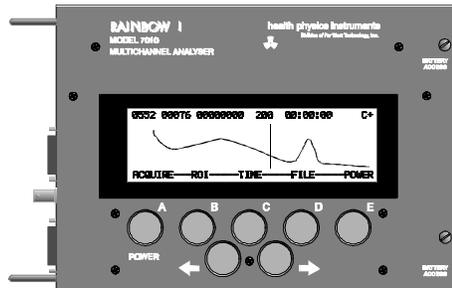

OPERATION MANUAL

Model 7000 *Rainbow MCA*

April 1998



Health Physics Instruments
330 South Kellogg Ave, Suite D
Goleta, CA 93117

IMPORTANT INFORMATION

BATTERIES: 3 D Cells. Alkalines are best.

RESET: Hold down POWER button for 10 seconds, then release. If this does not work, then hold down button E and push the POWER button for 10 seconds. Continue to hold down button E until the LCD contrast is correct, then release it.

STRAP CHECK: Check the strap periodically to make sure that it is not frayed or damaged. Also check that the ends will not come loose.

DETECTOR: When plugging in a new detector, the instrument may automatically turn off and you may not be able to turn it on. To reset it (see RESET above). To prevent this, turn the Rainbow off when plugging in a new detector.

SOFTWARE VERSION: To check the version of the software, turn the instrument on with the B button held down.



This manual belongs to: _____

Serial Number: _____ Date Purchased: _____

GENERAL INFORMATION

This instrument is manufactured in the United States of America by:

Health Physics Instruments
Suite D
330 South Kellogg Ave
Goleta, CA 93117-3814

Tel: 805.964.3615
Fax: 805.964.3162
Email: support@fwt.com

Health Physics Instruments is a division of Far West Technology, Inc.

Both Health Physics Instruments and Far West Technology have been manufacturing radiation measuring devices since 1972.

REPAIR SERVICE

Although we design and manufacture our instruments to a high standard, we realize that repairs are sometimes necessary. If you believe service is needed on this instrument please call our service department before shipping the instrument to us for repair; often we can help you with simple problems. If you do decide to return it to us for repair then please include:

1. Contact person's name
2. Organization or Company name
3. Address
4. Phone number of contact person
5. Description of the problem
6. Anything else you may think important

We will inform you of the repair charges and wait for your authorization before we repair your instrument.

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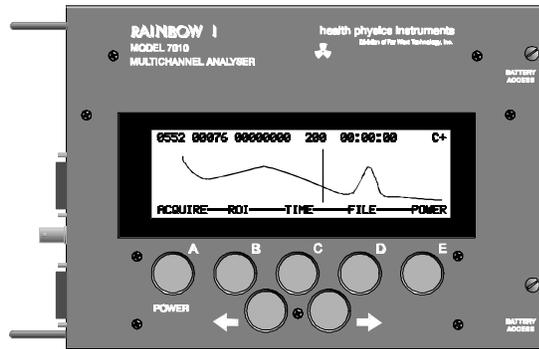


Figure 1 Front View of Rainbow

I. INTRODUCTION

The model 7000 is complete multichannel analyzer that is at home in both the field and the lab. It will find use in a diverse range of applications because of its portability, small size, long battery life and low cost. It puts an MCA in everyone's hand.

The software is designed to be easy to use with only a few easy to use menus. The softkeys also contribute to its simplicity. Some of its key features are:

- Live Time Display
- Small size
- Long Battery Life
- 1024 Channels
- Large LCD graphic display
- Flexible preamp/hv connection

This manual covers only the operation of the Rainbow. It does not teach nuclear spectroscopy.

II. ASSEMBLY

If you have bought the Rainbow with the optional preamp/hv card, it is already installed. Plug a scintillation/NaI detector into the BNC on the side of the Rainbow. If you have another type of detector, see the section on INTERNAL SETUP & CONNECTIONS. The batteries are already installed.

III. QUICK START

Turn the Rainbow on by pushing the power button on the front panel. Push ACQUIRE to change to the acquiring data menu and push START to start gathering data. The SCALE buttons will increase and decrease the vertical scale.

The MENU button will always get you back to the main menu that you can identify by the dashes between the words. You can save the data under FILE, change the ROI (Region of Interest) and expand the display under ROI, change the time for acquiring data in TIME and turn the power off in POWER. The Setup menu changes the gain.

The two bottom buttons will move the cursor left and right. To transfer the data and operate the Rainbow remotely, connect to a serial port at 19,200 baud and push the H key on your computer for a help menu.

IV. BUTTONS

The Rainbow is controlled by the 7 buttons on the front panel. The bottom line on the display shows the function of the 5 buttons just below the display. The two bottom buttons are for moving the cursor left and right. These are also used in moving the cursor in setting the acquire time and in file selection. All buttons repeat. The cursor buttons have ballistic control: they move the cursor further the longer they are held down. The cursor wraps around the display.

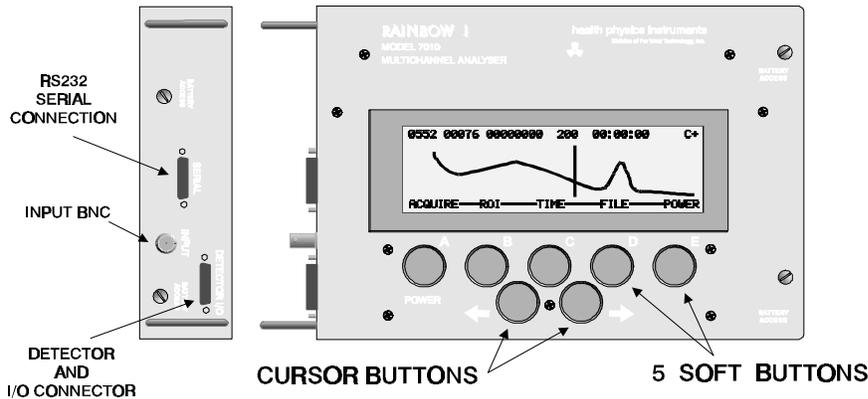


Figure 2 Control Locations

V. POWER ON/OFF AND AUTO POWER OFF

The power is turned on by pushing the POWER button (A) on the front panel. If you have problems on turn-on, see the section on Emergency Measures. It is turned off by pushing button (A) until the MAIN MENU is displayed, then pushing the POWER MENU selection (E), then the PWR-OFF button (E). The data will remain in memory while power is off. If the batteries are too low, then the Rainbow will show LOW BAT in the display. When the batteries are very low, the Rainbow will automatically turn itself off and will not turn back on until new batteries are installed.

The Rainbow will automatically turn itself off in about 1 hour if it is not acquiring a spectrum. This prevents it being left on unintentionally and ruining the batteries.

