Digital Pulse Processor

APV8108

Instruction Manual

Version 2.6.3

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Safety Precautions / Disclaimer

Thank you very much for purchasing the digitizer APV8108-14 (hereinafter "This board") of TechnoAP Co., Ltd. (hereinafter "We"). Please read this "Safety Precautions / Disclaimer" before using this device, be sure to observe the contents, and use it correctly.

We are not responsible for any damage caused by abnormality of device, detector, connected device, application, damage to failure, other secondary damage, even if accident caused by using this device.

Prohibited matter

- This device cannot be used for applications requiring special quality and reliability related to human life, accident.
- This device cannot be used in places with high temperature, high humidity and high vibration.
- Do not apply a power supply that exceeds the rating.
- Do not turn the power on while other metals are in contact with the board surface.

Note

- If there is smoking or abnormal heat generation in this device, turn off the power immediately.
- This board may not work properly in noisy environments.
- Be careful with static electricity.
- The specifications of this board and the contents of the related documents are subject to change without notice.

Warranty policy

The warranty conditions of "our product" are as follows.

Warranty period	One year from date of purchase.
Guarantee contents	Repair or replacement will be carried out in case of breakdown even though you have used correctly according to this instruction manual within the warranty period
Out of warranty	We do not warranty if the cause of the failure falls under any of the following. 1. Failure or damage due to misuse or improper repair or modification or disassembly. 2. Failure and damage due to falling etc. 3. Breakdown / damage in harsh environments (high temperature / high humidity, under zero, condensation etc.). 4. Causes other than the above, other than "our products". 5. Consumables.

- Contentss -

1. Overview

1.1. Overview

TechnoAP's DPP (Digital Pulse Processor) product APV8108 (hereinafter referred to as "this device") is a waveform analysis board equipped with 8 channels of high-speed, high-resolution ADC (1GHz, 14bit or 12bit).

In addition to 1GHz real-time analysis by FPGA, high-speed processing without dead time by signal processing is realized with high time resolution and high throughput. All ADCs operate synchronously at 1GHz clock and can be used for signal analysis from multiple high-speed scintillation detectors. Synchronous processing between multiple boards is also supported, allowing easy expansion to multi-CH analysis.

This manual describes this equipment.

* In the text, "CH" for signal input channels and "ch" for bin number channels are case-sensitive.
* In the text, "list" and "event" are synonymous.
* The model APV stands for the VME standard size board type. A separate VME power supply rack (such as our APV9007) is required to supply power to this board type. In addition, the type of model in which this board is housed in a unit (chassis) and AC power supply can be used directly is marked with APU instead of APV. For example, the model in which the VME-type APV8108 is installed in a unit is called APU8108. (This manual also includes a description of the APU8108.
* The -14 in the model number indicates that the resolution of the built-in ADC is 14 bits, and the -12 indicates that the resolution of the built-in ADC is 12 bits. (For convenience, the -14 and -12 may be omitted and the model's name APV8108 may be used.
* Additional functions can be added to this device as options. (In this document, the function part is specified as (optional).

1. 2. Feature

The main features are as follows

- Applications include high-speed timing, high time resolution, high counting, waveform discrimination, particle discrimination (n/γ)
- Target detectors include scintillators (plastic, LaBr3(Ce), liquid scintillators, etc.), wire chambers and MPPCs, which can directly input output signals from photomultiplier tubes (PMTs) and FAST-NIM signals.
- Digital pulse processor acquires time and energy information by digital CFD and QDC.
- Waveform fitting provides high temporal resolution based on sampling interpolation.
- Neutron/gamma radiation discrimination PSD function, LIST-WAVE waveform information, etc. can be added as an option.
- Data recording via Gigabit Ethernet (TCP/IP)

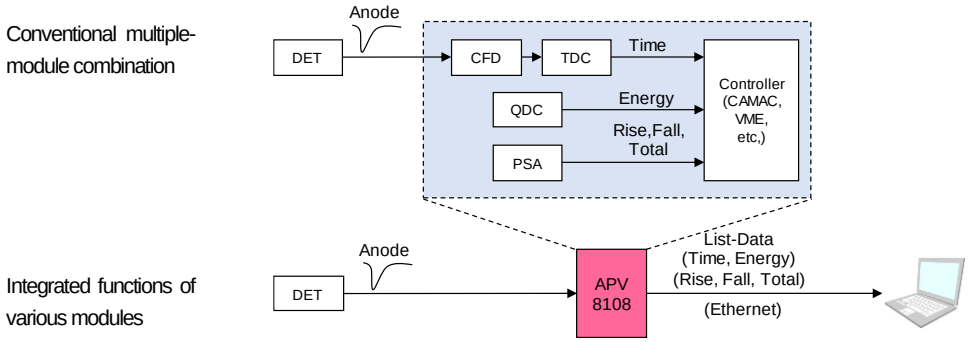


Figure 1 DPP configuration

Synchronous processing between multiple boards is also supported, allowing for easy expansion to multi-CH analysis.

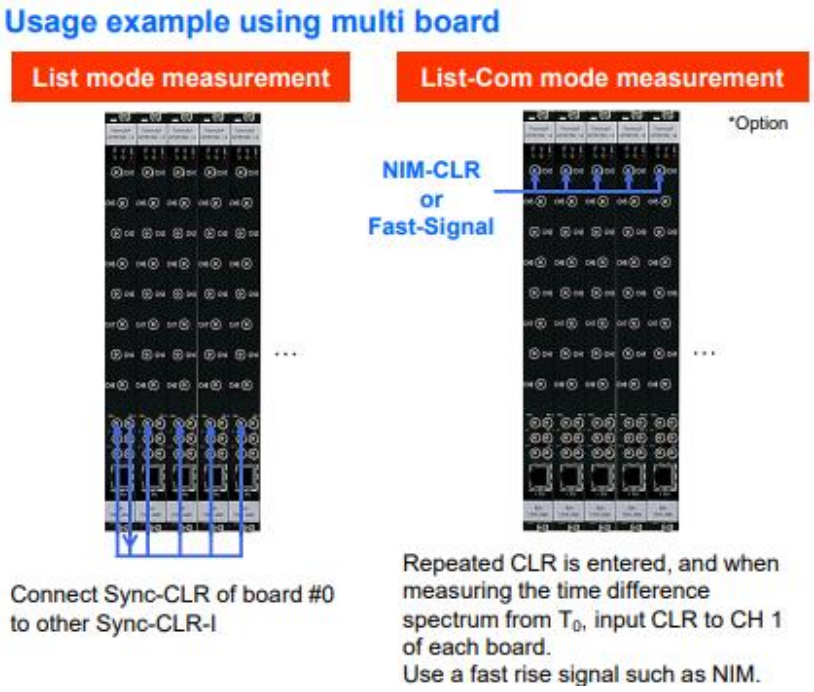


Figure 2 Multiple unit configuration

Configuration and data acquisition for DPP are performed by the supplied DPP application (hereafter referred to as "this application"). This application runs on Windows. Since communication with DPP is only via TCP/IP or UDP network communication, no special libraries are required, and the application can be used in environments other than Windows.

2. Specifications

（1） Analog input

• Number of channel	8CH
• Input range	±1V
• Input impedance	50Ω

（2） ADC

• Sampling frecuency	1GHz
• Resolution	14bit or 12bit
• SNR	68.3dBFS@605MHz

（3） Performance

• QDC output	2Mcps and more
• Time resolution	3.90625ps

（4） Functions

• Operation mode	Histogram mode, List mode (Time histogram). Wave mode
• Event transfer rate	About 20Mbyte per second, in case of 1 event 16Byte (128Bit)

（5） Option

• Functions	PSD, 2D histogram, Waveform List mode, Pile-up waveform list mode

（6） Communication Interface

• LAN	TCP/IP	Gigabit Ethernet 1000Base-T for data transfer
	UDP	for sending and receiving commands

（7） Currenct consumption

＋5V	6.0A (Max.)
＋12V	1.0A (Max.)
－12V	0.4A (Max.)

（8） Form

• VME type (VME6U)	APV8108
• Unit type	APU8108

（9） External dimension

• VME type (VME6U)	20 (W) x 262 (H) x 187 (D) mm
• Unit type	300 (W) x 56 (H) x 335 (D) mm

（10） Weight

• VME type (VME6U)	About 460g
• Unit type	About 3130g

（11） PC environment

• OS	Windows 7 or later, 32bit or 64bit or later
• Network interface	
• Screen resolution	Full HD (1920 × 1080) recommended

3. Appearance

Photo 1　APV8108

（1）	LED	P (green) lights up when power is turned ON, V (orange) and E (red) are not used
（2）	CH1～CH8	LEMO 00.250 connector for signal input. Input range ±1V, input impedance 50Ω
（3）	SYNC-O	LEMO 00.250 compatible connector for synchronous timing signal output. Outputs timing signals to adjust time between boards.
（4）	SYNC-I	LEMO connector for synchronous timing signal input. Used to input timing signals to adjust the time between boards.

NOTE
SYNC-O and SYNC-I should be interconnected by cable.

Photo 2 Interconnects SYNC-O and SYNC-I terminals

（5）	CLK-O	LEMO 00.250 compatible connector for external clock signal output. Outputs 25MHz LVTTL signal with 50% duty cycle.
（6）	CLK-I	LEMO 00.250 compatible connector for external clock signal input. It is possible to synchronize with external devices using an external clock. When using an external clock, with the power off, change the jumper JP3 on the board to 1-4 CPU, input a 25MHz, 50% duty cycle LVTTL or TTL signal to CLK-I, and then turn on the power.
（7）	VETO	LEMO 00.250 compatible connector for external VETO signal input; accepts LVTTL or TTL signals; disables data acquisition while high.
（8）	GATE	LEMO 00.250 compatible connector for external GATE signal input; accepts LVTTL or TTL signals. Enables data acquisition while the input is High.
（9）	LAN	RJ45 connector for Ethernet cable. 1000Base-T.

4. Setup

4. 1. Installation of application

This application runs on Windows. When using this application, it is necessary to install the EXE (executable format) file of this application and the LabVIEW runtime engine from National Instruments on the PC to be used.

Installation of this application is performed by the installer included on the accompanying CD. The installer includes the EXE (executable format) file and the LabVIEW runtime engine, which can be installed at the same time. The installation procedure is as follows.

（1） Log in to Windows with administrative privileges.
（2） Run setup.exe in the Application (or Installer) folder on the accompanying CD-ROM. Proceed with the installation in an interactive manner. The default installation directory is "C:¥TechnoAP". In this folder, the application's executable file and the configuration file config.ini, which contains the configuration values, will be installed.
（3） Start button - TechnoAP - APV8108 (or APV8108-8516).

To uninstall, go to Add or Remove Programs and select APV8108 to remove it.

4. 2. Connection

（1） Connect this device and PC with an Ethernet cable; use a crossover cable depending on the PC. When using a hub, use a switching hub.
（2） Interconnects SYNC-O and SYNC-I terminals.

Photo 3 Example of SYNC-I/O terminal connection

4. 3. Setup of the network

Check the communication status of this device and this application by the following procedure.

（1） Turn on the PC and change the network information of the PC.

IP address	:	192.168.10.2 * Addresses not assigned to this device
Sub-net mask	:	255.255.255.0
Default gateway	:	192.168.10.1

（2） Turn on the VME Crate power supply and wait for about 10 seconds after turning on the power.

（3） Check the communication status between the PC and the device by executing the ping command at the Windows command prompt to see if the device and the PC are connected.

The IP address of this device is clearly marked with a sticker on the board. Please be sure to check it.

The IP address of the device is located on the board or on the back of the unit. The factory default network information for this device is as follows.

IP address	:	192.168.10.128
Sub-net mask	:	255.255.255.0
Default gateway	:	192.168.10.1

> ping 192.168.10.128

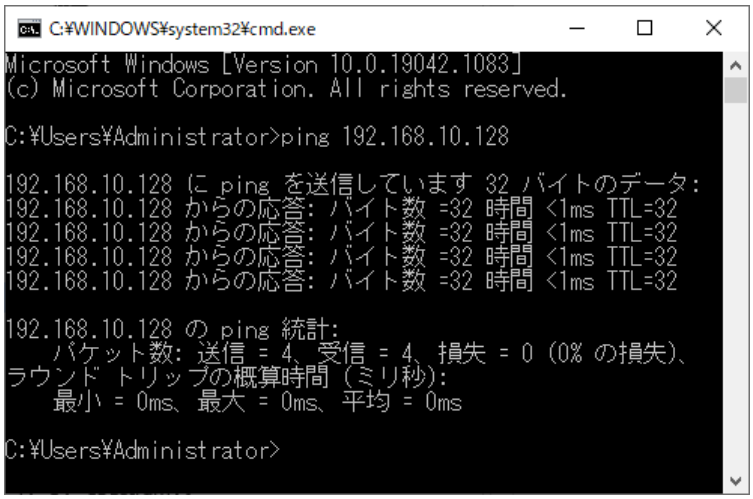


Figure 3 Confirm communication connection, execute ping command

（4） Launch this application. Search for APV8108 from the shortcut icon APV8108 on the desktop or the Windows button and launch it.

(If an error message is displayed when this application is launched, stating that the connection with this device has failed, please refer to the troubleshooting described below.

5. Application window

5. 1. Startup window

When this application is run, the following startup screen will appear.

