Digital Spectrometer
APU101

Instruction Manual

Version 7.1
2020 January

TechnoAP Co., Ltd.

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1. Safety precautions and disclaimers

Thank you for purchasing the product of TechnoAp Co., Ltd. (hereinafter "our company"). Before using this device, be sure to read this "Safety precautions and disclaimer" and be sure to follow the instructions for proper use.

We are not liable for any damages, including accidents caused by use of this equipment, including damages to equipments, detectors, connected devices, applications, malfunctions, and other secondary damages.

Prohibit

- It cannot be used for applications requiring special quality or reliability related to human life or accident.
- It cannot be used in places with high temperature, high humidity, or high vibration.
- Do not subject to strong shock or vibration this device.
- Do not disassemble or modify this device.
- Do not get wet with water or condensation and do not operate with wet hands this device.
- If this device generates heat, deforms, discolors, or smells, stop using it immediately and contact us.

Notes

- Please use the device in the operating temperature range of room temperature without condensation.
- If smoke or abnormal heat is generated in this device, turn off the power immediately.
- This device is a highly accurate precision electronic device. Please be careful about static electricity.
- Do not store this device in a dusty place or a hot and humid place.
- Keep away from devices that emit strong radio waves, such as mobile phones and transceivers.
- In an environment with a lot of electrical noise, malfunction may occur.
- Product specifications and related documents are subject to change without notice.

2. Overview

Digital Spectrometer APU101 (hereinafter referred to as "this device" or "APU101") is a digital spectrometer that combines a high-voltage power supply, preamplifier power supply, and MCA (multi-channel analyzer). Since it is a multi-channel analyzer (MCA) equipped with real-time digital signal processing function (DSP), waveform shaping processing by analog circuits is not required. Using a very high-speed A/D converter, the signal from the preamplifier is directly converted to digital, and the trapezoidal filter (Trapezoidal Filter) is processed in real time by the pipeline architecture of FPGA. As a result, it provides very good energy resolution and time resolution, and it has excellent stability even at high count rates (100 kcps or more).

This device is connected to a personal computer (hereafter PC) with a LAN cable, and by using the attached application "APU101_GbE" (hereafter this application), you can set parameters, read data, analyze and import measured data, etc. ..

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

* This document describes normal products, and it may differ from the one you are using depending on the presence or absence of options, special specifications, and specifications of the high-voltage power supply module.

* The contents of this document are subject to change without notice.

Revision history

2013 February	Version 1	First edition
2014 March	Version 2	For APU101
2014 June	Version 3	Interface change from USB to Ethernet
2014 July	Version 4	Additions and corrections of description in general
2014 September	Version 5	Additions, corrections, and changes to inserted images in general
2017 March	Version 6	Addition of ROI-SCA related information
2017 March	Version 6.1	Correction of pulse width of ROI-SCA to 2 u
2018 March	Version 6.2	Additions and corrections of description in general
2019 March	Version 6.3	Interface change from 100M to 1G
2019 December	Version 7	Additions, corrections, and changes to inserted images in general to APN101
2020 January	Version 7.1	For APU101

3. Appearance

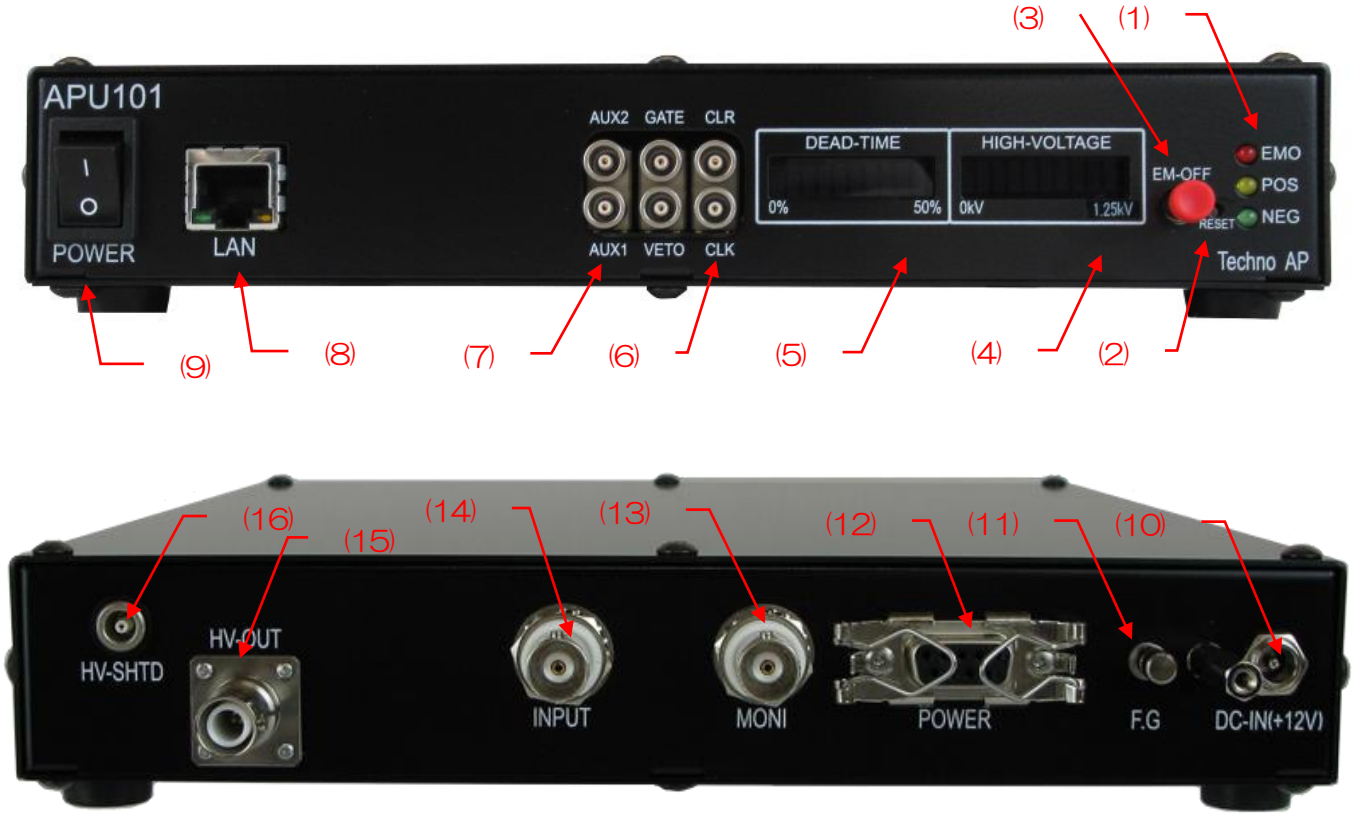


Image 1 APU101 (Upper: Front panel, Lower: Rear panel)

1	LED	EMO (red) lights during an emergency. POS (orange) lights when HV is positive polarity. NEG (green) lights when HV is negative polarity. When both POS and NEG are off, it is in "high-Z" state. It flashes long during step-up, flashes short during step-down, and switches to lighting when the set voltage is reached.
2	RESET	This is a button for restoring the Ethernet connection when communication is lost due to some trouble. It is used when hardware requires Ethernet reconnection (link-up processing).
3	EMERGENCY	Emergency HV stop button. It is provided for emergencies, if you cannot communicate due to some trouble with your PC. If you want to turn off the high voltage in an emergency, press and hold for 3 seconds or longer. The voltage will be stepped down according to the sweep voltage rate (V/min). If all the HV LEDs are turned off, you can confirm that the high voltage has dropped below 400V. (If you want to cancel the emergency state, the application will be terminated while the high voltage is sufficiently low → Power off the main body → Wait for 1 minute or more → Power on → It will be canceled only by starting the application)
4	HIGH-VOLTATGE	High voltage monitor. The polarity is ignored, and each LED lights up every 1/10 of the maximum voltage.
5	DEAD-TIME	Dead time monitor. 5% / LED.

6	CLR, CLK, GATE, VETO	LEMO connector for external signal (TTL signal) input. Normally unconnected. Detailed explanation in Section 5.5
7	AUX1, AUX2	LEMO connector for expansion external signal (TTL signal) input/output. (unused)
8	LAN	Connect the Ethernet cable.
9	POWER	This is the main power switch of the device. The "O" side is OFF and the "I" side is ON. **Do not switch during high voltage power output. It may cause a failure of this device and connected devices.**
10	DC-IN	Power input plug. Connect the included AC adapter. As shown in the image below, it is equipped with a cable drop prevention screw.  Image 2　Mounting the cable drop prevention screw
11	F.G.	If you cannot use a grounded outlet or the ground is weak, connect the ground wire to this terminal.
12	POWER	D-sub connector for preamplifier power supply. Supply ±12V, ±24V by pin allocation conforming to NIM standard.
13	MONI	BNC connector for DSP processing waveform output. Outputtable voltage range is ±1V (1MΩ termination).
14	INPUT	BNC connector for preamplifier signal input. The voltage range that can be input is ±1 V (ZIN: approx. 1 kΩ).
15	HV-OUT	SHV connector for high voltage output. (Zout: about 200kΩ). **Do not switch during high voltage power output. It may cause a failure of this device and connected devices.**
16	HV-SHTD	LEMO connector for detector bias shutdown signal input. Input up to ±24V is possible. (ZIN: About 13kΩ)

Conversion adapter

LEMO EPL.00.250.NTN and the equivalent shape are used for the input/output connector of this device. If you are using a BNC connector cable, you can use the following conversion adapter to connect to this device.
This conversion adapter is not included in this device. Please contact us if you want to purchase this item.

Manufacture: Huber & Suhner
Model: 33_QLA-BNC-01-1/1--_NE
Specification: QLA-01 to BNC

Also, when connecting the BNC cable to a place where the terminals are dense, such as (6) and (7) on the front panel, install the following conversion adapter on the BNC side. It is also possible to relay using a coaxial cable with LEMO connectors at both ends.

Manufacture: Huber & Suhner
Model: 33_BNC- QLA -01-1/1--_NE
Specification: BNC to QLA-01

4. Setup

4. 1. Application installation

To measure with this device, a PC with this application installed is required in addition to this device. The installation procedure of this application is described.

（1） Operating environment. The recommended environment is as follows.
Microsoft Windows 7 32Bit or later, screen resolution XGA (1024 x 768) or more.

（2） Log in with an account that has administrator privileges.

（3） Execute "setup.exe" in the "Installer" folder of the attached CD. Proceed interactively and reboot the OS after the installation is complete.

（4） Start this application. Click "Start"-"All Programs"-"Techno AP"-"APU101_GbE". After execution, this application will start.

To uninstall, delete "APU101_GbE" from "Uninstall or change a program" in "Control Panel".

4. 2. High-voltage power supply polarity confirmation and change method

Before using, check the polarity of the high-voltage power supply required for the target detector and the output polarity of the high-voltage power supply of this device.

※Note※

Never apply a high voltage power supply with a polarity different from the detector specifications. It may cause damage to the detector and this device.

（1） Check if the polarity of the high voltage power supply to the detector is + (plus) or-(minus)

（2） Check the current polarity of the high voltage power supply for this device. First, with the power off, disconnect all cables except the AC adapter cable.

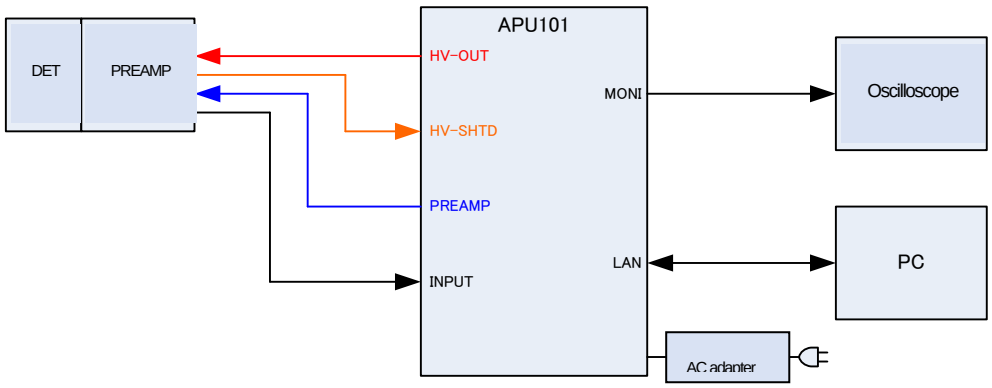
（3） Turn on the power of this device. Make sure the "POS" or "NEG" LED on the front panel is lit. "POS" indicates a positive output, and "NEG" indicates a negative output.

（4） f the polarities of the detector and the high-voltage power supply of this device are different, change the polarity from this application according to the specifications of the detector according to the following procedure. For details, see "5.6. HV tab" below.

n the "HV polarity" section of the "HV" tab, select the same polarity as the detector from the pull-down menu "HV output polarity" and press the "set polarity paramter" button → The setting confirmation dialog is displayed → This application's End → Power off this device → Wait for 1 minute or more, then power on this device → Launch this application → Check the current output polarity again in the "High Voltage" status at the upper left of this application screen.

4. 3. Cable connection

The basic cable connection diagram required for measurement with this device is shown below.
When all power supplies are off, connect according to the connection diagram and the following procedure.



（1） Confirm that the power of this device is turned off.
（2） As explained in the previous chapter, confirm in advance that the polarities of the high voltage power supply of this device and the detector match. Connect the "HV-OUT" output terminal on the rear panel to the SHV connector for high voltage power supply on the detector side with a cable for high voltage power supply.
（3） Connect the "POWER" output terminal on the rear panel to the power supply connector for the preamplifier on the detector side with a cable.
（4） Connect the "INPUT" input terminal on the rear panel and the preamplifier output signal on the detector side with a cable.
（5） Connect the “LAN” connector on the front panel to the LAN connector on the PC side with a LAN cable.
（6） Connect the round connector at the end of the included AC adapter to the "DC-IN" terminal.

Do the following as needed.

（7） Connect the "MONI" output terminal on the rear panel to the oscilloscope with a cable.
*The oscilloscope is not indispensable for every measurement, but it is convenient for adjustment work (necessary to make full use of the performance of this device and target detector).
（8） Connect the “HV-SHTD” input terminal and the bias shutdown connector of the detector with a cable. Please refer to "5.6. HV tab" below for the setting method of bias shutdown.

4. 4. Network connection

To measure with this device, a network connection between this device and a PC is required. This section describes how to check the network settings and connections.

（9）Confirmation of communication with the initial IP address
（10）The initial IP address of this device is **“192.168.10.128”**. Even if you need to change the IP of this

device, you must first connect to the PC with the initial IP.

（１１） Fix the IP address of the PC to "192.168.10.X" (any number other than X:128).

（１２） After fixing the IP address of the PC and connecting the cable for this device, set the "POWER" switch to "|" to turn on the main power of this device.

（１３） Use the Windows command prompt to send the ping command to "192.168.10.128" and check the connection.

5. Application

Describes the settings and display items for each screen and tab structure of this application.

