

**SERIES 10 PORTABLE
MULTICHANNEL ANALYZER**

Operator's Manual

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NOTICE

YOUR SERIES 10 MULTICHANNEL ANALYZER HAS BEEN THOROUGHLY TESTED, HOWEVER, SINCE THE INTERNAL BATTERIES MAY BE IN VARIOUS STATES OF CHARGE WHEN YOU FIRST RECEIVE IT, WE SUGGEST YOU RECHARGE THEM OVERNIGHT BEFORE PUTTING THE MCA INTO SERVICE. PLEASE REFER TO APPENDIX D IN YOUR OPERATOR'S MANUAL FOR DETAILS ON RECHARGING THE BATTERIES.

SINCERELY,

CANBERRA INDUSTRIES, INC.

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SECTION 1 INTRODUCTION

Canberra's Series 10 Portable Multichannel Analyzer (MCA) is available in three versions: Models 1002, 1003, and 1004. All three have all of the functions needed for standard spectroscopic analysis and have a self-contained high voltage power supply (HVPS).

Model 1002

The Model 1002 has:

- 1K channels of data memory;
- 1K of ADC Gain;
- one HVPS range: 25-1250 V.

and can:

- learn and execute a sequence of functions;
- define and use equations;
- perform multichannel scaling (MCS).

Model 1003

The Model 1003 has:

- 4K channels of data memory;
- 4K of ADC Gain;
- two HVPS ranges: 25-1250 V and 1200-5000 V.

Model 1004

The Model 1004 has:

- 8K channels of data memory;
- 4K of ADC Gain;
- two HVPS ranges: 25-1250 V and 1200-5000 V.

and can:

- learn and execute a sequence of functions;
- define and use equations;
- perform multichannel scaling (MCS).

To verify which model number you are using, refer to section 3.4, STATUS. The MCA's model number is displayed in the center of the Status display's top line: either as V1002, V1003, or V1004, followed by the currently installed firmware version (shown as a letter and a number).

The Series 10 is remarkably easy to use: it offers a "menu" of choices on its display - you make selections from the menu. The analyzer then performs whatever actions you have "programmed" it to do.

Before you start to use the Analyzer, please read all of this introductory section to learn about the Series 10 and its menu approach to multichannel analyzer functions.

V1100-52

1.1 FRONT PANEL

The Series 10's front panel can be divided into five sections:

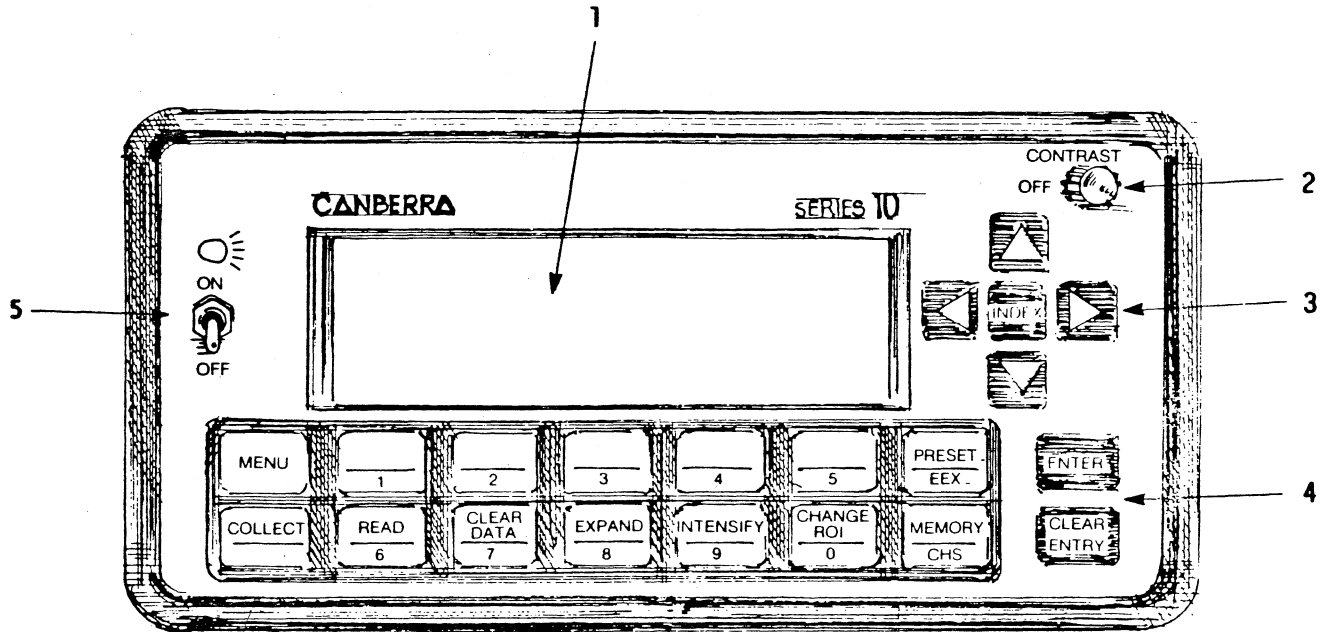


Figure 1.1 Front Panel

1. The screen is a flat-panel liquid crystal display. The display is always on when the Series 10's rear panel power switch is ON.
2. The CONTRAST control varies the display's contrast for comfortable viewing. The intensity is fixed. In later Series 10's, the CONTRAST control incorporates a power switch. Turning the control fully counterclockwise will put the Series 10 in the Standby (STBY) power mode; see section 1.17 for the meaning of this mode.
3. To the right of the display are four arrows and the INDEX key (covered in section 2.6). The two horizontal arrows ($\leftarrow \rightarrow$) and the Index key control cursor movement and the two vertical arrows ($\uparrow \downarrow$) control the display's Vertical Full Scale and some parameter entries (covered in section 4).

4. Below the front panel's display are a number of keys: they are best described as "hard" keys, which have a fixed function, and "soft" keys, which have variable functions. They are described in sections 2, 3, and 4.
5. To the display's left is a light switch. It provides backlighting for the display so you can use the Series 10 in low-light conditions. Place the switch in the OFF position when the light is not in use to prolong battery and lamp life.

1.2 SOFT KEYS

The soft keys are the numeric keys 1 through 5; unlike the hard keys, they have no function label. Their labels will be shown on the display and will change with the function being defined.

In this manual the soft keys are shown with the function name enclosed in a dotted outline.

(STATUS)

1.3 HARD KEYS

The remainder of the front panel's keys are the hard, fixed function, keys.

In this manual the hard keys are shown in boldface type in a box outline.

[**MENU**]

- 1.4 ENTER AND CLEAR ENTRY The ENTER key is used to "accept" the previous key selections. The CLEAR ENTRY key cancels the previous key selection.

1.5 APPLYING POWER

The Series 10 is shipped from the factory with the rear-panel power switch in the Reset (RST) position. Turning the switch to the ON position will set all system parameters to the default state, will turn on the display, and will enable all analyzer functions. Refer to section 3.8, DEFAULT, for a discussion of default parameters.

1.6 INITIAL DISPLAY

A few seconds after the power is applied, this display will appear on the screen:

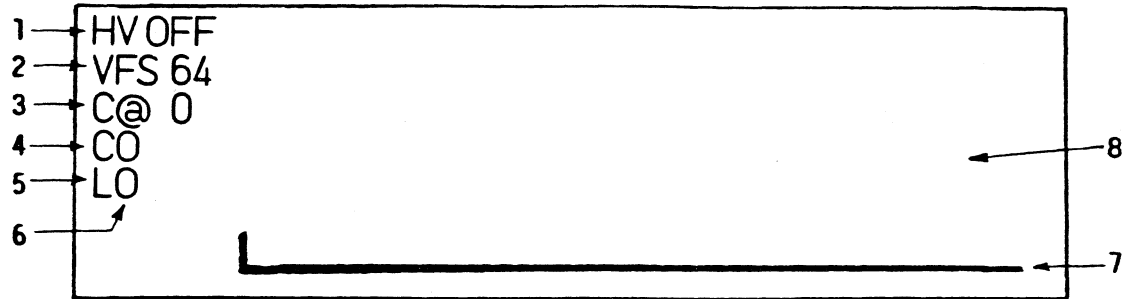


Figure 1.2 Initial Display

1. HV: shows the High Voltage output $\pm 10\%$. The reading will remain constant unless the measured output is beyond $\pm 2.5\%$ of the setting.
2. VFS: shows the display's Vertical Full Scale, in counts.
3. C@"n": means the CURSOR is at channel number "n". Channels are numbered relative to the displayed memory segment.
4. C"n": means the COUNTS in the cursor's channel are equal to "n".
5. Preset Line: depending on the preset, shows:
 - the letter "L" - elapsed PHA Live time;
 - the letter "T" - elapsed PHA True time;
 - the letter "S" - elapsed MCS sweeps
(Models 1002 and 1004 only).A computational preset will show the elapsed live time on this line.
6. Status Line: displays error messages and shows the Series 10's current status (MCS, READ). In PHA collect, it shows the percent dead time as a moving bar-graph. The line will be blank if the Series 10 is idle.

- 7. The Baseline is the bottom of the spectral data display.
- 8. The rest of the display is for spectral data.

When the Series 10 is in the menu mode, the data display will be moved up so the bottom two lines can be used for menu prompts and the soft key labels.

The lower line is the Soft Key Line, displaying all soft key labels. It also displays an error message if you issue an incorrect command.

The second line from the bottom is the Command Line; it shows dialog prompts and current parameters.

1.7 USING THE MENU

With the Series 10's power switch turned ON, you can start to use the menu.

Press the front panel hard key marked

[MENU]

to see a line of soft-key labels on the bottom line of the display:

SETUP ECAL COMPUTE ANALYZE ETC
(ANALYZE appears only on the Models 1002 and 1004)

This is the first line of the menu "tree". It is shown on the display's Soft Key Line, the bottom line of the display. When any key is pressed the line of soft keys labels will change to show the next "branch" of the tree.

You can leave the dialog at any time by pressing the MENU key. Any selections ENTERed up to that point will have been recorded in the parameters memory.

1.8 DEFAULT PARAMETERS

To see the default parameters, press

[MENU] (SETUP) (STATUS)

The display will change to show a listing all of the current system parameters

Refer to section 3.8 for a complete description of the default parameter display.

1.9 SETTING PARAMETERS

The clock and calendar readout in the upper right corner of the STATUS display were set at the factory; they are kept running by the internal power supply, even when the Series 10's power is off.

Setting the clock and calendar can be used as an example to illustrate the use of the menu.

While still in the STATUS display, press numeric key 5, which has the label

(ETC)

The Soft Key Line labels will change to show the remainder of the first branch of the menu tree. Now press

(CLOCK) then (TIME)

The Series 10 will wait for a numeric entry between 0 and 23. Use the numeric keys on the front panel to enter the time. For instance, if the current time is 1:30 pm, enter 13 hours and 30 minutes.

Press "1", then "3". The Command Line, the line above the Soft Key Line, will show

CLOCK TIME IS 13

which is correct. To accept this entry, press

[ENTER]

This will change the dialog to allow entry of the minutes. Make a deliberate mistake here and enter "20" instead of "30". To clear this incorrect entry, press

[CLEAR ENTRY]

twice, once for each numeral. The first press of the key will clear the "0" and the second press will clear the "2". Now you can enter the correct number, "30". The Command Line should now read

CLOCK TIME IS 13:30.

At this point a final press of

[ENTER]

will set the internal clock to the displayed value. If you are synchronizing the internal clock to an external clock, this final ENTER is the reference point to use to set the internal clock to zero seconds.

A final point to remember is that the last ENTER to accept the Command Line can usually be done only when the Soft Key Line is not displaying text.

The dialog is now brought back to the next earlier branch of the tree to allow you to set the date, if desired. The date is entered in the same manner as the time, using the format DD, MM, YY.

If you're not going to make any further changes, you can end the SETUP mode by pressing

[MENU]

Or you can press

[CLEAR ENTRY]

to move back through the dialog one branch and select another function from:

HVPS EIA CLOCK DEFAULT ETC

To use the Series 10, you'll have to connect a detector. The Models 1003 and 1004 are shipped with the High Voltage Power Supply (HVPS) set for a positive 5 kV maximum output. The default parameters for the internal amplifier and the ADC are:

<u>Model 1002</u>	<u>Models 1003 and 1004</u>
POSitive signal input	POSitive signal input
FAST shaping	SLOW shaping
GAIN of 3.5	GAIN of 3.5
ADC GAIN is 1024.	ADC GAIN is 4096.

If you're going to use a Sodium Iodide detector, with a Model 1003 or 1004, you'll have to change the HVPS jumper plug; the 5 kV range will not go below 1200 volts and can't supply the current required by a photomultiplier tube and its bias network.

Refer to appendix B for instructions on changing the HVPS jumper plug. The HVPS for the Model 1002 is fixed at the low range: 25-1250 V, but its polarity is reversable.

The Series 10 checks the position of the HVPS jumper for default parameters when the rear panel power switch is turned ON from the RST position (see section 1.17) or when the DEFAULT soft key is pressed (see section 3.8).

For the 1 kV jumper position, default sets the amplifier to FAST shaping and the ADC's GAIN to 512. You will want to use fast shaping but you might want to change the ADC's gain. To make the change, press

[MENU] (SETUP) and (ADC)

to see the ADC branch of the menu:

ZERO OFFSET GAIN PHA MCS
(MCS appears only on the 1002 and 1004.)

To change the ADC gain, press

(GAIN)

The Command Line will show the current value of the parameter:

ADC GAIN IS 512

and the Soft Key Line will show:

512 1024 2048* 4096*
(*not on the 1002)

To choose another gain, press 1024, for instance. The Command Line will change to show:

ADC GAIN 1024

To accept this parameter, press the ENTER key once more. The dialog will return to the ADC branch of the menu.

Now press the MENU key to leave the dialog.

1.10 REVIEW

This section reviews the entire process that you've just gone through.

- Each line of soft key choices is shown below as it appears on the Series 10's Option Line, one line at a time.
- As each key is pressed, the next level of the tree will be shown on the display's Option Line.
- The third level shows the ADC parameter choices.
- The fourth level shows the gain selections.

Whenever there are more than five choices in any level of the Menu, the fifth soft key will be labeled "ETC". Pressing this key will change the line to show the next five choices at the same level.

The bracketed key in each line is the one you pressed.

hard key	[MENU]				
1st level (of soft keys)	[SETUP]	ECAL	COMPUTE	ANALYZE	ETC
2nd level	AMP	SCA	[ADC]	STATUS	ETC
3rd level	ZERO	OFFSET	[GAIN]	PHA	MCS
4th level	512	[1024]	2048	4096	

(ANALYZE and MCS appear only on Models 1002 and 1004; 2048 and 4096 appear only on Models 1003 and 1004.)

When you pressed the 1024 soft key, your choice moved to the Command Line. Then you pressed the ENTER key to store your choice in memory.

1.11 MENU RULES

Now that you've had some experience using the MCA, please read the following rules that the Series 10 uses in the menu mode:

1. To start any function, press a hard key.
2. Complete the soft key dialog as it appears on the screen, line by line.
3. When a parameter or function is chosen, the display's Command Line will usually show the current value of that parameter or function.
4. Press CLEAR ENTRY before assigning a new numeric value. If the current value is zero, you don't need to clear it.
5. The ENTER key is used to display a changed function or redefined parameter on the Command Line.
6. If the Command Line is correct and no dialog is shown on the Soft Key Line, pressing the ENTER key will store the change in memory.
7. If you select a soft key labeled with an octothorp (#), the Series 10 will expect a number to be entered.

8. The CLEAR ENTRY key cancels any numeric entry, digit by digit, any error message, or any function key entry.
9. If the dialog line has been completed, pressing the CLEAR ENTRY key will let you back up through the menu level by level.
10. To leave the dialog at any time, press the MENU key. Any parameters ENTERed so far will have been stored in memory.

1.12 DISPLAY SCALE

The display's Vertical Full Scale (VFS) value is set by the ↑ and ↓ arrows when the Series 10 is not in dialog.

If either the ↑ or the ↓ arrow key is held down, the display will cycle up or down through all VFS values. The log values are at the "top end" of the linear values.

The linear VFS range is 2^6 to 2^{24} .
In log, the VFS range is either 2^{17} or 2^{24} .

The ↑ and ↓ arrows are also used in the Menu mode for parameter setup (section 4).

1.13 DATA ID

To identify a specific data spectrum, you can enter a DATA ID into the Series 10 by using READ IN, EIA. On an EIA terminal's keyboard:

- 1) Hold down CTRL and type B;
- 2) Type no less than 24 characters and spaces.

More than 24 characters will be ignored, so fill the field with spaces, if necessary. Press READ, STOP, and ENTER on the Series 10 to leave the readin mode.

1.14 SYSTEM RESET

In the unlikely event that the analyzer should stop operating normally, simply turn the CONTRAST switch OFF for a few seconds and then back ON. This will return the Series 10's program to a known state so that it can continue normal operation.

If you suspect a malfunction in the analyzer, you can use any of the many self-test functions to verify correct operation. Refer to section 4.7.

1.15 BOTTOM PANEL

On the bottom of the Series 10's case are two removable panels. The smaller one is the High Voltage Power Supply jumper (refer to appendix B). The larger one carries the battery pack (refer to appendix D).

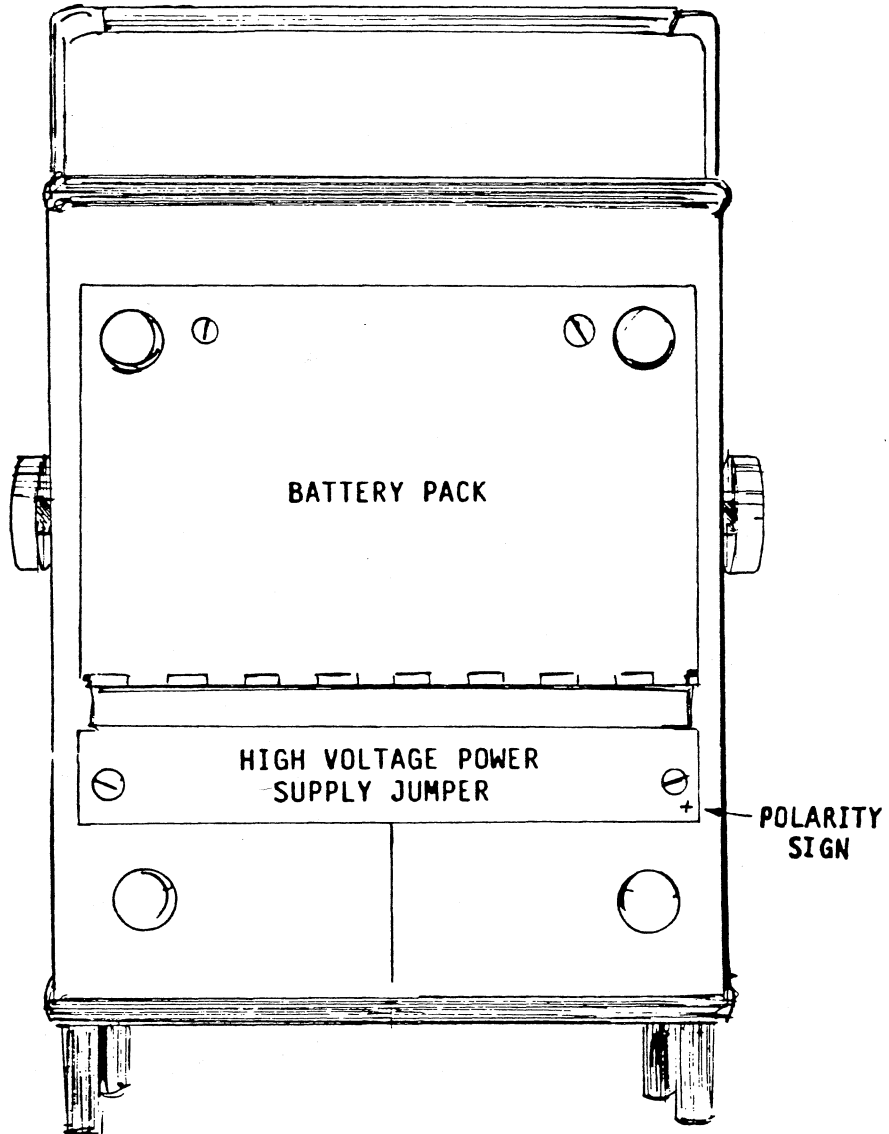


Figure 1.3 Bottom Panel

1.16 REAR PANEL

The rear panel carries:

the power switch, covered in section 1.17, and seven signal connectors, covered in section 1.18.