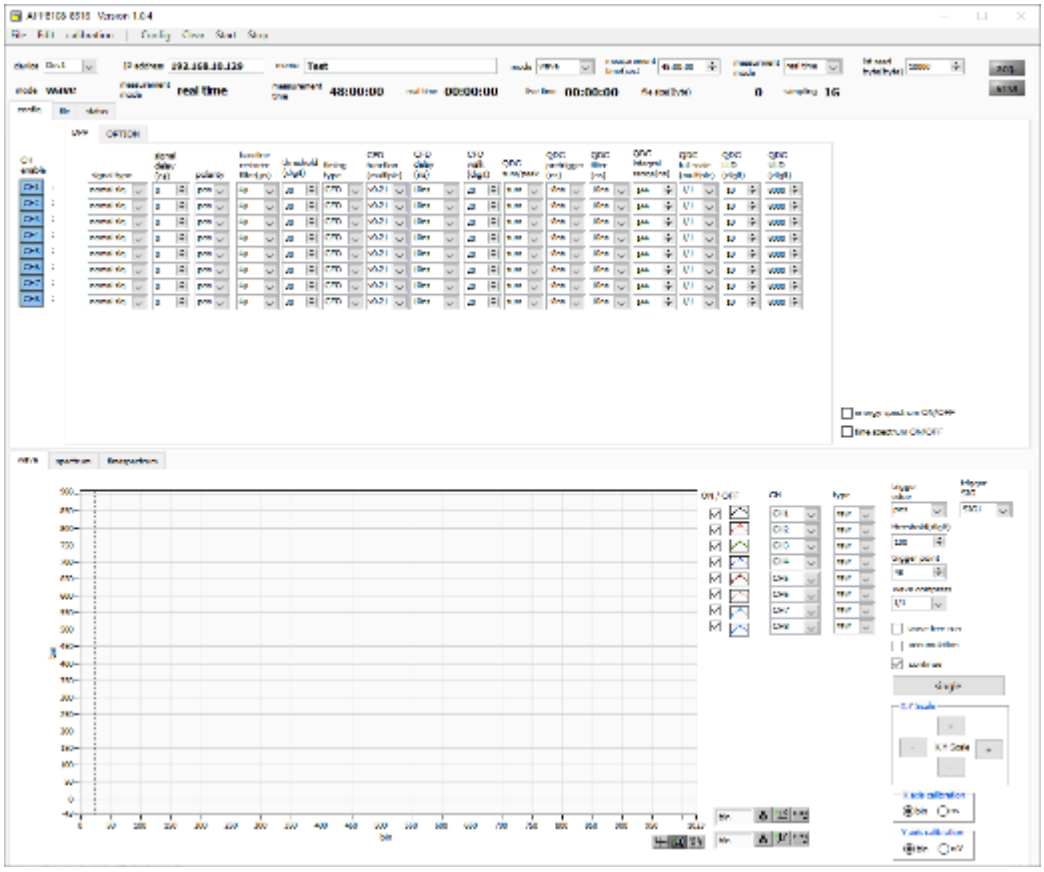


Figure 4 Startup window (may differ from image due to options and updates)

Menu

File - open config	Load configuration file
File - open histogram	Load histogram data file
File - open wave	Load waveform data file *option
File - open PSD	Load PSD data file * option
File - save config	Save current settings to a file
File - save histogram	Save current histogram data to file
File - save wave	Save waveform data file *option
File - save PSD	Save PSD data file * option
File - save image	Save this application screen as PNG format image
File - convert binary list file to csv	Open screen to convert list data file to CSV format
File - quit	Quit application
Edit - copy setting of CH1	CH1 and CH5 settings in CH tab are reflected in other CH settings
Edit - copy setting of CH1 to all module	CH1 and CH5 settings in the CH tab are reflected in the settings of all other board
Edit - IP configuration	Change the IP address of this device

calibration	Execute when there is a disturbance in the wave from CH1 to CH4.
Config	Set all items to this device
Clear	Initialize histogram data in this device
Start	Start measurement to this device
Stop	Stop measurement to this device

device	Select the device to be measured
IP address	IP Address. IP address defined in the configuration file and selected in Module

memo	You can write notes.
mode	The following modes can be selected.

hist	Integrates the input signal and displays the spectrum.
wave	Digitizes input signals and displays waveforms.
list	For an input signal, time, CH, and integral information can be output and saved as a binary file as a single event. It is also used to obtain time spectra and PSD 2D histograms.
list-wave	Waveform data is appended after the list data and output. * Option
list-pileup	Waveform data is inserted in the list data and output in case of pile-up. * Option
list-coinc-wave	The coincidence list data and waveform data are output together. Only CH1 and CH2 are valid for coincidence. * Option
list-com	Used when timing is synchronized among multiple boards, CH1 is used as a common signal input pin to input a fast pulse with low jitter after start. * Option

measurement time (sec)	Set the measurement time. Setting range is up to 48 hours.
measurement mode	Select measurement mode: real time or live time. Measurement is completed in the selected time mode.
list read byte (byte)	Sets the size of the list data to be read out once. 10 bytes per list data size per event, the setting range is from 1000 bytes to 100,000 bytes in 1000 byte increments. 1600 bytes per list data size per event, the setting range is from 1600 bytes to 160,000 bytes in 1600 byte increments. If the list data size per event is 1600 bytes, the setting range is from 1600 bytes to 160,000 bytes in 1600-byte increments.
acq. LED	Flashing during measurement.
error LED	Error indication
mode	Displays the name of the operating mode being set.
measurement mode	Measurement mode, displaying real time or live time.
measurement time	Displays the set measurement time.
real time	Real time (actual measurement time) of valid first CH.

live time	Live time (effective measured time) of the effective first CH. Calculation: real time - dead time
file size (Byte)	Displays the size of the list data file being saved. Displays the size in SI notation (0.789M, 10.100M, 1.230G, etc.).
sampling	Displays the sampling frequency of the target device. Unit is Hz.

• tab

config	CH settings and measurement settings.
file	File-related settings.
status	Displays the status of each CH.
wave	Display of input waveform, CFD waveform, and filter waveform data.
spectrum	Spectrum (histogram) display, ROI (Region Of Interest) setting.
timespectrum	Display of the time difference spectrum between two CHs set in advance from the time information of the list data, and the setting of ROI (Region Of Interest) and display of the result of time resolution calculation.
PSD	Display 2D spectra in QDC data set for CH1 and CH2 respectively from various information in the list data.

5. 2. config - DPP tab

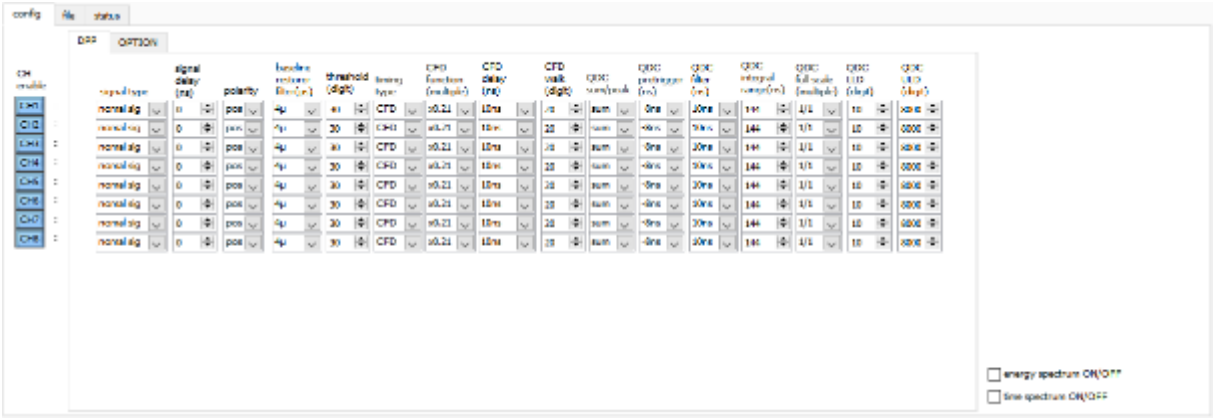
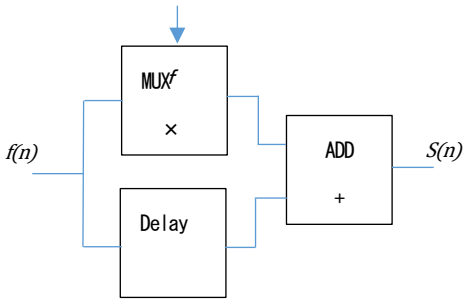


Figure 5 config – DPP tab

CH enable	CH Enable/Disable. Normally, all CHs are set to "enable" state.
signal type	Select the input waveform type.
	fast sig When NIM or Timing signal is input.
	normal sig When other than fast sig.
signal delay (ns)	The input signal is delayed inside this device. Maximum delay time is 2000ns (2us).
polarity	Input signal polarity. Select pos for positive polarity or neg for negative polarity.
baseline restorer filter	Sets the time constant for the baseline restorer; select Ext (no automatic baseline restorer), Fast, or 4μs. Normally set to 85μs.
threshold (digit)	Sets the threshold for waveform acquisition of the input signal. The unit is digits. The setting range is from 0 to 8191.

Constant Fraction Timing of APV8108 and APV8516 is realized by digital signal processing using FPGA



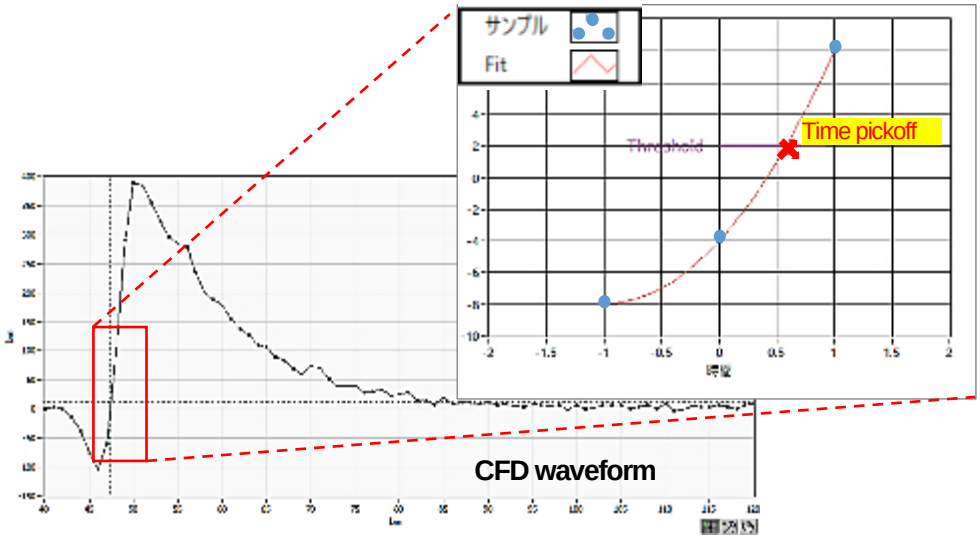
$$s(n) = fv(n) - v(n - delay)$$

The digital signal processing algorithm we have developed uses a polynomial approximation based on the least-squares method from sampled waveform data.

$$L(a,b,c) = \sum_{i=1}^{N} \{y_i - (ax_i^2 + bx_i + C)\}^2$$

The time information is calculated more precisely by finding the parameters a, b, and c that minimize the time information (i.e., the time information of the time of the data) and obtaining interpolation of the zero-crossing point (WALK) for CFD and the threshold point for leading edge.

Furthermore, by using FPGAs to perform pipelined calculations, a series of calculations is performed very quickly, with a calculation time of approximately 100 ns or less, resulting in low dead time and high throughput.



timing type　　Select the waveform to be time-stamped from CFD or LE waveform.

LE　　Leading Edge Timing (LET and LED agree)

The timing at which a certain trigger level t is reached. (Trigger acquisition timing is different for different wave heights, such as 'a' and 'b', and different times for different wave heights.

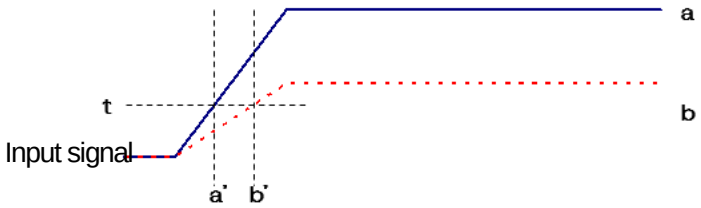
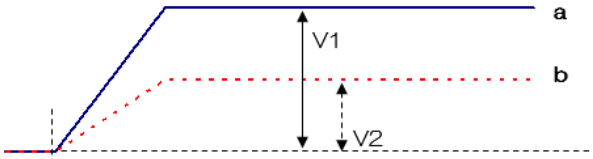


Figure 6　Thinking of Leading Edge Timing

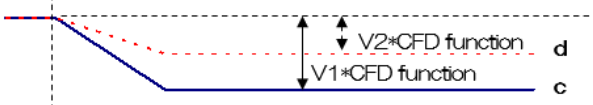
CFD　　Constant Fraction Disicriminator Timing

CFD, the zero-crossing timing of waveforms g and h in the figure below, is characterized by the fact that if the rise time of the waveform is the same, it is constant even if the wave height changes.

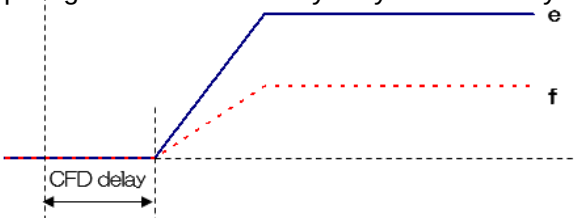
Input signal a and b



Inverts input signal multiplied by CFD function



Input signals a and b are delayed by the CFD delay described below.



Let g be the waveform obtained by adding c and e above, and let h be the waveform obtained by adding d and f above

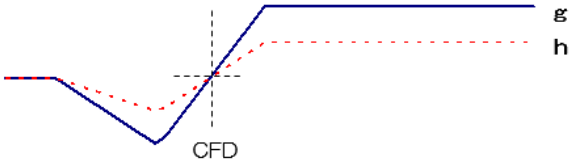
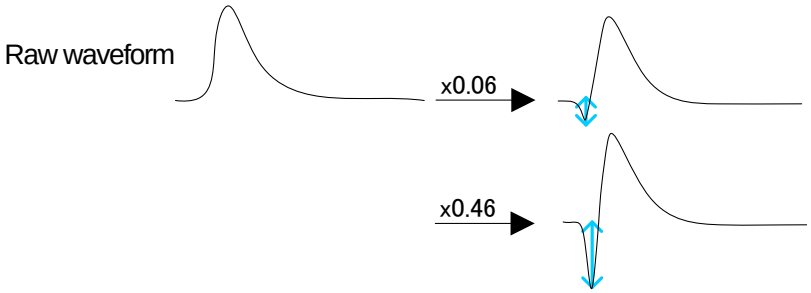
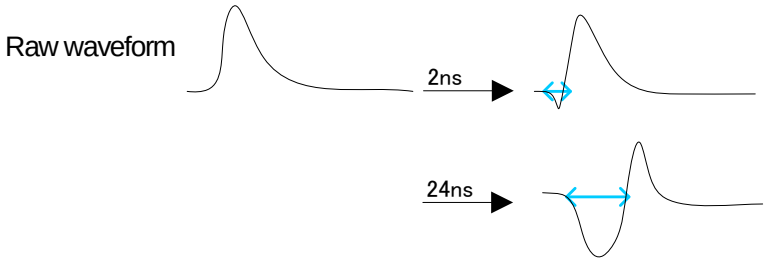


Figure 7　Thinking of Constant Fraction Disicriminator Timing

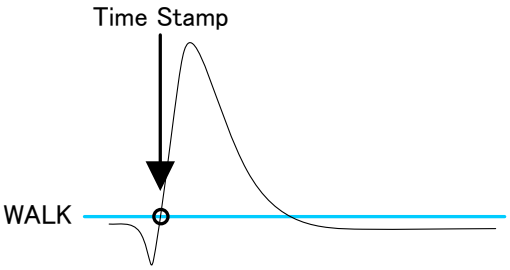
CFD function　　Magnification to reduce the original waveform for CFD waveform shaping, select from 0.03x, 0.06x, 0.09x, 0.12x, 0.15x, 0.18x, 0.21x, 0.25x, 0.28x, 0.31x, 0.34x, 0.37x, 0.40x, 0.43x, 0.46x



CFD delay　　Sets the CFD delay time; for the APV8108, set from 1ns to 16ns in 1ns increments.



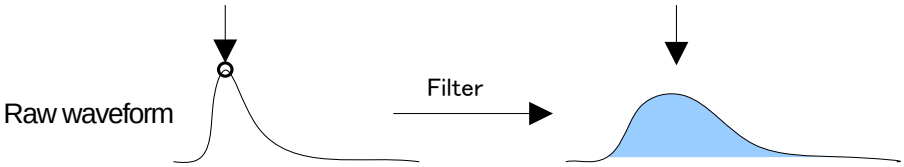
CFD walk　　Sets the threshold value to be time-stamped. The unit is in digits, and the value is set near the 0 crossing position while watching the CFD waveform in wave mode.