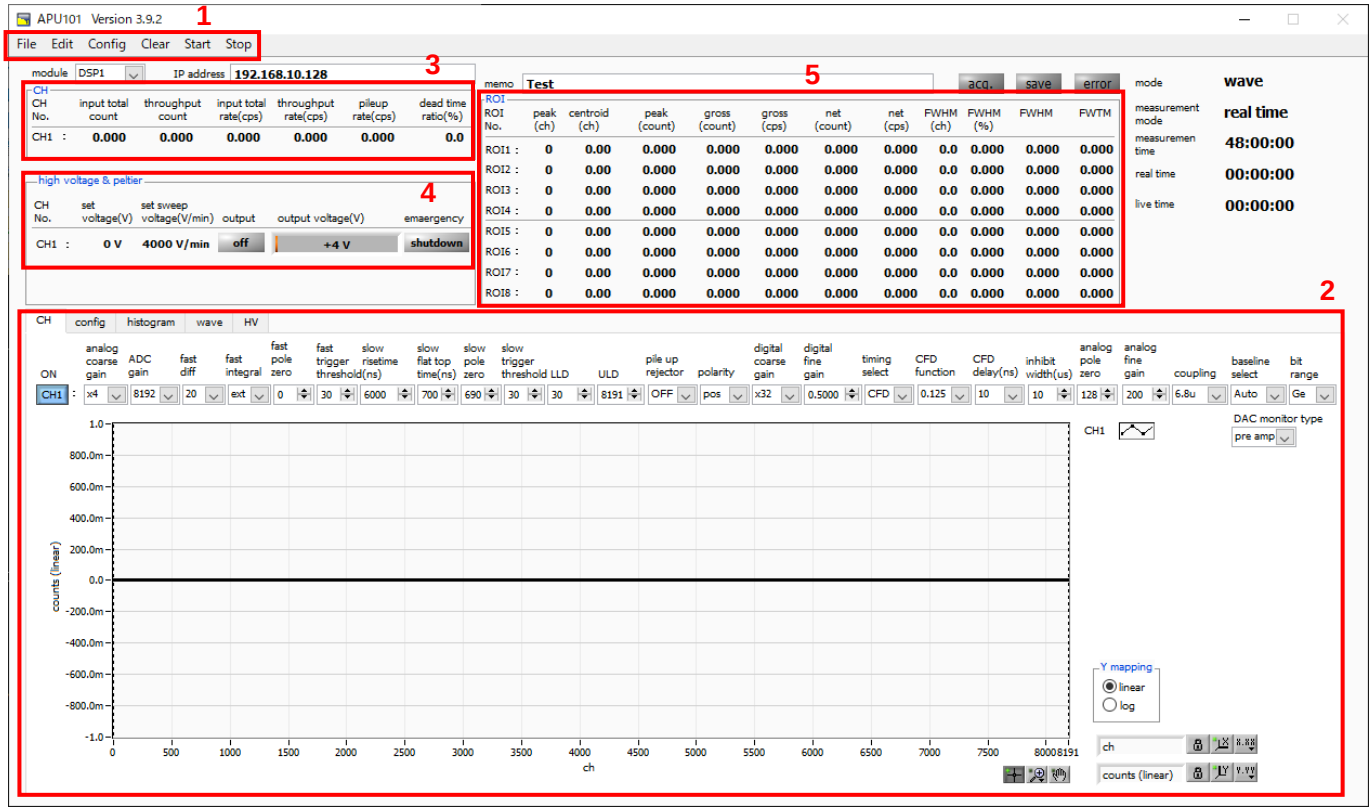


Image 3 Startup screen

5. 1. Startup screen

1. Menu bar: Consists of "File", "Edit", "Config", "Clear", "Start", and "Stop"

“File” - “open config”	Read configuration file
“File” - “open histogram”	Read histogram data file
“File” - “save config”	Save current settings to file
“File” - “save histogram”	Save the current histogram data to a CSV file
“File” - “save wave”	Save the current waveform data to a CSV file
“File” - “save image”	Save screen capture image to file (PNG format)
“File” - “reconect”	Reconnect with the device
“File”- “quit”	End this application
“Edit” - “IP configuration”	Change the network settings of this device
“Edit” - “copy setting of CH1 to all CH”	Copy CH1 settings to CH2 and later settings
“Config”	Sends all settings (excluding HV and pulser settings) to this device
“Clear”	Initialize the histogram data of this device
“Start”	Send measurement start to this device
“Stop”	Send measurement stop to this device

2. Tab: Consists of "CH", "config", "histogram", "wave", and "HV"

CH	Settings for DSP of this device
config	Settings related to measurement operation and measurement time of this device
histogram	ROI (Region Of Interest) and energy calibration settings
wave	Waveform display in wave mode, settings related to display
HV	Settings for high voltage of this device

3. CH section: Displays the counting rate during measurement

input total count	Total count. Number of input events
throughput count	Throughput count. Number processed for input
input count rate (cps)	Count rate. Number of input events per second
throughput count (cps)	Throughput count rate. Number processed for input per second
pileup rate (cps)	Pile-up count rate. Pile-up count per second
dead time ratio (%)	Dead time ratio (%)

4. high voltage section: Displays high voltage status information

set voltage (V)	Output voltage (V) set for this device
Set sweep voltage (V/min.)	Output sweep voltage (V / min.) set for this device for 1 minute
“output” LED	When the output voltage is 30V or more, it will be displayed as "on" and light up. During the sweep, "sweep" is displayed and flashes. When output is stopped, "off" is displayed and turns off
output voltage (V)	Displays the polarity and the voltage monitor value during output (the monitor voltage within the margin of error ± 1%) * Since the output voltage depends on the load, the set voltage and the monitor voltage may not match.
“bias shutdown emergency stop” LED	Lights when there is an abnormality related to HV, such as a bias shutdown state or when the emergency stop button is pressed.

5. ROI section: Display the calculation results between ROIs.

peak (ch)	Maximum count channel
centroid (ch)	Center value (ch) calculated from the sum of counts
peak (count)	Maximum count
gross (count)	Sum of counts between ROIs
gross (cps)	Sum of counts between ROIs for 1 second
net (count)	Sum of counts with background subtracted between ROIs
net (cps)	Sum of counts with background subtracted between ROIs for 1 second
FWHM (ch)	Half width (ch)
FWHM (%)	Half width / ROI set energy x 100 (%)
FWHM * Arbitrary units	Half width. See “6.4. Calculation method of full width at half maximum (FWHM)” described later. The unit depends on the state of energy calibration.

FWTM * Arbitrary units	1/10 width. The half-width is half the peak, while the width is 1/10 of the peak (the bottom of the peak). The unit depends on the state of energy calibration.

• Other: Display system status information

module	Used to select the control target device when using multiple devices
IP address	IP address of this device
memo	Text box. Please use for measurement data management
“acq.” LED	Flashes during measurement
“save” LED	Lights when saving data
“error” LED	Lights up when an error occurs
mode	Displays the setting status of "histogram", "list" and "wave"
measurement mode	Display "real time" or "live time"
measurement time	Set measurement time
real time	Actual measurement time
live time	Effective measurement time
dead time	Invalid measurement time
dead time ratio	Percentage of dead time of head valid CH (%). dead time / real time * 100
list data buffer	List data buffer status (%). 100% overflow

5. 2. CH tab

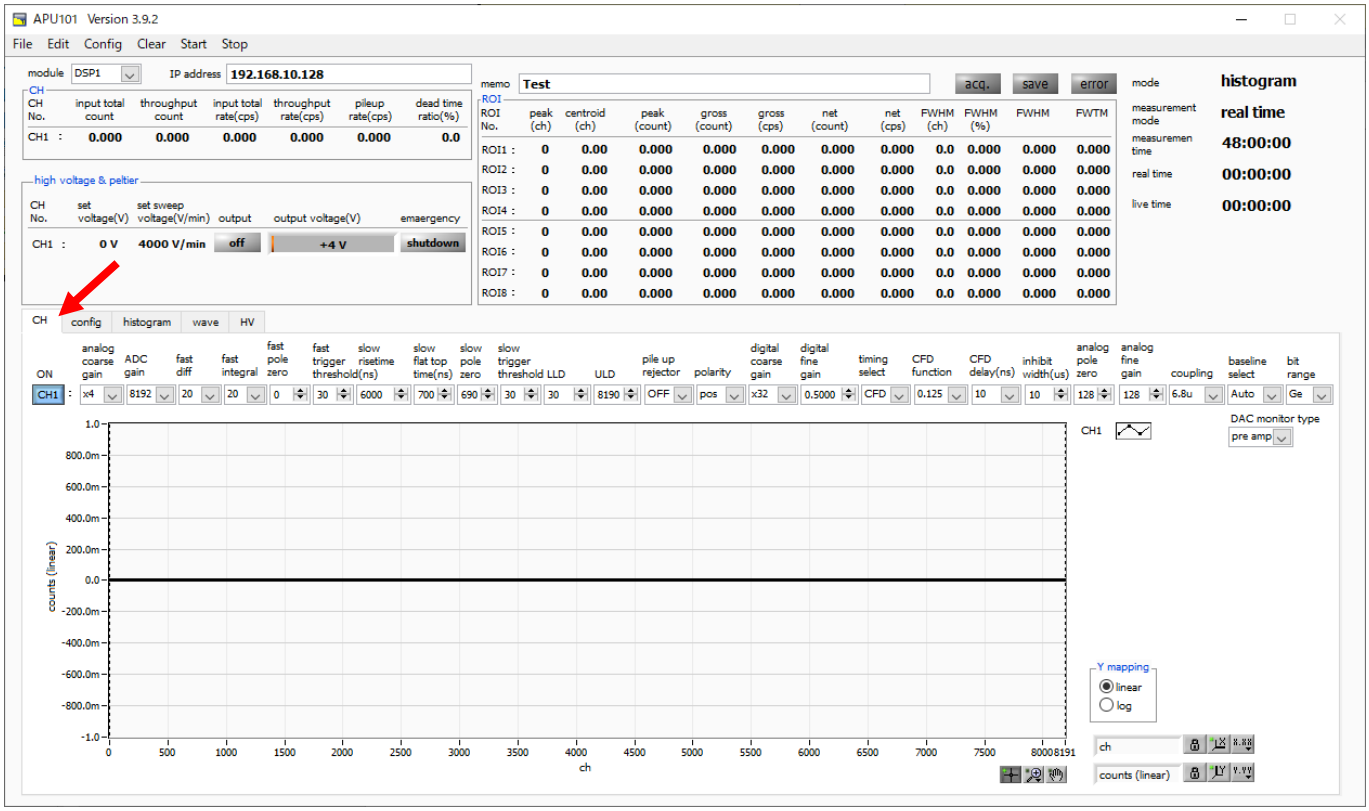


Image 4 CH tab

ON	CH availability ON when using. OFF when not in use
analog coarse gain	Coarse gain of the analog circuit of this device. Select from x1, x4, x10, x20
ADC gain	ADC gain. Selectable from 8192, 4096, 2048, 1024, 512 channels (ch)
fast diff	Constant of FAST differential circuit. Settings are ext, 20, 50, 100, 200
fast integral	Constant of FAST system integration circuit. Settings are ext, 20, 50, 100, 200
fast pole zero	Set FAST type pole zero cancel. Default setting is 0
fast trigger threshold	Set the threshold value for the time information acquisition timing using the FAST filter. The unit is digit. The setting range is 0 to 8191. While watching the "input total rate (cps)" rate, set a few digits higher than the boundary of the noise level at which the value increases extremely. The default setting is 30 digits
slow rise time (ns)	SLOW filter rise time setting. Default setting is 6000ns
slow flat top time (ns)	SLOW filter flat top time setting. The default setting is 700ns.
slow pole zero	SLOW pole zero cancel is set. The default setting is 690ns.
slow threshold	Set the threshold for the timing of waveform acquisition start using the SLOW system filter. The unit is digit. The setting range is 0 to 8191. Set it to a value less than or equal to LLD. While watching the "ithroughput rate (cps)", set a few digits higher than the boundary of the noise level where the value increases extremely. The default setting is 30 digits.
LLD	Energy LLD (Lower Level Discriminator) is set. The unit is ch. Channels below this threshold are not counted. Set to a value that is greater than or equal to show threshold and less than ULD.

ULD	Energy ULD (Upper Level Discriminator) is set. The unit is ch. Channels above this threshold are not counted. Set to a value greater than LLD and less than ADC gain.
pileup rejector	Set the availability of pile-up reject.
polarity	Select the preamp signal polarity. “Pos” is positive and “neg” is negative.
digital coarse gain	Digital course gain. Select from x1, x2, x4, x8, x16, x32, x64, x128.
digital fine gain	Digital fine gain. The setting range is from x0.3333 to x1
timing select	Select when to determine the time stamp "LET": Leading Edge Timing "CFD": Constant Fraction Disicriminator Timing
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, 0.875
CFD delay	Select CFD delay time from 10, 20, 30, 40, 50, 60, 70, 80 ns.
inhibit width(μs)	The time width of the inhibit signal for transistor reset type preamplifier is set internally. The setting range is 0 to 163 μs.
analog pole zero	Analog pole zero adjustment. Digit control is possible, and the setting range is 0 to 255
analog fine gain	Analog fine gain adjustment. The setting range is x0.10 to x1.50
coupling	Shaping type. Select from 6.8us, 2.2us, DC, 6.8us (ex RC), 2.2us (ex RC). "6.8us": Standard for resistance feedback type preamplifier "2.2us": For resistance feedback type preamplifier for high counting "DC": No coupling "6.8us (ex RC)": Standard for transistor reset type preamplifier "2.2us (ex RC)": For transistor reset type preamplifier for high counting
baseline select	Baseline processing settings. "Auto": Automatic (default) "High": Automatic setting for baseline stabilization during high counting
bit range	Settings related to operation bit processing for SLOW filters. "Ge": For Ge semiconductor detectors (mainly for resistance feedback type preamplifier) "SDD": In case of Si Drift Detector etc. (mainly for transistor reset type preamplifier)
DAC MONI	DAC MONI waveform selection. By viewing the DAC output signal on an oscilloscope, you can check the processing status inside the DSP as an analog waveform. (Full scale ±1 V @ 1 MΩ load in combination with polarity) "Preamp": Preamp signal "Fast": FAST filter signal "Slow": SLOW filter signal "CFD": CFD signal

