# Hybrid Digital Spectrum Analyzer

# APV8M44
# APV8M24

# Instruction Manual

Version 1.2.4
2022, December

TechnoAP Co., Ltd.

Add: 2976-15 Mawatari, Hitachinaka-shi, Ibaraki, Postcode: 312-0012
TEL: +81-29-350-8011
FAX: +81-29-352-9013
URL: http://www.techno-ap.com
e-mail: info@techno-ap.com

# 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.<br>1. Failure or damage due to misuse or improper repair or modification or disassembly.<br>2. Failure and damage due to falling etc.<br>3. Breakdown / damage in harsh environments (high temperature / high humidity, under zero, condensation etc.).<br>4. Causes other than the above, other than "our products".<br>5. Consumables. |

# - Contents -

# 1. Overview

TechnoAP's Digital Spectrum Analyzer APV8M44 and APV8M24 are hybrid digital signal processors with real-time DPP (Digital Pulse Processing) function and DSP (Digital Signal Processor) function with high-speed and high-resolution ADC.

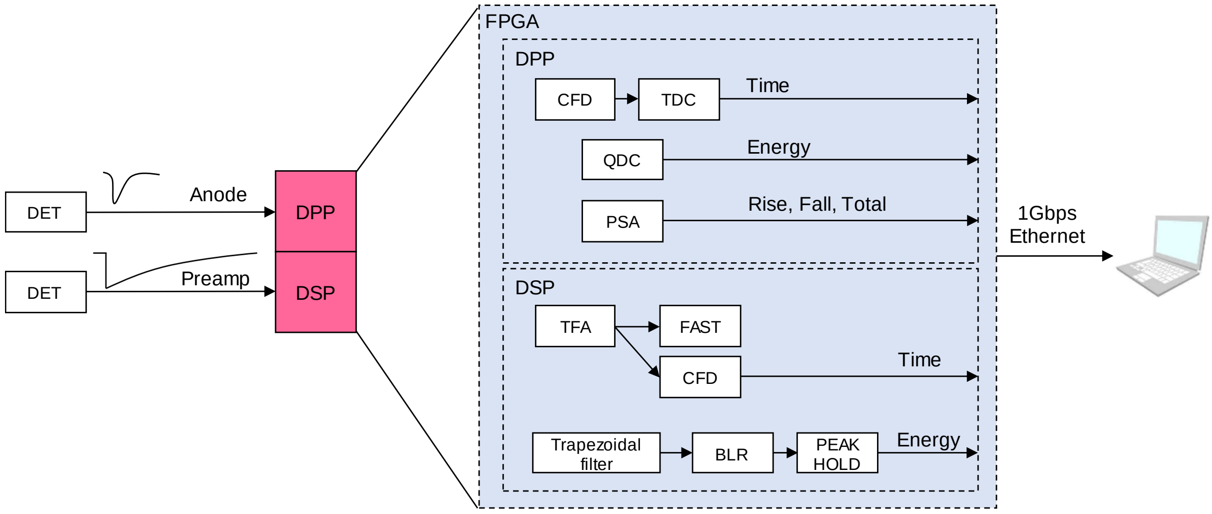



Figure 1 Block diagram

The APV8M44 is equipped with DPP from CH1 to CH4, and in addition to real-time signal analysis using a 500MHz high-speed A/D converter, it performs high-speed processing with no dead time by pipeline signal processing to achieve high time resolution and high throughput.

The APV8M24 is equipped with DPP in CH1 and CH2, and in addition to real-time signal analysis using a 1GHz high-speed A/D converter, it performs high-speed processing without dead time by pipeline signal processing to achieve high time resolution and high throughput.

The APV8M44 and APV8M24 are equipped with a DSP from CH5 to CH8, which uses a 62.5 MHz, 14 Bit A/D converter, and the output signal from the detector preamplifier is processed in real-time by a trapezoidal filter (Trapezoidal Filter) processing in real-time by a pipelined FPGA architecture. The configuration integrates a spectroscopy amplifier and MCA, and performs pulse shaping using the latest digital signal processing techniques instead of traditional analog methods
In addition to trapezoidal filter, it has functions such as timing filter amplifier, CFD, waveform digitizer, etc.

The standard configuration includes coincidence and anti-coincidence terminals, allowing a high degree of freedom in settings such as coincidence time and CH combinations.

This document describes an application for measurement and control of our digital spectrum analyzer products (hereafter referred to as "the Application")

* In the text, "CH" is used for the signal input channel and "ch" for the number of bins and is case-sensitive.

* In the text, "list" and "event" have the same meaning.

* The APV in the model's name indicates 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. As an example, the model in which the VME-type APV8M44 is installed in a unit is APU8M44. (This manual also includes descriptions of the APU8M44 and APU8M24.

* Additional functions can be added to this device as options. (In this document, the function part is specified as (optional).

# 2. Specifications

## 2. 1. Specifications of DPP, from CH1 to CH4

（1） Analog Input

- Number of channel 2CH, APV8M44
  4CH, APV8M24
- Input range ±1V
- Input impedance 50Ω
- Coarse gain ×1、×3

（2） ADC

- Sampling frequency 500MHz, APV8M44
  1GHz, APV8M24
- Resolution 14bit
- SNR 68.3dBFS@605MHz

（3） Performance

- QDC output 2Mcps and more
- Time resolution 7.8125ps@500MHz, 3.90625ps@1GHz

（4） MCA

- ADC gain 4096、2048、1024、512、256 channel

## 2. 2. Specifications of DSP, from CH5 toCH8

（1） Analog Input

- Number of channel 4CH
- Input range ±2V
- Input impedance 1kΩ
- Coarse gain ×1、×4、×10、×20
- Frequency band DC to 25MHz

（2） ADC

- Sampling frequency 62.5MHz
- Resolution 16bit
- SNR 85dB@3MHz

（3） Performance

- Resolution 1.70keV@1.33MeV, typical value
- Spectrum broadening 12 % or less, 1Kcps to 100Kcps
- Integral non-linearity ±0.025%, typical value
- Pulse pare resolution 1.25 × (Risetime + Flat top time)

（4） MCA

- ADC gain 16384、8192、4096、2048、1024、512、256 channel

（5） Digital pulse shaping

- Trigger timing　LET（Leading Edge Timing）、
  CFD（Constant Fraction Discriminator Timing）
- Time resolution　62.5ps

## ２．３． Common specifications

（1） Communication interface

- LAN　Ethernet　TCP/IP　1000Base-T and UDP

（2） Form

- VME type　APV8M44、APV8M24
- Desktop type　APU8M44、APU8M44

（3） Current consumption

* Case of APV8M44

+5V　4.0A Max.

+12V　1.0A Max

-12V　0.5A Max.

（4） External dimensions

- VME type　20 (W) x 262 (H) x 187 (D) mm
- Desktop type　300 (W) × 56 (H) x 335 (D) mm

（5） Weight

- VME type　About 460 g
- Desktop type　About 3360 g

（6） Computer environment

- OS　Version Windows 7 and more、32bit or 64bit and more
- Network interface
- Screen resolution　FHD (1920 x 1080) recommended

# 3. Appearance

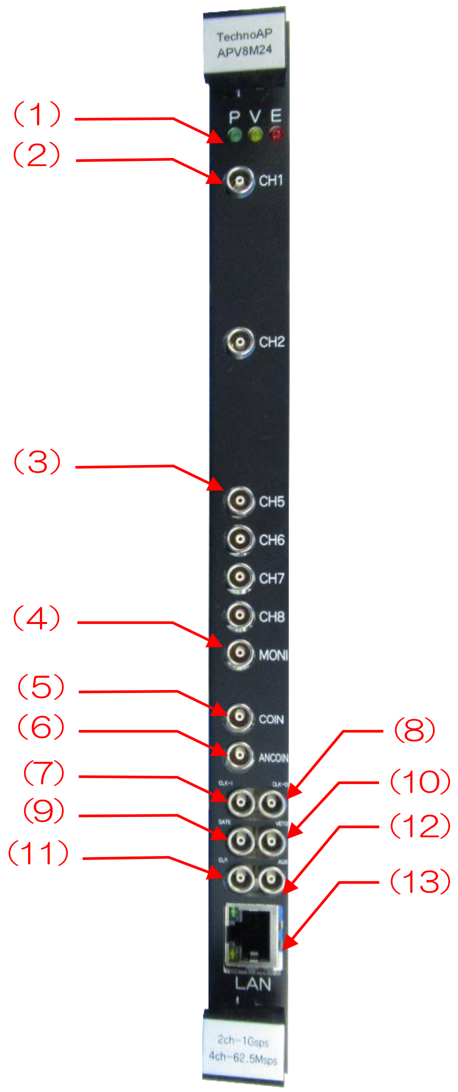



Photo 1　APV8M24

| | | |
|---|---|---|
| (1) | LED | P (green) lights up when power is turned ON, V (orange) and E (red) are not used |
| (2) | CH1～4 | LEMO 00.250 connector for anode output signal input. Input range ±1V, course gain selectable from app. x1 or x3, input impedance 50Ω. CH1 and CH2 for APV8M24. |
| (3) | CH5～8 | LEMO 00.250 connector for preamp output signal input. Input range ±2V, x1, x4, x10, x20 course gain selected from application, input impedance 1kΩ. |
| (4) | MONI | LEMO 00.250 connector for monitor output; DAC output of signals, etc. during DSP processing for CH5-8. |
| (5) | COIN | LEMO 00.250 connector for coincidence output. When a coincidence is detected on any CH, the LVTTL signal is output for an arbitrary time width. |
| (6) | ACOIN | LEMO 00.250 connector for anti-coincidence output. When an anti-coincidence is detected on any CH, the LVTTL signal is output for an arbitrary time width. |
| (7) | CLK-I | LEMO 00.250 connector for external clock signal input. An external clock can be used to synchronize with an external device.<br>When using an external clock, see "*When using an external clock" below. |
| (8) | CLK-O | LEMO 00.250 connector for external clock signal output; outputs 25 MHz LVTTL signal. |
| (9) | GATE | LEMO 00.250 connector for external GATE signal input, TTL or LVTTL signal input. Data acquisition is enabled while the input is "High". |
| (10) | VETO | LEMO 00.250 connector for external VETO signal input, TTL or LVTTL signal input. Disables data acquisition while "High". |

(１１)　CLR　LEMO 00.250 connector for external CLEAR signal input; TTL or LVTTL signal can be input to GATE or VETO to apply coincidence to the entire board. Clears the time counter data on the rising edge of "High".

(１２)　AUX　LEMO 00.250 connector for optional output; LVTTL OR logic (High if even 1 of all CHs is detected) is output.

(１３)　LAN　RJ45 connector for Ethernet cable. Ethernet TCP/IP 1000Base-T.

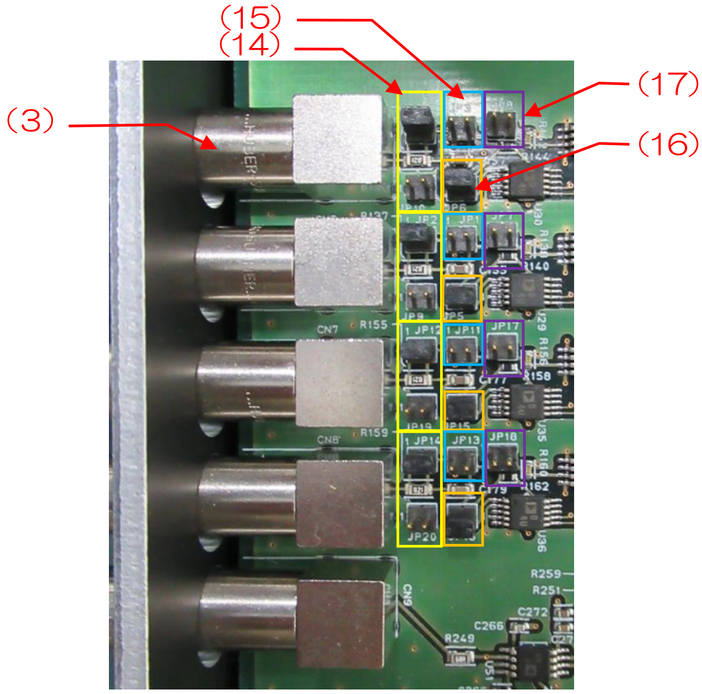



Photo 2　APV8M24, All CHs, no attenuator, analog pole zero adjustable through differential circuit.

(１４)　Jumper for attenuator　Yellow frame in the photo above. When the upper jumper is present and the lower jumper is not present, no attenuator is set (default). When the upper jumper is not present and the lower jumper is present, the attenuator is set to 1/10.

(１５)　First-stage differential circuit jumper　Light blue frame in the photo above. Without the jumper, the signal goes through the first-stage differential circuit to shorten the decay internally (default). When a jumper is attached, the signal is directly converted to analog-to-digital (AD) without passing through the differential circuit.

(１６)　Analog pole zero jumper　Orange frame in the photo above. When the jumper is present, the analog pole zero circuit is adjustable and is used for resistive feedback preamplifier output signal input, etc. (default). Without jumper, the analog pole zero circuit is not used and cannot be adjusted. Used for transistor reset preamplifier output signal input, etc.

(１７)　Evacuation jumper　Purple frame in the photo above. For evacuation when the above jumper is removed.

* When external clock is used

With the power off, change the jumper JP21 on the board to 1-6: CPU, input a 25MHz, 50% duty cycle LVTTL or TTL signal to CLK-I, and then turn the power on.

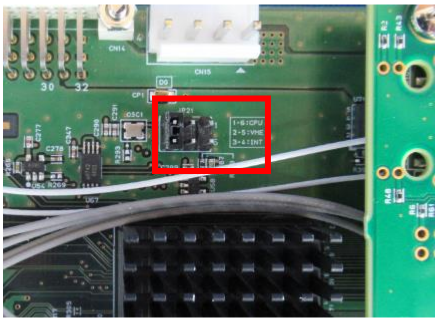


Photo 3　Position of JP21

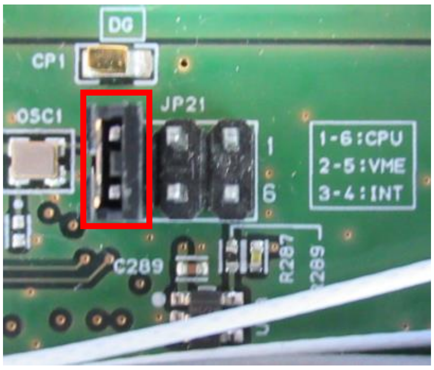



Photo 4　When using internal clock (3-4: INT jumper)

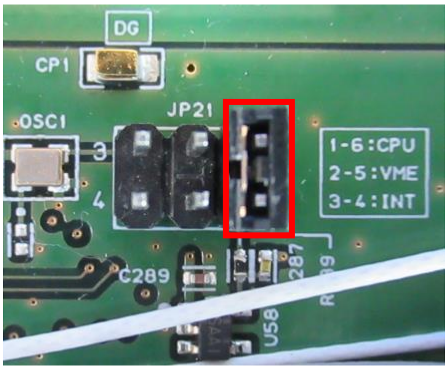



Photo 5　When using external clock (1-6: CPU jumper)

# 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 Installer folder on the supplied CD-ROM. Proceed with the installation in an interactive manner. The default installation destination is C:¥TechnoAP (3) In this folder, the executable file of this application and the configuration file config.ini, in which the setting values are saved, will be installed.
（３） Start button - TechnoAP - Run APP8M24.

To uninstall, go to Add or Remove Programs and select APP8M24 to remove it.

## ４．２． Connection

Connect this device to a PC with an Ethernet cable; use a crossover cable depending on the PC. When using a hub, use a switching hub.

## ４．３.　Set up 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 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

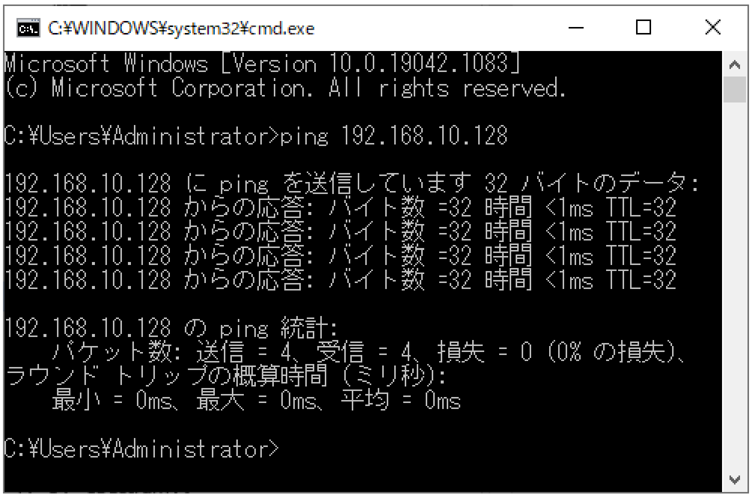



Figure 2　Confirm communication connection, execute ping command

Launch this application. Search for APP8M24 from the shortcut icon APP8M24 on the desktop or the Windows button and launch it.

