flag (Flag 0) high.
A	03:P00	Enter 10 and advance to third program instruction.
7 0	03:P00 70	The SAMPLE instruction. It directs the CR23X to take a reading from an Input Storage location and send it to Final Storage (an Output Processing Instruction).
A	Sample 01:Reps 0000	Enter 70 and advance to the first parameter (repetitions).
1	01:Reps 0000	There is only one input location to sample; repetitions = 1.
A	02:Loc 0000	Enter 1 and advance to second parameter (Input Storage location to sample).
1	02:Loc 0000 1	Input Storage Location 1, where the temperature is stored.
A	04:P00	Enter 1 and advance to fourth program instruction.
*	Mode	Exit Table 1.
0	Running Table 1	Enter * 0 Mode, compile program, log data.

The CR23X is now programmed to measure the internal temperature every 5 seconds and send each reading to Final Storage. Values in Final Storage can be viewed using the * 7 *Mode.*

Key	Display Will Show: (ID:Data)	Explanation
* 7	Mode 07	Enter * 7 Mode. The Loc 13 Data Storage Pointer (DSP) is at Location 13 (in this example).
A	Array ID 01: +0102	Advance to the first value, the Output Array ID. 102 indicates the Output Flag was set by the second instruction in Program Table 1.
A	02: +21.231	Advance to the first stored temperature.
A	Array ID 01: +0102	Advance to the next output array. Same Output Array ID.
A	02: +21.42	Advance to 2nd stored temp, 21.42 deg. C.

There are no date and time tags on the data. They must be put there with Output Instruction 77. Instruction 77 is used in the next example.

If a terminal is used to communicate with the CR23X, Telecommunications Commands (Section 5) can be used to view entire Output Arrays (in this case the ID and temperature) at the same time.

OV5.2 SAMPLE PROGRAM 2

EDLOG Listing Program 2:

```
*Table 1 Program
  01:     60.0        Execution Interval (seconds)

1: Panel Temperature (P17)
  1:        1         Loc [ CR23XTemp ]

2: Thermocouple Temp (DIFF) (P14)
  1:        1         Reps
  2:       21         ± 10 mV 60 Hz Rejection
  3:        5         DIFF Channel
  4:        1         Type T (Copper-Constantan)
  5:        1         Ref Temp Loc [ CR23XTemp ]
  6:        2         Loc [ TCTemp    ]
  7:      1.0         Mult
  8:      0.0         Offset

3: If time is (P92)
  1:        0         Minutes (Seconds --) into a
  2:       60         Interval (same units as above)
  3:       10         Set Output Flag High

4: Real Time (P77)
  1:      110         Day,Hour/Minute

5: Average (P71)
  1:        2         Reps
  2:        1         Loc [ CR23XTemp ]

6: If time is (P92)
  1:        0         Minutes (Seconds --) into a
  2:     1440         Interval (same units as above)
  3:       10         Set Output Flag High

7: Real Time (P77)
  1:      110         Day,Hour/Minute

8: Maximum (P73)
  1:        1         Reps
  2:       10         Value with Hr-Min
  3:        2         Loc [ TCTemp    ]

9: Minimum (P74)
  1:        1         Reps
  2:       10         Value with Hr-Min
  3:        2         Loc [ TCTemp    ]

10:     Serial Out (P96)
  1:       71         SM192/SM716/CSM1
```

This second example is more representative of a real data collection application. Once again, the panel temperature is measured, but it is used as a reference temperature for the differential voltage measurement of a type T (copper-constantan) thermocouple; the CR23X is initially supplied with a short type T thermocouple connected to differential channel 5.

When using a type T thermocouple, the copper lead (blue) is connected to the high input of the differential channel, and the constantan lead (red) is connected to the low input.

A thermocouple produces a voltage that is proportional to the difference in temperature between the measurement and the reference junctions.

To make a thermocouple (TC) temperature measurement, the temperature of the reference junction (in this example, the panel temperature) must be measured. The CR23X takes the reference temperature, converts it to the equivalent TC voltage relative to 0ºC, adds the measured TC voltage, and converts the sum to temperature through a polynomial fit to the TC output curve (Section 13.4).

