

# **AD111**

## **Photomultiplier Amplifier**

### **USB 2.0**

## **User Manual**

Ver.1.2

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*Spectral Products*

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### 1. Product Overview and Specifications

The AD111 is a convenient computer controlled photomultiplier detection system for use with Spectral Products' Digikrom line of monochromators. It features a detector housing that has a dynode divider chain and direct anode connection, mounts directly to exit-slit ports of Digikrom monochromators, and accommodates side-on photomultiplier tubes. (PMT's must be ordered separately.) It also features the Photomultiplier Amplifier Controller, a compact electronic unit containing the preamplifier and high voltage power supply for the PMT. Coaxial cables for the high voltage and PMT output current signals connect the detector housing and the amplifier unit. The entire operation, including wavelength and bandpass selection, is controlled with a customer-supplied PC. (The Digikrom monochromator uses one serial port and the AD111 uses one USB port.) An easy to use program is also included that allows full control of both PMT and monochromator. It graphically displays wavelength versus intensity, intensity versus time, and allows ASCII data storage for importing to other user interfaces as desired.

Wavelength Range:	per PMT detector
High Voltage Range:	0-1000 VDC
A/D Resolution:	16 bit (Successive Approximation)
Response Rate:	USB 2.0
High Voltage Resolution:	244 mV
Data Resolution:	76.3 $\mu$ V, (data range = 0-5V)
Time Constant per step:	Selectable from 1 $\mu$ s to 10 ms
Conversion time:	2 $\mu$ s (maximum)
USB 2.0 Transfer Rate:	480 Mbits/sec
Amplification Gains:	x1 to x10 (programmable)
Supply Voltage:	100-240 VAC
Current Input Range:	0 to -5 $\mu$ amps



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## 2. Installation

### 2.1. Checking System Requirements

Check to make sure that your computer meets the minimum requirements for the AD111CMDK system.

Requirements for the Hardware	Any IBM compatible machine with an 80486 processor or higher A VGA, SVGA display, or 1024x768 A mouse or any other pointing device 1 USB port for AD111 communication 1 serial port if using Digikrom monochromator
Requirements for the software	Microsoft Windows® 2000 or newer in standard or enhanced mode. A hard disk with at least 10MB free space, and 7MB for installation. Minimum of 32 MB of RAM recommended.

### 2.2. Checking System Package Contents

Your package should contain all of the following components:

- 1 AD111 Photomultiplier Amplifier
- 1 AD111 Controller with a wall plug power supply.
- 1 AD100 Photomultiplier Tube Housing
- 1 BNC Signal Cable
- 1 SMB High Voltage Cable
- 1 USB cable
- 1 Software CD

### 2.3. Installing Software

**Attention:** Software needs to be installed first before installing the hardware

The supplied control program is a LabVIEW executable that requires either LabVIEW 6i or LabVIEW's 6i Runtime Engine be loaded on the computer. LabView's 6i Runtime Engine is available on the Software CD.

Insert CD into the drive. If the CD does not auto-run, choose "run" from the file menu of the Microsoft Windows Program Manager or File Manager. Type D:\CDSoftware.exe on the line, and click "OK" to continue. (If CD disk drive is different, replace D: with an appropriate drive letter.) The CD Software Main Menu will appear with the software selections available.

To install the LabView 6i Runtime Engine select the tab "LABVIEW RUNTIME" and select version 6, then "Exit". Follow the Installation Wizard.

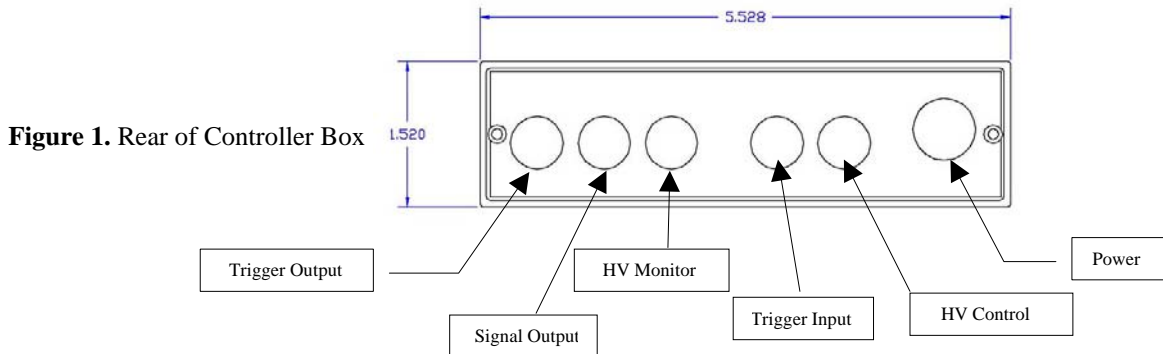
To install the program to run the AD111 as stand alone or in conjunction with a Digikrom monochromator, select the tab "DETECTORS" and select "AD111 CM/DK LabView Exe", then "Exit". Follow the Installation Wizard.

The source code is also available on the CD under the tab "SOURCE CODES".

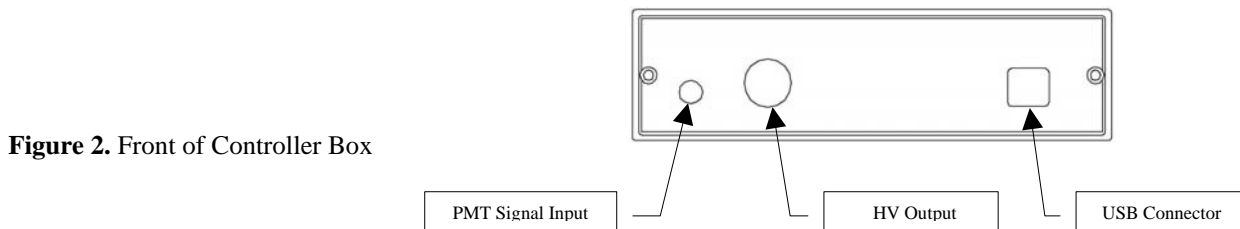
## 2.4. HardWare SetUp

The AD111 internal power supply can handle voltages from 100VAC to 240VAC. Make sure you have the appropriate AC cord. Insert the photo tube inside the PMT tube. Extreme care must be taken when handling the photomultiplier tube as fingerprints may cause serious degradation in the tube performance.