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

# 5. Screen of the application

## 5. 1. Startup screen

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

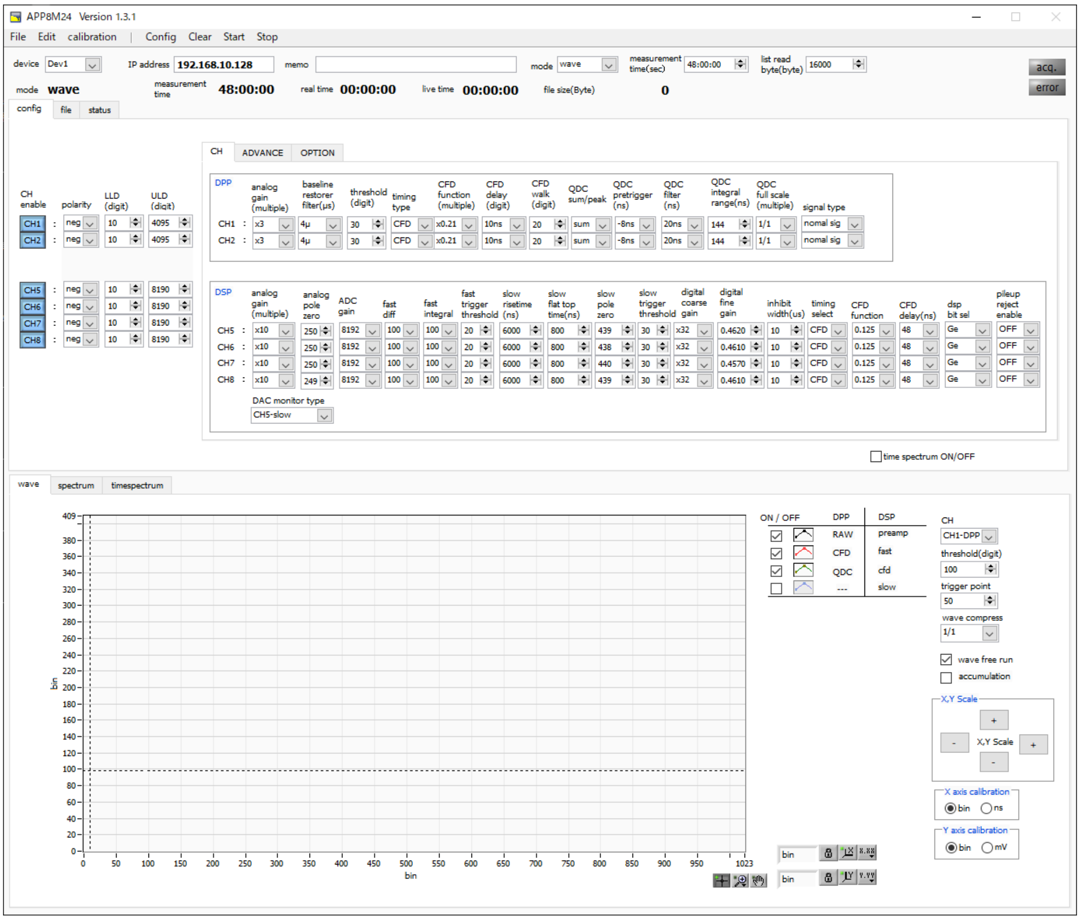



Figure 3 Startup screen (may differ from image due to options and updates)

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　Histogram mode stores the wave height values of the preamplifier output signal in up to 4096 channels for CH1 to CH4, and up to 16384 channels for CH5 to CH8, and creates a histogram.
- wave　You can check waveforms during signal processing like an oscilloscope.
- list　List mode is a mode in which the time stamp, wave height value, and CH number of the preamplifier output signal are used as one event data, and the data is continuously transferred to the PC.

measurement time　Sets the measurement time.

list read byte (byte)　Specifies the unit byte for reading list data. Note that if the value is too small, the readout will not be complete, and an error will occur when outputting high counts.

acq. LED　Flashing during measurement

error LED　Error indication

mode　Displays the currently selected mode

measurement time　Displays the set measurement time

measurement mode　Measurement mode, displaying real time or live time

- real time　Real time (actual measurement time) of the effective first CH. Equal to the measurement time at the end of measurement.
- live time　Live time (valid measurement time) of the first valid CH. real time - dead time.

file size (Byte)　Displays the capacity (in Bytes) of the file in which the list data is being saved.

Tab

| | |
|---|---|
| config | CH settings and measurement settings |
| file | File-related settings. |
| status | Displays the status of each CH. |
| wave | Display of input waveforms, trapezoidal processed waveforms, etc. |
| spectrum | Display of spectrum in hist mode. |
| timespectrum | When time spectrum on/off is checked in list mode, time spectrum is created from the list data and displayed. Note that if you try to create a time spectrum at high counts, the PC processing will not be able to keep up and an error will occur in data |

acquisition.

## 5. 2. Config tab

### 5. 2. 1. CH tab

DPP and DSP common settings

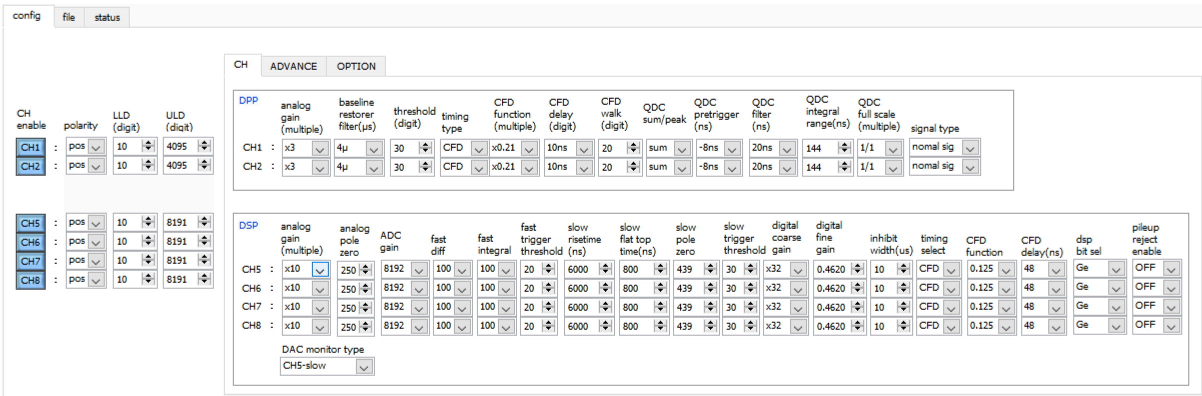
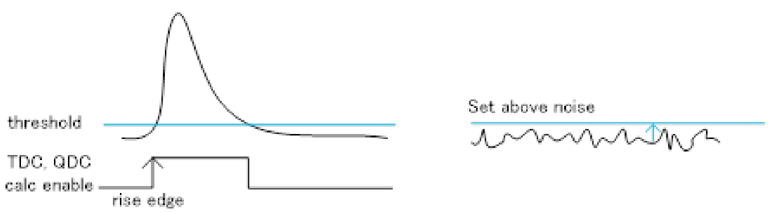



Figure 4 config tab

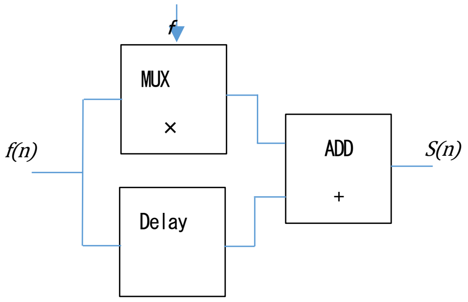
| | |
|---|---|
| ON enable | CH Availability. |
| polarity | The polarity of the input signal. pos is positive polarity, neg is negative polarity. |
| LLD (digit) | Energy LLD (Lower Level Discriminator). Unit is digits (ch). Set to a value greater than the show trigger threshold and less than the ULD. |
| ULD (digit) | Energy ULD (Upper Level Discriminator). Unit is digits (ch). Ch above this threshold is not counted; set to a value greater than LLD. |
| DAC monitor type | DAC output waveform selection. the DAC output signal can be viewed on an oscilloscope to check the internal processing status. |

| | |
|---|---|
| preamp | Differentiated signal from the preamplifier output signal. |
| fast | FAST filter signal. |
| slow | SLOW filter signal. |
| CFD | CFD signal |

| | |
|---|---|
| CH tab | Settings related to DPP's CH |
| analog coarse gain | Analog coarse gain; select from 1x or 3x. |
| baseline restorer filter | Sets the time constant for the Baseline Restorer; choose from Ext (Excluded, no AutoBLR), Fast, 4μs, 85μs, 129μs, or 260μs. 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. set it to a value greater than the noise level while viewing the raw waveform in wave mode. |



Constant fraction timing of APV8M44 and APV8M24 is realized by digital signal processing using FPGA.



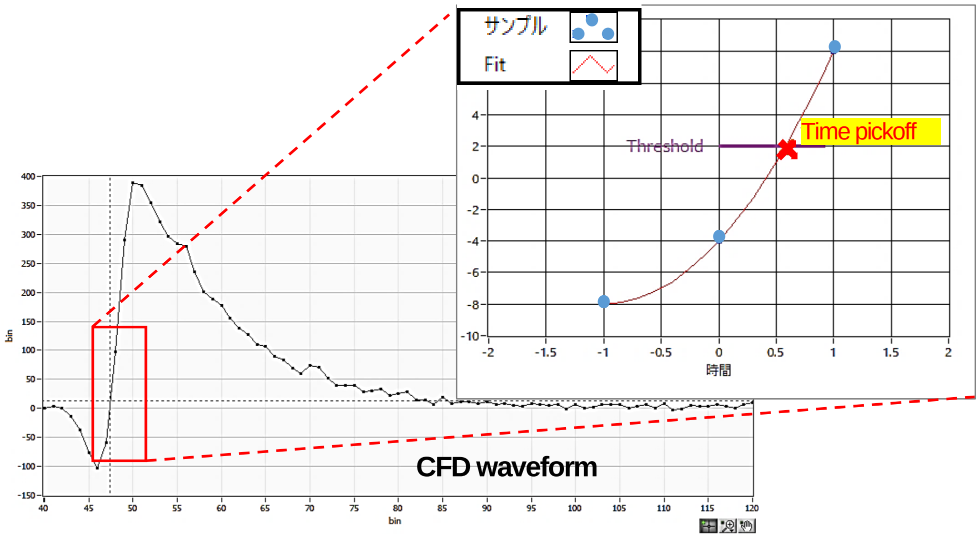

$$s(n) = fv(n) - v(n - delay)$$

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 less than 100 ns, resulting in low dead time and high throughput.



timing type

Select the waveform to be used when time stamping the event detected (time stamp) from CFD waveform or LE (raw waveform).

CFD: Constant Fraction Discriminator Timing

For the different preamp waveforms, a and b in the figure below, the following waveforms c, d and e, f and g, h are generated.

Waveforms c, d: Waveforms a and b multiplied by CFD function and inverted

Waveforms e, f: Waveforms a and b delayed by CFD delay

Waveforms g, h: Waveforms c and e plus waveforms d and f

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

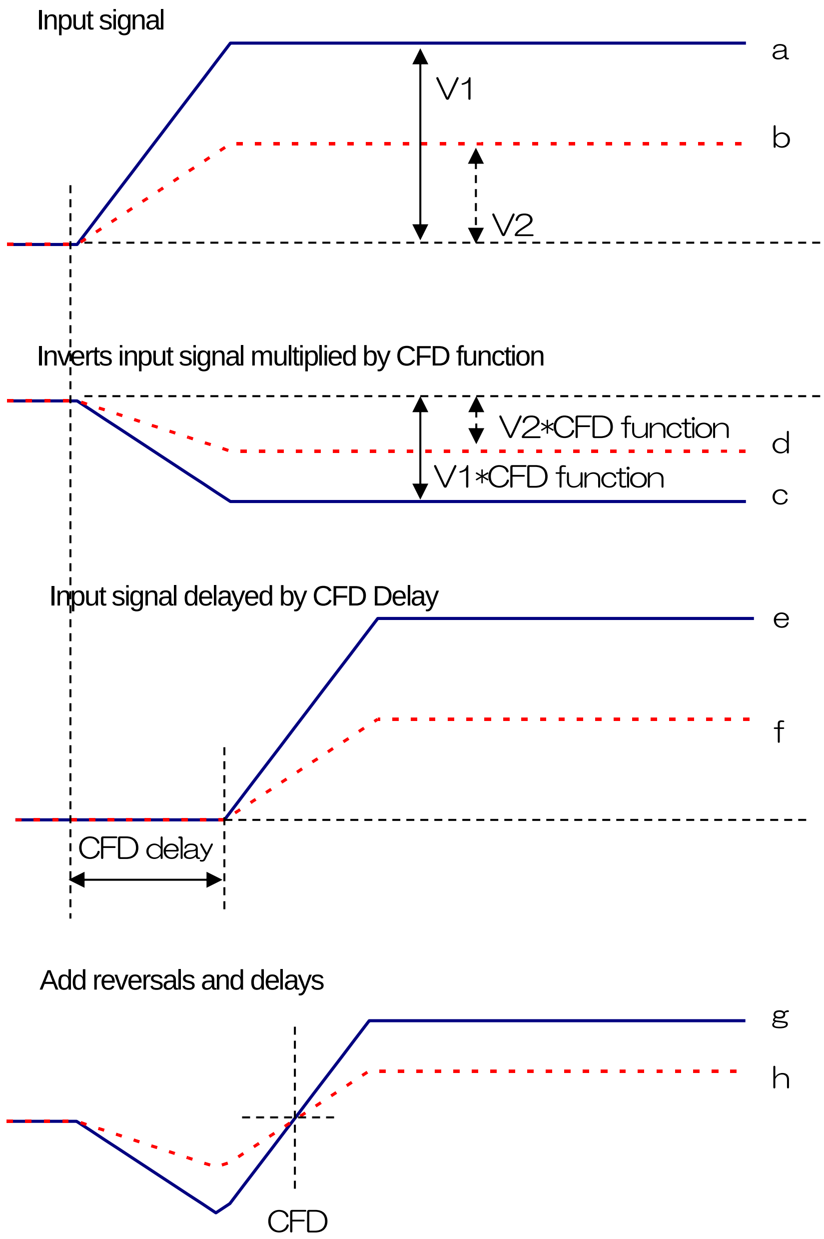


Figure 5 Thinking of Constant Fraction Disicriminator Timing

LE Leading Edge

This is the timing when a certain trigger level t is reached. (Trigger acquisition timing is different if the slope of the rise is different, as in the case of 'a' and 'b', and the time is also different.

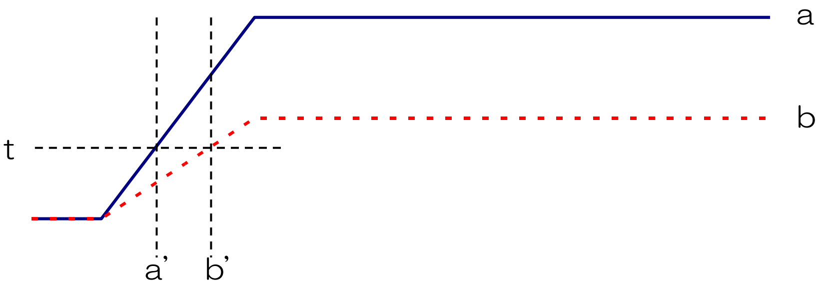
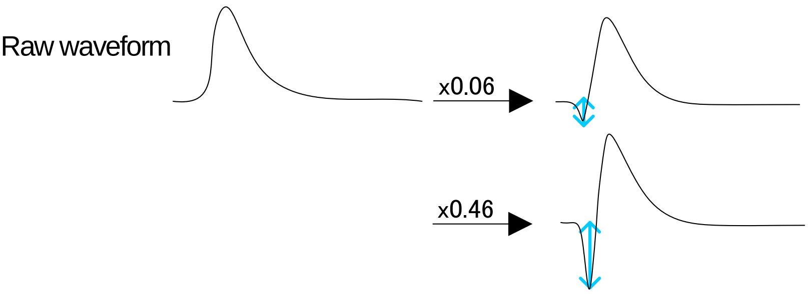
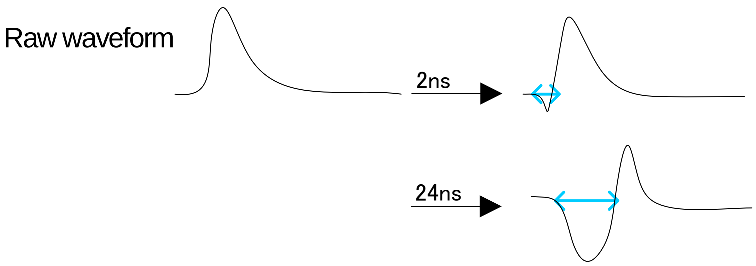



Figure 6 Thinking of Leading Edge

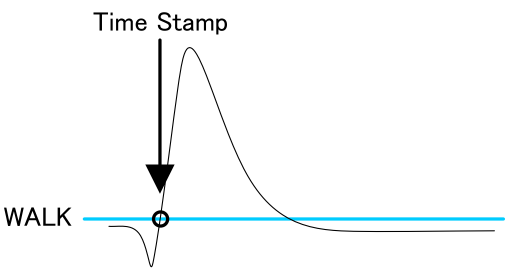
CFD function (multiple) Magnification to reduce the original waveform for CFD waveform shaping. 0.03x, 0.06x, 0.09x, and Select from 0.12x, 0.15x, 0.18x, 0.21x, 0.25x, 0.28x, 0.31x, 0.34x, 0.37x, 0.40x, 0.43x, 0.46




CFD delay Select the CFD delay time from 1ns to 24ns.



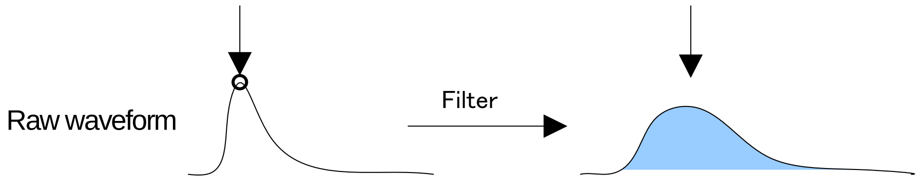

CFD walk (digit) Set the threshold value for time stamping. The unit is in digits, and the value is set near the 0 crossing position while watching the CFD waveform in wave mode.