Instruction 14 directs the CR23X to make a differential TC temperature measurement. The first parameter in Instruction 14 is the number of times to repeat the measurement. Enter 1, because in this example there is only one thermocouple. If there were more than 1 TC, they could be wired to sequential channels, and the number of thermocouples entered for repetitions. The CR23X would automatically advance through the channels sequentially and measure all of the thermocouples.

Parameter 2 is the voltage range to use when making the measurement. The output of a type T thermocouple is approximately 40 microvolts per degree C difference in temperature between the two junctions. The ±10 mV scale will provide a range of +1000/40 = +250ºC (i.e., this scale will not overrange as long as the measuring junction is within 250ºC of the panel temperature). The resolution of the ±10 mV range is 0.33 µV or 0.008ºC because a differential measurement is being made.

Parameter 3 is the analog input channel on which to make the first, and in this case only, measurement.

Parameter 4 is the code for the type of thermocouple used. This information is located on the Prompt Sheet, in the on-line help, or in the description of Instruction 14 in Section 9. The code for a type T (copper-constantan) thermocouple is 1.

Parameter 5 is the Input Storage location in which the reference temperature is stored. Parameter 6 is the Input Storage location in which to store the measurement (or the first measurement; e.g., if there are 5 repetitions and the first measurement is stored in location 3, the final measurement will be stored in location 7). Parameters 7 and 8 are the multiplier and offset. A multiplier of 1 and an offset of 0 outputs the reading in degrees C. A multiplier of 1.8 and an offset of 32 converts the reading to degrees F.

In this example, the sensor is measured once a minute, and the day, time, and average temperature are output every hour. Once a day the day, time, maximum and minimum temperatures and the times they occur will be output.

Final Storage data will be sent to Storage Module. Remember, all on-line data output to a peripheral device is accomplished with Instruction 96 (Sections 4.1 and 12).

The first example described program entry one keystroke at a time. This example does not show the "A" key. Remember, "A" is used to enter and/or advance (i.e., between each line in the example below). This format is similar to the format used in EDLOG.

It's a good idea to have both the manual and the Prompt Sheet handy when going through this example. Also look at the on-line help, key [D], whenever “?” is displayed on the screen. You can find the program instructions and parameters on the Prompt Sheet and can read their complete definitions in the manual.

To obtain daily output, the If Time instruction is again used to set the Output Flag and is followed by the Output Instructions to store time and the daily maximum and minimum temperatures and the time each occurs.

Any Program Control Instruction which is used to set the Output Flag high will set it low if the conditions are not met for setting it high. Instruction 92 above sets the Output Flag high every hour. The Output Instructions which follow do not output every hour because they are preceded by another Instruction 92 which sets the Output Flag high at midnight (and sets it low at any other time). This is a unique feature of Flag 0. The Output Flag is automatically set low at the start of each table (Section 3.7).

OV5.3 EDITING AN EXISTING PROGRAM

When editing an existing program in the CR23X, entering a new instruction inserts the instruction; entering a new parameter replaces the previous value.

To insert an instruction, enter the program table and advance to the position where the instruction is to be inserted (i.e., PXX in the display) key in the instruction number, and then key A. The new instruction will be inserted at that point in the table, advance through and enter the parameters. The instruction that was at that point and all instructions following it will be pushed down to follow the inserted instruction.

An instruction is deleted by advancing to the instruction number (P in display) and keying #D (Table 4.2-1).

To change the value entered for a parameter, advance to the parameter and key in the correct value then press A. Note that the new value is not entered until A is keyed.

SAMPLE PROGRAM 2

Instruction (Loc:Entry)	Parameter (Par#:Entry)	Description
* 1		Enter Program Table 1
01:60		60 second (1 minute) execution interval
Key # D until is displayed	01:P00	Erase previous Program before continuing.
01:P17		Measure panel temperature
	01:1	Store temp in Location 1
02:P14 (differential)		Measure thermocouple temperature
	01:1	1 repetition
	02:21	Range code (10 mV, 60 Hz Rejection)
	03:5	Input channel of TC
	04:1	TC type: copper-constantan
	05:1	Reference temp is stored in Location 1
	06:2	Store TC temp in Location 2
	07:1	Multiplier of 1
	08:0	No offset
03:P92		If Time instruction
	01:0	0 minutes into the interval
	02:60	60 minute interval
	03:10	Set Output Flag 0

The CR23X is programmed to measure the thermocouple temperature every sixty seconds. The If Time instruction sets the Output Flag at the beginning of every hour. Next, the Output Instructions for time and average are added.

