X-ray Digital Spectrometer

APU101X
APN101X

Instruction manual

Version 2.0.0
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TechnoAP Co., Ltd.

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Contents

Safety Precautions / Disclaimer

Thank you very much for purchasing this product from TechnoAP Co., Ltd. Before using this product, please read this "Safety Precautions and Disclaimer" and be sure to observe the contents and use the product properly.

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. Consumables.

1 Overview

The digital spectrometer for X-rays APU101X (hereinafter referred to as “this instrument”) is a digital spectrometer that integrates a high-voltage power supply, preamplifier power supply, and MCA (multi-channel analyzer) into a single unit. Since it features a multi-channel analyzer (MCA) with real-time digital signal processing (DSP), waveform shaping by analog circuits is unnecessary. Using a very high-speed A/D converter, signals from the preamplifier are directly converted to digital form and processed in real time by a trapezoidal filter through an FPGA-based pipeline architecture. This provides excellent energy resolution and time resolution, and ensures outstanding stability even at high counting rates (over 1 Mcps).

This instrument connects to a personal computer (hereinafter “PC”) via a LAN cable. By using the included application APP101X (or DSP MCA, hereinafter “this application”), parameters can be set, data can be read out, and measured data can be analyzed and imported.

This manual describes the handling of this instrument and this application.

※ This manual describes the standard model; depending on the presence of options, special specifications, or the specifications of the high-voltage power supply module, the instrument in use may differ.
※ The model designation “APU” indicates a type in which the circuit board is housed in a unit (chassis) and can be used with an AC power adapter. A model in which this board is housed in a NIM-standard chassis is designated with “APN” instead of “APU.” A separate NIM bin power supply is required to supply power to this model. For example, a unit-type APU101X housed in a NIM-type chassis is designated as APN101X. This manual also includes explanations for the APN101X.
※ Optional functions can be added to this instrument. Such functions are explicitly marked as (optional) in this manual.
※ Any model numbers shown in photos, such as APU101, should be read as APU101X.
※ This manual is compatible with application APP101X Ver.7.0.2 and later.
※ The contents of this manual are subject to change without notice.

2 Specifications

2.1 Specification

(1) Analog Input

Number of channels: 1 CH

Input range: ±1 V

Input impedance: 1 kΩ

Coarse gain: ×5, ×10, ×20 — set via the application. Depends on the specifications at delivery.

ADC

Sampling frequency: 100 MHz

Resolution: 16 bit

(2) MCA

ADC gain: 4096, 2048, 1024, 512, 256 channels

Measurement modes: Histogram, Quick Scan, Wave, List

(3) Digital Pulse Shaping

SLOW filter: 0.01 µs – 20 µs

Digital fine gain: ×0.333 – ×1.0

Digital pole zero cancel

Digital baseline restorer

Digital pile-up reject

LLD (Low Level Discriminator)

ULD (Upper Level Discriminator)

(4) Unit Panel, Switches, Buttons, Connectors

[Front]

Unit power, LED for HV application / EMERGENCY operation confirmation

Emergency (EMERGENCY) button

High-voltage monitor LED

Connector for clear signal input

Connector for clock signal input (unused)

Connector for gate signal input

Connector for quick scan gate signal input

Connector for ROI-SCA and FAST-SCA (optional) signal output

Connector for preamplifier output signal input

Connector for filter waveform signal output

RJ45 connector for LAN

[Rear]

Connector for DC power supply

F.G terminal

Connector for detector fan power

Pin connector for detector power

(5) High-Voltage Power Supply

Output voltage: up to -200 V

Output current: up to 1 mA

(6) Preamplifier Power Supply: +5 V, 60 mA max.

(7) Peltier Cooling Power Supply: +1.8 V, 1 A max.

(8) Communication Interface: RJ45 connector, Ethernet 1000Base-T TCP/IP and UDP

(9) External Dimensions:

Unit type: 210 (W) × 45 (H) × 275 (D) mm (excluding protrusions)

NIM type: 34 (W) × 221 (H) × 249 (D) mm (excluding protrusions)

(10) Weight:

Unit type: approx. 1550 g

NIM type: approx. 960 g

(11) Current Consumption: +12 V (approx. 0.8 A, max. 1.2 A)

(12) PC Environment:

OS: Windows 7 or later, 32-bit and 64-bit

Screen resolution: WXGA+ (1440×900) or higher recommended

2.2 Features

The main features are as follows:

Digital signal processing for X-ray spectroscopy
Optimal for high energy-resolution detectors with multi-element SSDs
Spectral analysis for SDD (Silicon Drift Detector), Si(Li), Si-PIN detectors, etc.
Digital pulse shaping using a highly integrated FPGA
Data acquisition via Ethernet (TCP/IP)

The output signal from the detector preamplifier is input directly to the DSP and digitized by the high-speed ADC (100 MSPS) within the DSP. The heart of digital pulse processing, the A/D converter, uses a state-of-the-art 100 MHz, 16-bit high-speed, high-resolution pipeline ADC to directly digitize signals from the preamplifier.

Trapezoidal waveform processing is performed by hardware computation in the FPGA. The shaping time required to form the trapezoidal waveform is set via parameters from the PC. Both the FAST and SLOW channels detect peak values digitally based on the peaking time (Peaking time = Rise time + Flat top time).

Processing is performed through two filter blocks: FAST and SLOW.
The FAST filter is used for timing acquisition and pile-up rejection.
The SLOW filter performs pole-zero canceling and baseline restoration, followed by energy analysis.

Signals from the preamplifier captured in the FPGA and the trapezoidal waveform processing signals can be output through a DAC (Digital-to-Analog Converter) and verified using a digital oscilloscope.

With the ROI-SCA function, peak detection timing within a pre-set ROI is available. Using the FAST-SCA function (optional), LVTTL logic output can be obtained at the input timing.

The Quick Scan function allows histogram data collected over external trigger intervals (minimum 10 ms) to be sent to the PC, where it can be continuously stored on the HDD. This is ideal for QXAFS measurements.

Settings and data acquisition for the DSP are performed using the included DSP application (hereinafter “this application”), which runs on Windows. In addition to the included application, programming is possible based on the command manual. Since DSP communication is only via TCP/IP or UDP network communication, no special libraries are required, and it can also be used in environments other than Windows.

3　Appearance

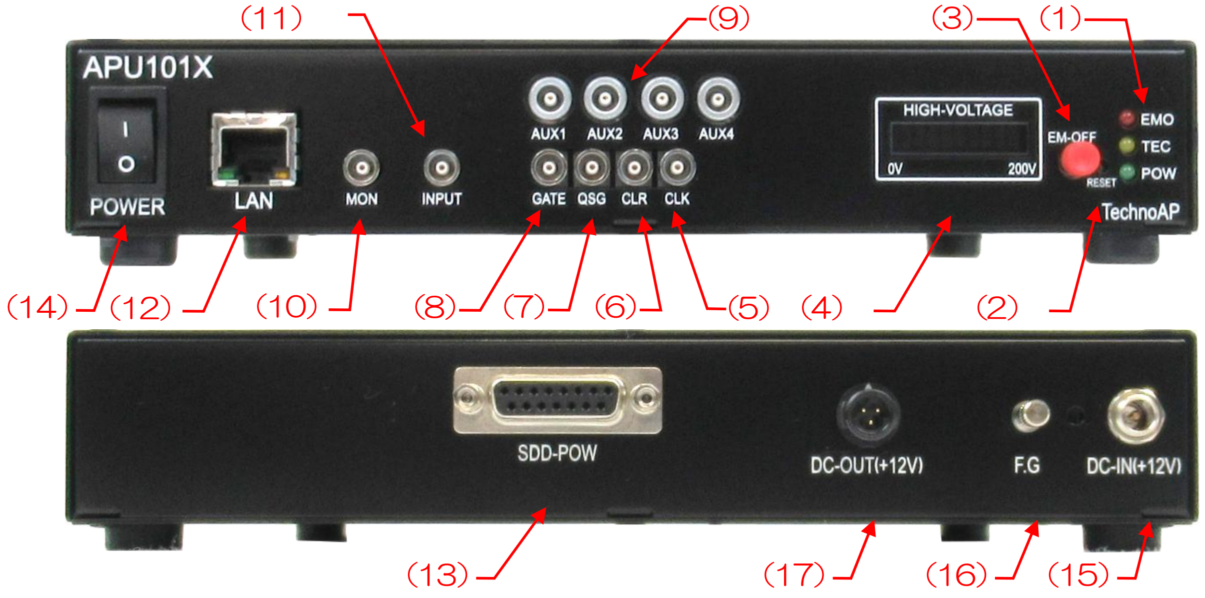


Figure 1: APU101X (Top: Front Panel, Bottom: Rear Panel)

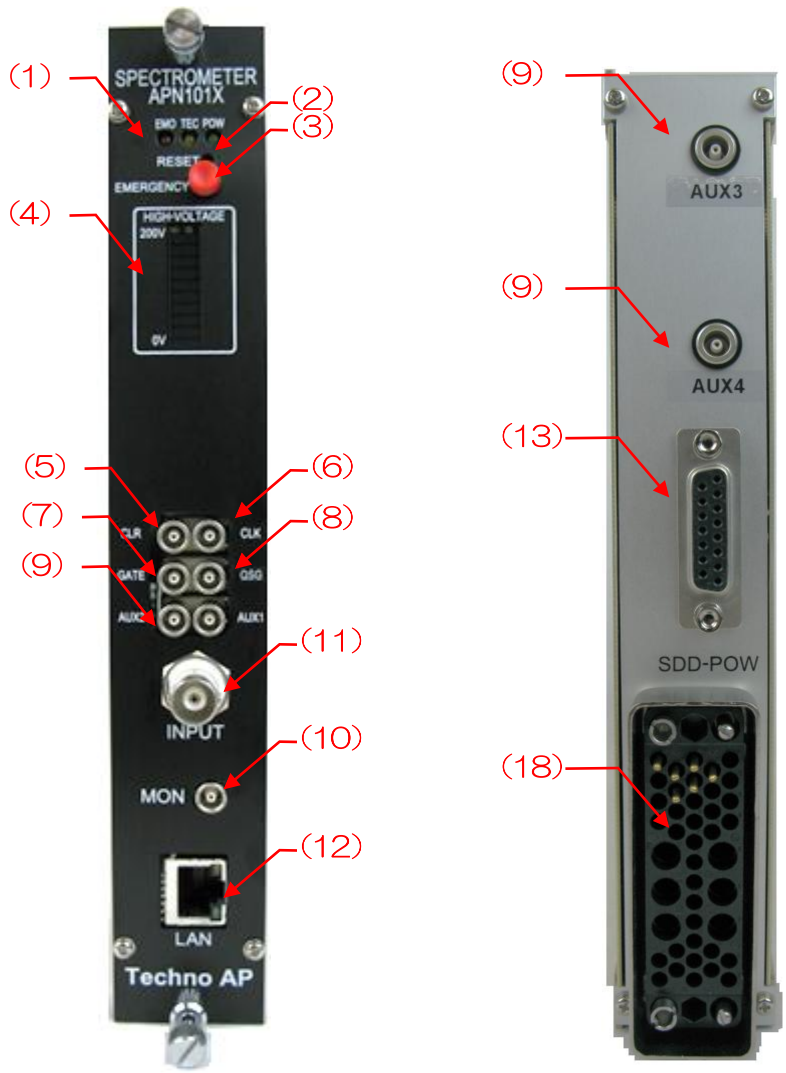


Figure 2: APN101X (Left: Front Panel, Right: Rear Panel)

(1) LED	EMO (Red): Lights when HV is applied under normal conditions, blinks during sweep. Blinks continuously during emergency. TEC (Orange): Lights shortly after power is turned on. POW (Green): Power lamp. Lights shortly after power is turned on.
(2) RESET	Button for restoring Ethernet connection if communication is lost. Use when hardware-level Ethernet reconnection (link-up) is required.
(3) EM-OFF	Emergency high-voltage (HV) off button. Use in emergencies, e.g., PC communication loss. Hold >3 s to turn off HV. Voltage decreases at sweep rate. HV LED off indicates voltage <20 V.To release emergency state: ensure HV is sufficiently low → close the application → turn off main power → wait more than 1 minute → turn on power → start the application.
(4) HIGH-VOLTAGE	HV monitor. Polarity ignored. 20 V per LED; each LED lights at ~20 V intervals.
(5) CLK	(Unused)
(6) CLR	LEMO 00.250-compatible connector for clear signal input. LVTTL logic signal. Applying a High-level signal longer than 20 ns clears the absolute counter.
(7) QSG	LEMO 00.250-compatible connector for Quick Scan external gate signal input. Accepts LVTTL gate signals from fan-out modules, etc. Minimum cycle: 10 ms (High-level 10 ms, followed by Low-level minimum 10 μs). During Quick Scan operation, negative edges are detected to switch histogram memory.
(8) GATE	LEMO 00.250-compatible connector for external gate signal input. Accepts LVTTL or TTL signals. Data acquisition is enabled while High.
(9) AUX1, AUX2, AUX3, AUX4	LEMO 00.250-compatible connectors for ROI-SCA output and FAST-SCA output (optional) functions.
(10) MON	LEMO 00.250-compatible connector for filter waveform output. Output voltage range: ±1 V (with 1 MΩ termination).
(11) INPUT	Input for preamplifier output signals. Unit type: BNC connector; NIM type: LEMO 00.250-compatible connector. Input voltage range: ±1 V. Input impedance: approx. 1 kΩ.
(12) LAN	RJ45 connector for Ethernet cable. Factory default IP address: 192.168.10.128.
(13) SDD-POW	D-sub 15-pin connector for detector power supply.
(14) POWER	(Unit type) Main power switch. ‘O’ = OFF, ‘I’ = ON. ※ Do not connect or disconnect cables while HV output or power is ON, as this may damage both the instrument and the detector.
(15) DC-IN	(Unit type) Power input plug. Connect the included AC adapter. The AC adapter features a screw-lock mechanism; fully insert and tighten the screw to prevent accidental disconnection.