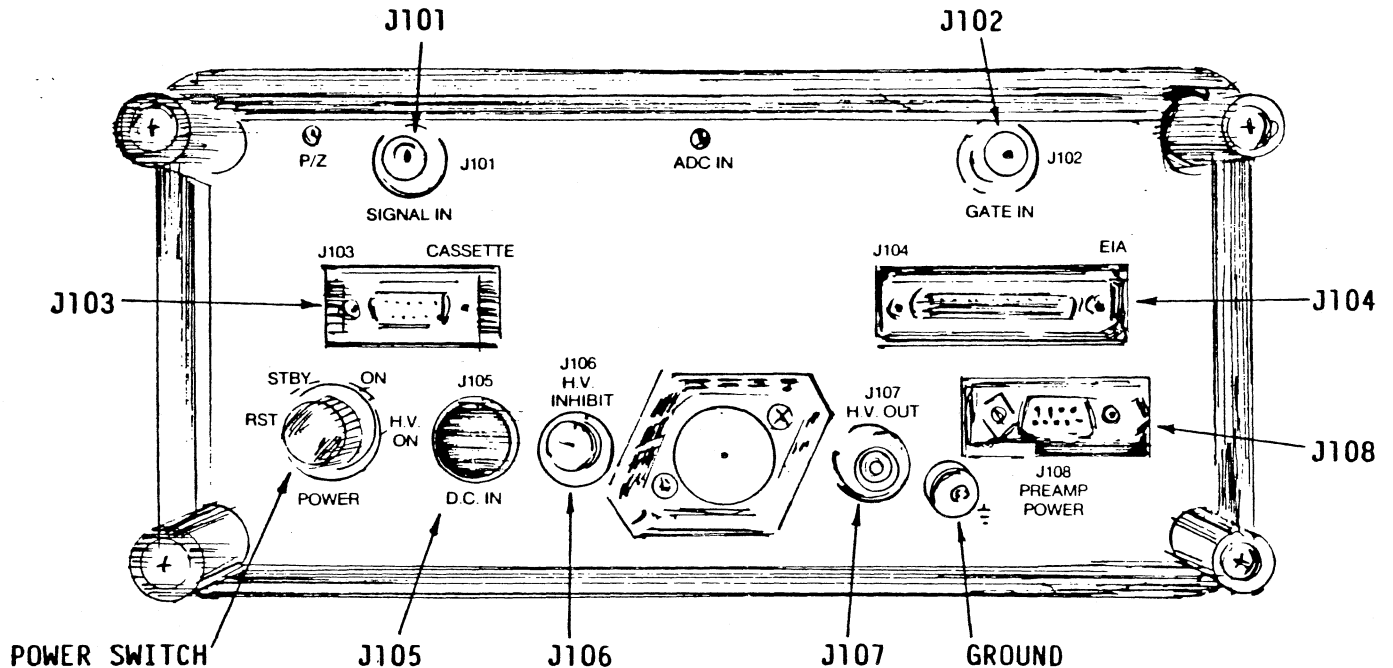


Figure 1.4 Rear Panel

1.17 POWER SWITCH

The power switch has six positions:

1 RST, 2-3 STBY, 4-5 ON, and 6 HV ON.

The STBY and ON positions are both doubled to provide some protection against accidentally moving the switch from ON to RST or from STBY to HV ON.

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rst RESET clears the data memory and initializes the default system parameters; it does not stop the clock/calendar. The power switch must be in the RST position for at least 15 seconds for the current system parameters to be changed to the default parameters.

stby Standby (STBY) shuts off power to all of the unit except the memory. All data and parameters are retained in memory.

on ON supplies power to all circuits for normal use of the unit.

hv on HV ON turns on the internal High Voltage Power Supply, which must first be enabled and set for correct voltage through the SETUP dialog.

The HVPS in the Models 1003 and 1004 is factory set for positive high voltage output with a range of 1200 to 5000 volts. If your detector uses a negative high voltage or operates below 1200 volts, refer to appendix B. The Model 1002 is set for its only HVPS range: 25-1250 V.

1.18 SIGNAL CONNECTORS

This section gives a brief description of each of the signal connectors on the rear panel. The connectors' electrical specifications are covered in appendix G.

In addition to the numbered connectors described in this section, there is a grounding stud located next to J108. It is connected directly to the Series 10's chassis.

J101 SIGNAL IN The SIGNAL connector accepts input signals for the amplifier from the associated preamplifier.

J102 GATE IN GATE IN signals can enable/disable PHA conversion or MCS counting.

J103 Cassette The Model 5421M Cassette Recorder connects to J103 for read in or read out of Sequences, Functions, and data.

J104 EIA Any device using the EIA RS-232C convention can be attached to this port for read in and read out.

J105 D.C. IN	The Power Converter/Adapter must be connected to J105 to recharge the internal battery or to operate the Series 10 from line power. The Series 10 can also be operated from an external dc power source through this connector (see appendix G).
J106 H.V. INHIBIT	Applying a low-level logic signal (for example, from a Model 1786 LN ₂ Monitor) to or grounding this connector will inhibit the internal High Voltage Power Supply's output. A high level or open connector will restore the output.
J107 H.V. OUT	The HV OUT connector supplies High Voltage to the detector from the internal High Voltage Power Supply.
J108 PREAMP POWER	This connector provides the filtered voltages needed by an associated preamplifier.
ADC IN	The ADC IN jack is a monitor point for the internal amplifier's output.
P/Z	The pole/zero (p/z) control is used to compensate for the fall-time constant of the preamplifier's output signal and the amplifier's shaping-time constant. Refer to appendix H for further information.

1.19 MANUAL FORMAT

The remainder of this manual includes:

Section 2, listing the front panel hard key functions.

Section 3, describing the operating setup parameters found in the first soft key after pressing MENU.

Section 4, covering the analysis functions, which are all of the soft keys other than SETUP.

Several appendices containing technical information.

In sections 2, 3, and 4, the left-hand page outlines the use of the function; the right hand page details the necessary and optional key pushes required to execute the function.

To get to the function's dialog, follow the listing of key pushes (approach) at the top of every right-hand page.

1.20 BATTERY CARE

The Series 10 uses an assembly of five rechargeable NiCad batteries for portable power. Fully-charged batteries allow 8 hours of continuous operation using a preamplifier drawing 1 watt.

BATLOW Message

When the battery voltage drops below 6 volts, a "BATLOW" warning message appears on the display. The Series 10 will typically operate for at least 30 minutes after this message appears.

When the battery voltage drops to about 5.6 volts, the Series 10 goes into a non-operating standby mode without losing data. To return to the fully on condition, turn the rear panel power switch to STBY (or the front panel Contrast switch to OFF) for a few seconds, then back to ON.

Recharging

The Series 10 can be charged either while it is in use or while in the standby mode. At least 32 hours is required to fully charge the battery while the Series 10 is in use or about 16 hours if the Series 10 is in STBY or RST.

To recharge the battery pack, connect the charger to the Series 10 then connect the charger to an ac line outlet. Turn the rear panel power switch to RST while charging unless data is to be saved. To save data, put the Series 10 in STBY (or front panel OFF) while charging.

Continuous Charge

The charger can be left connected to the Series 10 indefinitely without harming the battery pack. However, continuous charging will eventually lower the loaded battery's output voltage and decrease the Series 10's operating time.

The ideal way to get maximum battery operating time is to operate under battery power until the BATLOW message appears, then recharge the battery pack.

If you use the Series 10 for long periods with the charger connected, the battery can be returned to its rated capacity by fully discharging it.

Refer to appendix D for more information on the batteries and the charger.

This section covers the use of the "hard" keys, the Series 10's front panel controls.

2.1 COLLECT	Causes the analyzer to start or stop data collection.
2.2 READ	Starts or stops data readout or readin.
2.3 CLEAR DATA	Clears data channels or time channels.
2.4 EXPAND	Expands the data display to show the 200 channels around the cursor.
2.5 INTENSIFY	Changes the display to show Regions of Interest (ROIs).
2.6 CHANGE ROI	Enters or deletes ROIs.
2.7 MEMORY	Displays any part of the memory.
2.8 PRESET	Enters a preset value at which data collection will automatically stop.
MENU	Is covered in sections 3 and 4.
ENTER	Used to enter parameters into the memory; covered in section 1.4.
CLEAR ENTRY	Used to delete incorrect entries; covered in section 1.4
INDEX	Moves the cursor from one ROI to another; covered in section 2.6.

2.1 COLLECT

Used to start or stop data acquisition. The analyzer will collect data using the SETUP parameters stored in its memory.

For optimum performance, the rear panel pole/zero (P/Z) control should be properly adjusted for the amplifier parameters and preamplifier used. See appendix H.

- START** START clears the memory and begins data collection in the currently displayed data memory.
- RECYCLE** RECYCLE is a repeating sequence which performs memory clear, collects to preset, reads out the data, then starts over. The process will continue until the assigned number of cycles has been completed or until ended manually with COLLECT STOP.
- STOP** STOP ends data collection manually before the preset or recycle assignment is reached.
- CONTINUE** CONTINUE lets you continue adding data to the memory until preset is reached; it does not clear the memory first. If CONTINUE is used after a time preset has been reached, Collect will not stop until the LT or TT preset is equalled again (in about 6 months).

Note

If Read is active in the current memory group, Collect Start or Continue will start when Read ends.

When you read out a spectrum, the current Collect parameters are also transmitted and will be read back in with the data.

When PHA Collect ends, the elapsed Live time and True Time will be placed in channels 0 and 1, respectively. MCS Collect uses these two channels for the first two dwell periods in each sweep.

approach COLLECT

choose (START) (STOP) (CONTINUE)

then Press ENTER to execute.

RECYCLE Appears after the START key is pressed.

first Press CLEAR ENTRY, enter the number of cycles and press ENTER.

then Press ENTER again.

and choose (EIA) (TERMINAL) (TAPE) (COMPUTER)

now choose (ALL) (ROIS) (BRIEF)
 Brief doesn't appear for TAPE or COMPUTER.

optional Assign a TAG number, if desired, and press ENTER.

finally If the Command Line is correct, press ENTER to execute.

2.2 READ

The memory segment displayed during READ dialog will be used for data input and output. If this segment is in active PHA Collect, Read will start when Collect ends. If any segment is in active MCS Collect, read in and read out can't be used. All readouts include the Data ID (section 1.13); tape readouts also include the collect parameters, which can be read back in with the data. See appendix E for sample hard-copy readouts and tape compatibility with other Canberra MCAs.

eia devices

There are 3 classes of EIA devices:
.EIA-ASCII (with control characters);
.TERMINAL-ASCII (no control characters);
.COMPUTER-binary.

Refer to appendix E for formats.

parameters

To make a data transfer you will have to match the analyzer's EIA parameters to the I/O device's parameters. See section 3.6, EIA.

cassette

TAPE is used to select the FSK interface for the Model 5421M Cassette Recorder. The Model 5421M's volume control must be set to 8 or greater and its tone control to MAXimum. Gaps are recorded at the beginning and end of Read Out. For a Read In, position the tape at the beginning of the record using the Model 5421M's tape counter. When the read in is finished, verify the Tag number on the Status display; see section 3.4.

tag

The TAG number will be incremented by one each time Collect starts. It is read out/in with the data.

all

ALL reads out all data in the memory segment.

rois

ROIS reads out the data in each Region of Interest wholly contained in the displayed memory segment. An ROI that starts or ends in another memory segment will be ignored. A hard-copy readout starts with a summary of each ROI, followed by channel data.

brief

BRIEF is a ROIS readout without the channel data.

stop

STOP halts the READ operation. For READ IN, input characters must be recognized prior to STOP. If no characters are read in, it may be necessary to turn the CONTRAST switch to OFF to end READ.

errors

A faulty readin can cause an "ERR n" message to be displayed. Refer to appendix C.1 for an explanation.

approach [READ]

choose (IN) (OUT) (STOP)

STOP Stops READ. Press ENTER to execute.

IN, choose (EIA) (TAPE)
 Press ENTER to execute.

OUT, choose (EIA) (TERMINAL) (TAPE) (COMPUTER)

now choose (ALL) (ROIS) (BRIEF)
 BRIEF doesn't appear for Tape or Computer.

optional Assign a TAG number, if desired, and press ENTER

finally If the Command Line is correct, press ENTER to execute.

2.3 CLEAR DATA

The CLEAR DATA key is used to clear (erase) the currently selected memory segment.

CLEAR DATA clears both data and PHA time or MCS sweeps.

CLEAR TIME clears just the PHA time counters or the MCS sweep counter. Data channels are not affected.

Note

Using CLEAR DATA while in active Collect may result in incorrect data and will not clear the time or sweep counters.

approach

[CLEAR DATA]

choose

(DATA) (TIME)
Press ENTER to execute.

DATA

Both the data and the time channels in the currently selected memory segment are cleared.

TIME

Only the Live and True time counters are cleared in the currently selected PHA memory segment, not data channels. In MCS, this key clears the sweep counter.

note

[CLEAR DATA] [ENTER]

Will also clear all channels in the currently selected memory segment.

2.4 EXPAND

The normal display compresses data to fit on the 200 point display. For instance, full memory (4096 channels) is divided into 200 segments of 20 or 21 channels each. The largest current value in each segment is displayed.

This function expands the display to show 200 consecutive channels so that you can examine the data more closely.

The expanded data display will begin 50 channels lower than the current cursor location, but not lower than the left end of the currently displayed part of the memory.

Pressing EXPAND again or changing the current memory segment will disable the function and place the cursor in a channel corresponding to its location before EXPAND was enabled.

2.5 INTENSIFY

In a normal display, all channels are darker than the background.

INTENSIFY makes the data channels lighter; channels entered in an ROI will be darkened to make them stand out.

Press the INTENSIFY key again to disable the function; all channels will be darker than the background once again. The ROIs will still be in memory, but will not be seen in the display.

The function is automatically enabled when the CHANGE ROI key is pressed.

EXPAND 2.4
INTENS 2.5

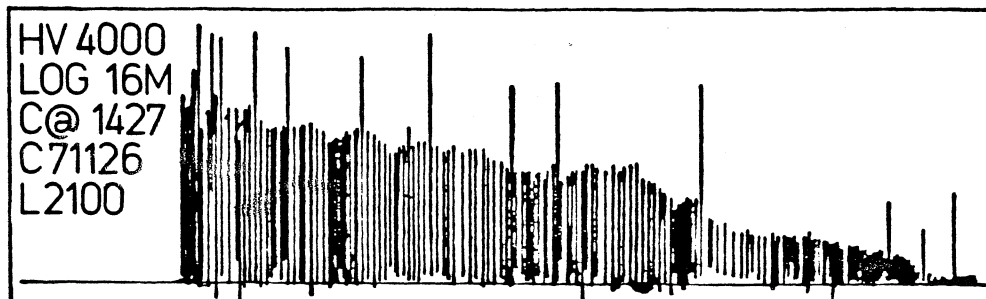


Figure 2.1 Normal Display

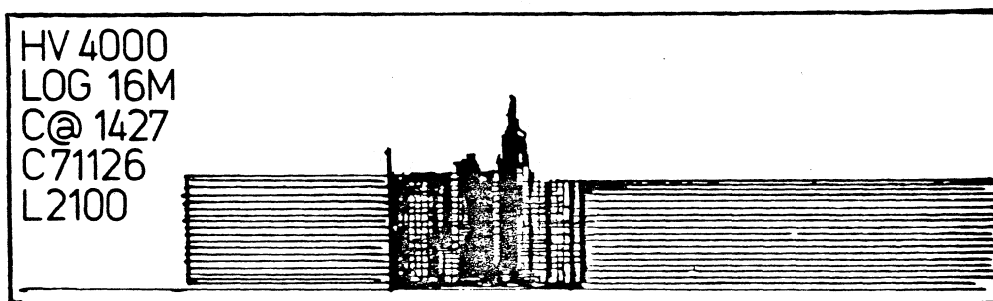


Figure 2.2 Expanded Display

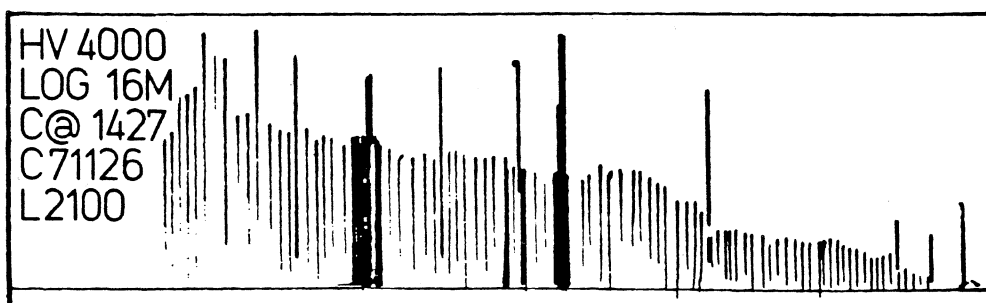


Figure 2.3 Intensified Display

2.6 CHANGE ROI

This function enters or deletes intensified Regions of Interest (ROIs), which are used to mark parts of the spectrum for later analysis and readout. You will number the ROIs as they are entered; these numbers can be referred to in other dialog and for readout. ROIs can be erased by using delete or by creating another ROI with the same number.

An ROI can be entered by choosing CURSOR then moving the cursor through the channels to be in the ROI. Every channel that the cursor moves through will be darkened to show that it is part of the ROI.

Another way to enter an ROI is to choose (#) then enter the start and stop channel numbers for the ROI.

Up to 50 ROIs can be entered; any number may be overlapped.

index

The front panel INDEX key moves the cursor to the start channel of each ROI in turn moving from display-left to display-right. It will also move the cursor from the right-most ROI in the display to the left-most one.

approach

[CHANGE ROI]

choose

(CREATE) (DELETE)

CREATE

Assign a number (1 to 50) and press ENTER.

now choose

(CURSOR) (#)

if cursor

Enter the Region Of Interest with the cursor by following the on-screen dialog.

if (#)

Enter the first channel and press ENTER. Then enter the last channel and press ENTER.

DELETE

(ALL) (#)

Choose one and press ENTER.

if all

Deletes all ROIs in the memory.

if (#)

Enter the number of the ROI to be deleted.

finally

If the Command Line is correct, press ENTER to execute.

2.7 MEMORY

Allows you to choose which part of the memory you want to display. You can display:

- the full memory
- either half
- any quarter
- any 8th
- any 16th

When choosing halves or quarters, the dialog asks you to choose which half or which quarter to display.

When choosing 8ths or 16ths, the dialog asks you to assign a number to display that fraction of memory. For instance, for 8ths, entering a 5 will display the fifth 8th of the memory.

An error message will be displayed if the entered number is too small or too large.

approach [MEMORY]

choose (FULL) (HALF) (QUARTER) (EIGHTH) (16TH)

if full Press ENTER.

if half (1) (2)
 Choose one and press ENTER.

if quarter (1) (2) (3) (4)
 Choose one and press ENTER.

if eighth Assign the number of the 8th you want to see and
 press ENTER.

if 16th Assign the number of the 16th you want to see and
 press ENTER.

finally If the Command Line is correct, press ENTER to
 execute.

2.8 PRESET

Stops data collection when an assigned value (the preset) is reached. Unlike the entry of other values in the Series 10, CLEAR ENTRY must always be pressed before assigning a new preset value.

live time PHA Collect stops after the assigned number of live seconds of collect time have passed.

true time PHA Collect stops after the assigned number of true seconds of collect time have passed.

area PHA Collect stops after the Area of a region equals the preset value.

integral PHA Collect stops after the Integral of a region equals the preset value.

counts PHA Collect stops after the number of counts in a channel equals the preset value. Both the number of counts and the channel number must be entered.

Models 1002 and 1004 only:

function PHA Collect stops when the solution of a defined function equals the preset value. Both the function's number and its final value must be entered.

mcs sweeps MCS Collect stops after the number of sweeps equals the preset.

mcs dwell Sets the time interval for each MCS dwell period. The dwell range is 128 μ s to 4.19 s. The actual dwell used may not be the same as your entry because the program will convert the entered number to the nearest multiple of 64. The exact value used is seen in STATUS (section 3.6) or, after exiting the PRESET dialog, when PRESET is pressed again.

note Setting a PHA preset will change the ADC mode to PHA and setting an MCS preset will change the ADC mode to MCS.

approach PRESET Displays the current preset.

use current preset Press MENU to accept the preset and exit the dialog.

choose (CHANGE) will bring up the preset menu:

 (LIVETM) (TRUETM) (AREA) (INTEG) (ETC)

 (FUNC) (COUNT) (SWEEP) (DWELL) (ETC)

 (CHANGE)

Note: FUNC, SWEEP, and DWELL appear only on the Models 1002 and 1004.