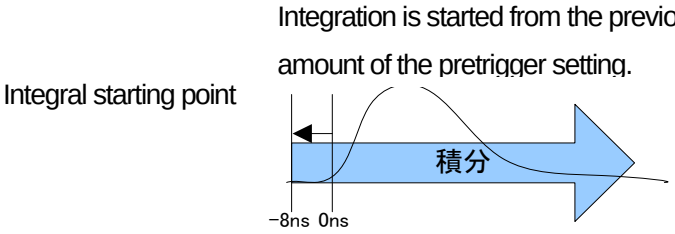
QDC sum/peak　　Select the output format of the QDC data, from PEAK value or SUM value.

When PEAK is selected, the PEAK value for the raw waveform is output as a QDC value.

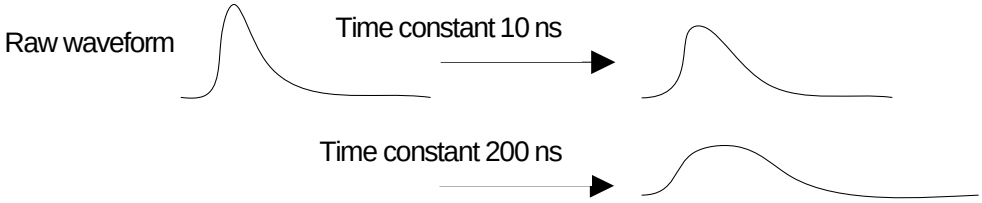
When SUM is selected, FILTER is applied to the raw waveform and the integral value is output as QDC value.



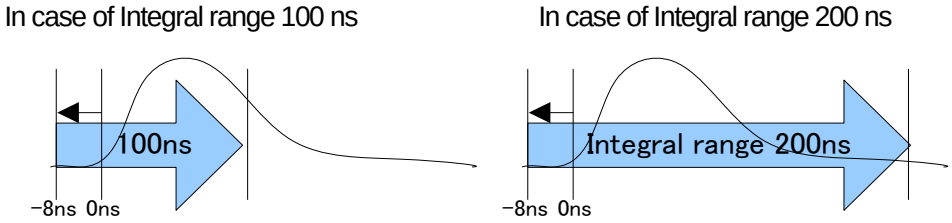
QDC pre trigger (ns) Selects the timing to start waveform shaping for integral value calculation from 0ns, -8ns, -16ns, -24ns, and -32ns.



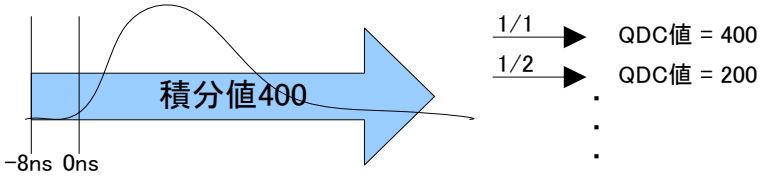
QDC filter (ns) Sets the time constant for shaping the waveform for integral value calculation. Select the setting from Ext, 10ns, 20ns, 50ns, 100ns, 200ns.



QDC integral range (ns) Set the QDC integration time from 48ns to 32000ns in 8ns increments.



QDC full scale Sets the gain of the QDC data. Select the setting from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, or 1/512 to set the QDC value to 8191 or lower.



QDC LLD (digit) Sets the LLD (Lower Level Discriminator) of the QDC. The unit is digits. Set a value smaller than ULD. The setting range is from 0 to 8191.

QDC ULD (digit) Sets the ULD (Upper Level Discriminator) of the QDC. The unit is digits. Set to a value greater than the LLD. The setting range is from 0 to 8191.

PSD ON/OFF Select whether to display PSD 2D histograms, etc. while acquiring list data in list mode. Uncheck this checkbox if you wish to acquire list data only. (Note that turning ON at high counts slows down the acquisition of list data. * Option

energy spectrum ON/OFF Selects whether spectrum is displayed while acquiring list data in list mode. Uncheck this checkbox if you wish to acquire list data only. (Note that turning ON at high counts slows down the acquisition of list data.

time spectrum ON/OFF Selects whether to display time spectrum while acquiring list data in list mode. Uncheck this checkbox if you wish to acquire list data only. (Note that turning ON at high counts slows down the acquisition of list data.

5. 3. config – OPTION tab

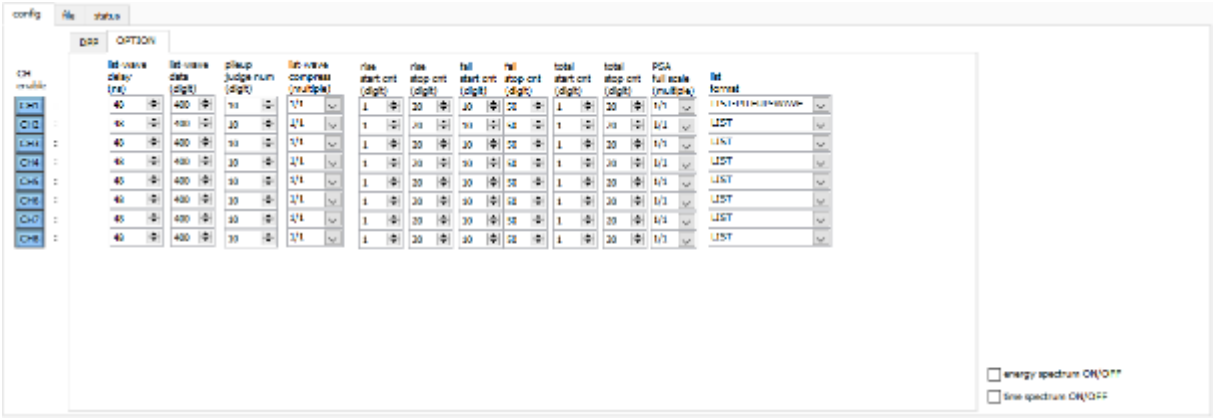
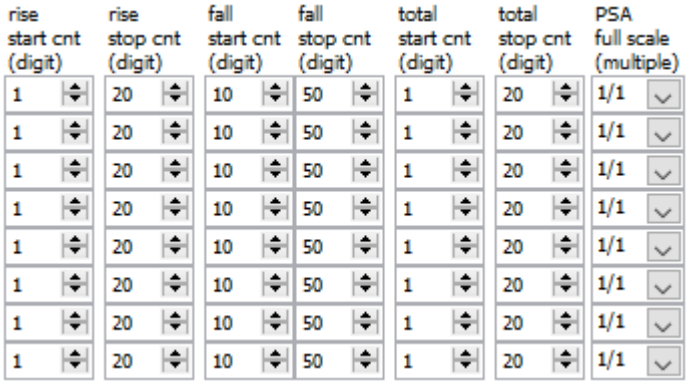


Figure 8　config-OPTION tab, setting example: Pulse Shaping Analysis and list-pileup-wave * option



rise start cnt (digit)	rise stop cnt (digit)	fall start cnt (digit)	fall stop cnt (digit)	total start cnt (digit)	total stop cnt (digit)	PSA full scale (multiple)
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1
1	20	10	50	1	20	1/1

Figure 9　Setting related PSA

（1） PSA * Option

PSA is additional data in the list mode, and is used to set RISE for the rising edge of the acquisition waveform, FALL for the falling edge, and the integral range of TOTAL for the entire waveform, etc. In the PSA operation, if the input waveform is negative polarity, it is inverted to positive polarity, and the waveform is always positive polarity.

rise start cnt (digit)　The start position of the target range of RISE for the integral value of the rising edge, from the position beyond threshold to the range before it. The setting range is from 1 to 498 (498ns=498 x 1ns).

rise stop cnt (digit)　This is the end position of the target range of the integral value RISE for the rising part. Set the range of integration from the RISE start cnt. The setting range is from 1 to 16383 (16383ns=16383 x 1ns).

Example of RISE value calculation:

Setting example, threshold: 50, rise start cnt:5, rise stop cnt:8, PSA full scale: 1/1.

Integrate the green line in the figure below for 8 points from 5 points before the point where the threshold is exceeded. The integrated value is then multiplied by PSA full scale to obtain the RISE value of the list data.

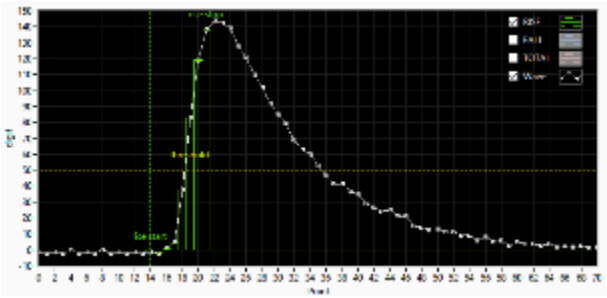


Figure 10 Example of RISE coverage setting

fall start cnt (digit) The start position of the target range of the falling integral value FALL. The setting range is from 1 to 16383 (16383ns=16383×1ns).

fall stop cnt (digit) The start position of the target range of the falling integral value FALL. The setting range is from 1 to 16383 (16383ns=16383×1ns).

Example of FALL value calculation:

Setting example: threshold: 50, fall start cnt: 5, fall stop cnt: 25, PSA full scale: 1/1

The FALL value is integrated for 25 points from the 5th point beyond THRESHOLD and the blue box line in the figure below. The integral value is then multiplied by PSA full scale to obtain the FALL value of the listing data.

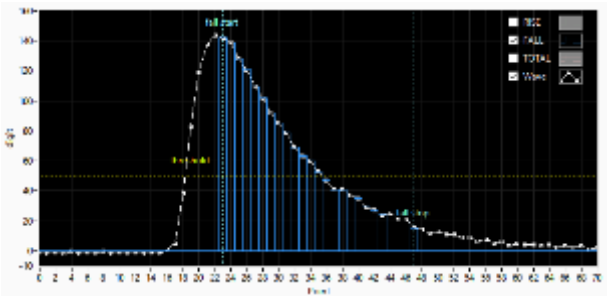


Figure 11 Example of FALL coverage setting

total start cnt (digit) The start position of the target range of the whole waveform integral value TOTAL. Set the range from the point where the threshold is exceeded to the point before the threshold. The setting range is from 1 to 498 (498ns=498 x 1ns).

total stop cnt (digit) This is the end position of the target range of the total waveform integration value TOTAL. Set the range to be integrated from the total start cnt mentioned above. The setting range is from 1 to 16383 (16383ns=16383 x 1ns).

Example of TOTAL value calculation:

Setting example: threshold: 50, total start cnt: 5, total stop cnt: 50, PSA full scale: 1/1

Integrate the red line in the figure below for 50 points from 5 points before the point where the threshold is exceeded. The integrated value is multiplied by PSA full scale to obtain the TOTAL value of the list data.

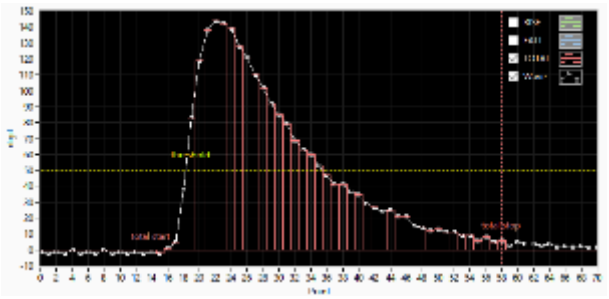


Figure 12　Example of TOTAL coverage setting

PSA full scale (multiple)　Select the reduction factor for the RISE, FALL, and TOTAL values of the list data from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, and 1/512. If the integral value exceeds 65535, set a larger reduction factor.

（2） list-pileup-wave * Option

Waveform data can be added to each CH in list mode by selecting enable/disable.

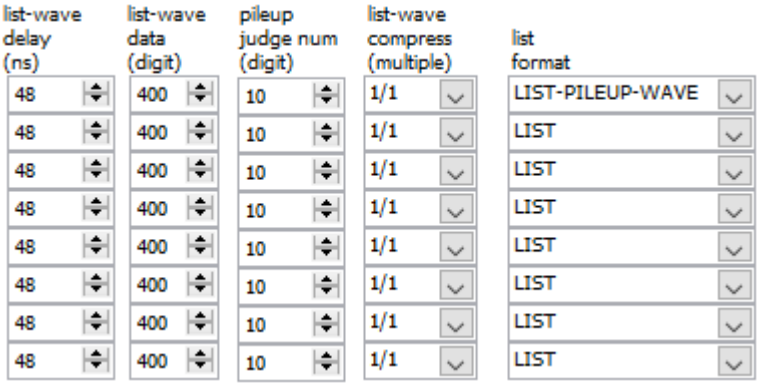


Figure 13 list-pileup-wave related settings

list-wave delay (digit) Settings for list-wave or list-pileup mode. Adjusts the delay of the acquisition waveform. Setting range is from 8digit to 248digit. 1digit is for 8 waveforms.

list-wave data (digit) Parameter for list-pileup mode or list-wave. Sets the number of data points for pileup waveform output. Setting range is from 8 to 8000 points.

pileup jugde num (digit) Sets the amount of the pileup waveform to be determined. The unit is in digits, and is correlated with the vertical axis (digits), which corresponds to the amplitude of the waveform. Note that if this value is too small, even noise may be judged as a pileup.

list- wave compless Sets the waveform data compression when acquiring waveforms in list-wave format. The setting range is 1/1 to 1/256; for the APV8108, 1/1 is 1ns/point, 1/2 is 2ns/point, and 1/256 is 256ns/point.

list format Sets the format of the list data

LIST	Normal list data format
LIST-PILEUP-WAVE	When a pile-up is detected in the mode, information on the presence or absence of a pile-up is included in the list data, and the waveform data of the pile-up is appended after the list data.

5. 4. file tab

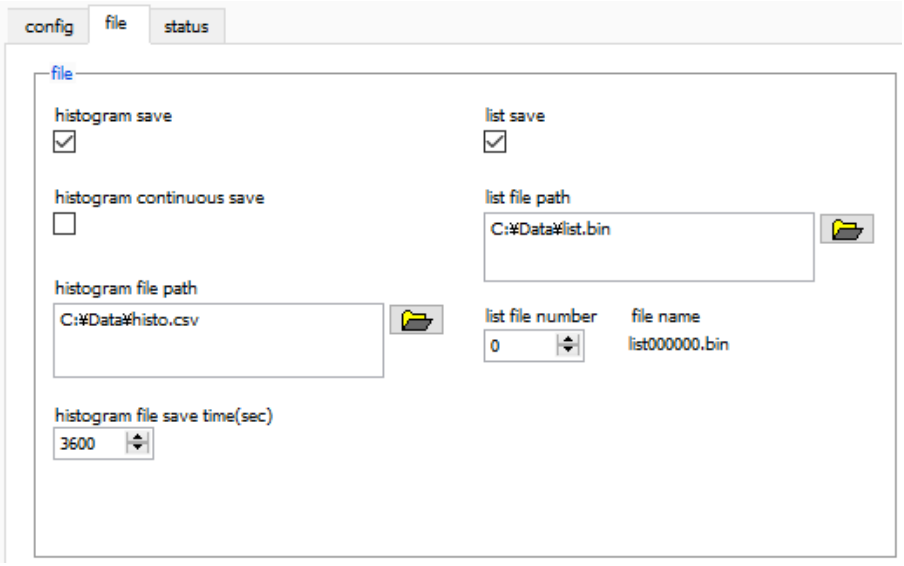


Figure 14 file tab

• file part

histogram save — Saves the histogram data displayed in the spectrum tab at the end of measurement to a file. The file is saved in the format described below.

histogram continuous save — Enables/disables continuous saving of histogram data to file at set time intervals Valid only when "hist" is selected in "mode".

histogram file path — Set the absolute path of the histogram data file. No extension is also possible.