### 2.4.1. Controller Box Connectors



- **Trig\_Out:** A TTL output between 0-4.1 Vdc that gives a short high pulse when data is acquired.
- **Sig\_Out:** An output between 0-4.1 Vdc.
- **HV\_Mon:** An output between 0-10 Vdc that corresponds to 0-1000 Vdc.
- **Trig\_In:** A TTL external input between 0-5 Vdc. May keep the data acquired in wait mode until this input reaches a specified level.
- **HV\_Ctrl:** An external input between 0-10 Vdc that controls the high voltage between 0-1000 Vdc.
- **J2 Power Connector:** Connects to the PUP30-32 switching power supply.



- **HV\_Out:** A negative output voltage between 0-1000 Vdc that connects to the PMT high voltage connector.
- **Sig\_In:** A current input signal between 0-5  $\mu$ A that connects to the PMT signal connector.
- **USB:** A USB connector for connection to a USB computer port.

Connect cables in the following order:

- 1) Power supply cables to AD111 Controller and Digikrom Monochromator (if applicable)
- 2) Signal and High Voltage Cables between AD111 Controller and PMT
- 3) RS232 cable between Monochromator and computer (if applicable)
- 4) USB cable between AD111 Controller and computer

Make sure that the com and USB ports on the computer do not have any IRQ conflicts.



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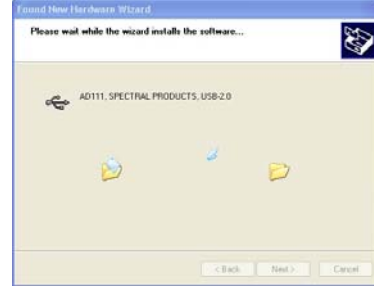
# Installation

## 2.4.2. USB Installation Pop-up Windows

After connecting the USB AD111 controller to a computer for the first time the following windows will be displayed if using Windows XP.



1. Welcome to the Found New Hardware Wizard  
Click 'Next' to continue



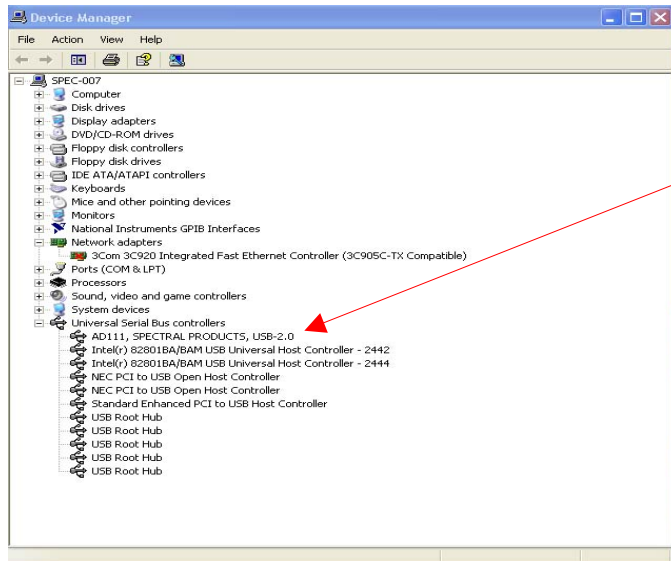
2. Found New Hardware Wizard  
Do nothing



3. Hardware Installation  
Click 'Continue Anyway'



4. Found New Hardware Wizard  
Click 'Finish'



To check the installation, open the Windows Device Manager window. The line 'AD111, SPECTRAL PRODUCTS, USB 2.0' should appear under Universal Serial Bus Controllers.

If the AD111 is not listed, unplug the power supply and USB cable to AD111 controller and then plug back in the two cables.

If the AD111 is still not listed call Spectral Products for support.



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### 3. Getting Started

#### 3.1. Main Screen

The default screen of the AD111/CM/DK Executable program (**SPAD111.vi**) consists of a display area with active buttons and a menu bar across the top. This and other LabVIEW programs are referred to as Virtual Instruments (VIs) and the control display screen is called the “front panel”.