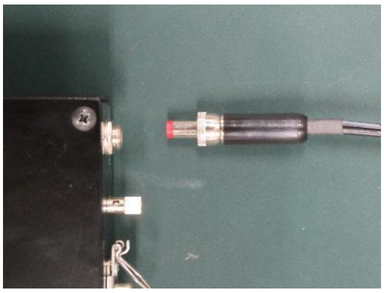


Figure 3: Screw-lock plug

(16) F.G　(Unit type) Connect a grounding wire to this terminal if a grounded wall outlet is not available or if the ground connection is weak.

(2) DC-OUT (+12V)　(Unit type) Connector for detector fan power supply. Connect with the included cable.
(NIM type) Use the included AC power adapter.

(3) NIM Bin Power Supply　(NIM type) Connect to the NIM bin power supply to provide power to this device.

※ Introduction of Conversion Adapter

The signal input/output connectors of this device use LEMO EPL.00.250.NTN connectors or connectors with the same shape on both ends. When using BNC connector cables, you can connect them to this device by using the conversion adapter shown below:

Manufacturer: Huber & Suhner
Model: 33_QLA-BNC-01-1/1--_NE
Description: QLA-01 to BNC
Connector Gender 1: Interface QLA-01
Connector Gender 2: Interface BNC
Figure 4: 33_QLA-BNC-01-1/1--_NE

Figure 4: 33_QLA-BNC-01-1/1–_NE

If interference occurs when using adjacent connectors, use a LEMO-BNC conversion cable as shown in the photo below.

Figure 5: Example of LEMO-BNC Conversion Cable

4 Setup

4.1 Application Installation

This application runs on Windows. To use it, you need to install the EXE (executable) file of this application and the LabVIEW Runtime Engine from National Instruments on your PC.

The application is installed using the installer included on the supplied CD. The installer contains both the EXE file and the LabVIEW Runtime Engine, allowing them to be installed simultaneously. The installation procedure is as follows:

If you are installing on a PC that already has other LabVIEW applications, make sure to close all LabVIEW applications beforehand.

(1) Log in to Windows with administrator privileges.

(2) Run setup.exe located in the Application (or Installer) folder on the supplied CD-ROM.
The installation proceeds through a dialog-based interface. The default installation folder is:
C:¥TechnoAP¥APP101X
The EXE file of this application and the configuration file containing settings (with the .ini extension) will be installed in this folder.

(3) Click Start → TechnoAP → APP101X to launch the application.

※To uninstall, select this application from **Add or Remove Programs** and delete it.

4.2 Cable Connection

Connect the cables required for measurements with this device. Make sure all power is **OFF** and follow the steps below:

(1) Confirm that the power of this device is OFF.

(2) Connect the device to the SDD-POW connector (D-sub 15-pin) using the supplied detector power supply cable.

(3) Connect the INPUT connector to the detector-side preamplifier output signal connector using a cable.

(4) Connect the LAN connector to the PC's LAN connector using a LAN cable.

(5) (For the unit type) Connect the round connector at the end of the supplied AC adapter to the DC-IN connector.

Perform the following if necessary:

Connect the MON connector to an oscilloscope using a cable.

Note: The oscilloscope is not required for every measurement, but it is useful during adjustment procedures to fully optimize the performance of the device and the detector.

4.3 Network Setup

Check the communication status between the device and the application using the following steps:

(1) Turn ON the PC and modify the network adapter settings as follows:

IP Address: 192.168.10.2 *(any address other than the one assigned to the device)*

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.10.1

(2) Turn ON the device and wait about 10 seconds after powering up.

(3) Check the communication status between the PC and the device. Open the Windows Command Prompt and execute the ping command to verify that the PC can connect to the device. The device's IP address is located on the back or bottom of the unit. The factory default network settings of the device are as follows:

IP Address: 192.168.10.128

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.10.1

> ping 192.168.10.128

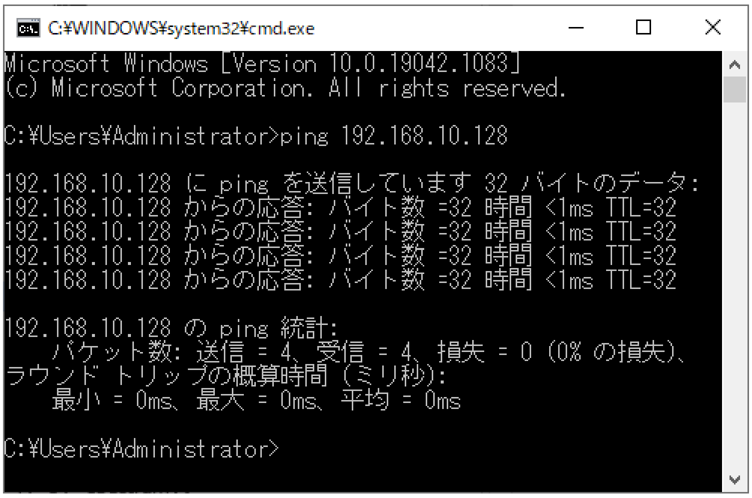


Figure 1: Verifying Communication Connection – Executing the ping Command

(4) Launch the application from the APP101X shortcut icon on the desktop.

If an error message appears indicating that the connection to the device has failed when starting the application, please refer to the troubleshooting section described later.

5 Application Screen

5.1 Startup Screen

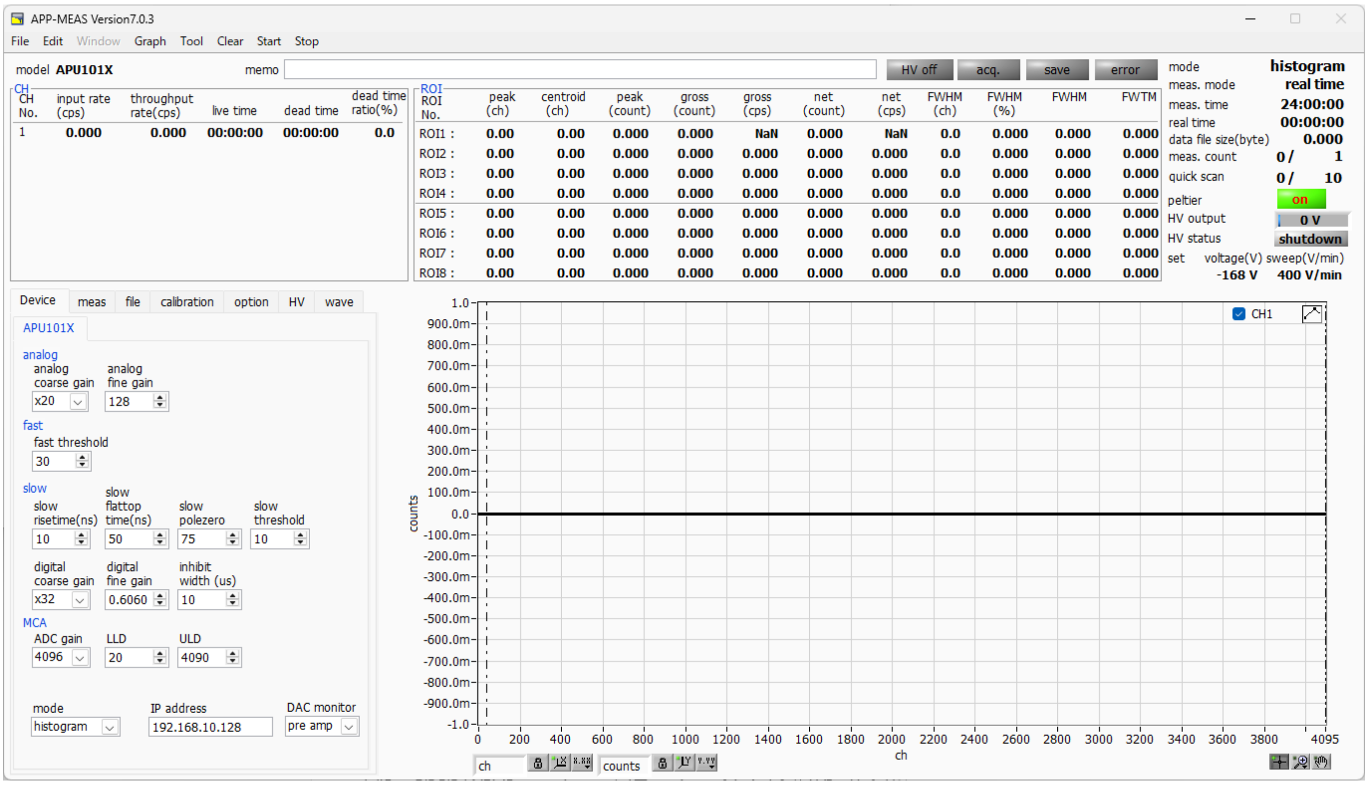


Figure 2: Startup screen (image may vary depending on optional configurations or updates)

• Menu

File - open config	Load a configuration file
File - open histogram	Load histogram data file
File - open wave	Load waveform data file
File - save config	Save current settings to a file
File - save histogram	Save current histogram data as CSV file
File - save wave	Save current waveform data as CSV file
File - save image	Save screen capture as a PNG file
File - convert to text from binary list data file	Open a screen to convert list data file to CSV
File – reconnect	Reconnect to the device
File – quit	Exit the application
Edit - IP configuration	Set IP address
Graph – histogram	Display histogram graph
Graph – wave	Display waveform graph
Tool - gauss fit analysis	Display Gauss fit screen; perform Gaussian fitting on specified peak and FWHM analysis
Tool - peak search analysis	Display peak search screen; detect peaks in histogram data and perform FWHM analysis
Tool – auto pole zero	Display automatic pole-zero adjustment screen

Tool - auto threshold	Display automatic threshold (wave acquisition timing t hreshold) setting screen
Tool – spectrum calculation	Display calculation result graph of two different spectrum data
Tool - create calibration file	Display screen to create energy calibration file and FWHM calibration file
Clear	Initialize histogram data / real-time data of the device
Start	Send measurement start command to the device
Stop	Send measurement stop command to the device

• Top of screen

model	Displays APU101X
memo	Free text box for managing measurement data
HV LED	Lights when output voltage ≥10V (HV on). Blinks during sweep (HV sweep).Off when output stopped (HV off)
acq. LED	Blinks during measurement
save LED	Lights when data is saved
error LED	Lights when an error occurs

• CH section

input rate(cps)	Count rate, events per second throughput rate(cps)Throughput count rate, processed events per second
live time	Live time (effective measurement time)
dead time	Dead time
dead time ratio(%)	Dead time ratio (%) per acquisition

• ROI section

peak (arbitrary unit)	Maximum count; unit depends on energy calibration
centroid (arbitrary unit)	Centroid calculated from total counts; unit depends on energy calibration
peak(count)	Maximum count
gross(count)	Total counts in ROI
gross(cps)	Total counts in ROI per second
net(count)	Total counts in ROI after subtracting background
net(cps)	Net counts in ROI per second
FWHM(ch)	Full width at half maximum (channels)
FWHM(%)	FWHM ÷ ROI energy × 100 (%)
FWHM (arbitrary unit)	Full width at half maximum; see FWHM calculation method; unit depends on energy calibration
FWTM (arbitrary unit)	1/10 width; width at 1/10 of peak height; unit depends on energy calibration

• Top-right section

mode	Displays current mode (e.g., histogram)
meas. Mode	Measurement mode (real time, live time, or auto stop)
meas. Time	Set measurement time
real time	Actual measurement time
data file size (byte)	Size of saved list or quick scan data file
	meas. count: Current / total measurement count
	(total count set in meas tab via repeat count)
HV output	Displays polarity and monitored output voltage (± ~1% error).