After a preset condition is chosen, you must press CLEAR ENTRY before assigning its value.

AREA/INTEG Assign a value and press ENTER. Now assign a ROI number and press ENTER.

LIVETM/TRUETM
SWEEP/DWELL Assign a value and press ENTER.

FUNC Select a function (F1-F5), assign a value, and press ENTER.

COUNT Assign the number of counts and press ENTER, then press CLEAR ENTRY to see:

now choose (CURSOR) (#)

cursor Selects the current cursor channel. Press ENTER

(#) Enter a channel number and press ENTER.

finally If the Command Line is correct, press ENTER to execute.

When you press the MENU key, the first choice offered is SETUP. This key is used to change all of the current parameters except Tag, section 2.2, Memory, section 2.7, and Preset, section 2.8.

SETUP choices	AMP	SCA	ADC	STATUS	ETC
	HVPS	EIA	CLOCK	DEFAULT	ETC
ETC	Changes each dialog line to the next line. The last ETC returns to the first line.				
3.1 AMP	Sets the amplifier's: polarity, shaping, and gain*.				
3.2 SCA	Sets the SCA's: LLD and ULD limits.*				
3.3 ADC	Sets the ADC's: zero*, offset, gain, pha, mcs (mcs in Models 1002 and 1004 only), and additive or subtractive acquisition.				
3.4 STATUS	Shows you all of the current parameters.				
3.5 HVPS	Sets the High Voltage Power Supply for: on, off, set voltage*, and stabilizer on/off.				
3.6 EIA	Sets the EIA's: baud rate, character length, and parity.				
3.7 CLOCK	Sets the internal clock and calendar's: time and date.				
3.8 DEFAULT	Resets all parameters to the factory default values.				

***Note** These parameters are set using Digital to Analog Converters . Although the dialog will allow any number within the parameter's range to be entered, the Converter will use the nearest value within its resolution.

Because of this, you may find that the value used by the Series 10 is not exactly the same as the value you entered.

3.1 AMP

Lets you set the amplifier's:

- POLARITY of the input signal to POSitive or NEGative depending on your detector's output.
- SHAPING time-constant to FAST for Sodium Iodide detectors or SLOW for Germanium detectors. (The Model 1002 is fixed at FAST).
- GAIN* to place the radioisotope peaks higher or lower (right or left) in the display.

You will see the current amp gain setting and you will be offered the choice of COLLECT or a number entry (#).

Pressing the COLLECT soft key at any point in the amp dialog will clear data and start collect so that you can see the effect of the changes. Note that this Collect shows 100% on the dead time meter because it does not record Live Time.

To change the gain, use the ↑ and ↓ arrows or press (#) and the CLEAR ENTRY key, then enter a number between 3.5 and 1230 and press ENTER. If the Command Line is correct press ENTER again.

Now press the COLLECT soft key and use the front panel ↑ and ↓ arrows to slowly change the displayed gain. It will be easier to see the changes if you press the COLLECT soft key occasionally to clear the display.

For optimum performance, the rear panel pole/zero (P/Z) control should be properly adjusted for the amplifier parameters and preamplifier used. See appendix H.

*Amplifier GAIN is set using a Digital to Analog Converter. Although the dialog will allow any number within the parameter's range to be entered, the Converter will use the nearest value within its resolution.

Because of this, you may find that the value used by the Series 10 is not exactly the same as the value you entered and you may not be able to put a peak in the exact channel desired. The Gain D/A is stable and repeatable, but not monotonic.

approach

[MENU] (SETUP) (AMP)

choose

(POS) (NEG) (FAST) * (SLOW) * (GAIN)
 *Not available in the Model 1002.

GAIN

(COLLECT) (#)

Press the (#) key and assign a number between 3.5 and 1230 for the gain setting, then press ENTER.

If the Command Line is correct, press ENTER again to store the value.

now

press the COLLECT soft key to see the effect of gain changes.

Use the ↑ and ↓ arrows to make fine adjustments in the Gain. It helps to press the COLLECT soft key after each adjustment to clear data and restart collect.

OTHER KEYS

Press ENTER.

finally

Press CLEAR ENTRY to return to the Setup dialog line or MENU to exit the dialog.

3.2 SCA

This key lets you set or change the SCA's:

- LLD limits
- ULD limits*.

LLD means Lower Level Discriminator and ULD means Upper Level Discriminator. These two together set a "window" for conversion of input signal energies to a digital address.

Any inputs that are below the LLD setting or above the ULD setting will not be converted in PHA or counted in MCS.

If you press either LLD or ULD, you will see its current setting in percent and you will be offered the choice of COLLECT or a numeric entry (#).

Pressing the COLLECT soft key at any point in the SCA dialog will clear data and start collect so that you can see the effect of the changes. Note that this Collect shows 100% on the dead time meter because it does not record Live Time.

To change the setting, use the ↑ and ↓ arrows or press (#) and the CLEAR ENTRY key, then enter a number between 0 and 110 (%) and press ENTER. If the Command Line is correct press ENTER again.

Now press the COLLECT soft key and use the front panel ↑ and ↓ arrows to slowly change the displayed setting. It will be easier to see the changes if you press the COLLECT soft key occasionally to clear the display.

*The LLD and ULD parameters are set using a Digital to Analog Converter. Although the dialog will allow any number within the parameter's range to be entered, the Converter will use the nearest value within its resolution.

Because of this, you may find that the value used by the Series 10 is not exactly the same as the value you entered.

approach [MENU] (SETUP) (SCA)

choose (LLD) (ULD)

LLD or ULD (COLLECT) (#)

Press the (#) key and assign a number between 0 and 110 (% of ADC's full scale), then press ENTER.

then If the Command Line is correct, press ENTER to store the value.

now Press the COLLECT soft key to see the effect of the change.

Use the ↑ and ↓ arrows to make fine adjustments in LLD or ULD. It helps to press the COLLECT soft key after each adjustment to clear data and restart collect.

finally

Press CLEAR ENTRY to return to the Setup dialog line or MENU to exit the dialog.

3.3 ADC

Sets the ADC parameters.

- ZERO*** ZERO shifts the ADC zero relative to zero volts input (the zero intercept). The range is $0 \pm 5\%$ of full scale input, in steps of 0.04%. For greatest accuracy it should be reset whenever the ADC Gain is changed, but it is not critical. The ADC zero setting method will be found in appendix I.
- OFFSET** OFFSET relates memory channel zero and the ADC channel conversions. The range is 0 to 4000 channels, which is used by the processor in multiples of 4 channels. The effect of Offset is to shift the spectrum by the selected number of channels.
- GAIN** GAIN sets the ADC's full-scale resolution; that is, the number of parts that the full-scale input is divided into. The higher the gain, the smaller the voltage increment from channel to channel and the better the resolution. You have a choice of four gains.
- PHA** PHA selects the Pulse Height Analysis Mode of data collection. Stores only inputs that are within the limits set by the SCA.
- MCS** MCS (Models 1002 and 1004 only) selects the Multichannel Scaling Mode of data collection. Stores only inputs that are within the limits set by the SCA.
- ADD** ADD adds incoming data to the data already in memory.
- SUB** SUB subtracts incoming data from the data already in memory.

*The ADC ZERO is set using a Digital to Analog Converter. Although the dialog will allow any number within the parameter's range to be entered, the Converter will use the nearest value within its resolution.

Because of this, you may find that the value used by the Series 10 is not exactly the same as the value you entered.

approach

[MENU] (SETUP) (ADC)

choose

(ZERO) (OFFSET) (GAIN) (PHA) (MCS)

MCS is seen only on the Models 1002 and 1004.

ZERO

Assign a number (0±5% of the ADC's full scale input) and press ENTER.

OFFSET

Assign a number between 0 and 4000 and press ENTER.

GAIN

(512) (1024) (2048) (4096)

Choose one and press ENTER. 2048 and 4096 are not allowed on the Model 1002.

PHA or MCS

(ADD) (SUB)

Choose one and press ENTER.

finally

Press CLEAR ENTRY to return to the Setup dialog line or press MENU to exit the dialog.

3.4 STATUS

The STATUS key displays all current parameters in place of the spectrum. The Soft Key Line will still show the current branch of the SETUP menu.

To change any of the SETUP parameters, you can:

- select any soft key in this branch;
- press ETC to go on with this branch;

Memory (section 2.7) and Preset (section 2.8) can't be changed through Setup; they have separate hard keys. TAG is set in READ OUT (section 2.2) and is incremented by one at the start of each Collect cycle.

status readout

The Status Page is read out with the spectrum data. It is also read in with the spectrum, except that the first line of the page, the HVPS on/off status, and the EIA parameters are disregarded.

In addition to the Status Page, the Data ID, the ECAL coefficients, and the Start of Collect time are read out and in.

This Status page readout feature lets you save a set of Collect parameters for later use. Simply assign the parameters and do a short no-data collect. These parameters can then be read in any time you want to use them.

approach

[MENU] (SETUP) (STATUS)

Default status page:

```

MEMORY 1/1 V1000-Xn dd mmm yy hh:mm
AMP: INPUT= POS TC=SLOW GAIN= 3.5000
SCA: LLD= 0% ULD= 110.0%
ADC: GAIN=4096 OFFSET= 0 ZERO= 0%
      PHA ADD PRESET= 1000s LT
HVPS: + 0V OFF STABLZ OFF
MODE: IDLE TAG= 0 EIA: 300
      AMP SCA ADC STATUS ETC

```

```

Memory: full Model and firmware version date time
Amp input: positive*; time constant (shaping): slow*; gain = 3.5
SCA LLD set for 0%; ULD set for 110%
ADC gain = 4096*; offset = none; adc zero = 0%
  data acquisition: PHA ADDitive preset = 1000 live seconds
HVPS: positive high voltage (+)*; set for 0 volts; currently OFF
Series 10 currently IDLE readout TAG number is 0; EIA Baud = 300
This last line is the Soft Key Line.

```

*Default amplifier shaping, ADC gain, and HVPS polarity depend on the setting of the HVPS jumper plug; see appendix B. The values shown here are for the Models 1003 and 1004 high-range jumper setting as shipped from the factory.

3.5 HVPS

HVPS, together with the rear panel HV ON switch, enables and disables the High Voltage Power Supply and set its output voltage. The output polarity and range are set by the HVPS jumper (see appendix B).

meter

A high-voltage meter reading, accurate to within 10% is always shown at the top left corner of the display when the HVPS is on.

HV inhibit

The rear panel HV INHIBIT connector must be an open circuit or at a high TTL level to enable the HVPS. A low-level TTL signal (for instance, from a Model 1786 LN₂ Monitor) at the connector will turn off (inhibit) the HVPS.

range

The low range is 25 to 1250 volts; it is used with a Sodium Iodide (NaI) detector. The high range (Models 1003 and 1004) is 1200 to 5000 volts; it is used with a Germanium (Ge) detector.

ON

ON enables the HVPS; the rear-panel power switch must be in the HV ON position to produce the HV output. The full output voltage will be reached in about 8-10 seconds.

OFF

OFF disables the HVPS.

SET

SET is used to set the output voltage level.

STABLZ

STABLZ is used only with an Americium-doped Sodium Iodide detector. The Stabilizer can be turned ON or OFF. Requires internal calibration to the characteristics of the source detector and photomultiplier. Refer to the Stabilizer manual for operating instructions.

error

An incorrect setting will cause an "ERR n" message (appendix C.1) to be displayed.

Note

Some high-resolution detectors are affected by the small amount of ripple present in the high range. A Model 1083 Filter box can be placed in the HV cabling between the Series 10 and the detector/preamp to achieve optimum detector performance. The filter has two SHV connectors and is not polarized; it can be connected in either direction. It is not be used with photomultipliers or any detector that draws more than a few microamps of current from the HVPS.

approach [MENU] (SETUP) (ETC) (HVPS)

choose (ON) (OFF) (SET) (STABLZ)

ON or OFF Press ENTER.

SET Assign a number matching the voltage required by the detector and press ENTER twice.

STABLZ (ON) (OFF) Choose one; press ENTER.

finally Press CLEAR ENTRY to return to the Setup dialog line or MENU to exit the dialog.

3.6 EIA

Sets the EIA's output for:

- Baud Rate - 110, 300, 600, 1200, or 2400
- Character Length - 7 or 8
- Parity - off, even, or odd

These parameters must be set to match the needs of the EIA device being used. You will find the device's parameters listed in its operating manual. Note that the Computer format requires 8-bit character length.

The EIA connector (see Appendices E and F) is designed to interface directly to EIA terminals. The Series 10 emulates a modem.

The TAPE connector's parameters are set for the Model 5421M and cannot be changed. The TAPE connector is the port for an FSK analog circuit designed for compatibility with the Model 5421M only.

approach

[MENU] (SETUP) (ETC) (EIA)

choose

(BAUD) (LENGTH) (PARITY)

BAUD

(2400) (1200) (600) (300) (110)

Select one and press ENTER.

LENGTH

(7) (8)

Select one and press ENTER.

PARITY

(OFF) (EVEN) (ODD)

Select one and press ENTER.

finally

Press CLEAR ENTRY to return to the Setup dialog line or MENU to exit the dialog.

3.7 CLOCK

Used to set the Series 10's internal clock and calendar to current values.

The clock and calendar will continue to update even with the rear panel power switch at OFF, as long as the Series 10's batteries are supplying power.

synchronizing clocks

If you are synchronizing to an external clock, the final ENTER in the time dialog is the reference point for setting the internal clock to zero seconds.

approach

[MENU] (SETUP) (ETC) (CLOCK)

choose

(TIME) (DATE)

TIME

Assign hours (0-23) and press ENTER. Assign minutes (0-59) and press ENTER. Don't enter leading zeros.

Sync Point

If the Command Line is correct, press ENTER to execute.

DATE

Assign day (1-31) and press ENTER. Assign month (1-12) and press ENTER. Assign year (0-99) and press ENTER. Don't enter leading zeros.

then

If the Command Line is correct, press ENTER to execute.

finally

Press CLEAR ENTRY to return to the Setup dialog line or MENU to exit the dialog.

3.8 DEFAULT

The DEFAULT key returns all parameters to the factory default condition.

Some of the default parameters are different for the two types of detectors: Sodium Iodide or Germanium. Amp shaping, ADC gain, and HVPS range and output polarity will be set according to the position of the HVPS jumper (See appendix B) when DEFAULT is pressed.

DEFAULT PARAMETERS

The data spectrum, ROIs, memory assignment, data ID, Use Functions, and Execute Sequences are as last set. The time and date will be current. The default parameter values are:

		HVPS Jumper		Model
		<u>1 kV</u>	<u>5 kV</u>	<u>1002</u>
AMP	POSitive input Gain = x3.5 shaping =	FAST	SLOW	FAST
SCA	LLD = 0% ULD = 110%			
ADC	Offset = 0; Gain = Zero = 0; PHA, ADD Preset = 1000 sec LT	512	4096	1024
HVPS	HV OFF; volts = 0 polarity = jumper plug setting Stabilizer OFF			
MODE	Idle			
TAG	= 0			
EIA	Baud = 300 Length = 7 data bits Parity = even			

approach `[MENU] (SETUP) (ETC) (DEFAULT)`

choose DEFAULT and press ENTER.

All parameters will be set to their factory default values (see the opposite page).

Default status page:

```

MEMORY 1/1 V1000-Xn dd mmm yy hh:mm
AMP: INPUT= POS TC=SLOW GAIN= 3.5000
SCA: LLD= 0% ULD= 110.0%
ADC: GAIN=4096 OFFSET= 0 ZERO= 0%
      PHA ADD PRESET= 1000s LT
HVPS: + 0V OFF STABLZ OFF
MODE: IDLE TAG= 0 EIA: 300
      AMP SCA ADC STATUS ETC
    
```

Memory: full Model and firmware version date time
 Amp input: positive*; time constant (shaping): slow*; gain = 3.5
 SCA LLD set for 0%; ULD set for 110%
 ADC gain = 4096*; offset = none; adc zero = 0%
 data acquisition: PHA ADDitive preset = 1000 live seconds
 HVPS: positive high voltage (+)*; set for 0 volts; currently OFF
 Series 10 currently IDLE readout TAG number is 0; EIA Baud = 300
 This last line is the Soft Key Line.

*Default amplifier shaping, ADC gain, and HVPS polarity depend on the setting of the HVPS jumper plug; see appendix B. The values shown here are for the Models 1003 and 1004 high-range jumper setting as shipped from the factory.

These functions are used to set the data collection parameters, to analyze the data in memory, and to diagnose the analyzer's operation.

MENU choices	SETUP	ECAL	COMPUTE	ANALYZE	ETC
		STRIP	XFER	XCHANGE	ETC
	DIAGNOSE		EXIT		ETC

ETC Changes each dialog line to the next line. The last ETC returns to the first line.

EXIT Leaves the dialog.

SETUP Discussed separately in section 3.

4.1 ECAL Calibrates the spectrum in energy units (PHA) or time units (MCS - Models 1002 and 1004 only).

4.2 COMPUTE Computes the Area or Integral of the current ROI or (in the Models 1002 and 1004 only) solves a defined Function.

4.3 ANALYZE Models 1002 and 1004 only. Defines a Function equation, learns or executes an analyzer Sequence, reads a Function or Sequence in or out.

4.4 STRIP Subtracts data in one memory segment from another segment.

4.5 XFER Copies data in one memory segment into another segment.

4.6 XCHANGE Model 1004 only. Exchanges the contents of the display memory with the contents of the background memory.

4.7 DIAGNOS performs diagnostic tests on the analyzer.

4.1 ECAL

Energy calibrates a PHA spectrum and, in the Models 1002 and 1004, Time calibrates an MCS spectrum. When a spectrum has been calibrated, the cursor location will be shown as calibration units instead of as a channel number. This information helps you to identify an unknown radioisotope.

The Series 10 uses a first order (straight line) equation, so you will have to enter two known energy points (for example, from a radioisotope standard), one at each end of the spectrum, to define the line. For a better definition, enter more than two points.

The equation is used for all displayed or read out segments of the memory. Since cursor location and channels are numbered relative to the displayed memory segment, a spectrum can be collected in one quarter and transferred to or overlapped with another quarter with the ECAL or channel readout being the same. If a spectrum is viewed with a smaller memory segment than it was collected in, the ECAL readout may not be correct.

When you press ECAL you will see the current calibration equation on the Command Line. You can accept the old equation or enter a new one.

The IS key makes the cursor address read as channel numbers or as calibration units.

The AT key assigns calibration values to specific channel locations.

The CLEAR key clears the old equation from memory.

Changing Units

After the calibration is made, you can re-enter the dialog to select a different calibration unit. The display's "C@" line will automatically change to show the correct value using the new unit.

Adding Points

If you find that the calibration is not correct at some known point in the spectrum, go into the AT dialog again and add one or more points; the more points entered the better the equation's fit.

Calibrated Read Out

If you enable ECAL before READ OUT, the equation will be read out to one decimal place. All channel addresses will be reported in calibration units.

approach `[MENU] (ECAL)`
 The current calibration equation will be displayed.

accept old To accept it, press IS, ENERGY (or TIME), select a unit, press ENTER, then MENU.

or choose `(IS) (AT) (CLEAR)`
 CLEAR Press ENTER to erase the old calibration from the memory.

IS `(CHANNEL) (ENERGY) (TIME)`
 to turn off Press CHANNEL, ENTER, and MENU to turn ECAL off while retaining the current equation.

if energy `(eV) (keV) (MeV)`
 if time `(us) (ms) (sec)` Models 1002 and 1004 only

then Choose one calibration unit and press ENTER.
 The dialog will return to the first ECAL line.

to calibrate Press `(AT)`

AT Choose `(CURSOR) (#)`

if cursor Press ENTER to assign current cursor channel number.

or if (#) Assign a channel number and press ENTER.

then Assign the calibration value and press ENTER.

finally
 - If the Command Line is correct, press ENTER to execute.

use equation After entering at least two calibration points, press MENU to leave the dialog.