5. 3. config tab

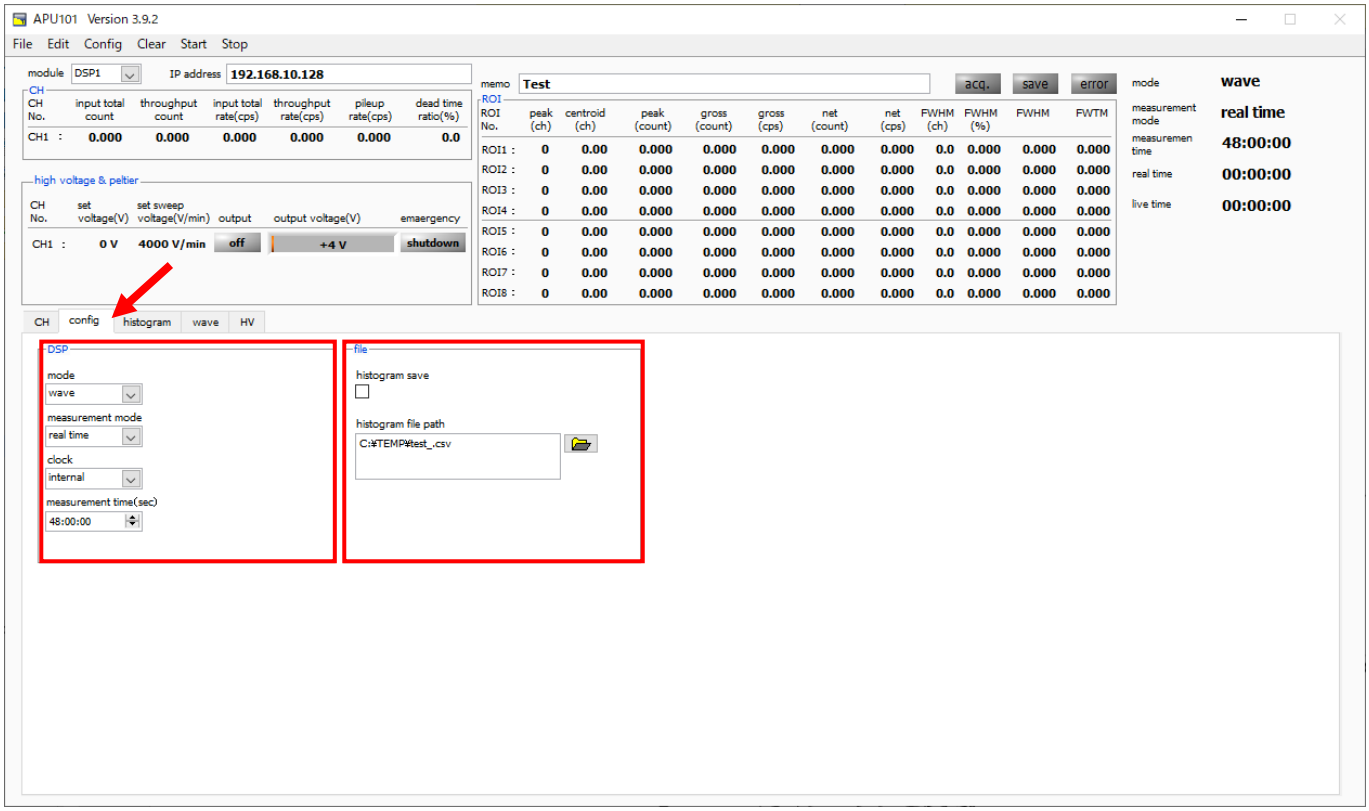


Image 5 config tab

• DSP section

mode	Data processing selection	
	histogram	Store the peak value of the preamplifier signal in up to 8192ch and create a histogram
	wave	Digitize input signal and display waveform
measurement mode	Measurement mode selection	
	real time	Measures preset time data
	live time	Measure until the effective measurement time (difference between real time and dead time) reaches a preset time
clock	Clock source selection	
	internal	Uses internal clock
measurement time	Measurement time setting	The setting range is 00:00:00 to 24:00:00

• file section

histogram save	Save histogram data to a file at the end of measurement
histogram file path	Set the absolute path of the histogram data file. It is possible to have no extension. **NOTE:** It will not be saved with this file name. The format is as follows based on this file name. Example: When "C:¥Data¥histogram.csv" is set for "histogram file path" and "10" is set for "histogram file save time (sec)", and the date and time is 2014/09/01 12:00:00 Starts saving data with the file name "C:¥Data¥histogram_20140901_120000.csv". After 10 seconds, save the file

	as "C:¥Data¥histogram_20140901_120010.csv". *The above "120010" may become "120009" or "120011".

5. 4. histogram tab

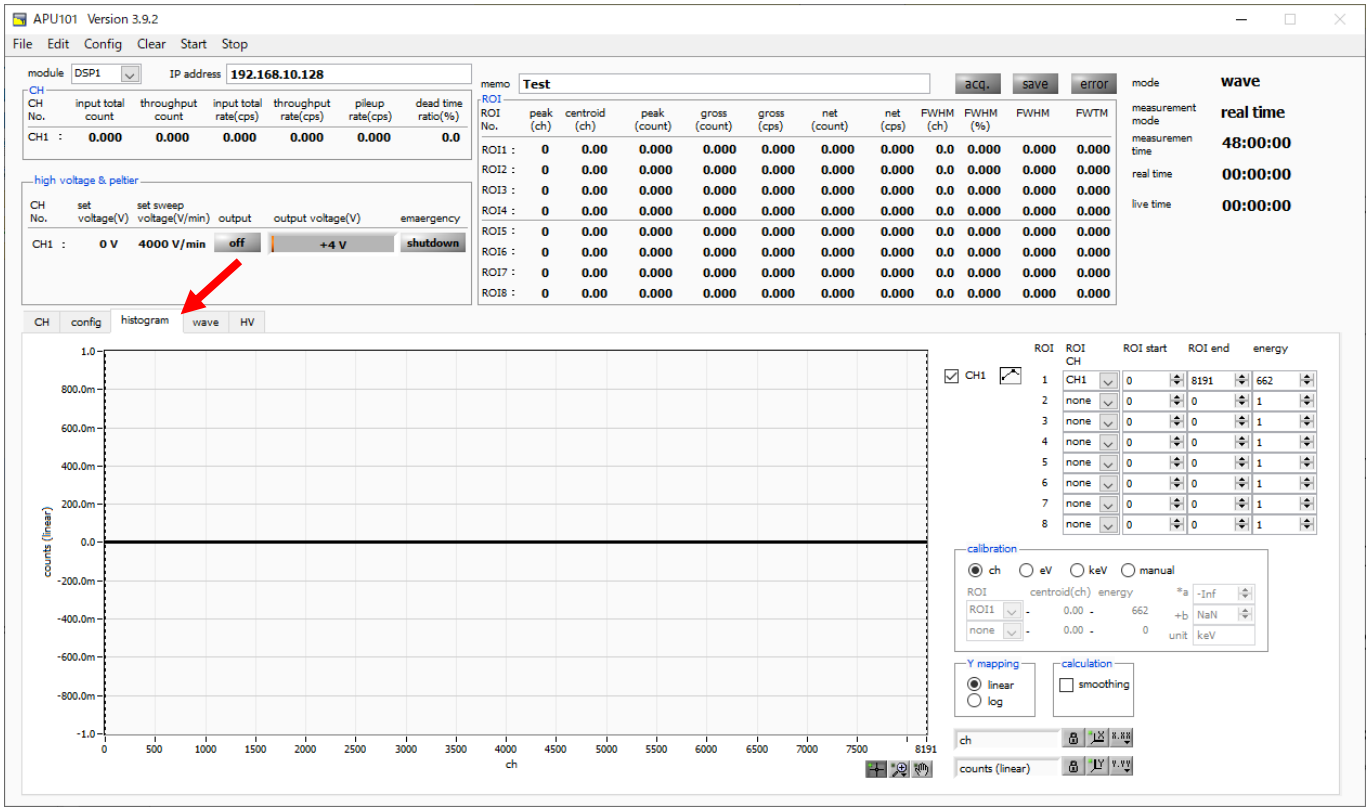


Image 6 histogram tab

Graph	Histogram graph. When "histogram" is selected for "mode" in the "config" tab, a histogram is displayed during measurement.	
plot ON	Setting whether to display the histogram for each CH in the graph	
ROI CH	Select the CH number that corresponds to the ROI (Region Of Interest). Up to 8 ROIs can be set for one CH signal. It also shares ROI and CH correspondence and settings in the ROI-SCA function.	
ROI start (ch)	Set the start position of ROI. The unit is ch. It also shares the ROI start position and settings for ROI-SCA measurement.	
ROI end (ch)	Set the end position of ROI. The unit is ch. It also shares the ROI end position and settings for ROI-SCA measurement. Example: When the peak value is detected in the range of RO1 CH, ROI start to ROI end in ROI CH, TTL logic signal (negative logic, pulse width 2 μs) is output from AUX1 connector.	
energy	Define the energy value of the peak position (ch). For Co-60, set as 1173 or 1333 (keV). When “ch” is selected in “calibration”, the peak between ROIs is detected, keV/ch is calculated using the peak position (ch) and the set energy value, and the result of half-width calculation is summarized.	
calibration	Select the unit for the X axis. The label of the X-axis is also changed according to the setting.	
	ch	Displays in units of ch. ROI "FWTM" "FWHM" and other units are optional.
	eV	eV unit display. Two-point calibration of two types of peak (center value) and energy value in one histogram. Calculate the slope “a” and intercept “b” of the linear function y=ax+b so that ch becomes eV and set it on the X axis. The unit of “FWHM” of “FWTM” of ROI is “eV”.
	keV	KeV unit display. Two-point calibration of two types of peak (center value) and energy

		value in one histogram. Calculate the slope a and intercept b of the linear function y=ax+b so that ch becomes keV and set it on the X axis. The unit such as "FWTM" of "FWTM" of ROI is "keV". Example: If 5717.9ch has Co-60 1173.24keV and 6498.7ch has Co-60 1332.5keV, “a” is calculated as “0.20397” and “b” is calculated as “6.958297” from the two-point calibration.
	manual	Set the slope "a", intercept "b", and unit label of the linear function y=ax+b to the X axis. The unit can be set arbitrarily.
Y mapping	Select the Y-axis mapping for the graph. The Y-axis label is also changed according to the setting.	
	linear	straight line
	log	logarithm
smoothing	Smoothing function to calculate the half width when there are few statistics	
X-axis range	Right-click on the X-axis and select "Auto scale" to change to auto scale. If unchecked, it will not be auto scale and the minimum and maximum values of the X axis will be fixed. To change the minimum or maximum value, place the mouse pointer on the number to be changed, click or double-click and enter the value.	
Y-axis range	Right-click on the Y-axis and select "Auto scale" to change to auto scale. If unchecked, it will not 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 on the number to be changed, click or double-click and enter the value.	
	Cursor movement tool. Cursor can be moved on the graph when setting ROI	
	Zoom. Click to select and execute the following 6 types of zoom in and zoom out	
	Pan tool. You can grab the plot and move on the graph.	

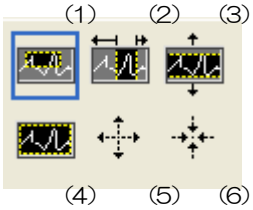


Image 7　Graph, Tool of Zoom-in and Zoom-out

(1) Rectangle: Zoom Use this option to click a point on the display that will be the corner of the zoom area and drag the tool until the rectangle occupies the zoom area.

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

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

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

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

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

5. 5. wave tab

*** Some models cannot be used.**

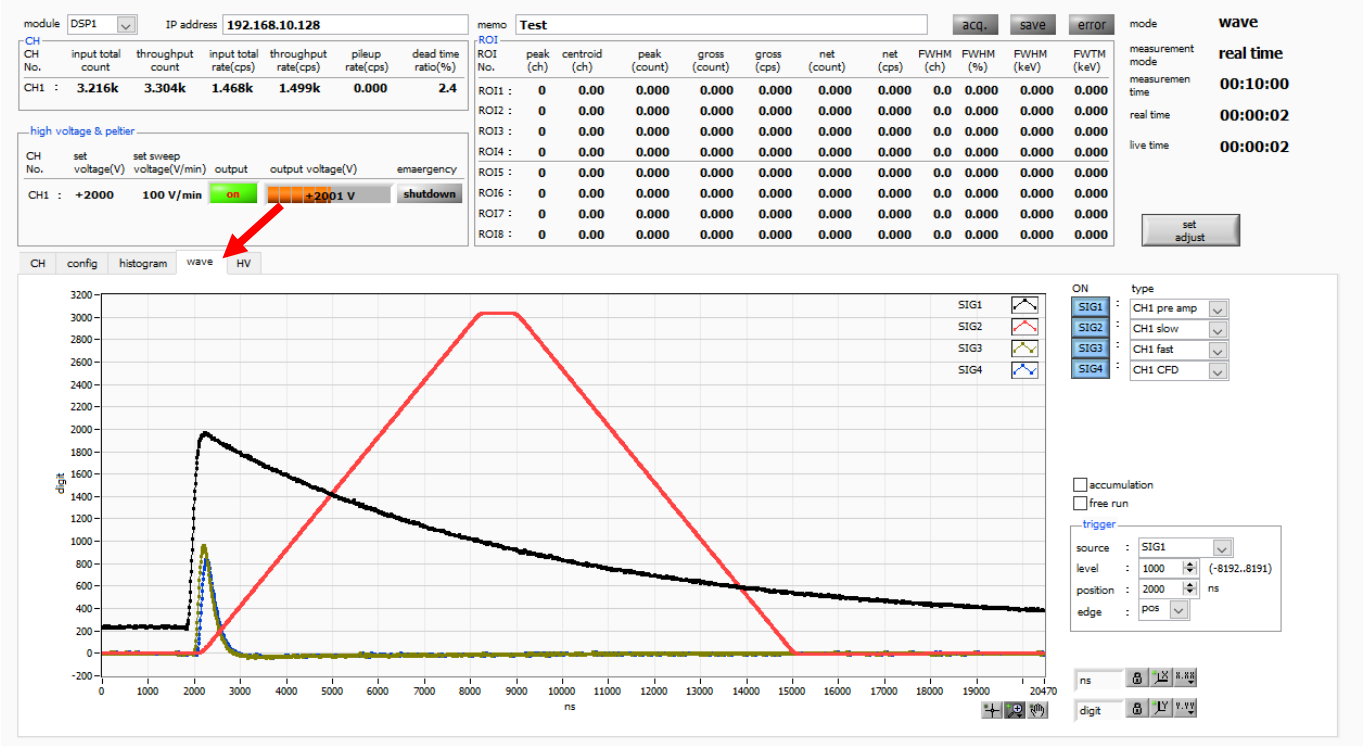


Image 8 wave tab

Graph	Waveform graph. When "wave" is selected for "mode" in the "config" tab, the waveform is displayed during measurement	
ON	Set waveform display availability NOTE: The waveform selected for "SIG1" is the trigger source.	
type	Select the type of waveform to display for each CH	
	pre amp	Preamplifier signal
	slow	SLOW filter signal
	fast	FAST filter signal
	CFD	CFD signal
trigger level	Trigger waveform acquisition threshold. (Function similar to rising edge trigger on oscilloscope) When this threshold is exceeded, trigger is applied and waveform data is acquired (displayed). When set to 0, free-run operation (forcibly acquiring data at a cycle of about 1 second regardless of the threshold) is useful when determining the guideline for threshold setting.	
trigger position	Set offset points to the triggered point. Set when waveform data before trigger is required. The offset time linked to the "sampling rate" is displayed on the right side.	
trigger edge	Select the trigger polarity.	
accumlation	Enables the pasting process of the past 16 waveform data. If it is difficult to analyze with a single waveform, turn it ON to make the waveform easier to see.	
free run	When checked, the trigger-free waveform is displayed, and when unchecked, the triggered waveform is displayed. It can be used to see baseline and noise levels.	