Monitored voltage may differ from set voltage depending on load

HV status LED	Lights when HV abnormality occurs (bias shutdown, emergency stop pressed, etc.)
voltage(V):	Output voltage set on the device
sweep voltage(V/min)	Output sweep voltage per minute set on the device

• Tabs

Device	APU101X tab; settings for CH, histogram, and list mode
meas	Settings for measurement operation and measurement time
file	Settings for data saving
calibration	Settings for ROI and energy calibration
option	Settings for options; includes waveform settings in wave mode
HV	Settings for the high-voltage power supply

5.2 Device Tab

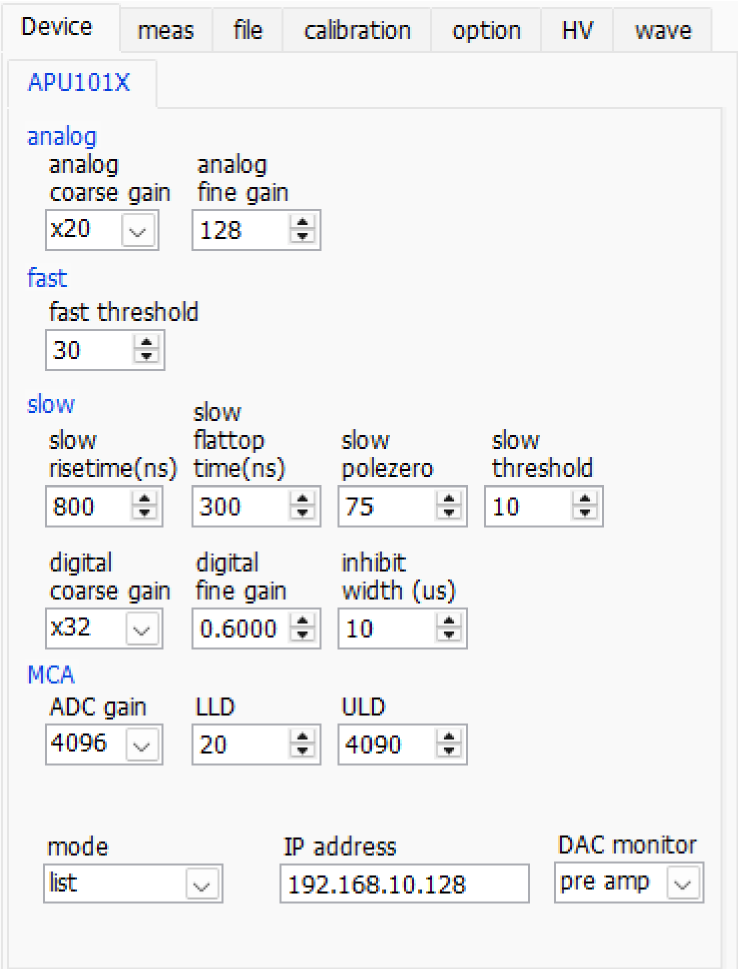


Figure 3 – Device Tab

【Analog Section】

Analog coarse gain — Selectable coarse analog gain (5×, 10×, 20×). Internally amplifies the preamplifier output signal.

Analog fine gain — Fine analog gain adjustment. Range: 0–255, equivalent to ×0.1 to ×1.5.

【Fast Section】

Fast threshold — Threshold for waveform acquisition start using FAST filter. Unit: digit. Range: 0–4095, default: 50 digits. Based on preamp output, the timing filter amplifier performs differentiation/integration to generate the FAST filter waveform. When the waveform exceeds this threshold, time information and spectroscopy amplifier waveform generation are triggered. If the threshold is too low, noise may be detected, increasing input total rate (cps). Set the threshold a few digits above the noise level while monitoring input total rate.

【Slow Section】

Slow risetime (ns)

Rise time of the SLOW (trapezoidal) filter, i.e., time to reach the top of the trapezoid. Short values reduce energy resolution but increase throughput; long values improve energy resolution but reduce throughput.

Typically set about 2× the linear amplifier time constant. Default: 800 ns (equivalent to 1 μs shaping time of linear amplifier).

Slow flat top time (ns)

Flat top time of the SLOW filter, i.e., width of the top of the trapezoid.

Adjust errors caused by variations in preamplifier signal rise/fall times. Set between 0–100 % of the preamplifier rise/fall time; typically twice the longest time. Default: 300 ns. In this case, the slowest rise (or fall) time is assumed to be 150 ns.

Throughput (DSP)　Calculated as

(slow rise time + slow flat top time) × 1.25

Slow pole zero

Pole-zero cancellation for the SLOW filter. Reduces undershoot/overshoot at the falling edge. Default: 75, adjustable depending on the detector. Connect MONI and oscilloscope, select SLOW filter, and adjust for a flat falling edge.

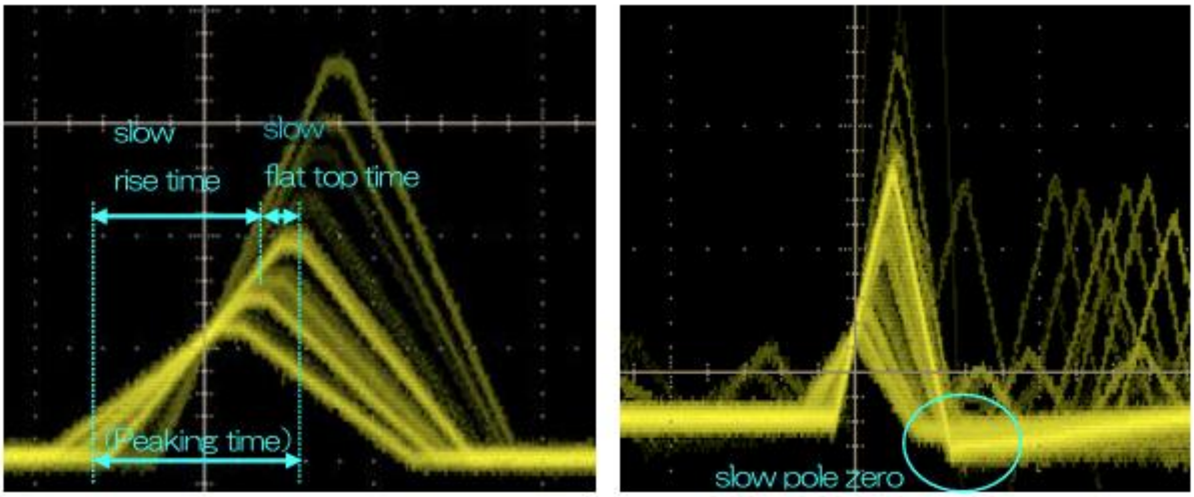


Figure 4: SLOW (Trapezoidal) Filter

※The right figure shows an example where the SLOW filter has an undershoot and the pole zero is not matched. In this case, lowering the value of the slow pole zero from the current setting will raise the undershoot portion upward.

slow threshold Setting range:	Threshold for the start timing of waveform acquisition in the SLOW filter. Unit: digit. 0 to 4095. Default setting: 50 digits. Adjust this value up or down and set it about 10 digits above the noise level where the throughput rate (cps) increases. Set below the LLD described later. In the generated SLOW filter waveform, when this threshold is exceeded, the pulse height at the pre-set time (slow rise time + slow flat top time) is secured.
digital coarse gain	Select the gain digitally from 1×, 2×, 4×, 8×, 16×, 32×, 64×, 128×. For trapezoidal filters, the integration circuit is calculated by sum-of-products operation. The larger the slow rise time is set, the more sum-of-products operations occur, resulting in larger values; the smaller it is set, the smaller the values. Since this value directly becomes the SLOW filter value, correction is required. Use together with the slow rise time setting.
digital fine gain	Digitally set the fine gain. Setting range: 0.3333× to 1×. Used for correction similarly to digital coarse gain. The SLOW filter pulse height changes according to the digital coarse gain and digital fine gain settings, so this can be used to adjust the peak position of the resulting histogram.
inhibit width (μs)	Dead time width from reset detection for transistor-reset type preamplifiers. The counts during this period are ignored internally without input from the detector inhibit signal.

【MCA section】

ADC gain	ADC gain (channels). Select from 4096, 2048, 1024, 512, 256 channels (ch). This sets the number of divisions on the horizontal axis of the histogram graph.
LLD	Energy LLD (Lower Level Discriminator). Unit: ch. Channels below this threshold are not counted. Set a value above the show threshold and below the ULD.
ULD	Energy ULD (Upper Level Discriminator). Unit: ch. Channels above this threshold are not counted. Set a value larger than the LLD and smaller than the ADC gain.

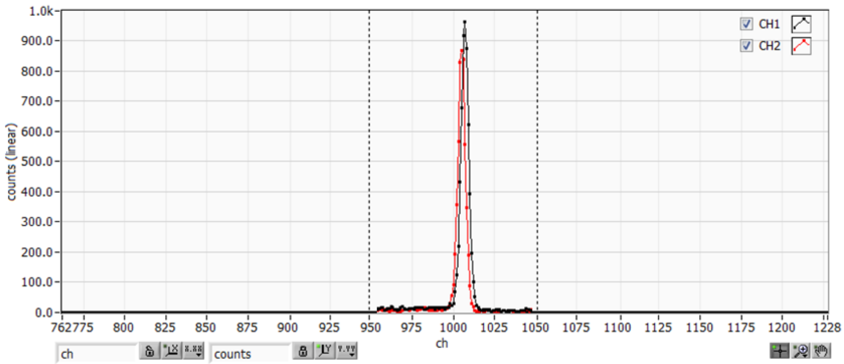


Figure 5: Example of LLD and ULD Settings

※The above figure shows an example where LLD is set to 955 and ULD to 1045.

It can be seen that portions below the LLD and above the ULD are not measured.

【Others】

mode	Selection of data processing histogram	
	Histogram	Histogram mode stores the peak heights of the preamplifier signal into up to 4096 channels and creates a histogram.
	Wave	wave mode acquires waveforms of preamp, fast, slow, and CFD, processed internally based on the preamplifier output signal.
	Quick scan	Quick scan mode. In this mode, a histogram is acquired each time a rising edge of LVTTL is received at the QSG (Quick Scan Gate) terminal. The minimum time interval is 10 ms. The peak heights of the preamplifier output signal are stored in 4096 channels to create a histogram.
	List	the preamplifier signal's timestamp, peak height, and channel number are treated as a single event data and continuously transferred to the PC. (Optional)
IP address	Displays the IP address of the device.	
DAC monitor type	Selection of DAC output waveform. Among the waveforms processed internally by the DSP, the selected waveform signal is output from the MON connector. By observing this signal with an oscilloscope, the processing state inside the DSP can be confirmed.	
	preamp	Differentiated preamplifier signal. Used to check whether the measurement target energy range is within 1 V at the time of internal acquisition and for analog pole-zero adjustment.
	fast	FAST filter signal.
	slow	SLOW filter signal. Used for pole-zero adjustment after waveform shaping.
	CFD	CFD signal. When using CFD timing, allows confirmation of CFD delay and function settings.

5.3　Meas Tab

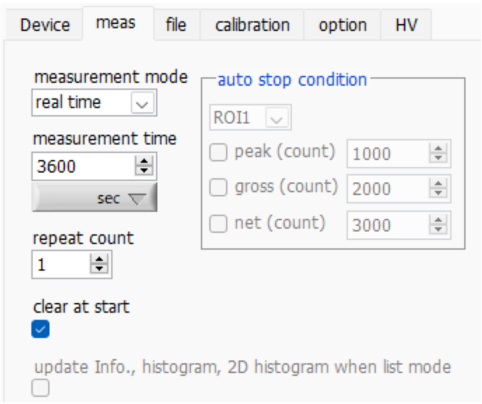


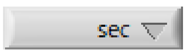
Figure 6　meas Tab

measurement mode　Select real time, live time, or auto stop.

- real time　Measures data in real time until the measurement time described later.
- live time　Measures until the effective measurement time (real time minus dead time) reaches the preset time.
- auto stop　Measures until the condition specified in the auto stop condition section described later is met.

measurement time　Measurement time setting. The range is from 00:00:00 to 781:00:00 in histogram mode, and up to 48:00:00 in list mode.

For auto stop above, this setting is ignored, and it automatically becomes 781:00:00.



Dropdown for switching display units.

repeat count　Specifies the number of repeated measurements.

clear at start　If checked, histogram data will be initialized at the start of measurement.

update Info, histogram, 2D histogram when list mode

During list mode measurement, CH data acquisition and display are performed. Histograms are also created from the received list data and displayed.

※Note※

Depending on the PC’s specifications, it may not be able to process all event data in time, so please be aware of this.

【auto stop condition section】

Specifies the stopping condition for a single measurement. If any one of the checked conditions is met, the measurement stops.

ROI selection　Select one ROI to be the target for the various counts below.

peak(count)　If the peak(count) of the selected ROI reaches or exceeds the specified value, the stop condition is met.

gross(count)　If the gross(count) of the selected ROI reaches or exceeds the specified value, the stop condition is met.

net(count)　If the net(count) of the selected ROI reaches or exceeds the specified value, the stop condition is met.