4.2 COMPUTE

Used to calculate the Area or Integral of the current ROI (the ROI containing the cursor or the next one to its right). If no ROIs have been entered or if INTENSIFY is off, the Integral will be calculated for the entire memory segment. Methods of calculation will be found in appendix J.

Compute is also used to show time information for the memory segment's collect cycle and, in the Models 1002 and 1004 only, to calculate a defined Function.

area/integ

The results of the calculation are displayed until Compute is turned OFF. The results will be included in any ROI readout whether or not Compute is on.

If overlapping ROIs have been entered, the cursor must be in a channel higher than the lower ROI's stop channel in order to calculate the higher ROI's Area or Integral.

The Integral of an ROI is the total number of counts in the ROI. It is displayed with the first and last channels of the ROI. This allows you to find all ROIs previously entered.

The Area of an ROI is its Integral minus its background and includes a percent error (% err is not read out). You can compute the Area based on either three (3 BKG) or five (5 BKG) background channels. For Preset, Function equations, and Read Out, only the 3 BKG area is calculated.

function

In the Models 1002 and 1004, FUNC will solve the specified defined Function (section 4.3a). The solution will be displayed and will be updated as the data changes. The equation and its solution can be read out. To include a Function in the ROI readout, enable the Function immediately after pressing COMPUTE.

off

With COMPUTE enabled, OFF will turn off the displayed evaluation, but the Function can still be read out. To omit the Function from the readout, go into the Menu again and press COMPUTE, then OFF.

time

The TIME key is used to display start of collect time, elapsed Live and True time, and in MCS, elapsed sweeps

note

With Function enabled, the computation can slow the response to soft key commands. It may be necessary to disable Compute (by pressing MENU), issue the soft key commands, then re-enable the Function.

- approach [MENU] (COMPUTE)
- choose (AREA) (INTEG) (FUNC) (OFF) (TIME)
- AREA (3_BKG) (5_BKG)
Choose one and press ENTER.
- INTEG Press ENTER
- FUNC (Models 1002
and 1004 only) (F1) (F2) (F3) (F4) (F5)
and press ENTER.
- TIME Press ENTER.
- OFF Turns off Function's display or display and readout
(see "off" on the left-hand page).

4.3 ANALYZE (Models 1002 and 1004 only)

Analyze lets you define up to 5 Functions (equations) or learn or execute up to 5 Sequences (tasks).

DEFINE Define is covered in section 4.3a. Several sample equations are included in appendix K

LEARN Learn is covered in section 4.3b.

EXECUTE Execute is covered in section 4.3c.

SAVE SAVE reads out a binary-encoded record of any defined Sequence or all 5 Functions (defined or not) to a Model 5421M Cassette Recorder (TAPE) or to any EIA recording device for future use.

LOAD LOAD reads in a saved Sequence or all Functions from a Model 5421M Cassette Recorder (TAPE) or any EIA device on which the record was made. A recorded TAG number will be read back in; it can be seen by enabling STATUS (section 3.4).

predefined equations The Models 1002 and 1004 include a set of equations for Enrichment Calculation, which are loaded into the parameters memory each time the rear panel power switch is moved from RST to ON. These equations may be cleared and others entered in their place. See appendix K for the five Enrichment equations and for several other useful equations.

Available in Models 1002 and 1004 only.

approach	[MENU] (ANALYZE)
choose	(DEFINE) (LEARN) (EXECUTE) (SAVE) (LOAD)
DEFINE	See section 4.3a.
LEARN	See section 4.3b.
EXECUTE	See section 4.3c.
SAVE or LOAD	(SEQUENCE) (FUNCTIONS)
SEQUENCE only	(S1) (S2) (S3) (S4) (S5)
SEQUENCE or FUNCTIONS	(EIA) (TAPE)
SAVE only	Enter a Tag Number if desired, and press ENTER.
<hr/> finally	If the Command Line is correct, press ENTER to execute.

4.3a DEFINE (Models 1002 and 1004 only)

		Defines up to five Functions (equations) of up to 37 characters each. A Function can be displayed and read out (section 4.2, COMPUTE), or used for a PHA preset (section 2.8, PRESET). The default and other useful equations are defined in appendix K.
Function Chaining		Any Function can include the results of other Functions at any point in its calculations; use FUNC.
END		END ends the equation.
CLEAR		CLEAR ALL erases the current equation from memory and allows a new equation to be defined in its place. CLEAR ONE corrects an error by erasing only the last displayed step of the current equation.
CONTINU		CONTINU allows you to define the Function using the 10 digits, the decimal point (.), the CHS (change sign), and EEX (base10 exponent) keys on the front panel, and any of the terms shown under CONTINU,. The terms found under CONTINU are defined as:
CL	(C)	Channel number* of the cursor's location at the time the equation is evaluated.
CNTS@CL	(@C)	Counts at the cursor's location at the time the equation is evaluated.
INTEG/AREA	(I/A)	Integral or Area of an ROI (enter the ROI number).
#		Used for numeric entries.
* / + -		Arithmetic operators.
()		Parentheses used to set the order of calculation, which is performed left to right.
LIVETIME/ TRUETIME	(LT/TT)	Value of Live (LT) or True (TT) Time in fractional seconds (resolution = 0.015 s).
FUNC	(Fn)	Use the results of equation Fn (enter the Function number). You can only use a Function number higher than the current one.
@LOW	(@Ln)	Low channel counts of an ROI (enter the ROI number).
@HIGH	(@Hn)	High channel counts of an ROI (enter the ROI number).
@#	(@n)	Counts in channel "n"* (enter the channel number).
LOW	(Ln)	Number of the lowest (first) channel* in an ROI (enter the ROI number).
HIGH	(Hn)	Number of the highest (last) channel* in an ROI (enter the ROI number).
EXP	(EXP[n])	Takes the natural log e of the expression following the opening parenthesis (enter the expression; follow it with a closing parenthesis).
SQR	(SQR[n])	Takes the square root of the expression following the opening parenthesis (enter the expression; follow it with a closing parenthesis).

*Channels are numbered as if FULL memory was selected.

Available in Models 1002 and 1004 only.

approach

[MENU] (ANALYZE) (DEFINE)

choose

(F1) (F2) (F3) (F4) (F5)

Displays current equation.

choose

(END) (CLEAR) (CONTINU)

END

Accepts the equation; no further action is needed

CLEAR choose one

(ALL) (ONE)

CONTINU

choose one at a time

(CURSOR) (INTEG) (AREA) (#) (ETC)

(*) (/) (+) (-) (ETC)

([) (]) (LIVETIME) (TRUETIME) (ETC)

(FUNC) (@) (LOW) (HIGH) (ETC)

(EXP) (SQR) (ETC)

finally

When the equation has been defined, press END to exit the dialog.

note

ROI 0 means the current ROI at the time the calculation is done. That is, the ROI that the cursor is in, or if the cursor is not in an ROI, the next one to the right of the cursor.

4.3b LEARN (Models 1002 and 1004 only)

Used to learn up to five Sequences (tasks) of up to 64 steps each, where a step is an Series 10 dialog function. The scan-arrow, INDEX, EXPAND, and INTENSIFY keys are not learnable.

Sequence Chaining

The "EXECUTE Sn" function can be used as a step in one Sequence to call and execute another Sequence. At the end of the first Sequence's execution, the second Sequence will be executed automatically.

Note

Do not place any steps after the "EXECUTE Sn" statement; the second sequence can't return to the first sequence.

EDIT

EDIT is used to define or change a Sequence. The EDIT functions are:

CHANGE

CHANGE deletes the current (displayed) step and allows you to enter another in its place.

INSERT

INSERT adds a step following the current step, but before the "end of sequence" step. Used to define a Sequence.

INIT

INIT erases a defined Sequence and allows another one to be learned in its place.

END

END inserts the "end of sequence" step at any point in the Sequence. Used to place the end of the Sequence at an earlier point in the list of steps without having to delete each of the remaining steps.

DELETE

DELETE erases the current step from the memory.

The remaining first-line terms are:

NEXTLINE

NEXTLINE displays the next step in the Sequence.

EXIT

EXIT leaves the Learn function and retains all steps entered in the Sequence.

ABORT

ABORT leaves the Learn function without accepting any of the entered changes.

TOP

TOP moves to the first step in a defined task.

Available in Models 1002 and 1004 only.

approach

[MENU] (ANALYZE) (LEARN)

choose

(S1) (S2) (S3) (S4) (S5)

and press ENTER. The first step of the current sequence is displayed; press EXIT and ENTER to accept the sequence.

now choose

(EDIT) (NEXTLINE) (EXIT) (ABORT) (TOP)

and press ENTER.

NEXTLINE or TOP

No further action needed.

EXIT or ABORT

Press ENTER to confirm.

EDIT

(CHANGE) (INSERT) (INIT) (END) (DELETE)

CHANGE or INSERT

Press any function key and complete its dialog.

INIT or END

Press ENTER to confirm.

DELETE

No further action needed.

4.3c EXECUTE (Models 1002 and 1004 only)

Execute performs a previously learned Sequence (see section 4.3b).

sequence cycling

The Sequence's execution can be repeated a specified number of times (cycles). If the Sequence's last step is EXECUTE S"n", where "n" equals the current or earlier executed Sequence number, the Sequence will continue cycling until manually stopped or aborted.

During execution, the display shows each step in the sequence. When a step is one that takes time, such as collect or read out, the next step will be displayed but may not become active until the preceding step is finished.

available keys

During execution, the scan-arrow, INDEX, ENTER, CLEAR ENTRY, STOP, and ABORT keys are available to you; all other keys are locked out.

EXECUTE

EXECUTE starts performance of a defined Sequence and lets you specify how many times it is to be repeated if the Sequence does not chain to other Sequences.

STOP

STOP ends a Sequence when its current cycle finishes.

ABORT

ABORT ends the current Sequence immediately.

Available in Models 1002 and 1004 only.

approach

[MENU] (ANALYZE) (EXECUTE)

choose

(S1) (S2) (S3) (S4) (S5)

now

Assign the number of cycles and press ENTER.

finally

If the Command Line is correct, press ENTER to execute.

During Execution

(STOP) (ABORT) SEQUENCE Sn

STOP

Terminates the current Sequence at the end of the current cycle. Press ENTER to execute.

ABORT

Terminates the current Sequence immediately. Press ENTER to execute.

4.4 STRIP

Strip is usually used to subtract a fraction of the data in one memory segment from the data in another segment of the same size. The data, but not the time information, in the first segment will change; the data in the "with" segment will not change.

The factor is the term used to multiply the "with" (reference) segment's data by before stripping it from the data spectrum segment. The factor's range is $\pm 1.17 \times 10^{-30}$ to $\pm 1.677 \times 10^7$. The Strip algorithm is in appendix J.

A positive strip factor causes a subtract of one segment from another. If the result is negative, it will be stored as zero.

Using a negative strip factor causes the two segments to be added together.

If a segment in active Collect or Read is included as part of the dialog, the Strip will be performed when Collect or Read ends.

full-bkg

The FULL-BKG key (Model 1004 only) allows the full background memory to be stripped from the full display memory.

normalizing data

A spectrum can be normalized by stripping a region from itself using a negative factor.

approach

[MENU] (ETC) (STRIP)

choose

(HALF) (QUARTER) (EIGHTH) (16TH) (FULL-BKG)

Assign the segment number to be stripped from, press ENTER. This step is not done with FULL-BKG.

Assign the reference memory number, press ENTER. This step is not done with FULL-BKG.

now

Assign the strip factor which the reference memory is to be multiplied by. Press ENTER.

finally

If the Command Line is correct, press ENTER.

4.5 XFER

Used to copy data from one memory region to another; the data in the "from" region is not erased or changed.

Any two memory segments of the same size can be transferred. To transfer data between the foreground memory and the background memory, use XCHANGE (Model 1004 only).

Choose a memory segment, then enter the "from" segment number and the "to" segment number. For instance, to copy data from the first half to the second half, press HALF, 1, ENTER, 2, ENTER. When you enter the second number, the data will be copied to the "to" segment.

If a segment in active Collect or Read is included as part of the dialog, the Transfer will be performed when Collect or Read ends.

approach

[MENU] (ETC) (XFER)

choose

(HALF) (QUARTER) (EIGHTH) (16TH)

then

Assign the "from" segment number, press ENTER.

Assign the "to" segment number, press ENTER.

finally

If the Command Line is correct, press ENTER to execute.

4.6 XCHANGE (Model 1004 only)

Exchange moves background memory data to the display memory and at the same time moves the display memory data to the background memory.

You can exchange full memories, either half, or any quarter, eighth, or sixteenth of the memories.

If a segment in active Collect or Read is included as part of the dialog, the Exchange will be performed when Collect or Read ends.

Available in the Model 1004 only.

approach

[MENU] (ETC) (XCHANGE)

choose

(FULL) (HALF) (QUARTER) (EIGHTH) (16TH)

full

Press ENTER.

other keys

Assign the segment number of the display memory,
press ENTER.

Assign the segment number of the background memory,
press ENTER.

finally

If the Command Line is correct, press ENTER to
execute.

4.7 DIAGNOSE

DIAGNOSE allows you to check the analyzer's operating condition.

- battery** Displays the internal battery's voltage. If the charger is connected, the charge voltage of 7-8 V is displayed. If the Model 1082 Battery Pack is connected, the display shows the higher of the internal or the external battery voltage.
- If the voltage is less than 6 V, the message "BATLOW" appears on the status line. At about 5.6 V, the Series 10 will switch to STANDBY to save all data and parameters; no functions can be performed until the charger is connected.
- supply** Checks the +5 V, ± 12 V, and ± 24 V power supply lines for correct voltage. If the ± 24 V supply is correct, nothing is displayed.
- ram** Checks the Random Access Memory chips. Displays either "RAM OK" or the first error found and its decimal address (see appendix C.6).
- prom** Checks the Programmable Read Only Memory chips. Displays either "PROM OK" or the first error found and the number of the faulty chip together with either an "M" for PROMs on the CPU board or an "R" for PROMs on the RAM board.
- adc** Tests the operation of the ADC and amplifier. Remove the input signal and set the pole/zero control fully counterclockwise before starting the test. The test puts 64 counts in each of the first 256 channels; the data will not be seen if VFS = 64. Refer to appendix C.2 and C.3.
- sca** Tests the operation of the LLD and ULD. Requires an input from a random source which covers the full range of the amp/ADC. Refer to appendix C.4 for the test procedure.
- eja/fsk** Performs a test on the EIA and Cassette ports. Requires use of I/O Test Cable supplied with the Model 1081 Service Kit. Refer to appendix C.5 for the test procedure.

approach

[MENU] (ETC) (ETC) (DIAGNOSE)

choose

(BATTERY) (SUPPLY) (RAM) (PROM) (ETC)
 (ADC) (SCA) (EIA/FSK) (ETC)

ADC or SCA

(STOP) stops at the end of the current sweep.

REFERENCE

See appendix C for details of the diagnostics.

Appendix A SPECIFICATIONS

A.1 PROCESSOR

DATA MEMORY	4096 Channels; $2^{24}-1$ counts/channel; full memory is divisible into 1/16s, 1/8s, 1/4s, or 1/2s
STORAGE MODES	PHA add or subtract; MCS add or subtract (Models 1002 and 1004 only)
PRESETS	Choice of: Live Time; True Time; Counts in a Channel; Integral of ROI; Area of ROI; or USE Function. For MCS: number of sweeps and dwell time (USE and MCS only in Models 1002 and 1004)
DISPLAY	Liquid Crystal Display (LCD); 12.7 cm (5 in.) diagonal measurement; Direct Memory Access (DMA) interface
Data Display:	Linear and Log vertical scales Intensified ROIs with histogram bars Digitally-controlled cursor Vertical Resolution 1 part in 64 Horizontal Resolution 1 part in 200 Horizontal expansion of 200 channels; resolution 1:1
Character Display:	8 lines of alphanumeric characters 40 characters per line, max., determined by display mode
ROIs	Maximum of 50; can be overlapped
PERCENT DEAD TIME	Moving Bar (in PHA mode only)
BATTERY BACKUP	In standby power mode, all parameters and data are retained. The clock and calendar are active in all power modes.

STANDARD FEATURES (1002, 1003, 1004)	INTEGRAL NET AREA	Full or ROI Full or ROI - 3 or 5 end points averaged for display
	SPECTRUM STRIP	Any memory group from any similar sized memory group
	ENERGY CALIBRATION INPUT/OUTPUT	2 point; Units: eV, keV, or MeV EIA RS232C port
	NaI STABILIZER	FSK cassette tape port
	PULSE HEIGHT ANALYSIS	HVPS gain control Energy vs. counts (PHA)

ADDITIONAL FEATURES (1002 and 1004 only)	LEARN/EXECUTE	Up to 5 sequences
	DEFINE/USE	Up to 5 functions
	MULTICHANNEL SCALING	Time vs. counts (MCS)
	TIME CALIBRATION	2 point; Units: μ s, ms, or s
	4K BACKGROUND MEMORY	Exchangeable with display memory; Model 1004 only.

CONNECTORS	EIA - 25-pin
	CASSETTE - 9-pin
	PREAMP POWER - 9-pin
	HVPS - SHV
	AMP In - BNC
	GATE In - BNC
	HV Inhibit - BNC
	Power - 5-pin DIN

STANDARD ACCESSORIES	AC Charger/Power Supply
	FSK Cable for Model 5421M
	External dc power adapter cable*
	Nylon Carrying Case*
	High Voltage Filter Box (Model 1083)*
	*These accessories are not supplied with the Model 1002

PHYSICAL	SIZE: 11.4 x 22.9 x 27.9 cm (4.5 x 9 x 11 in.)
	WEIGHT: approximately 5.3 kg (11.6 lb.)
	POWER:
	<ul style="list-style-type: none"> • 10 hour operation from 5 F-size NiCad batteries • Overnight recharge using external charger • 115 V - 230 V ac operation possible from charger • 12 V operation from external source

OPERATING TEMPERATURE - 0 to 45° C

RFI/EMI EMISSION Complies with FCC rules (47 CFR Part 15) for Class A equipment

A.2 AMPLIFIER Programmable unipolar spectroscopy amp with gated baseline restorer (older units use a programmable bipolar amp without the restorer)

SIGNAL INPUT Accepts positive or negative tail pulses from the associated preamplifier; rear panel BNC

Amplitude: 0 to ± 12 V maximum
Rise Time: Less than 0.5 μ s
Decay Time Constant: 40 μ s to ∞
Input Impedance: ≈ 1.5 k Ω

OUTPUT 0 to +5 V, full scale; directly connected to the ADC's input. Rear panel test point and Pole/Zero pot to adjust for the decay time constant of the input signal.

GAIN 3.5X to 1230X corresponding to a full scale input of 2.8 V to 8.2 mV; programmable

INPUT POLARITY Positive or negative; programmable

PULSE SHAPING Fast (NaI) or Slow (Ge); programmable; (1002- Fast only)

<u>Characteristic</u>	<u>Fast</u>	<u>Slow</u>
Time to Peak	4.4 μ s	7.5 μ s
(bipolar amp)	3.2 μ s	12.5 μ s)
(Time to Crossover	5.2 μ s	21.0 μ s - bipolar only)
Pulse Width	12.5 μ s	25.0 μ s
(bipolar amp)	18.0 μ s	80.0 μ s)
Width measured at 0.2% of full scale output		

INTEGRAL NON-LINEARITY Slow Shaping: $\leq \pm 0.05\%$ of full scale output range
Fast Shaping: $\leq \pm 0.10\%$ of full scale output range

OVERLOAD RECOVERY Recovers to within $\pm 2\%$ of full scale output from X200 overload in three unipolar (two bipolar) non-overloaded pulse widths when properly pole-zeroed.

NOISE CONTRIBUTION Slow Shaping: $\leq 20 \mu\text{V}$ (17.75 μV bipolar) true rms
referenced to the input at 1200 gain
Fast Shaping: $\leq 35 \mu\text{V}$ (44.4 μV bipolar) true rms
referenced to the input at 1200 gain

PEAK SHIFT $\leq 0.05\%$ of full scale, to 50 kHz (includes ADC)

DRIFT GAIN: $\leq \pm 0.02\%$ per $^{\circ}\text{C}$
ZERO: $\leq \pm 25 \mu\text{V}$ (0.0005%) per $^{\circ}\text{C}$
 ($\leq \pm 50 \mu\text{V}$ [0.001%] per $^{\circ}\text{C}$ bipolar)

SPECTRUM
BROADENING The FWHM of the ^{60}Co 1.33 MeV peak for an incoming count
rate of 2 kcps and a pulse height of 90% of full scale
will be less than 200 eV broader than a spectrum taken
with an 8K ADC and a Spectroscopy Amplifier with Unipolar
shaping comparable to the SLOW shaping of the Series 10
amplifier.