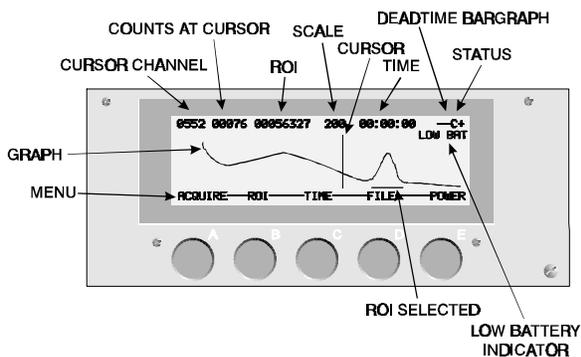


Figure 3 Display Description

VI. DISPLAY

The spectrum is displayed in all menus except the FILE menu. The bottom line shows the function of the buttons below the display. The top line shows, from left to right:

Channel number of the cursor, 0 to 1023

Counts in the cursor channel: In compressed this is average of 4 channels

Counts in the Region of Interest (ROI) (Except when acquiring data; then it shows RUNNING)

Number of counts full scale (vertical) Choices are: Log, 50, 100, 200, 400, 800, 1K, 2K, 3K, 5K, 10K, 25K, 50K, .1M

Acquire time in HH:MM:SS (Deadtime corrected)

Deadtime Bargraph ("- " is 20%, "-- " is 40%, "--- " is 80% and "---- " is 90%)

Status: "C" is Compressed display, "E" is Expanded display, "+" is count up, "-" is count down)

The display has only 240 horizontal dots and therefore shows only 240 channels either in compressed or expanded form. In the compressed display every four channels are averaged and only channels 0 through 960 are shown. Thus the channels shown are: 0,4,8,12,16,20, etc. Channel 0 is the average of channels 0, 1, 2 & 3; channel 4 is the average of 4, 5, 6, & 7. In expanded display only 240 channels can be seen at once, but all of the channels can be viewed by scrolling through the display (<--> and cursor in ROI MENU).

The channels that are included in the ROI are marked with a dot on the bottom of the graphic portion of the display. In compressed display, if any of the 4 averaged channels are included in the ROI, then the channel is marked as part of the ROI. Also in compressed display, the ROI counts are true counts and not an average.

Low battery is indicated by "LOW BAT" in the upper right corner of the display. Contrast is set in POWER MENU.

The display will sometimes show more than one dot on for each channel. This happens with high count rates especially on the lower scale of 50. Change scale to remove excess dots.

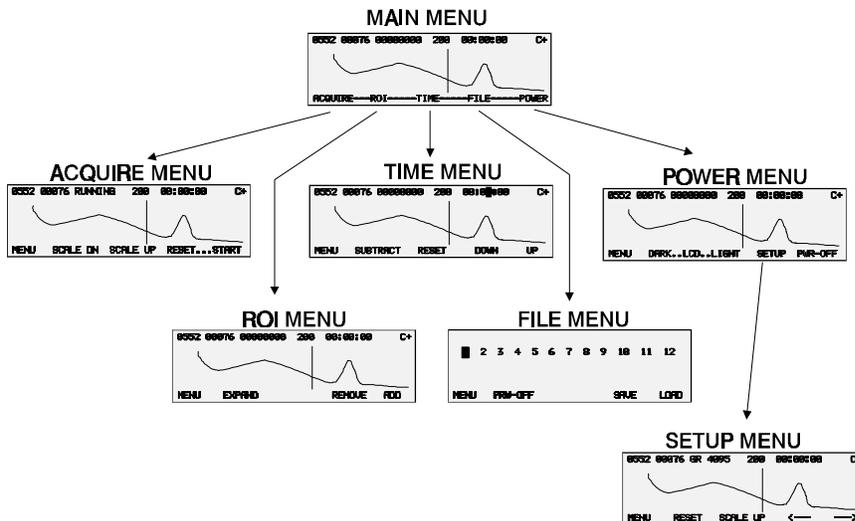


Figure 4 Menu Selection From Main Menu

VII. MENUS

During normal operation, there are 6 menus. The main menu is identified by the dashes-between-the-words. Its only function is to select one of the other menus. To get back to the main menu, push the MENU button that is always on the left. The selections from the main menu are:

ACQUIRE: This allows you to start, stop and reset the MCA. It also has the scale up and down functions.

ROI: This sets and resets the ROI or Region of Interest. The menu allows setting and clearing all of the channels or individually. This menu also has the button to expand or compress the display.

TIME: This sets the acquire time. It can be set from 00:00:00 to 99 hours, 59 minutes, 59 seconds. If it is set to 0 then the time will count up, otherwise it will count down and stop acquiring data when it gets to 0. This menu also has a button that will add or subtract counts for background subtract.

FILE: Saves or retrieves spectrums from memory. There are 12 files and each file stores a spectrum. The 13th file is the current display.

POWER: Power off, LCD contrast and Setup are all in this menu.

In addition there is:

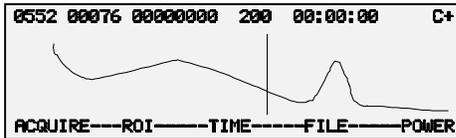
SETUP: Accessed only through POWER. Setup adjusts the Gain to expand or compress the spectrum horizontally.

MENU	BUTTON A	BUTTON B	BUTTON C	BUTTON D	BUTTON E
MAIN MENU	ACQUIRE--- Acquire Menu	--ROI— ROI Menu	--TIME— Time Menu	--FILE— File Menu	--POWER Power Menu
ACQUIRE MENU	MENU To Main Menu	SCALE DN Decreases Scale	SCALE UP Increases Scale	RESET Resets the spectrum	START STOP Acquisition
ROI MENU	MENU To Main Menu	EXPAND COMPRESS Display	<<-->> Move Expanded display quickly*	REMOVE +REMOVE ROI Points where cursor moves	ADD +ADD ROI Points where cursor moves
TIME MENU	MENU To Main Menu	SUBTRACT ADD To each channel	RESET Reset time to:00:00:00	DOWN Decreases the digit where the cursor is	UP Increases the digit where the cursor is
FILE MENU	MENU To Main Menu	PWR-OFF Turns the power off		LOAD Get file #__	SAVE Save file to #___
POWER MENU	MENU To Main Menu	DARK..LCD Darkens the display	LCD..LIGH T Lightens the display	SETUP Goes to Setup menu	PWR-OFF Turns power off
SETUP MENU (From Power Menu)	MENU To Main Menu	RESET Resets the channels	SCALE Changes scale (rollovers)	<----- Decreases Gain	-----> Increases Gain

* Changes to "REMOVE ALL" or "ADD ALL" when +REMOVE or +ADD are shown.

Table 1 BUTTON REFERENCE GUIDE

MAIN MENU

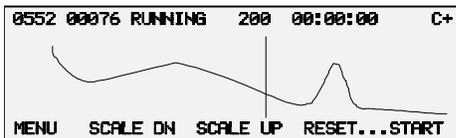


A. MAIN MENU

The main menu is the pathway to select one of the other menus. It can be easily identified by dashes between the words on the bottom line. The Choices are:

- Acquire Menu: Changes to Acquire Menu
- ROI Menu: Changes to ROI (Region of Interest) Menu
- Time Menu: Changes to Time Menu
- File Menu: Changes to File Menu
- Power Menu: Changes to Power Menu

ACQUIRE MENU

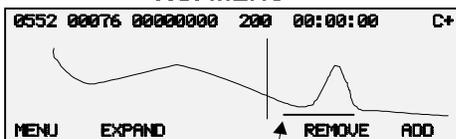


B. ACQUIRE MENU

Used to acquire, and display data. The choices are:

- MENU: Back to main menu
- SCALE DN: Lower the scale, i.e. show lower part of scale
- SCALE UP: Increase the scale, i.e. show upper part of scale
- RESET: Reset the time and data. If it is set to subtract counts, this will change to add counts.
- START and STOP: Start and Stop acquisition. Alternate action. If time is set to zero, it will acquire data until manually stopped and will show the acquiring time. If it is not zero, it will count down and stop at zero, then reset the time in the display to the preset time. Running time is deadtime corrected.