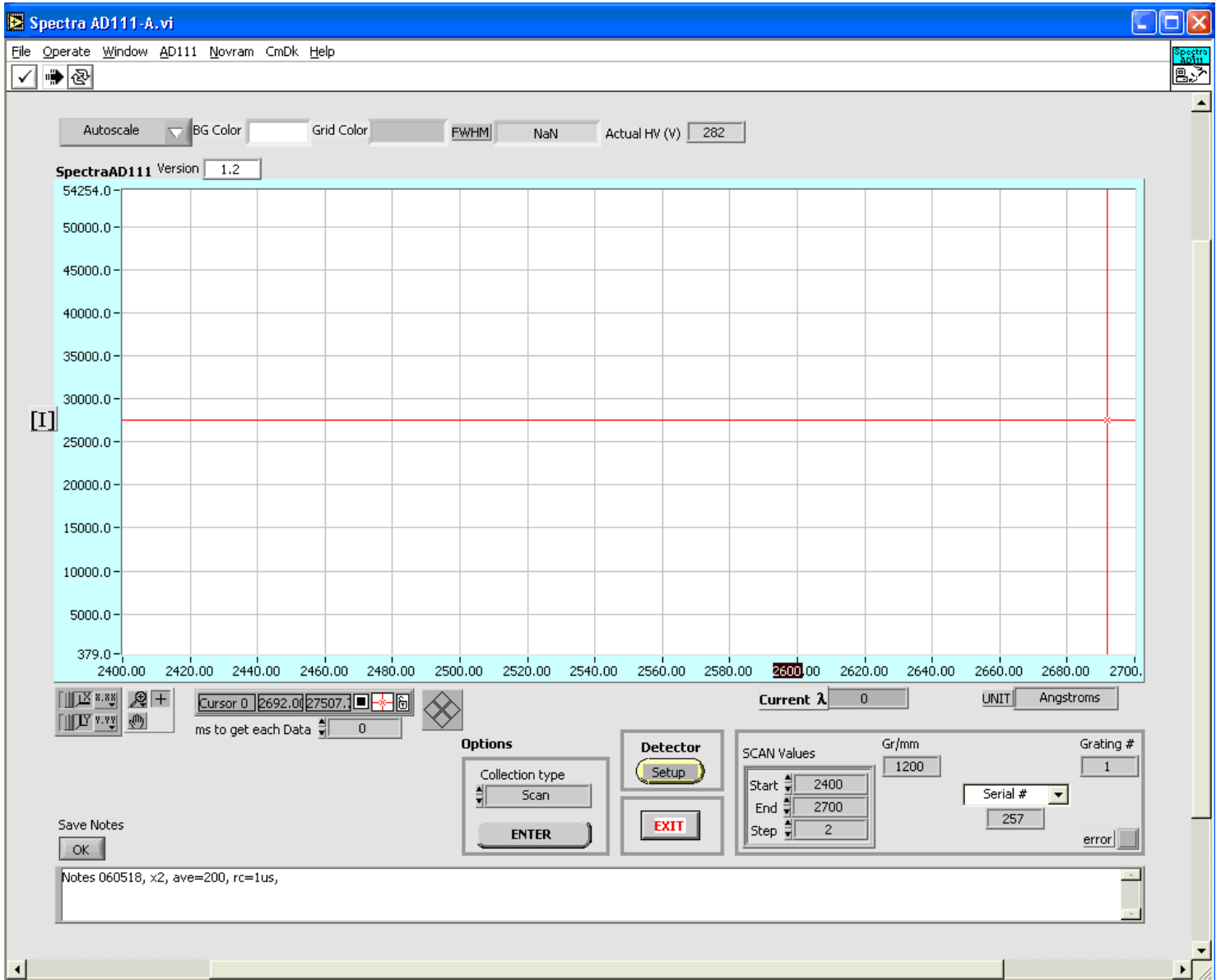


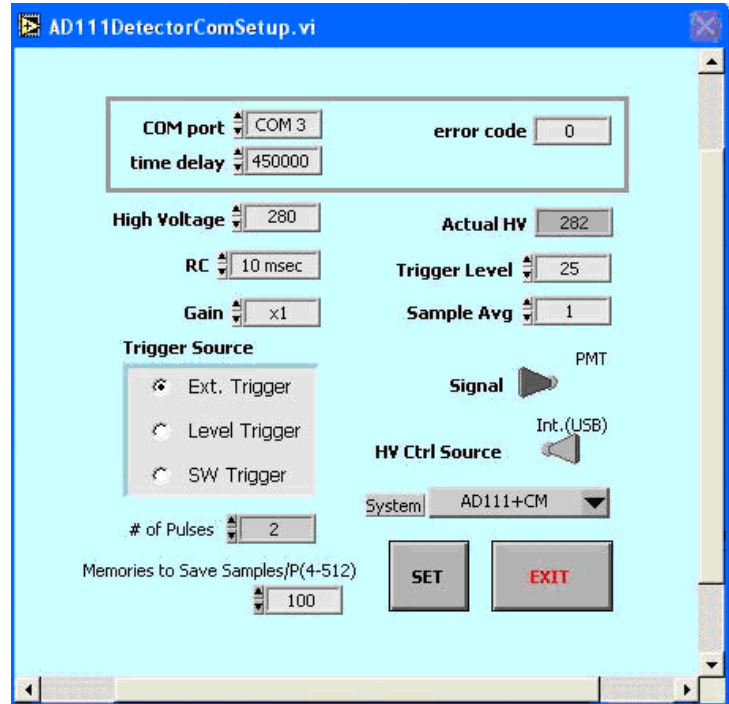
Figure 3. Front panel of program SPAD111.vi



### 3.2. Setup Screen

The detector setup screen appears first. The following pages assume the user has selected in this screen a system using the AD111 detector with a CM or DK Digikrom Monochromator.

Figure 4 SPAD111.vi Setup Screen

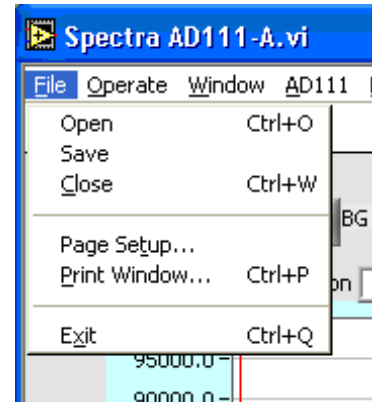


- **COM port:** Set this value to an open com port for the AD111 Detector.
- **time delay** sets the time in ms to wait before echo back.
- **error code:** Any value here other than 0 indicates a communication problem with the AD111.
- **High Voltage** controls the voltage supplied to the PMT between 0 – 1000 volts. Too small a value will not produce a signal large enough for amplification. Larger values produce more signal but higher anode dark current noise.
- **RC** sets the time constant for detector.
- **Gain** sets the electronic gain for the system. Larger values produce more signal but higher noise.
- **Trigger Source:**
  - Ext. Trigger allows AD111 to operate using an external triggering from the Trigger In port on the controller
  - Level Trigger causes the AD111 to ignore external voltages below a certain value (as set by **Trigger Level**)
  - SW Trigger: Internal triggering through the software
- **Actual HV:** Should read close to the set value of HV
- **Trigger Level** sets the value for Level Trigger. Selectable values between 0 – 50 correspond to 0 – 5 volts.
- **Sample Avg:** Number of readings to average into a single data point
- **Signal** sets the data collected. The switch toggles between signal out from **PMT** or High Voltage (**HV**) supplied to PMT.
- **HV Ctrl Source** sets the source for the high voltage supplied to the PMT. The switch toggles between External (**Ext.(0-10Vdc)**) and Internal software specified (**Int. (USB)**).
- **System** selects the configuration of either using AD111 alone or with a CM or DK series Digikrom Monochromator.
- **# of Pulses** (Ext. Trigger and Level Trigger only): sets the number of triggered pulses to be averaged into a single data point.
- **Memories to Save Samples/P(4-512)** (Ext. Trigger and Level Trigger only): The system may collect more than one sample for each triggered pulse. The user must set this to a value larger than or equal to the number of samples that will be acquired. Setting this number close to the actual number of samples will save on RAM. Start with the following:  $[\text{Time between pulses in } \mu\text{s}] \div 29$ .

### 3.3. Menus

#### 3.3.1. File Menu

- **Open** displays data from a x, y data file to the graph
- **Save** saves the current x, y data on the screen into 'x tab y' format file.
- **Close** closes the active window and does not save any changes you have made.
- **Page Setup...** use to set margins, headers, page orientation and other printer options. Setup settings are saved with your VI.
- **Print Window...** prints out the contents of the currently active window. Using this option, you can make a quick printout with the minimum number of prompts.
- **Exit** quits program.

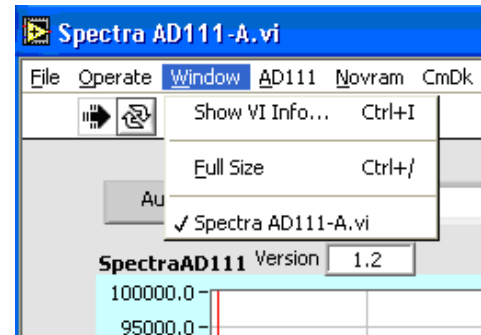


#### 3.3.2. Operate Menu

- **Print at Completion** prints the contents of a VI's front panel after each execution.
- **Log at Completion** logs a time stamp and the data in all front panel controls of a VI to a separate datalog file.
- **Data Logging-** use to set data logging options. (Optional if you have LabVIEW software).
- **Reinitialize All to Default** sets all controls and indicators to their default values

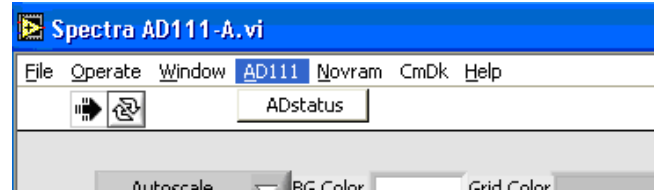
#### 3.3.3. Windows Menu

- **Show VI Info...** displays the VI file path, revision number, and memory usage.
- **Full Size** uses the entire screen to display the active window.