PEAK SHIFT With a count rate change of 2 kcps to 50 kcps, the FWHM
will typically change less than 30% and the peak will
typically shift less than 0.05%.

A.3 ADC Pulse stretcher with programmable Wilkinson converter
having a 100 MHz clock (older units with the bipolar amp
have a 50 MHz clock), 4K conversion gain, and 4K range.
The Model 1002 has 1K gain, max.

INPUT The ADC's input is normally the output of the internal
amplifier; changing three jumpers on the ADC Board allows
the the ADC to accept its input from an external source.
Rise time = 0.5 μs , min.; width = 1 μs , min.; Z_{in} =
10 kilohms, nominal. Calibrated for +5.0 V full scale.

GATE TTL input to enable conversion in PHA mode or count in
MCS mode. Open circuit or positive level enables; low
level (0 to 0.5 V) disables. For proper operation, the
Gate signal must be valid from the time of the input's
peak amplitude until the signal drops more than 10% from
the peak amplitude.

PEAK DETECT	Constant Fraction circuit. Conversion is initiated when the ADC input falls to 90% of its peak value.
SCA	<p>Programmable; sets window on ADC's input to allow conversion in PHA mode or counting in MCS mode.</p> <p>Range: 0 to 110% of ADC Full Scale input Drift: $\leq \pm 0.025\%$ of range per °C</p> <p>Resolution: LLD - 1/1024 of SCA Range ULD - 1/256 of SCA Range</p> <p>Non-Linearity: LLD - $\leq \pm 0.05\%$ of SCA Range ULD - $\leq \pm 0.25\%$ of SCA Range</p>
CONVERSION GAIN	Program selectable as 512, 1024, 2048* or 4096* Channels per 5 volt input. *Not on Model 1002.
CONVERSION RANGE	Programmed by memory group selected at the start of Collect; 256-4096 channels in binary steps.
DIGITAL OFFSET	Program selectable from 0 to 4000 in 4 channel increments
ZERO	Program selectable; range = 0 to $\pm 5\%$ of full scale input in steps of $\pm 0.04\%$ (1/256)
NON-LINEARITY	<p>Integral: $\leq \pm 0.025\%$ of full scale over top 99% of the input range</p> <p>Differential: $\leq \pm 1\%$ over top 99% of the input range</p>
DRIFT	<p>Zero: $\leq \pm 0.0025\%$ of full scale</p> <p>Gain: $\leq \pm 0.01\%$ of full scale</p> <p>Long Term: $\leq 0.005\%$ of full scale per 24 hours</p>
CONVERSION TIME	<p>PHA Mode: $\leq 2 + 0.01 [+0.02 \text{ bipolar}] (N + D) \mu\text{s}$ where N = Converted Address D = Digital Offset</p> <p>MCS Mode: $\leq 2 \mu\text{s}$ (Count rate to $> 200 \text{ kHz}$ with amplifier bypassed by internal jumpers - J5, J6, and J7 on ADC Board)</p>

HOLD TIME Hold time is the time needed to complete the DMA cycle after the conversion ends. Average cycle completion time (latency and cycle time) is less than 4 μ s. Direct Memory Access (DMA) logic in the Series 10 uses the ADC address (held in a latch) as the memory pointer.

ADC DEAD TIME Equal to the Linear Gate Time plus the Conversion Time plus the Hold Time; displayed as a moving bar graph during PHA data acquisition.

MCS DWELL TIME 128 μ s to 4.19 s in multiples of 64 μ s

A.4 HIGH VOLTAGE POWER SUPPLY

RANGE Dual jumper selectable
Low range: 25 to 1250 V
High range: 1200 to 5000 V (not on Model 1002)

POLARITY Positive or negative; jumper selectable

CONTROL Set via program and with rear panel HV ON safety switch

TURN ON TIME Low Range: <150 V/s
High Range: <500 V/s

CALIBRATION Low Range: within 0.1%
High Range: within 4%

RESOLUTION Within 0.4% of full scale (1 part in 256)

NON-LINEARITY <0.3% of full scale

RIPPLE AND NOISE Peak-to-peak percent of full scale, using a 1 MHz bandwidth scope:
Low Range <8 x 10⁻⁴% (10 mV P-P)
High Range <4 x 10⁻³% (200 mV P-P)

DRIFT	<0.01% per °C (after 1 hour warmup when using charger)
REGULATION	Line Regulation <0.02% Load Regulation Low Range: 0.4%, 0 to 300 μ A High Range: 1%, 0 to 25 μ A
INHIBIT INPUT	Logic Level (TTL low) or contact closure to turn High Voltage OFF
INDICATOR	Front panel meter display of output; includes polarity Meter error: < \pm 10% of full scale
STABILIZER	Provision for gain control with Americium-doped and thermistor-compensated NaI detector using the Brookhaven method (See BNL 24950). High Voltage variation: \pm 10%
CONNECTORS	OUTPUT - Rear panel SHV INHIBIT - Rear panel BNC
CONTROLS	ON/OFF - Rear panel Rotary Switch POLARITY/RANGE - Bottom panel jumper plug

Appendix B HIGH VOLTAGE POWER SUPPLY JUMPER

CAUTION Turn the high voltage OFF when changing the jumper plug.

jumper removal To remove the HVPS jumper, loosen the screw at each end of the smaller plate on the bottom of the Series 10 and pull up to remove the plate. To reinstall the plate, press its board firmly into the connector and tighten the screws.

When reinstalling the plate, seat the board fully into the connector by tightening the screws with a screwdriver. This pulls the jumper card into the socket for a sure connection. Finger-tightening these screws may result in intermittent contact.

polarity To check the HVPS polarity, look at the HVPS jumper plate. The polarity is visible through a hole in one corner of the plate as "+" or "-". The unit is shipped with the jumper set for "+".

To change the polarity, remove the jumper plate, turn it around, and reinstall it in the unit so that the other polarity sign is visible through the hole.

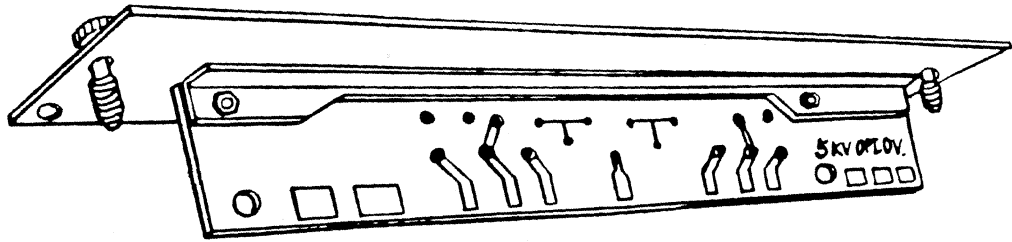
voltage range The Model 1002 is set for the low range (25 V to 1.25 kV); its HVPS can't be enabled in the high range. The Models 1003 and 1004 are shipped with the HVPS range set to high (1.20 kV to 5 kV) for use with a Germanium detector.

To change the Model 1003 or 1004 to the low range (25 V to 1.25 kV) for a Sodium Iodide detector, pull the jumper plug out of the Series 10, remove the two screws holding the board to the bracket, reverse the board, and reinstall the screws.

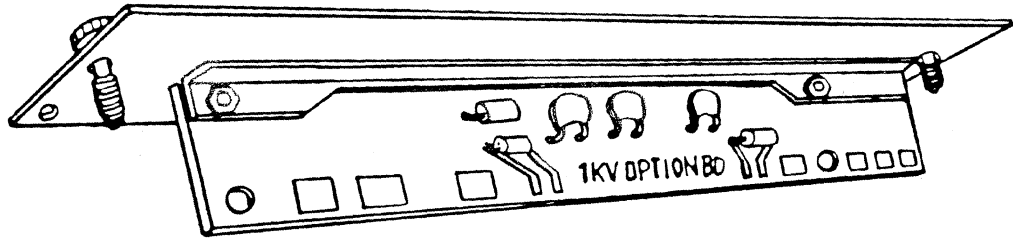
check To verify the jumper setting, select HVPS (section 3.5). The display will show the current jumper setting for both polarity and range. The HVPS does not need to be enabled for this check.

CAUTION Turn the high voltage OFF when changing the jumper plug.

5 kV Position



1 kV Position



Note: When changing the voltage range, the board must be reattached to the outside of the supporting angle bracket as shown in this detail drawing:

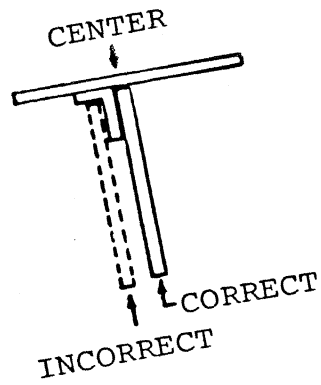


Figure B.1 HVPS Jumper

Appendix C ERROR MESSAGES

The Series 10 may display an error message during normal operation or while performing diagnostic tests (section 4.7). Except for BATLOW, all error messages are cleared by pressing CLEAR ENTRY.

Some error messages seen during normal operation are self-explanatory, such as "ADC BUSY"; other messages are covered in section C.1.

Section C.1 - Error Messages.

Section C.2 - ADC Diagnostic Tests.

Section C.3 - ADC Tests defined.

Section C.4 - SCA Diagnostic Tests.

Section C.5 - EIA/FSK Test.

Section C.6 - RAM Test.

C.1 ERROR MESSAGES DURING NORMAL OPERATION

BATLOW	Battery voltage is less than 6 V; remaining operating time is about 30 minutes.
ERR 1	Parameters not read in because: a) HVPS jumper plug is incompatible with parameters read in; polarity or range different. b) Collect is active. c) High voltage on. Both the rear panel switch and the HVPS dialog must be set OFF.
ERR 2	Stabilizer cannot be turned ON because the HVPS jumper plug is not set for POS, 1 kV range.
ERR 3	HVPS set by dialog for out-of-range voltage.
ERR 4	Stabilizer has drifted out of its correction range.
ERR 5	Illegal ROI (stop channel lower than start channel).
ERR 9	Parity error (read in).
ERR 10	Framing error (read in).
ERR 11	Parity and framing errors (read in).
ERR 12	Overrun error (read in).
ERR 13	Overrun and parity errors (read in).
ERR 14	Overrun and framing errors (read in).
ERR 15	Overrun, framing and parity errors (read in).
ERR 16	Wrong type of file being read in (for instance: Sequence file into Function file).
ERR 17	Bad data block in spectrum header being read in.
ERR 20	Overflow; function's equation is too long.

ERR 21	Illegal function call; Fn current can't be \geq Fn called.
ERR 22	Use-stack overflow; function's equation is too long.
ERR 23	Use-stack underflow; function's equation is incomplete.
ERR 24	Use-stack unresolved; for instance, more opening than closing parentheses in the equation.
ERR 25	Undefined ROI in the equation.
ERR 26	Equation operator rejected; meaningless.
ERR 30	Overflow; learn sequence is too long.

C.2 ADC DIAGNOSTICS

The diagnostics check each programmable function within the ADC separately. A built-in test pulser is used for the self tests. It should be noted that the purpose of these diagnostic tests is to find failed components. Because the test pulser may drift slightly during the test, occasional random errors may be reported. This does not necessarily indicate a problem.

The functions tested are: ADC Gain, Offset, Range, Base, Zero; the SCA LLD and ULD; and the PHA-ADD, PHA-SUB, and MCS operating modes. In addition, the ADC-to-memory interface is tested.

The status message, which will appear on the display's Status Line, has two numbers separated by a comma. The first number indicates the function, the second number indicates the value of the function. For instance, a display of "128, 0" indicates that the ADC has passed all tests.

The ten tests are executed in the order shown in table C.1. Within each test there are one or more segments, so that a failure can be clearly defined. For example, the ADC-Gain test has four segments, one for each gain setting.

If a test fails, the diagnostic stops, and the test I.D. number and segment number are displayed. Section C.3 lists and identifies the segment number for each test. If the operator does not stop the operation, the diagnostic is restarted. Each time the diagnostic is restarted, the displayed Pass Count total is incremented by one.

If the STOP key is pressed, the test will continue until an error is found or to test completion, whichever occurs first. A second press of the STOP key will then exit the diagnostic.

Table C.1
Diagnostic Test Order

<u>Function Tested</u>	<u>Test I.D. Number</u>
ADC Gain	1
ADC to Memory (add)	8
ADC to Memory (subtract)	9
Digital Offset	2
ADC Range	3
ADC Base	4
ADC Zero	5
SCA - ULD	6
SCA - LLD	7
MCS Mode	10

C.2.1 Test Setup

At the start of the diagnostic, the ADC is programmed to the following initial values:

<u>I/O Port # Hex</u>	<u>Data Hex</u>	<u>ADC Function</u>
D0	07	PHA Mode
D1	FF	Offset = 0
DC	FF	ULD = 110%
D8 DD	0 } 0	LLD = 0
DA	0	ADC Zero = -5%
D8 D9	3E } 0	AMP Fine Gain = 0.242*
D2	08	AMP Coarse gain = 24 to 190* Shaping = slow
DE	40	ADC Gain = 4K Range = 4K Base = 0

*Total amp gain: 46.

C.2.2 Test Data Generation

The ADC has a test pulse generator that is controlled by the program. By setting bit 7 of output port DE to one, a pulse is sent to the Amplifier input. During each test segment the program toggles this bit 64 times, generating pulses with a period of 480 ms. The ADC converts and stores the conversions into the data memory.

The program then locates where the data was stored. If the data is peaked within the allowed range for the setup, the program clears the data memory and proceeds to the next test segment. For a peak to be acceptable, it must have a maximum width of less than 16 channels and contain at least 60 out of the 64 possible counts. If a failure occurs, the program sets the error status and exits.

C.3 THE ADC TESTS

This section lists the setup and the expected location for the peak for each test segment. Tests and segments are listed in the order executed. Only the parameters changed from the initial values (see section C.2.1) are listed.

The location of the peak for each test is listed in two columns. The first column indicates the lowest channel that the peak is expected in. The second column (Range CH), indicates the number of channels above the minimum that the test program will search for a peak.

C.3.1 ADC Gain Test 1

<u>Segment</u>	<u>ADC Gain</u>	<u>Port D2 Data Hex</u>	<u>Peak Location</u>	
			<u>Minimum in CH</u>	<u>Range CH</u>
4	4K	08	2200	872
3	2K	0C	1100	872
2	1K	0E	550	872
1	512	0F	275	872

The location of the peak for 4K Gain is saved by the program and is used as a Reference Peak (RP) for other tests.

C.3.2 ADC to Memory - Add; Test 8 This test checks the ADC-memory interface circuits, located on the Display Processor board. The program presets the low byte of the data memory to FF (all ones) and repeats the 4K Gain Test. It then looks for data in the middle byte. The test then presets both low and middle bytes to all ones and tests for data being stored in the high byte.

C.3.3 ADC to Memory - Subtract; Test 9 ADC Setup - Output port D0 set to 87 Hex. Test clears memory, then repeats the 4K Gain Test, and tests that negative value data is stored at RP.

C.3.4 Digital Offset Test 2

<u>Segment #</u>	<u>Offset Channels</u>	<u>ADC Setup</u>		<u>Peak Location</u>	
		<u>Port D1</u>	<u>Port D0</u>	<u>Min CH</u>	<u>Range CH</u>
10	4	FE	07	RP-6	32
9	8	FD	07	RP-10	32
8	16	FB	07	RP-18	32
7	32	F7	07	RP-34	32
6	64	EF	07	RP-66	32
5	128	DF	07	RP-130	32
4	256	BF	07	RP-258	32
3	512	7F	07	RP-514	32
2	1024	FF	06	RP-1026	32
1	2048	FF	05	RP-2050	32

C.3.5 ADC Range Test 3

<u>Segment #</u>	<u>Range</u>	<u>Gain</u>	<u>ADC Setup</u>		<u>Peak Location</u>	
			<u>Port DE</u>	<u>Port D2</u>	<u>Min CH</u>	<u>Range</u>
7	2K	4K	30	08	No data stored	
6	2K	2K	30	0C	RP/2	256
5	1K	2K	20	0C	No data stored	
4	1K	1K	20	0E	RP/4	256
3	512	1K	10	0E	No data stored	
2	512	512	10	0F	RP/8	256
1	256	512	0	0F	No data stored	

C.3.6 ADC Base
Test 4

Setup that is fixed for all segments:

<u>ADC Gain</u>	<u>Digital Offset</u>	<u>Port D2</u>	<u>Port D1</u>
512	128	0F	DF

<u>Segment #</u>	<u>Base</u>	<u>Range</u>	<u>Port DE</u>	<u>Min CH</u>	<u>Peak Location Range</u>
5	0	256	0	(RP/8-128)	256
4	256	512	11H	(RP/8-128)+256	256
3	512	1024	22H	(RP/8-128)+512	256
2	1024	2048	34H	(RP/8-128)+1024	256
1	2048	4096	48H	(RP/8-128)+2048	256

C.3.7 ADC Zero
Test 5

<u>Segment #</u>	<u>Port DA Hex</u>	<u>Zero Value(%)</u>	<u>Min CH</u>	<u>Peak Location Range</u>
8	01	-4.96	RP-4	256
7	02	-4.92	RP-5	256
6	04	-4.84	RP-7	256
5	08	-4.69	RP-15	256
4	10	-4.37	RP-29	256
3	20	-3.75	RP-59	256
2	40	-2.5	RP-116	256
1	80	0	RP-230	256

Because of the wide range used to locate peaks, the test checks that the location of the peak is lower than the location of the peak found in the previous segment of the test.

C.3.8 SCA - ULD
Test 6

This test has one segment. The purpose is to check that the associated circuits are functional. Complete testing of this function is done in the SCA diagnostic. This program sets the ADC to the initial values, and sets the ULD below the Reference Peak. The test checks that no data is stored with this setup.

C.3.9 SCA - LLD
Test 7

This test has one segment. The purpose is to check that the associated circuits are functional. Complete testing of this function is done in the SCA diagnostic. This program sets the ADC to the initial values and sets the LLD above the Reference Peak. The test checks that no data is stored with this setup.

C.3.10 MCS Mode
Test 10

ADC Setup:			
<u>ADC Function</u>	<u>Output Port</u>	<u>Data</u>	<u>Remarks</u>
LLD	DB	33H	} LLD = 20%
LLD	DD	0	
Range	DE	0	Range = 256
Base	DE	0	Base = 256
Mode	DO	3CH	MCS Initialize
Mode	DO	6CH	MCS Collect

This test has two segments. In each segment a MCS collect is executed for 256 channels with 64 counts stored in each channel. The test program generates the address advance (AADV) as well as the data test pulses. The function tested in each segment is as follows:

<u>Segment #</u>	<u>Function Tested</u>
2	Address Advance Control
1	Last Sweep Control

C.3.11 Data Memory Error
STATUS: 15, 15

Between each test, the memory is cleared one byte at a time. An error is indicated if a non-zero byte is then detected. This can indicate a memory error (use the RAM Test -- appendix C.6) or a failure by the program to disable the ADC from storing.

C.4 SCA DIAGNOSTIC

SCA Test To perform this test, first
 Set the ADC for: Set the SCA for*:
 Gain = 4096 LLD = 0%
 Offset = 0 ULD = 110%
 Zero = 0

Connect the Series 10's INput to a signal source and adjust the Amp so that in 10 seconds at least one count is collected in each channel between channel 28 and channel 4095, then enable the test.

*To test the Model 1002's SCA function, manually enter values for LLD and ULD from 0 to 110%.

The test starts with the LLD at 0% and the ULD at 110%. Channel 4095 is checked for data after a ten second collect. If none is found, the test is terminated and the "no data" error status is displayed. The program then locates the lowest channel that contains data. This location is used as the reference, as the test sequentially checks other LLD settings. The test then sets the LLD to 0 and then sequentially checks ULD settings.

1) STATUS: 144, 0 = SCA Test Passed.