ROI MENU



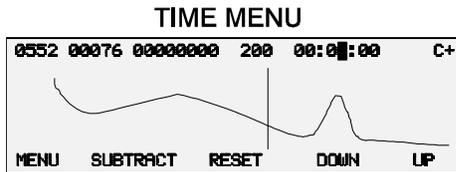
ROI

C. ROI MENU

Used to set the Region of Interest (ROI). A channel that is part of the ROI is shown by a dot on the bottom of the graph. The choices are:

- MENU: Back to main menu
- EXPAND: Changes display to show a detail of the spectrum. It will display only 240 channels and will center the display on the cursor when it changes to this display. Also changes Status in top line to "E".
- COMPRESS: Changes the display to show almost the whole spectrum (960 out of 1024 channels). Also changes Status in top line to "C".
- <<-->> Push this button and hold it down along with the cursor button and the whole display will move in the direction of the cursor buttons.
- REMOVE: Pushing this button will change the button to +REMOVE. This changes the cursor to an ROI remove cursor. Wherever the cursor is moved, the channel will be removed from the ROI. Pushing +REMOVE or MENU will cancel the remove function.

ADD: Pushing this button will change the button to +ADD. This changes the cursor to an ROI add cursor. Wherever the cursor is moved, the ROI will be added. Pushing +ADD or MENU will cancel the add function.
 REMOVE ALL: Removes all channels from the ROI. Visible only when +REMOVE is showing.
 ADD ALL: Adds all channels to the ROI. Visible only when +ADD is showing.



D. **TIME MENU**

This menu sets the integrate time for acquisition. If time is set to 00:00:00 then time will increase when acquiring data. If it is set to a number other than zero, it will decrease until it reaches zero and will stop the data acquisition. The choices are:

MENU: Back to main menu

SUBTRACT: Changes the MCA from adding counts in each channel to subtracting counts in each channel. Shows "-" in Status on top line.

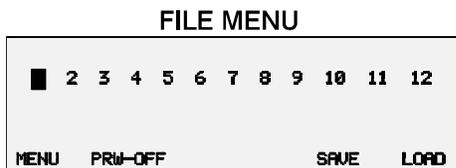
ADD: Changes the MCA from subtracting counts in each channel to adding counts in each channel. Shows "+" in Status on top line.

RESET: Resets the time in the top line to 00:00:00.

DOWN: Decrements the number at the cursor location in the time display located in the top line.

UP: Increments the number at the cursor location in the time display located in the top line.

CURSOR BUTTONS: Change the digit to change in the time display.



E. **FILE MENU**

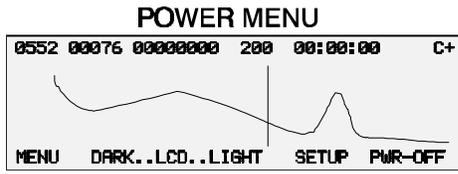
The FILE MENU saves and retrieves spectrums from 12 different files. Each file can store only 1 spectrum. Only the spectrum data is stored. The display changes to showing the numbers 1 through 12. Each one represents a file/spectrum. The cursor buttons move the cursor. The Choices are:

MENU: Back to main menu

PWR-OFF:: Turns off the power

LOAD: Loads a spectrum from the file that is marked by the cursor. The scale is automatically changed to LOG and the cursor moves over to the next file.

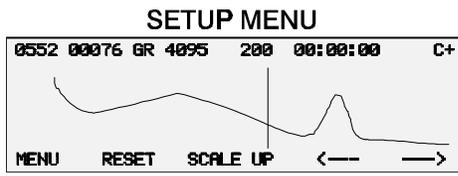
SAVE: Saves the current cursor in the file that is marked by the cursor. The cursor automatically moves over to the next file.



F. **POWER MENU**

The POWER MENU has many functions. It is used primarily in turning the power off. It also can adjust the LCD contrast and is the only way to enter the SETUP MENU. The choices are:

MENU: Back to main menu
 DARK..LCD: Darkens the LCD Display
 LCD LIGHT: Lightens the LCD Display
 SETUP: Changes to the SETUP MENU
 PWR-OFF: Turns the power off.



G. **SETUP MENU**

This menu can only be reached through the POWER MENU by pushing SETUP.

This menu is used to set the gain of the amplifier. The Gain is set digitally by the arrow buttons in this mode. The Gain will compress and expand the horizontal portion of the display. Increasing the Gain will expand the peaks to the right, and decreasing it will compress them to the left. If the Gain does not go high enough, then it will be necessary to increase the high voltage. See the section on First Time Calibration.

The display will show a normal display and it will be acquiring data. The scale is set to 50 counts full scale. The Gain (GN) is shown in the top line where the ROI counts normally are. It has a range from 0 (no Gain) to 4095 (Full Gain). The choices are:

MENU: Back to main menu
 RESET: Resets the time and counts in each channel
 SCALE: increases the scale factor. The factor will rollover at the end.
 <--- Decreases the Gain
 ---> Increases the Gain

The <--- and ---> buttons have ballistic control. The longer they are held down the more they change the Gain.

VIII. TYPICAL OPERATION

This section will walk through a typical acquisition of a spectrum. There are several steps that need to be followed to obtain data.

1. Calibrate the Rainbow
2. Acquire a spectrum
3. Background subtract
4. Look at region of interest
5. Saving the data
6. Transfer the data

A. *Calibrate the Rainbow*

It is helpful if you have some idea of the energy of the spectrum that you will obtain. Often just the characteristic look of a spectrum is enough to identify different isotopes, but often you want to verify the energy of several peaks.

You will need a check source to set the sensitivity of the Rainbow. Usually this isotope is Cesium 137, Cobalt 60 or a lower energy isotope such as Cadmium 109. It should be in the energy range of the intended spectrum.

1. **First Time Calibration**

First time calibration is different from routine calibration. First time calibration involves setting the high voltage adjustment that changes the gain of the scintillator. Routine calibration will probably use only the finer Digital Gain setting in SETUP MENU.

Turn the Rainbow on and change to the SETUP MENU. (Through POWER MENU). Adjust the Gain using the <--- and ---> controls until it is at 3500. With 4096 as full Gain this will allow a routine adjustment of +17%. Turn the Rainbow off. Remove the bottom cover. Locate the high voltage adjustment on the optional preamp/high voltage board. If you are using an external high voltage control on an external preamp, locate the control.

Turn the Rainbow back on and put it in either ACQUIRE MENU or SETUP MENU. Place the check source near the detector. Adjust the high voltage until the peak(s) of the check source fall into an area that you want. For example, if you are using a CS137 you may wish to put its peak of 660 KeV in Channel 660. While you are adjusting the high voltage, you can push the reset button to reset the spectrum so it is easier to see the peak. It is usually easier to do this in compressed format. Start with the high voltage at a low value and slowly increase it. This way you can always see the peak. This sets the high voltage and gain.

2. **Routine Calibration**

Once the high voltage has been set, then use the SETUP MENU for fine adjustments to the peak. Place the check source near the detector and check the peak location in any menu you want. If it is not where you want it, then use the SETUP MENU with the <--- and ---> buttons to move the peak to the desired channel.