NOTE The file will not be saved with this file name, but will be formatted as follows based on this file name

Example: If the histogram file path is set to C: ¥Data¥histogram.csv and the date and time is 2010/09/01 12:00:00, the data saving will start with the file name C: ¥Data ¥ histogram _201009 01_120000.csv

histogram file save time (sec) — Sets the time interval for continuous storage of histogram data. The unit is seconds. The setting range is from 5 to 3600 seconds.

list save — Sets whether or not data in list mode is saved in a file.

list file path — Set the absolute path of the listing data file. No extension is also possible.

NOTE The file will not be saved with this file name, but will be formatted as follows based on this file name

Example: If the list file path is set to C:¥Data¥list_.bin and the list file number is 0 as described below, data saving will start with the file name C:¥Data¥list_000000.bin

list file number — Sets the starting number of the number appended to the list data file, from 0 to 9999999, reset to 0 if the number exceeds 9999999.

file name — Displays the file name when the file is saved based on the list file path and list file number.

5. 5. status tab

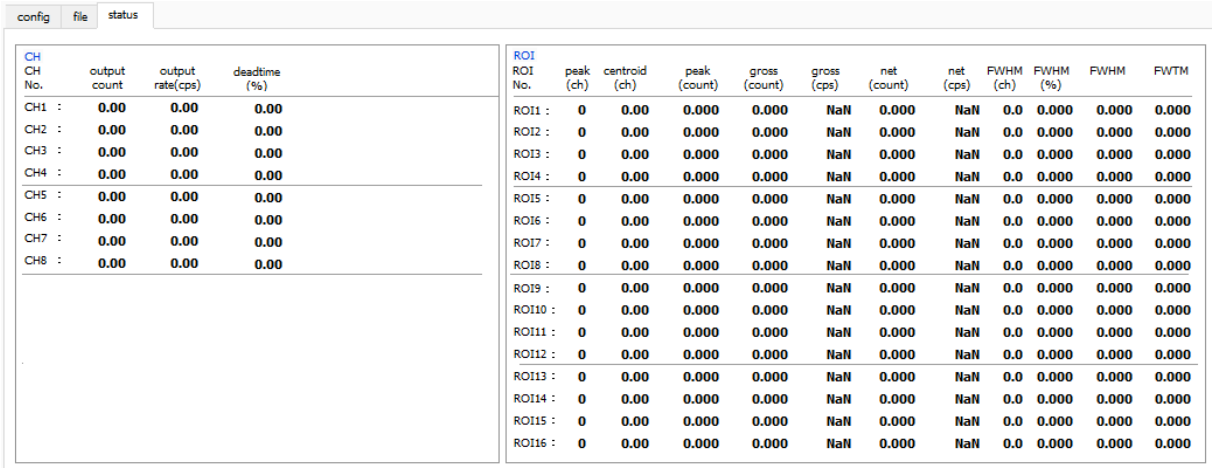


Figure 15 status tab

• CH part

Displays the status of each CH.

output count	Total number of counts processed by the signal
output rate (cps)	Output count per second
deadtime (%)	dead-time ratio

• ROI part

Displays the calculated results between ROIs.

peak (ch)	Maximum count ch
centroid (ch)	Center value calculated from the sum of all counts (ch)
peak (count)	Maximum count
gross (count)	Sum of counts between ROIs
gross (cps)	gross (count) per second
net (count)	Sum of counts minus background between ROIs
net (cps)	nets per second (count)
FWHM (ch)	Half-width (ch)
FWHM (%)	Half-width (%). Half width / ROI defined energy x 100
FWHM	half-width
FWTM	1/10 width

5. 6. wave tab

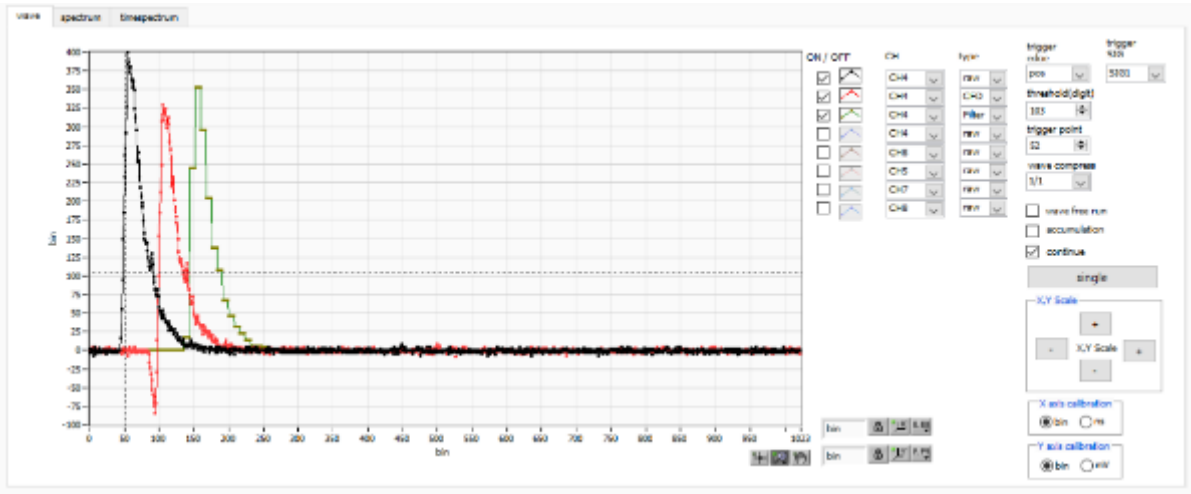


Figure 16 wave tab

Graph	Waveform graph. waveform is displayed during measurement when wave is selected in mode.
ON/OFF	Set whether to display the data on the graph. Checked: displayed, unchecked: not displayed.
CH	Select the CH of the waveform to be displayed
type	Select the type of waveform to display from the following.
	raw Digitized with ADC and baseline restored waveforms
	CFD CFD shaped waveform
	Filter Waveform integrated by QDC
	PTG Piled-up timing square wave * Option
trigger edge	Select the polarity of the trigger. Normally select pos.
trigger SIG	Select the SIG (Signal) to be triggered. Normally, select SIG1.
threshold	Set the trigger threshold. * Cursors in the graph can also be set.
trigger point	Specifies the starting point for waveform display. * It can also be set by the cursor in the graph.
wave compress	Selects the degree of time scale compression for the X axis from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, and 1/256. Used to display waveforms with long fall times.
wave free run	Unchecking the box displays the triggered waveform, and checking the box displays the trigger-free waveform. Can also be used to view baseline levels and noise levels.
accumulation	Enables or disables waveform data superimposition.
continue	Continuous waveform data read/unread setting.
Single	Waveform data single (one time) measurement execution.
X,Y Scale	The X-axis and Y-axis scales can be adjusted with the buttons. + (plus) for enlargement, - (minus) for reduction.
X axis calibration	Select the unit for the X axis from bin or ns
Y axis calibration	Select the unit for the Y-axis from bin or mV. * The mV display is for reference only.

X axis range　　Right-click on the X-axis and check Auto Scale to make it auto scale. If unchecked, it is no longer auto scale, and the minimum and maximum values of the X-axis are fixed. To change the minimum or maximum value, place the mouse pointer over the value to be changed and click or double-click.

Y axis range　　Right-click on the Y-axis and check Auto Scale to make it auto scale. If unchecked, it will no longer be auto scale and the minimum and maximum values on the Y-axis will be fixed. To change the minimum or maximum value, place the mouse pointer over the value to be changed and click or double-click.

 　　Cursor movement tool to move the cursor on the graph when setting ROI.

 　　Zoom. Click to select and execute the following six types of zooming in and out.

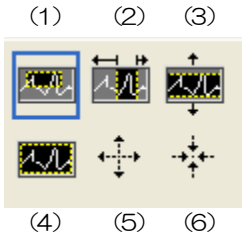


Figure 17　Graph　Zoom in and out tool

（1）Quadrangle　　Zoom Using this option, click on a point on the display that is a corner of the zoom area and drag the tool until a rectangle occupies the zoom area.

（2）X-zoon　　Zoom in on an area of the graph along the X-axis.

（3）Y-zoom　　Zoom into the area of the graph along the Y-axis.

（4）Fit zoom　　Zoom into the area of the graph along the Y-axis.

（5）Zoom out around the point　　Click on the center point to zoom out.

（6）Zoom in around the point　　Click the center point to zoom in.

 　　Pern tool　　Allows you to grab the plot and move it around on the graph.

5. 7. spectrum tab

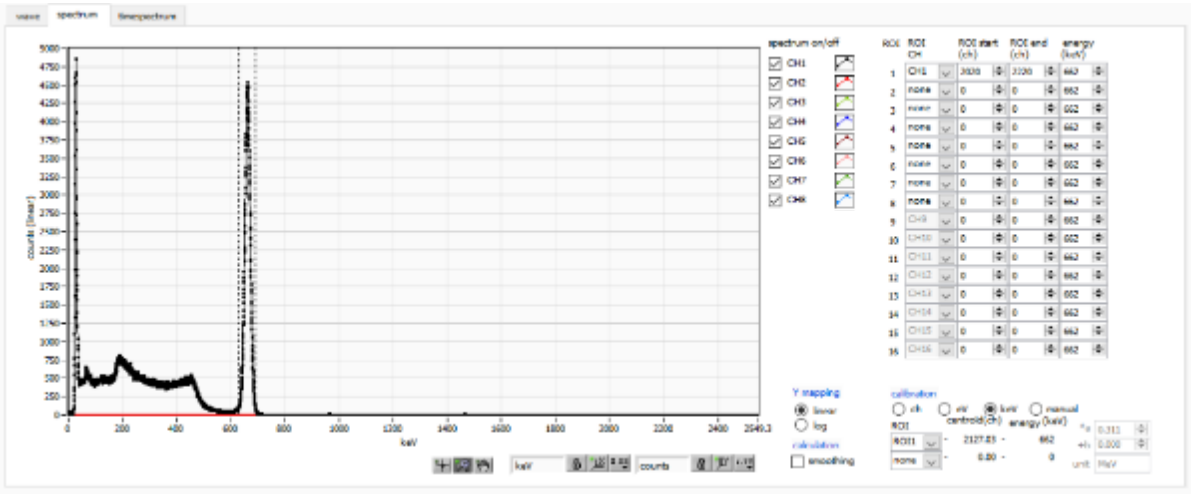


Figure 18 spectram tab

Graph	Histogram graph, which displays the energy histogram during measurement if histogram is selected in mode in the config tab or if list is selected in mode and the energy spectrum ON/OFF checkbox is enabled.
Legend checkbox	Selection of whether to display a histogram for each CH in the graph.
ROI CH	Select the CH number to which the ROI (Region Of Interest) is to be applied; up to 16 ROIs can be set for a single histogram.
ROI start	Start position of the ROI. The unit is the unit selected in the calibration described below.
ROI end	End position of the ROI. The unit is the unit selected in the calibration described below.
energy	Definition of energy value at peak position (ch), set as 1173 or 1332 (keV) for Co-60. When "ch" is selected in the calibration described below, the peak between ROIs is detected and keV/ch is calculated from the peak position (ch) and the set energy value and applied to the result of the calculation of the FWHM.
calibration	X-axis units. X-axis labels will change according to the setting
ch	Display in units of ch (channel); units such as FWHM of FWTM of ROI are optional.
eV	The slope a and the intercept b of the linear function y=ax+b are calculated and set on the X-axis so that ch is eV by two-point calibration of the two types of peaks (center values) and energy values in a histogram.
keV	The unit of keV is displayed. Example: If there are 1173.24 keV of Co-60 at 5717.9ch and 1332.5 keV of Co-60 at 6498.7ch, a is automatically calculated as 0.20397 and b as 6.958297 from the two-point calibration.
manual	Set the slope a, the intercept b, and the unit label of the linear function

y=ax+b arbitrarily and set them on the X axis. The units can be set arbitrarily.

Y mapping	Select the mapping for the Y axis of the graph. The Y-axis labels will change according to the settings. linear straight line log logarithm
smoothing	Smoothing function to calculate half-widths when statistics are low.

5. 8. time spectrum tab

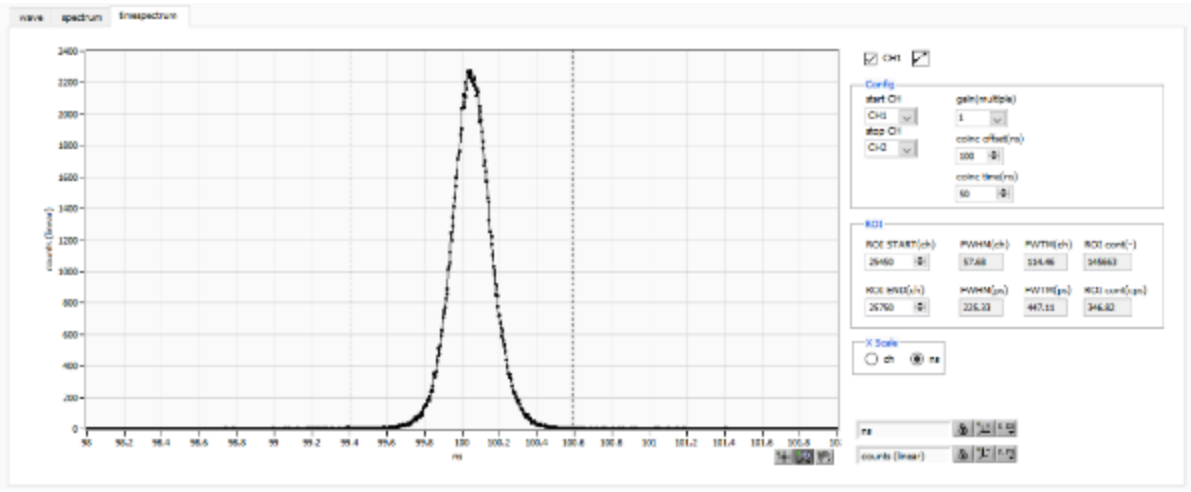


Figure 19 time spectram tab

* Settings related to timespectrum display. This setting is limited to the measurement within the board.