5. 6. HV tab

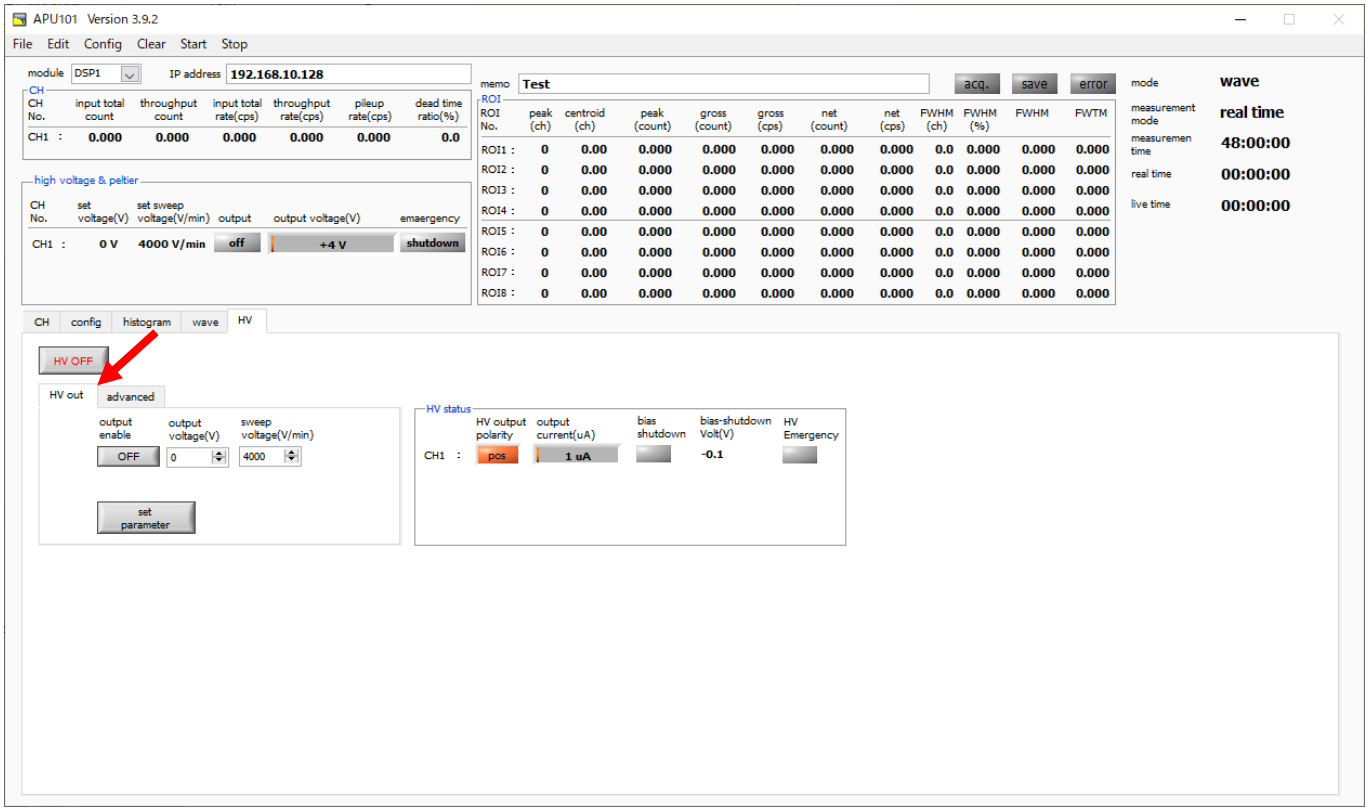


Image 9 HV out in HV tab

• HV out tab section

output enable	High voltage output ON/OFF
output volgate (V)	High voltage output value setting. Input as an absolute value regardless of polarity (0 to 4000)
sweep voltage (V/min)	Setting of step-up/step-down rate (V/min) of high-voltage output (1 to 4000). *** Sudden step-up/step-down may cause detector failure. Please set the optimum value for the detector.**
set parameter	Sends the setting value related to the above high voltage to this device

• HV status section

HV output polarity	Polarity of high voltage output. "Pos" is positive polarity, "neg" is negative polarity
current	Output current value (uA) (monitor current has an error of about ±5%) *** Since there is a load dependency, when the load is light (equivalent to several tens uA or less), the expected current value and the monitor value may differ greatly.**
“bias shutdown” LED	Lights when the detector enters the bias shutdown state. Turns off the high-voltage output immediately at the rate of step-down when lighting
bias shutdown volt (V)	Monitor voltage of the signal input to the HV-STHD terminal.
“HV emergency” LED	Lights when there is a problem with the HV or when the emergency stop button is pressed. Turns off the high-voltage output immediately at the rate of step-down when lighting.

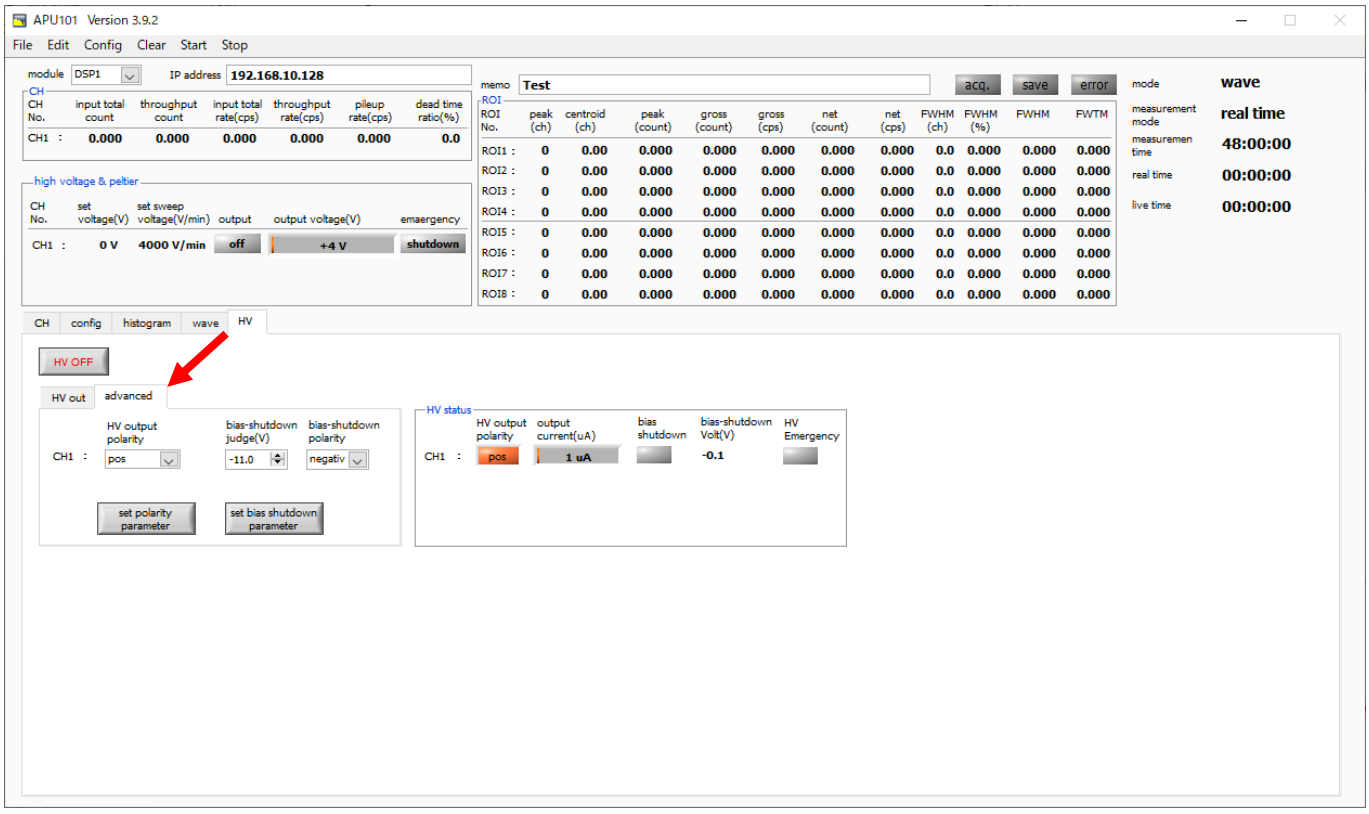


Image 10　advanced tab in HV tab

• advanced tab section

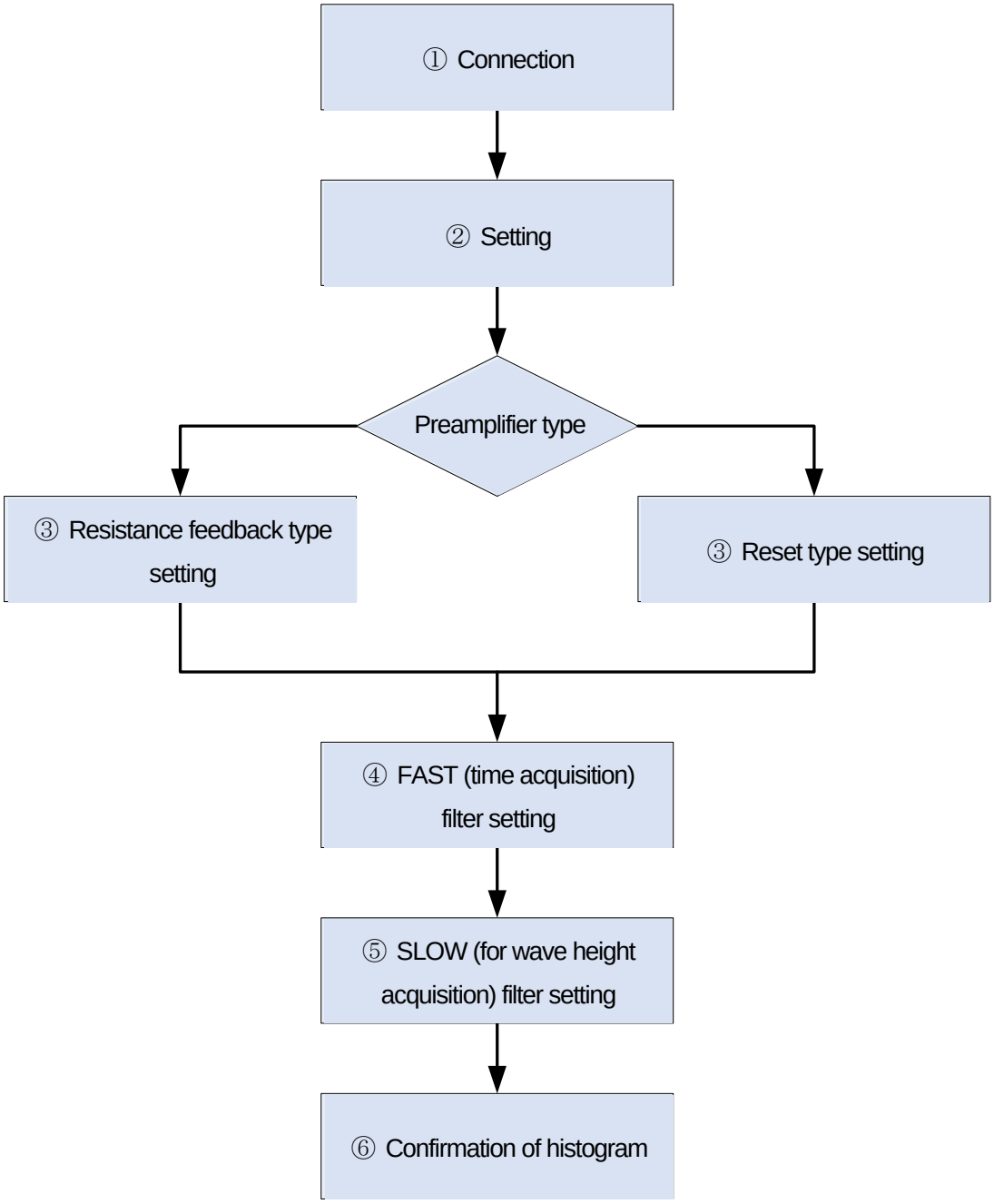
HV output polarity	Select from "positive", "negative", and "high-Z".
set polarity paramter	Send the above "HV output polarity" setting value to this device. After confirming the HV polarity of the detector sufficiently, execute the following procedure. (1) When switching, turn off the output high voltage. (2) After waiting for the output voltage to reach a few volts, send the "HV output polarity" data with the "set polarity parameter" button and then exit this application. (3) Turn off the power of this device. (4) If you wait for more than 1 minute and then turn the power of this device back on (ON), the polarity will switch after a few seconds.
bias shutdown judge (V)	Threshold voltage (V) for bias shutdown.
bias shutdown polarity	Polarity for judging bias shutdown.
set bias shutdown polarity parameter	The set value of the bias shutdown polarity is sent to this device. After confirming the status of the normal bias shutdown signal from the detector, perform the following procedure. (1) When switching, turn off the output high voltage. (2) After waiting until the output voltage reaches several V, Click the "set bias shutdown polarity parameter" button to send the data. Example: When the bias shutdown signal is normal: -12V, shutdown: +5V In this case, the threshold value must be set in the range of -12V to +5V.

	Normally, set a threshold value (eg, about -11.0V) near normal and with some margin. Set it to positive because the threshold value is below normal and the threshold value is above bias shutdown. In this example, "bias shutdown judge(V)" is set to "-11.0" and "set bias shutdown polarity parameter" is set to "positive".

6. Preparation and adjustment method

6. 1. Flow of measurement

The flow until the start of measurement is as follows.



① Connection

（1） After confirming that the power of this device is OFF, proceed with the connection work by the following procedure.

*The oscilloscope is not essential for measurement, but it is convenient for adjustment work (necessary to make full use of the performance of this device and target detector).

1. Connect the POWER output terminal and the power supply connector for the preamplifier on the detector side with a cable
2. Connect the INPUT input terminal and the preamplifier signal on the detector side with a cable
3. Connect the LAN connector and the LAN connector on the PC side with a cable

Perform step 4 if necessary.

4. Connect MONI terminal and oscilloscope with cable

* To confirm the current high voltage output polarity of this device, proceed with the procedure without connecting the HV-OUT output terminal on the rear panel and the high voltage application connector on the detector side.

（2） Turn on the power of the PC. (Please move to the next step after the OS starts up)

（3） Turn on this device (and the power supply of the oscilloscope).

（4） After about 30 seconds, check that the PC and the device are connected by the following procedure.

The default IP address of this device is 192.168.10.132. Set the IP address on the PC side as a private address with a value other than 128, and confirm that "> ping 192.168.10.132" can be executed normally in "Command Prompt"

（5） Start the attached application “DSP MCA”

（6） The status of the screen is updated normally after a few seconds have passed since the communication was performed normally. Check the current output polarity with the High Voltage status on the left side of the screen.

If there is problem with the polarity, continue from the next (7).

（7） If the polarity does not match the specifications of the detector, select the desired polarity from the pull-down menu in "HV output polarity" in the "advanced" tab in the "HV" tab, and then click the "set polarity parameter" button. Please click on the. A message dialog is displayed. Follow the steps below to perform the following work.

Confirm that the HV has dropped to about several V → Exit this application → Turn off the power of this device → Wait for 1 minute or more and turn on the power of this device → Start this application.

Check the current output polarity again with the "High Voltage" status on the left side of this application screen.

（8） After confirming the polarity of the appropriate high-voltage power supply, connect the high-voltage application cable according to the following procedure. Confirm that the HV has dropped to about a few V → Exit this application → Turn off the power of this device → After waiting for 1 minute, **connect the HV-OUT output terminal on the rear panel to the high-voltage applying connector on the detector side with a cable** → Turn on the power of this device → Start this application.

The connection and confirmation work of this device and the detector are completed. Continue to set ②

② Configuration

The trapezoidal filter is used for pulse shaper by DSP of this device. The preamp signal is shaped into two types of Fast and Slow waveforms. In the figure below, the black waveform is the preamp signal, the blue waveform is fast, and the red waveform is slow.