2) STATUS: 7,N = LLD Test

where	<u>N</u>	<u>LLD Bit Setting</u>	<u>% Setting</u>
	9	$2^5 = 32$	3.441
	8	$2^5, 2^0 = 33$	3.548
	7	$2^5, 2^1 = 34$	3.656
	6	$2^5, 2^2 = 36$	3.871
	5	$2^5, 2^3 = 40$	4.301
	4	$2^5, 2^4 = 48$	5.161
	3	$2^6 = 64$	6.882
	2	$2^7 = 128$	13.76
	1	$2^8 = 256$	27.53
	0	$2^9 = 512$	55.05
	11	LLD = 0 - No data found ULD = 110%	0

3) STATUS: 6, N = ULD Test

where	<u>N</u>	<u>ULD Bit Setting</u>	<u>% Setting</u>
	8	127	54.78
	7	128	55.22
	6	128 + 1	55.65
	5	128 + 2	56.08
	4	128 + 4	56.94
	3	128 + 8	58.67
	2	128 + 16	62.12
	1	128 + 32	69.02
	0	128 + 64	82.82
	9	255 - No data found LLD = 0	110.0

4) STATUS: 15, 15 = Data memory failure or failure to stop Collect.
See ADC Test (C3.11).

C.5 EIA/FSK TEST To perform this test, the I/O Test Cable included in the service kit must be plugged into the CASSETTE and EIA connectors.

The CASSETTE jumper connects the output data through an amplifier to the contacts of the cassette relay (closed during the test) and into the input amplifier.

The EIA jumper connects the data output amplifier into the data input amplifier and connects the RDY output to the FLAG input.

Test Status Message:

<u>Status</u>	<u>Meaning</u>
1	Test passed
5	No EIA data detected*
7	No Flag signal detected
101	No FSK data detected
133	No serial clock (J1 or J2)

*For firmware version C, the diagnostic program for EIA data will always indicate an error. To check EIA data, a readout device or scope will have to be connected and a normal READ OUT enabled.

C.6 RAM TEST The RAM test will show either "RAM OK" or a decimal failure address. Tables C.2 and C.3 convert that address to the location of the faulty RAM chip.

Table C.2
Memory Board Revision A, B, or C

<u>Decimal Address Range</u>	<u>Hexadecimal Address</u>	<u>RAM Board Location</u>
32768-34815	8000-87FF	A9
34816-36863	8800-8FFF	A29
36864-38911	9000-97FF	A19
38912-40959	9800-9FFF	A8
40960-43007	A000-A7FF	A18
43008-45055	A800-AFFF	A17
45056-47103	B000-B7FF	A7
47104-49151	B800-BFFF	A6
49152-51199	C000-C7FF	A32
51200-53247	C800-CFFF	A22
53248-55295	D000-D7FF	A11
55296-57343	D800-DFFF	A10
57344-59391	E000-E7FF	A21
59392-61439	E800-EFFF	A31
61440-63487	F000-F7FF	A30
63488-65535	F800-FFFF	A20

Table C.3
Memory Board Revision D or later

<u>Decimal Address Range</u>	<u>Hexadecimal Address</u>	<u>RAM Board Location</u>
Model 1002, 1003 (and former Model 1001)	45056-47103	B000-B7FF
	47104-49151	B800-BFFF
	49152-57343	C000-DFFF
	57344-65535	E000-FFFF
Model 1004 or 1008	32768-40959	8000-9FFF
	40960-49151	A000-BFFF
	49152-57343	C000-DFFF
	57344-65535	E000-FFFF

Appendix D BATTERY AND CHARGER

D.1 BATTERY

The Series 10 uses a rechargeable battery pack of 5 NiCad F-cells for power in portable applications. Fully charged batteries allow 8 hours of continuous operation using a preamplifier drawing 1 watt.

When the battery pack's voltage drops below 6 volts, a "BATLOW" warning message appears on the display. The Series 10 will typically operate for at least 30 minutes after this message appears.

When the voltage drops to about 5.6 volts, a circuit in the power supply will put the unit into a standby mode without loss of data. The Series 10 must now be connected to a charger, then the rear panel power switch turned to STBY (or the front panel CONTRAST switch to OFF) and back to ON before any functions can be enabled.

Note

Although turning the front panel CONTRAST switch OFF places the Series 10 in the standby mode, it does not affect the charging rate.

D.2 CHARGER

If the Series 10's rear panel power switch is in STBY or RST, the charger will fully charge the battery pack overnight (about 14 to 16 hours).

If the rear panel power switch is in ON or HV ON, the charger allows the Series 10 to operate normally while charging the battery pack. The charging rate requires at least 1.5 days to fully charge the battery pack if the Series 10 is ON. The Series 10 can be charged either while it is being used or while in the standby mode.

The charger can be left connected to the Series 10 indefinitely without harm to the battery pack. However, NiCad batteries have a characteristic called "memory", which is seen after long-term charging. Continuous charging causes crystals of active material in cell plates to grow larger, increasing the effective internal resistance. This will not lower the battery's capacity (amp-hour rating) but will lower the loaded battery's output voltage.

Lowering the voltage will cause the Series 10 to shut itself down before the full amount of charge has been drawn from the battery. This means that the Series 10 will not operate for the expected period of time.

The ideal way to get maximum battery operating time is to operate under battery power until the BATLOW message appears, then recharge before further use.

If you use the Series 10 for long periods with the charger connected, the battery can be returned to full output voltage by completely discharging it. To discharge the batteries, put a 20 ohm 3 watt resistor across pins 3 and 5 on the power connector (J105) for at least 24 hours, then recharge the batteries for 12 to 16 hours. A higher value resistance can be used with a proportionately longer discharge time.

To eliminate the possibility of damage to the batteries, the resistor should be disconnected when the voltage drops below 4.5 V.

CAUTION

Allowing the voltage to drop below 3 volts can cause permanent damage to the battery's cells.

- D.3 LINE VOLTAGE** The charger operates from a 120 V (down to about 95 V) or 230 V ac supply. Early chargers are internally protected with a 0.5 A slow-blow fuse. Later chargers use a panel mounted fuse rated at 0.5 A slow-blow for a 110 V line or at 0.25 A slow-blow for a 220 V line.
- D.4 ADAPTER CABLE** An adapter cable is available which will allow the Series 10 to be powered from a 12 V automobile battery through the auto's cigarette lighter (draws 1.2 A when charging).
- D.5 BATTERY RATING** The battery pack is rated for at least 1000 discharge/recharge cycles. Typically this is at least 3 years of operation.
- D.6 MODEL 1082** The Model 1082 is an external battery pack which can be recharged overnight by connecting it directly to the charger. It should be disconnected after charging. Refer to the Model 1082 Operators Manual for details.
- D.7 BATTERY REPLACEMENT** If it becomes necessary to replace the battery pack, move the power switch to RST and place the Series 10 upside down on a flat surface. Then:
1. Loosen the two thumbscrews on the large door on the bottom of the Series 10.
 2. Carefully open the door.

3. Disconnect the cable at J2 between the battery pack and the power supply board (refer to figure D.1).
4. Remove the nuts from the four mounting studs.
5. Remove the two metal brackets holding the battery.
6. Remove the battery pack.
7. Install the new battery pack and replace the brackets, nuts and J2 connector. The display will appear momentarily when the battery is connected.
8. Be sure to firmly tighten the nuts on the studs.
9. Carefully close the battery-pack door and tighten its thumbscrews.
10. Connect the charger to the DC IN connector on the Series 10 and turn the charger on.
11. Turn the Series 10 ON, enable the DIAGNOSE function (section 4.7), and check the BATTERY and SUPPLY voltages.
12. After charging the battery, remove the charger and check the BATTERY voltage again. It should be about 6.5 volts. After several hours of discharge, the voltage should stabilize; that is, it should change less than 100 mV/hour. A larger change during the first hour or two is normal.

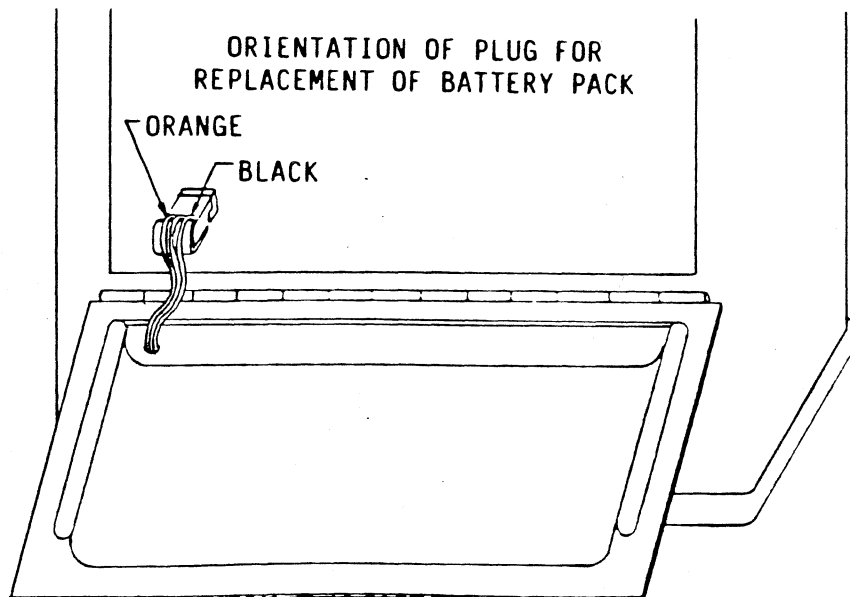


Figure D.1 Battery Plug Orientation

Appendix E INPUT/OUTPUT FORMATS

E.1 EIA/TERMINAL FORMAT All data transmissions through the EIA port are in ASCII format except Computer which is in binary format. If EIA readout is selected, the Series 10 will transmit the non-printing control codes listed in table E.1 prior to the corresponding data field.

Table E.1 EIA Control Codes

<u>Item</u>	<u>Octal</u>	<u>Hex</u>	<u>Code</u>	<u>Description</u>
1. Tagword	5	5	(ENQ)	8 digits, with leading spaces.
2. Data ID	2	2	(STX)	24 ASCII characters ¹ .
3. End field	3	3	(ETX)	Ends Data ID and ECAL coeff.
4. Live Time	36	1E	(RS)	8 digits, with leading spaces.
5. True Time	37	1F	(US)	8 digits, with leading spaces.
6. ECAL units	11	9	(HT)	eV, keV, MeV, μ s, ms, sec.
7. ECAL "B" coeff.	7	7	(BELL)	Floating point field ¹
8. ECAL "C" coeff.	10	8	(BS)	Floating point field ¹
9. Channel Address	33	1B	(ESC)	5 digits, with leading spaces.
10. Channel Data	17	F	(SI)	8 digits, with leading spaces.
11. End of Data	4	4	(EOT)	End of transmission.

¹These fields are terminated by (3) ETX.

Terminal Format

If TERMINAL readout is selected, the Series 10 transmits only these non-printing characters with the data:

CR (0D) (followed by 4 NULLs and 1 LF.)

LF (0A)

SP (20)

NULL (00)

All other control codes are changed to NULLs.

E.2 COMPUTER
FORMAT

The first line of a computer readout is in ASCII format, followed by binary data and parameters.

E.2.1 Overall
Format

TAG NO. n DATA ID DATE TIME PAGE 1

Binary Data Block 1
Binary Data Block 2
Binary Data Block 3
.
.
.
Binary Data Block n

HEADER
(01)_H (04)_H (53)_H XXX (←83 bytes)

Parameter Block (see section E.2.4, Status Page).

The HEADER is the Title and Summary information as listed in table E.1 and illustrated in appendix F.

E.2.2 Binary Data Block Format

1C_H
Region Channel Count Low Byte
Region Channel Count High Byte
Starting Channel Address Low Byte
Starting Channel Address High Byte
Data High Byte } Data from the starting
Data Low Byte } address in the
Data Middle Byte } memory region
.
.
.
Data High Byte } Data from the
Data Low Byte } last channel in
Data Middle Byte } the memory region

E.2.3 Read IN

For READ IN from a computer, the Series 10 can accept a format of Binary Data Block(s) or Parameter Blocks for setup values, or both. If only Data Blocks are read in, the READ IN must be terminated by (04)_H.

E.2.4 Status Page

The Status Page (section 3.4) is read out with the spectrum data. It is also read in with the spectrum, except that the first line of the page, the HVPS on/off status, and the EIA Baud rate are disregarded.

In addition to the Status Page, the Data ID, the ECAL coefficients, and the Start of Collect time are read out and in.

E.3 TAPE FORMAT The Tape format is the same as the Computer format (section E.3) but it is read out in FSK mode instead of binary mode.

The Tape Format is a record of the Status Page (section E.2.4) and all spectral data in the current memory region. It is meant to be used only with the Model 5421M Cassette Recorder. The Status Page information will be read back in with the data as described in section E.2.4.

Note: if the HV jumper plug is incorrectly set, HV is enabled, or Collect is active, "ERR 1" (appendix C.1.) will be set and only the spectrum and time data will be accepted. Clear the message, correct the error condition, and repeat the read in to load the Status Page's parameters.

Using a Model 5421M Recorder with a Model 5421F Interface, a Series 10 cassette tape can be read into the Series 20, 35, 35 PLUS, 40, 80, 85, or 90 MCAs. Exception: the ECAL equation can't be read in by the Series 80 or 85 using the xx52/53E Cassette Interface.

E.4 READOUT COMPATIBILITY Table E.2 lists both Direct and Cassette I/O to and from other Canberra analyzers. I/O referenced to the Series 10.

Table E.2 Readout Compatibility

Analyzer Model	DIRECT I/O		CASSETTE I/O	
	Read Out ¹	Read In ²	Read Out	Read In
S30, 4100, 8100, 8180	No	No	No	No
SERIES 20 ³	Yes	Yes	Yes	Yes
SERIES 35 and 35 PLUS	Yes	Yes	Yes	Yes
SERIES 40	Yes	Yes	Yes	Yes
SERIES 80	Yes	No ⁴	Yes	Yes ⁵
SERIES 85	Yes	No ⁴	Yes	Yes ⁵
SERIES 90	Yes	No ⁶	Yes	No ⁶

- Notes:
- 1) Read out COMPUTER, ≤ 1200 baud, 8 bits/character, parity as enabled.
 - 2) Read in EIA, binary, ≤ 1200 baud using RDY OUT from the Series 10 connected to FLAG IN to the Series 35/35 PLUS/40; ≤ 600 Baud with no connection to RDY OUT. Requires putting the Series 10 in Read In or removing the cable if the transmitting Analyzer does not end Readout when all data is transmitted.
 - 3) To transfer the Series 20's Status Page parameters to the Series 10, the 10's HV polarity plug must be set for Positive, 1 kV. The plug can be in any position when reading from the 10 to the 20.
 - 4) Series 80/85 read out doesn't have EOT in the correct place for a terminal output.
 - 5) Series 80/85 format doesn't include Live Time, True Time, ECAL, etc.
 - 6) Series 10 can't read in Series 90 Data Format (4 bytes/channel).

Appendix F SAMPLE READOUTS

```

TAG NO.      1      SERIES 10      02 JUN 03 00:20 PAGE 1
MEMORY= 1/10  LIVE TIME= 7 SECS  TRUE TIME= 12 SECS
COLLECT STARTED ON 02 JUN 03 AT 00:24:22
AMP: INPUT= POS TC=FAST GAIN= 3.5000
SCA: LLD= 1.000U ULD= 110.0U
ADC: GAIN= 512 OFFSET= 0 ZERO= 0U
PHA ADD PRESET= 1000U LT
MUPS: - BU OFF STABL OFF

CHANNEL#      DATA
0
7      12 10770075 10770008      0      0      07      102
0      100      234      229      208      320      374      347      312
10     331      208      323      353      330      275      324      317
24     330      342      298      281      328      317      313      312
32     293      319      311      314      305      313      307      311
40     319      311      293      305      306      310      301      292
48     304      335      320      330      357      310      300      327
56     302      329      324      342      354      300      313      329
64     300      320      332      311      345      353      351      329
    
```

Figure F.1 Read Out ALL

Shows format with some 8-digit data. After the last data channel is printed, line feeds are used to fill the page. There are 66 lines per page.

```

TAG NO.      12      SERIES 10      20 MAY 03 14:51 PAGE 1
MEMORY= 1/1  LIVE TIME= 100 SECS  TRUE TIME= 114 SECS
COLLECT STARTED ON 20 MAY 03 AT 10:51:12
CHANNEL CALIBRATION IN KEV = 0.405110E00 * CH0 + 0.072070E00
FUNCTION F1=(L2-H1)+F2+F3)*F4
FUNCTION F2=(CH1-0H)(3/2)/(CH1-0L1)*CH1-L11
FUNCTION F3=(0L2-0H)(3/2)/(0L2-0H2)
FUNCTION F4=159.20/(H13-H11)
AMP: INPUT= POS TC=SLOW GAIN= 00.000
SCA: LLD= 0U ULD= 110.0U
ADC: GAIN=4096 OFFSET= 0 ZERO= 0U
PHA ADD PRESET= 100U LT
MUPS: +3000U OFF STABL OFF

ROI#  FROM KEV TO KEV  INTEGRAL  AREA:30KB  FUNCTION
1      1331.5  1332.0      3000      0  1.937950E 00
2      1333.4  1333.0      3109      0  1.937950E 00
11     1172.5  1172.5      3053      0  1.937950E 00
13     1332.5  1332.5      3310      0  1.937950E 00
    
```

Figure F.2 Read Out ROI BRIEF

This readout shows the spectrum calibrated for energy. After the last ROI summary is printed, several line feeds are used for spacing.


```

TAG NO. 12 SERIES 10 20 MAY 83 14:52 PAGE 1
MEMORY= 1/1 LIVE TIME= 100 SECS TRUE TIME= 114 SECS
COLLECT STARTED ON 20 MAY 83 AT 10:51:12
CHANNEL CALIBRATION IN KEV = 0.405118E00 * CH# + 0.072070E00
FUNCTION F1=(L2-H1)+F2+F3+F4
FUNCTION F2=(OH1-OH13/2)/(OH1-OL11)*(H1-L1)
FUNCTION F3=(OL2-OH13/2)/(OL2-OH2)
FUNCTION F4=159.26/(H13-H11)
AMP: INPUT= POS TC/SLOW GAIN= 00.000
SCA: LLD= 07 JLD= 110.07
ADC: GAIN=4836 OFFSET= 0 ZERO= 07
PHA: ADD PRESET= 100% LT
MPS: +3000U OFF STABLE OFF

ROI# FROM KEV TO KEV INTEGRAL AREA:30K0 FUNCTION
1 1331.5 1332.0 3000 0 1.937958E 00
2 1333.4 1333.8 3189 0 1.937958E 00
11 1172.5 1172.5 3953 0 1.937958E 00
13 1332.5 1332.5 3318 0 1.937958E 00

CHANNEL# DATA
2001 1387 2419
2005 2151 1036
2519 3953
2003 3318

```

Figure F.3 Read Out ROI

This readout shows the spectrum calibrated for energy. After the last data channel is printed, line feeds are used to fill the page. There are 66 lines per page.

Appendix G CONNECTORS

<u>Number</u>	<u>Name</u>	<u>Pin</u>	<u>Signals (IN/OUT referred to Series 10)</u>	
J101	SIGNAL IN	BNC	Linear Signals IN (signal parameters: appendix A.2)	
J102	GATE IN	BNC	Gate Signals IN (signal parameters: appendix A.3)	
J103	CASSETTE 9-pin male	1 2 3 4 5	Motor control contact; rated for 200 mA maximum FSK ground Motor control contact; rated for 200 mA maximum FSK IN FSK OUT	
J104	EIA ⁵ 25-pin female	1 2 3 5 6 7 8 9 10 11 20	Ground EIA IN ¹ EIA OUT ¹ RDY OUT ^{2,3} DSR Ground CD +12 V OUT; -12 V OUT FLAG IN ⁴ DTR	No function. No function. {For Model 9182: Current- loop to EIA Adapter. No function.
¹ RS-232 compatible: Mark (logic 1) = -5V; Space = +5 V. ² RS-232 compatible: Logic 1 = +5 V; Logic 0 = -5V. ³ When EIA port able to accept a character during input modes. ⁴ TTL or RS-232 LOW suspends character transmission from the Series 10. ⁵ Unlisted pins are reserved.				
J105	DC IN (DIN type) 5-pin female	2 3 4 5	Charger IN, +11 to 16 V at 1.2 A, maximum. Ground. {External +5.8 to 8.0 V battery (draws 800 mA.)	
J106	HV INHIBIT	BNC	TTL Low or ground inhibits HV OUTput.	
J107	HV OUT	SHV	High Voltage OUT: 25-5000 V.	