*** timespectrum is generated based on the list data acquired in the list mode.**

Graph	Time difference spectrum. list is selected in mode and timespectrum on/off is checked, the time difference spectrum is displayed during measurement.
Legend Check	Select whether to display the spectrum.
• Config part	Time spectrum settings.
start CH	Select the CH number from which to obtain the start timing.
sotp CH	Select the CH number from which to obtain the stop timing.
gain	Selectable from 1x to 128x; at 1x, full scale is approx. 780ns (approx. 3.9ps per digit); at 128x, full scale is approx. 100μs (0.5ns per digit).
coinc offset	Sets the X-axis offset of timespectrum. The setting range is from 0.008ns to 100,000ns.
coinc time	Set the coincidence time. If the time difference between event detection in the start CH and stop CH mentioned above is within this setting range, it is considered coincidence (simultaneous) and considered valid data. The setting range is up to 500,000 ns.
• ROI part	
ROI START	Start channel of ROI.
ROI END	End channel of ROI.
FWHM	The calculated half-width is displayed.
FWTM	The calculated total-width is displayed.
• Xscale part	Select the unit for the X axis from ch or ns.

5. 9. PSD tab

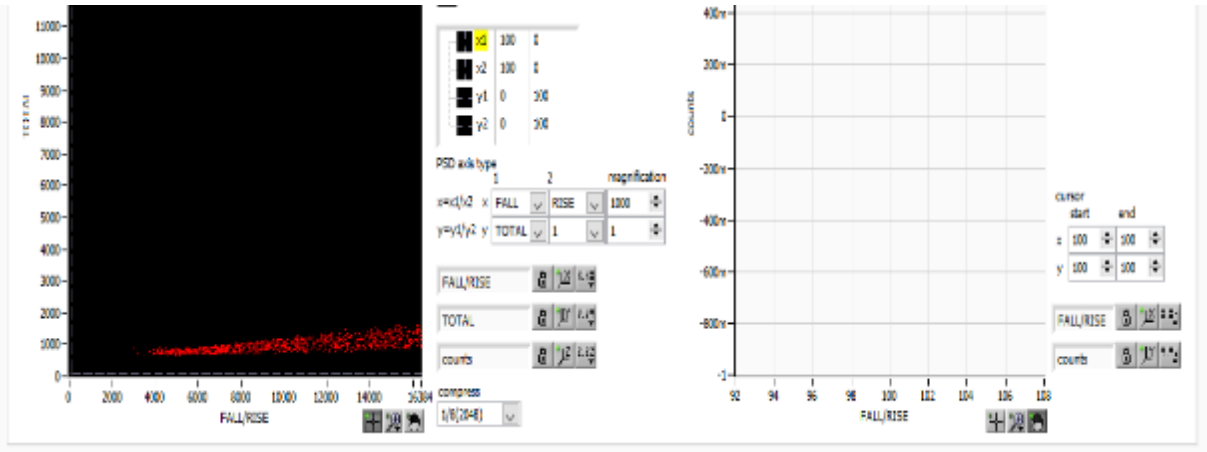


FIgure 20 PSD tab

Settings for PSD display.

*** PSD graphs and cursor area graphs are generated based on the list data obtained in list mode.**

PSD graph — A two-dimensional histogram using the values in the list data, with the data type selected arbitrarily for the X and Y axes, respectively, and the frequency integrated at the intersection of the X and Y axes.

NOTE

The number of channels on the X and Y axes is 16384, which requires about 537 MB (16384 x 16384 x 2 Bytes (counts)) of memory, which is compressed by the compress setting described below.

PSD axis type — Select items in the list data to be assigned to the X and Y axes of the PSD graph: the X axis is x1/x2 from the combination of x1 and x2; the Y axis is y1/y2 from the combination of y1 and y2. The selections are TOTAL, FALL, RISE, QDC, 1

magnification — The settings are summed up against the values on the X and Y axes of the PSD graph. For example, if this setting for the X-axis is 1000, and FALL is selected for x1 and RISE for x2, the X-axis will be FALL/RISE, and if the quotient is 1.234, the value will be multiplied by 1000 to 1234.

compress — Select the compression ratio for the PSD graph from the following items. The number of divisions and the amount of memory used in that case are described. (Note that an error message may appear, and you may not be able to use the item if you select an item that uses a lot of memory, depending on the condition of your PC.

1 (16384)	Disabled. 16384 × 16384. approx. 537MB
1/2 (8192)	1/2 of 16384 channels. 8192 x 8192. approx. 135MB
1/4 (4096)	1/4 of 16384 channels. 4096 × 4096. approx. 34MB
1/8 (2048)	1/8 of 16384 channels. 2048 × 2048. approx. 8.4MB
1/16 (1024)	1/16 of 16384 channels. 1024 × 1024. approx. 2.1MB
1/32 (512)	1/32 of 16384 channels. 512 × 512. approx. 0.52MB

	1/64 (256)	1/64 of 16384 channels. 256 × 256. approx. 0.13MB
	1/128 (128)	1/128 of 16384 channels. 128 × 128. approx. 0.03MB

cursor area graph　This is a 1D histogram of data extracted within the range specified by the cursor in the PSD graph and viewed from the X-axis direction.

cursor　To extract data for the cursor area graph, a range is set with this cursor in the PSD graph. The cursor in the PSD graph will reflect any changes made to the settings, and the cursor graph will display a 1D histogram of the data in the area enclosed by the four corners, viewed from the X-axis direction.

6. Measurement

As an example, we describe the operation procedures for energy spectrum measurement, list measurement, PSD measurement, and time spectrum measurement when using a LaBr3(Ce) detector (hereafter referred to as "detector").

6. 1. Histogram mode

6. 1. 1. Environment

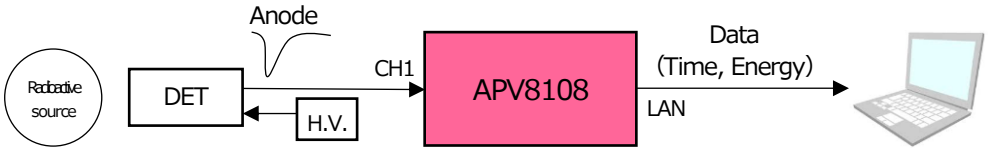


Figure 21 Configuration for measurement

6. 1. 2. Power supply and connection

（1） Make sure all equipment (VME power rack, HV (high voltage power supply), PC) is OFF.
（2） Connect the detector to the HV with a cable with SHV connector.
（3） Connect the anode output signal from the detector to CH1 of the APV8108 with a LEMO connector coaxial cable; for BNC connector, use a BNC-LEMO conversion adapter.
（4） Connect the APV8108 to the PC with a LAN cable.
（5） Turn on the power to the PC. Launch this application.
（6） Turn on the power to the VME rack.
（7） Turn on the high-voltage power supply and apply the appropriate voltage to the detector.
（8） This example uses a Cs-137 source.

6. 1. 3. Application startup and configuration

（1） Double-click the APV8108 shortcut icon on the desktop to launch this application. Immediately after startup, a network connection between this application and the device will be established. If a connection error occurs during this process, please refer to the troubleshooting described below.
（2） Click on Menu Config to send all settings to this device. After execution, the histogram data in DPP will be initialized.

6．1．4． Waveforme confirmation

First, check the signal from the detector input in waveform mode.

（1） In the config tab, make the following settings, then click on the Config menu.

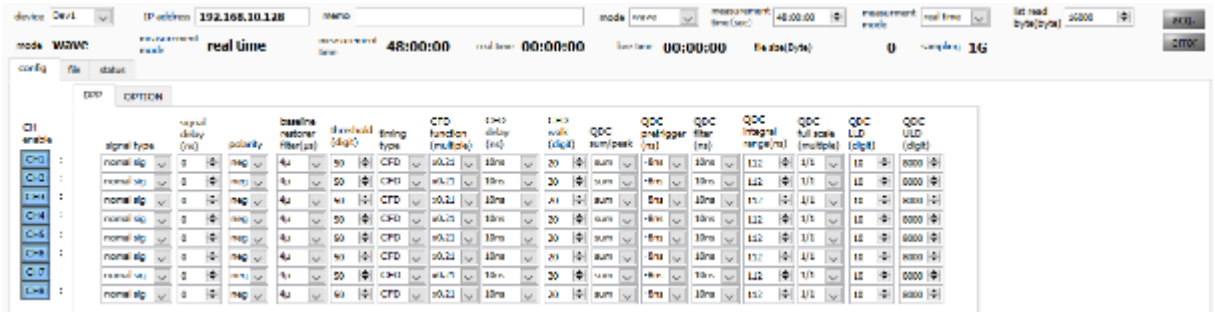


Figure 22 Waveform Measurement Settings

Open the wave tab, confirm the settings shown in the figure below, and then click the menu Clear → Start. You can see the waveform from the detector on the graph.

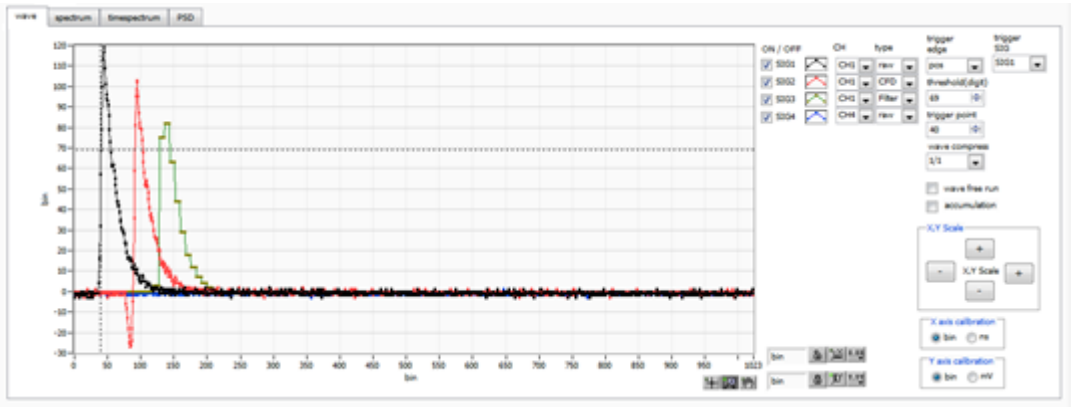


Figure 23 Waveform Measurement Window

Note the following

If wave data is not displayed on the graph, it may not be triggered. First, to check the baseline, check "wave free run" in the wave tab and execute the menu Config → Clear → Start. You can check the baseline and the approximate wave height of the signal.

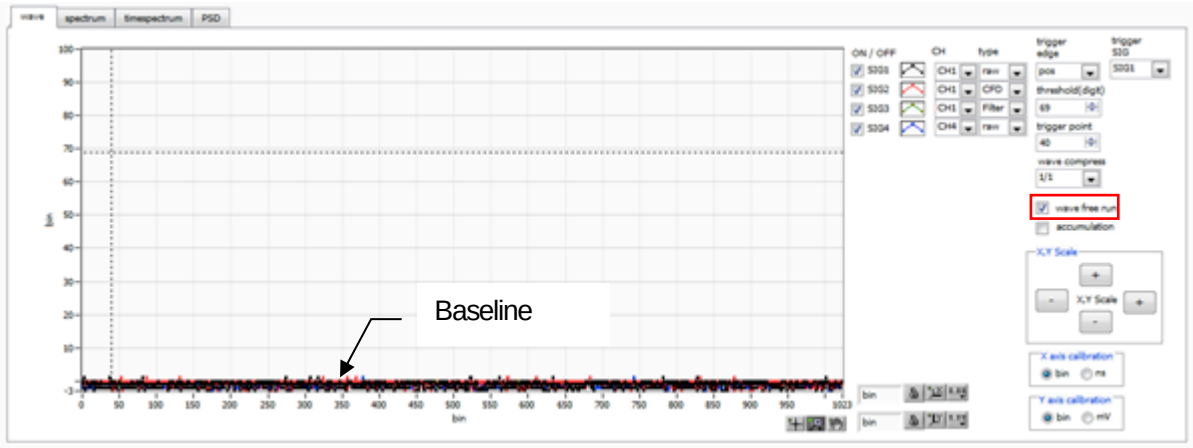


Figure 24　Baseline confirmation in progress

Next, uncheck "wave free run" and gradually increase the threshold from about 10, and note the threshold value at which the waveform is captured well, as shown on the previous page. This note will be used for later settings.

Check if the wave height is too large for saturation. If the wave height is too large, lower the amplitude of the input signal to the instrument by setting the ANALOG GAIN in the CH tab in the CONFIG tab to x1 or by lowering the applied high voltage power supply of the detector.

6. 1. 5. Measurement start

After making the following settings in the config tab, click on the Config menu. Set the threshold value you noted in the waveform measurement to the threshold in the config tab.

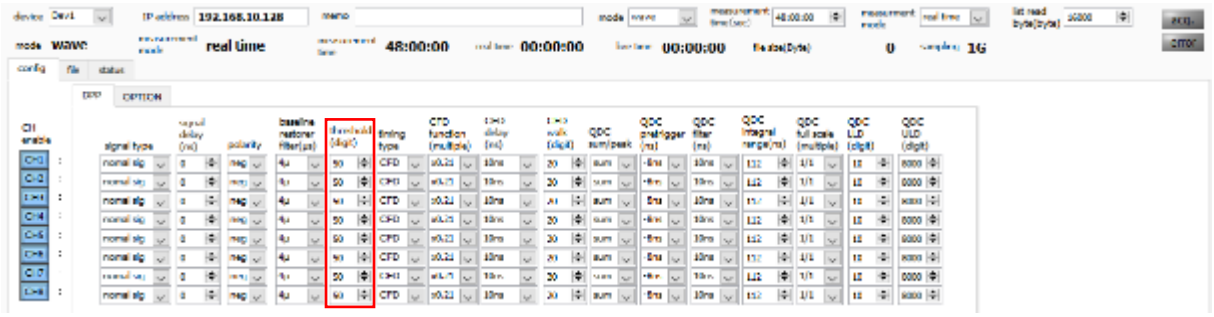


Figure 25 Threshold setting in config tab

Open the spectrum tab, confirm the settings shown in the figure below, and then click on the menu Clear > Start. After execution, you will see the spectrum as shown below

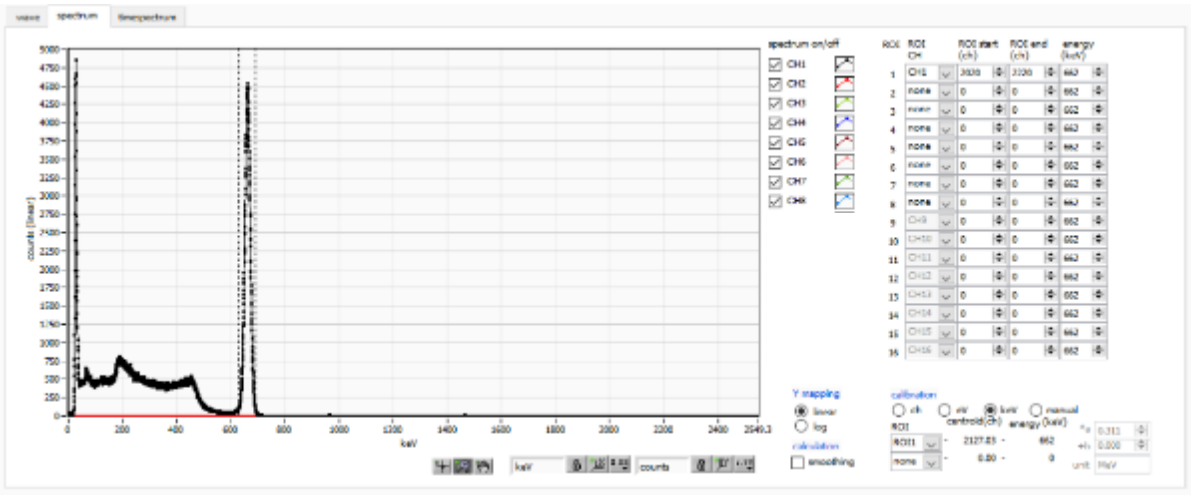


Figure 26 Histogram mode measurement in progress

- The measurement status of each CH is displayed in the CH section.
- The acq LED blinks.
- The measurement time displays the set measurement time.
- The elapsed time acquired from the device is displayed in real time.
- The "hist" is displayed in "mode".
- The calculation results for each ROI are displayed in the ROI section.
- Check CH1 in spectrum on/off, and the histogram is displayed in the spectrum tab.