B. *Acquire a Spectrum*

The spectrum is usually acquired in the ACQUIRE MENU. The display is typically compressed because it shows most of the spectrum. Check the right top corner of the display, if has a C in it then it is a compressed display. If there is an E it means an expanded display and you will only see a portion of the spectrum. To change between the compressed and expanded display use the ROI MENU.

The time to acquire data is set in TIME MENU. It needs to be set long enough to obtain enough data to show a good spectrum. 1 minute, 10 minutes or 1 Hr 40 minutes (100 minutes) are logical choices. If you set the time to 00:00:00 then the Rainbow will acquire data until you manually stop it. If you set it to a number, then the time will count down in seconds until it gets to 00:00:00 then stop the acquisition and reset the time display to the preset time.

Start acquiring data by pushing the START button. The STOP button will stop it. You can start and stop without losing any data. Time may be offset by 0.05 seconds for every stop/start action. Reset will reset the data and time. When the Rainbow is acquiring data the ROI section of the display will show RUNNING and the time will change in 1 second intervals.

C. *Background Subtract*

After you have acquired a spectrum you may wish to subtract the background. Go to the TIME MENU and push the SUBTRACT button. This will change the Rainbow to its subtracting mode. The top right hand corner of the display should now show a "-". This indicates it will subtract counts. If it shows a "+" then it will add counts. Now acquire data for the same time as you did when you originally acquired it, but without the source of radiation present. This will remove the extra counts from background. It will automatically go back to adding counts when you reset the data.

D. *Look at Region of Interest*

If you want to know the counts in a particular region of interest, then switch to the ROI menu. To add a channel to the ROI, push the ADD button. The button will change to +ADD. This indicates that anywhere you move the cursor, those channels will be added to the ROI. The channels that are included in the ROI count are indicated by looking at the bottom line of the graph portion of the display, but above the bottom line of text. If there is a dot or line there, then all those channel(s) are included. Remove channels in the same way as you added them but push the REMOVE button. The ROI counts are visible only when the Rainbow is not acquiring data.

E. *Saving the Data*

Once you have a spectrum, you may wish to save it. Switch to the FILE MENU. The data can be saved into one of the 12 files that are numbered on the display. Select the file with the CURSOR and then push the SAVE button. The data will be saved into that file and the cursor will automatically increment to the next file.

F. *Transferring the Data*

To transfer the data to your computer, see the section on Transferring Data. This will transfer the data from the Rainbow to your computer.

IX. EXTERNAL COMMUNICATION & TRANSFERRING DATA

The 12 files/spectrums can be transferred on the RS232 serial connection. Connect the serial connector on the side of the Rainbow to your PC computer using a 9 pin RS232 cable. Use a communications program to turn your computer into a terminal. Communications programs are included in most operating systems.

The settings for the serial port in the computer should be:

9600 baud rate, 1 stop bit, no parity
There is no flow control.

When the Rainbow is first turned on it outputs a sign-on message that you should see on your computer. Typing an H or a ? on your computer will display the help menu.

All commands must be followed by <enter>. Only the last command or digits are used. The choices are:

A This will change to the acquire menu and start the MCA acquiring data.

S This will change to the acquire menu and stop the MCA acquiring data.

R This will change to the ACQUIRE MENU and reset the data and time.

Thhmmss Sets the acquisition time in HH (hours), MM (Minutes) and SS (Seconds). T30 will set the time to 30 seconds. T100 will set it to 1 minute. T14000 will set it to 1 hour, 40 minutes. (100 minutes).

G Gain Sets gain to xxxx Setable from 0 to 4095.

I This will show the counts in the ROI and stop acquisition.

C Shows Preset time, Live time, and Gain. Live time is the time shown in the LCD.

Xxx This will transfer the file specified by xx. Typing D3 will transfer file #3. Typing X12345611 will transfer file #11. File #13 is the current display.

Vxx This is the same as Xxx except the transfer rate is slower for slower computers

Z Transfer all the files. This takes about 1 minute.

H or ? Help Menu

A. Data Structure

The data consists of 1 channel per line with 1 to 5 ASCII digits per channel (0 to 65535). The leading zeros are suppressed. There are 1024 channels in the X and V command, and 13,312 channels in the Z command. The Z command transfers files 0 through 13 consecutively. The first line of each file is the file number. File number 13 is the current display.

X. BATTERIES

Wait 1 minute after turning the Rainbow off before replacing the batteries. Removing the rear cover immediately can short high voltage and damage the instrument.

NOTE: The main batteries besides powering the Rainbow, are also used for powering the data memory for the 12 files. The memory will hold for 2 minutes while changing batteries. To be safe, transfer any important files to a computer before changing the batteries.

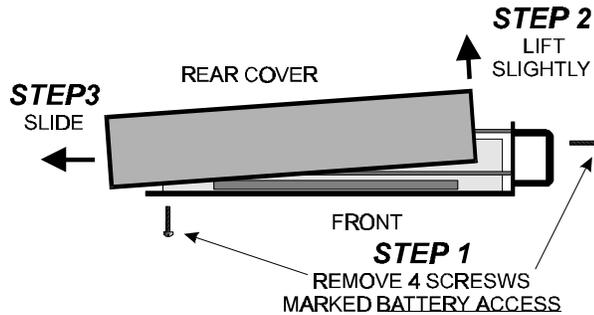


Figure 5 Removing Rear Cover

The batteries are replaced by removing the back cover. It is held in place by 4 screws. Two of these are on the right hand side of the front panel, and two are on the side with the connectors and handle. They are all marked BATTERY ACCESS. Slip the cover off and the 3 D cells are clearly visible. Replace them in the sleeve. Make sure the polarity is correct. The + or positive side of the batteries all face in the same direction and go toward the red end on the battery holder.

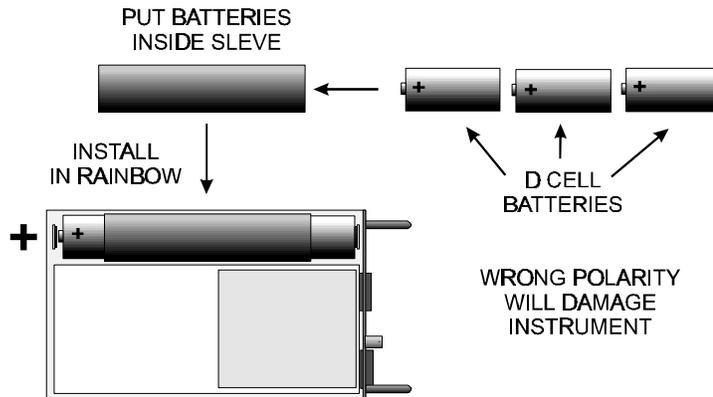


Figure 6 Battery Replacement

XI. OPERATIONAL

A. *Deadtime*

The Rainbow has deadtime correction. It measures the time for each pulse and compensates for this lost time by altering the internal timekeeping clock. The actual time displayed will not be the same as clock time because of this correction.

B. *Button Repeat*

All of the buttons will repeat. The cursor has a ballistic movement. It will move further the longer the cursor button is held down. It does this in both the expanded and compressed displays. The same type of enhanced action is also true when setting the Gain in the SETUP MENU.

C. *Pulser Input*

An external pulser can be used with the internal preamp/HV board. Connect it between pin 5 (signal) and 1 (ground) on the DB9 connector marked DETECTOR I/O on the side of the Rainbow. Internally it has a 50 ohm load.