QDC sum/peak — Select the output format of the QDC data: choose from peak or sum.

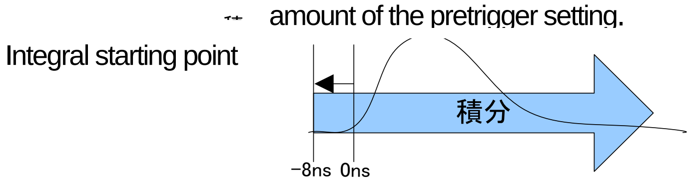
When PEAK is selected, the PEAK value for the raw waveform is output as a QDC value.

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

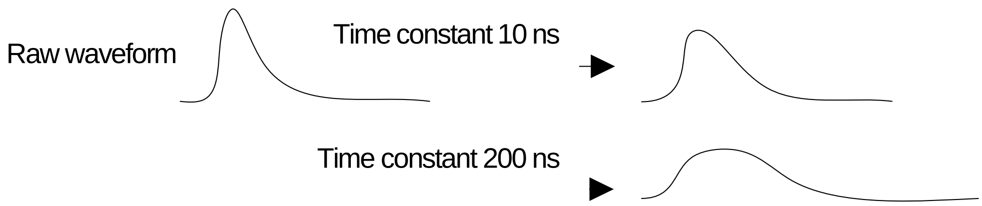



QDC pretrigger — Select the timing to start waveform shaping for integral value calculation from 0ns, -8ns, -16ns, -24ns, and -32ns.

Integration is started from the previous time by the amount of the pretrigger setting.



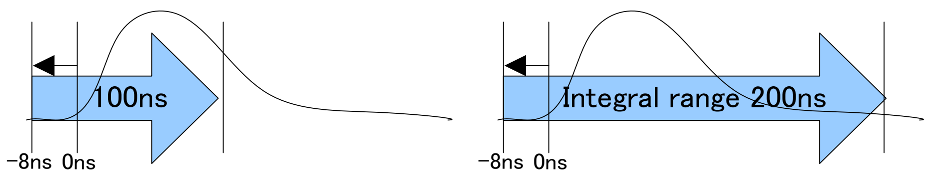

QDC filter — Sets the time constant for shaping the waveform for integral value calculation. Select the setting from ext (excluded, no filter used), 10ns, 20ns, 50ns, 100ns, and 200ns.



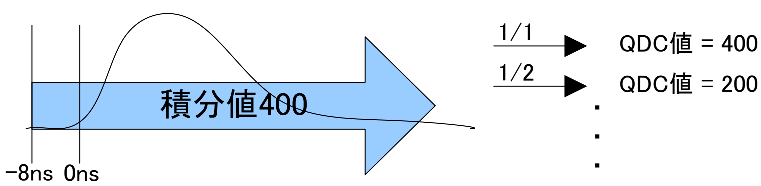

QDC integral range (ns) — Set the QDC integration time from 48ns to 32000ns in 8ns increments.

In case of Integral range 100 ns

In case of Integral range 200 ns




QDC full scale (multiple) — 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.



signal type — Selects the input waveform type. fast sig should be set for NIM or Timing signal input. For other input signals, set to "normal" sig.

CH tab Settings related to DSP CH

analog coarse gain — Select from 1x, 2x, 5x, or 10x. Amplifies the captured preamplifier output signal internally.

analog pole zero — This setting corrects for overshoot or undershoot of the internal falling edge in the preamplifier output signal input to this device. The setting range is 0 to 255.

ADC gain — ADC gain (channels). select from 16384, 8192, 4096, 2048, 1024, 512, 256 channels (ch). the number of divisions on the horizontal axis of the spectrum graph.

fast diff — Select the constant of the differential circuit of the FAST system from ext (excluded, no filter), 20, 50, 100, 200, and 500. For detectors with fast rise time, select ext or 20; for Ge semiconductor detectors, etc., set 100 or 200.

fast integral — Select the constant of the FAST-based integrating circuit from ext (excluded, no filter used), 20, 50, 100, and 200. For detectors with fast rise time, select ext or 20; for Ge semiconductor detectors, etc., set 100 or 200.

fast trigger threshold — Threshold for the timing of the start of waveform acquisition using a FAST-type filter. The unit is DIGIT; the setting range is 0 to 8191. The FAST filter waveform is generated by differential and integral processing of the timing filter amplifier circuit based on the preamplifier output signal. When the waveform exceeds this threshold value, the timing for acquiring time information at that point and the timing for starting waveform generation in the spectroscopy amplifier circuit are acquired. It is mainly related to time acquisition (time stamp). If this threshold value is too small, noise is easily detected, and input count rate (cps) will increase.

slow risetime (ns) — Rise time of a SLOW-type filter. This is the rise time to reach the upper bottom of the SLOW-type (trapezoidal) filter in the figure below. Shorter values tend to have poorer energy resolution but more throughput, while longer values tend to have better energy resolution but less throughput. Since the peaking time of linear amplifiers is often 2.0 to 2.4 x time constant, a rise time of about twice the time constant of the linear amplifier will give similar resolution. The default setting is 6000 ns. This corresponds to a shaping time of 3 µs for a linear amplifier.

slow flat top time (ns) — Flat top time of a SLOW-type filter. This is the time at the top of the SLOW-type (trapezoidal) filter in the figure below. The length of the trapezoidal top part is used to adjust the wave height error caused by variations in the rise (fall) of the preamplifier output signal. The setting value is from 0 to 100% of the rise (fall) time of the preamplifier output signal and should be twice the slowest time. The default setting is 700 ns. In this case, the slowest rise (fall) time is assumed to be 350ns.

* The throughput of the DSP is shown in the following equation

(slow rise time + slow flattop time) × 1.25

slow pole zero — SLOW-type pole zero cancellation; the falling undershoot or overshoot of the SLOW-type filter can be reduced by setting this value appropriately. The default value is 680. Since this value varies depending on the detector, connect the MONI terminal on the front panel to the oscilloscope, select the SLOW series filter in the DAC monitor type, and adjust the SLOW series filter so that the falling edge of the SLOW series filter is flat.

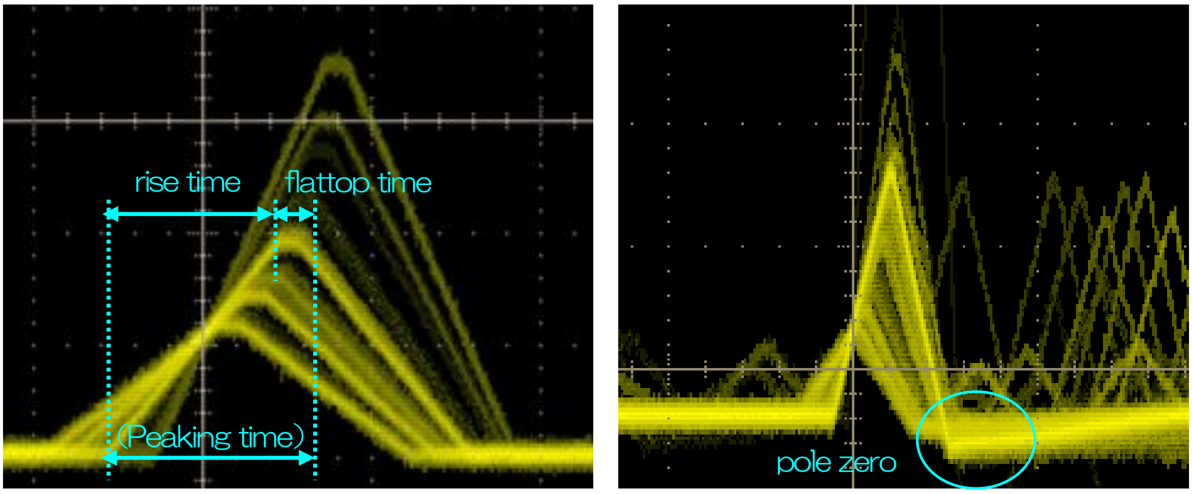



Figure 7　SLOW type (trapezoidal) filter

* The figure on the right shows an example where there is an undershoot in the SLOW filter and pole zero is not set correctly. In this case, lowering the value of slow pole zero from the current setting will lift the undershoot to the upper side.

slow trigger threshold — Threshold value for the timing of the start of waveform acquisition for the Slow system filter. Unit is digits. The setting range is from 0 to 8191. Set this value up or down by about 10 digits above the noise level where the out rate (cps) increases. Set this value below the LLD described below. When the generated SLOW filter waveform exceeds this threshold value, the wave height value at the preset time (slow rise time + slow flattop time) is secured.

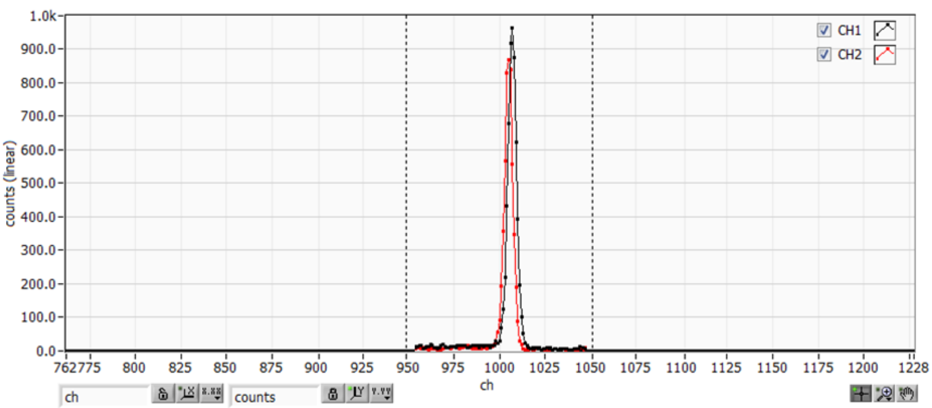



Figure8　Example of LLD and ULD configuration

* The above figure shows an example where the LLD is set to 955 and the ULD to 1045; you can see that the areas smaller than the LLD and larger than the ULD are not measured.

| | |
|---|---|
| digital coarse gain | The gain is digitally selected from 1x, 2x, 4x, 8x, 16x, 32x, 64x, and 128x. In the case of a trapezoidal filter, the integral circuit is calculated by sum-of-products operations; the larger the slow rise time, the greater the number of sum-of-products operations and the larger the value, and the smaller the value, the smaller. This value is used in conjunction with the slow rise time setting. |
| digital fine gain | This sets the digital fine gain, which ranges from 0.3333 to 1. The setting range is from 0.3333 to 1. Like digital coarse gain, it is used for correction. The resulting histogram can be used to adjust the peak position of the histogram. |
| inhibit width (μs) | Dead time width from the time of reset detection for transistor reset type preamplifier. The INHIBIT signal from the detector is processed internally without input and no counting is performed during this period. |
| timing select | Select the timing acquisition method from LET (Leading Edge Timing) or CFD (Constant Fraction Disicriminator Timing) to determine the time when the event was detected (time stamp). See above for details. |
| CFD function | Magnification for reducing the original waveform for CFD calculation; select from 0.125, 0.25, 0.375, 0.5, 0.625, 0.75, and 0.875. The default is 0.25 to 0.625 times. |
| CFD delay | Select the time to delay the original waveform for CFD calculation from 16, 32, 48, 64, 80, 96, 112, and 128ns. The default is 48 to 80 ns. |
| dsp bit sel | Select Ge or SDD according to the amplitude and other characteristics of the preamplifier output signal to be input; Ge is selected when there is a certain amount of amplitude, such as in Ge semiconductor detectors, and SDD is selected when the amplitude is very weak. |
| DAC monitor type | Selects the combination of target CH and waveform for DAC output. Of the waveforms processed inside the DSP based on the signal from the selected input CH, the selected type of waveform signal is output from the MONI pin. By viewing this signal on an oscilloscope, the processing status inside the DSP can be checked. |

| | |
|---|---|
| pre amp | Differentiated signal from the preamplifier signal. Used to confirm that the energy range to be measured is within 1V when taken internally, and to adjust pole zero. |
| fast | FAST filter signal |
| slow | SLOW filter signal. Used for pole zero adjustment after waveform shaping processing. |
| CFD | CFD signal, which allows the user to check the CFD delay and function setting status when using CFD timing. |

## 5. 2. 2. ADVANCE tab

Settings related to PSA (optional) CH of DPP

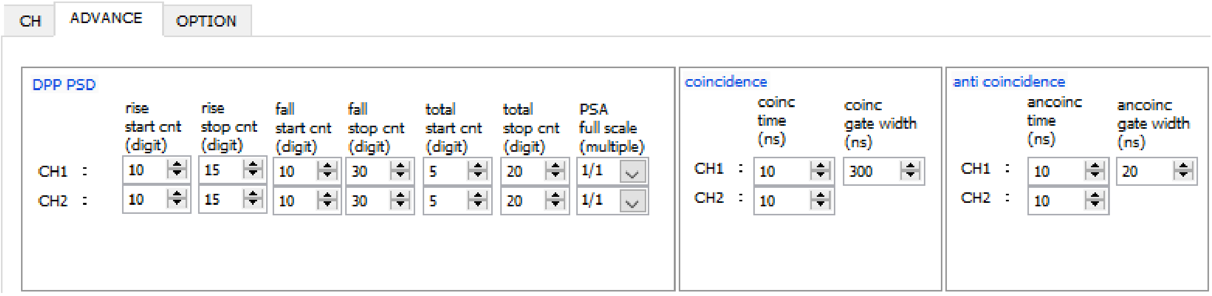



Figure 9 ADVANCE tab

Settings related to PSA (Pulse Shaping Analysis) calculation.

In the PSA operation, if the input waveform is negative polarity, it is inverted to positive polarity, and the waveform is always considered positive polarity.

rise start cnt — The start position of the target range for the integral value rise of the rising edge. The setting range is from 1 to 498 (498ns=498 x 1ns).

rise stop cnt — This is the end position of the target range of the rise integral value rise. Set the range of integration from the rise start cnt. The setting range is from 1 to 16383 (16363ns=16383 x 1ns).

Calculation example of rise value:

In the case of the setting threshold: 50, rise start cnt: 5, rise stop cnt: 8, PSA full scale: 1/1, the green line in the figure below is integrated for 8 points from 5 points before the point where the threshold is exceeded. The integral value is multiplied by PSA full scale and is the rise value of the list data.

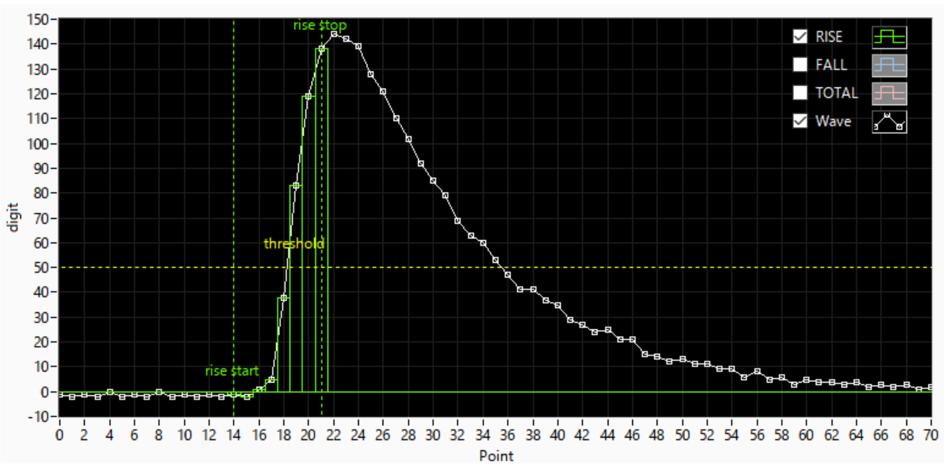



Figure 10 Example of rise start cnt and rise stop cnt settings

fall start cnt — The start position of the target range for the integral value fall of the falling edge. The setting range is from 1 to 16383 (16383ns=16383 x 1ns). Set a value smaller than the fall stop cnt described below.

fall stop cnt — This is the end position of the target range of the fall integral value fall. Set the range to be integrated from the fall start cnt. The setting range is from 1 to 16383 (16383ns=16383 x 1ns). Set a value greater than the fall start cnt.

Calculation example of fall value:

In the case of the settings threshold: 50, fall start cnt: 5, fall stop cnt: 25 , PSA full scale : 1/1, the FALL value exceeds threshold and is integrated from the 5th point to the 25th point in the blue line in the figure below. The integrated value is multiplied by PSA full scale to obtain the fall value of the list data.

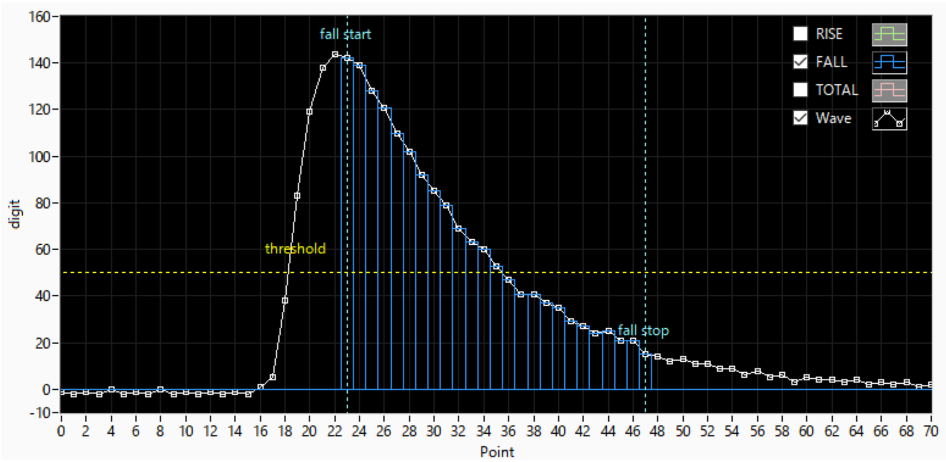



Figure 11 Example of fall start cnt and fall stop cnt settings

total start cnt — The start position of the target range of the total waveform integral value. The setting range is from 1 to 498 (498ns=498 x 1ns).

total stop cnt — This is the end position of the target range of the total waveform integral value. 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).