6. 1. 6. End of measurement

To end the measurement, click on the menu Stop.

6. 2. List mode

6. 2. 1. Preparation

The same preparations are made from 6.1.1. "Environment" to 6.1.5. "Start of Measurement" in the previous section 6.1. "Histogram Mode.

6. 2. 2. Confirmation of energy spectrum

In histogram mode, note the following

- The output rate (cps) is the number of events per second. Check (1) in the figure below to see if the output rate is too low or too high compared to the expected value.
- Check the graph in the spectrum tab to see if there are any abnormalities in the shape of the spectrum, and especially check (2) in the figure below to see if excessive noise data is being acquired.

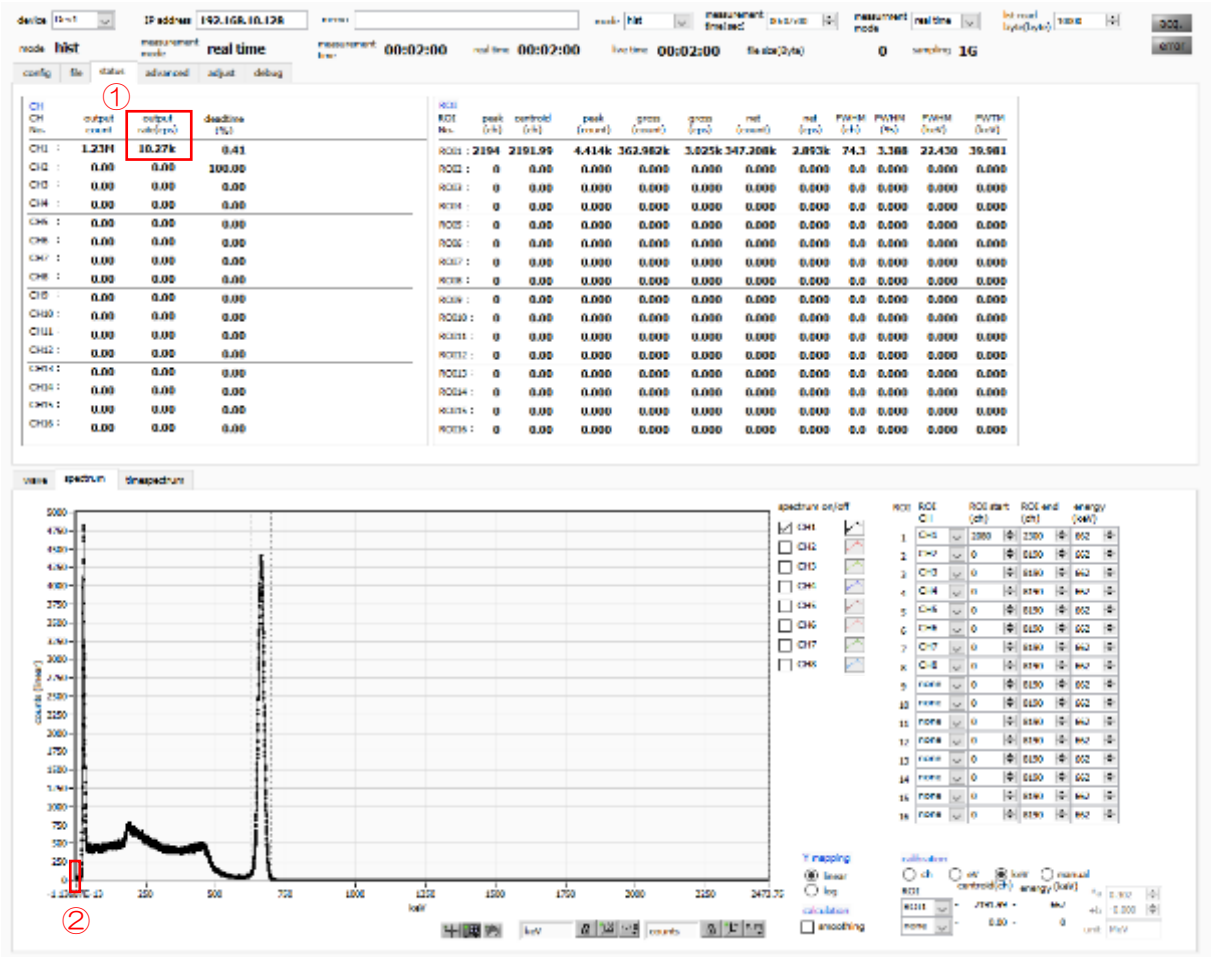


Figure 27 Precautions before measurement in list mode

6. 2. 3. Setting

（1） In the config tab, set mode to list.
（2） To save the list data, set each of the following items in the file tab.

list save	Check
list file path	Reference file path
list file number	Arbitrary from 0 to 99999999. Be careful not to duplicate.

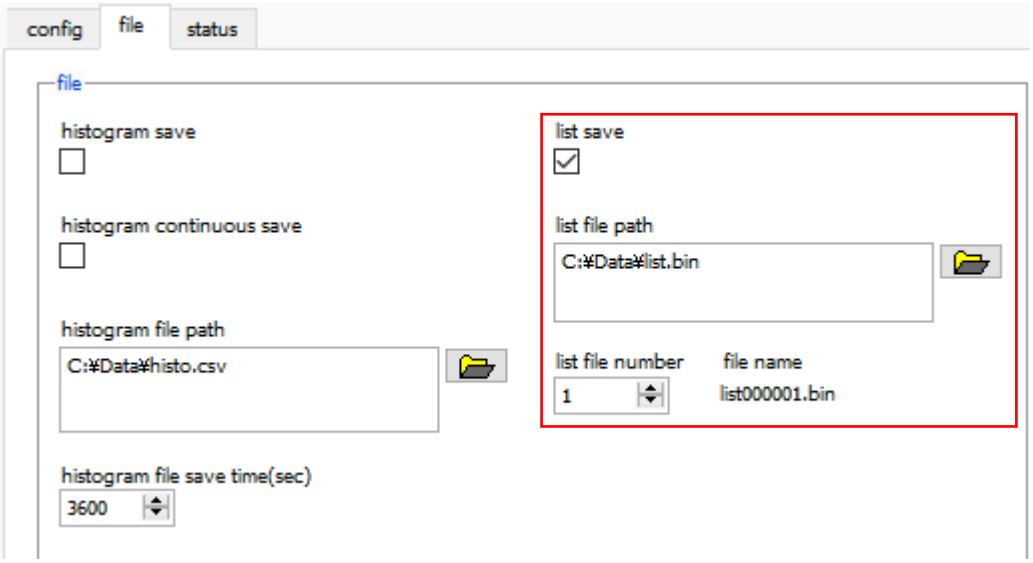


Figure 28 Settings related to saving list data in the file tab

6. 2. 4. Measurement start

Click the menu Config → Clear → Start. After execution, when an event is detected and list data is acquired, the file size (Byte) in the red frame in the figure below will increase.

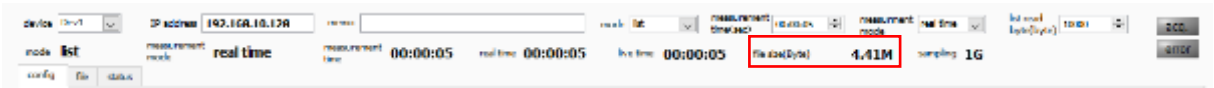


Figure 29 list data measurement and saving window

6. 2. 5. End of measurement

To end the measurement, click on the menu Stop.

6. 3. Time Spectrum Measurement

6. 3. 1. Environment

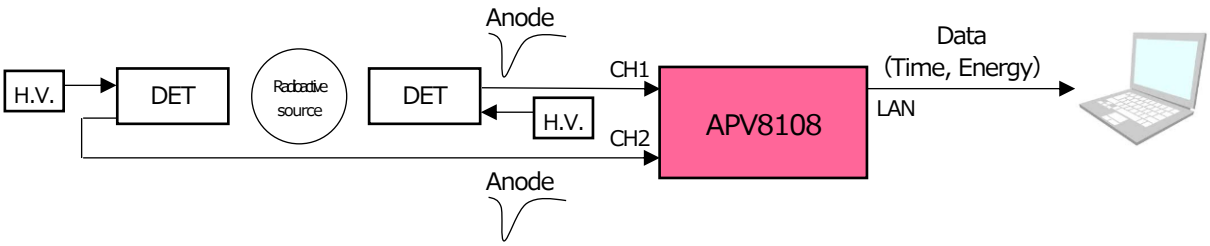


Figure 30 Configuration of time spectrum measurement

6. 3. 2. Power supply and connection

（1） Make sure all equipment (VME power rack, HV (high voltage power supply), PC) is OFF.
（2） Connect the detector to the HV with a cable with SHV connector.
（3） Connect the anode output signal from the detector to CH1 of the APV8108 with a LEMO connector coaxial cable; for BNC connector, use a BNC-LEMO conversion adapter.
（4） Connect the APV8108 to the PC with a LAN cable.
（5） Turn on the power to the PC. Launch this application.
（6） Turn on the power to the VME rack.
（7） Turn on the high-voltage power supply and apply the appropriate voltage to the detector.
（8） This example uses a Na-22 source.

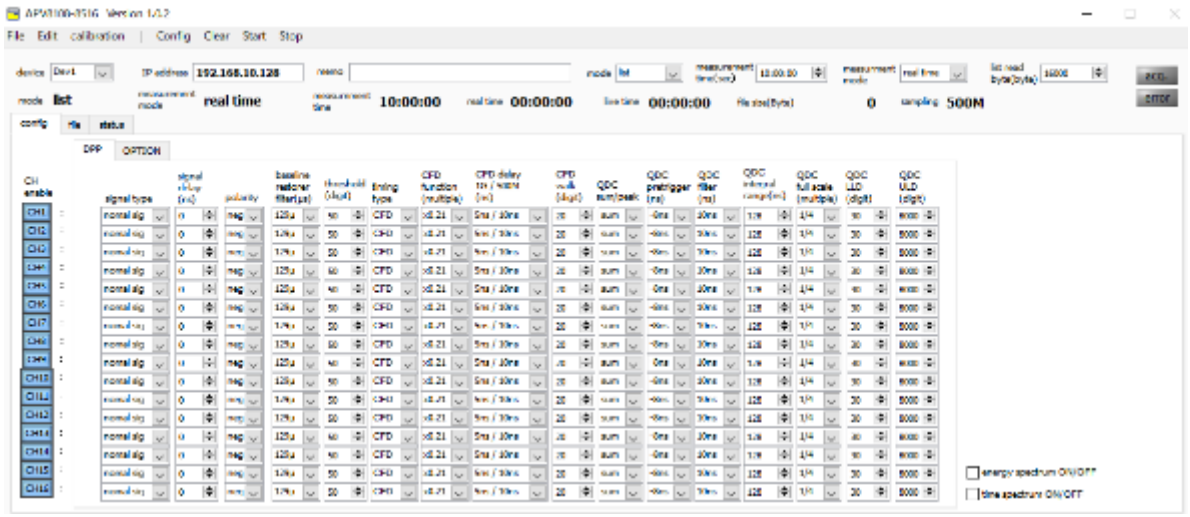
6. 3. 3. Preparation

Perform the same preparation as in the previous chapter 6.1.1. in histogram mode, 6.1.4. waveform confirmation.

6. 3. 4. Confirmation of energy spectrum

While checking the status of the detector, specify the range of energy to be measured in time.

First, perform the energy spectrum measurement with the following settings.



Fgure 31 Energy spectrum measurement setting before time spectrum measurement (full energy range)

Open the spectrum tab and click on the menu Clear > Start. After execution, the following spectrum will be displayed. While checking the shape and counts of the spectrum, use ROI start and ROI end to set the approximate peak range.

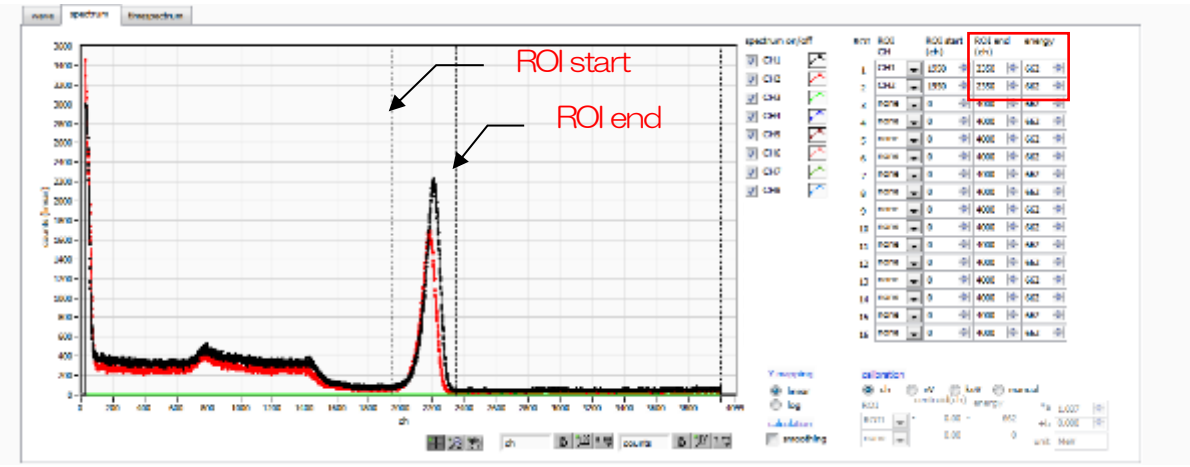


Figure 32 Energy spectrum measurement before time spectrum measurement (full energy range)

Next, to narrow down the target energy for time measurement (in this case, the 511 keV peak of Na-22), make the following settings. Set ROI start for QDC LLDs and ROI end for QDC ULDs in the config tab in the red frame in the figure below, using the values you estimated in the ROI start and ROI end on the previous page.