### 3.3.4. AD111 Menu

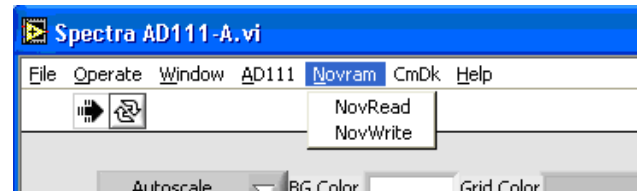
- **ADstatus** reads the data saved in the Eeprom of the AD111. Eeprom values are high voltage, RC constant, gain, trigger value, trigger source, HV source, HV control source, firmware version, DC power, and sample average.



### 3.3.5. Novram Menu

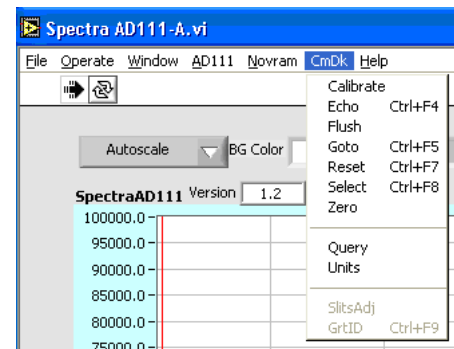
Nonvolatile memory in the monochromator is accessed by using read and write novram commands.

- **NovRead** reads the memory values from Novram chip and displays the values
- **NovWrite:** Use this command to write 128 (0-127) bytes to the monochromator's non-volatile memory.



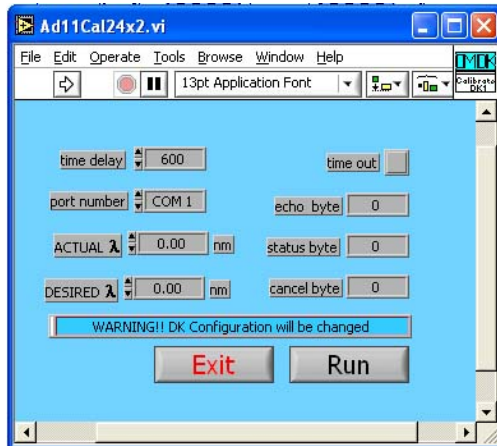
### 3.3.6. CmDk Menu

The dropdown menu controls and calibrates the CM or DK monochromator.



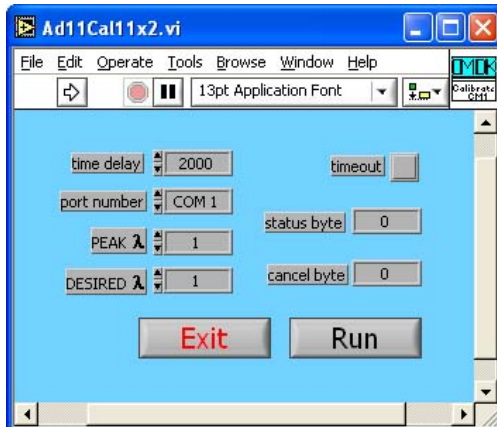
- **Calibrate** allows recalibration of the monochromator positioning scale factor. A source of known wavelength is needed for recalibration. The user must first execute a scan and note the displayed peak value. **Calibrate** should always be used immediately after using the ZERO command.

## CM-Series



- **time delay** sets the time in ms to wait before echo back.
- **port number** sets the com port of the monochromator.
- **ACTUAL  $\lambda$ /PEAK  $\lambda$ :** Enter the measured wavelength of the peak from the known source.
- **DESIRED  $\lambda$ :** Enter the theoretical peak wavelength of the known source.
- **time out, echo byte, status byte, and cancel byte** are diagnostic parameters associated with the LabVIEW program.
- **Run** enters the values and recalibrates with the current wavelength.
- **Exit** closes the Command window.

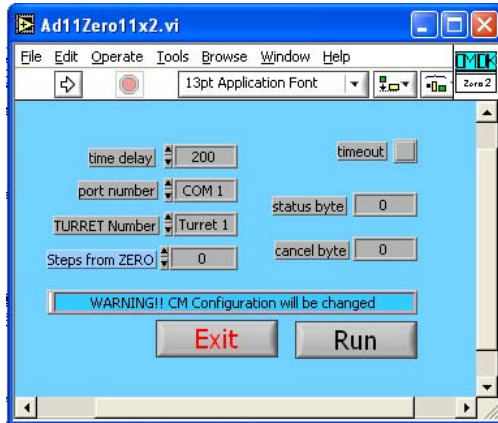
## DK Series



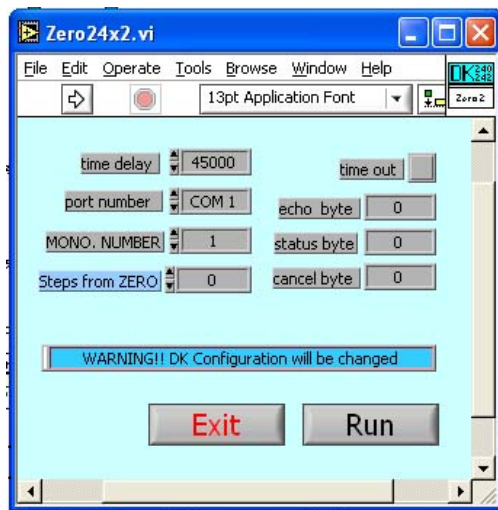
- **Echo** verifies communications with the monochromator.
- **Flush** cleans the serial communications receiver buffer.
- **Goto** moves the monochromator to a selected position.
- **Reset** returns the grating to home position.
- **Select** selects the grating that will be used.

- **Zero** allows the recalibration of the position of the zero order transmission of the monochromator. The user must first execute a Zero Scan and note the value (in steps) of the zero order transmission peak.