D. *Subtracting Counts*

When the Rainbow is set to subtract counts (TIME MENU), the counts will stop at zero. There are no negative counts.

E. *Overflow*

The counts will stop at 65535 counts per channel. They will not overflow or roll over to lower values.

F. *Error Messages*

There is only one error message. When the Rainbow is first turned on, it checks the memory. If it has been corrupted, then it will show an on screen error message that it is programming the memory with default values for scale, contrast, etc.. It will not program over any data memory.

XII. ADJUSTMENTS

There are 4 manual adjustments in the basic Rainbow and one adjustment on the optional Preamp/HV card. In addition there is the digital adjustment of Gain on the Rainbow (SETUP MENU). For all of the adjustments except LLD, it is best if the Gain in SETUP MENU is set to 4095. Usually only LLD and HV will need adjustment. You may need to remove the Preamp/HV card to access the testpoints. The adjustments are:

LLD: Low Level Discriminator. This adjusts the lowest channel that the Rainbow will detect in the spectrum. If it is set to channel 100, then the Rainbow will only accept inputs above channel 100. If it is set too low there will be excessive counts or no counts in the lower channels. Usually it is set at a minimum of channel 40 to 60. If it cannot be set low enough, the **zero** may be incorrectly set. For a preliminary setting, turn it 20 turns CCW or until it clicks, then 8 turns CW. When setting this control raise it high enough to see the cutoff (use 50 scale in Acquire). Then lower it to the value you want. As you lower it close to zero, the counts usually increase from background counts and noise; as you lower it further, the instrument will stop counting.

PZ: Pole Zero. This corrects for the ballistics of the preamp circuit. Connect an oscilloscope between TP9 (signal) and TP5 (ground). The detector should be connected to the Rainbow. Trigger on the positive peaks. Adjust PZ (R57) until the waveform has no undershoot. If no oscilloscope is available, turn PZ 20 turns CW or until it clicks, then 8 turns CCW.

ZERO: This adjusts the zero of the analog to digital converter. Connect an oscilloscope between TP10 (signal) and TP5 (ground). The detector should be connected to the Rainbow. Trigger on the positive pulses from the detector. Adjust Zero (R47) until the end of the ramp is at the same voltage as the input to the triangle waveform. If no oscilloscope is available, turn it 20 turns CCW or until it clicks, then 10 turns CW although this is a course adjustment.

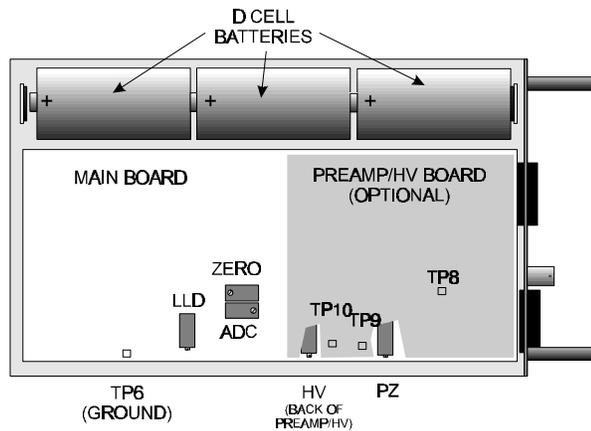


Figure 7 Adjustment Locations

ADC: This adjusts the gain of the Analog to Digital Converter. Connect an oscilloscope between TP8 (signal) and TP5 (ground). Connect a pulser to either the DB 9 connector on the front panel or to the input directly through a matching network. Adjust the pulser heights until the height of the pulses on the oscilloscope are 2 volts.

Connect the oscilloscope between TP10 (signal) and TP5 (ground) trigger on the positive part of the ramp. Adjust ADC (R53) until the length of the ramp is 75ns.

HV: The high voltage adjustment will change the gain of the detector. Normally the Gain in SETUP MENU is set to around 3500 and the high voltage is adjusted until a peak from a check source is located wherever the user wants. The Gain is then used to adjust the peak if any further adjustments are necessary.

XIII. INTERNAL SETUP & CONNECTIONS

A. Detectors

The Rainbow has the capability of accepting detectors in four arrangements. The first is with a preamp/high voltage board installed inside the Rainbow. The second is with an external preamp/high voltage module plugged onto the base of a detector and powered by the Rainbow. The third is with a NIM bin external high voltage power supply coupled to an external preamp. The fourth is a NIM bin external high voltage power supply coupled to an external preamp and amplifier.

The input of the Rainbow is designed to be flexible for external inputs. It has an input attenuator, and can accept positive and negative inputs.

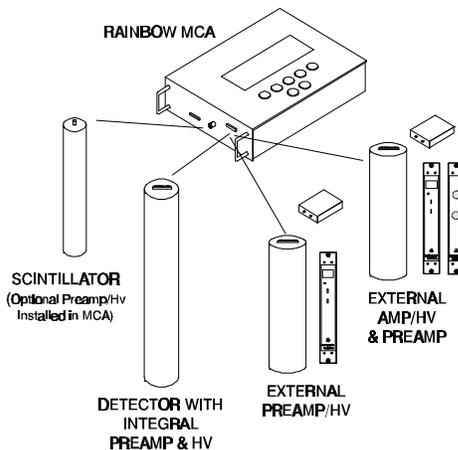


Figure 8 Detector Configurations

B. Where to Plug in the Detector

With the optional preamp/HV board installed, plug the detector into the BNC connector marked INPUT on the side of the Rainbow. All other options plug into the 9 pin DETECTOR I/O connector on the side of the Rainbow.



Figure 9 Side View of Rainbow Showing the Connectors

C. Jumper Settings

There are many jumpers on the Rainbow. They setup the instrument for detector, gain polarity, attenuation, and input connector. The following tables describe the settings for the jumpers. The default settings shown in column 1 in the General Jumper Table are the settings used at the factory and are also used with the internal Preamp/HV board.

The block diagram shows the signal path for the jumpers.