5.4 File Tab

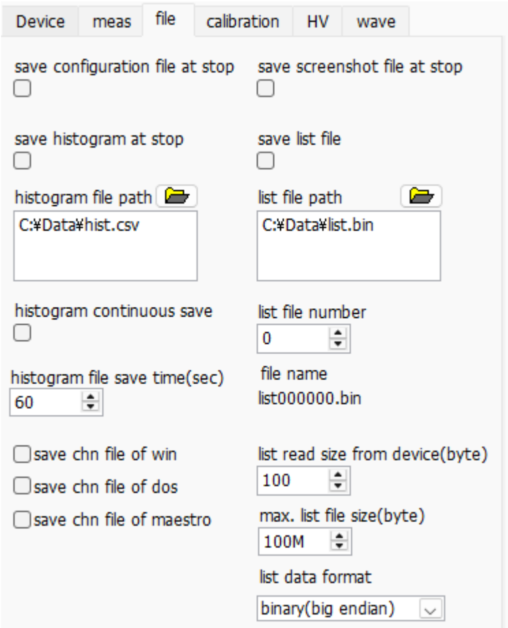


Figure 7 file tab

save configuration file at stop	Check to save the configuration file. The file extension will be .ini.
save histogram at stop	Saves the histogram data file when the measurement stops.
histogram file path	Set the absolute path for the histogram data file. Extension is optional. The data is not saved under this file name directly; instead, a timestamp string in the format "_YYYYMMDD_hhmmss" is appended to the specified name, followed by the extension. Example: If histogram file path is set to C:¥Data¥histogram.csv and the date/time is 2024/09/01 12:00:00, the data will be saved as: C:¥Data¥histogram_20240901_120000.csv
histogram continuous save	Check to save the histogram data file at regular intervals specified below. A time-tamp string will be appended to the file name.
histogram file save time	Specify the interval for saving the file as set above.
save screenshot file at stop	Check to save a screenshot of the application display when measurement stops. The file extension is .png.
save chn file of win	If “save histogram at stop” is checked, outputs the chn file (Windows version).
save chn file of dos	If “save histogram at stop” is checked, outputs the chn file (DOS version).
save chn file of maestro	If “save histogram at stop” is checked, outputs the chn file (Maestro version). Example: If histogram file path is set to C:¥Data¥histogram.csv and date/time is 2014/09/01 12:00:00, the following files are saved: C:¥Data¥histogram_20240901_120000_win_CH1.chn C:¥Data¥histogram_20240901_120000_dos_CH1.chn C:¥Data¥histogram_20240901_120000_maestro_CH1.chn

save list file — Set whether to save list data to a file. Only effective in list mode.

list file path — Set the absolute path for the list data file. Extension is optional.
※Note※
The actual saved file name will follow the format below, not exactly this name.
Example: If list file path is set to C:¥Data¥list_.bin and list file number is 0, the data will start saving as: C:¥Data¥list_000000.bin

list file number — Set the starting number appended to the list data file.
Valid range: 0 to 999999. Exceeding 999999 resets to 0.

file name — Displays the actual file name when saving, based on list file path and list file number.

list read size from device (byte)
Minimum read size of list data in bytes. Default is 10000. For high count rates, set 20000 bytes to allow the PC to receive more events. For low count rates, reduce this to receive fewer events.

max. list file size (byte) — Maximum size of the list data file. If exceeded during saving, a new file name is generated by incrementing the list file number, and saving continues.

list data format — Select the file format for saving list data: binary or text.
binary (big endian)
Big-endian binary format. Smaller file size. The most significant byte occupies the lowest memory address. Commonly used as network byte order. Easy to inspect data sequence visually.

binary (little endian) — Little-endian binary format. Smaller file size. The least significant byte occupies the lowest memory address. Used in Windows, macOS, Linux. Difficult to inspect data visually.

txt (CSV) — Comma-separated text format. Data can be easily viewed with Notepad, Excel, etc.
※Note※
Commas and line breaks are included, and as measurement time increases, the number of digits in time data also increases. This increases the data size per event and overall file size.

5.5 Calibration Tab

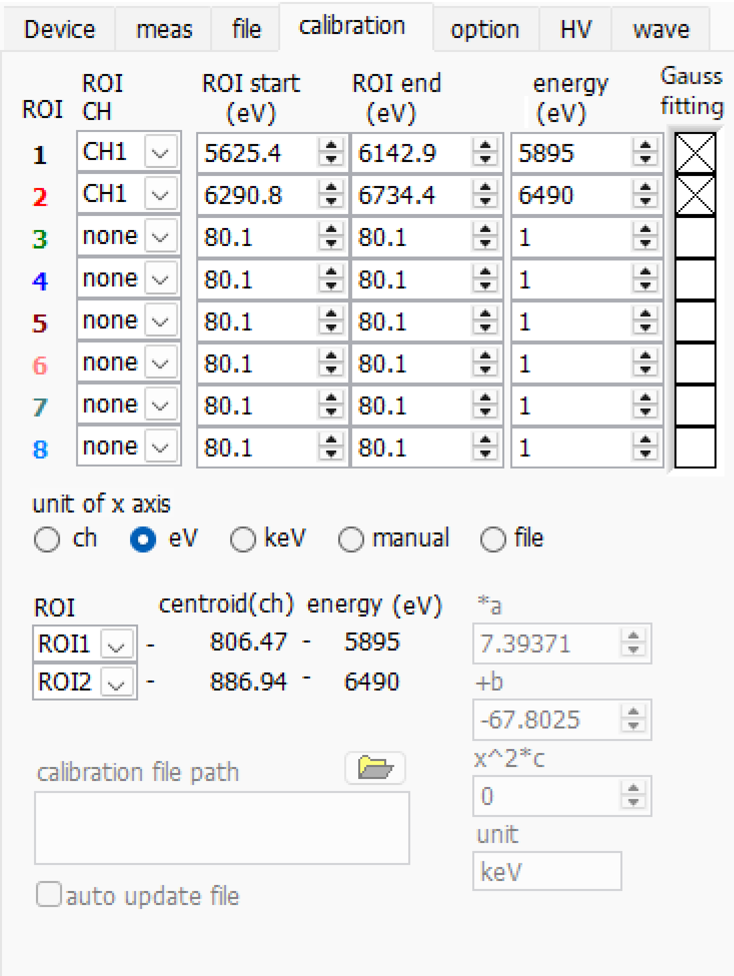


Figure 8 – histogram tab

ROI CH	Select the CH number to which the ROI (Region Of Interest) is applied. Up to 8 ROIs can be set per histogram.
ROI start	Start position of the ROI. The unit is as selected in “unit of x axis” described below.
ROI end	End position of the ROI. The unit is as selected in “unit of x axis” described below.
Energy	Definition of the energy value at the peak position (ch). For 55Fe, set to 5895 or 6490 (eV). When “ch” is selected in calibration described later, the peak within the ROI is detected, and eV/ch is calculated from the peak position (ch) and the set energy value, then applied to the FWHM calculation result.
Unit of x axis	Unit of the X-axis. The X-axis label will also change accordingly.

Ch — Display in channel units. Units of peak, centroid, FWHM, and FWTM in the ROI section are in channels.

eV — Display in eV. Using two-point calibration with two peaks (centroids) and energy values in one histogram, calculate slope a and intercept b of the linear function $y = ax + b$ so that ch is converted to eV on the X-axis. Units of peak, centroid, FWTM, FWHM in the ROI section become eV.

	keV	Display in keV. Using two-point calibration with two peaks (centroids) and energy values in one histogram, calculate slope a and intercept b of the linear function y = ax + b so that ch is converted to keV on the X-axis. Units of peak, centroid, FWTM, FWHM in the ROI section become keV. Example: If 55Fe has 5895 eV at 806.47 ch and 6490 eV at 886.94 ch, the two-point calibration automatically calculates a = 7.39371 and b = -67.80225.
	manual	Apply a and b of the linear function y = ax + b. Units can be set arbitrarily.
	File	Use the energy calibration file created with “create calibration file.” File extension is fixed as “.ec.” For details on energy calibration files, refer to the attached “Integrated Application Tool Manual.”

ROI — Select the ROI number referenced when calculating with eV or keV above. For single-point calibration, set one side to none.

a, +b, x^2c — Enter arbitrary values used when “manual” is selected above. When eV, keV, or file is selected, values calculated at that time are displayed.

Unit — Enter arbitrary units used when “manual” is selected above.

calibration file path — Specify the file name used in “file” above.

auto update file — Check to periodically update the file specified in calibration file path. The ROI selected in the energy calibration file creation screen is used for calculation. See the attached “Integrated Application Tool Manual” for details.

Gauss fitting — Apply Gaussian function fitting to the peak waveform within the ROI range and output the result.

5.6 Option Tab

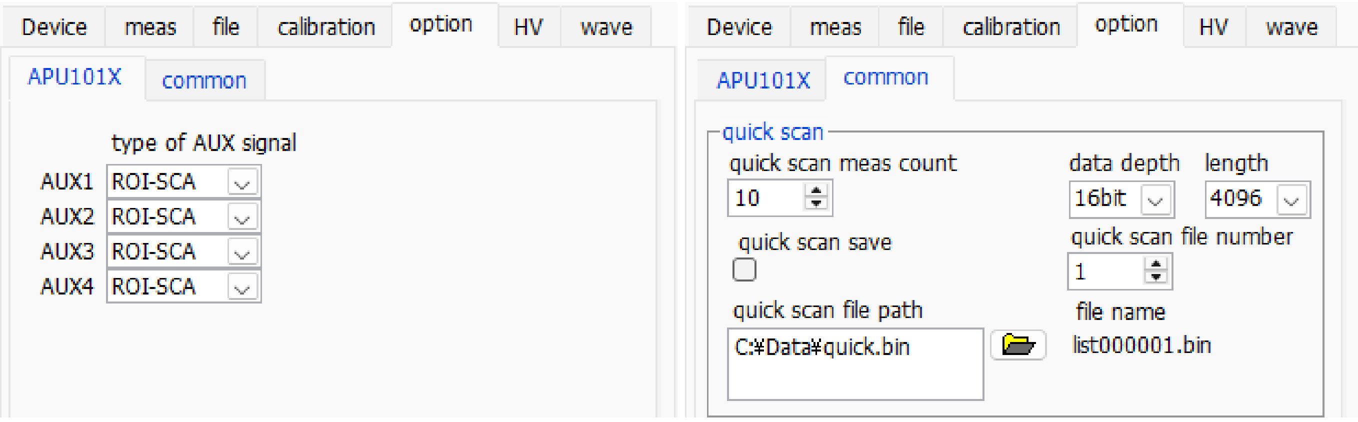


Figure 9 – option tab (common tab)

type of AUX signal	When ROI-SCA is selected, if energy is detected within the CH number and ROI range set in the calibration tab described above, an LVTTL logic output as an SCA (Single Channel Analyzer) can be obtained from the corresponding AUX terminal. When fast (optional) is selected, an LVTTL logic output can be obtained at the input timing.
【quick scan section】	
Quick scan meas count	Number of data reads in quick scan mode.
Quick scan save	Set whether to save quick scan data to a file. Only effective when quick scan mode is selected.
Quick scan file path	Set the absolute path of the quick scan data file. Extension can be omitted.
Data depth	As described in section 9.3, input count data can be added to quick scan data, expanding the data from 16-bit to 32-bit (optional).
Length	Select the number of divisions of pulse heights to acquire in quick scan data from 4096 or 8192 (optional).
Quick scan file number	Set the starting number to append to the quick scan data file. The range is 0 to 999999. If it exceeds 999999, it resets to 0.

5.7 HV　Tab

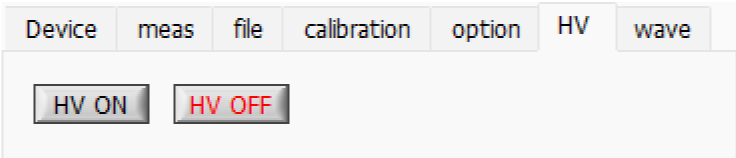


Figure 10 – HV tab

HV ON　High-voltage output ON button. After clicking, the voltage ramps up at the rate specified in sweep voltage (V/min) described below.

HV OFF　High-voltage output OFF button. After clicking, the voltage ramps down at the rate specified in sweep voltage (V/min) described below.

【HV Monitor Section】

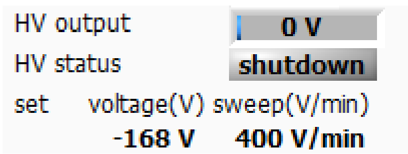


Figure 11 – HV Monitor Section

set voltage (V)　Setting of the high-voltage output value. Default setting is −168 V output.

sweep voltage (V/min)　Rate of increase/decrease of the high-voltage output (V/min). Default setting is 400 V/min.

5.8 Wave Tab

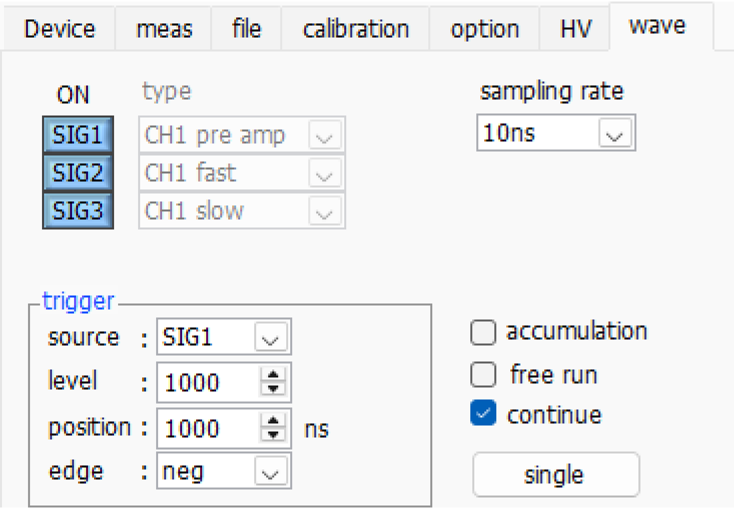


Figure 12 – Wave Tab

ON	Sets whether waveform display is enabled.
Type	Selects the type of waveform to display.Fixed on this device.
	CH1 preamp Preamp signal
	CH1 fast FAST filter signal
	CH1 slow SLOW filter signal
Sampling rate	Sets the sampling frequency of the displayed waveform. Choose from 10 ns, 20 ns, 40 ns, or 80 ns as the sampling interval.
【Trigger Section】	
Source	Trigger source. Select the waveform number to trigger.
Level	Threshold for waveform acquisition trigger. Similar to a rising-edge trigger on a digital oscilloscope. When this threshold is exceeded, the trigger activates, and waveform data is acquired. Setting 0 enables free-run operation (acquires data approximately every 1 s regardless of threshold) useful for estimating threshold values.
Position	Offset points to the triggered location. Use this to capture waveform data before the trigger point.
Edge	Select the edge for trigger timing: rising or falling.
	- neg Falling edge
	- pos Rising edge
Accumulation	Enable/disable overlaying multiple waveform data acquisitions.
Free run	Acquire waveforms regardless of trigger.
Continue	Select continuous waveform acquisition.
Single	Execute single-trigger acquisition (one measurement).