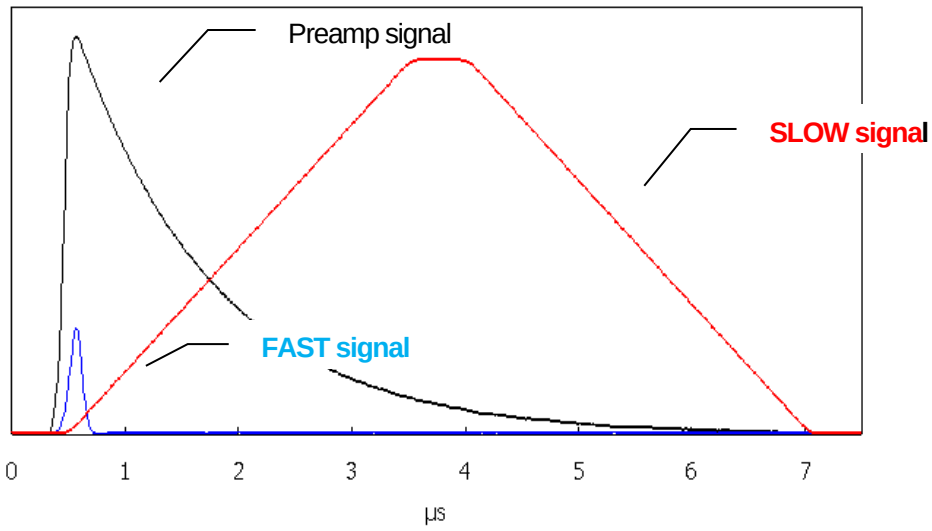


Image 11　Fast and Slow signals generated based on the preamp signal

With FAST, the time timing of detection can be obtained, and with SLOW, the peak value corresponding to energy can be obtained. A histogram can be created by counting the detected peak values. The setting of each parameter required for these waveform shaping is explained later. First, set as follows on the "CH" tab, "config" tab, and "HV" tab.

NOTE:
This is the case when the measurement target is 662 keV peak using the preamplifier of NaI(Tl) detector and the radiation source Cs-137 owned by our company.
The settings vary greatly depending on the detector, preamplifier, and measurement target used.

“CH” tab

analog coarse gain	x5		polarity	pos
ADC gain	2048		digital coarse gain	x32
fast diff	100		digital fine gain	any (around 0.5 to 1.0)
fast integral	100		timing select	CFD
fast polezero	0		CFT function	0.125
fast threshold	20		CFT delay(ns)	10
slow risetime(ns)	3000		inhibit width(us)	6
slow flattoptime(ns)	700		analog polezero	around 250
slow polezero	around 685		analog fine gain	Any (around 0.8 to 1.5)
slow trigger threshold	25		coupling	6.8us
LLD	25		baseline select	Auto
ULD	2047		bit range	Ge
pile up rejector	OFF		DAC MONI	preamp

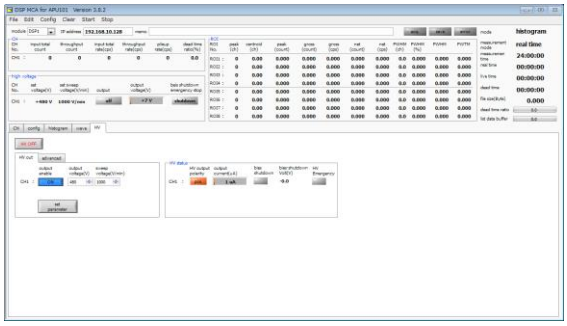
“config” tab

mode	histogram		measurement mode	real time
measurement time	24:00:00 (24 hours)			

“HV” tab

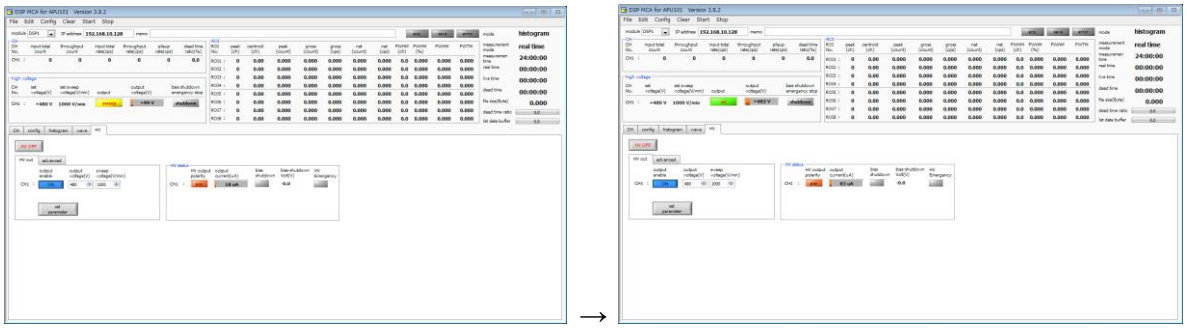
output voltage (V)	480		sweep voltage(V/min)	1000
High voltage status	positive			

（1） In the HV section of the "HV" tab, switch "output enable" to ON and click the "set parameter" button



（2） A confirmation message dialog will be displayed. Check the high voltage parameters again. If there are no problems, click OK.

（3） At the boost rate of "sweep voltage (V/min)", the HV is applied while the "output" LED display flashes "sweep". Wait until the “output” LED turns off, the voltage reaches the specified value, and the display turns “ON”.



Now the detector (preamplifier section) is ready to output a signal according to the radionuclide. Proceed to the adjustment work from the next page.

③ Preamplifier type

Check the preamplifier signal input to this device. The setting method differs depending on whether the preamplifier is "resistive feedback type" or "reset type".

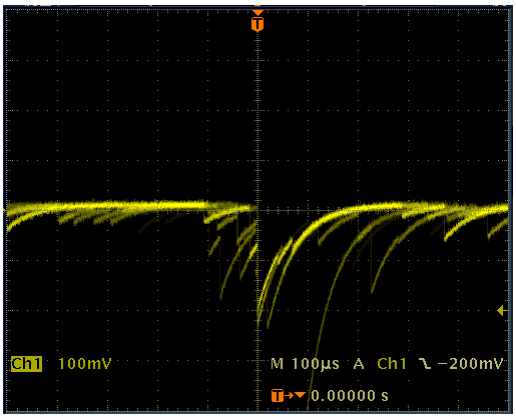


Image 12　Resistive feedback type

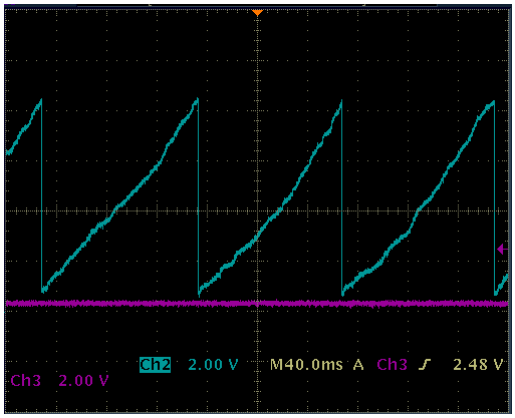
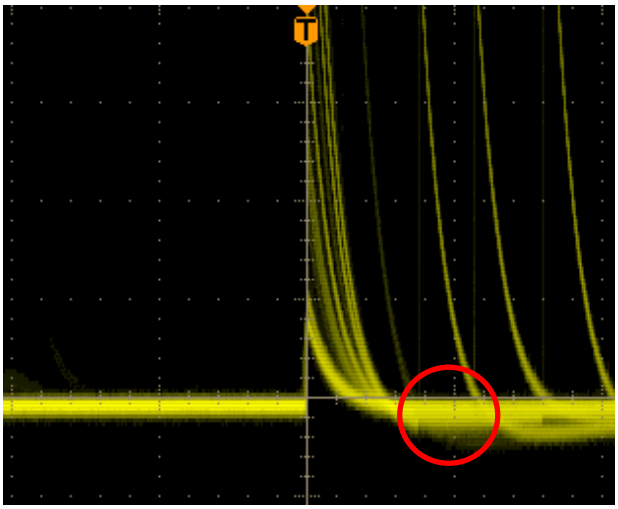


Image 13　Reset type

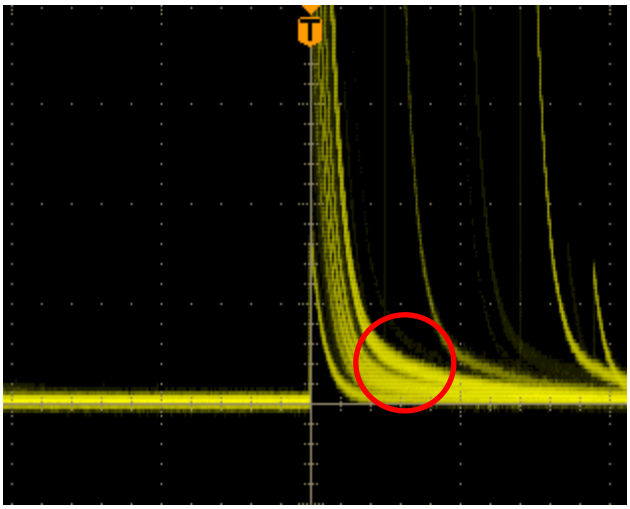
The analog front end of this equipment consists of a pole-zero-canceling differential circuit, a gain adjustment amplification stage, and an anti-aliasing low-pass filter to make the preamplifier signal the optimum environment for digital signal processing.

（1）　Pole-zero

The signal of the preamplifier is usually a signal with a decay (attenuation) of about 50 µs to 100 µs. The decay is too long to be processed by DSP, so high throughput cannot be supported. Therefore, differentiate it into a time constant that is easy to process. The undershoot that occurs at that time is given by the following formula, and the overload characteristics are worse in DSP as well as in analog systems.



Example 1　Undershoot

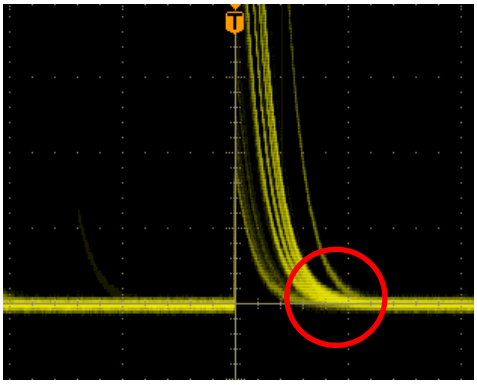


Example 2　Overshoot

Better resolution can be provided by adjusting the pole-zero cancellation circuit.

The matching with the preamplifier is done by analog polezero of the software. This setting does not need to be

readjusted unless you change the preamp. Digital pole zero cancellation adjustment is an undershoot correction for the trapezoidal filter (Trapezoidal Filter) of DSP.



Example 3　After adjuestment

The decay time of this device is 40 μs or more. The input impedance is about 1kΩ.

The preamplifier compatible with this device is a resistance feedback type. It can be changed to a transistor reset type preamplifier upon request. Please refer to the setting below for the adjustment in each method.

（2） Gain adejustment

The ultra-low-noise high-speed programmable gain amplifier can amplify the signal from the preamplifier that requires a fast rise and low noise with high accuracy. The setting of Coarse Gain can be selected from 1x, 4x, 10x, 20x and can be set from the PC. Adjustment of analog fine gain can be done in software as well.

Although the gain can be adjusted digitally with respect to the digitized data, since the gain of the preamplifier signal itself is adjusted in the above, the signal-to-noise ratio (S/N) may be improved.

（3） Anti Aliansing Low Pass Filter

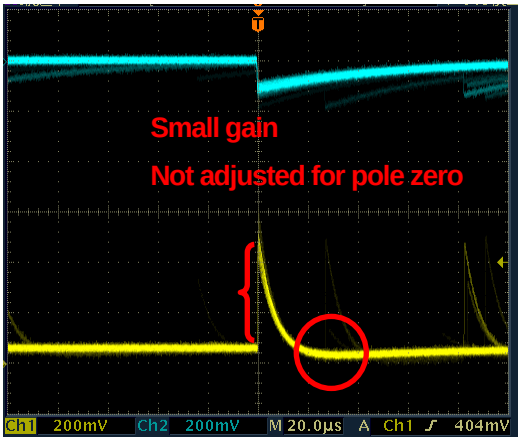
It is placed before the ADC to improve S/N and eliminate aliasing noise. Cutoff frequency is set to about 16MHz.

Resistance feedback type setting

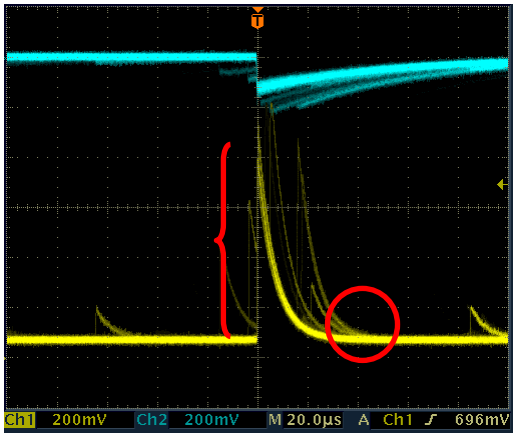
（1） Check the preamplifier output signal from the MONI terminal on the front panel of this device with an oscilloscope.

（2） Adjust and set the optimum value with analog polezero of the software

（3） Adjust and set the optimum value with analog fine gain of the software. When the preamplifier signal wave height is about 2 to 3 MeV full scale, adjust it so that it falls within the range of 800 mV to 900 mV. (When load is 1 MΩ)



Before adjustment



After adjustment

Reset type setting

（1） Check the preamplifier output signal from the MONI terminal on the front panel of this device with an oscilloscope.

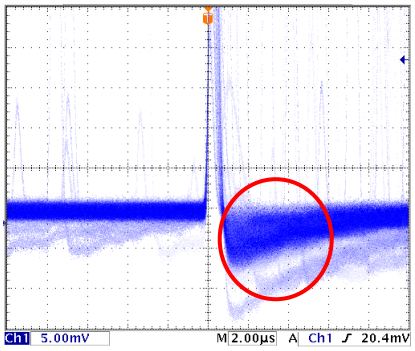
（2） Set the value of analog pole zero of software to “0”

（3） Adjust and set the optimum value with analog fine gain of the software. When the preamplifier signal wave height is about 2 to 3 MeV full scale, adjust it so that it falls within the range of 800 mV to 900 mV. (When load is 1 M)

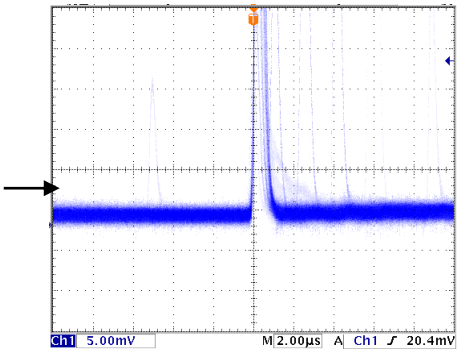
④ FAST (time acquisition) filter setting

（1） Set “DAC MONI” on the “CH” tab to “fast”

（2） Select "100" for both "fast diff" and "fast integral" settings. Check the FAST system shaping signal from the MONI terminal on the front panel of this device with an oscilloscope. Set "fast pole zero" to "0", but adjust if necessary.



Before adjustment “fast polezero”



After adjustment ”fast polezero”

（3） Reference setting

The settings for "fast diff" and "fast integral" depend on the detector and signal conditions.