Calculation example of total value:

In the case of the settings threshold: 50, total start cnt: 5, total stop cnt: 50, and PSA full scale : 1/1, the integral value is multiplied by the red line in the figure below for 50 points from 5 points before the point where the threshold is exceeded. The integral value is then multiplied by PSA full scale to obtain the TOTAL value of the list data.

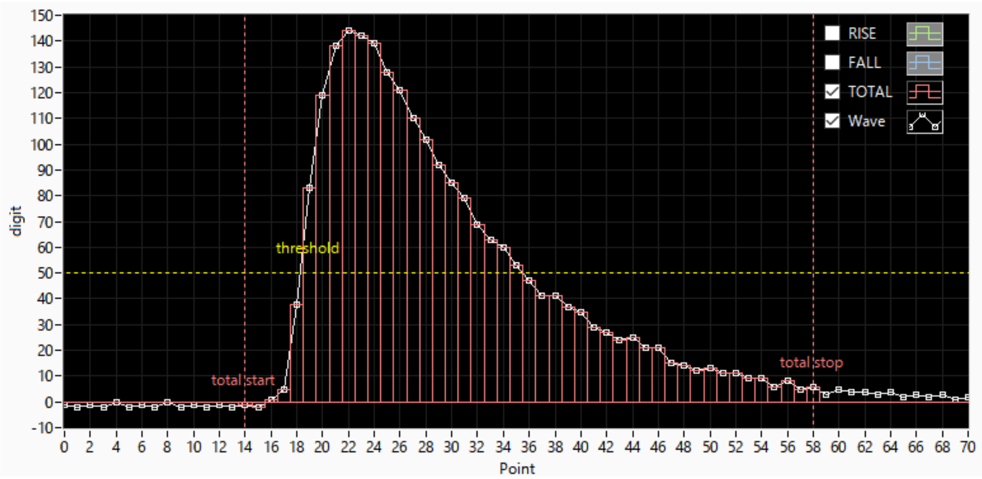



Figure 12 Example of total start cnt and total stop cnt settings

PSA full scale Sets the reduction factor for the rise, fall, and total values of the list data. If the result of each integration exceeds 65535, this reduction factor is increased to keep the result within 65535.

Coincidence part

coinc time (ns) Set the effective time for each CH to detect an input signal and wait for the other CHs to detect it as coincidence. The unit is ns, and the setting range is from 16ns to 524μs. When all CHs become valid, the signal becomes coincidence, and the LVTTL logic signal is output from the COIN pin for the period of coinc gate width (see below).

coinc gate width (ns) Set the effective time for each CH to detect an input signal and wait for the other CHs to detect it as coincidence. The unit is ns, and the setting range is from 16ns to 524μs. When all CHs become valid, the signal becomes coincidence, and the LVTTL logic signal is output from the COIN pin for the period of coinc gate width (see below).

anti-coincidence part

ancoinc time (ns) When one CH detects an input signal and the other CHs do not, it becomes anticoincidence and outputs an LVTTL logic signal from the ACOIN pin for the duration of the anticoinc gate width described below. The setting time of anticoincidence is set for each CH. The unit is ns, and the setting range is from 16ns to 524μs.

ancoinc gate width (ns) Sets the time width to hold the state after anticoincidence is detected. The unit is ns, and the setting range is from 120 ns to 524 μs. During this period, an LVTTL logic signal is output from the ACOIN pin.

time spectrum ON/OFF Enable/Disable the display of time difference spectrum. If you try to generate a time difference spectrum at high count output, the CPU load will increase and errors may occur in the list data acquisition.

PSD ON/OFF

(Option) Enable/Disable to display PSD graph if checked when acquiring data in list mode. If you try to generate a time difference spectrum at high count output, the CPU load will increase and errors may occur in the list data acquisition.

### 5. 2. 3. OPTION tab

Waveform data can be added during list mode

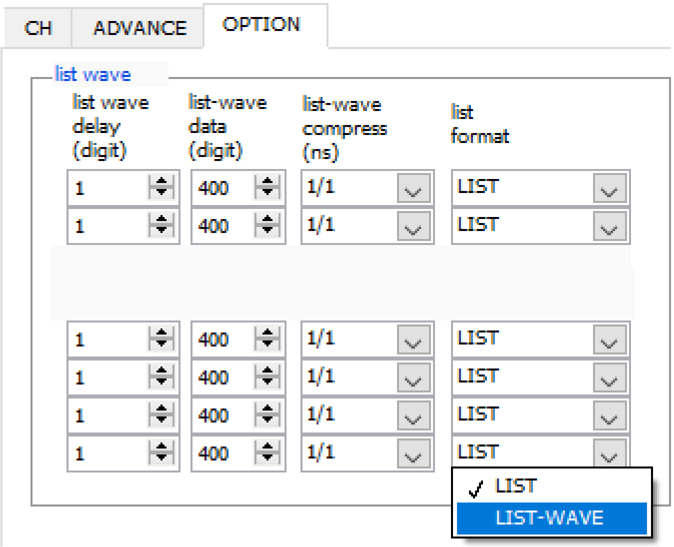



Figure 13 list-wave related settings

LIST-WAVE part

list-wave delay (digit) — Setting for list-wave mode. Adjusts the delay of the acquisition waveform. The setting range is from 0 to 30 digits. Read the acquired waveform and adjust the signal rise position.

list-wave data (digit) — Parameters for list-wave mode. Sets the number of data points for waveform output. The setting range is from 8 to 1000 points.

list-wave compress — Parameter for list-wave mode, allowing you to specify the degree of compression of the X-axis time scale. 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, or 1/256 can be selected. Used to display waveforms with long fall times.

List-format — Select the output format in list mode from 2: list data only or list data + wave data.

## 5. 3. file tab

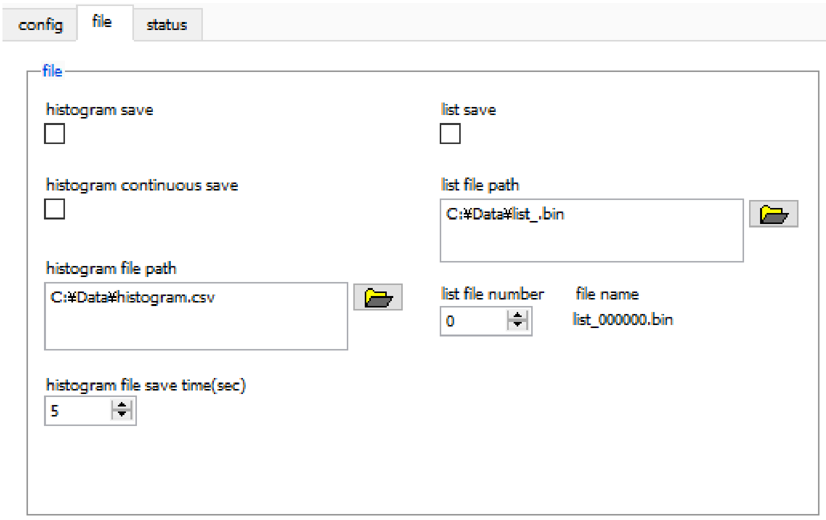



Figure 14 file tab

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

histogram continuous save — Sets whether the histogram data is continuously saved to file at set time intervals. This setting is valid only when Histogram mode is selected.

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 you set histogram file path as C:¥Data¥histogram.csv and histogram file save time(sec) as 10, and the date and time is 2010/09/01 12:00:00, it will start saving data as C:¥Data¥histogram_20100901_120000.csv. After 10 seconds, it saves the data in a file named C:¥Data¥histogram_20100901_12000010.csv
* 120010 above may become 120009 or 120011.

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.

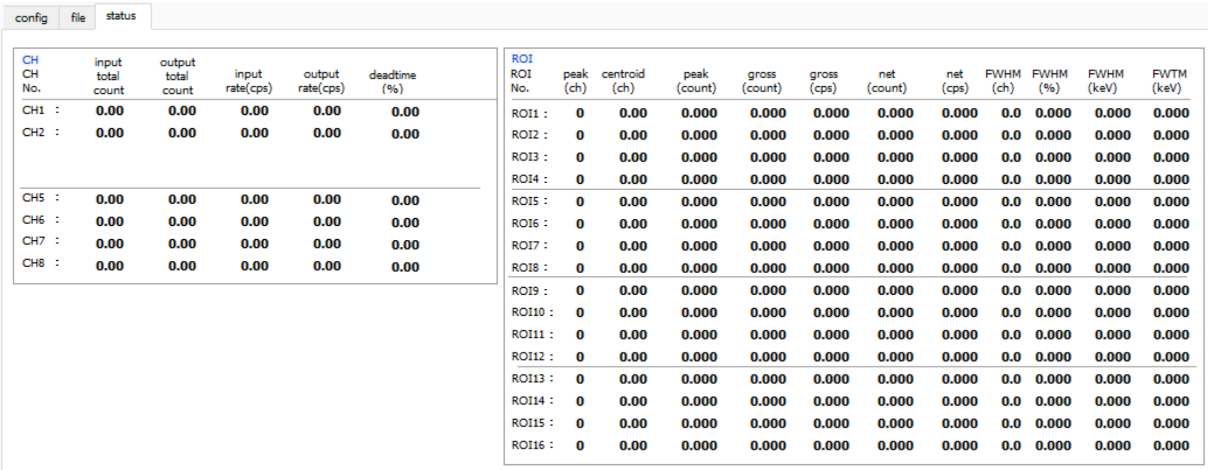
list save — Sets whether the list data is saved in a file or not. Valid only when list mode is selected.

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 | The file name is displayed when the file is actually saved based on the list file path and list file number. |

## 5. 4. status tab




| CH No. | input total count | output total count | input rate(cps) | output rate(cps) | deadtime (%) |
|---|---|---|---|---|---|
| CH1 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CH2 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CH5 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CH6 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CH7 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CH8 : | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| ROI No. | peak (ch) | centroid (ch) | peak (count) | gross (count) | gross (cps) | net (count) | net (cps) | FWHM (ch) | FWHM (%) | FWHM (keV) | FWTM (keV) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROI1 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI2 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI3 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI4 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI5 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI6 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI7 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI8 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI9 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI10 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI11 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI12 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI13 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI14 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI15 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |
| ROI16 : | 0 | 0.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.000 |

Figure 15 status tab

CH part

| | |
|---|---|
| input count | Total input count. Number of events for which input was received. |
| output count | Output total count. Number of inputs processed. |
| input rate (cps) | Input rate, the number of events with input per second. |
| output rate (cps) | Output rate, the number of inputs processed per second. |
| dead time (%) | Dead time percentage. Instantaneous value for each acquisition. |

ROI 部

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

## 5. 5. wave tab

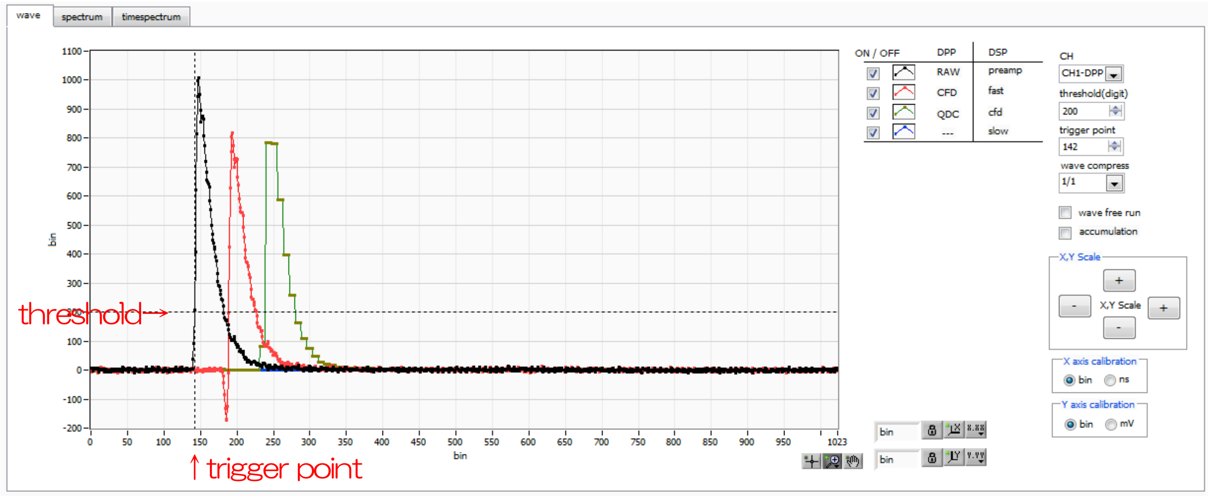



Figure 16 wave tab

| | |
|---|---|
| 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: If the CH of DPP is selected, the graph displays the input signal RAW, the CFD processed CFD, and the integral processed QDC. The graph displays the signal of the preamplifier output signal input and differentiated, the signal of fast processed by timing filter, CF processed by CFD, and slow processed by trapezoidal filter. |
| threshold | Set the trigger threshold. Get the waveform when this threshold is exceeded. Can also be set by the cursor in the graph. |
| trigger point | Sets the position on the graph X-axis where threshold is applied. Can also be set by the cursor in the graph. |
| wave compress | Sets the X-axis time scale compression ratio. Used to display waveforms with long fall time. |
| wave free run | Acquire waveforms at random time intervals. |
| accumulation | Sets whether the waveform data of the last several acquisitions are superimposed on the display. Checked: Overlay display is performed, unchecked: Only the final waveform is displayed. |
| X,Y Scale | Sets the expansion and contraction of the display range of the X and Y axes of the graph. The “+” button expands the range when pressed, and the “-“ button contracts it when pressed. |
| X axis calibration | Select the unit for the X axis of the graph from bin or ns. |
| Y axis calibration | Select the unit for the Y-axis of the graph from bin or mV. |

# 5. 6. spectrum tab

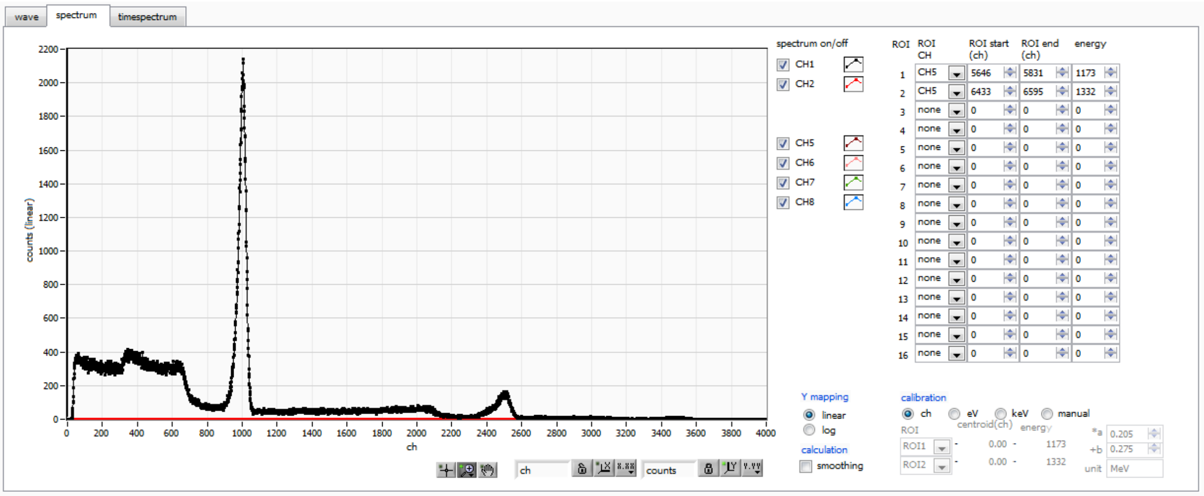



Figure 17 spectrum tab

| | |
|---|---|
| Graph | If histogram is selected in mode, an energy histogram is displayed during measurement |
| spectrum on/off | Set whether the histogram for each CH is displayed on the graph. If checked, the histogram is displayed; if unchecked, the histogram is not displayed. |
| ROI CH | Select the CH number to which the ROI (Region Of Interest) is applied. up to 8 ROIs can be set for one CH signal. when the ROI-SCA option function is available, a 50nsec wide LVTTL logic signal is output from the AUX output terminal on the front panel when a signal is detected between these ROIs. LVTTL logic signal is output from the AUX output terminal on the front panel when a signal is detected between these ROIs. When multiple ROIs are selected, the output is OR. |
| ROI start | Set the starting position of the ROI near the left hem of the peak. The unit is ch. |
| ROI end | Set the end position of the ROI near the right hem of the peak. The unit is ch. |
| energy | Define the energy value of the peak position (ch). 1173 or 1332 (keV) for 60Co. When "ch" is selected in the following calibration, 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 half value width calculation. |
| calibration | Select the unit of measure for the X axis. The X-axis label will change according to the setting. |

| | |
|---|---|
| ch | Display in units of ch (channel); units such as FWHM of ROI are optional. |
| eV | The unit of eV is displayed by calculating the slope a and the intercept b of the linear function y=ax+b so that ch becomes eV by two-point calibration of two kinds of peaks (center value) and energy values in one histogram, and setting them on the X axis. |
| keV | The slope a and intercept b of the linear function y=ax+b are calculated and set on the X-axis so that ch is keV by two-point calibration of the two types of peaks (center values) and energy values in a histogram. Example: If there are 1173.24 keV of 60Co in 5717.9ch and 1332.5 keV of 60Co in 6498.7ch, |

a is automatically calculated as 0.20397 and b as 6.958297 from 2-point calibration.

manual — Set the slope a and intercept b of the linear function y=ax+b and the unit label arbitrarily and set them on the x-axis. The units can be set arbitrarily.