5.9 Graph

Histogram Graph

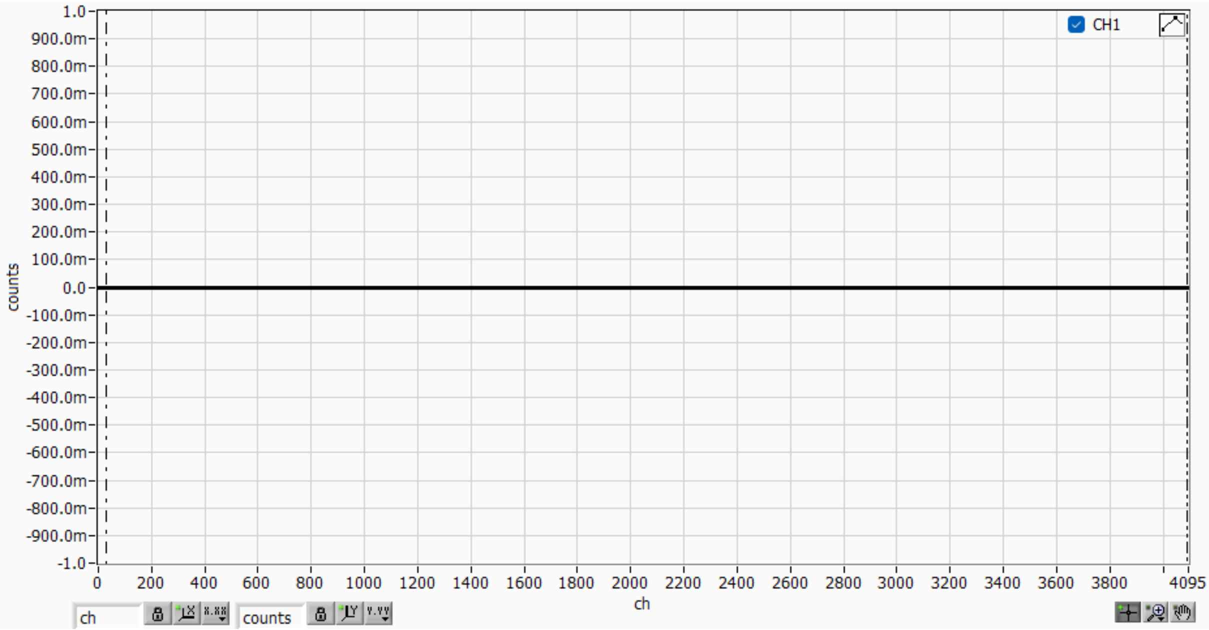


Figure 13 Histogram Graph

Graph — Histogram graph. When histogram is selected in the mode of the Device tab, the energy histogram is displayed during measurement.

Legend Checkbox — Select whether to display the histogram on the graph.

X-axis Range — Right-click on the graph or the X-axis and check “Auto Scale” for automatic scaling. Uncheck it to disable auto scale, fixing the minimum and maximum X-axis values. To change the minimum or maximum, place the mouse pointer over the value to be changed and click or double-click.

Y-axis Range — Right-click on the graph or the Y-axis and check “Auto Scale” for automatic scaling. Uncheck it to disable auto scale, fixing the minimum and maximum Y-axis values. To change the minimum or maximum, place the mouse pointer over the value to be changed and click or double-click.

Cursor Move Tool  — Allows moving the cursor on the graph with the mouse, useful for setting ROIs.

Zoom  — Click to select and execute one of six types of zoom-in and zoom-out options.

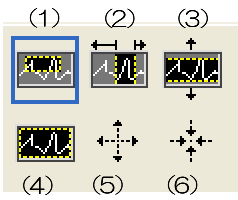


Figure 14 Graph Zoom-In and Zoom-Out Tool

(1) Rectangle: Zoom. Using this option, click a point on the display to define a corner of the zoom area, then drag the tool until the rectangle covers the desired zoom region.

(2) X-Zoom: Zoom in along the X-axis of the graph.

(3) Y-Zoom: Zoom in along the Y-axis of the graph.

(4) Fit Zoom: Automatically scale all X and Y axes on the graph.

(5) Zoom Out Centered on Point: Click the point that will serve as the center for zooming out.

(6) Zoom In Centered on Point: Click the point that will serve as the center for zooming in.

Pan Tool: Grab the plot to move the graph around.

• wave Graph

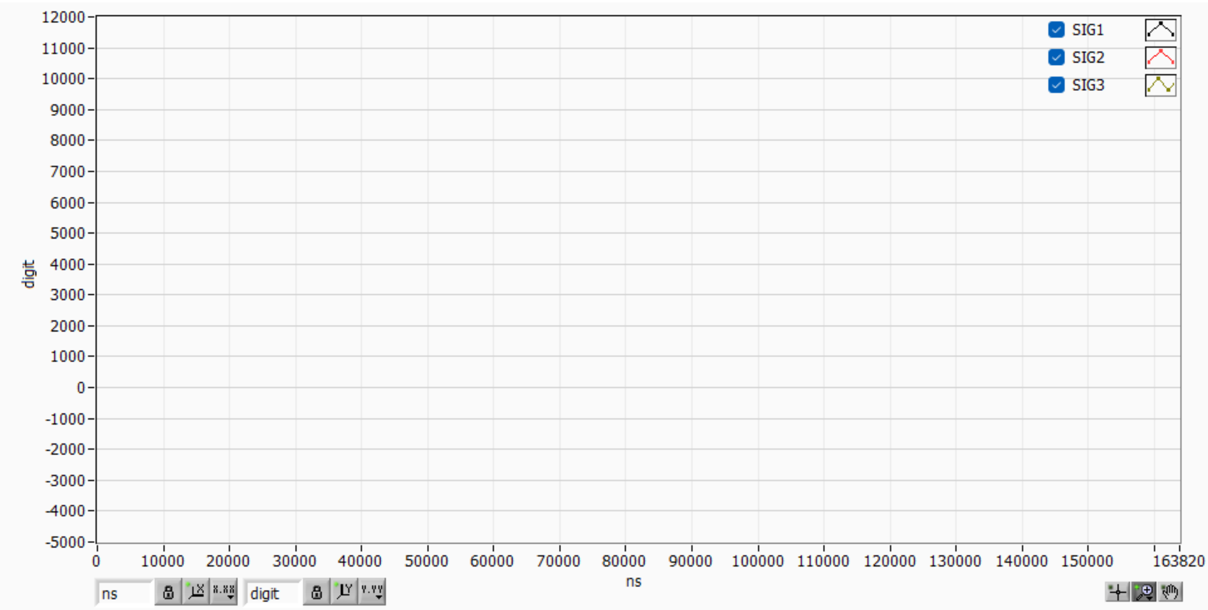


Figure 15 Wave Graph

Graph Wave graph. When "wave" is selected in the mode of the Device tab, the processed waveform signal is displayed during measurement.

6 Initial Setup

6.1 Connections and Power

(1) Confirm the cable connections as described above.

(2) Connect the MON connector to the oscilloscope if necessary.

(3) Turn ON the power of the device.

(4) Turn ON the PC.

(5) Launch the application.

6.2 High-Voltage Power Application

Check and operate the high-voltage power status using the HV tab and HV monitor section described above.

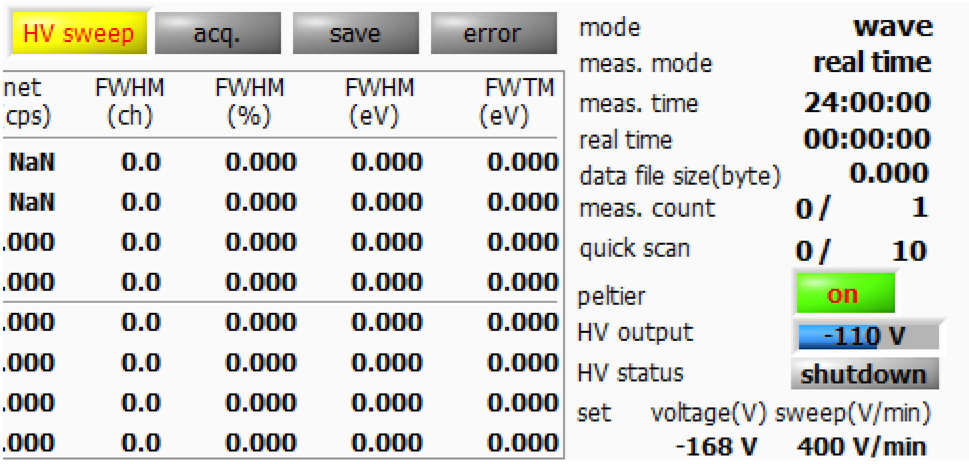


Figure 16 Checking the Peltier and High-Voltage Power Status

(1) Confirm that the Peltier LED is lit green.

(2) Confirm that the HV LED is off.

(3) Confirm that the HV status LED is off.

(4) Confirm that the set voltage is around -168 V.

(5) Confirm that the set sweep voltage is 400 V/min.

(6) Apply the high-voltage power to the detector by clicking the HV ON button. After execution, the HV LED will blink yellow, and the HV output value and slider will increase. When the voltage reaches near the set voltage, the HV LED will light green.

6.3 Checking the Preamp Output Signal

Connect the preamp output signal to an oscilloscope and confirm the pulse height (mV) and polarity.

For transistor-reset type preamps, an upward slope indicates positive polarity, while a downward slope indicates negative polarity.

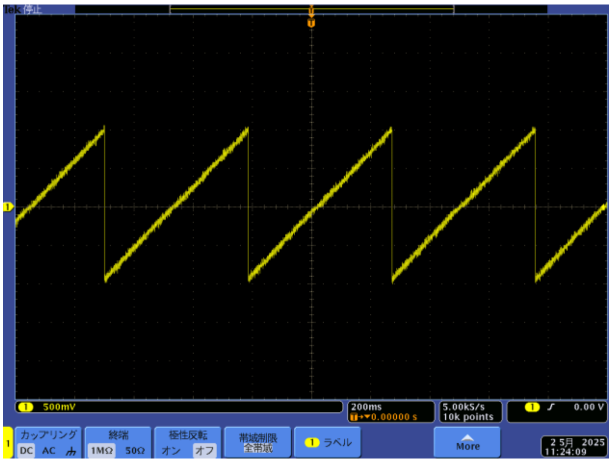


Figure 17: Transistor-reset type preamplifier waveform (for positive polarity)

6.4 Executing Settings

Configure the Device tab and other relevant settings. An example of settings is provided below.

※Note※

Optimal settings may vary depending on the detector, preamp, and environment used.

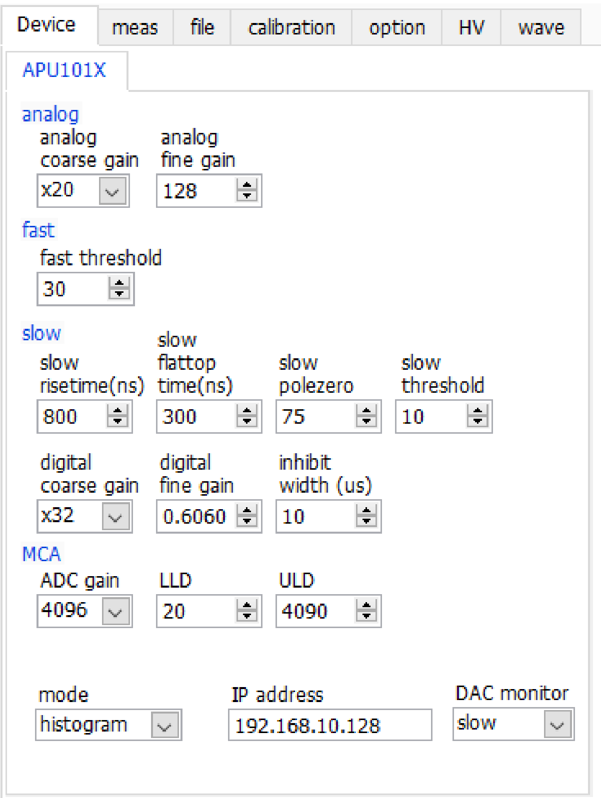


Figure 18: Example of Device Tab Settings

6.5 Confirmation of the Input Range of the Preamplifier Output Signal

The analog input range of the ADC implemented in this device is ±1 V centered on the circuit ground level. You can check whether this range covers the signal amplitudes corresponding to the X-ray energy range of interest using the output signal from the MON connector.