Below is a rough reference example

Detector	Features	fast diff	fast integral
Scintillator, such as $LaBr_3$	Fast rise time	20	Ext or 20
Semiconductor, such as Ge	High energy resolution	100	100

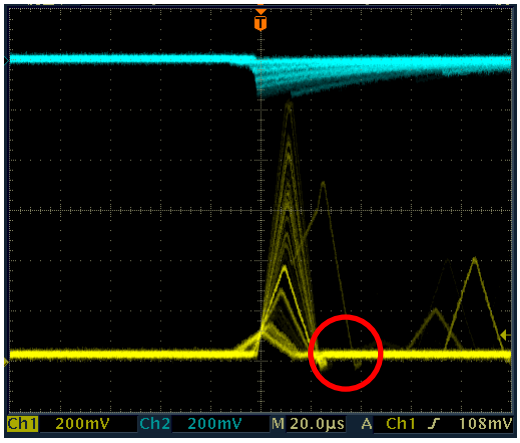
⑤ SLOW filter setting

（1） Set “DAC MONI” on the “CH” tab to “slow”

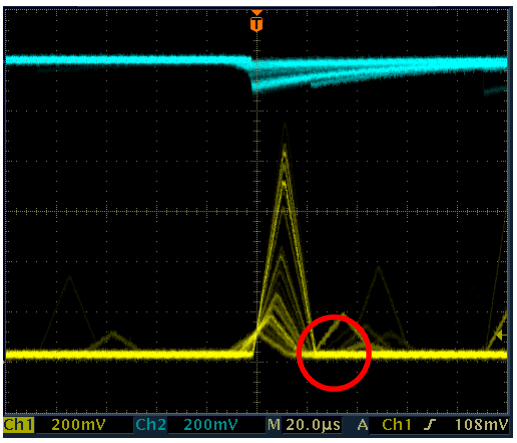
（2） Check the SLOW system shaping signal from the MONI terminal on the front panel of this device with an oscilloscope.

（3） Adjust the pole zero with "slow pole zero" on the "CH" tab.

* For details on the settings, see "6.2. Adjusting digital parameters" below.



Before adjustment



After adejustment

⑥ Confirmation of histogram

（1） Execute the menu "config". Send all settings to the device

（2） Execute the menu "clear". Clear the histogram data

（3） xecute the menu "start". Start measurement

Confirm that the histogram is displayed at the bottom of this application screen and that it is updated with time. * ROI operation can be done in the histogram tab

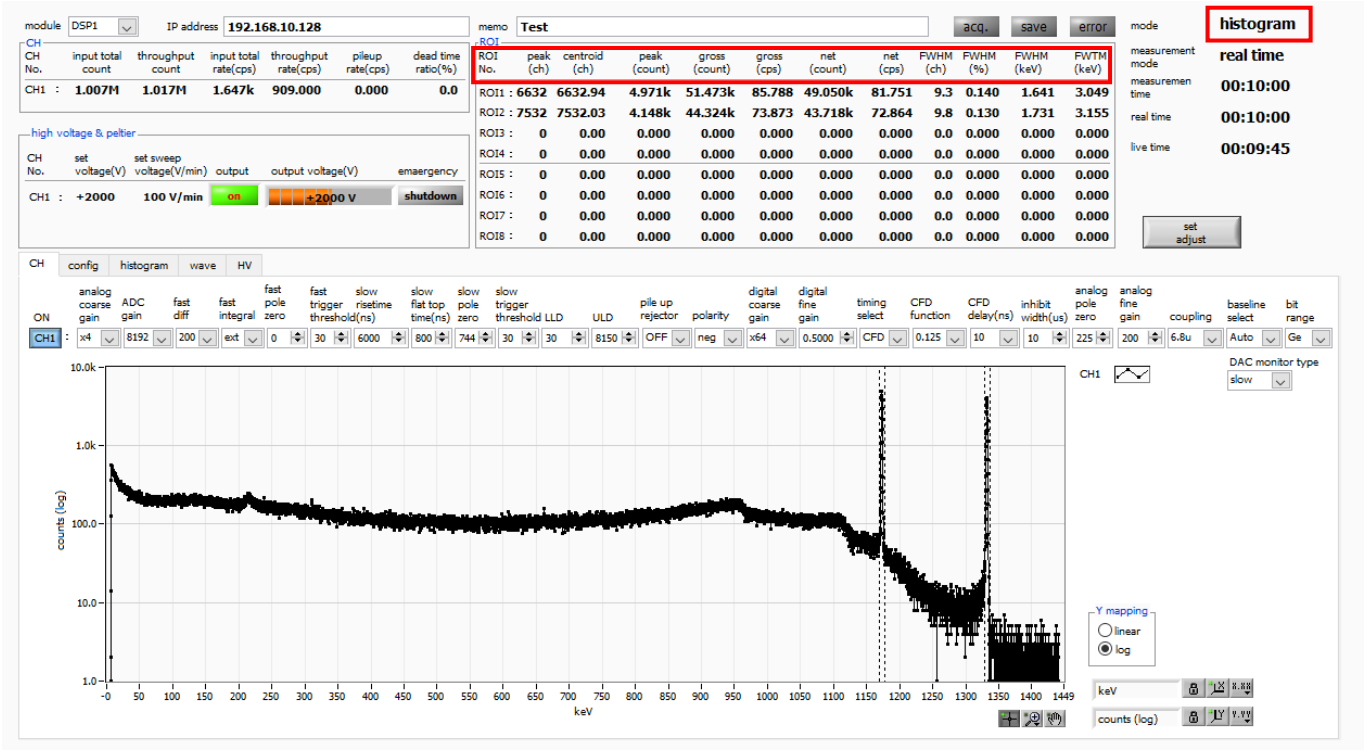


Image 14 Histogram measurement screen

- During measurement, the "meas." LED flashes and the "real time" and "live time" are updated.
- In "real time" mode, the measurement ends when "real time" reaches "measurement time".
  In "livel time" mode, measurement ends when "live time" reaches "measurement time"
- In the "ROI" section, the following items are sequentially calculated for the spectra in the range set for "ROI start" and "ROI end" in the "calibration" tab in advance, and the results are displayed.

peak (ch)	Maximum count ch
centroid (ch)	Central value (ch) calculated from the sum of all counts
peak (count)	Maximum count
gross (count)	Sum of counts between ROIs
net (count)	Sum of counts minus background between ROIs
FWHM (ch)	Half width (ch)
FWHM	Half width
FWTM	1/10 width

（4） To end the measurement manually, execute the menu "Stop". Stop measurement.
（5） If you want to re-measure or change the condition and continue the measurement, start from step (1).
（6） When ending the application, step down HV before ending.
（7） Switch off "output enable" in the HV out section of the "HV" tab and click "Set".
（8） A confirmation message dialog will be output. Click OK if there is no problem.
（9） The HV will be stepped down while the sweep LED blinks at the sweep voltage rate.
（10） Wait until the sweep LED goes out and the output LED goes out.

*** Depending on the load, the output voltage may remain high. This is because it takes some time for the charge voltage to escape from the HV power supply protection circuit and the capacitor for ripple suppression. In this state, it is extremely dangerous to turn off the power of this device or attach/detach the HV cable. The voltage will drop gradually, so please wait until the output LED goes off.**

（11） After waiting for more than 1 minute, select "quit" from the menu "File" to terminate the application.
（12） Turn off the PC power and end
（13） Turn off the power of the device (and oscilloscope)
（14） After a few minutes, remove all the wiring done in "① Connection".

6. 2. Digital parameter adjustment

（1） FPGA

The DSP of this device is built into the Field Programmable Gate Array (FPGA). FPGA is a programmable hardware logic operation LSI. By programming the algorithms required for the DSP, a very large-scale circuit is contained in a single chip, which enables a significant reduction in space. Unlike microprocessors and DSPs (ICs) that perform sequential processing by software, hardware logic circuits that have a special pipeline architecture are processed in real time. As a result, there is no dead time due to DSP calculations or ADC conversions.

（2） Trapezoidal Filter

The trapezoidal filter is used for the pulse shaper by DSP of this device. Trapezoidal shaping of the preamp signal into two types of Fast and Slow. In the figure below, the black waveform is the preamp signal, the blue waveform is the FAST, and the red waveform is the SLOW.

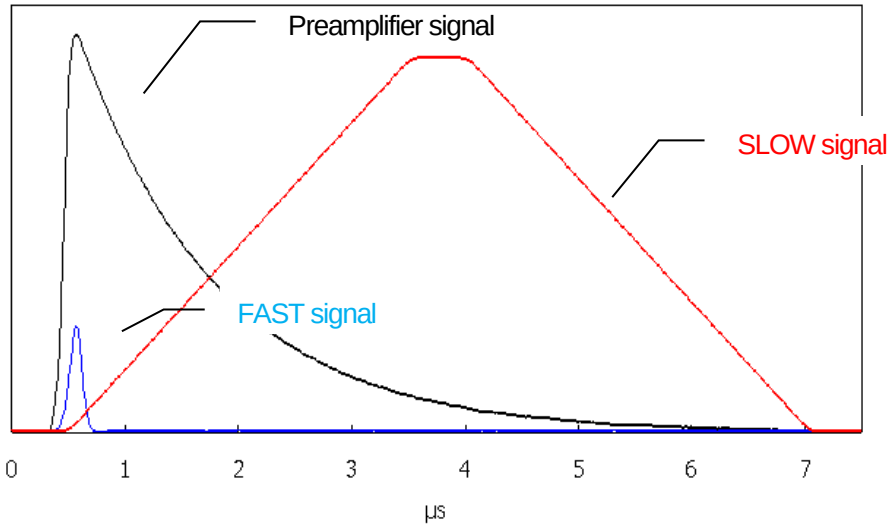


Image 15 Two types of pre-amplified signal trapezoidal filter (FAST and SLOW) processed

FAST is a filter to get the timing. To extract the rising part of the preamplifier, it is usually set to a rise time of 0.1 μs to 0.5 μs, and the baseline is restored as soon as possible to prepare for the next pulse. When the Fast Shaper exceeds the set threshold, pulse detection, pileup rejector execution and baseline detection are performed.

Slow is a filter for measuring energy (wave height). A rise time of 0.5 μs to 16 μs can be set. Settings such as rise time, flat top time, and pole zero are very important for measurements that require high resolution.

（3） Trapezoidal Filter Algorithm

The filter block configured with the pipeline architecture calculates the delay, addition, subtraction, and integration values required for the trapezoidal filter in synchronization with the ADC's 100 MHz clock.

$$FIL(n) = \sum_{i=0}^{n} \sum_{j=0}^{l} DIFF^{r,w}(j) + DIFF^{r,w}(i)P$$

$$DIFF^{r,w} = v(j) - v(j-r) - v\{j-(r+f)\} - v\{j-(2r+f)\}$$

$$P = (\exp(CLK/\tau) - 1)^{-1}$$

$$r = risetime$$

$$f = flattoptime$$

$$w = 2r + f = pulsewidth$$

（4） Trapezoidal Filter setting value

The parameter adjustment of the trapezoidal filter can be set in the same way as the analog module by connecting the DAC MONI of the MONI terminal on the lower part of the front panel to the oscilloscope with a coaxial cable.

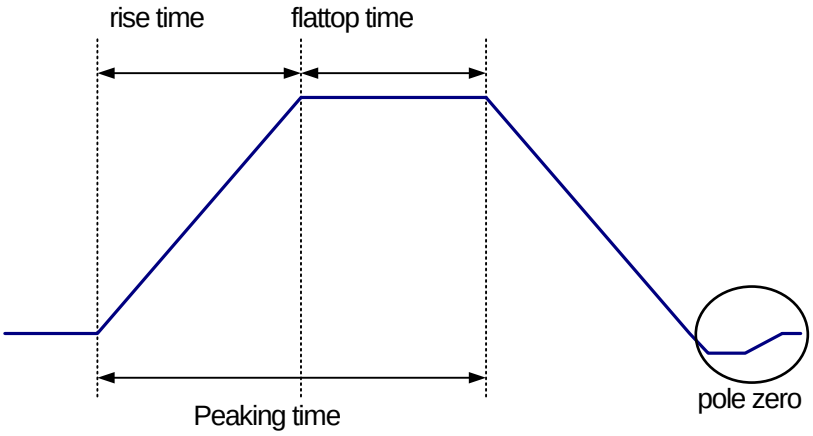


Image 16　Relation of “rise time “, “flattop time” and “pole zero”

Refer to the pre-amplifier signal (black), FAST type signal (red) and SLOW type signal (blue) as shown in the figure below, and describe the setting points for realizing fast type and slow type trapezoidal filter processing

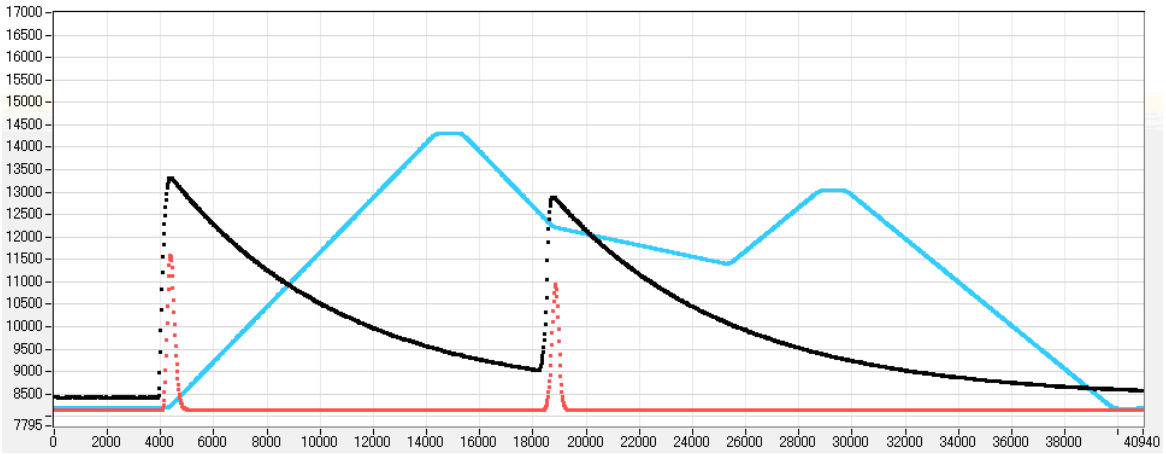


Image 17　Waveform example of each signal

SLOW (blue) setting point

slow rise time: It is the rising time to reach the top of the trapezoid. This value greatly affects the energy resolution. Similar to linear amplifiers, there is a tendency that "a short value results in poor resolution but high throughput" and "a long value results in good resolution but low throughput".

As a guide for setting, the peaking time of the linear amplifier is generally set to a time constant of 2.0 to 2.4×. Setting a rise time value that is about twice the time constant of the linear amplifier will give similar resolution.

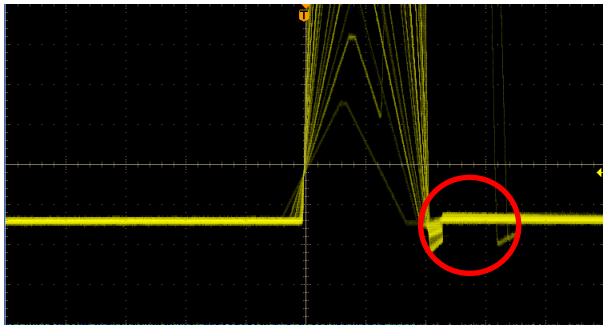
Compared to the linear amplifier, the throughput has a dead time of 6.0 to 6.5×, and the DSP has the following formula for the time constant.