Instruction # (Loc.:Entry)	Parameter (Par.#:Entry)	Description
04:P77		Output Time instruction
	01:110	Store Julian day, hour, and minute
05:P71		Average instruction
	01:1	one repetition
	02:2	Location 2 - source of TC temps. to be averaged
06:P92		If Time instruction
	01:0	0 minutes into the interval
	02:1440	1440 minute interval (24 hrs.)
	03:10	Set Output Flag 0
07: P77		Output Time instruction
	01:100	Store Day of Year
08: P73		Maximize instruction
	01:1	One repetition
	02:10	Output time of daily maximum in hours and minutes

	03:2	Data source is Input Storage Location 2.
09: P74		Minimize instruction
	01:1	One repetition
	02:10	Output the time of the daily minimum in hours and minutes
	03:2	Data source is Input Storage Location 2.

The program to make the measurements and to send the desired data to Final Storage has been entered. At this point, Instruction 96 is entered to enable data transfer from Final Storage to Storage Module.

10:P96		Activate Serial Data Output.
	1:71	Output Final Storage data to Storage Module.

The program is complete. (Here the example reverts back to the key by key format.)

Key	Display	Explanation
* 5	00:21:32	Enter * 5 Mode. Clock running but perhaps not set correctly.
A	05:0000	Advance to location for year.
1 9 9 6	05:1996	Key in year (1996).
A	05:0000	Enter and advance to location for Julian day.
1 9 7	05:197	Key in Julian day.
A	05:0021	Enter and advance to location for hours and minutes (24 hr. time).
1 3 2 4	05:1324	Key in hrs.:min. (1:24 PM in this example).
A	:13:24:01	Clock set and running.
* 0	Running Table 1	Exit * 5, compile Table 1, commence logging data.

OV6. DATA RETRIEVAL OPTIONS

There are several options for data storage and retrieval. These options are covered in detail in Sections 2, 4, and 5. Figure OV6.1-1 summarizes the various possible methods.

Regardless of the method used, there are three general approaches to retrieving data from a datalogger.

1) On-line output of Final Storage data to a peripheral storage device. On a regular schedule, that storage device is either "milked" of its data or is brought back to the office/lab where the data is transferred to the computer. In the latter case, a "fresh" storage device is usually left in the field when the full one is taken so that data collection can continue uninterrupted.

2) Bring a storage device to the datalogger and milk all the data that has accumulated in Final Storage since the last visit.

3) Retrieve the data over some form of telecommunications link, whether it be RF, telephone, cellular phone, short haul modem, or satellite. This can be performed under program control or by regularly scheduled polling of the dataloggers. Campbell Scientific's Datalogger Support Software automates this process.

Regardless of which method is used, the retrieval of data from the datalogger does NOT erase those data from Final Storage. The data remain in the ring memory until:

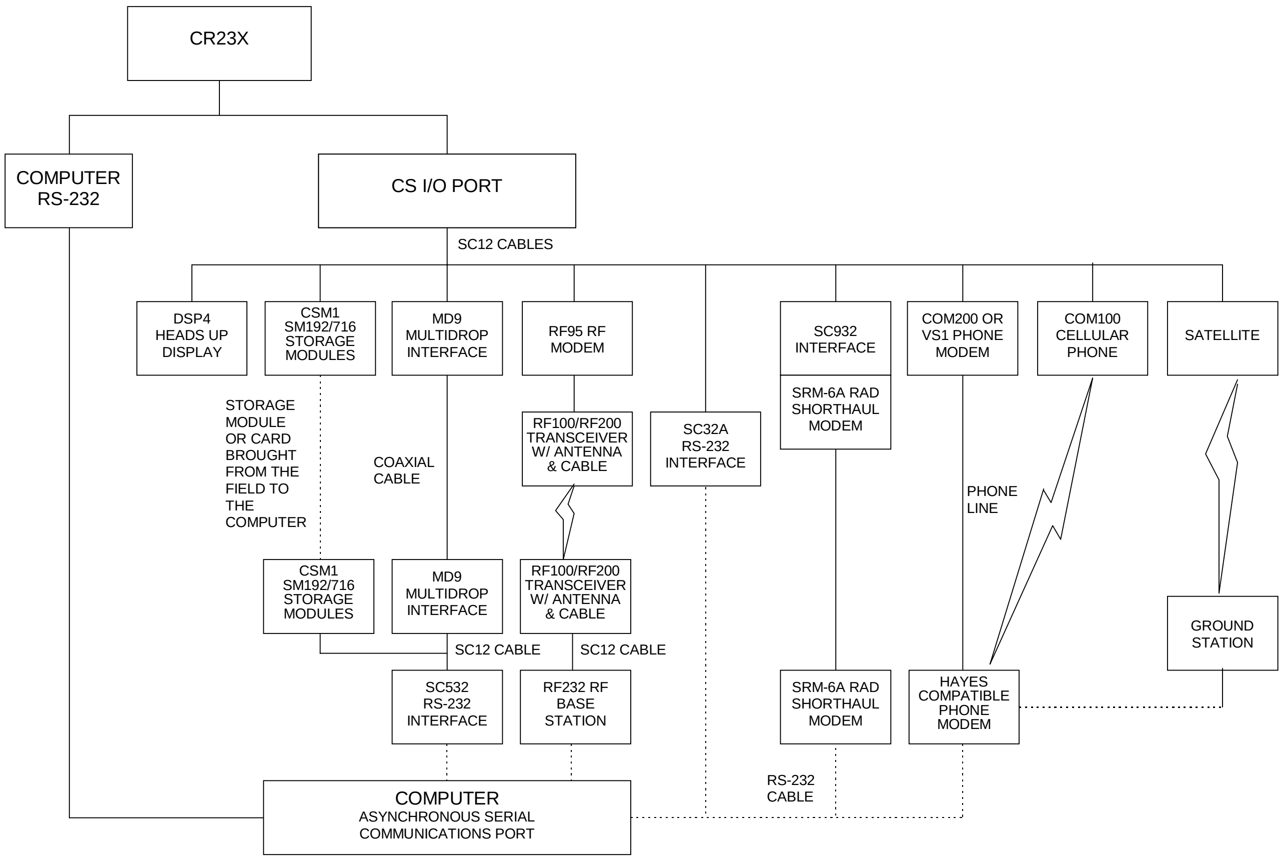
They are written over by new data (Section 2.1)

Memory is reallocated or the CR23X is reset (Section 1.5)

Table OV6.1-1 lists the instructions used with the various methods of data retrieval.

TABLE OV6.1-1. Data Retrieval Methods and Related Instructions

Method	Instruction/Mode	Section in Manual
Storage Module	Instruction 96	4.1, 12
	* 8	4.2
	* 9	4.5
Telecommunications	Telecommunications Commands	5
	Instruction 97	12
	Instruction 99	12
Printer or other Serial device	Instruction 96	4.1, 12
	Instruction 98	12
	* 8	4.2



NOTES:

1. ADDITIONAL METHODS OF DATA RETRIEVAL ARE:
   A. SATELLITE TRANSMISSION
   B. DIRECT DUMP TO PRINTER
   C. VOICE PHONE MODEM TO VOICE PHONE OR PC WITH HAYES COMPATIBLE PHONE MODEM

2. THE DSP4 HEADS UP DISPLAY ALLOWS THE USER TO VIEW DATA IN INPUT STORAGE. ALSO BUFFERS FINAL STORAGE DATA AND WRITES IT TO PRINTER OR STORAGE MODULE.

3. ALL CAMPBELL SCIENTIFIC RS-232 INTERFACE PERIPHERALS HAVE A FEMALE 25 PIN RS-232 CONNECTOR.

4. THE “COMPUTER RS-232” PORT HAS A FEMALE 9 PIN CONNECTOR.

FIGURE OV6.1-1. Data Retrieval Hardware Options

OV7. SPECIFICATIONS

Electrical specifications are valid for -25° to 50°C range unless otherwise specified. To maintain electrical specifications, yearly recalibrations are recommended.

PROGRAM EXECUTION RATE

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

CLOCK ACCURACY

±1 minute per month

ANALOG INPUTS

DESCRIPTION: 12 differential or 24 single-ended, individually configured. Channel expansion provided through AM416 Relay Multiplexers and AM25T Thermocouple Multiplexers.