Y mapping — Select a mapping for the Y axis of the graph. The Y-axis labels will change accordingly.

- linear — Straight line (linear)
- log — logarithm

smoothing — Smoothing function for calculating half-widths when statistics are low. Enabled when checked, disabled when unchecked.

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 to change it by direct input.

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 to change it by direct input.

 Cursor movement tool that allows you 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.

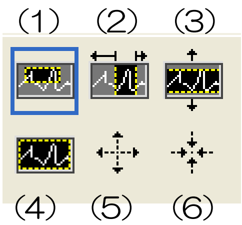



Figure 18　Graph, Zoom in and out tool

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

（2）X-zoom — Zoom into the area of the graph along the horizontal axis.

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

（4）Fit zoom — All X and Y scales are automatically scaled on the graph.

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

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

 Pan Tool. You can grab the plot and move it around on the graph.

## 5. 7. timespectrum tab

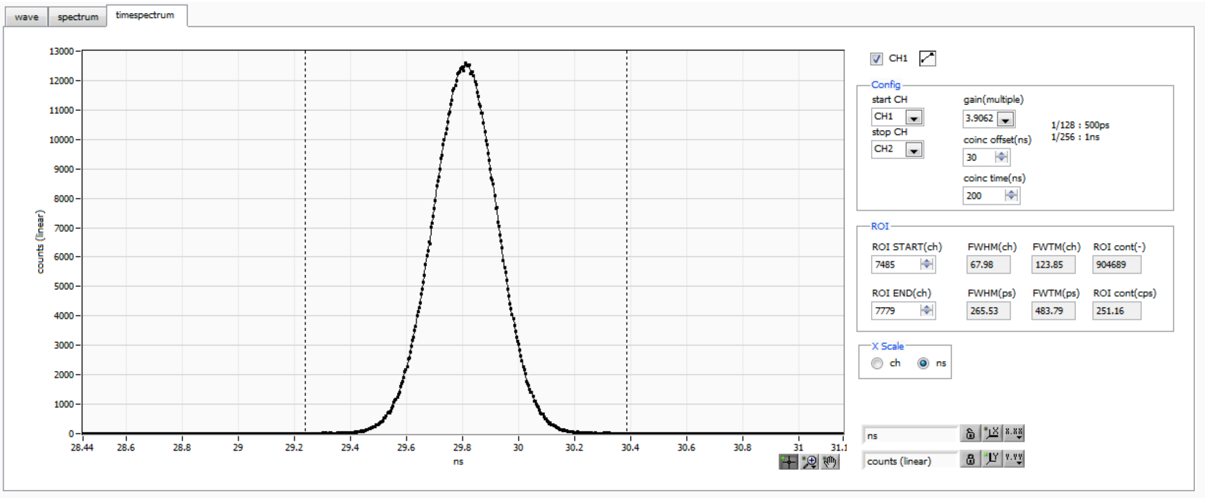



Figure 19 timespectrum tab

* 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. |
| CH1 checkbox | Select whether to display the time-difference spectrum. When checked, the time difference spectrum is displayed; when unchecked, it is not displayed. |

Config part

| | |
|---|---|
| start CH | Select the CH number from which to obtain the start timing. |
| stop CH | Select the CH number from which the stop timing is to be obtained. |
| gain | Selectable from 1x to 1/128x; full scale at 1x is about 780 ns (about 3.9 ps per digit), full scale at 1/128x is about 100 μs (0.5 ns per digit). |
| coinc offset | Set the offset in 1ns increments. |
| coinc time | Set the coincidence time in 1ns increments. If the time difference between the start CH and stop CH detections is within this setting range, it is considered coincidence (simultaneous) and time difference data is acquired. |

ROI part

| | |
|---|---|
| ROI START (ch) | Start channel of ROI |
| ROI END (ch) | End channel of ROI |
| FWHM (ch) | The calculated half-width between ROIs is displayed. |
| FWTM (ch) | The calculated 1/10 width between ROIs is displayed. |

| | |
|---|---|
| Xscale part | Select ch (channel) or ns display for the unit of the X axis. |

## 5. 8. PSD tab *option

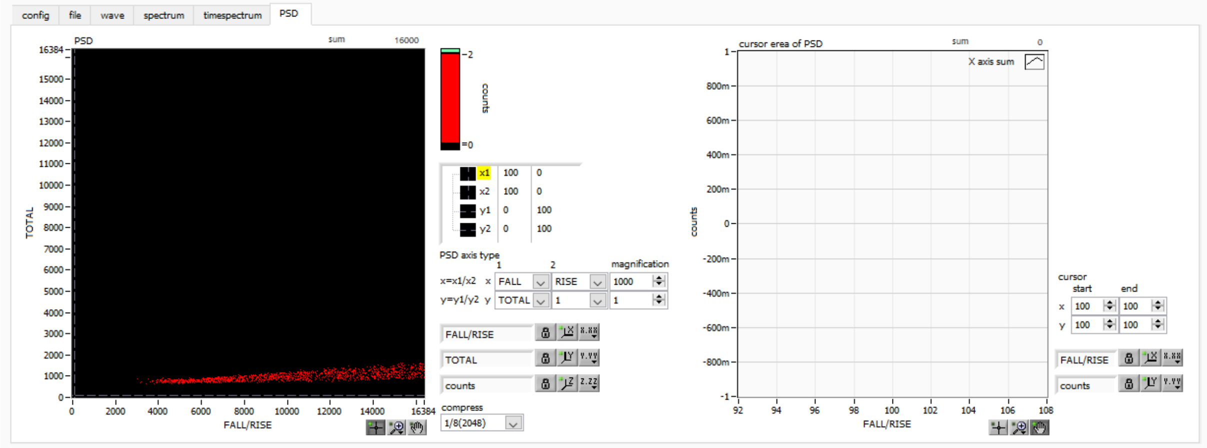



Figure 20 PSD tab

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

PSD Graph

This is a two-dimensional histogram using the wave height values within two lists of data obtained by coincidence (coincidence), where the type of data is arbitrarily selected on the X and Y axes, respectively, and the frequencies are accumulated at the intersection of the X and Y axes.

***NOTE***

The number of channels on the X and Y axes is 16384, but this requires approximately 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, and 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 set to 1000 and FALL is selected for x1 and RISE for x2, the X-axis will be FALL/RISE, but if the quotient is 1.234, the value will be multiplied by 1000 to 1234.

• compress

This is a setting related to compression for up to 16384 channels. 1/8 (2048) is selected to represent a 16384 x 16384 range in a 2048 x 2048 range. In this case, the data for each of the 8 channels is summed up to 1 and stored in 1 of the 2048 channels.

# 6. DPP initialization

## 6. 1. 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 this instrument with a LEMO connector coaxial cable. If a BNC connector is used, use a BNC-LEMO conversion adapter.
(4) Connect this device and a PC with a LAN cable.

## 6. 2. Power ON

(1) Turn on the VME power supply crate.
(2) Turn on the power to the PC. Start this application.
(3) Turn on the high-voltage power supply and apply the appropriate voltage to the detector.

## 6. 3. Waveform Measurement

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

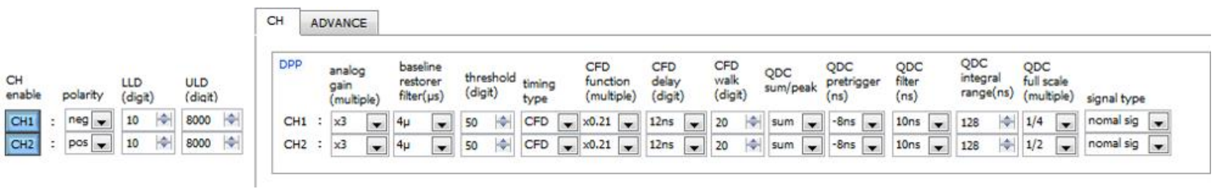



Figure 21 Waveform measurement setting example

(2) 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.

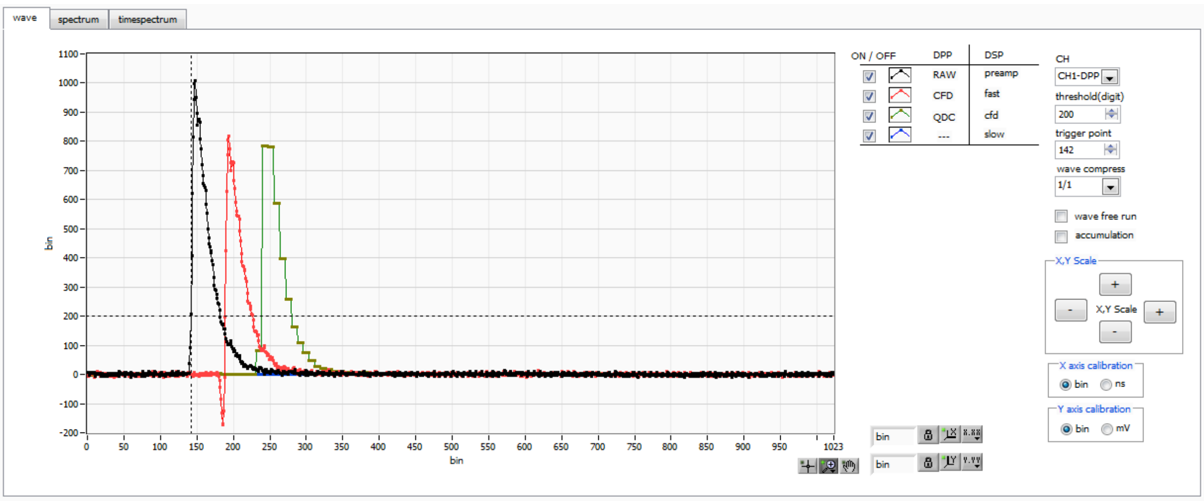



Figure 22 Waveform Measurement Screen

**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.

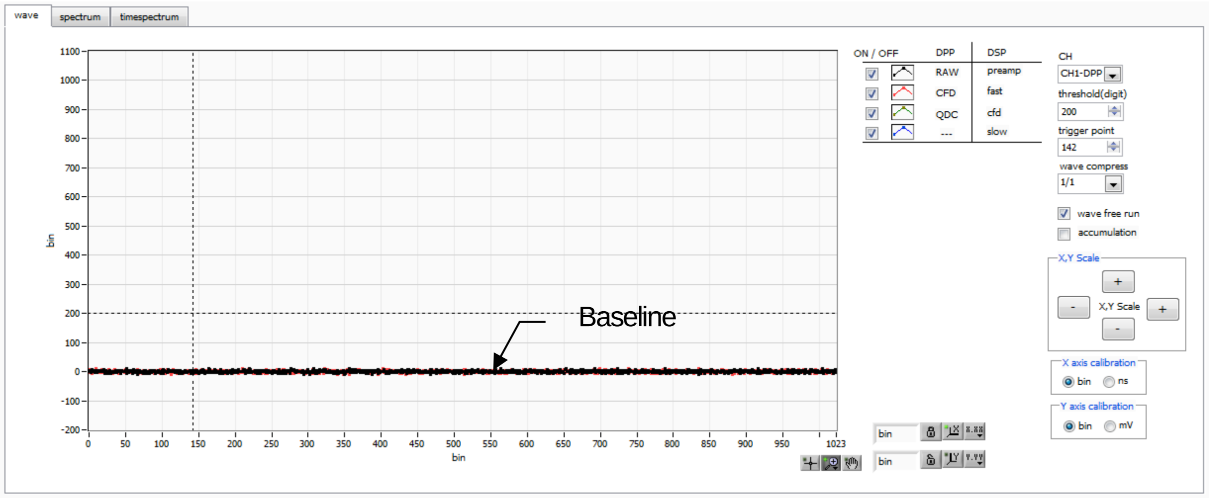



Figure 23　Baseline confirmation in progress

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. 4. Energy Spectrum Measurement

(1) Set "mode" to "hist", make the following settings in the config tab, and then click on "Config" menu. Set the threshold value that was noted in the waveform measurement to the threshold in the config tab.

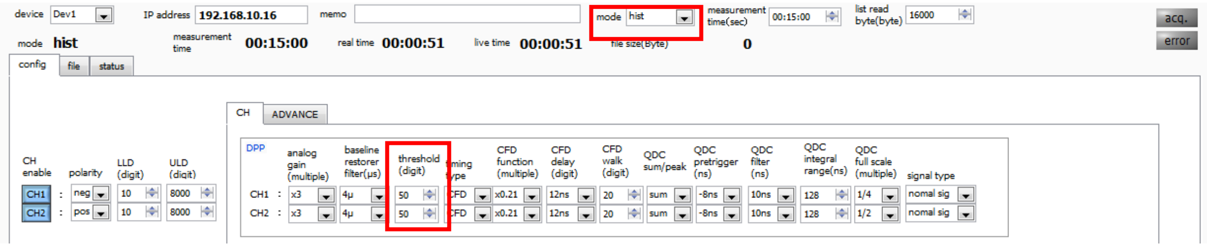



Figure 24 config tab

(2) Open the spectrum tab, confirm the settings shown in the figure below, and then click the menu Clear → Start. After execution, the following spectrum will be displayed.

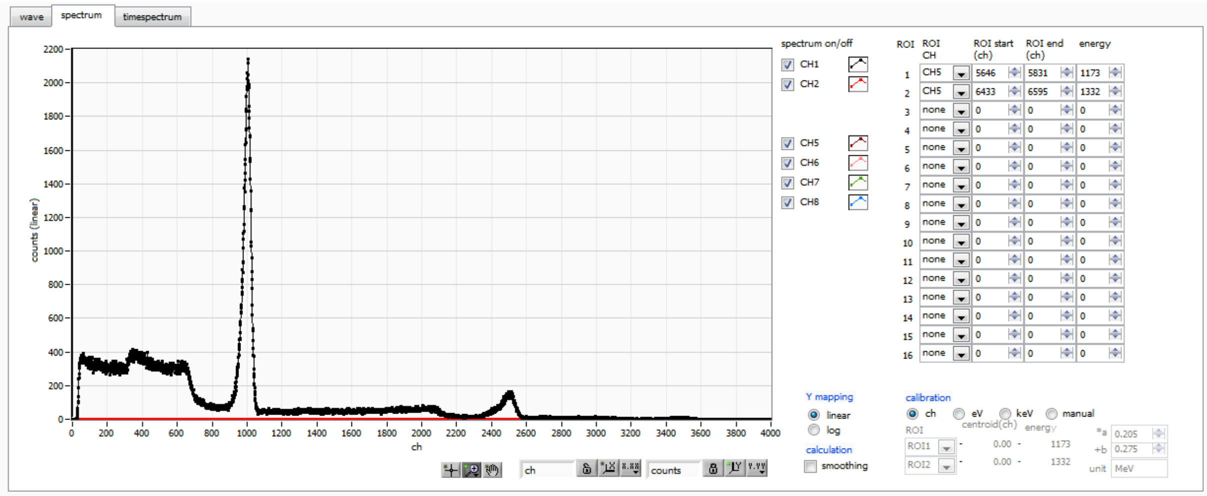



Figure 25 Example of energy spectrum measurement * Source is Cs-137

Note the following points

Check CH1 in spectrum on/off so that the spectrum of CH1 can be displayed.

When analyzing peaks, set the ROI.

(3) To end the measurement, click on the menu Stop.

## 6. 5. List and Time Difference Spectral Measurements

(1) Set "mode" to "list" and make the following settings in the config tab, then click on "Config" menu. Set the threshold value that was noted in the waveform measurement to the threshold in the config tab.

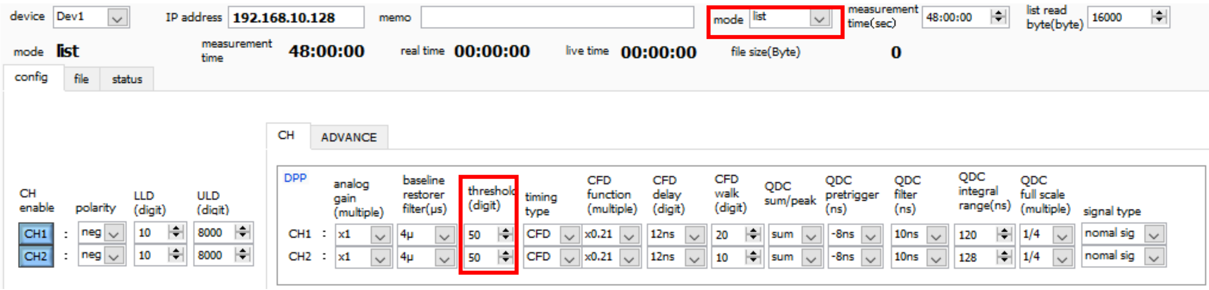



Figure 26 config tab

(2) Check the list save checkbox in the file tab and set the location and name of the file.