J108 PREAMP POWER

9-pin female	1	Ground
	2	Ground
	4	+12 V
	5	Stabilizer Thermistor In
	6	-24 V
	7	+24 V
	9	-12 V

Note: Total power from all supplies, about 1.5 W, maximum. If more power is needed, increase value of R39 on power supply (A5, pin 5 to ground); the power taken by the preamp will reduce the battery operating time.

CAUTION: R39 protects the circuitry from overloading; it should not be greater than 1.6 kilohms.

Appendix H POLE/ZERO ADJUSTMENT

The pole/zero (P/Z) control is used to compensate for the fall-time constant of the preamplifier's output signal and the amplifier's shaping-time constant. It is factory-set for a 50 μ s tail-pulse input with slow amplifier shaping.

For best resolution of the input signals, the rear panel P/Z control should be properly adjusted for the amplifier parameters and preamplifier used. It should be readjusted whenever any of these is changed.

To correctly trim the pole/zero:

1. Set the Series 10's amplifier for maximum gain and desired shaping (fast or slow). See section 3.1.
2. Attach a x1 oscilloscope probe to the ADC IN test jack on the Series 10's rear panel.
3. Ground the probe at the ground nut below the preamp power jack or on any bare metal on the rear panel.
4. Set the scope for 100 mv/cm vertical* and 20 or 50 μ s/cm horizontal.

While looking at the ADC IN signal on the scope, turn the P/Z control (in the upper left corner of the rear panel) so that the trailing edge of the amp signal returns to the baseline with no over- or undershoot (figure H.1 or H.2).

*With the vertical sensitivity set for 100 mV/cm, some scopes overload with a 5 V input signal, which will distort the signal's recovery to baseline. This can cause the P/Z setting to be incorrectly adjusted, resulting in a loss of resolution at high count rates. To prevent overloading the scope, Canberra recommends using the Model LB1502 Schottky Clamp Box.

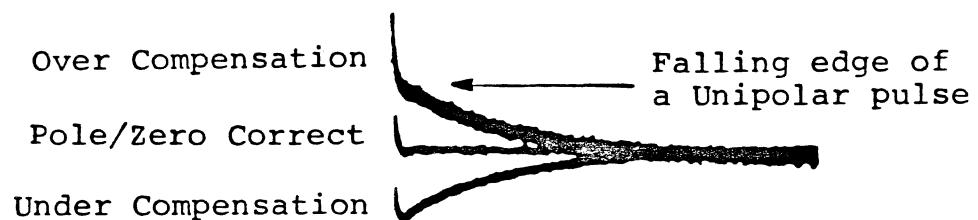


Figure H.1 Properly Adjusted Unipolar Pole/Zero

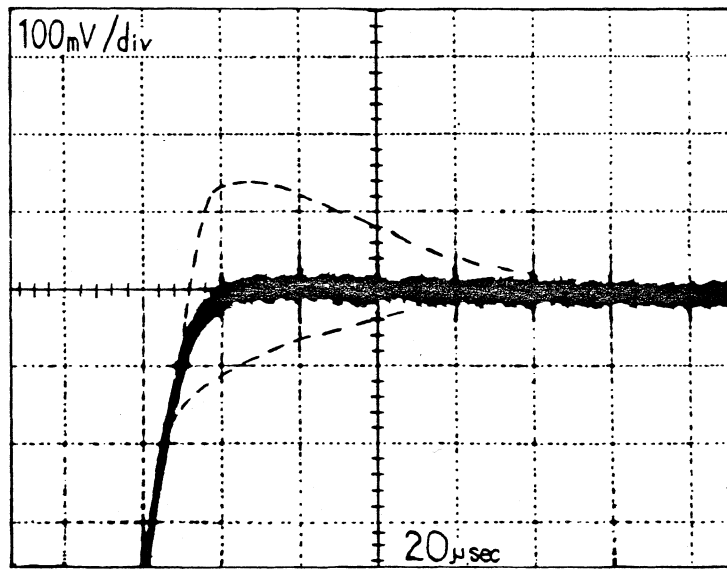


Figure H.2 Properly Adjusted Bipolar Pole/Zero

Appendix I ADC ZERO ADJUSTMENT

The ADC ZERO should be recalibrated each time the ADC GAIN is changed, though it is not critical.

A quick adjustment of the ADC ZERO can be done using an Energy Calibrated spectrum:

1. Collect a spectrum and Energy Calibrate it. Refer to section 4.1.
2. Make a note of the energy calibration equation.
3. Divide the equation's offset (last) term, by the energy per channel (the first term).
4. The result is the number of channels that the spectrum must be moved, using the ZERO parameter, to place zero energy in channel zero.
5. Divide the number found in step 4 by the ADC GAIN being used (512, 1024, 2048, or 4096) and multiply the result by 100. The resulting percent is the ADC ZERO to be entered, but must be entered as a number of the opposite sign. For instance, if the percent is 0.56, enter -0.56.
6. Clear the memory, turn ECAL off, and enter the percent found in step 5 as the ZERO parameter (section 3.3). Be sure to enter the percent as a number of the opposite sign.
7. Repeat steps 1 and 2. When no further correction is necessary, the offset (last) term will now be at or very close to zero.

Appendix J CALCULATION ALGORITHMS

Refer to figure J.1 for an illustration of a typical peak.

J.1 Integral Calculation

The integral, the sum of all data in the current Region of Interest (ROI), is found by:

$$I = I_p + B_1 + B_2$$

where

$$I_p = \sum_{a=b}^{a=c} X_a \quad (\text{Peak Integral})$$

$$B_1 = \sum_{a=d}^{a=e} X_a \quad (\text{Left background})$$

$$B_2 = \sum_{a=f}^{a=g} X_a \quad (\text{Right background})$$

X_a = contents of channel a.

b = Start + K

c = Stop - K

d = Start

e = Start + K-1

f = Stop - K+1

g = Stop

Start = ROI start channel (left limit)

Stop = ROI stop channel (right limit)

K = Number of end points considered (3 or 5)

J.2 Area Calculation

The peak area is found by:

$$A = I_p - \text{Background}$$

$$A = I_p - \frac{N \cdot (B_1 + B_2)}{(2 \cdot K)}$$

where

$N = \text{Stop} - \text{Start} - 2K + 1$

I_p , K, B_1 , B_2 , Stop, and Start are defined in section J.1.

J.3 Area Percent Error Calculation

$$\% \text{ ERR} = \frac{F}{A} \cdot \sqrt{I_p + (N \div (2 \cdot K))^2 \cdot (B_1 + B_2)}$$

F = 165, which equals a σ of 1.65 x 100 to yield percent.
All other terms are as defined in sections J.1 and J.2

J.4 Strip Calculation

$$Y_a' = Y_a - F \cdot X_a$$

where

- F = the strip factor,
- X_a = the contents of channel "a" in the reference spectrum,
- Y_a = the contents of channel "a" in the original spectrum,
- Y_a' = the contents of channel "a" in the stripped spectrum.

The peak shown in figure J.1 illustrates the algorithms defined in appendix J.

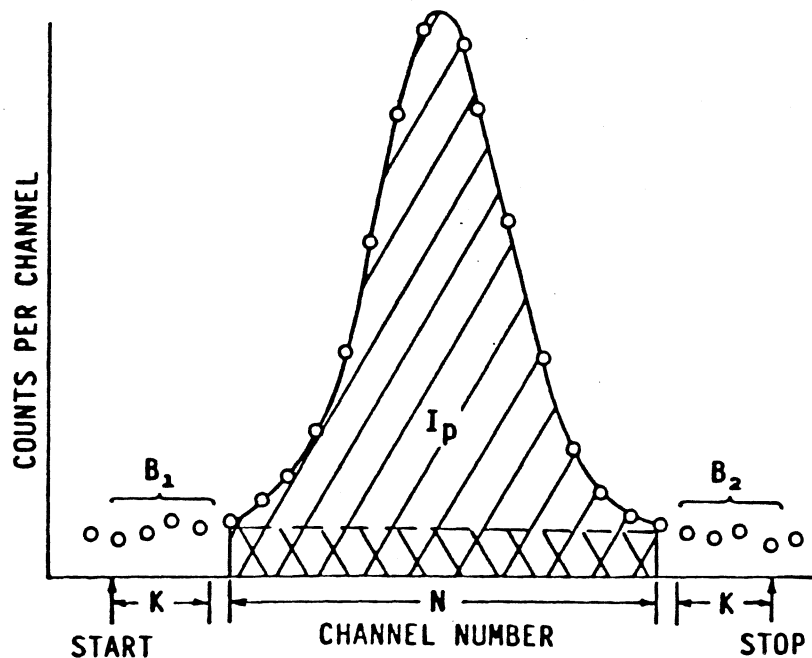


Figure J.1 Typical Spectrum Peak

Appendix K USE EQUATIONS

K.1 ENRICHMENT MEASUREMENT

A set of equations defined for an Enrichment calculation is included as part of the Models 1002 and 1004. These can be replaced by manually Defining other equations or by Loading them from a Cassette tape. The Enrichment calculation is often used in a Safeguards application and gives a measure of the ^{235}U in a sample. It uses the count rate in the 186 keV peak compared to two known standards. The equations are derived from the following relationships:

$$E = AC_1 + BC_2$$

where

- E = Percent enrichment of the sample
- C_1 = Count Rate in the 186 keV peak window
- C_2 = Count Rate in the background window
- A and B are constants obtained from the spectra of the two standards

$$A = \frac{E_1 C_{22} - E_2 C_{21}}{C_{11} C_{22} - C_{12} C_{21}}$$

$$B = \frac{E_2 C_{11} - E_1 C_{12}}{C_{11} C_{22} - C_{12} C_{21}}$$

where:

- E_1 = Percent Enrichment of High Standard
- E_2 = Percent Enrichment of Low Standard
- C_{11} = Count Rate in 186 keV window of High Standard
- C_{12} = Count Rate in 186 keV window of Low Standard
- C_{21} = Count Rate in background window of High Standard
- C_{22} = Count Rate in background window of Low Standard

$$\text{Count Rate} = \frac{\text{Integral of window}}{\text{Live Time of Collection}}$$

All five of the USE equations are required to determine the Enrichment. They are loaded into the parameters memory when the rear panel power switch is turned to ON from RESET.

The equations are:

$$\begin{aligned} F1 &= (F2 * I1 - F3 * I2) / LT \\ F2 &= (F4 + F3 * I4) / I3 \\ F3 &= (F5 - F4 * I5 / I3) / (I4 * I5 / I3 - I6) \\ F4 &= @2048 * |O \\ F5 &= @3072 * |H| \end{aligned}$$

The elements "LO" (L) and "HI" (H) in F4 and F5 must be replaced by the Percent Enrichment E_2 and E_1 (Low and High Standards). To do this press:

```
MENU ANALYZ DEFINE F4 CLEAR ONE CONTINUE #  
Enter the percent enrichment of the low standard.  
Press END
```

```
MENU ANALYZ DEFINE F5 CLEAR ONE CONTINUE #  
Enter the percent enrichment of the high standard.  
Press END
```

Collect a spectrum of the high enrichment standard in the fourth memory quarter (4/4) and a spectrum of the low enrichment standard in the third memory quarter (3/4). Enrichment measurement will be made by collecting a spectrum in quarter 1.

Setup the following regions of interest:

ROI #1	quarter 1	186 keV peak
ROI #2	quarter 1	background region
ROI #3	quarter 3	186 keV peak
ROI #4	quarter 3	background region
ROI #5	quarter 4	186 keV peak
ROI #6	quarter 4	background region

It is important that the peak and background ROIs in all three quarters occupy the same relative channel positions. This can be easily accomplished by setting the display memory to quarters to enter the ROI start and stop channels.

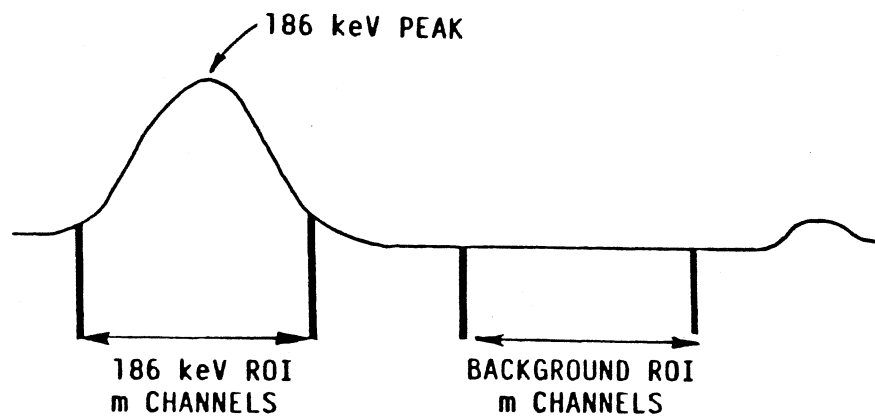


Figure K.1 Peak and Background ROIs

To perform the enrichment calculation select memory quarter 1 and press:

MENU COMPUTE FUNC F1 ENTER

The answer will appear as "F1= n.nnnnnnE nn".

Note that after collecting the two spectra from the standards in quarters 3 and 4, the values of F2 and F3 will be constants that can be evaluated and then entered to replace F2 and F3 in F1 or as values for the F2 and F3 equations. In this way equations can be made available for other calculations.

K.2 OTHER DEFINE/USE EQUATION EXAMPLES:

A) Counts per second:

CPS	=	Counts ÷ Live time	
Fn	=	@#n/LT	n = channel #
	=	In/LT	n = ROI #
	=	An/LT	n = ROI #
	=	@Ln/LT	n = ROI #
	=	@Hn/LT	n = ROI #

B) Percent Error of an Integral:

$$\% \text{ Error} = 1.65 \times \frac{\sqrt{\text{Integral}}}{\text{Integral}} \times 100$$

$$Fn = 165/\text{SQR}(In)$$

Activity:

$$Bq = (\text{Area} \div \text{Live Time}) \div (\text{Efficiency} \times \text{Gammas per disintegration})$$

$$Fn = An / (LT/n_1/n_2)$$

where n_1 = Efficiency

n_2 = Gammas per disintegration

D) Conversion of Bq to μCi of Activity:

$$\mu\text{Ci} = Bq \div (3.7 \times 10^4)$$

$$Fm = Fn / 3.7E04$$

where Fn is equation C, Activity.

E) Original Activity:

$$\text{Original Activity} = \text{Activity now} \times e^{(0.693t \div T^{1/2})}$$
$$F_m = F_n \cdot \text{EXP}(.693 \cdot n_1 / n_2)$$

where F_n = Equation C, Activity
 n_1 = decay time (t)
 n_2 = half-life ($T^{1/2}$)

F) Percent Dead Time:

$$\%DT = (T_{\text{true}} - T_{\text{live}}) \div T_{\text{true}} \times 100$$
$$F_n = (TT - LT) / TT \cdot 100$$

G) Radiochemical Component in Paper Chromatography:

$$\text{Component} = \left[\frac{\text{Counts (in the peak of interest)}}{\text{Total counts (in the entire spectrum)}} \right] \times 100$$

$$F_n = I_n / I_m \cdot 100$$

where n = ROI# of the peak of interest
 m = ROI# of full-spectrum ROI

Appendix L FIRMWARE INSTALLATION PROCEDURE

L.1 COMPONENT ACCESS The purpose of this section is to familiarize the user with the assembly of the Series 10 to allow firmware installation, board replacement or board repair (refer to figure L.1).

The Series 10 is built with all plug-in assemblies mounted in a card cage. To gain access to the boards:

1. Pull off the black trim around edge of the front panel.
2. Disconnect all cables from the rear panel.
3. Remove the rear panel grounding nut from its stud.
4. Turn the unit over.
5. Remove the High Voltage Polarity/Range plug.
6. Open the battery door and disconnect the harness from the battery at the Power Supply Board. Leave the door open so the card cage can slide out.
7. Pull the card cage out of the cover.

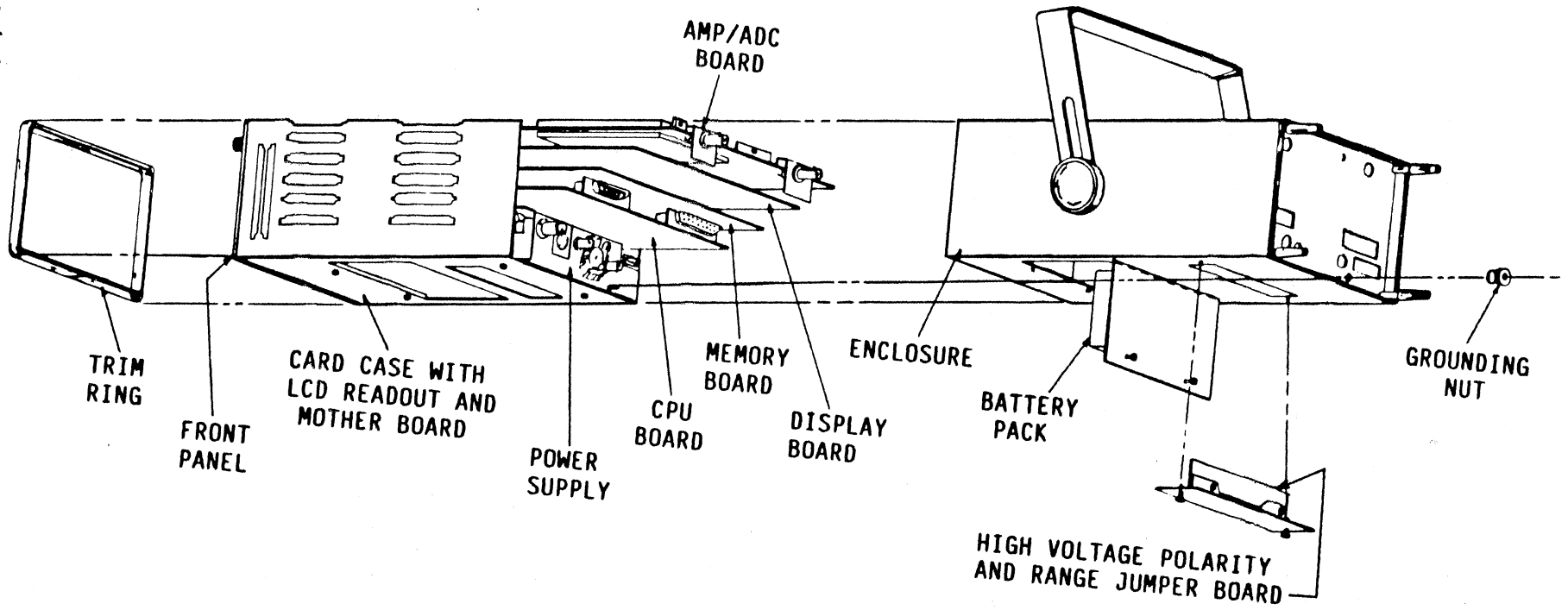
The circuitry is partitioned into five printed circuit boards which plug into an Interconnection Board. The front panel keyboard and display are connected by plug-in cables to the display board. The normal order of the boards from the top of the unit to the bottom is:

PC1	AMP/ADC
PC2	Display
PC3	Memory
PC4	CPU
PC5	Power Supply

The general function of each of these boards is:

AMP/ADC	Spectroscopy amplifier and 100 MHz Wilkinson ADC (50 MHz on older boards).
DISPLAY	Microprocessor-based liquid crystal display (LCD) and keyboard controller.
MEMORY	Data and Background memory RAM, part of system firmware (PROM) and DMA logic for PHA and MCS data storage.
CPU	System microprocessor with part of system firmware, calendar and clock, EIA and FSK I/O interface, and live/dwell timer.
POWER SUPPLY	Battery inverter, high voltage, stabilizer, and voltage monitor.

Figure L.1 Series 10 Assembly Drawing



Service Note The compact mechanical design requires that the boards must be ordered as shown to fit into the enclosure, but can be positioned in any order outside of it. Extender boards are not supplied for the Series 10 since the board to be worked on can be placed at the top of the stack.

The Power Supply is functional outside the card cage if it is connected to the charger. To remove or replace boards, the procedure in sections L.2 and L.3 must be used.

- L.2 REMOVING BOARDS**
1. Use care when sliding boards in or out of the card cage to avoid scraping components on an adjacent board.
 2. The AMP/ADC, CPU and Power Supply each can be moved in or out of their assigned sockets without restriction.
 3. The Display Board cannot be removed or returned to its socket unless the AMP/ADC is removed first. The Display Board has connecting cables to the keyboard and LCD: These must be disconnected before removal and reconnected after installation.
 4. The Memory Board cannot be removed or returned to its socket unless the CPU is first removed.