(1) Set the DAC monitor in the application to “pre amp.”
(2) Input a signal with a known energy to the INPUT connector.
(3) Confirm the signal output from the MON connector using an oscilloscope.
(4) While switching the analog coarse gain, adjust so that the amplitude of the preamplifier signal corresponding to the energy range of interest is within ±1 V.
(5) For example, when measuring up to 20 keV, if a ^55Fe checking source is available, align the densest part of the overlapping Kα line (5895 eV @ ^55Fe) to below 196 mV.

196 mV ≒ 5.895 keV ÷ 30 keV × 1000 mV

The analog coarse gain setting can be selected and adjusted in the CH tab under “analog coarse gain.”
The analog fine gain can be adjusted from 0.5× to 1.5×. Digital fine gain adjustment is also possible, but unlike that, adjusting the preamplifier signal itself can improve the signal-to-noise ratio (S/N).

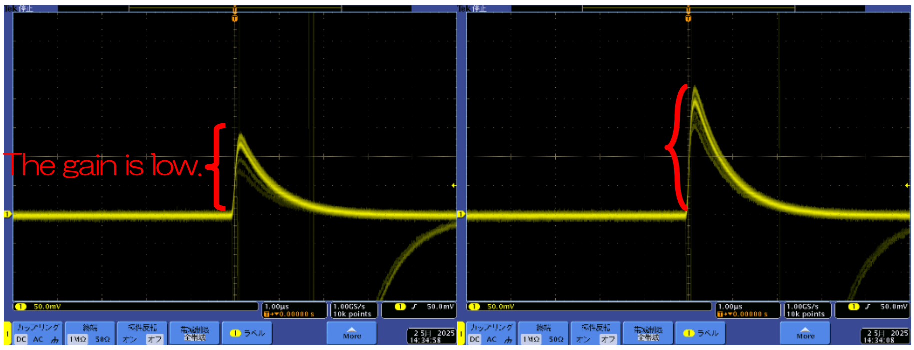


Figure 19: DAC monitor preamp signal from the MON connector
(Left: Before adjustment, Right: After adjustment)

6.6 SLOW Filter Settings

The SLOW trapezoidal shaping is applied to the preamplifier output signal. As the algorithm for the trapezoidal filter, the filter block configured in a pipeline architecture calculates the values required for the trapezoidal filter—such as delays, addition/subtraction, and integration—synchronized with the 100 MHz clock of the ADC.

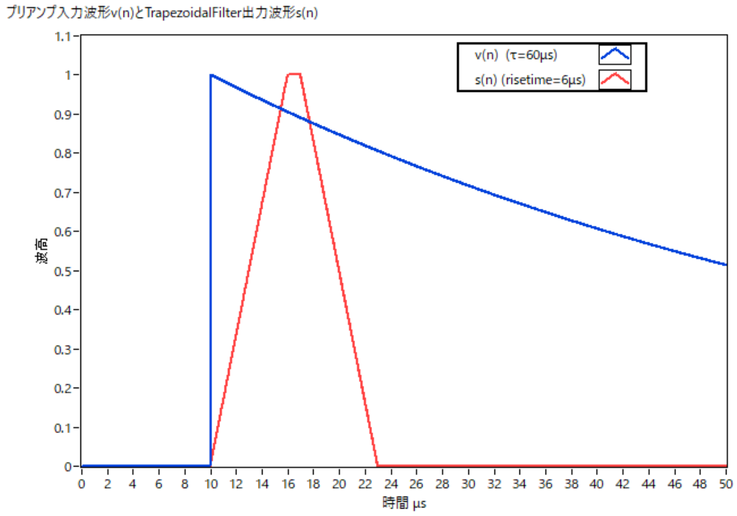
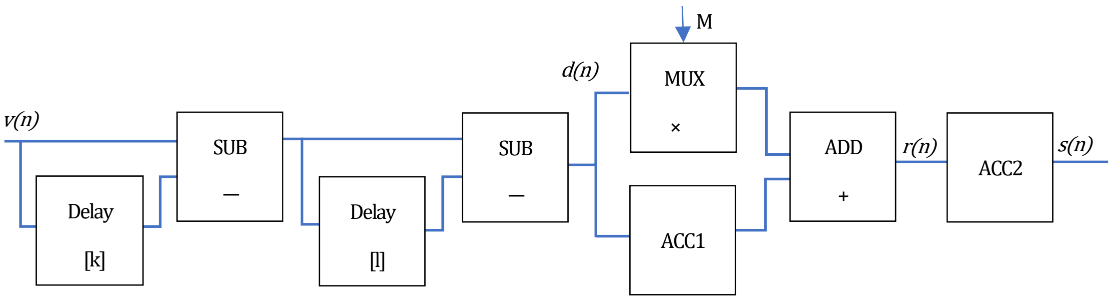


Figure 20: SLOW Filter (red)



$$d(n) = v(n) - v(n-k) - v(n-l) + v(n-k-l)\,,$$
$$p(n) = p(n-1) + d(n)\,,$$
$$r(n) = p(n) - M * d(n)\,, \quad n \geq 0\,,$$
$$s(n) = s(n-1) + r(n)\,, \quad n \geq 0\,,$$

$Where:$

$k:\ risetime\,,$

$l:\ risetime + flottoptime\,,$

$M:\ pole\ zero$

References:

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

Figure 21: SLOW Filter (Trapezoidal Filter) Block Diagram and Equations

The figure below shows the difference in pulse response compared to the conventional analog Semi-Gauss Filter. Compared to the Semi-Gauss Filter, the DSP achieves approximately half the time to the peak and about one-third the pulse width.

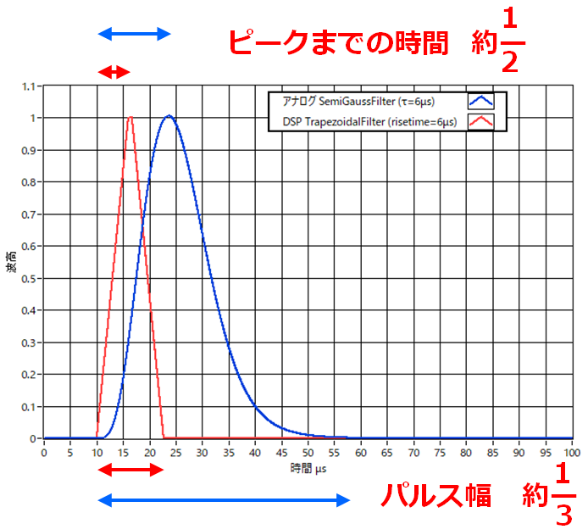


Figure 22: Difference in response between the Trapezoidal Filter and the Semi-Gauss Filter.

Despite the fast pulse response of the DSP, as shown in the figure below, it can acquire data while maintaining energy resolution even at high rates.

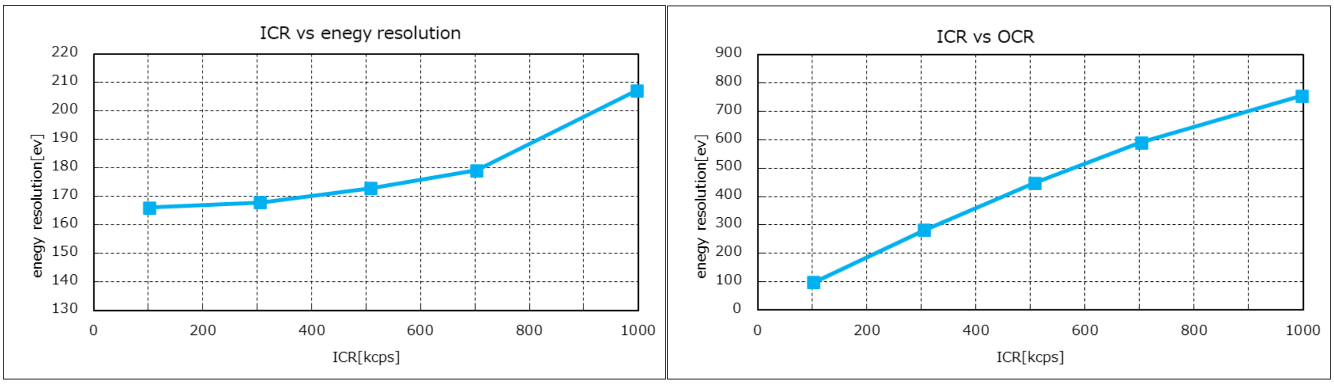


Figure 23: Count rate and energy resolution of the Trapezoidal Filter

The SLOW filter settings are as follows:

(1) Connect the MON connector to an oscilloscope, select the corresponding channel in DAC monitor CH, and set DAC monitor type to slow. Prepare the oscilloscope so that the signal can be observed.
(2) To match the condition when the linear amplifier's shaping time is 0.5 µs, set the slow rise time to 800 ns. This value affects the energy resolution. Setting it shorter allows higher counting rates but reduces energy resolution. Conversely, setting it too long may prevent sufficient counts.
(3) Set the slow flattop time. Adjust in ±100 ns increments while checking the energy resolution (FWHM).
(4) Set the slow pole zero. This adjustment reduces overshoot or undershoot in the falling edge of the SLOW filter. The optimal value varies by detector, so adjust while observing on the oscilloscope.

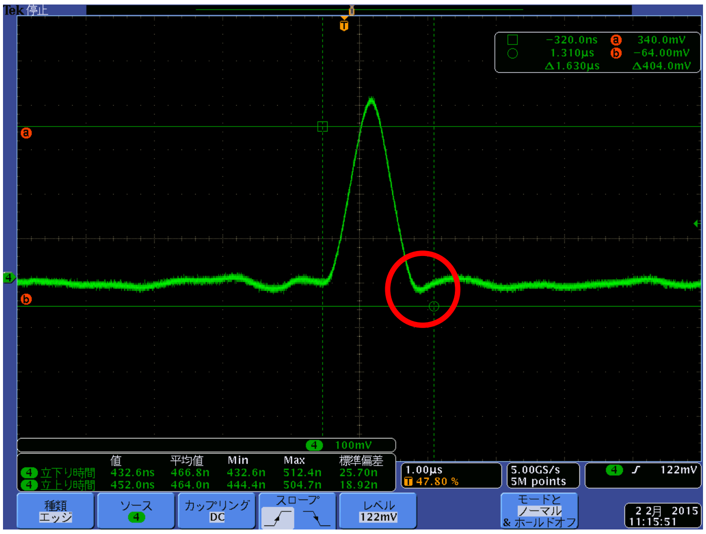


Figure 24: After adjusting the slow pole zero.

6.7 Setting the SLOW Filter Threshold

First, enter a relatively large value (around 100) and observe the throughput rate (cps). Gradually decrease the slow trigger threshold and identify the value at which the throughput rate (cps) increases significantly. This value represents the boundary between signal and noise, so set the threshold approximately 3–10 digits above this point.

6.8 Signal Processing via External Input Connectors

By using the GATE, VETO, CLR, and CLK connectors, the following signal processing can be performed. When using these, LVTTL or TTL level signals are required. The acceptable High signal level is 2–5 V; however, the system is optimized for 3.3 V signals, so it is recommended to use signals below 3.3 V. (The required signal amplitude and pulse width vary depending on the type of signal processing used.)

Data Acquisition Using the GATE Signal

When you want to acquire event data at the occurrence of a specific event, use the GATE connector. Data is acquired when the signal is High and not acquired when it is Low. The procedure is as follows:

1: Observe the SLOW filter "slow" signal from the DAC monitor output using an oscilloscope.

2:Apply a GATE signal that covers the SLOW filter pulse range—approximately from the rising edge to the falling edge of the slow signal—to ensure proper event capture.

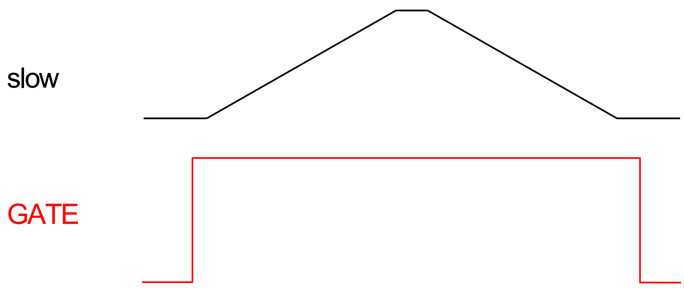


Figure 25　External Gate Timing

Data Acquisition Using VETO Signal

If you want to discard event data when a specific event occurs, use the VETO connector. Measurement occurs when the VETO signal is Low, and it is not performed when the signal is High. The required pulse width is the same as for the GATE signal, covering the period during which the SLOW filter waveform is finalized.

Use of External Clock

Not used.

Use of External CLR

If you want to zero-clear the measurement time with an external timing signal, use the CLR connector. Clearing occurs when the signal is High. Input a signal with a High-level pulse width of at least 50 ns so that the system can reliably detect the CLR input.

6.9 Method for Calculating Full Width at Half Maximum (FWHM)

The FWHM (Full Width at Half Maximum) displayed in the ROI section is calculated as follows.