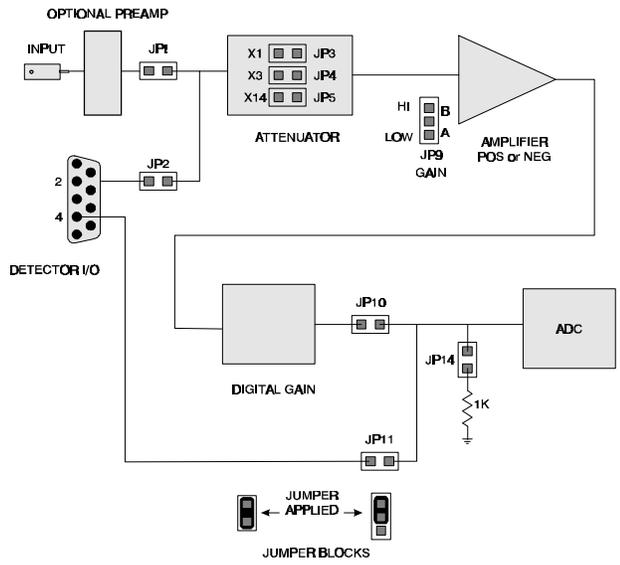


Figure 10 Jumper Block Diagram

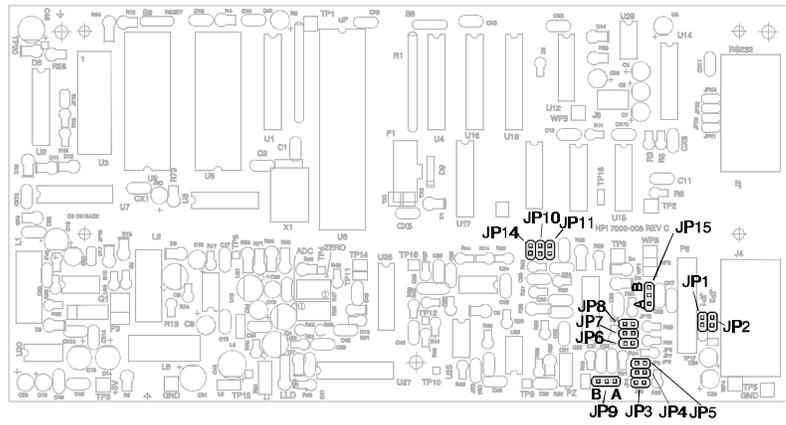


Figure 11 Jumper Locations

GENERAL JUMPER TABLE: The table shows the jumper settings for each different configuration. The standard settings for the internal preamp/HV are shown in column one. The remaining columns may be modified by the tables that follow.

Yes indicates jumper, NO indicates no jumper	1 INTERN AL PREAMP & HV*	2 EXTERNA L PREAMP & HV	3 EXTERNA L NIM BIN PREAMP	4 EXTERNAL NIM BIN AMP
JP1	YES	NO	NO	NO
JP2	NO	YES	YES	NO
JP3	YES	YES	YES	NO
JP4	NO	NO	NO	NO
JP5	NO	NO	NO	YES
JP6	NO	NO	NO	YES
JP7	YES	YES	YES	NO
JP8	NO	NO	NO	NO
JP9	B	B	B	A or B
JP10	YES	YES	YES	NO
JP11	NO	NO	NO	YES
JP14	YES	YES	YES	NO
CONNECT DETECTOR TO	INPUT BNC	DETECTOR I/O	DETECTOR I/O PIN 2	DETECTOR I/O PIN 4

* Default settings for internal Preamp/HV board.

GAIN: The first amplifier has two gain settings. Yes indicates jumper; NO indicates no jumper. The two are:

GAIN	JP9A	JP9B
HIGH	NO	YES
LOW	YES	NO

POSITIVE/NEGATIVE IN/OUT: The first amplifier can accept positive or negative inputs.

INPUT	JP6	JP7	JP8
POSITIVE	NO	YES	NO
NEGATIVE	YES	NO	YES

TEST JUMPER (Consult repair manual for details)

	JP15A	JP15B
NORMAL OPERATION	NO	YES

ATTENUATOR: The input to the post amplifier in the Rainbow has an attenuator.

Attenuation	JP3	JP4	JP5
1	YES	NO	NO
3	NO	YES	NO
14	NO	NO	YES

DETECTOR I/O: The DB9 connector marked DETECTOR/IO has the following fanout:

PIN#	FUNCTION
1	Ground, Analog
2	External Preamp Input
3	Internal Test Point
4	External Amp Input
5	Pulser Input
6	Switched Battery Positive
7	+5 VDC
8	-5 VDC
9	Ground, Digital

D. Serial Connector

The DB9 connector marked SERIAL has the following connections:

PIN#	FUNCTION
1	Jumper JPX3
2	TXD
3	RXD
4	Jumper JPX1
5	Ground
6	Jumper JPX4
7	No Connection
8	Jumper JPX2
9	+5 VDC

The Jumpers JPX1 through JPX3 are all connected together on the circuit board. The connections between them can be cut and a jumper connector installed instead. The +5VDC is for external use and cannot supply more than 5 mA.

XIV. FUNCTIONS/ GLOSSARY

The following will describe each of the functions and words that will appear in the display and on the Rainbow. The functions appear alphabetically.

---->: (SETUP MENU) Increases the Gain and expands the spectrum to the right.

<----: (SETUP MENU) Decreases the Gain and compresses the spectrum to the left.

<<--->>>: (ROI MENU only in expanded mode). Moves the whole display. Push this button down, then push a cursor key. The whole display will move rather than just the cursor.

ACQUIRE: ACQUIRE MENU, reached from MAIN MENU.

ADC: Adc adjustment. See Adjustment Section.

+ADD: (ROI MENU) Will add channels to the ROI. To add more than just 1 channel, move the cursor. Push +ADD again to stop the cursor from adding channels. Or push MENU.

ADD: (ROI MENU) Push this to add channels to the ROI. Will then change to +ADD.

ADD: (TIME MENU) Will change from subtracting counts to adding counts in each channel when acquiring data.

COMPRESS: (ROI MENU) Changes the display to the compressed mode. Shows channels 0 through 960. Each horizontal dot is the average of 4 channels.

CONTRAST: Adjustment is in DARK and LIGHT in POWER MENU.

DARK: (POWER MENU) Darkens the contrast on the LCD display.

DEADTIME: The clock time is extended to compensate for deadtime losses.

DETECTOR I/O: Multiple use connector. Use for external detector with external preamp/HV, pulser connection for internal preamp/HV board, and external power connection.

DOWN: (TIME MENU) Lowers the value of the highlighted number by 1. Cursor moves the highlighted number.

EXPAND: (ROI MENU). Changes the display to show 240 channels out of 1024. Will center the display on the location of the cursor.

FILE: FILE MENU reached from MAIN MENU. Saves/retrieves files or spectrums.

GAIN: Sets the sensitivity of the instrument from the front panel. See Setup Menu.

HV: High Voltage Adjustment. See Adjustment Section.

INPUT: BNC connector that is used for external detector when used with internal preamp/HV board.

LCD: Contrast in the display. Light and Dark in POWER MENU.

LIGHT: (POWER MENU) Lightens the contrast on the LCD display.

LOAD: (FILE MENU) Loads the highlighted file into the display. Will overwrite the existing display. Select the highlighted file with the cursor buttons.

MAIN MENU: Starting point for all other menus. Identifiable because the words have dashes between them.

MENU: Button A that will display MAIN MENU.

POWER: POWER MENU reached from MAIN MENU. Turns power off, sets LCD contrast and is only way to get to SETUP MENU.

PWR-OFF (FILE MENU and POWER MENU) Turns the power off.

PZ: Pole Zero Adjustment. See Adjustment Section.

+REMOVE: (ROI MENU) Will remove channels from the ROI. To remove more than just 1 channel, move the cursor. Push +REMOVE again to stop the cursor from removing channels. Or push MENU.

REMOVE: (ROI MENU) Push this to remove channels from the ROI. Will then change to +REMOVE.

RESET: (ACQUIRE MENU and SETUP MENU) Resets the counts in each channel to 0 and sets the time the preset time.

ROI: Region of Interest. ROI MENU that will set/clear channels for ROI count, reached from MAIN MENU; Total number of counts in all of the channels that are marked with ROI on the bottom line of the graph.

SAVE: (FILE MENU) Saves the current display into the highlighted file. Will overwrite any data in the file. Select the highlighted file with the cursor buttons.

SCALE DN: (ACQUIRE MENU). Decreases the scale factor.

SCALE UP: (ACQUIRE MENU). Increases the scale factor.

SCALE: (SETUP MENU) Increases the scale factor. Will rollover at the upper end.