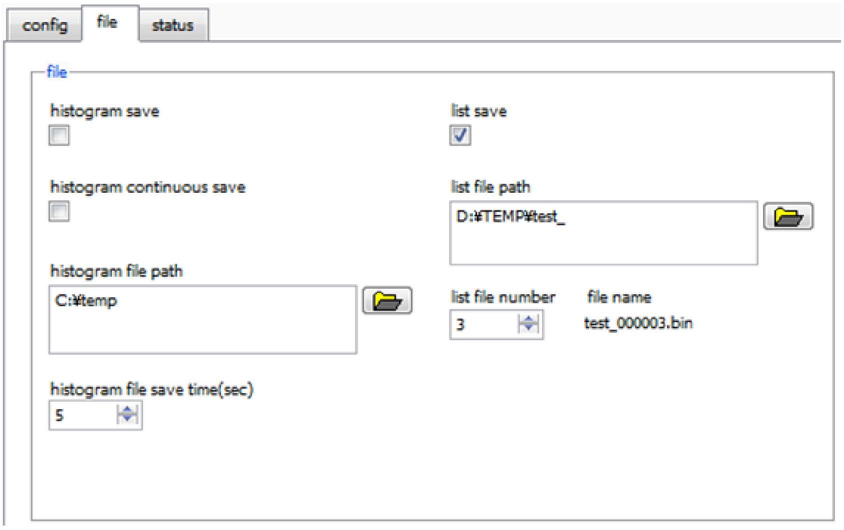



Figure 27 file tab

(3) Execute menu config → clear → start to get list data.

(4) If you check the "time spectrum ON/OFF" checkbox when acquiring data in the list mode, a time difference spectrum can be displayed in the timespectrum tab. Note, however, that if you try to generate a time difference spectrum at high count output, the computer will not be able to calculate it in time, and an error will occur in the list data acquisition.

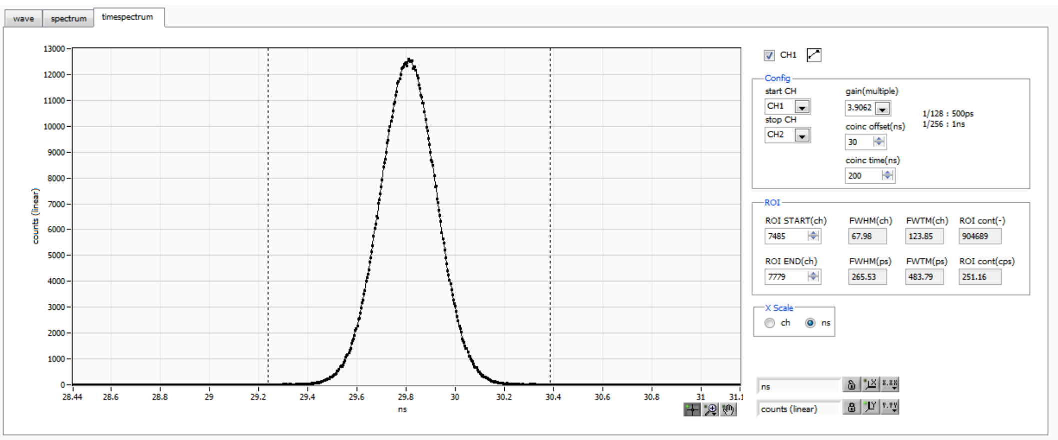
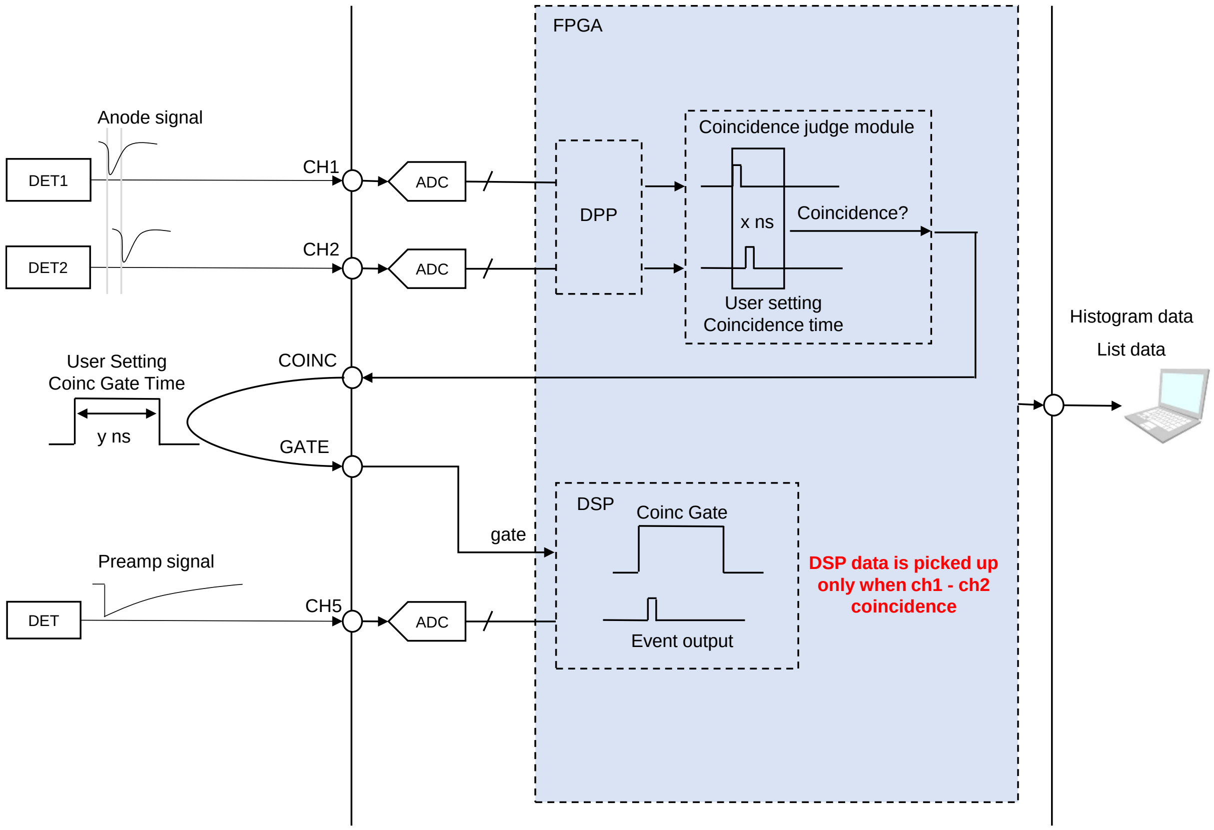



Figure 28 timespectrum screen, example of $LaBr_3(Ce)$ vs $LaBr_3(Ce)$

## 6. 6. Coincidence and anti-coincidence outputs

The measurement information from CH1 to CH4 can be time, energy, and waveform fractionation information. In addition, it can determine the coincidence and anti-coincidence between input channels and output logic signals from the front panel terminals.

By inserting this logic signal output into GATE or VETO on the front panel, GATE can be applied to CH5 to CH8 measurements and measurement information can be picked up.




Fiure 29 Block diagram of coincidence logic output

# 7. DSP initialization

## 7. 1. 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 this device and a PC with a LAN cable.

## 7. 2. Power ON

（1） Turn on the VME power supply crate.
（2） Turn on the power to the PC. Launch this application.
（3） Turn on the high-voltage power supply and apply the appropriate voltage to the detector.

## 7. 3. Confirmation of preamplifier output signal

（1） Connect the preamplifier output signal to an oscilloscope and check the wave height (mV) and polarity. (In the case of a transistor-reset preamplifier, a right ascension indicates positive polarity, and a right descent indicates negative polarity.

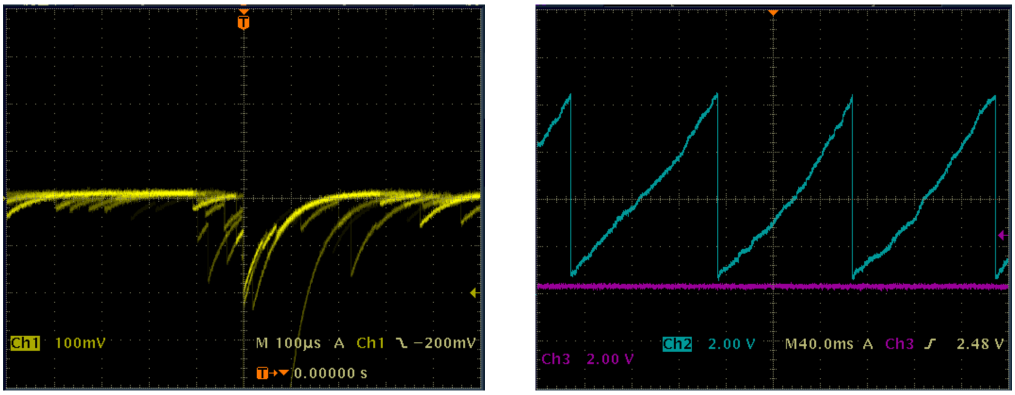



Figure 30 **LEFT** Resistive feedback type for negative polarity, **RIGHT** Transistor reset type for positive polarity

（2） In the config tab, set the polarity of CH5 or later on the DSP side to the polarity that you have confirmed, and click on the menu Config.

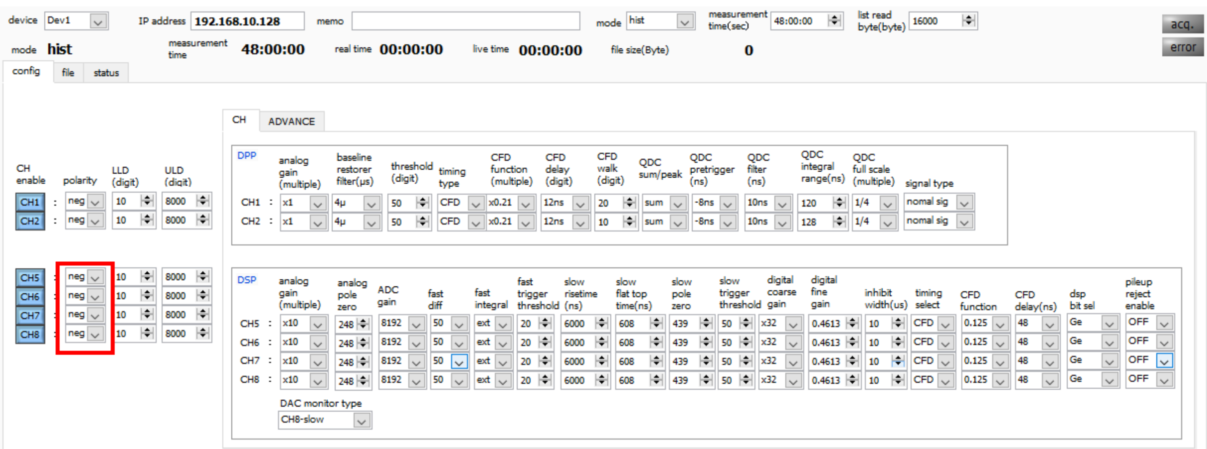



Figure 31 config tab

From now on, the main settings of the DSP are configured in the DSP section of the CH tab in the config tab.

## 7. 4. Analog fine gain and analog pole zero adjustment of preamplifier output signal

The ultra-low noise high-speed programmable gain amplifier enables high-precision amplification of signals from preamplifiers that require fast rise time and low noise. The analog course gain can be set by selecting from 1x, 2x, 5x, and 10x in this application.

The setting method varies depending on whether the output signal of the preamplifier of the detector input to this device is a resistive feedback type or a reset type.

### 7. 4. 1. Resistive feedback preamplifier output signal

Preamplifier output signals usually have a decay of about 50μs to 100μs. The decay is too long for this device to process, so it cannot handle high counts. Therefore, the signal is differentiated to a time constant that is easy to process internally. The undershoot that occurs in such a case is shown in the following equation, and the overload characteristic of this device deteriorates in the same way as in the conventional analog system.

Undershoot (%) = different amplitude / preamp decay time

（1） It is necessary to set the pole zero adjustment to enable (factory default) on the board. Turn off all power supplies and slowly pull out this unit from the power rack. For the unit type, unscrew the lid and open it slowly, taking care of the cables attached to the lid. As shown in the red frame in the photo below, the pole zero adjustment is enabled by inserting one of the jumpers on the CH that inputs the preamp output signal.

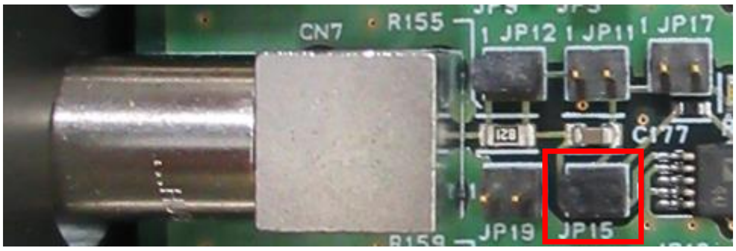



Photo 6 Transistor reset type setting (Insert JP15 for CH7)

（2） Check the differential preamplifier output signal from the MONI output terminal on the front panel with an oscilloscope, and select the appropriate CH-preamp in the DAC monitor type on the CH tab in the config tab.
Set the analog course gain so that the wave height including the energy element to be measured in the preamp signal is within 1V.
For example, if you want to measure energy up to 2000 keV, if you have a 60Co checking source, set the overlapped area of 1332keV@60Co to 0.666V (1V÷2000keV×1332keV) or less.

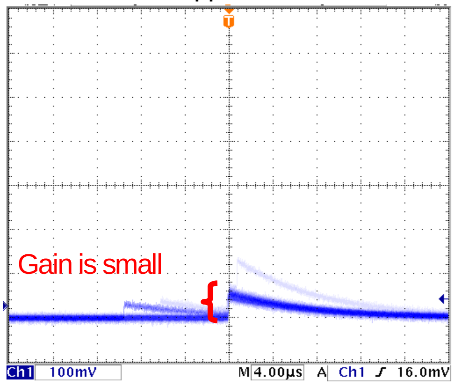



Figure 32 Before adjustment

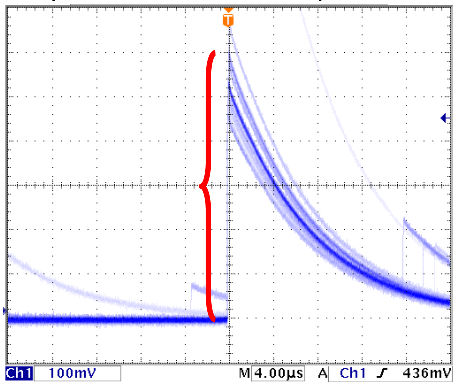



Figure 33 After adjustment

（3） Vary the analog pole zero value and adjust the pole zero so that the falling edge is flattened while switching the oscilloscope's vertical and horizontal ranges.

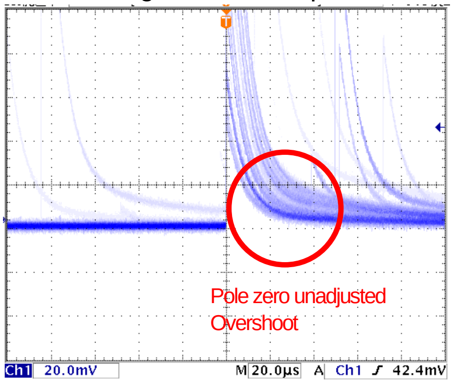



Figure 34　Before adjustment, Overshoot

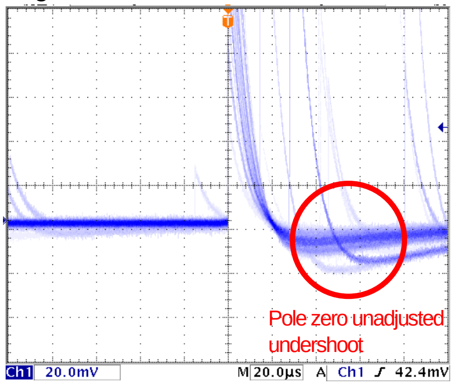



Figure 35　Before adjustment, Undershoot

↓

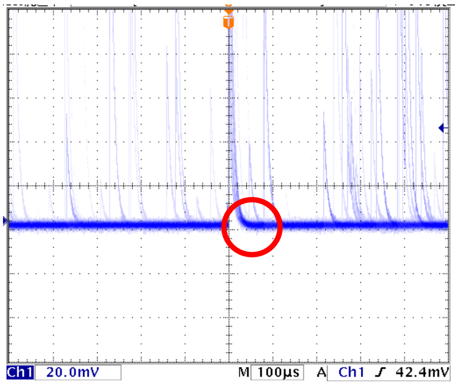



Figure 36　After adjustment

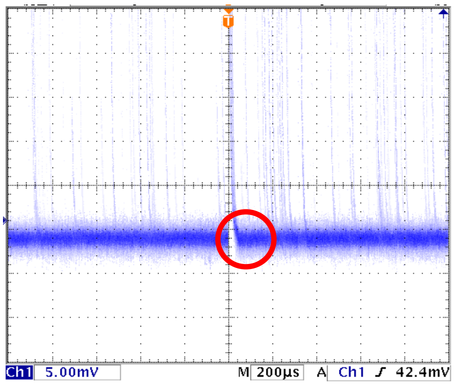



Figure 37　After adjustment, the horizontal axis is widened

## 7．4．2.　Transistor-reset preamplifier output signal

（1） The board must be set to disable the pole zero adjustment. If the power can be turned off, turn off all power and slowly pull out this unit from the power rack. If it is a unit type, unscrew the lid and open it slowly, taking care of the cables attached to the lid. As shown in the red frame in the photo below, the pole zero adjustment can be disabled by removing and moving one of the jumpers on the CH that inputs the preamp output signal.

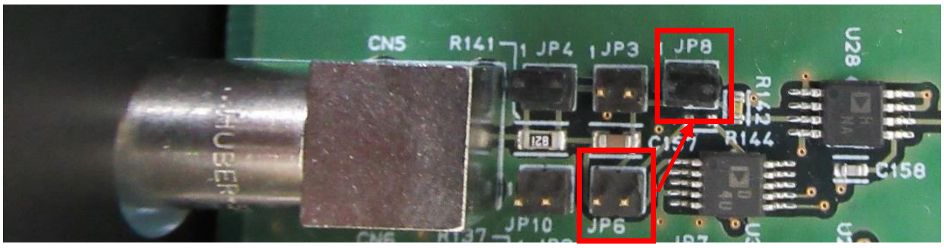



Photo 7　Transistor reset type setting (In case of CH5, remove JP6 and insert into JP8)

If the power cannot be turned off, set the ANALOG POLE ZERO setting to 0.