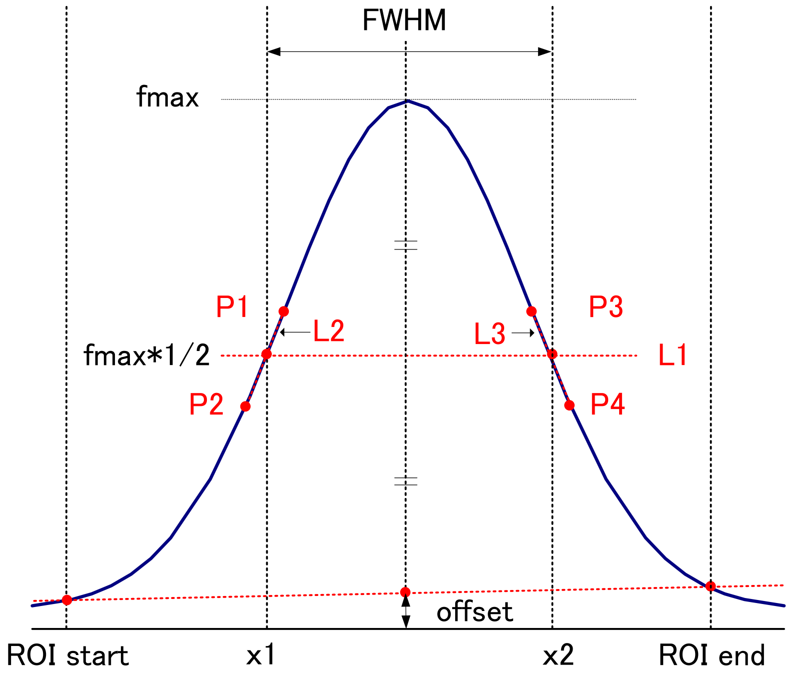


Figure26: FWHM Calculation

(1) Detect the maximum value fmax within the ROI range between ROI Start and ROI End in the histogram.

(2) Draw a straight line connecting the intersection points of the histogram with ROI Start and ROI End. Determine the intersection of this line with the vertical line from the peak value fmax down to the X-axis to calculate the background offset (offset).

(3) Subtract the offset from fmax, take half of this value, and draw a horizontal line L1 parallel to the X-axis at this level.

(4) Identify the two intersection points of the histogram with L1 by detecting the surrounding points P1 and P2, and P3 and P4.

(5) Draw straight lines L2 connecting P1 and P2, and L3 connecting P3 and P4.

(6) Determine the X-coordinate x1 of the intersection between L1 and L2, and x2 of the intersection between L1 and L3.

(7) Calculate FWHM as the difference x2 - x1.

7　Measurement

※ This section describes the measurement procedure, assuming that power and high voltage have already been applied to the detector and preamplifier, and that the preamplifier signal is being input to the INPUT connector.

7.1　Initialization

Click the menu item Clear. This will initialize the histogram data inside the device.

If you want to continue from the previously measured histogram or results, do not click Clear and proceed to the next measurement.

7.2　Start Measurement

- Click the menu item Start to begin measurement.
- The CH section will display the measurement status of each channel.
- The acq. LED will blink.
- The measurement time setting will be shown in the measurement time field.
- The real time obtained from the DSP will be displayed in the real time field.

7.2.1 In Histogram Mode

- The mode field will display histogram.
- Calculation results will be shown in the ROI section.
- The histogram tab will display the histogram.

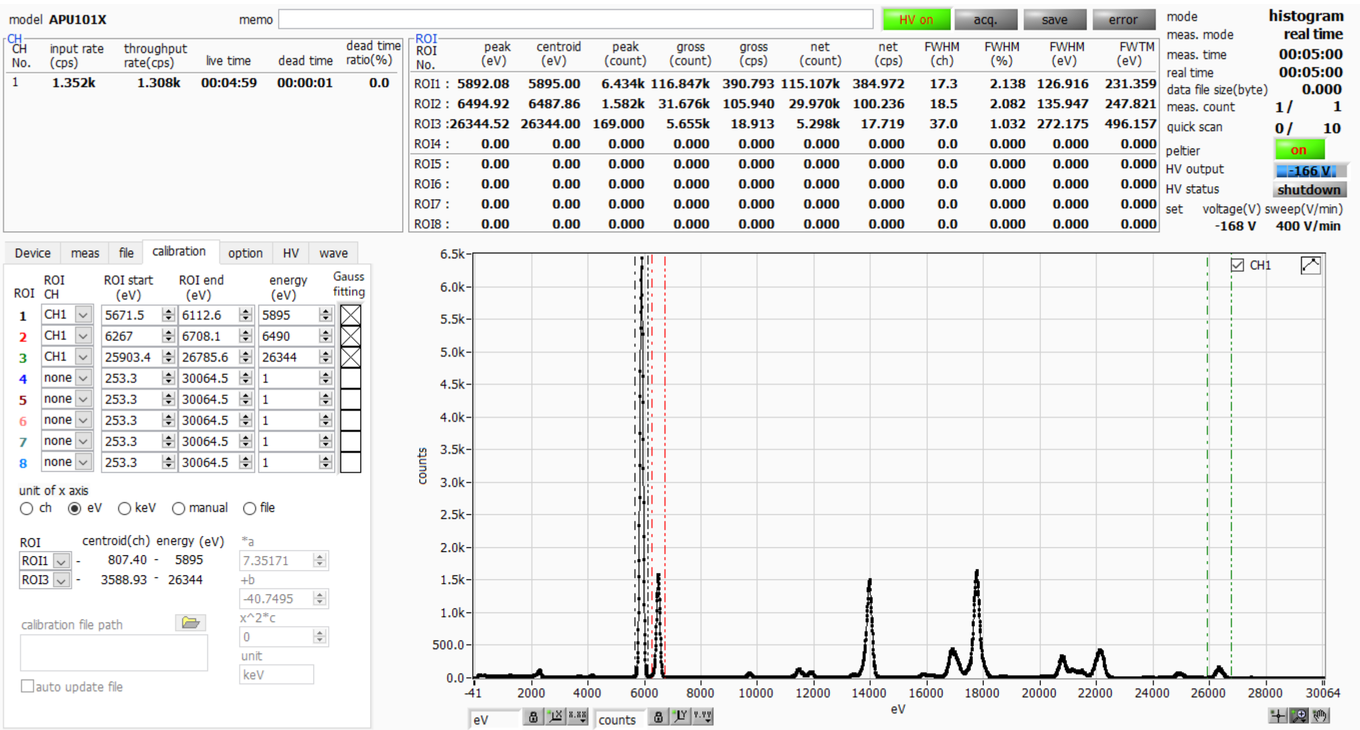


Figure27　Histogram mode

7.2.2 In Wave Mode

The mode field will display waves.

Waveform information will be displayed in the wave graph.

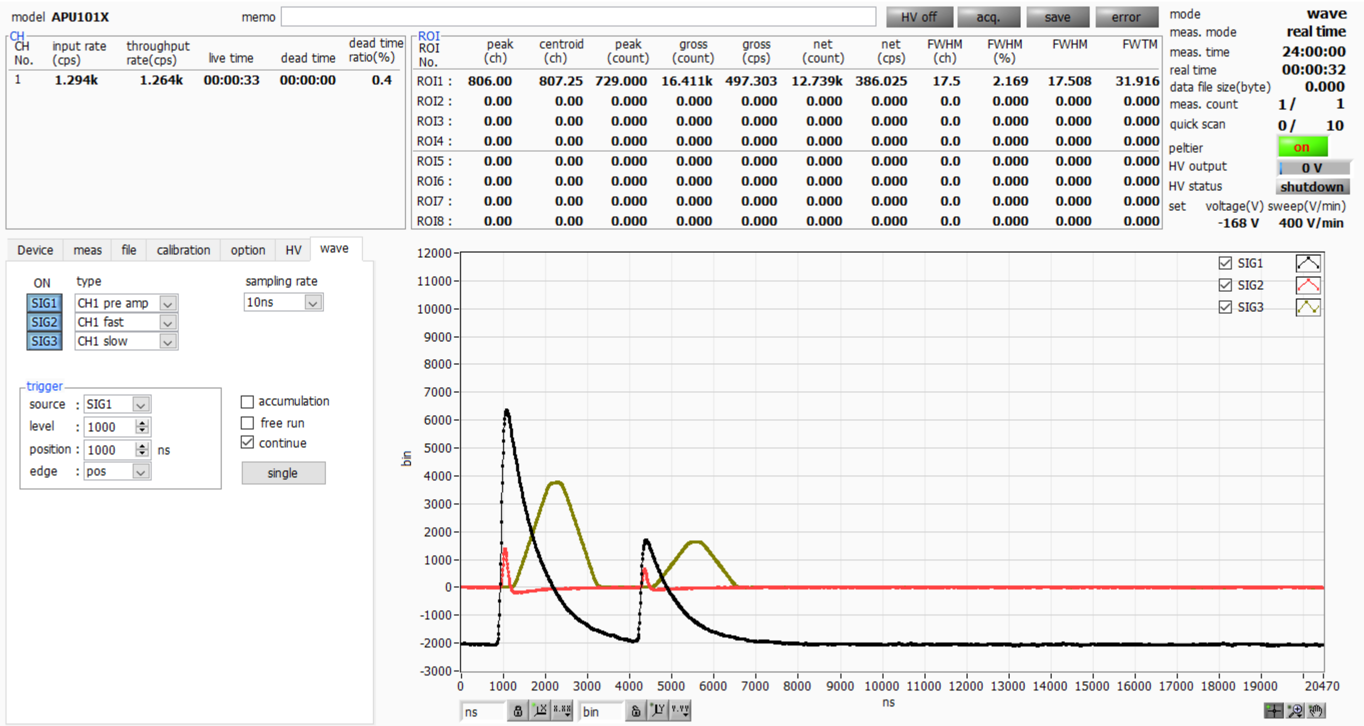


Figure 28 Wave mode

7.2.3 In Quick Scan Mode

- The mode field will display quick scan.
- Before starting measurement, the QSG terminal signal must be 0 V (LOW level).
- Click the Start menu; when the acq. LED begins blinking, a data file is generated and the system waits for an LVTTL signal at the QSG terminal.
- When a rising edge of the LVTTL signal at the QSG terminal is detected, CH1 spectral data are generated while the signal remains High. After detecting the falling edge, the data are transferred to the PC, which saves the read data to a file. The number of falling edges detected corresponds to the pre-set quick scan meas. count.
- The pulse width of the signal at the QSG terminal is, for example, a 10 ms High state followed by a minimum 10 µs Low state, counted as one cycle.

7.2.4 In List Mode

- “mode” is displayed as “list.”
- The save LED blinks, and the current file size being saved is shown in “list file size (byte).”

7.3 Stopping Measurement

- The measurement ends automatically when the real time reaches the measurement time.
- To stop the measurement manually, click the “Stop” menu. The measurement will halt immediately after execution.

8 Shutdown

8.1 Lowering the High Voltage Output

Click the “HV OFF” button to turn off the high voltage output. After execution, the voltage will ramp down at the rate set in “sweep voltage.” During ramp-down, the output LED blinks. When the output voltage approaches 0 V, the output LED turns off.

8.2 Exiting the Application

Click “File – Quit” from the menu. In the confirmation dialog, click “Quit.” The application will terminate after execution.

9 File

9.1 Histogram Data File

(1) File Format

Comma-separated CSV text format

(2) File Name

User-defined

(3) Structure

Consists of Header, Calculation, Status, and Data sections.

[Header]	
Memo:	Notes
Measurement mode	Measurement mode (Real Time or Live Time)
Measurement time	Measurement time in seconds
Real time	Real time
Live time	Live time
Dead time	Dead time
Start Time	Measurement start time
End Time	Measurement end time
※For the following CH:	
ACG	Analog coarse gain
ADG	ADC gain
FIT	FAST filter integration
FDT	FAST filter differentiation
SFR (ns)	SLOW rise time
SFP (ns)	SLOW flat top time
FPZ	FAST pole-zero cancel
SPZ	SLOW pole-zero cancel
FTH	FAST threshold
LLD	Energy LLD
ULD	Energy ULD
STH	SLOW threshold
PUR	Pile-up reject
POL	Polarity
DCG	Digital coarse gain
DFG	Digital fine gain
TMS	Timing selection
CFF	CFD function
CFD	CFD delay
IHW	Inhibit width
PZD	Analog pole-zero

FGD	Baseline count manual
DIF	Coupling
BRS	Baseline restore selection
BTS	Baseline select
IHT	(unused)

※The CH section ends here.

MOD	Operating mode
MMD	Measurement mode
MTM	Measurement time
CLS	Clock selection
SCS	WAVE sampling selection

[Calculation]

※Saved per ROI:

ROI_CH	Input channel number for ROI
ROI_start	ROI start position (ch)
ROI_end	ROI end position (ch)
Energy	Peak energy value within ROI
peak(ch)	Peak position within ROI (ch)
centroid(ch)	Centroid within ROI (ch)
peak(count)	Peak counts within ROI
gross(count)	Total counts within ROI
gross(cps)	gross(count) ÷ elapsed measurement time
net(count)	Background-subtracted total counts within ROI
net(cps)	net(count) ÷ elapsed measurement time
FWHM(ch)	Full width at half maximum (ch)
FWHM(%)	Full width at half maximum (%)
FWHM	Full width at half maximum
FWTM	1/10 width within ROI

[Status]

input total count	Total counts
throughput count	Throughput counts
input total rate	Total count rate
throughput rate	Throughput count rate
pileup rate	Pile-up rate
dead time ratio	Dead time ratio

[Data]

Histogram data	Maximum 4096 points.