## CM-Series



## DK-Series

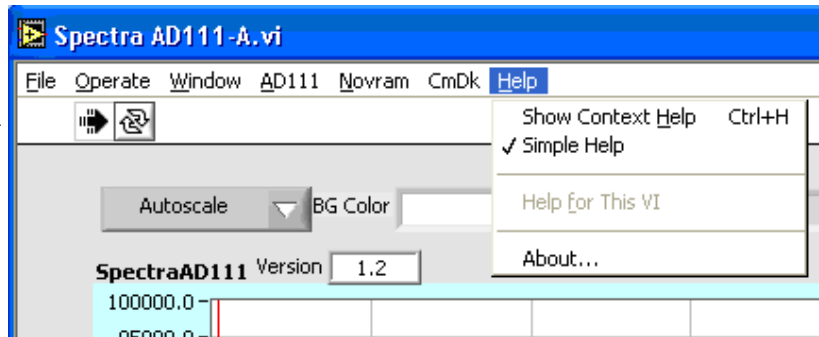


- **time delay** sets the time in ms to wait before echo back.
- **port number** sets the com port of the monochromator.
- **TURRET Number:** Use to select Turret 1, Turret 2, or both if you have double monochromator model CM112. For CM110 select Turret 1.
- **MONO Number:** Use to specify DK model. For DK240 or DK480 select 1. For DK242 select 2.
- **Steps from Zero:** Enter the value in steps of the zero order transmission peak from the Zero Scan.
- **time out, echo byte, status byte, and cancel byte** are diagnostic parameters associated with the LabVIEW program.
- **Run** enters the new zero position.
- **Exit** closes the command window.

- **Query** (CM Models only) displays the monochromator status.
- **Units** (CM Models only) sets the units used in the *Goto*, *Scan*, *Size*, and *Calibrate* commands. For DK models the only unit available is nm.
- **SlitsAdj** (DK models only) adjusts all slits to a given width.
- **GrtID** (DK models only) returns the six byte ruling identifier of the current grating.

### 3.3.7. Help Menu

- **Show Context Help:** A Context-sensitive Help window that displays the VI's parameters, parameter type definitions, and the description for the object.
- **About** - Information on LabVIEW software version number and serial number.



### 3.3.8.

## 3.4. LabView Toolbar

The LabVIEW toolbar contains command buttons for running the VI



**Run** runs the VI.



**Run Continuously** runs the VI until you stop the execution.



While the VI is executing, the buttons change appearance.

### 3.5. Front Panel Control and Indicators.

The front panel of the SP AD111.vi displays the graph, graph controls, and collection parameters.

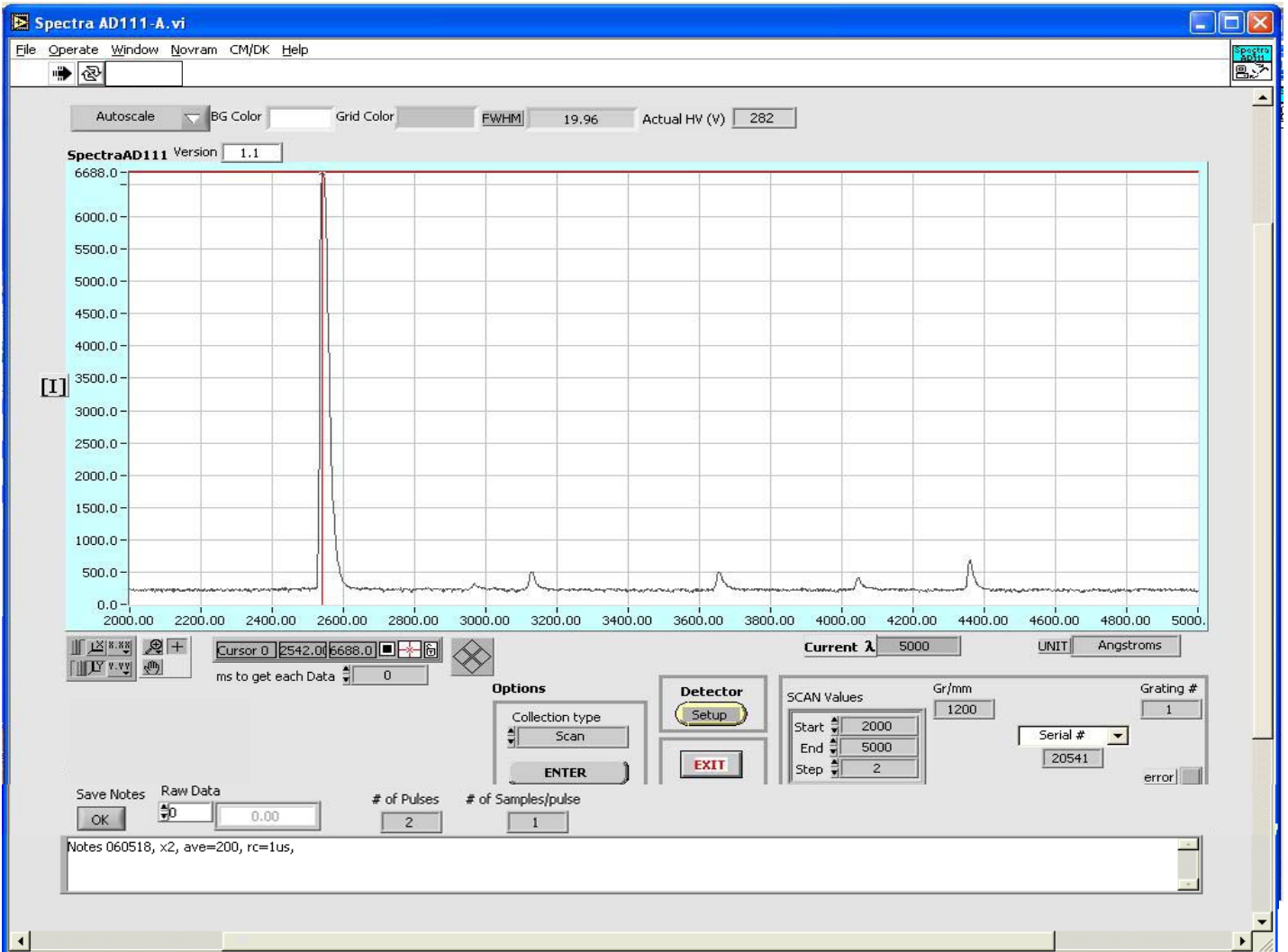
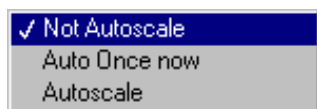


Figure 5. Program SP AD111.vi Main Screen

#### 3.5.1. Graph Control



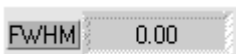
**Autoscale Dropdown Box** may be used to select autoscaling for the Y axis.