SCALE: The number of counts full scale (vertical) in the graph portion of the display. Choices are: Log, 50, 100, 200, 400, 800, 1K, 2K, 3K, 5K, 10K, 25K, 50K, .1M

SERIAL: DB9 Connector on the side of the Rainbow for connection to a computer.

SETUP: (POWER MENU) Changes to SETUP MENU.

START: (ACQUIRE MENU). Starts acquiring data. Time will change. Button will change to STOP after being pressed.

STOP: (ACQUIRE MENU). Stops acquiring data. Time will stop. Button will change to START after being pressed.

SUBTRACT: (TIME MENU) Will change from adding counts to subtracting counts in each channel when acquiring data. This is normally used to subtract background.

TIME: TIME MENU reached from MAIN MENU. Sets the time for acquire and also sets add/subtract mode.

UP: (TIME MENU) Raises the value of the highlighted number by 1. Cursor moves the highlighted number.

ZERO: Zero adjustment. See Adjustment Section.

XV. EMERGENCY MEASURES

Try the following if:

1. The Rainbow quits and will not function and the batteries are good.
2. The display shows gibberish.
3. Any other function that does not seem to operate correctly.

COMPUTER RESET: Hold down the POWER button (button A) for about 15 seconds, then release it. This action resets the microprocessor inside the Rainbow. You can do this at any time that the Rainbow is operating. It will not change the memory and initiates the same actions as turning on the Rainbow.

If the display is not showing any characters, it may be that the contrast is set too low to show anything. In that case try:

EMERGENCY CONTRAST: To set the emergency contrast, hold down button E while turning on the Rainbow (by momentarily pushing button A). Continue to hold down the E button until the display shows words that are of proper contrast, then release button E.

XVI. SPECIFICATIONS

MECHANICAL

Size: 9 ½" L x 6" W x 1 7/8 " H **Weight:** 3.1 Lb.

Construction: Painted aluminum case with gasketed keyboard

ELECTRICAL

Display: 240 x 64 dot LCD with Contrast Adjustment

Keyboard: 7 push-button switches protected with silicone rubber gasket

Batteries: 3 D cells will operate Rainbow with detector for 100 hours. Low battery indication. Will automatically turn off when batteries are too low for proper operation.

Internal Adjustments: LLD, ADC Zero, Pole Zero, Conversion Gain, HV (on optional Preamp/HV board)

External Connectors: DB9 Connector for RS-232 Interface, DB9 Connector for External Detector, BNC Input for use with optional HV/Preamp Board

MCA

Channels: 1024 **Counts/Channel:** 65,535

Amplifier Gain: Digitally adjustable in 4096 steps from front panel

ADC: Wilkinson type **14 MHz Clock:** **Conversion time:** 10 μ s to 150 μ s

Maximum Count rate: >10,000 CPS

OPERATIONAL

Modes: Acquire & View data, File Data

LIVE TIME Display, Background Subtraction, Dead Time Correction

Region of Interest: Set individual channels

Storage: 13 ea. 1024 Channel Spectra (Includes Display)

ENVIRONMENTAL

Temperature Range: 0°C to 50°C **Storage Temperature:** -20°C to 60°C

OPTIONS

Options: Internal HV/Preamp Board, Scintillation Probes, shoulder strap, repair manual.