9.2 Wave Data File

(1) File Format

Comma-separated CSV text format

(2) File Name

User-defined

(3) Structure

Consists of Header, APU101, HighVoltage, and Data sections

(Sections other than Data are the same as the Histogram Data File, see above)

[Data]

Wave data. Maximum 2048 points.

9.3 Quick Scan Data File

9.3.1 Standard

(1)File format

Binary format, either big-endian or little-endian. The selection is possible depending on the pre-measurement settings. In the configuration file config.ini, within the Config section, when ByteOrder is 0, it is big-endian; when 1, it is little-endian.

(2)File Name

The file path set in the Quick Scan file path in the Config tab.

(3)Structure

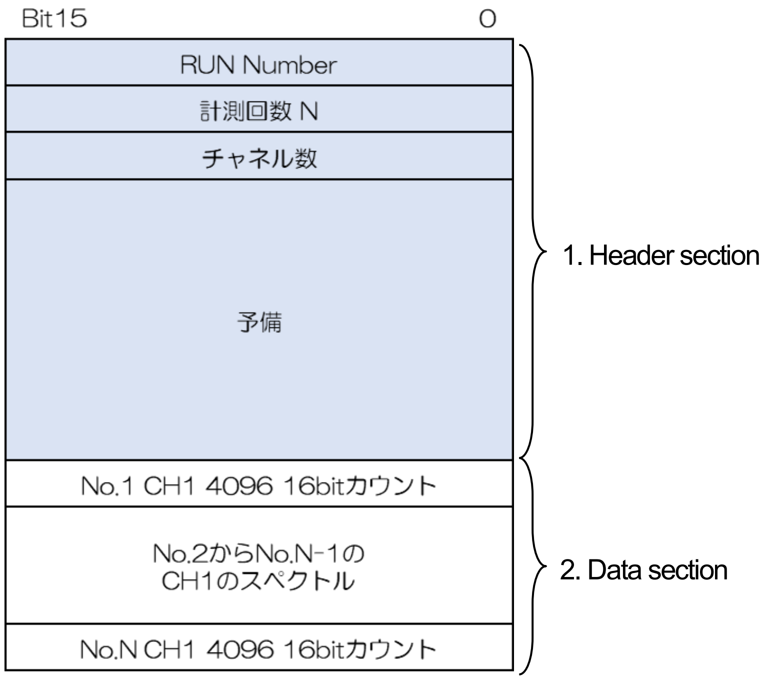


Figure 29 Quick Scan Data File Structure

1. Header section

   The first 20 bytes of the data file are fixed.

RUN Number	Execution number, 0 to 65535, 2 bytes
Number of measurements N	Number of measurements, 1 to 65535, 2 bytes
Number of channels	Number of channels (bins), fixed at 4096, 2 bytes
Reserved	14 bytes

2. Data section

   Each channel (bin) of the spectrum uses 2 bytes.

   The data size varies depending on the number of measurements and channels.

   Example: For a maximum of 8000 measurements,

   65,536,020 bytes = 20 bytes + 4096 channels × 2 bytes × 8000 measurements

9.3.2 Count Limit Expansion (Optional)

In the Quick Scan function, which allows high-speed histogram acquisition at intervals of external GATE signals (10 ms/min), it is possible to select an upper limit for the count per scan. This enables support for long-term measurements such as step scans. Additionally, input counts per scan can be added to the Quick Scan data.

(1)File format

Binary format, either big-endian or little-endian. The selection is possible before measurement. In the configuration file `config.ini`, under the Config section, ByteOrder set to 0 indicates big-endian, and 1 indicates little-endian.

(2)File name

The file path set in the Quick Scan File Path under the Config tab.

(3)Structure

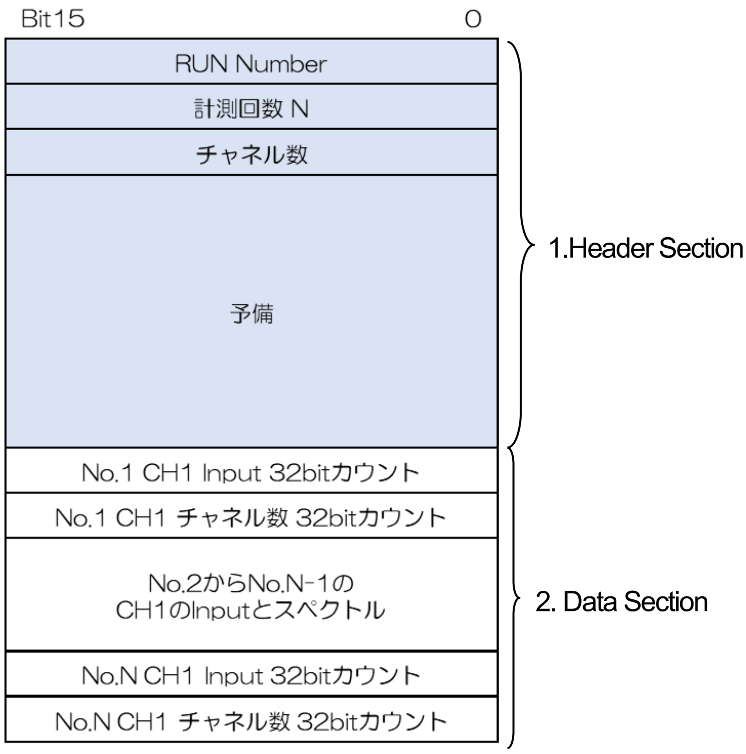


Figure 30: (Optional) Count Limit Expansion — Quick Scan Data File Structure

1. Header Section

   The first 20 bytes of the data file are fixed.

   RUN Number: Execution number, 0 to 65535, 2 bytes.

   Number of measurements N: Number of measurements, 1 to 65535, 2 bytes.

   Number of channels: Number of channels (bins), 4096, 2048, 1024, 512, or 256, 2 bytes.

   Reserved: 14 bytes.

2. Data section

   Input: Input counts during High state of the QSG connector, 4 bytes per channel.

   Spectrum: 4 bytes per channel (bin).

   The data size varies depending on the number of measurements and channels.

   Example: For a maximum of 8000 measurements and 4096 channels, the total size is

   131,104,020 bytes = 20 bytes + (4 bytes + 4096 channels × 4 bytes) × 8000 measurements.

9.4 List Data File

(1) File Format

Binary, big-endian format

(2)File Name

The file path set in the list file path of the config tab, with the file number appended as a zero-padded 6-digit number.

Example 1: If the list file path is “D:¥data¥123456.bin” and the number is “1”, the file name becomes “D:¥data¥123456_000001.bin”.

Example 2: If the list file path is “D:¥data¥123456” and the number is “100”, the file name becomes “D:¥data¥123456_000100.bin”.

When the list file size limit is reached, the currently open file is closed. The list file number is then automatically incremented by one, a new file is opened, and data saving continues.

(3)Structure

Each event occupies 80 bits (10 bytes, 5 WORDs).

<table>
<tr><td colspan="4">79 … 64
ABS[43..28]</td></tr>
<tr><td colspan="4">63 … 48
ABS[27..12]</td></tr>
<tr><td colspan="2">47 … 36
ABS[11..0]</td><td colspan="2">35 … 32
Unused [3..0]</td></tr>
<tr><td>31 30
空き[1..0]</td><td colspan="3">29 … 16
PHA[13..0]</td></tr>
<tr><td colspan="2">15 … 6
Unused [9..0]</td><td>5 … 2
UNIT[3..0]</td><td>1 0
CH[1..0]</td></tr>
</table>

Figure 31 List Data (80-bit) Structure

Bits 79–36 ABS (Absolute) count, 44 bits
Each bit corresponds to 10 ns.
Maximum measurement time is approximately 24 hours
(24 hours ≈ 2^{43} × 10 ns).

Bits 35–30 Reserved, 6 bits

Bits 29–16 PHA (Pulse Height), 14 bits if ADC gain is maximum 16384, range 0–16383
Bits 15–6: Reserved, 10 bits

Bits 5–2 Unit number, 4 bits
※For multiple devices: Unit 1 = 0, Unit 16 = 15

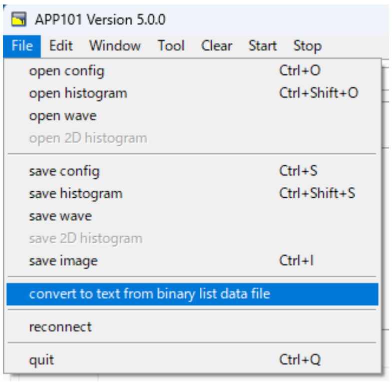
Bits 1–0 CH number, 2 bits
For this device, CH1 is fixed as 0

9.5 List Data File Text Conversion

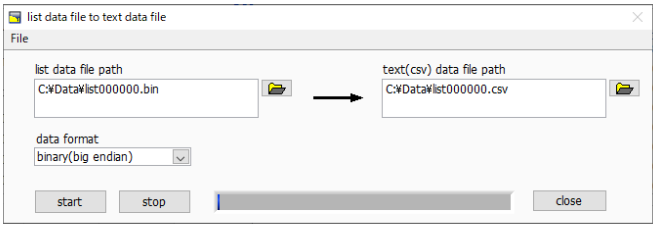
It is possible to convert a list data file saved in binary format during list mode measurement into a comma-separated text (CSV) format. Each event is saved on a single line in the format: ABS (time information), CH number, PHA (pulse height).

- ABS (absolute count) is in units of 10 ns in binary, and in ns in text format.
- CH number is 0 in binary and 1 in text format.
- PHA (pulse height) ranges from 0 to 16383 in both binary and text formats.

To convert a binary list data file to text (CSV) format, click the menu File → Convert to text from binary list data file.

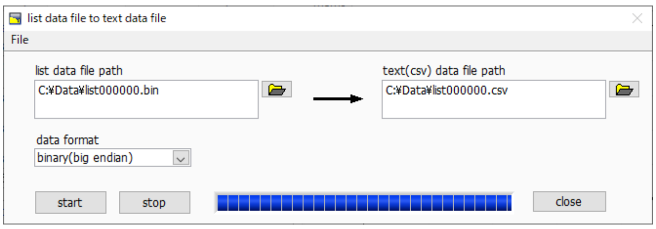


The following List Data File to Text Data File window will open.



- List data file path — Set the absolute path of the binary list data file saved in list mode that you want to convert.
- Data format — Specify the format of the binary list data file saved in list mode. Choose either binary (big endian) or binary (little endian).
- Text (csv) data file path — Set the absolute path where the converted comma-separated text (CSV) list data file will be saved. After setting the list data file path, a path with the .csv extension will be automatically generated.

Click the Start button to begin the conversion. The conversion is complete when the blue status bar at the bottom of the window fills up. To interrupt the conversion, click the Stop button.



Click the Close button to exit this window.

10 Tool functions

Please refer to the “Integrated Application Tool Edition User Manual.”

11 Troubleshooting

11.1 Connection Error

If a connection error occurs at startup or when selecting the config menu, the network may not be properly connected. In this case, check the following:

(4) Before starting the application, ensure that the IP in the configuration file config.ini is set to 192.168.10.128 and that the port numbers in the [System] section are defined as follows. Also, verify that the IP Address displayed in the application matches this setting.

[System]
PCConfigPort = 55000
PCStatusPort = 55001
PCDataPort = 55002
DevConfigPort = 4660
DevStatusPort = 5001
DevDataPort = 24
SubnetMask = "255.255.255.0"
Gateway = "192.168.10.1"

(4) Next, confirm that the PC's network settings allow it to connect to the device.
The default settings of the device are:
IP Address 192.168.10.128,
Subnet Mask 255.255.255.0
Default Gateway 192.168.10.1.

(5) If the PC-side UDP port number conflicts with other software, define a different port number in config.ini before starting the application.

(6) Turn on the device power while the Ethernet cable is connected.

(7) Use the ping command in the command prompt to check communication between the PC and the device.

(8) If needed, restart the device and run the ping command again.

(9) Temporarily disable antivirus and firewall software.

(10) Keep power-saving functions such as PC sleep mode always ON.

(11) For laptops, disable Wi-Fi if possible.

11.2 Command Error

Command errors may occur if the combination of the device firmware and the application does not match, for example, due to optional features. In this case, please contact our support team.

11.3 Histogram Not Displayed

If nothing appears in the histogram tab after executing the Start menu, check the following.

(1) Ensure that CH1 is turned ON in the plot ON setting within the histogram tab.

(2) Verify that input total rate (cps) and throughput rate (cps) are counting.

(3) Set DAC Monitor CH to CH1 and DAC Monitor type to pre amp, and check that the preamp pulse height is within the input range—not too small or too large.

(4) Change DAC Monitor type to fast to confirm that the FAST filter signal is output.

(5) Change DAC Monitor type to slow to confirm that the SLOW filter signal is output.

(6) Adjust the fast trigger threshold and slow trigger threshold values while observing input total rate (cps) and throughput rate (cps), lowering the thresholds from around 100 down to 30 as needed, so that the two rates match closely.

(7) Right-click the graph axes and select auto scale for both X and Y axes.

11.4 Changing the IP Address

Refer to the separate manual “APG5107 Equipped Product IP Address Change Procedure.” If the attachment is not available, contact our support team.

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