（2） Check the oscilloscope for the preamp signal, which is a derivative of the preamplifier output signal from the MONI terminal on the front panel.

（3） As with the resistive feedback type described above, the wave height including the energy element of the preamp signal is adjusted to keep it within 1V.

## 7．5． FAST filter setting

The instrument has FAST filters to obtain time information during radiation detection and SLOW filters to obtain energy (wave height). First, the settings related to the FAST system filter must be configured. The settings have the same characteristics as general timing filter amplifiers.

The light blue waveform in the figure shows the waveform when the FAST system differential FAST diff is set to 200 ns and the FAST system integral FAST integral is set to 200 ns.

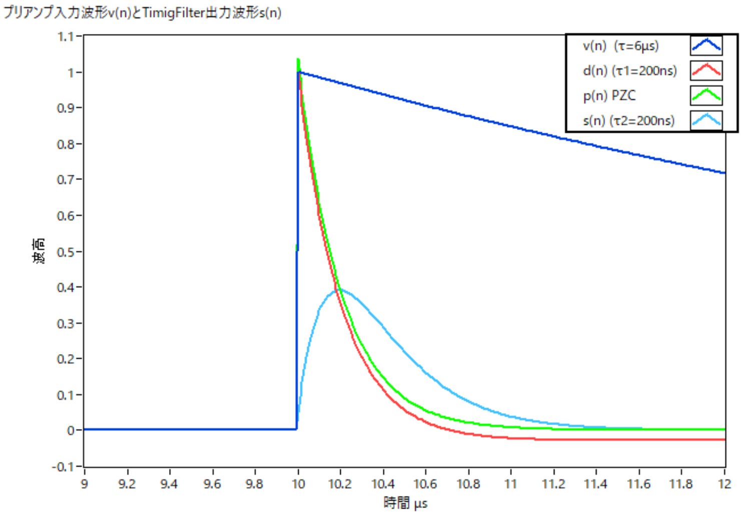
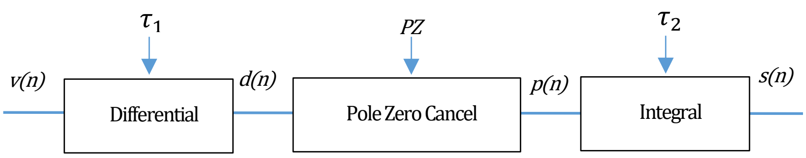



Figure 38 FAST filter, Light blue




$$d(n) = v(n) - v(n-1) + \tau_1 * d(n-1)\,,$$
$$p(n) = v(n) * PZ + d(n)\,,$$
$$s(n) = (1 - \tau_2) * p(n) + \tau_2 * s(n-1)\,,$$

$Where:$

$\tau_1$ : $differential\ time$ ,

$\tau_2$ : $integral\ time$

$PZ$ : $polezero$

Figure 39 FAST filter Block diagram and numerical formula

Describes the settings for FAST-type filters.

（1） Connect the MONI output terminal to the oscilloscope, select the appropriate DAC monitor CH, and set the DAC monitor type to fast. Prepare to see this signal on the oscilloscope.

（2） Set the constant of the FAST differential circuit with fast diff, selecting from ext (excluded, no filter used), 20, 50, 100, 200, and 500.

（3） Set the constant of the FAST system integral circuit with fast integral. select from ext (excluded, no filter used), 20, 50, 100, and 200.

The fast diff and fast integral settings depend on the detector and signal conditions. Examples of settings are shown below

Table 1 fast diff and fast integral configuration examples

| Detector | Feature | fast diff | fast integral |
|---|---|---|---|
| $LaBr_3$（Ce）scintillator | Fast risetime | 20 | ext or 20 |
| Ge semiconductor | High energy resolution | 100 | 100 |

（4） Set the threshold for the signal detection of the FAST system filter at the fast trigger threshold. When the threshold is exceeded, leading edge timing (LET) is time-stamped. It is also used as a threshold for the baseline restorer and pileup rejector. This value should be set to the lowest possible value that can be discriminated from noise when connected to a detector. The default value is 25.

First, input a somewhat large value (around 100) and observe the input rate (cps), then gradually decrease the fast trigger threshold and find a value at which the input rate (cps) becomes large. Since this value is the boundary between signal and noise, set the input rate (cps) to +3 to +10 above this value.

## 7．6．　SLOW filters setting

The SLOW trapezoidal filter performs SLOW trapezoidal shaping on the preamplifier output signal. As an algorithm for the Trapezoidal Filter, the filter block, which is composed of a pipeline architecture, calculates the delay, add/subtract, and integral values required for the Trapezoidal Filter in synchronization with the 100 MHz clock of the ADC.

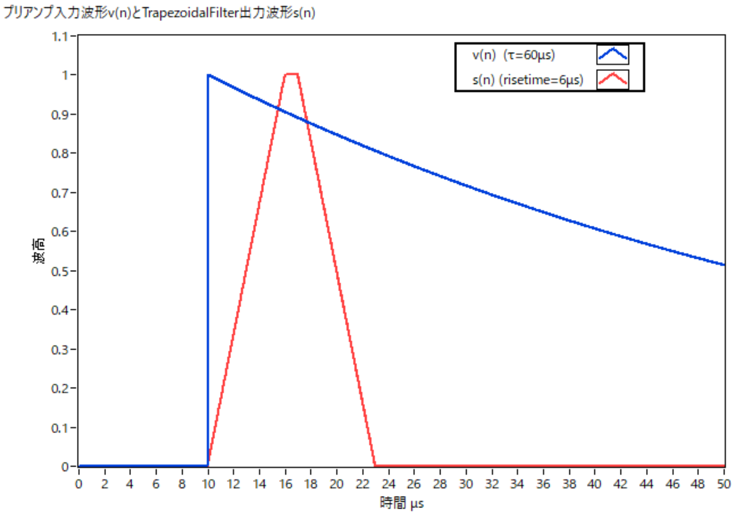
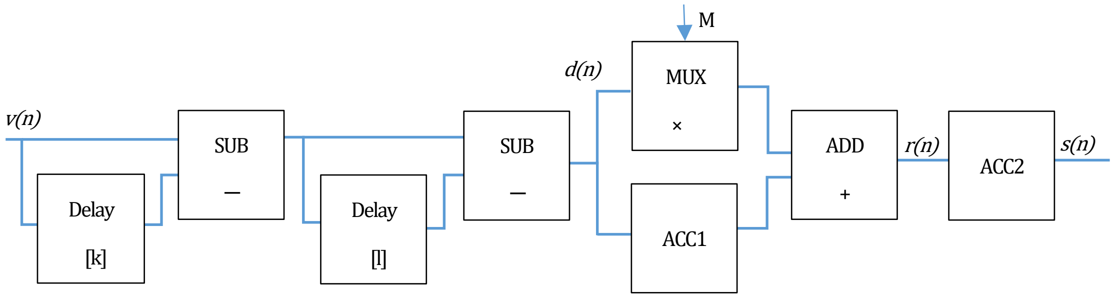



Figure 40　SLOW filter, red




$$d(n) = v(n) - v(n-k) - v(n-l) + v(n-k-l)\ ,$$

$$p(n) = p(n-1) + d(n)\ ,$$

$$r(n) = p(n) - M * d(n)\ ,\quad n \geq 0\ ,$$

$$s(n) = s(n-1) + r(n)\ ,\quad n \geq 0\ ,$$

$Where$:

$k$ : $risetime$ ,

$l$ : $risetime + flottoptime$ ,

$M$ : $pole\ zero$


References:

[1] V.T. Jordanov and G.F. Knoll, Nucl Instr. and Meth.A353(1994)261-264


Figure 41　SLOW filter, (Trapezoidal Filter, Block diagram and numerical formula

The figure below shows the difference in pulse response between the conventional analog Semi Gauss Filter and the DSP, which has about 1/2 the time to peak and 1/3 the pulse width compared to the Semi Gauss Filter.

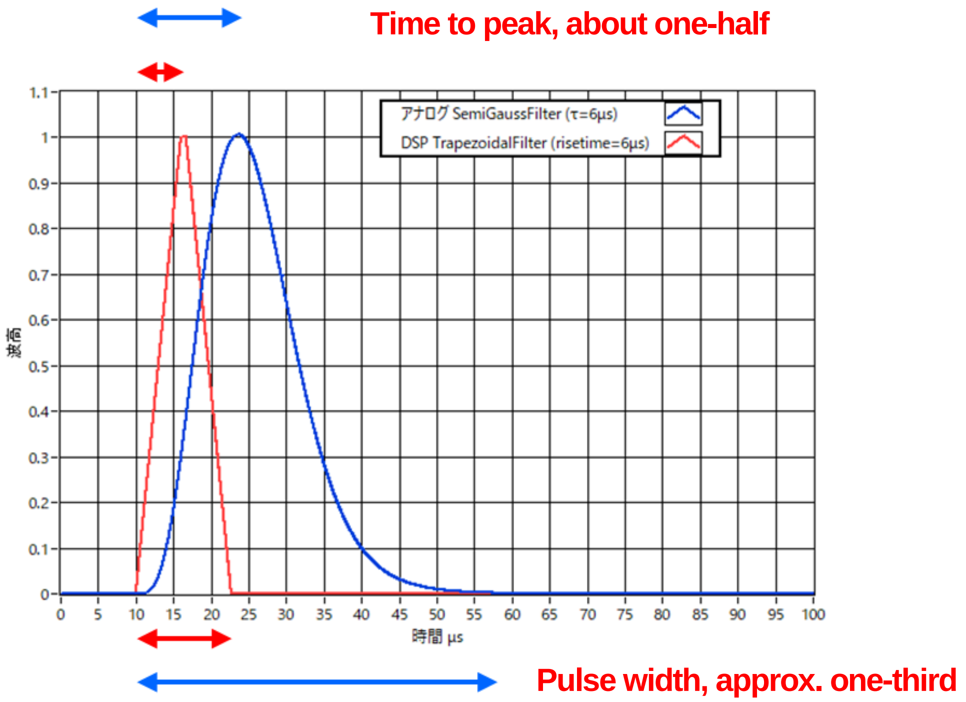



Figure 42　Difference in response between Trapezoidal Filter and Semi Gauss Filter

Despite the faster pulse response of the DSP, a comparison of the energy resolution using the Ge semiconductor detector shows that the same high resolution can be obtained at lower rates at the Input Rate, as shown in the figure below, and at higher rates, the data remains more resolved than the Semi Gauss Filter The higher rate data can be obtained with better resolution than with the Semi Gauss Filter. The digital Trapezoidal Filter process provides higher counts and richer data, allowing a wider variety of analyses than the Semi Gauss Filter.

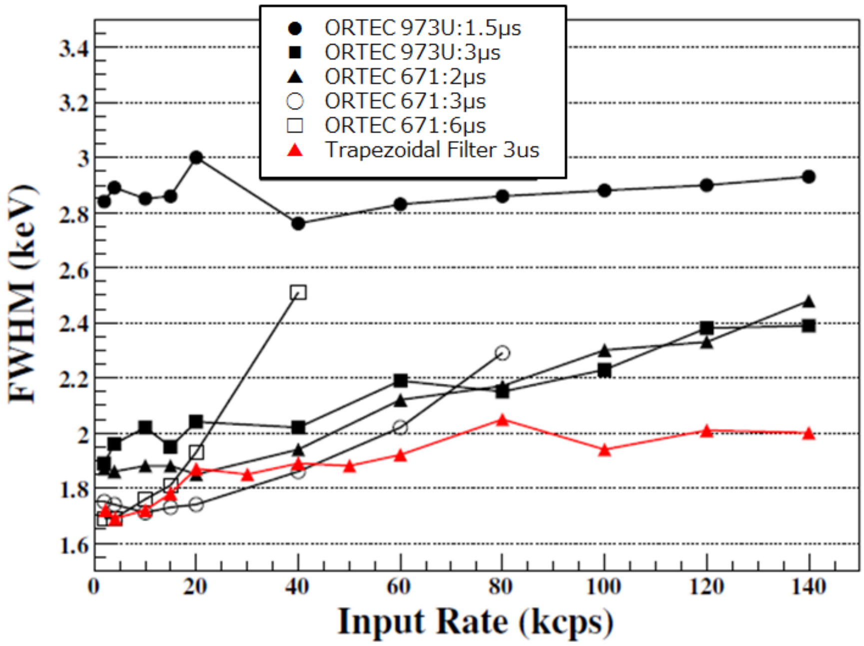



Figure 43　Difference in counting rate and energy resolution between Trapezoidal Filter and Semi Gauss Filter

SLOW filter settings are described.

（1）　Connect the MONI output terminal to the oscilloscope and set the DAC monitor type to the appropriate CH-slow. Prepare to see the signal on the oscilloscope.

（2）　To achieve the same conditions as when the linear amplifier shaping time is set to 3 μs, set the slow rise time to 6000 ns. This value affects the energy resolution. A shorter setting allows higher counts, but the energy resolution is reduced. Conversely, setting it too long may result in a low count. The default value is 6000ns.

（3）　Set the slow flattop time. For resistive feedback preamplifier output signals, set the value from 0 to 100% of the rise time, twice the slowest rise. The recommended value is 608ns. (In the case of transistor reset type, adjust in ±96ns increments from 608ns while checking the energy resolution (half value width).

（4）　Set SLOW POOL ZERO. This setting reduces overshoot and undershoot at the falling edge of SLOW filters. The default value is 680. (This value varies depending on the detector, so use an oscilloscope to set the optimum value.

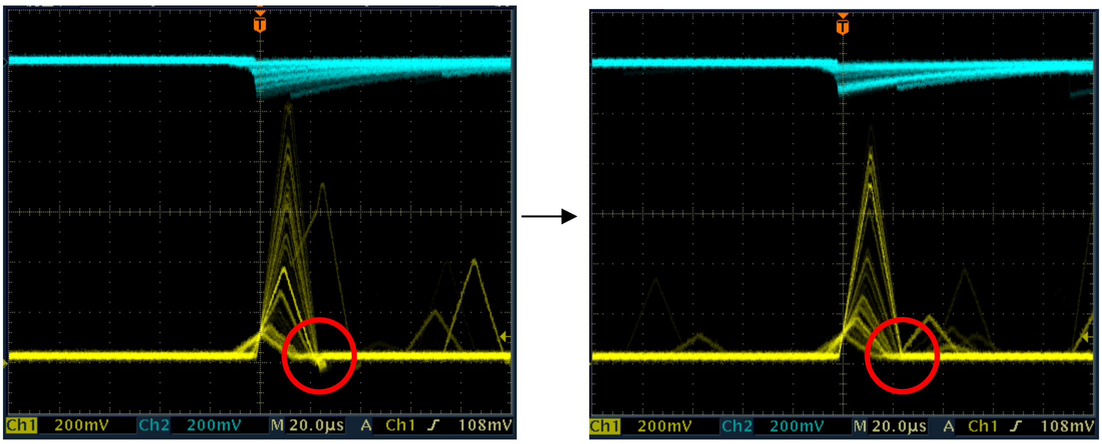



Figure 44　slow pole zero, **LEFT**: before adjustment with undershoot, **RIGHT**: after adjustment

## ７．７． Setting the SLOW threshold

First, input a somewhat large value (around 100) and observe the output rate (cps), then gradually decrease the slow trigger threshold, and find a value at which the output rate (cps) becomes large. This value is the boundary between signal and noise, so set the value to +3 to +10 from that value. The default value is 30.

# 8. Measurement

## 8. 1. Setting

(1) Click Menu Config to send all settings to this device. After the Config menu is executed, the histogram data in the DSP will be initialized.

(2) To initialize the last measured histogram or measurement results, click on Menu Clear. To continue with the histogram data without initialization, start the next measurement without clicking on Menu Clear.

## 8. 2. Start measurement

Click on the menu Start. The measurement will start, and the following will be performed.

- 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".
- live time" displays the live time acquired from the device.
- dead time" displays the dead time acquired from this device.
- The dead time ratio displays the ratio (%) of dead time/real time.

## 8. 3. Histogram mode

When "hist" is selected in "mode" and measurement is started, the following is executed.

- Histogram is displayed in mode.
- The calculation results for each ROI1 to ROI8 are displayed in the ROI section.
- Histograms are displayed in the CH and histogram tabs.

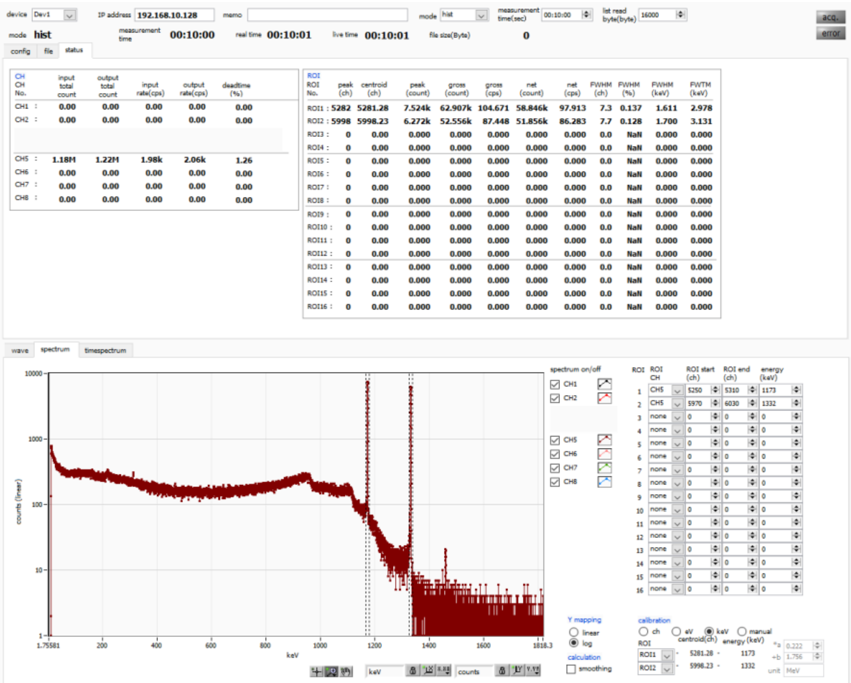


Figure 45 histogram mode measurement

## 8. 4. List mode

When "list" is selected in "mode" and measurement is started, the following is executed.