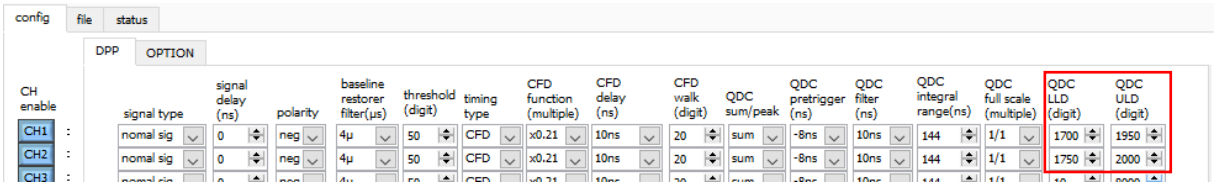


Figure 33　Energy spectrum measurement before time spectrum measurement (energy range narrowing setting)

Open the spectrum tab and click on the menu Clear > Start. After execution, you will see the energy peaks narrowed down in the QDC LLD and QDC ULD ranges, as shown below.

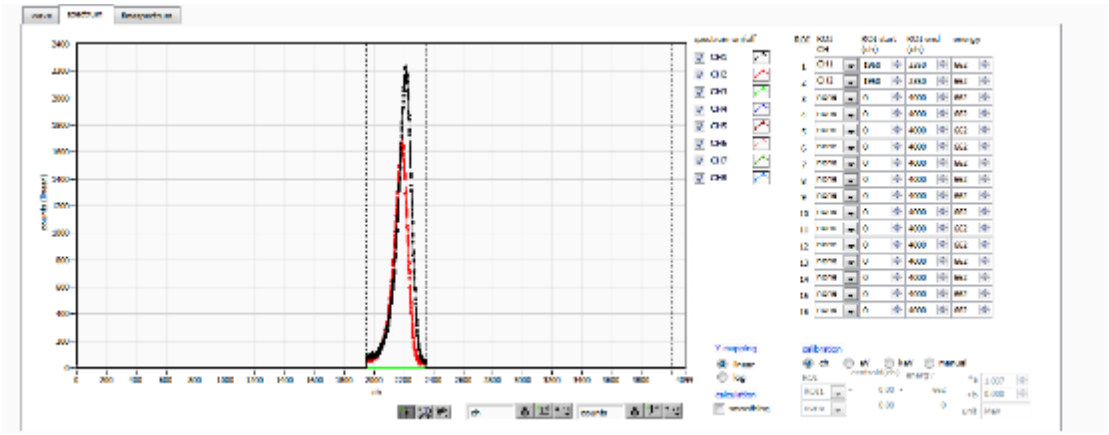


Figure 34　Energy spectrum measurement before time spectrum measurement (energy range refinement)

6. 3. 5. Setting

（1） On config tab
mode list
timespectrum ON/OFF check
（2） Click on the menu Config
Please note that measurement at high counts in this mode may cause unstable behavior due to the computational load on the PC.

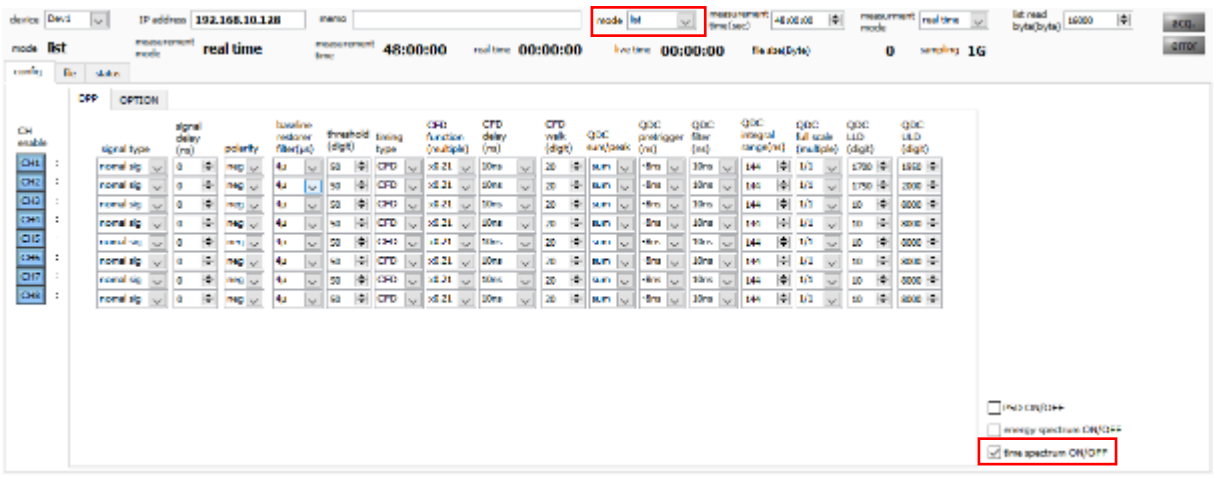


Figure 35 Time Spectrum Measurement Settings

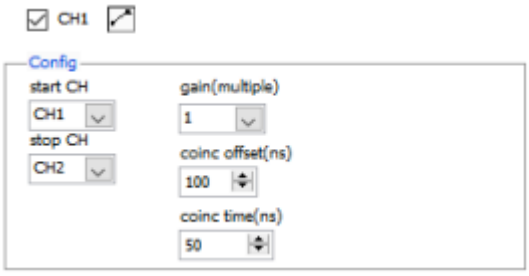


Figure 36 Time spectrum measurement settings in timespectrum tab

Open the timespectrum tab and click on the menu Clear > Start. After execution, the following spectrum will be displayed. The time resolution FWHM (ps) is calculated by setting the ROI in the lower right side of the screen.

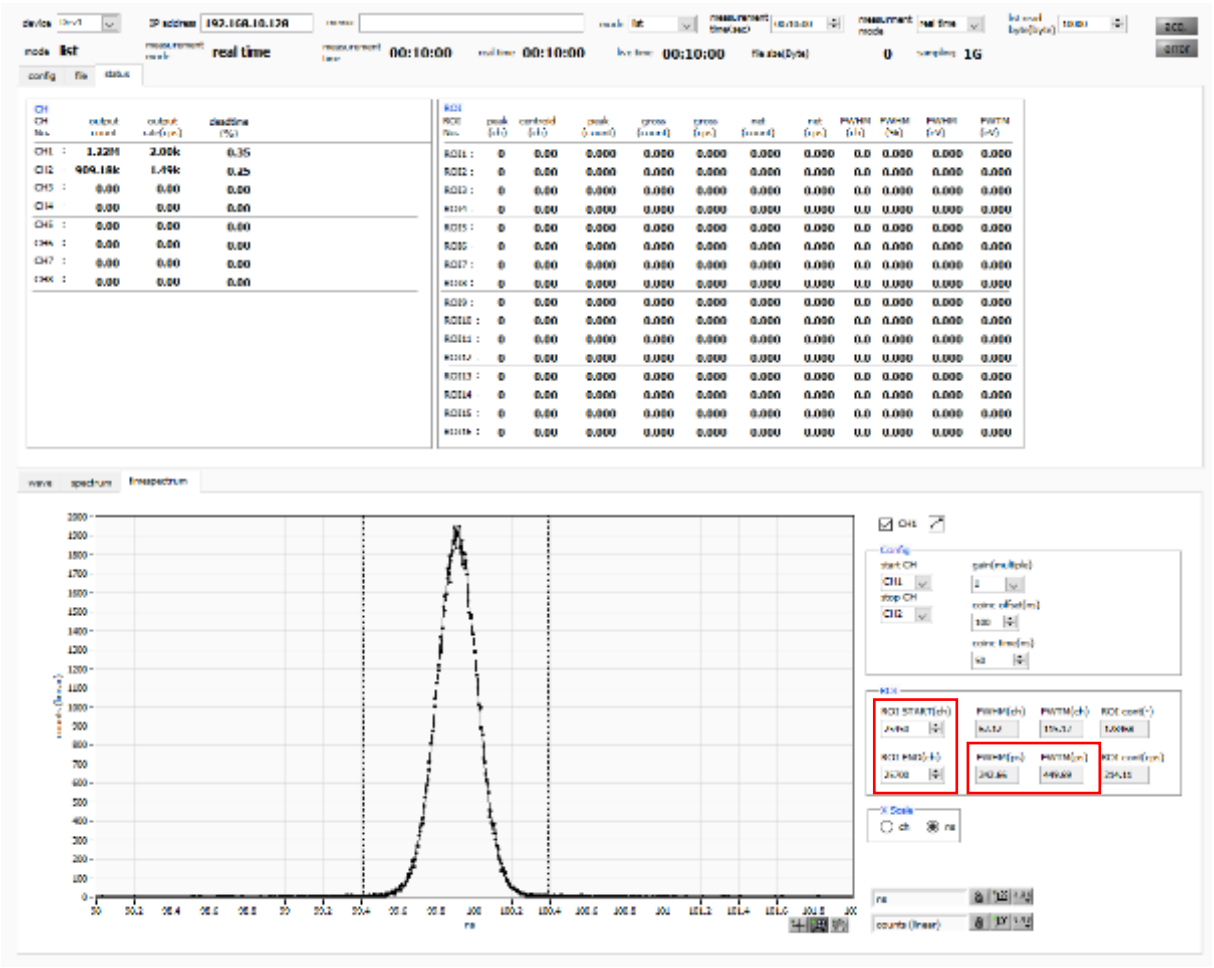


Figure 37　Time Spectrum Measurement

6. 3. 6.　End of measurement

To end the measurement, click on the menu Stop.

6. 4. PSD mode * Option

6. 4. 1. Preaparation

The same preparation is performed from 6.1.1 Environment to 6.1.4 Waveform Check in the previous chapter 6.1. Histogram Mode.

6. 4. 2. Checking input waveforms

Remember the number of points on the rising edge from the THRESHOLD setting and the number of points to the falling edge.

6. 4. 3. Checking energy spectrum

The same checks are performed as in the histogram mode in the previous section 6.1.

6. 4. 4. Setting

（1） Configure the following settings in the config tab.

mode list

PSD ON/OFF check

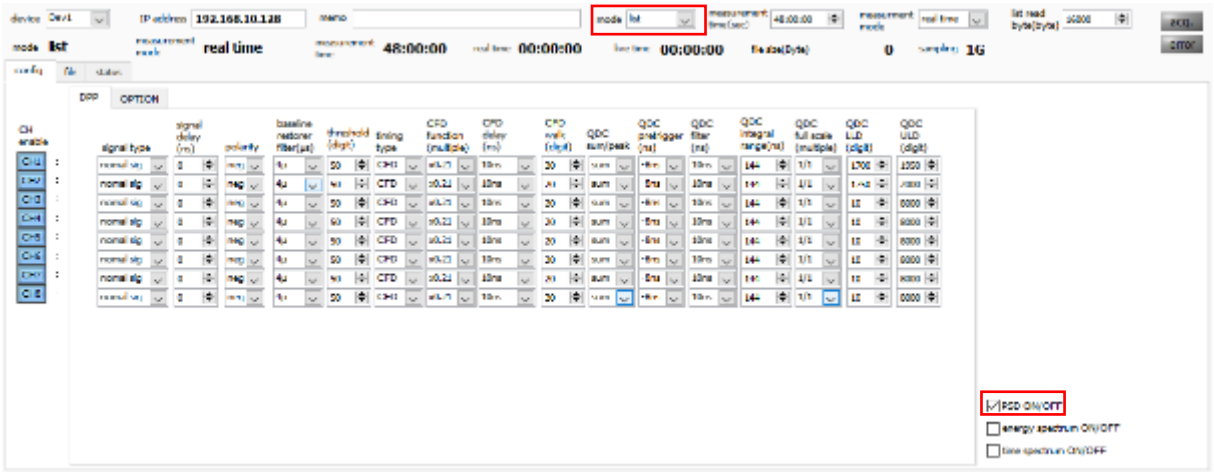


Figure 38 config tab

（2） PSD measurement is possible without saving the list data. By saving the list data, it is also possible to generate a PSD graph by loading this file.

（3） In the PSD tab, make the following settings.

PSD axis type　Select the data to be assigned to the X and Y axes. If the decimal point is also expressed in the division result, set the multiplier to the quotient. (This cannot be changed during measurement.

cursor　Sets the area of interest in the PSD graph. Can be changed during measurement.

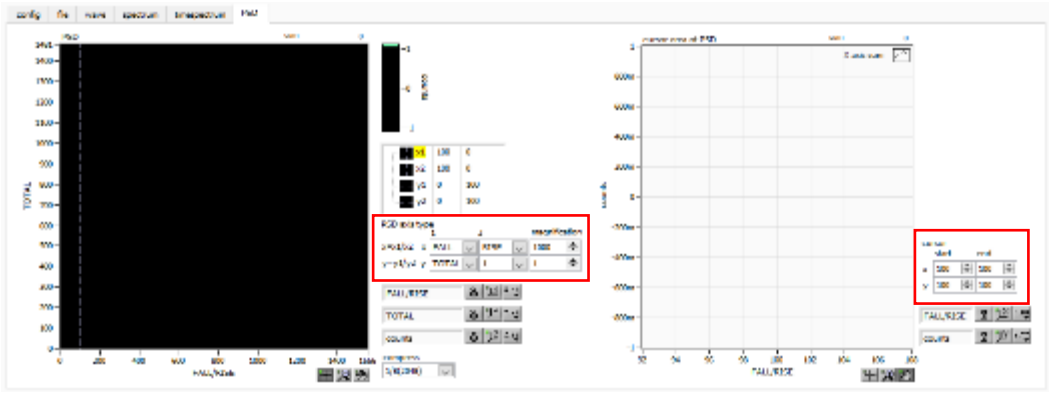


Figure 39　PSD tab

6. 4. 5.　Measurement start

Click the menu Config → Clear → Start. After execution, the PSD graph and the cursor area of PSD graph are updated. file save is checked, the following file size (byte) is increased when the event is detected, and the list data is acquired. The measured data can be saved in the menu File - save PSD.

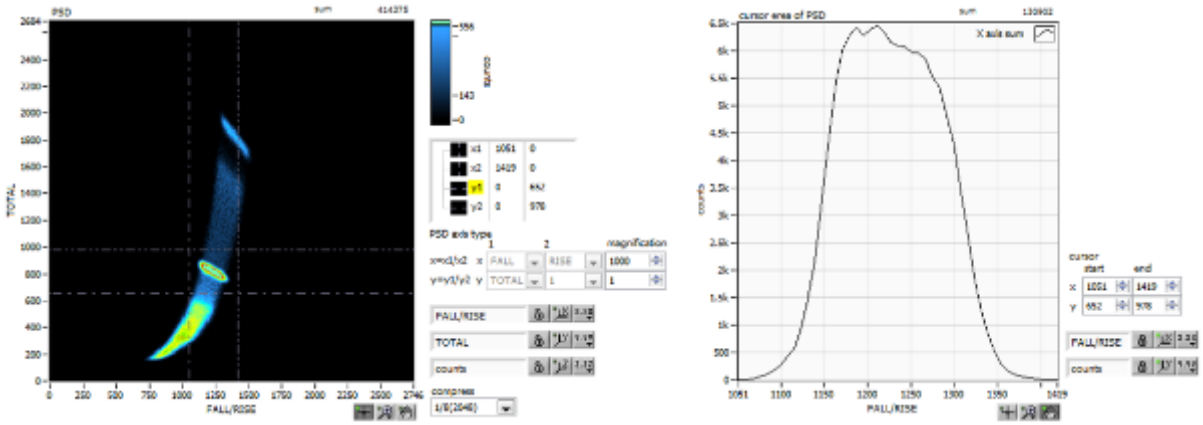


Figure 40　PSD graph and cursor area graph updated during list data measurement

6. 4. 6.　End of measurement

To end the measurement, click on the menu Stop.