- L.3 BOARD INSTALLATION**
- Replacing the boards in the card cage is the reverse of removing them. Take care not to scrape the components on one board against the solder side of an adjacent board. To reinstall the card cage in the cover:
1. Make sure that the connector clips on the preamp power connector are turned inward so they can pass through the rear panel cut-out.
 2. Be certain that the boards are all centered in their respective card guides. Hold the cage securely at the top until it is returned to the enclosure; this will keep the boards in place.
 3. Reconnect the battery and replace the grounding nut.
 4. Turn on the rear panel power switch and verify that the Series 10 is operating correctly.
 5. It will be necessary to reset the clock and calendar because the battery has been disconnected.

L.4 REPLACING BOARDS Exchange the replacement printed circuit board with the existing board. The PROMs on the replacement board must have the same version number as the removed board. Refer to figures L.2, L.3 and L.4 for board layouts.

A replacement AMP/ADC board needs no adjustment except for the normal Pole/Zero compensation. If the Stabilizer is being used, the power supply's gain control must be adjusted. Refer to the Stabilizer manual for details.

The only adjustment required when replacing a Power Supply is calibration of the Stabilizer to an Americium-Doped NaI detector (Canberra Model 802-3A or 802-1A), if you are using one. Refer to the Stabilizer Manual for details.

L.5 FIRMWARE INSTALLATION The Firmware version currently installed in the Series 10 can be determined by using the STATUS soft key (section 3.4). Replacement firmware is labeled with its version.

If the PROM diagnostic indicates a bad chip, it can be replaced individually. A diagnostic error will indicate "Mxx?" or "Rxx?". Where M = CPU Board, R = Memory Board, and xx = socket number.

If the Series 10 is to have a firmware update, all PROMs must be updated to the same revision level for proper operation. None of the earlier PROMs can remain installed. The PROMs are located on the CPU, Memory and Display Boards.

1. Locate the correct board and, following the guidelines in sections L.1 and L.2, remove the card cage and CPU, Memory and AMP/ADC Boards. The Display board can be removed, but it isn't necessary.
2. Using a small screwdriver or LSI chip-puller carefully remove the PROM from its socket. Refer to figure L.2, L.3 or L.4 for chip location).

CAUTION!

These CMOS chips are subject to damage from static electricity and are shipped in anti-static containers for protection. Handle them with care!

3. Insert the replacement PROMs in their sockets. If you are replacing an individual PROM, its replacement must be marked with same version as the existing PROM.

WARNING!

The chips must be plugged into the sockets exactly as in the figures. If a chip is plugged in backwards, it can be permanently damaged. Take care that all of the legs on the chip are firmly in the socket connectors.

4. Put the boards back in the card cage. Be sure that they are in the correct order; see section L.1.
5. Reinstall card cage in enclosure.
6. Reconnect the battery and replace the grounding nut.
7. Turn on the rear panel power switch and verify that the Series 10 is operating correctly.
8. Reset the clock and calendar; see sections 1.9 and 3.7.
9. Perform the PROM diagnostic to verify proper Memory Operations; see section 4.7.
10. If you replaced all of the PROMs with a firmware update, insert the old set of PROMs in the chip carriers that the new PROMs came in and return them to Canberra or its authorized representative for credit.

L.6 FIRMWARE
VERSIONS

Table L.1 lists chips per board vs. firmware versions and details the labeling protocol. The table also includes the former Model 1001.

Table L.1 Firmware Versions vs. Chips per Board

<u>Version</u>	<u>CPU</u> ¹	<u>Memory</u> ²	<u>Display</u> ³
V1001.C7, .C8, .D1	8	7	2
V1001.D2	4	7	2
V1001.D3	4	4 ⁴	2
V1002.C7, .C8	8	7	2
V1002.D2, .E2, .F2	4	8	2
V1002.D3, .E3, .F3	4	4 ⁴	2
V1003.C7, .C8, .D1	8	7	2
V1003.D2, .E2, .F2	4	7	2
V1003.D3, .E3, .F3	4	4 ⁴	2
V1004.C7, .C8	8	7	2
V1004.D1	8	8	2
V1004.D2, .E2, .F2	4	8	2
V1004.D3, .E3, .F3	4	4 ⁴	2

¹The chip label is Mxx in Versions C7 & C8; the assembly configuration is "A" for 4 chips and "B" for 8 chips (figure L.4)

²The chip label is Rxx in Versions C7 & C8 (figure L.3)

³The chip label is Dxx in Versions C7 & C8 (figure L.2)

⁴Versions D3, E3, and F3 use Memory Board revision D (or later), which has fewer chips.

where

M is the CPU board,
R is the Memory board,
D is the Display board, and
xx is the socket number

Note: in Version D1 and later, the chips are labeled with the name of the board and the chip's socket number. For instance, the chip for Memory board socket 34 is labeled R34.

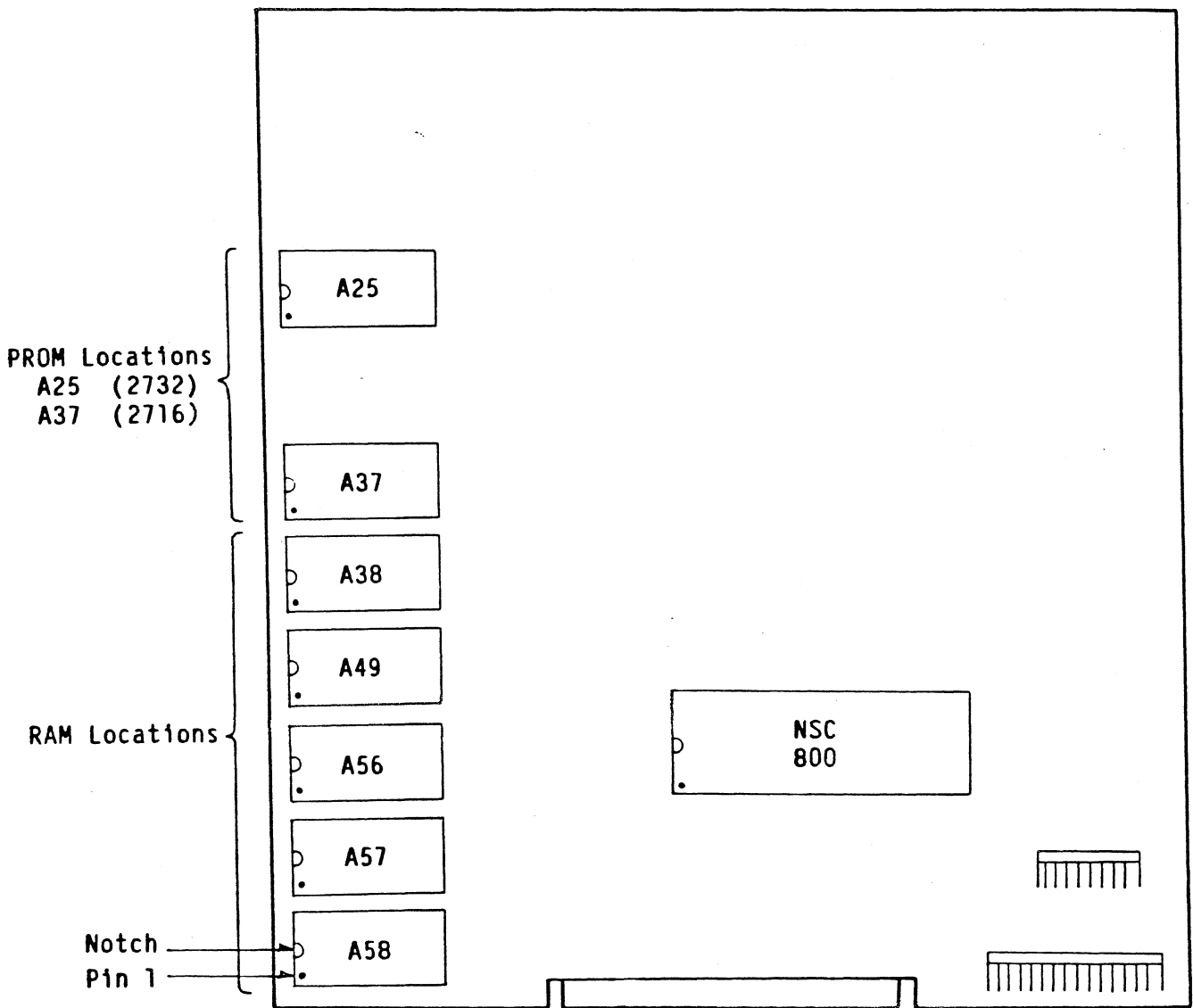
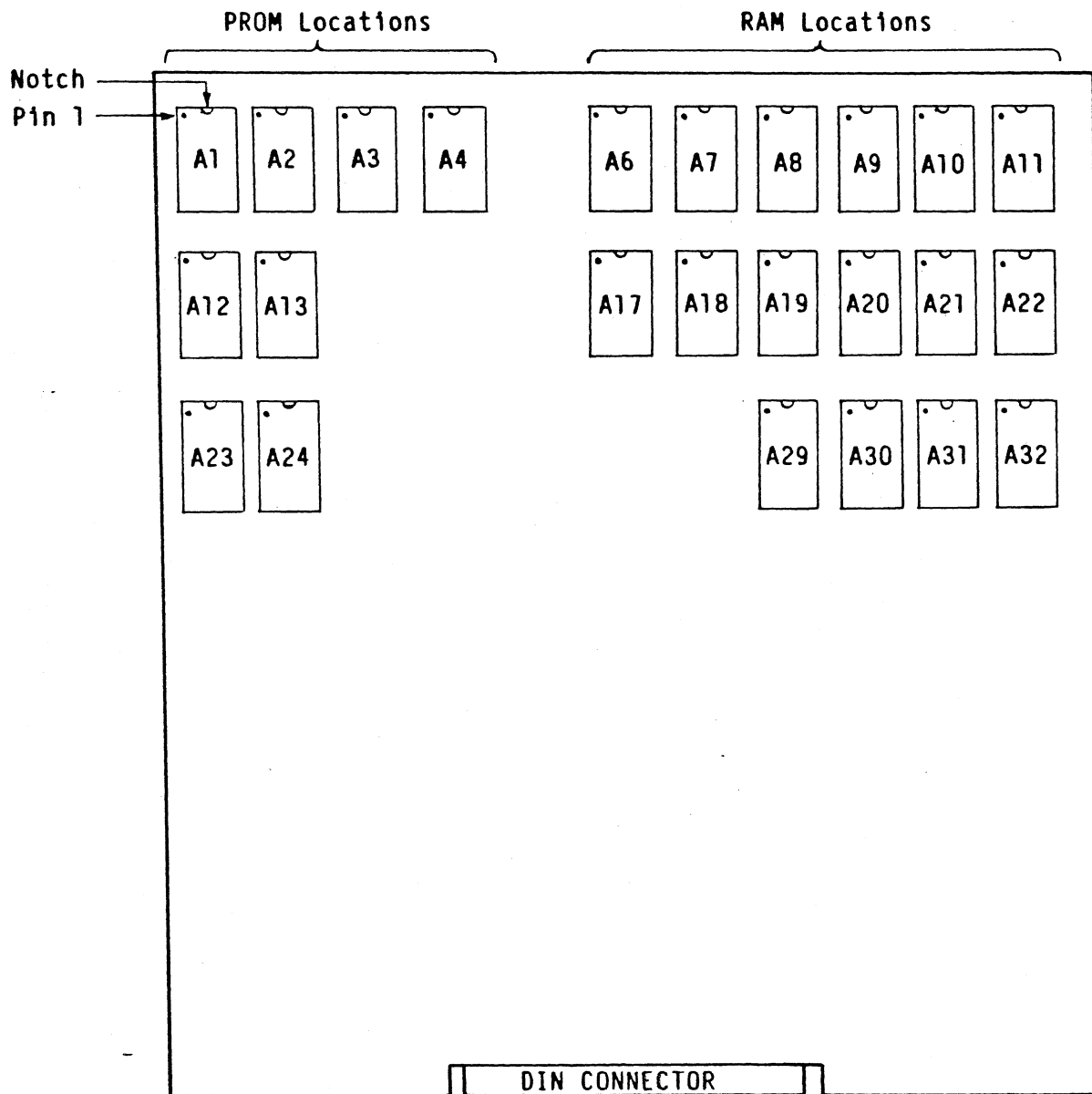


Figure L.2 Display Board



Note:
 Model 1004-D1
 and later.
 Versions C6, C7
 and C8 did not
 use a PROM in
 socket A1.

Figure L.3 Memory Board, Revision A, B, C

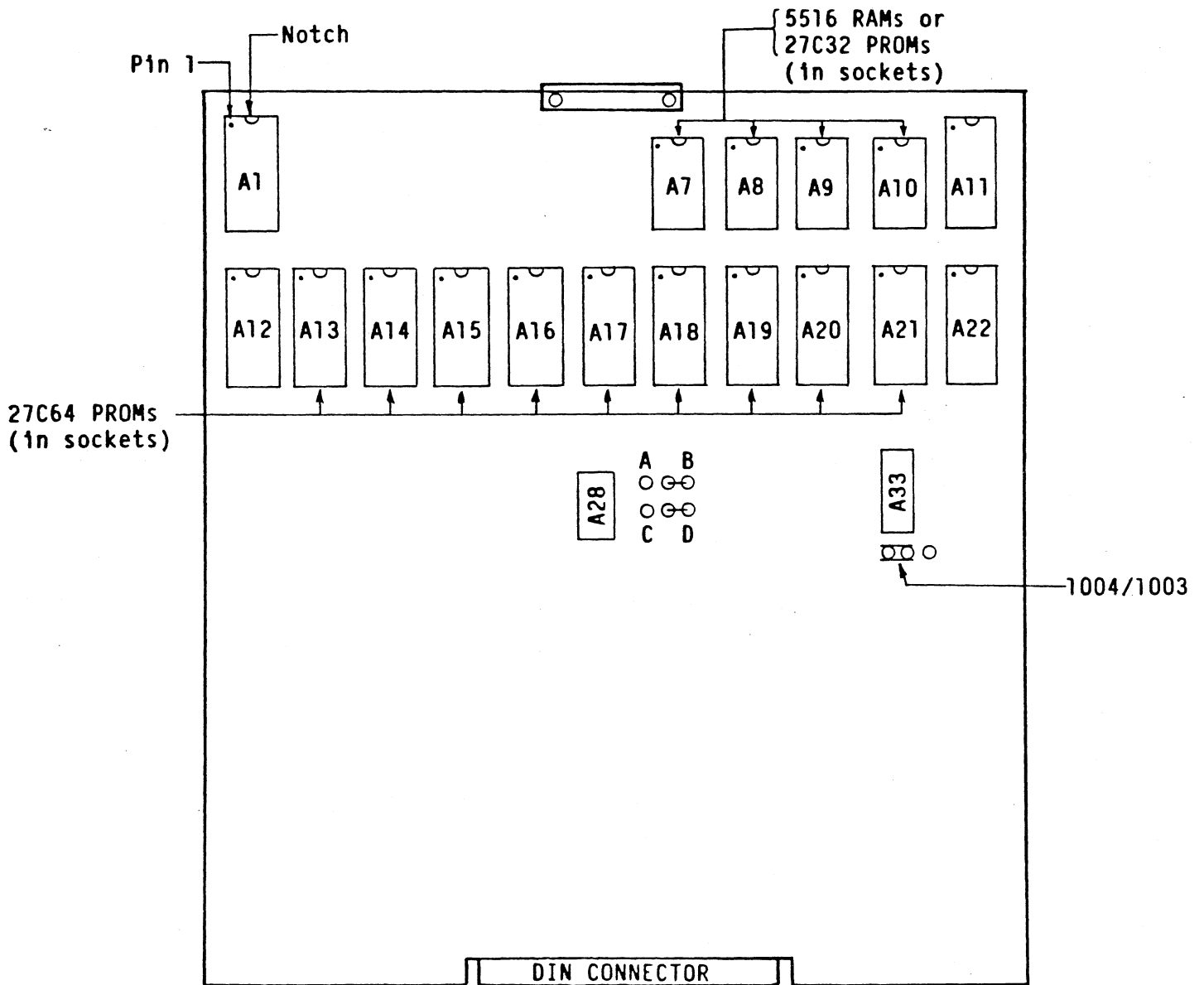


Figure L.4 Memory Board, Revision D and Later

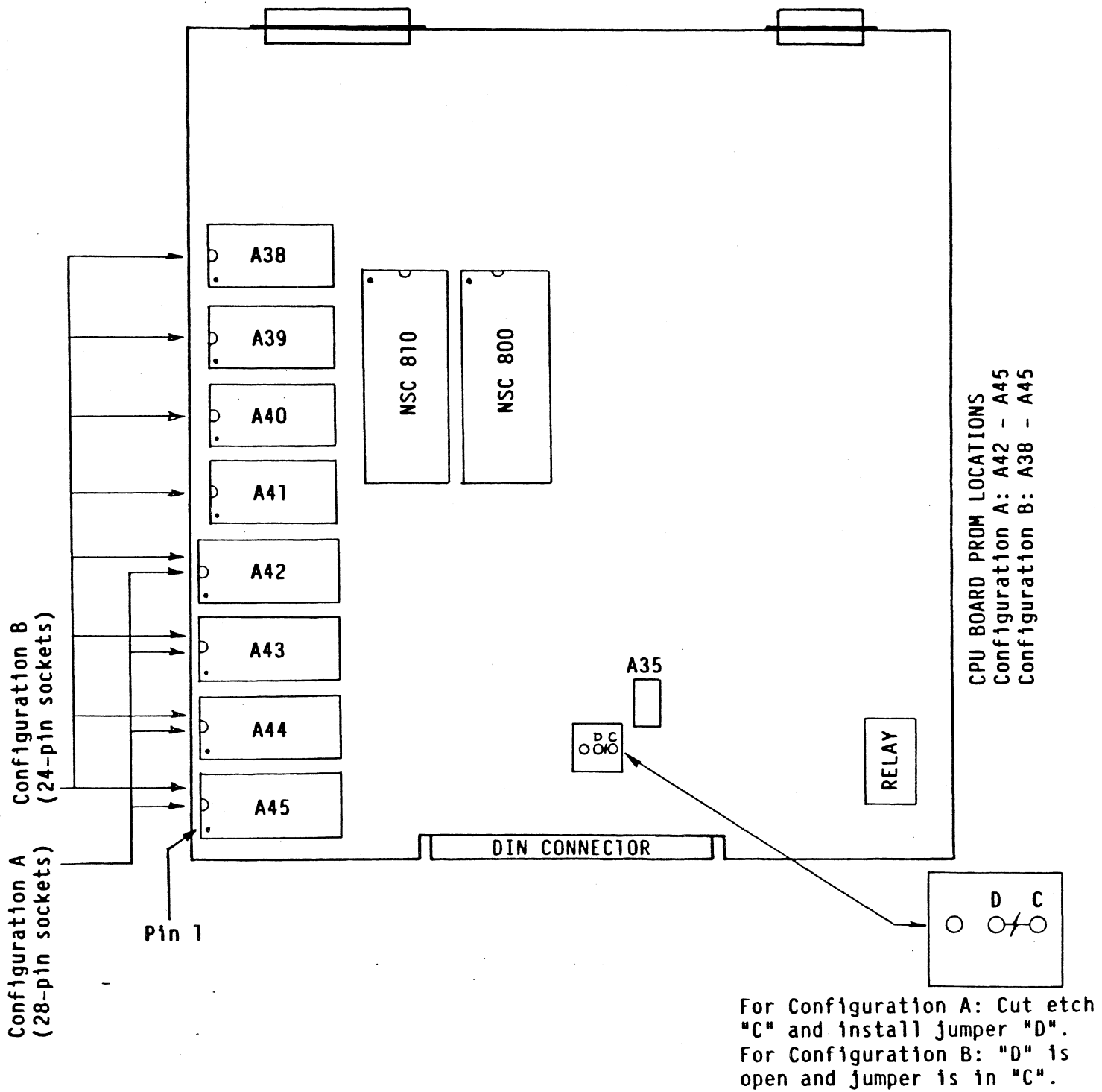


Figure L.5 CPU Board

FCC Warning:

WARNING:

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