(rise time + flattop time) × 1.25

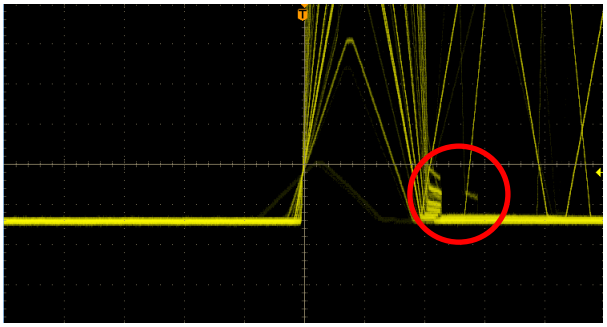
To set the same conditions as when setting **the time constant of the linear amplifier to 6 µs as the settings related to resolution characteristics, set the DSP rise time to 12 µs and the flat top time to 1 µs**. Although the rise time setting is doubled, the dead time is about half, which is 16.25 µs for the linear amplifier and 36 µs for the linear amplifier, so high throughput can be obtained even with a long time constant.

slow flattoptime: The time width of the upper base of the trapezoid. Adjust the error of the crest value due to the variation in the rising of the preamplifier by setting the length of the upper base of the trapezoid. The set value is 0 to 100% of the rise time of the preamplifier, and the double of the slowest rise time is set. Normally, it will be 0.8 μs to 1.2 μs. For large germanium detectors with large variations in rise time, it may be set to about 1.2 μs to 2 μs. The default value is 1000ns.

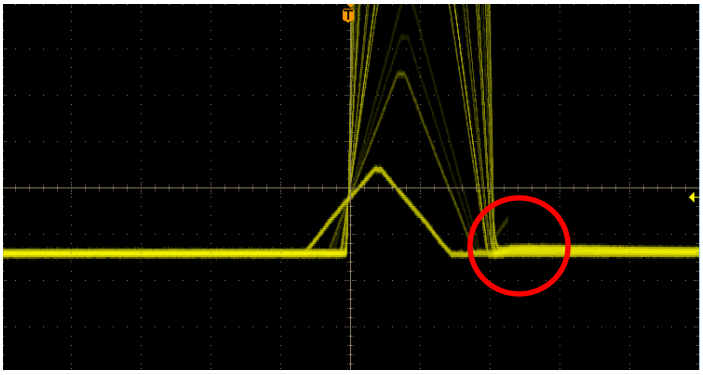
slow pole zero: The falling undershoot and overshoot of the slow filter can be reduced by setting this value appropriately. The default value is 750. Since this value varies depending on the detector, connect the filtered signal output from the MONI pin (DAC MONI) to an oscilloscope and set it to the optimum value while adjusting.



Example 4　Undershoot



Example 5　Overshoot



Example 6　After adjustment

（5） Setting values other than filters

fast trigger threshold: Settings affect the following three

① Threshold value for fast filters. Time stamping is performed as the leading edge timing (LET) when the threshold value is exceeded.

② Used as a threshold for gated baseline restara (BLR).

③ Used as a threshold for pile-up rejector. Set this value as low as possible to distinguish it from noise when connected to the detector.

As a setting method, input a somewhat large value (about 100) and observe the Input Rate. Find the value that gradually decreases the threshold and increases the Input Rate. Since that value is the boundary between signal and noise, set it to about +3 to +10 from that value.

LLD: Set for Lower Level Discriminator. Channels below this threshold are not counted

ULD: Set for Upper Level Discriminator. Channels above this threshold will not be counted

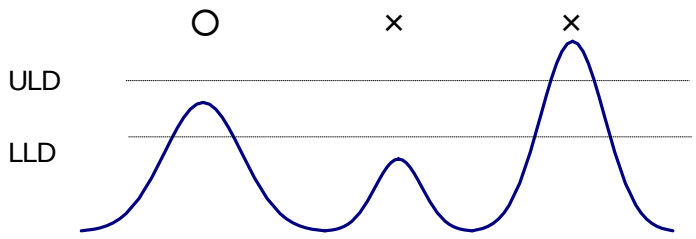


Image 18 LLD and ULD

pile up rejector: Set availability of pile-up reject

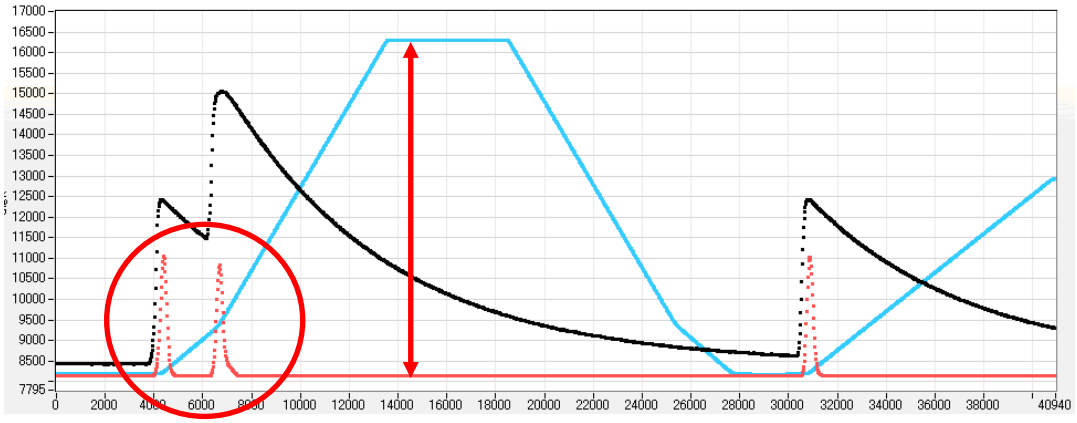


Image 19 Pile-up reject

As shown in the figure above, the two pulses generated within the rise time of the signal whose waveform has been shaped have different values from the actual peak value due to the overlapping waveforms. At high count rates, it becomes a large background noise. To reject this event, a pileup reject is performed by digital signal processing.

The target time is "(risetime + flattoptime) x 1.25", and if there are two events in this period, they will be rejected.

As the number of pile-up rejects increases, the Input Count increases, but the Throughput Count becomes "0", so the difference increases.

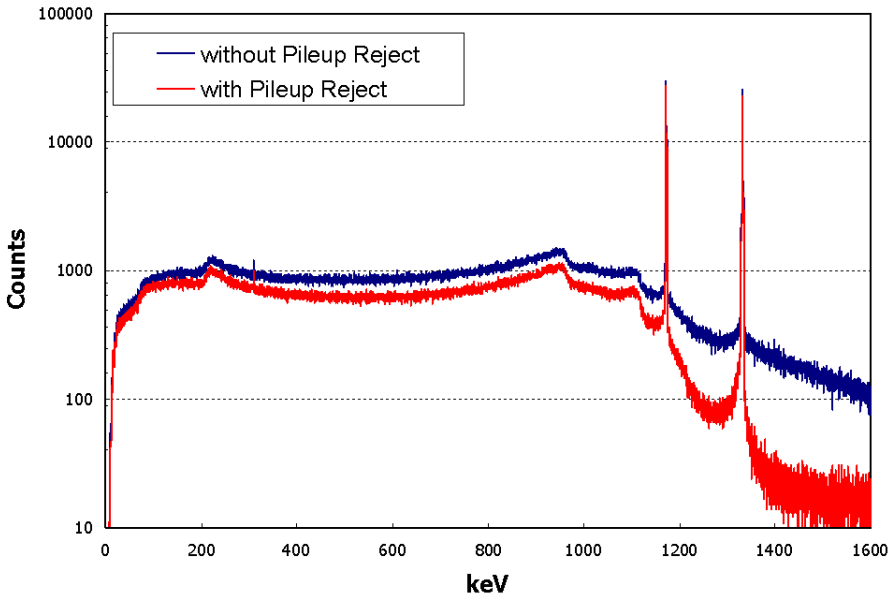


Image 20 Comparison with or without pile-up reject

polarity: Select the preamp signal polarity. “Positive” is positive polarity, “negative” is negative polarity

digital coarse gain: Digitally select the gain from 1x, 2x, 4x, 8x, 16x, 32x, 64x, 128x. For trapezoidal filters, the integrator circuit is calculated by multiply-accumulate operation. The larger the rise time, the larger the number of multiply-accumulate operations and the larger the value. The smaller the rise time, the smaller the value. This value becomes the output of the filter as it is, so it must be corrected. It is used together with the rise time setting value.

digital fine gain: Fine gain is set digitally. The setting range is 0.3333 to 1.

timing select: Select the timing to determine the time stamp from "LET" or "CFD".

“LET”: Leading Edge Timing

It is the timing when a certain trigger level t is reached. The trigger acquisition timing is different if the wave height changes like a'and b'.

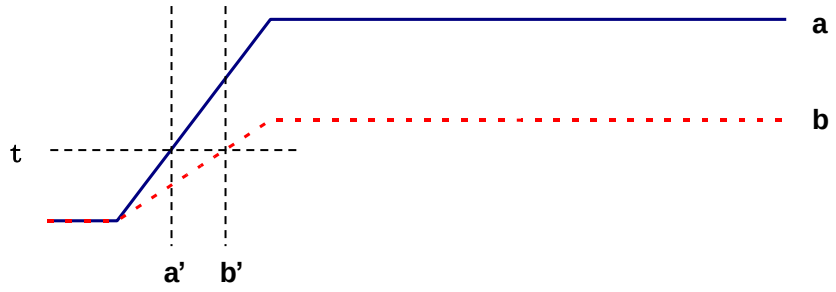


Image 21　Concept of Leading Edge Timing

"CFD": Constant Fraction Disicriminator Timing

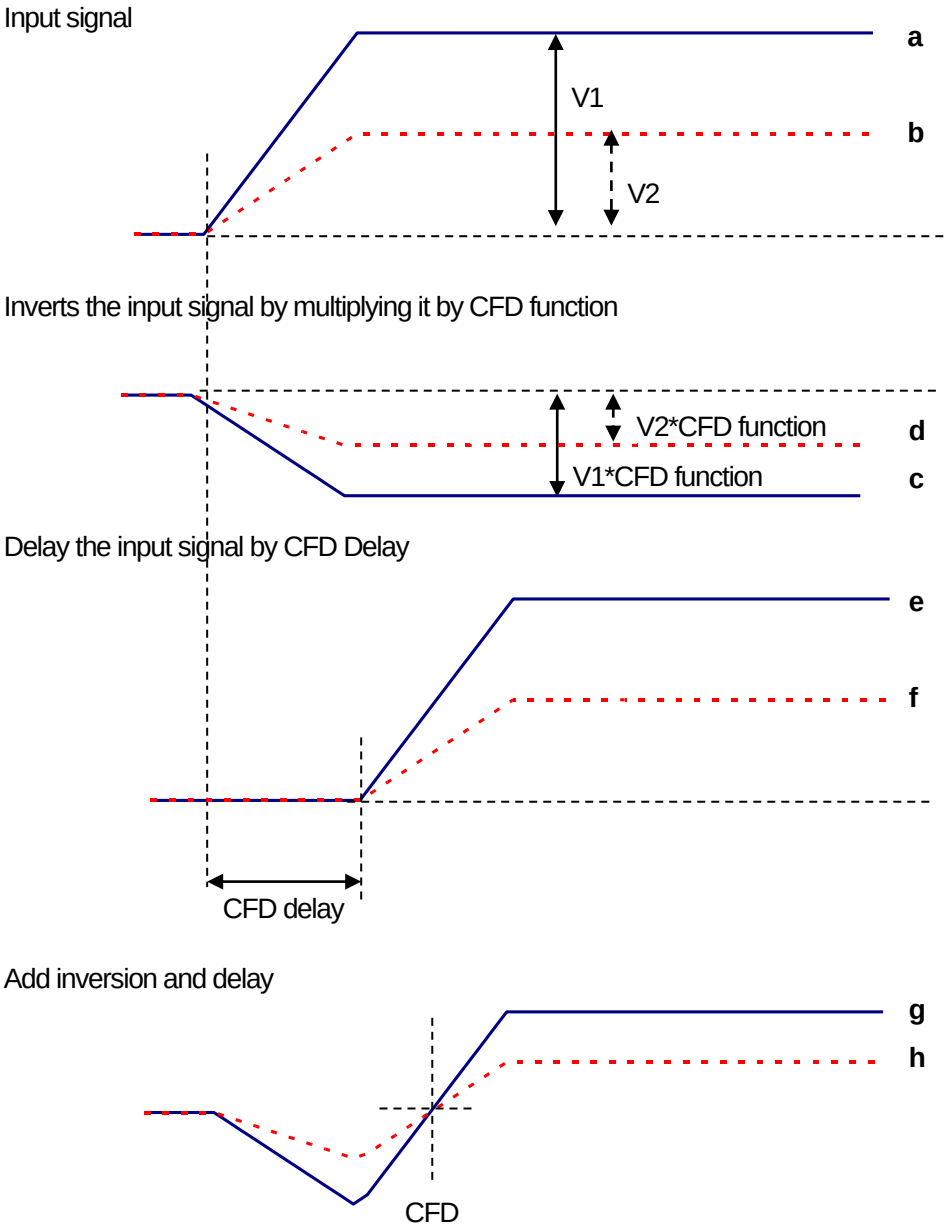


Image 22 Concept of Constant Fraction Disicriminator Timing

Generate the following waveforms c, d and e, f and g, h for different waveforms a and b in the above figure.
Wave form c, d: Waveforms a and b are multiplied by CFD function and inverted
Wave form e, f: Waveform a and b delayed by CFD delay
Wave form g, h: Waveforms with waveforms c and e and waveforms with waveforms d and f added

CFD, which is the zero-cross timing of waveforms g and h, is characterized by being constant even if the wave height changes, if the waveform rise time is the same.

- CFD function: Set the magnification to reduce the original waveform for CFD calculation. Select from 0.125, 0.25, 0.375, 0.4, 0.5, 0.625, 0.75, 0.875.
- CFD delay: Select CFD delay time from 10, 20, 30, 40, 50, 60, 70, 80 ns.

6. 3. Signal processing by external input terminal

The following signal processing is possible by using LEMO connectors “GATE” “VETO” “CLR” “CLK” on the front panel. A TTL level signal is required when using. The allowable high signal level is 2 to 5V, but it is recommended to use 3.3V or less because it is optimized for 3.3V signal. The required signal amplitude (pulse width) depends on the signal processing used.

（1） Event data acquisition by GATE signal

Use LEMO connector “GATE” on the front panel to acquire event data at the time of a certain event.

When high, it measures, when low, it does not measure. The setting procedure is as follows.

① Observe "slow" of SLOW filter of DAC monitor output with oscilloscope.

② Create a GATE signal (pulse width that covers the slow signal from the rising edge to the falling edge) within the range defined by the SLOW filter and input it.

（2） Event data acquisition by VETO signal

Use the LEMO connector "VETO" on the front panel to discard the event data when a certain event occurs. When Low is measured, when High is not measured. The required pulse width is the same as for GATE processing

（3） Use of external clock

It is possible to synchronize by supplying an external clock to the LEMO connector "CLK" on the front panel. The setting procedure is as follows

① Input a TTL level 25MHz rectangular signal (Duty ratio: 50%) to "CLK" from the outside.

② Change "clock" to "external" in "config" tab of DSP MCA. Be sure to perform the above (1) before setting.

（4） Use of external clear

Use the LEMO connector "CLR" on the front panel to zero the time information of the measurement time and list data time stamp with an external signal. Clear when High. Input a signal with a pulse width (High level of 50 ns or more) that allows the system to determine clear input sufficiently.