7. Quit

Click on the menu File - quit. After a confirmation dialog appears, click the quit button to exit this application and the screen will disappear. (The next time the application is launched, the settings at the time of quitting will be applied.

8. File

8. 1. Histogram data file

（1） File format

CSV text format, separated by commas

（2） File name

Set arbitrarily

（3） Component

• Header part

Measurement mode	Operation Mode
Measurement time	Measurement setting time. Unit is seconds.
Real time	Real time
Start Time	Measurement start time
End Time	Measurement stop time

*Saved for each CH below

POL	polarity
TGE	Waveform display trigger CH
TGC	Waveform acquisition polarity
RJT	Waveform acquisition threshold
CCF	CFD function
CDL	CFD delay
CWK	CFD walk
CTH	CFD threshold
FLK	Baseline time constant
PTS	QDC pretigger
LIG	QDC filter time constant
LIT	QDC sum or peak
AFS	QDC integral reduction
CLD	QDC LLD
CUD	QDC ULD
TTY	Timing type

*Save to single below

MOD	Moe
MTM	Measurement time
MEMO	memo

• Calculation part

*Saved for each ROI below

ROI_ch	Input channel number that was the subject of the ROI
ROI_start	ROI start position (ch)
ROI_end	ROI end position (ch)

Energy(keV)	Energy of ROI setting (keV)
peak(ch)	Peak position between ROIs (ch)
centroid(ch)	Center position between ROIs (ch)
peak(count)	Peak ch count between ROIs
gross(count)	Sum of counts between ROIs
gross(cps)	cps of counts between ROIs
net(count)	Sum of counts minus background between ROIs
net(cps)	cps of total counts minus background between ROIs
FWHM(ch)	Half-width between ROIs (ch)
FWHM(%)	Resolution between ROIs (%)
FWHM	Half-width between ROIs
FWTM	Full width between ROIs

• Status part

*Saved for each CH below

outtput count	Output count
outtput rate	Output count rate
dead time	Dead-time ratio

• Data part

Histogram data per channel. Maximum 8192 points.

8. 2. Waveforme data file

（1） File format

CSV text format, separated by commas

（2） File name

Set arbitrarily

（3） Component

• Header part

Measurement mode	Operation Mode
Measurement time	Measurement setting time. Unit is seconds.
Real time	Real time
Start Time	Measurement start time
End Time	Measurement stop time

*Saved for each CH below

POL	polarity
TGE	Waveform display trigger CH
TGC	Waveform acquisition polarity
RJT	Waveform acquisition threshold
CCF	CFD function
CDL	CFD delay
CWK	CFD walk
CTH	CFD threshold
FLK	Baseline time constant
PTS	QDC pretigger
LIG	QDC filter time constant
LIT	QDC sum or peak
AFS	QDC integral reduction
CLD	QDC LLD
CUD	QDC ULD
TTY	Timing type

*Save to single below

MOD	Moe
MTM	Measurement time
MEMO	memo

• Status part

*Saved for each CH below

outtput count	Output count
outtput rate	Output count rate
dead time	Dead-time ratio

• Data part

Waveform data of the device being displayed

8. 3. List data file

（1） File format

Binary, network byte order (big-endian, MSB First) format

（2） File name

The file number is the file path set in the "list file path" in the "config" tab, with 0's and 6 digits appended to it. For example, if list file path is set to D:¥data¥123456.bin and file number is set to 1, the file size is D:¥data¥123456_000001.bin.

When list file size is reached, the file being saved is closed. After that, it automatically moves up the list file number by one, opens a new file, and continues to save the data in the file.

（3） Component

80 bits per event (10 Byte, 5 WORD)

Bit79	78	64
WAV[0]	real time[53..39]	
63		48
real time[38..23]		
47		32
real time[22..7]		
31 25	24 17	16
real time[6..0]	real time fixed fraction [7..0]	CH[3]
15 13	12	0
CH[2..0]	QDC[12..0]	

Figure 41 list data format

- Bit79 Presence of waveform. 0: without waveform. 1: with waveform.
- Bit78 to Bit25 real time. 54Bit. 1ns per 1Bit
- Bit24 to Bit17 real time fixed fraction. 8Bit. 3.90625ps per 1Bit
- Bit16 to Bit13 CH. Number of channel. 4Bit. CH1 is 0, CH16 is 15.
- Bit12 to Bit0 QDC, integral value. unsigned 13bit integer.
  The collected waveforms are filtered, and the waveforms are integrated over a set range from the point where the threshold is exceeded.

8. 4. PSA list data file * Option

（1） File format

Binary, network byte order (big-endian, MSB First) format

（2） File name

The file number is the file path set in the "list file path" in the "config" tab, with 0's and 6 digits appended to it. For example, if list file path is set to D:¥data¥123456.bin and file number is set to 1, the file size is D:¥data¥123456_000001.bin.

When list file size is reached, the file being saved is closed. After that, it automatically moves up the list file number by one, opens a new file, and continues to save the data in the file.

（3） Component

128 bits per event (16 bytes, 8 WORD) + waveform data

If it is pile-up data, Bit79 is set to "1" and 128-bit list data + waveform data is added and output.

If it is not pile-up data, Bit79 is set to "0" and only 128-bit list data is output.

<table>
<tr><td colspan="4">Bit127 112
RISE[15..0]</td></tr>
<tr><td colspan="4">Bit111 96
FALL[15..0]</td></tr>
<tr><td colspan="4">Bit95 80
TOTAL[15..0]</td></tr>
<tr><td>Bit79
WAV[0]</td><td colspan="3">78 64
TDC[53..39]</td></tr>
<tr><td colspan="4">63 48
TDC[38..23]</td></tr>
<tr><td colspan="4">47 32
TDC[22..7]</td></tr>
<tr><td colspan="2">31 25
TDC[6..0]</td><td>24 17
TDC fixed fraction[7..0]</td><td>16
CH[3]</td></tr>
<tr><td>15 13
CH[2..0]</td><td colspan="3">12 0
QDC[12..0]</td></tr>
</table>

Figure 42 list data format

- Bit127 to Bit112 RISE (Rise-Integral Partial Integration of Waveforms) value. Unsigned 16-bit integer.
- Bit111 to Bit96 FALL (waveform falling partial integral) value. Unsigned 16-bit integer.
- Bit95 to Bit80 TOTAL (total integral of waveform) value. Unsigned 16-bit integer.
- Bit79 WAVE data presence/absence. If yes, 1.
- Bit78 to Bit25 TDC. 54Bit. 1ns per Bit.
- Bit24 to Bit17 TDC FP. 8Bit. 3.90625ps per Bit.
- Bit16 to Bit13 CH. channel number. 4Bit. 0 for CH1, 15 for CH16.
- Bit12 to Bit0 QDC (integral value). Unsigned 13-bit integer. The summed value of the waveforms between the set ranges from where the collected waveforms are filtered and the threshold is exceeded.

8. 5. PSD data file * Option

（1） File format

CSC text format, separated by commas

（2） File name

Set arbitrarily

（3） Component

The data in the PSD 2D histogram and the cursor area spectrum are variable-length data with a count of 1 or more.

[PSD]

XAxisCursorRange　X axis range start and end channels at cursor

YAxisCursorRange　Y-axis range start and end channels at cursor

Compress (x/16384)　Number of channels of compression ratio

[PSD 2D histogram]

#FALL,TOTAL,Counts　X-axis: data in the selected List, Y-axis: data in the selected List, total count

6952,9192,1

:

Variable length. Maximum 8192 x 8192 = 67108864

[cursor area spectrum]

FALL,Counts: Data in selected List on X-axis, Integral count

6644,0

:

Variable length. Maximum 8192

8. 6. List-wave data file * Option

（1） File format

Binary, network byte order (big-endian, MSB First) format

（2） File name

Set arbitrarily

（3） Component

① Normal (In case of 80 bit of list data part)

Bit79	78	64
WAV[0]	real time[53..39]	
63		48
real time[38..23]		
47		32
real time[22..7]		
31 25	24 17	16
real time[6..0]	real time, fixed fraction [7..0]	CH[3]
15 13	12	0
CH[2..0]	QDC[12..0]	
wave number[15..0]		
header[31..16]		
header[15..0]		
wave data[15..0] × wave number 分		

Figure 43 list-wave data format (normal)

- Bit79 WAVE data presence/absence. If yes, 1.
- Bit78 to Bit25 real time. 54Bit. 1ns per 1Bit
- Bit24 to Bit17 real time, fixed fraction. 8Bit. 3.90625ps per 1Bit
- Bit16 to Bit13 CH. Number of channel. 4Bit. CH1 is 0, CH16 is 15
- Bit12 to Bit0 QDC, integral value. Unsigned 13-bit integer. The collected waveforms are filtered, and the waveforms are integrated over a set range from the point where the threshold is exceeded.
- Waveform data wave number. 16Bit. Waveform points
- Waveform data header. 32Bit. The following CH information is added as a header

CH1 header	0x57415630 (=WAV0)
CH2 header	0x57415631 (=WAV1)
CH3 header	0x57415632 (=WAV2)
CH4 header	0x57415633 (=WAV3)
CH5 header	0x57415634 (=WAV4)
CH6 header	0x57415635 (=WAV5)
CH7 header	0x57415636 (=WAV6)
CH8 header	0x57415637 (=WAV7)
CH9 header	0x57415638 (=WAV8)
CH10 header	0x57415639 (=WAV9)
CH11 header	0x57415641 (=WAVA)

CH12 header	0x57415642 (=WAVB)
CH13 header	0x57415643 (=WAVC)
CH14 header	0x57415644 (=WAVD)
CH15 header	0x57415645 (=WAVE)
CH16 header	0x57415646 (=WAVF)

- Waveform data — wave data. 16 bits per waveform, with an offset of 16384 digits. waveform information for wave number is added.

② List with PSA (in case of list data part 128Bit)

Bit127	RISE[15..0]	112
Bit111	FALL[15..0]	96
Bit95	TOTAL[15..0]	80
Bit79 WAV[0]	78 real time[53..39]	64
63	real time[38..23]	48
47	real time[22..7]	32
31 real time[6..0]	25 24 real time, fixed fraction[7..0]	17 16 CH[3]
15 13 CH[2..0]	12 QDC[12..0]	0
wave number[15..0]		
header[31..16]		
header[15..0]		
wave data[15..0] × wave number 分		

Figure 44 list-wave data format (List with PSA)

- Bit127 to Bit112 RISE (Rise-Integral Partial Integration of Waveforms) value. Unsigned 16-bit integer.
- Bit111 to Bit96 FALL (waveform falling partial integral) value. Unsigned 16-bit integer.
- Bit95 to Bit80 TOTAL (total integral of waveform) value. Unsigned 16-bit integer.
- Bit79 WAVE data presence/absence. If yes, 1.
- Bit78 to Bit25 Real time. 54Bit. 1ns per Bit.
- Bit24 to Bit17 Real time fixed decimal. 8Bit. 3.90625ps per bit.
- Bit16 to Bit13 CH. channel number. 4Bit. 0 for CH1, 15 for CH16.
- Bit12 to Bit0 QDC (integral value). Unsigned 13-bit integer. The summed value of the waveforms between the set ranges from where the collected waveforms are filtered, and the threshold is exceeded.
- Waveform data wave number. 16Bit. number of waveform points
- Waveform data The following CH information is added as a header

  CH1 header 0x57415630 (=WAV0)
  CH2 header 0x57415631 (=WAV1)
  CH3 header 0x57415632 (=WAV2)
  CH4 header 0x57415633 (=WAV3)
  CH5 header 0x57415634 (=WAV4)
  CH6 header 0x57415635 (=WAV5)

CH7 header	0x57415636 (=WAV6)
CH8 header	0x57415637 (=WAV7)
CH9 header	0x57415638 (=WAV8)
CH10 header	0x57415639 (=WAV9)
CH11 header	0x57415641 (=WAVA)
CH12 header	0x57415642 (=WAVB)
CH13 header	0x57415643 (=WAVC)
CH14 header	0x57415644 (=WAVD)
CH15 header	0x57415645 (=WAVE)
CH16 header	0x57415646 (=WAVF)

- Waveform data — wave data. 16bit per waveform. 16384digit offset. Waveform information for wave number is added.

8. 7. List pileup waveform data file * Option

（1） File format

Binary, network byte order (big-endian, MSB First) format

（2） File name

The file number is the file path set in the "list file path" in the "config" tab, with 0's and 6 digits appended to it. For example, if list file path is set to D:¥data¥123456.bin and file number is set to 1, the file size is D:¥data¥123456_000001.bin.

When list file size is reached, the file being saved is closed. After that, it automatically moves up the list file number by one, opens a new file, and continues to save the data in the file.

（3） Component

9. Troubleshooting

9. 1. Connection error occurs

If you get a connection error at startup or in menu config, your network may not be connected properly. In this case, check the following.

（1） Confirm that the IP in the configuration file config.ini is set to 192.168.10.128, that each port number in the [System] section is defined as follows, and that the IP address is the same when you start this application

[System]

PCConfigPort = 55000

PCStatusPort = 55001

PCDataPort = 55002

DevConfigPort = 4660

DevStatusPort = 5001

DevDataPort = 24

SubnetMask = "255.255.255.0"

Gateway = "192.168.10.1"

（2） Check if the PC's network information is configured to connect to this device. The default values for this device are as follows.

IP address	192.168.10.128
Sub-net mask	255.255.255.0
Default gateway	192.168.10.1

（3） There is a conflict with an arbitrary port number on the PC side for the UDP connection. In this case, define another number for Port in the configuration file config.ini before startup.

（4） Turn on the power with the Ethernet cable connected.

（5） Execute the ping command at the command prompt to check if the device and PC can communicate.

（6） Turn the power of the device back on and execute the ping command again.

（7） Turn off virus detection software and firewall software.

（8） Always turn on power-saving functions such as PC sleep mode.

（9） Disable the wireless LAN function for laptops, etc.

9. 2. Command error occurs

The combination of firmware and application for this device may not match due to the presence or absence of options, etc. Please contact us for further information.

9. 3. Histogram is not displayed

If nothing appears in the histogram tab graph after executing Menu Start, check the following points

（1） Set CH1 to ON in spectrum on/off in spectrum tab.
（2） Check if output rate (cps) is counting.
（3） The value of THRESHOLD should not be too small or too large, and while watching the count of OUTPUT RATE (cps), change the setting from 100 down to about 30, and adjust it so that OUTPUT RATE (cps) does not detect noise and become high.
（4） Right-click on the X and Y axes of the graph to auto scale.

9. 4. Change IP address

Refer to the attached "Instruction Manual: How to Change the IP Address of the APG5107-Equipped Product". (If you do not have the attached document, please contact us.

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