**BG Color** controls the background color for plotting surface.



**Grid Color** Controls the grid color.



**FWHM** automatically displays the Full Width at Haft Maximum of the highest bell shape on the graph.



**AutoScale (X or Y)** turns autoscaling on or off of the appropriate axis. With autoscale off graph scale may be adjusted by highlighting a value along an axis and typing in a new value.



**Lock Scale** - Clicking the lock switch causes the graph to continuously autoscale (when slider appears to the right).



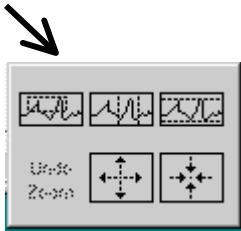
**Scale Format:** use to set the format of the x and y scale markers respectively.



**Crosshatch and Panning Tool:** An either-or pair. When **Crosshatch** is depressed, clicking in the graph area allows cursor movement. Clicking **Panning Tool** switches to a mode that allows scrolling of the visible data by clicking and dragging the plot area of the graph.



**Zoom Tool** displays a pop-up menu to choose methods of zooming in or out on the graph.



**Zoom by rectangle.**



Zoom by rectangle; with zooming restricted to x data (the y scale remains unchanged)



Zoom by rectangle; with zooming restricted to y data (the x scale remains unchanged)



**Zoom in about a point.** If you hold down the mouse on a specific point, the graph continuously zooms in until you release the mouse button.

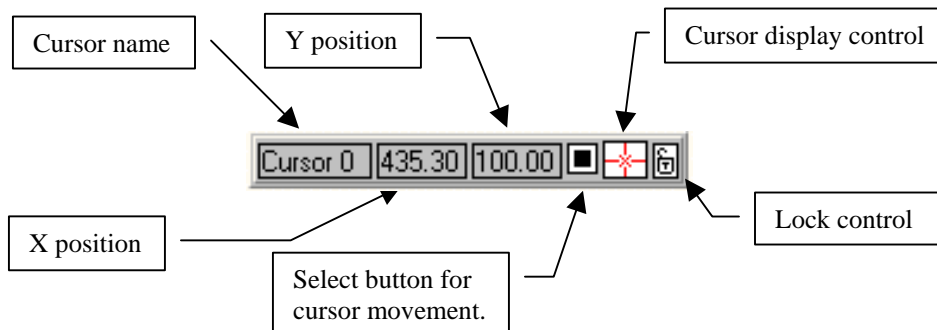


**Zoom out about a point.** If you hold down the mouse on a specific point, the graph continuously zooms out until you release the mouse button.



**Cursor movement control:** use for fine up, down, left, or right motion of cursor by clicking on corresponding area of the figure.

**Cursor Options:**





### 3.5.2. Data Collection Parameters

Actual HV (V) 282

**Actual HV** displays the voltage supply to the PMT.

Current  $\lambda$  5000

**Current  $\lambda$**  displays the current wavelength of the monochromator

UNIT Angstroms

**UNIT** displays the current units used in the graph and the scan setup screens. (Selectable for CM only under menu item **Cmdk:Units.**)

ms to get each Data 0

**Time delay** sets a pause in ms between the grating step and data acquisition. The default value is 0.

There are two options for data collection: *ZeroScan* and *Scan*. To activate one of the options first select the *collection type*, second, click on *ENTER* button.



**ZeroScan** – Scans the monochromator above and below zero order with the number of steps in the ‘Steps Below 0’ box.

**Scan** – Scans the monochromator from the ‘Start’ to the ‘End’ wavelength, with the increment in ‘Step’.

#### ZeroScan



**Gr/mm** displays the current grating ruling (groove/mm).

**Grating #** displays the number of the current grating (selectable under menu item **Cmdk:Select**)

**Info** allows choice of display between monochromator serial number, the number of gratings, or the blaze wavelength of the selected grating.



**Error** shows red if an error occurred

**Steps Below 0:** use to set the number of steps below and above 0nm for zero scan.

**Turrets** (DK models only): use to activate the specified turret in zero scan mode. The selections are:

- 0: Turret 1&2 (Double monochromator only)
- 1: Turret 1 (default)
- 2: Turret 2

### Scan

The screenshot shows a control panel for the Scan function. It includes a 'SCAN Values' section with three spinners for 'Start' (2000), 'End' (5000), and 'Step' (2). To the right, there are input fields for 'Gr/mm' (1200) and 'Grating #' (1). A 'Serial #' dropdown menu is set to '20541'. An 'error' checkbox is located at the bottom right of the panel.

**Start:** Enter the start wavelength of the scan

**End:** Enter the end wavelength of the scan

**Step:** Enter the step size for the scan.



**Detector Setup:** Opens the Detector Setup Screen (see Figure 4, pg. 9)

The screenshot shows a control panel for Slitwidth. It has two rows of spinners: 'Ent. Slit' and 'Exit Slit', both set to '0' with 'um' units indicated to the right.

**Slitwidth:** (DK models only) Used to adjust the width of entrance and exit slit.

The screenshot shows a control panel for Raw Data. It features a spinner set to '0.00' and a small icon to its left.

**Raw Data** displays the data collected in each pulse prior to averaging

The screenshot shows a control panel for the number of pulses. It has a spinner set to '2' with the label '# of Pulses' above it.

**# of Pulses** sets the number of triggered pulses to be averaged

The screenshot shows a control panel for the number of samples per pulse. It has a spinner set to '1' with the label '# of Samples/pulse' above it.

**# of Samples/pulse** displays the actual number of data samples collected during each triggered pulse. These samples are summed to make up one Pulse Raw Data Point.



## 4. Troubleshooting

### No communication with AD111

- Verify USB cable between computer and AD111 is properly attached.
- Check AC line voltage.
- Check for USB driver. With Windows XP, select Start | Control Panel | System | Hardware | Device Manager. Expand the 'Universal Serial Bus controllers' folder by clicking the plus sign and look for the AD111 driver with the name "AD111 PMT, SPECTRAL PRODUCTS, USB-2.0". If you do not see the name, unplug the USB & power cables then plug them back in. If you still cannot find the name, reinstall the AD111 driver.
- The AD111 does not have user serviceable parts. Please call Spectral Products directly at (505) 343-9700 for service.

### No communication with Monochromator

- Verify RS232 cable between computer and monochromator is properly attached.
- Check for appropriate COM port and/or IRQ conflict.
- Unplug AC cord and check all connections.