XVII. SCHEMATICS

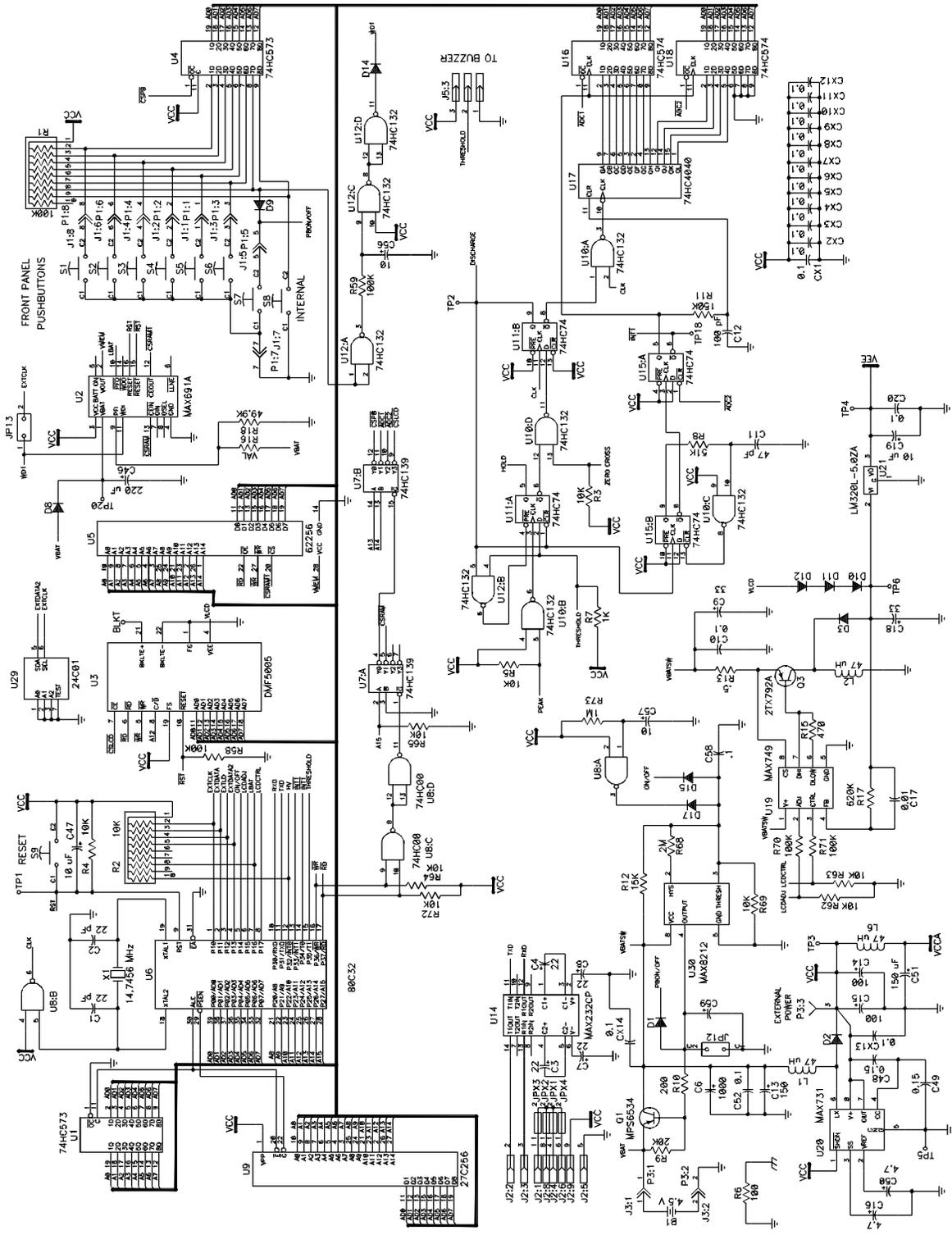


Figure 12 Digital Schematic

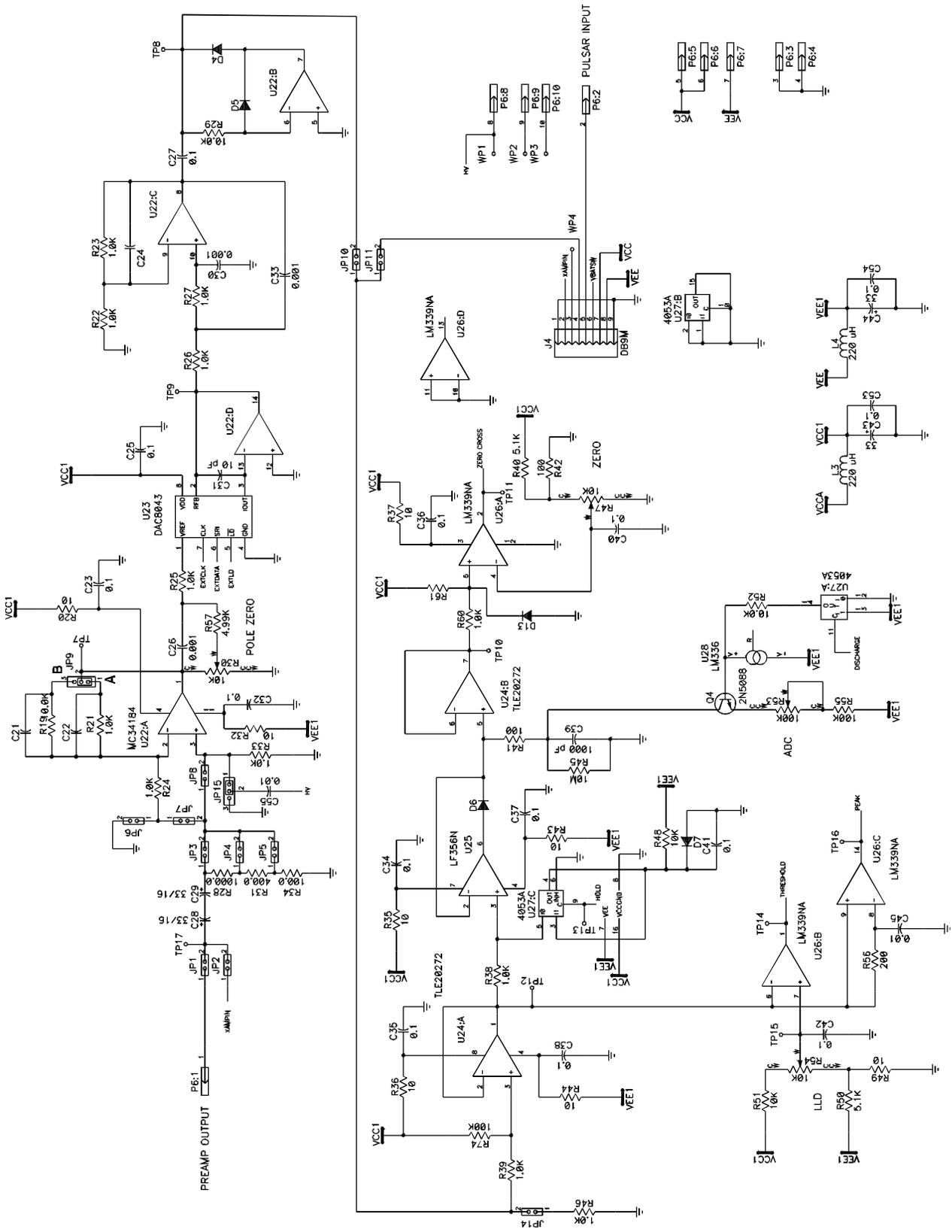


Figure 13 Analog Schematic

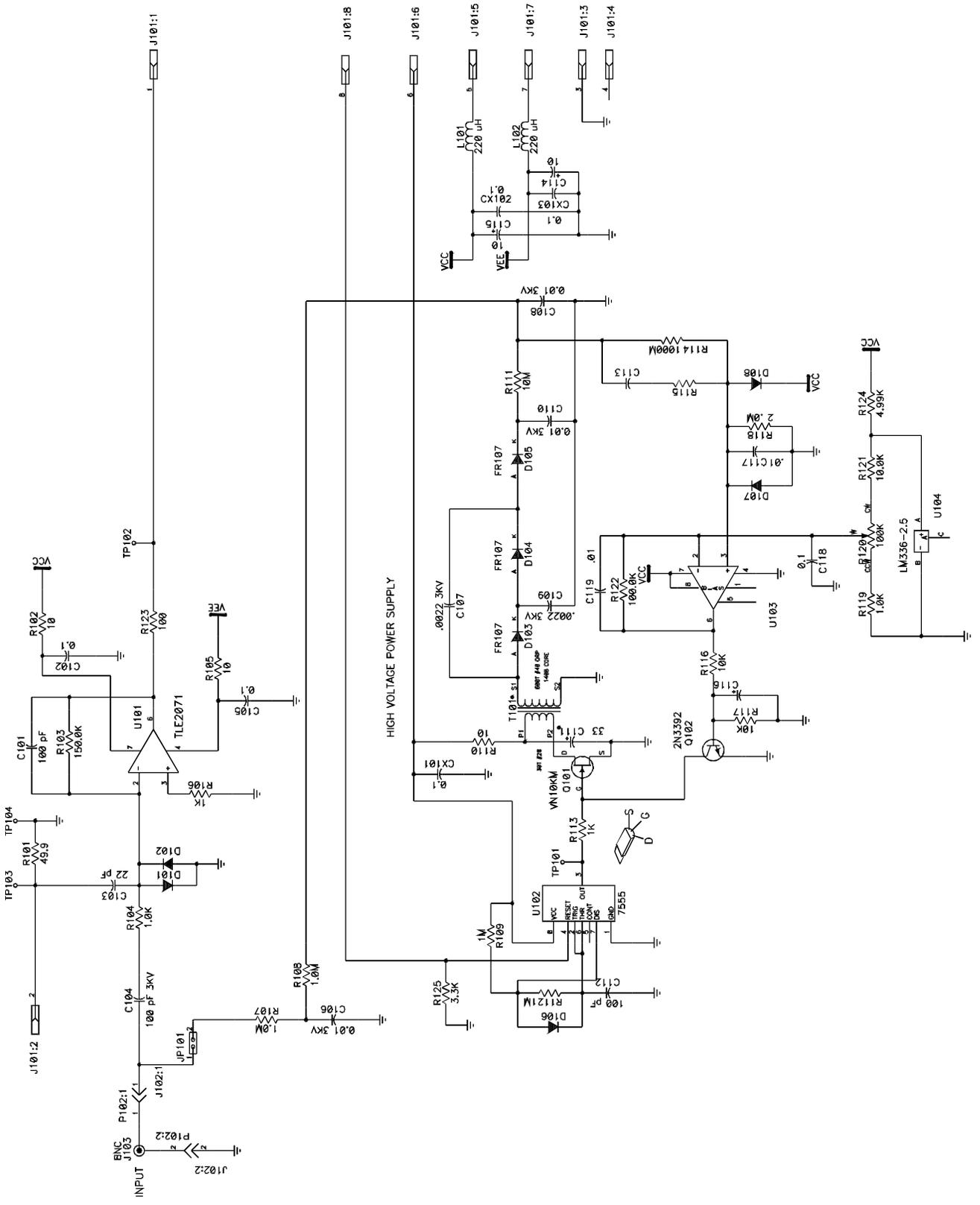


Figure 14 Optional Preamp/HV Board

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