ACCURACY: ±0.025% of FSR; 0° to 40°C
±0.05% of FSR; -25° to 50°C
±0.075% of FSR; -40° to 80°C (optional)
±5 µV offset voltage error is possible with SE measurements.

RANGES AND RESOLUTION

Input Range (mV)	Resolution (µV) Diff.	SE	Accuracy (mV) (-25° to 50°C)
±5000	166	333	±5.00
±1000	33.3	66.6	±1.00
±200	6.66	13.3	±0.20
±50	1.67	3.33	±0.05
±10	0.33	0.66	±0.01

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 REFERRED NOISE: 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 with slow diff. measurement).

SUSTAINED INPUT VOLTAGE WITHOUT DAMAGE: ±16 VDC max.

INPUT CURRENT: ±2.5 nA typ., ±10 nA max. at 50°C.

INPUT RESISTANCE: 20 Gohms typical.

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 P133).

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 ionic 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 is typically required.

INPUT FREQUENCY RANGE: Signal centered around ground.

Max. Input Frequency	Min. signal (Peak to Peak) @ Max. Freq.
10 kHz	2 mV
20 kHz	5 mV
30 kHz	10 mV
200 kHz	500 mV

RESOLUTION: 12 ns divided by the number of cycles measured.

ACCURACY: ±0.03% 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; 500 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 µs.
Maximum Input Frequency: 500 kHz.
Voltage Thresholds: Count upon transition from below 1.5 V to above 3.5 VDC. Larger transitions required at high frequencies because of 0.5 µs time constant filter.
Maximum Input Voltage: ±20 V.

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.

Frequency Range	Min. sine wave rms
1.0 Hz to 1 kHz	20 mV
0.5 Hz to 10 kHz	200 mV
0.3 Hz to 16 kHz	1000 mV

DIGITAL I/O PORTS

DESCRIPTION: 8 ports selectable as binary inputs or control outputs. Ports C5-C8 capable of counting switch closures and high frequency.

HIGH FREQUENCY MAX: 2.5 kHz

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

OUTPUT RESISTANCE: 500 ohms.

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

INPUT RESISTANCE: 100 kohms.

SDI-12 INTERFACE SUPPORT

DESCRIPTION: Digital I/O Ports C5-C8 support SDI-12 asynchronous communication; up to 10 SDI-12 sensors can be connected to each port.

EMI and ESD PROTECTION

Encased in metal with gas discharge tubes on the panel, the CR23X has EMI filtering and ESD protection on all input and output connections.

CE COMPLIANCE (as of 01/98)

APPLICATION OF COUNCIL DIRECTIVE(S): 89/336/EEC as amended by 89/336/EEC and 93/68/EEC

STANDARD(S) TO WHICH CONFORMITY IS DECLARED:
ENC55022-1: 1995 and ENC50082-1: 1992

CPU AND INTERFACE

PROCESSORS: Hitachi 6303; Motorola 68HC708 supports communications.

MEMORY: 1 M Flash stores 500K data values; 512K Flash stores OS and user programs with 128K battery-backed SRAM. Optional 4 M Flash available.

DISPLAY: 24-character-by-2-line LCD.

SERIAL INTERFACES: Optically isolated RS-232 9-pin interface for computer or modem. CS 9-pin I/O interface for peripherals such as card storage module or modem.

BAUD RATES: Selectable at 300, 1200, 2400, 4800, 9600, 19.2K, 38.4K, and 76.8K. ASCII protocol is one start bit, one stop bit, eight data bits, no parity.

SYSTEM POWER REQUIREMENTS

VOLTAGE: 11 to 16 VDC.

TYPICAL CURRENT DRAIN: 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: 7 Ahr alkaline or 7 Ahr rechargeable base; low-profile base without batteries optional. 1800 mAhr lithium battery for clock and SRAM backup typically provides 10 years of service.

EXTERNAL BATTERIES: Any 11 to 16 V 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 surface.

WEIGHT: 3.6 lbs (1.6 kg) with low-profile base,
8.3 lbs (3.8 kg) with alkaline base,
10.7 lbs (4.8 kg) with rechargeable base.

WARRANTY

3 years against defects in materials and workmanship.