## 5. Appendices

### 5.1. Appendix A: USB 2.0 Port

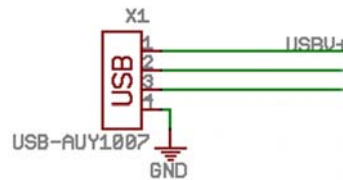
#### A.1. USB2.0 PINOUT

The USB connection requires a cable with a USB type B connector at the Spectrometer and a computer USB port type A. Spectral Products supplies a USB 2.0 plug type A to plug type B cable for connecting to AT, PS2, and MAC style computers.

#### Pin Assignments for the USB Connector at one end of AD111 controller

**Table 1.** USB Pin Function

Pin	Function
1	USB Power
2	Data out
3	Data in
4	GND



**Figure 6.** USB Pinout

5.2. Appendix B: AD111 Reference Drawings

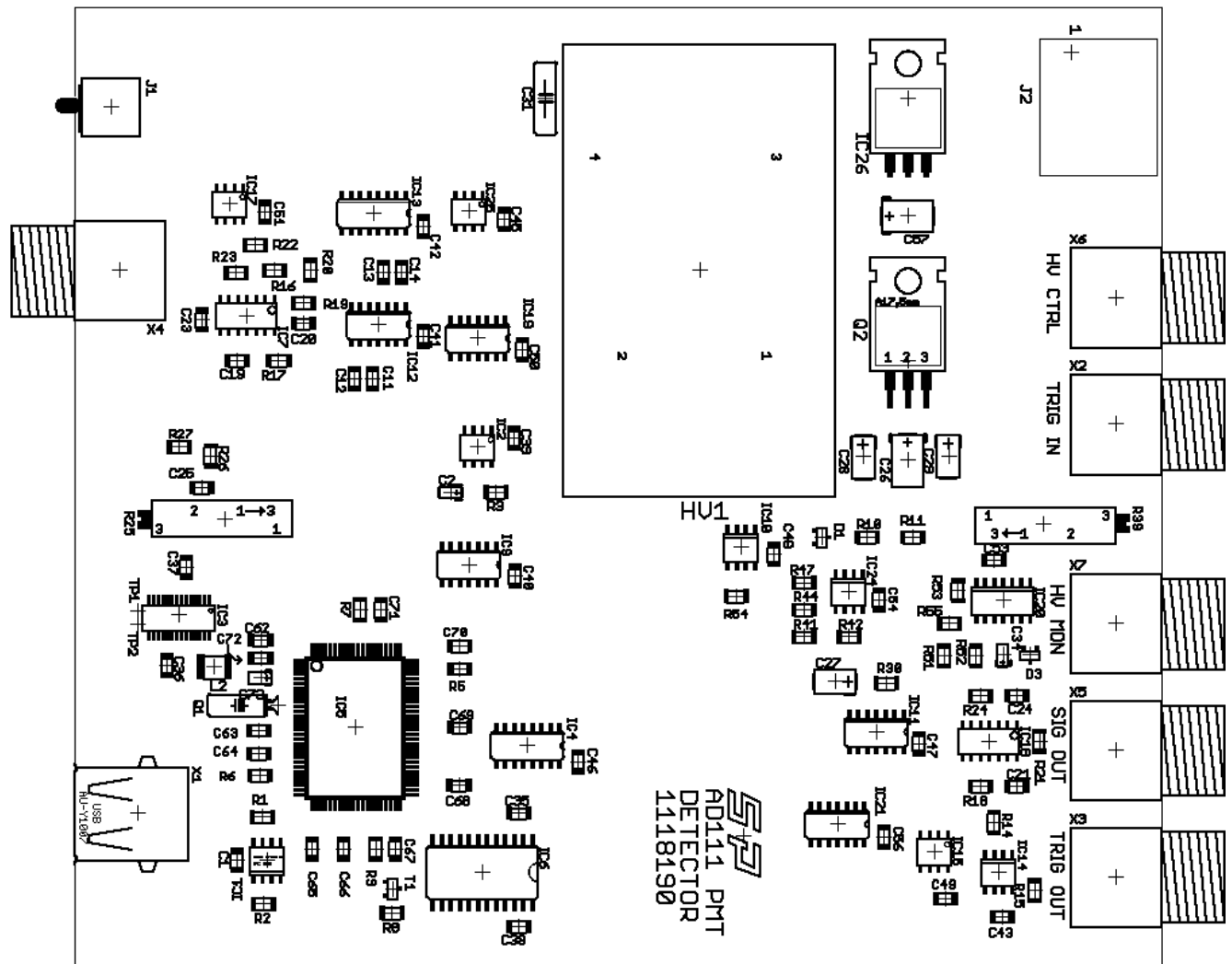


Figure 7. PC Board Layout

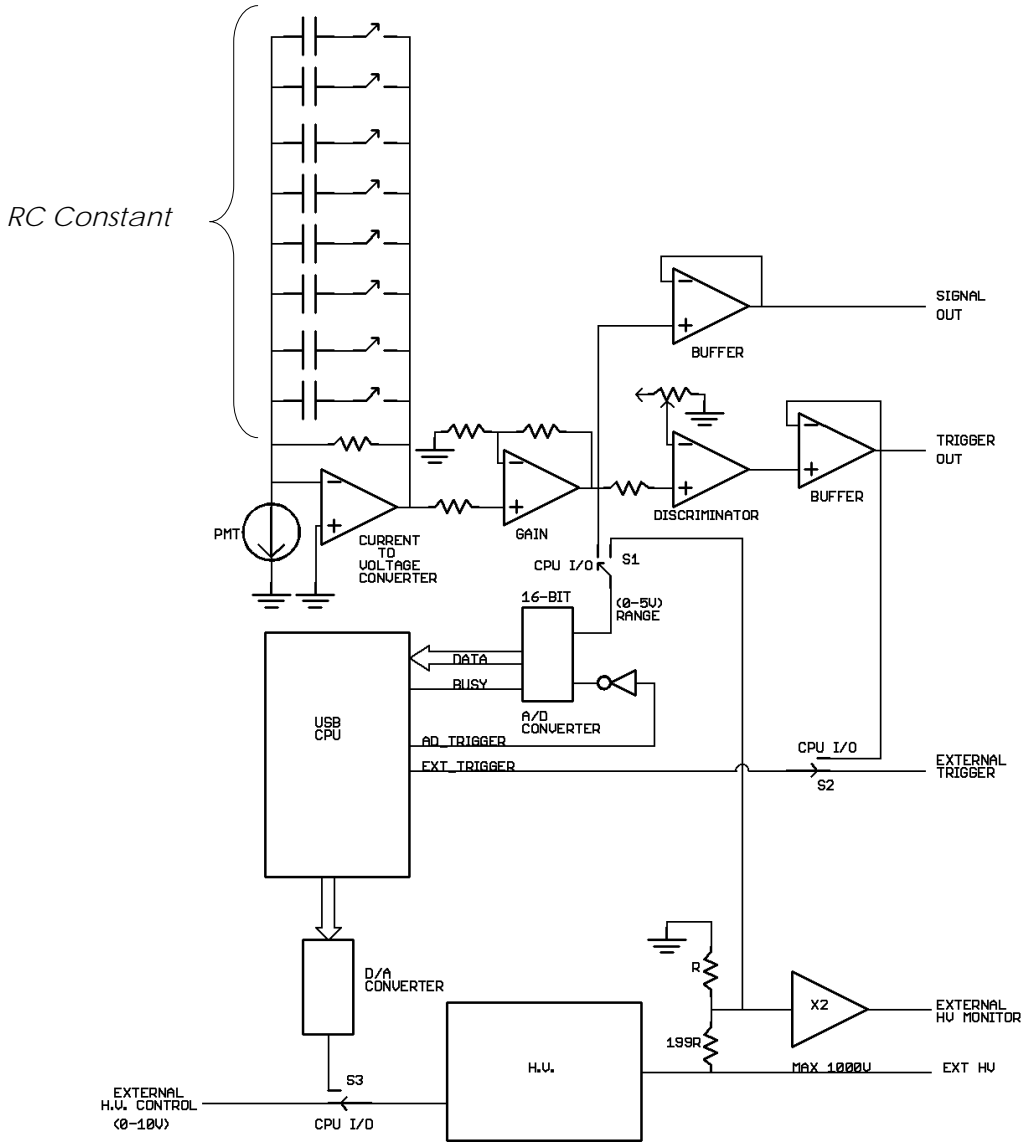


Figure 8. Block Diagram



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**C.1. SP SDK functions**

Function spTestBoard() should be called first to get and set the appropriate information of the board. Then spSetHv(), spSetRC(), spSetGain(), spSetTrigLevel(), spSetTrigSource(), spHvSource(), spSetAvg().

For AD111 status call spReadInfo(), and for data call spReadDataEx().

Call spCloseEx() as the last function before exiting the AD111 software.

Function Name	Description	RETURN when successful	RETURN when unsuccessful
<b>spTestBoard</b> short spTestBoard ( )	Checks the status of the electronic board and its connection.	Zero	A non-zero number
<b>spCloseEx</b> void spCloseEx ( )	Closes the USB board. It should be called when exiting the application.	None	None
<b>spSetHv</b> short spSetHv ( short sHV )	sets the high voltage (1-1000V)	Zero	A non-zero number
<b>spSetRC</b> short spSetRC ( short sRC )	Sets the time constant. <i>sRC</i> can be 1 $\mu$ s, 10 $\mu$ s, 100 $\mu$ s, 1 ms, and 10 ms (0 to 4 respectively).	Zero	A non-zero number
<b>spSetGain</b> short spSetGain ( short sGain )	Sets the gain. <i>sGain</i> can be from 1 to 10	Zero	A non-zero number
<b>spSetTrigLevel</b> short spSetRC ( short sTrigValue )	Sets the voltage trigger level. <i>sTrigValue</i> can be from 0 to 50, which corresponds to 0 - 5V.	Zero	A non-zero number
<b>spSetTrigSource</b> short spSetTrigSource ( short sTrigSource )	Sets the voltage trigger source. <i>sTrigValue</i> can be External, Level, or Software (0, 1, or 2 respectively).	Zero	A non-zero number





Function Name	Description	RETURN when successful	RETURN when unsuccessful
<b>spHvSource</b> short spHvSource ( short sHvSource )	Sets the source of high voltage. <i>sHvSource</i> can be 0 for External high voltage control, or 1 for Software control	Zero	A non-zero number
<b>spMonSource</b> short spMonSource ( short sMonSource )	Selects whether to read the signal or to monitor the high voltage. <i>sMonSource</i> can be 0 for data signal, or 1 for monitoring the high voltage.	Zero	A non-zero number