- The mode is displayed as "list".
- The save LED blinks and the file size (in bytes) displays the size of the file currently being saved.
- If the buffer reaches 100%, it will be overflowed, and data will be missed. Please make sure that the sum of output rate (cps) of all CHs does not exceed 160 kcps.

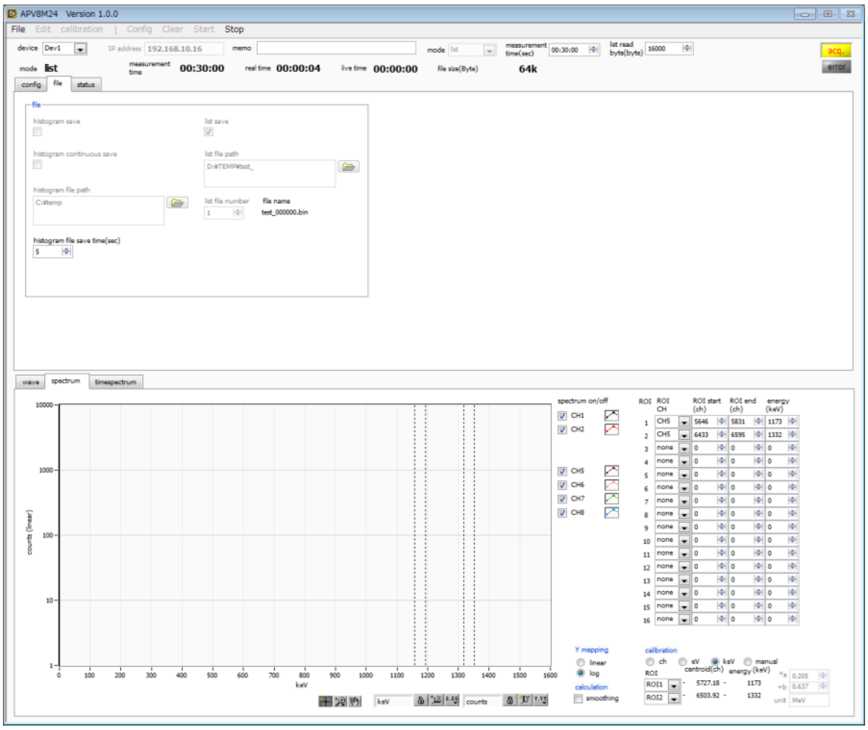


Figure 46 list mode measurement

## 8. 5. Stop measurement

- When the measurement mode is "real time", the measurement is terminated when the real time reaches the measurement time.
- When the measurement mode is "live time," the measurement is terminated when the live time reaches the measurement time.
- If you want to stop the measurement, click "Stop" menu. Measurement is stopped after execution.
- The save LED turns off.
- Update of real time stop.
- Update of live time stop.
- Update of dead time stop.
- Update of file size (Byte) stop.
- Update "dead time ratio" stop.

# 9. 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 quit will be applied.

# １０. File

## １０. １. Histogram data file

（１） File format
CSV text format, separated by commas

（２） File name
Set arbitrarily

（３） Component
It consists of 4 parts: "Header" part, "Calculation" part, "Status" part and "Data" part

[Header]

| | |
|---|---|
| Measurement mode | Measurement mode, Real time or Live time |
| Measurement time | Measured time. Unit is seconds. |
| Real time | Real time |
| Start Time | Measurement start time |
| End Time | Measurement end time |
| *Saved for each CH below | |
| POL | polarity |
| CLD | LLD |
| CUD | ULD |
| GSL | CH1～4 analog gain |
| FLK | baseline restorer filter |
| CTH | threshold |
| TTY | timing type |
| CCF | CDF function |
| CDL | CFD delay |
| CWK | CDF walk |
| LIT | QDC sum/peak |
| PTS | QDC pretrigger |
| LIG | QDC filter |
| QIR | QDC integral range |
| AFS | QDC full scale |
| WAS | signal type |
| GSM | analog gain |
| PZD | analog pole zero |
| ADG | ADC gain |
| FFD | fast diff |
| FFI | fast integral |
| FTH | fast trigger threshold |

| | |
|---|---|
| SFR | slow risetime |
| SFP | slow flat top time |
| SPZ | slow pole zero |
| STH | slow trigger threshold |
| DCG | digital coarse gain |
| DFG | digital fine gain |
| IHW | inhibit width |
| TMS | timing select |
| CFF | CFD function |
| CFD | CFD delay |
| DBS | dsp bit sel |

*Saving per CH ends here.

| | |
|---|---|
| MOD | Mode |
| MMD | Measurement mode |
| MTM | Measurement time |

[Calculation]

*Saved for each CH below

| | |
|---|---|
| ROI_ch | The input channel number that was the subject of the ROI. |
| ROI_start | ROI start position (ch) |
| ROI_end | ROI end position (ch) |
| peak (ch) | Peak position between ROIs (ch) |
| centroid (ch) | Center position between ROIs (ch) |
| peak (count) | Sum of peak counts between ROIs |
| gross (count) | Sum of counts between ROIs |
| gross (cps) | cps of gross |
| net (count) | Sum of counts minus background between ROIs |
| net (cps) | cps of net |
| FWHM (ch) | Half-width between ROIs (ch) |
| FWHM (%) | Half-width between ROIs (%) |
| FWHM (keV) | Width at half maximum between ROIs (keV) |
| Energy (keV) | Energy value of the peak between ROIs (keV) |

[Status]

*Saved for each CH below

| | |
|---|---|
| input total | Total count |
| output total | Output count |
| input rate | Total count rate |
| output rate | Output count rate |
| dead time | Deadtime (%) |

[Data]

Histogram data of each channel

## １０．２． Waveform data file

（１） File format

CSV text format, separated by commas

（２） File name

Set arbitrarily

（３） Component

It consists of 4 parts: "Header" part, "Calculation" part, "Status" part and "Data" part

The Header, Calculation, and Status sections are the same as the histogram data described above.

The Data section contains the following types of waveform data for the CH selected in the wave tab.

| | |
|---|---|
| For CH1 to CH4 | DPP RAW, CFD, QDC<br>1024 points for APV8M24<br>512 points for APV8M44 |
| For CH1 to CH4 | preamp, fast, cfd, slow 512 point for each. |

## １０．３．　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)

<table>
<tr><td>79<br>WAV[0]</td><td colspan="3">78 … 64<br>TDC[54..40]</td></tr>
<tr><td colspan="4">63 … 48<br>TDC[39..24]</td></tr>
<tr><td colspan="4">47 … 32<br>TDC[23..8]</td></tr>
<tr><td colspan="2">31 … 24<br>TDC[7..0]</td><td colspan="2">23 … 16<br>TDCFP[7..0]</td></tr>
<tr><td>15 13<br>CH[2..0]</td><td colspan="3">12 … 0<br>QDC[12..0]</td></tr>
</table>

- Bit79 — Presence of waveform. 0: without waveform. 1: with waveform.
- Bit78 to Bit24 — TDC count. 55bit.
  APV8M24 is 1ns per Bit, APV8M44 is 2ns per Bit.
- Bit23 to Bit16 — TDCFP, decimal count. 8bit.
  APV8M24 is 3.90625ps Bit.
  Interpolation between sampling points 1ns ÷ 256 = 3.90625 ps.
  For CH5 to CH8, TDCFP [3..0] is fixed at zero
- Bit15 to Bit13 — CH number. 0 is CH1, 1 is CH2, 7 is CH8
- Bit12 to Bit0 — QDC integral or PEAK value.
  Unsigned 13-bit integer; CH1 to CH4 of DPP are the waveforms collected and filtered, and the waveforms are integrated over a set range from the point where the threshold is exceeded; CH5 to CH8 of DSP are PHA values.

（4） Component

128 bit per 1 event (16 Byte, 8 WORD)

| Bit (high) | Bit (low) | Field |
|---|---|---|
| Bit127 | 112 | RISE[15..0] |
| 111 | 96 | FALL[15..0] |
| 95 | 80 | TOTAL[15..0] |
| 79 | | WAV[0] |
| 78 | 64 | TDC[54..40] |
| 63 | 48 | TDC[39..24] |
| 47 | 32 | TDC[23..8] |
| 31 | 24 | TDC[7..0] |
| 23 | 16 | TDCFP[7..0] |
| 15 | 13 | CH[2..0] |
| 12 | 0 | QDC[12..0] |

図 47 list データフォーマット

- Bit127 to Bit112 RISE, Waveform Rise Partial Integral value. Unsigned 16-bit integer.
- Bit111 to Bit96 FALL, Waveform falling partial integral value. Unsigned 16-bit integer.
- Bit95 to Bit80 TOTAL, Total Waveform Integral value. Unsigned 16-bit integer.

- Bit79 to bit0 Same as 80-bit list data.

## １０．４． 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 list data part 80Bit)

<table>
<tr><td>Bit79<br>WAV[0]</td><td colspan="3">78 … 64<br>TDC [54..40]</td></tr>
<tr><td colspan="4">63 … 48<br>TDC [39..24]</td></tr>
<tr><td colspan="4">47 … 32<br>TDC [23..8]</td></tr>
<tr><td colspan="2">31 … 24<br>TDC [7..0]</td><td colspan="2">23 … 16<br>TDC FP[7..0]</td></tr>
<tr><td>15 13<br>CH[2..0]</td><td colspan="3">12 … 0<br>QDC[12..0]</td></tr>
<tr><td colspan="4">wave number[15..0]</td></tr>
<tr><td colspan="4">header[31..16]</td></tr>
<tr><td colspan="4">header[15..0]</td></tr>
<tr><td colspan="4">wave data[15..0] × wave number 分</td></tr>
</table>

Figure 48 list-wave data format (normal)

- Bit79 to bit0 Same as 80-bit list data.

- Number of waveform point wave number. 16 Bit.
- Waveform head header. 32 Bit. 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）
- Waveform data wave data. 16 bits per waveform point, with an offset of 16384 digits. Waveform information for the wave number is added.

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

<table>
<tr><td colspan="4">Bit127 … 112<br>RISE[ [15..0]</td></tr>
<tr><td colspan="4">Bit111 … 96<br>FALL[15..0]</td></tr>
<tr><td colspan="4">Bit95 … 80<br>TOTAL[15..0]</td></tr>
<tr><td>79<br>WAV[0]</td><td colspan="3">78 … 64<br>TDC[54..40]</td></tr>
<tr><td colspan="4">63 … 48<br>TDC[39..24]</td></tr>
<tr><td colspan="4">47 … 32<br>TDC[23..8]</td></tr>
<tr><td colspan="2">31 … 24<br>TDC[7..0]</td><td colspan="2">23 … 16<br>TDC FP[7..0]</td></tr>
<tr><td>15 13<br>CH[2..0]</td><td colspan="3">12 … 0<br>QDC[12..0]</td></tr>
<tr><td colspan="4">wave number[15..0]</td></tr>
<tr><td colspan="4">header[31..16]</td></tr>
<tr><td colspan="4">header[15..0]</td></tr>
<tr><td colspan="4">wave data[15..0] × wave number 分</td></tr>
</table>

Figure 49 list-wave data format (list data with PSA

- Bit127 to bit0 Same as 128-bit list data.

- Number of waveform point wave number. 16 Bit.
- Waveform header header. 32 Bit. 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）
- Waveform data wave data. 16 bits per waveform point, with an offset of 16384 digits. Waveform information for the wave number is added.

・

## １０．５． PSD data file *Option

（１） File format

CSV 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 |
| Commpress (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 |

6952 , 9192 , 1

:

Variable length. Max. 8192×8192＝67,108,864

[cursor area spectrum]

| | |
|---|---|
| FALL , Counts | Data in selected List on X-axis, Integral coun |

6644 , 0

:

Variable length. Max. 8192

# １１． Troubleshooting

## １１．１． 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.

## １１．２． Command error occurs

The number of valid CHs for this device may be incorrect. Check the following.

（1） Check the number of DSP CHs used

（2） Check that the number of CH in the config tab is the same as the number of CHs to be used.

## １１．３． Histogram is not displayed

If nothing appears on the graph after executing Menu Start, check the following

（１） Set CH1 to ON in spectrum on/off in spectrum tab.
（２） Check if input rate (cps) and output rate (cps) are counting.
（３） Set the DAC monitor type to the appropriate CH-preamp and check that the preamp wave height is not too small or too large, and that it is within 1V.
（４） Set the DAC monitor type to "fast" and check if the FAST filter signal is output.
（５） Set the DAC monitor type to slow and check if the signal from the SLOW-type filter is being output
（６） Adjust the fast trigger threshold and slow trigger threshold values so that they are not too small or too large, and while watching the input rate (cps) and output rate (cps) counts, change the settings down from 100 to about 30, so that the two rates are close in count.
（７） Right-click on the X and Y axes of the graph to auto scale.

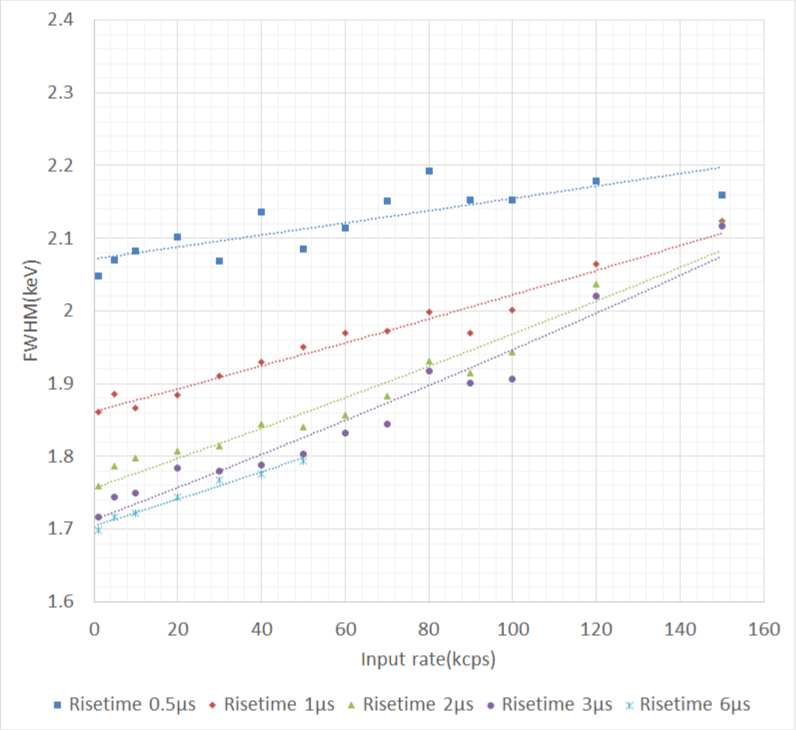
## １１．４． Change IP address

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.)

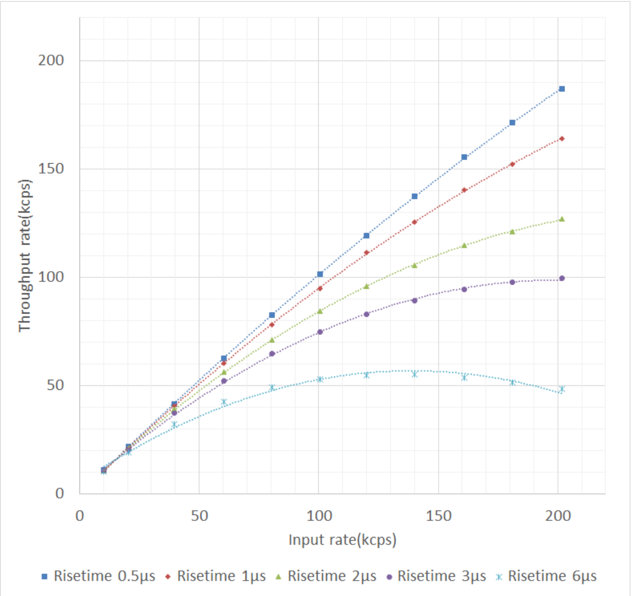
# １２. Performance of APV8M44、8M24

## １２. １. Resolution of DSP

The latest digital pulse processing technology enables **high-resolution and high-count-rate spectroscopy**.




Throughput is achieved by employing digital signal processing using FPGA, eliminating the dead time of conversion, and reset times in conventional MCA. The throughput of this device is well consistent with the paralysis model curve m=ne^((-nτ)) where τ = risetime+flattoptime. However, since the response speed of the detector is also a factor, the slower the detector or the higher the counts, the greater the difference will be.




* IGC10200 HPGe semiconductor detector manufactured by PGT, owned by our company

TechnoAP Co., Ltd.
Add: 2976-15 Mawatari, Hitachinaka-shi, Ibaraki, Postcode: 312-0012
TEL: +81-29-350-8011 FAX: +81-29-352-9013
URL: http://www.techno-ap.com
e-mail: info@techno-ap.com