<b>spSetAvg</b> short spSetAvg ( short sAvg )	Sets the sample average. <i>sMonSource</i> can be from 0 to 300.	Zero	A non-zero number
<b>spReadDataEx</b> short spReadDataEx ( long *pArray )	Reads the data from USB port. <i>*pArray</i> points to a data address. Its memory size should be one or bigger.	Zero	A non-zero number
<b>spReadInfo</b> short spReadDataEx ( short *sRdInfo )	Reads the data saved in the Eeprom of the interfacing USB board. The data are: High voltage (HV), RC constant, Gain, Trigger value, Trigger source, HV source, HV control source, the firmware version, DC power, and the sample average. <i>pArray[0...1]</i> is the current high voltage, where $HV = pArray[0]*256 + pArray[1]$ . <i>pArray[2]</i> is the RC time constant. <i>pArray[3]</i> is the Gain. <i>pArray[4]</i> is the Trigger value. <i>pArray[5]</i> is the Trigger source. <i>pArray[6]</i> is the HV source. <i>pArray[7]</i> is either data or monitored HV. <i>pArray[8...9]</i> is the firmware version in the format of <i>pArray[8].pArray[9]</i> . <i>pArray[10]</i> is DC voltage indicator, where 0: not DC, 1: yes DC. <i>pArray[11...12]</i> is the sample average (SA), where $SA = pArray[11]*256 + pArray[12]$ .	Zero	A non-zero number





Function Name	Description	RETURN when successful	RETURN when unsuccessful
<b>spPulseCmd</b> short spPulseCmd (                    Long *lArray )	This function is called to send the acquired command only, and not received data. The function must call before calling <i>spPulseData</i> function. <b>*lArray</b> is the number of samples, which will be passed to the <i>spPulseData</i> function. <i>Note: This function uses together with spPulseData, and for 'External trigger' only.</i>	Zero	A non-zero number
<b>spPulseData</b> short spPulseData (                    unsigned long *lArray int iNData )	This function reads data from the AD111 and is called right after the spPulseCmd function. <b>*lArray</b> points to a data address. Its memory size should be one or bigger. <b>iNData</b> number of samples, which gets from <i>spPulseCmd</i> <i>Note: This function uses together with spPulseCmd, and for 'External trigger' only.</i>	Zero	A non-zero number
<b>spPower</b> short spPower (                    short sPwr )	This function is called to turn on/off the external power supply. The AD111 has to be on in order to operate. <b>sPwr</b> can be 0 for OFF, or 1 for ON	Zero	A non-zero number
<b>spPowerQ</b> short spPowerQ (                    short *Pwr )	Reads the external power status. <b>*Pwr</b> points to a data address. The data can be 0 for OFF and 1 for ON. <i>Note: This function works with the external OFF, and it uses to query at beginning of a program.</i>	Zero	A non-zero number