6. 4. Calculation method of Full Width at Half Maximum (FWHM)

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

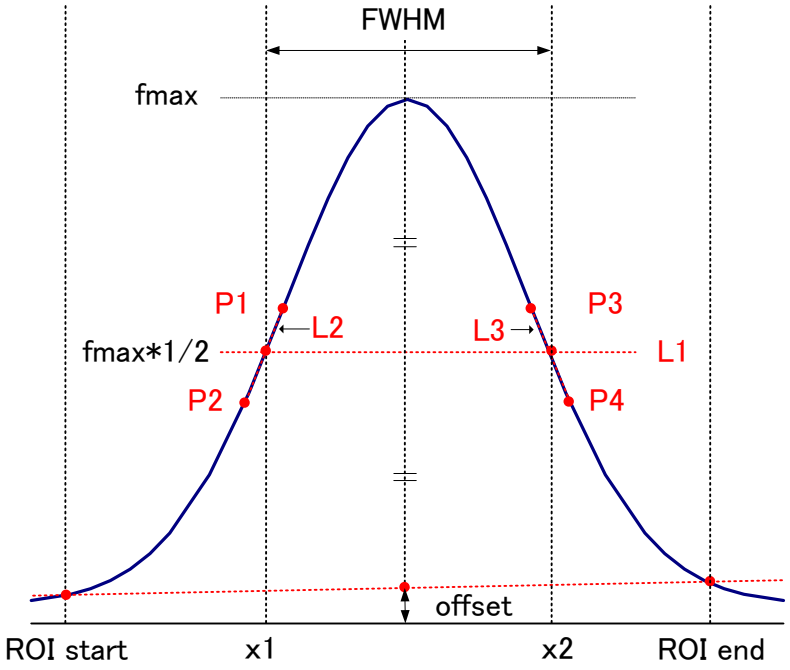


Image 23 Calculation of FWHM

（1） Detect maximum fmax between ROI Start and ROI end in histogram.

（2） A straight line connects the intersection of the histogram and ROI start and the intersection of the histogram and ROI end. Calculate the background offset (offset) by finding the intersection of the straight line and the line drawn from the peak value fmax to the x-axis.

（3） Calculate 1/2 of fmax minus offset and draw a straight line L1 parallel to the X axis

（4） To find the two points where the histogram and L1 intersect, the front and back points P1 and P2, and P3 and P4 that intersect are detected.

（5） To find the two points where the histogram and L1 intersect, draw a straight line L2 that connects the front and back points P1 and P2, and P3 and P4 that intersect P1 and P2, and a line L3 that also connects P3 and P4.

（6） Calculate the X coordinate x1 of the intersection of L1 and L2 and the X coordinate x2 of the intersection of L1 and L3.

（7） The difference between x2 and x1 is FWHM.

7. Measurement

NOTE: This chapter describes the measurement section. It is a procedure in which the user has already applied power or high voltage to the detector or preamplifier and the signal from the preamplifier is input to the INPUT terminal of this device.

7. 1. Initialization settings

（1） Click the menu "Config". After execution, all settings in DSP are sent to DSP.
（2） Click the menu "Clear". After execution, the histogram data in DSP is initialized. If you want to continue the previously measured histogram and measurement results, start the next measurement without clicking "Clear".

7. 2. Measurement start

- Click the menu "Start" to start measurement.
- The measurement status of each CH is displayed in the "CH" section.
- "Acq" LED flashes.
- "Measurement time" displays the measurement set time.
- The real time acquired from DSP is displayed in "real time".
- The live time acquired from DSP is displayed in "live time".
- The dead time acquired from DSP is displayed in "dead time".
- "Dead time ratio" shows the ratio of "dead time"/"real time".

[In histogram mode]

- Display "histogram" in "mode".
- Each calculation result is displayed in the "ROI" section.
- The histogram is displayed in the "histogram" tab.

[In list mode] * Some models cannot be used.

- Display "list" in "mode".
- When saving a file in list mode, the "save" LED flashes and the currently saved file size is displayed on the right side of "file size (Byte)" in the "config" tab.
- The status of the DSP list data transmission buffer is displayed in "list data buffer". If it reaches 100%, it will overflow, and you will miss the data. Use it so that the sum of "throughput rate (cps)" of all CHs does not exceed 160kcps.

[In wave mode]

- Display "wave" in "mode".
- Waveform information displayed in wave tab.

7. 3. Measurement stop

- “Measurement mode”: “real time” ⇒ Measurement ends when “real time” reaches “measurement time”.
- “Measurement mode”: “livel time” ⇒ Measurement ends when “live time” reaches “measurement time”.
- To stop during measurement, click the menu "Stop". Stop measurement after execution.

8. File

8. 1. Histogram data file

（1）File format

Text format with comma separated

（2）File name

Any

（3）Consist

Consists of "Header" section, "Status" section, "Calculation" section and "Data" section.

• Header section

Measurement mode	: Real time or Live time
Measurement time	: Unit is seconds
Real time	: Real time
Live time	: Live tiem
Dead time	: Dead time
Start Time	: Measurement start time
End Time	: Measurement stop time

* The following part is saved for each CH

ACG	: Coarse gain
ADG	: ADC gain
FFR	: FAST rise time
FFP	: FAST flattop time
SFR	: SLOW rise time
SFP	: SLOW flattop time
FPZ	: FAST pole-zero cancel
SPZ	: SLOW pole-zero cancel
THR	: FAST threshold
LLD	: Energy LLD
ULD	: Energy ULD
OFF	: Offset
PUR	: Pile-up reject
POL	: Polarity
DCG	: Digital coarse gain
TMS	: Timing selection
CFF	: CFD function
CFD	: CFD delay
IHW	: width of inhibit

* Up to here is the part saved for each CH

MOD	: Mode
MMD	: Measurement mode
MTM	: Measurement time
CLS	: Clock selection
SCK	: WAVE sampling clock

• Calculation section

* The following part is saved for each CH

ROI_ch	: Input channel number subject to ROI。
ROI_start	: ROI start position (ch)
ROI_end	: ROI stop position (ch)
peak (ch)	: Peak position between ROIs (ch)
centroid (ch)	: Center position between ROIs (ch)
gross (count)	: Sum of counts between ROIs
net (count)	: Sum of counts less background between ROIs
FWHM (ch)	: Half-width between ROIs (ch)
FWHM (keV)	: Full width at half maximum between ROIs (keV)
Energy (keV)	: Energy value of peak between ROIs (keV)

• Status section

* The following part is saved for each CH

input total count	: total count
throughtput count	: throughput count
pileup count	: pile-up count
input total rate	: total count rate
throughtput rate	: throughput count rate
pileup rate	: pile-up count rate

• Data section

Histogram data for each channel. Up to 8192 points.

8. 2. List data file

* Some models cannot be used.

（1） File format

Binary, big endian format

（2） File name

The file path set in "list file path" in the "config" tab with "file number" padded with 0 digits and 6 digits

Example 1: If "list file path" is set to "D:¥data¥123456.bin" and "number" is set to "1",
"D:¥data¥123456_000001.bin"
Example 2: When "D:¥data¥123456" is set in "list file path" and "100" is set in "number",
"D:¥data¥123456_000100"

When the "list file size" is reached, the file being saved is closed. After that, the "list file number" is automatically incremented by one and a new file is opened, and data saving is continued.

（3） Consist

80bit per event (10Byte, 5WORD)

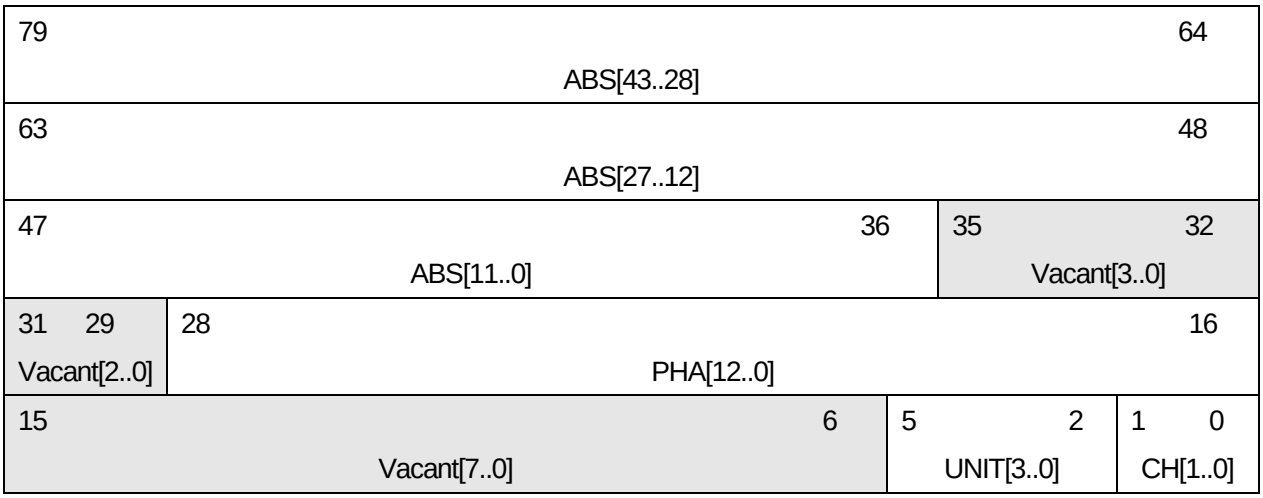


Image 24 List data (80 bit) structure

- Bit79 to Bit36 ABS (absolute) count. 44 Bit
  10 ns per bit.
  Maximum measurement time is about 24 hours (24 hours ≈ 243 * 10ns)
- Bit35 to Bit29 Vacant. 7Bit.
- Bit28 to Bit16 PHA. 13Bit when ADC gain is up to 8192, 0 to 8191.
- Bit15 to Bit6 Vacant. 10Bit.
- Bit5 to Bit2 Unit number. 4Bit.
  * For multiple units: 0 for unit 1 and 15 for unit 16.
- Bit1 to Bit0 CH number. 2Bit.

9. Other

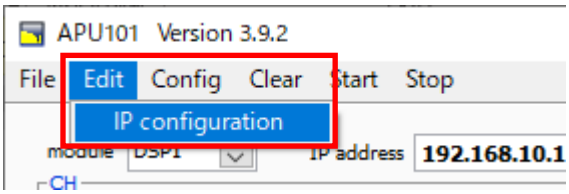
9. 1. Change network information

* Some models cannot be used.

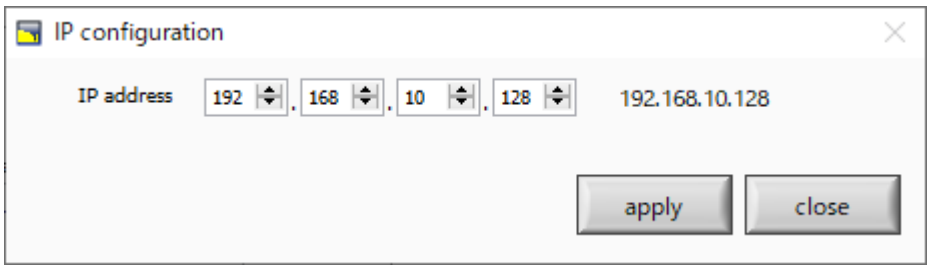
Network settings such as the IP address, subnet mask, and default gateway of this device can be changed from the application. Only when it is necessary to change the IP address of this device, follow the procedure below.

*This operation uses the network communication function of the application, so it is necessary to establish communication between the PC and this device in advance.

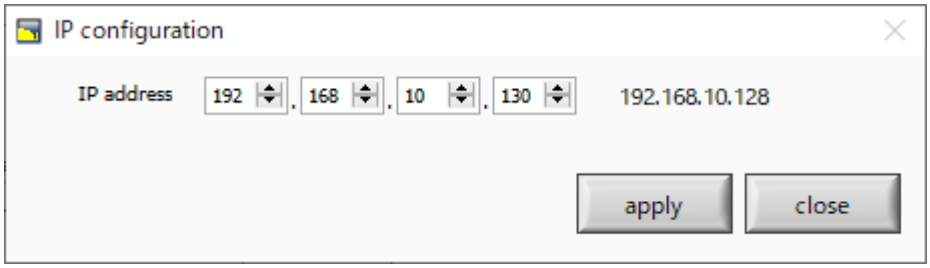
（1）Start the application after turning on the main power of this device. Click the menu "Edit"-"IP configuration".



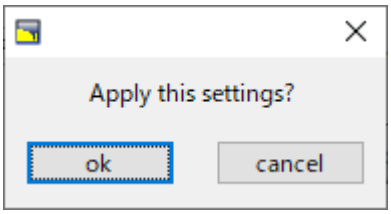
After execution, the setting screen "IP configuration" is displayed.



（2） Enter the value to be set in this device on the screen "IP configuration". The value before the change is displayed on the right side of the screen. In the example below, only "IP address" is changed to "192.168.10.130".

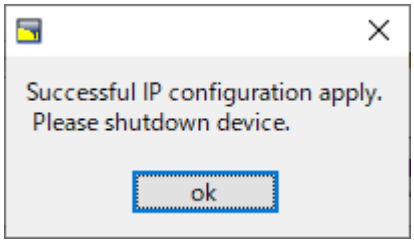


（3） After changing, click the "OK" button.



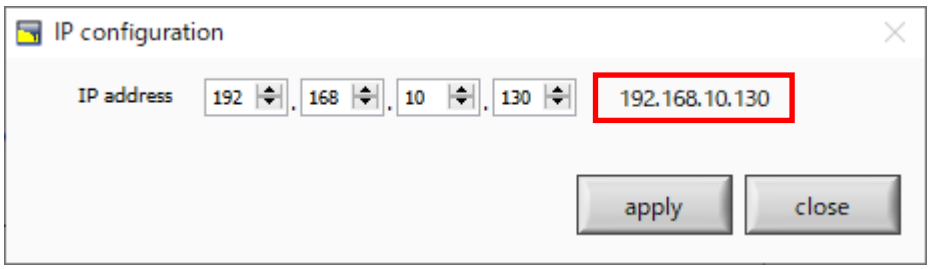
After execution, the following confirmation dialog will be displayed.

To change the settings, click the "OK" button. To cancel, click “cancel”. The following dialog will be displayed if the changes are made normally by clicking the "OK" button.



If this dialog is displayed, click the "OK" button. After that, confirm that the HV has dropped to a few V → Exit this application → Turn off the power of this device → Wait for 1 minute and then turn on the power of this device → Restart the device by the procedure of starting this application I do.

（4） Confirm that the main screen "IP address" is updated.



Confirm that the PING command can be executed normally at the command prompt.

9. 2. If the initialization fails

When you start this application, an error message that the connection with the device failed may be displayed.
The main causes are as follows.

***To solve this problem, do not turn off the power of this device suddenly.**

- Insufficient insertion of LAN cable on PC side.
- Insufficient insertion of LAN cable on the device side.
- The power of this device is OFF, or the LAN cable is broken.
- The network setting on the PC is DHCP, or it is not set with a private address (192.168.10.2 to 255 except 192.168.128).

In this case, please restart this application after confirming the cable connection.

１０. Specifications

Table 1　specifications of APU101

ITEM	DESCRIPTION
Model	APU101
Analog input	1CH ±1V レンジ、入力インピーダンス：約 1kΩ
Analog gain	Coarse Gain x1, x4, x10, x20、 Fine Gain(ソフトウェアにて調整可)
Sampling	100MSPS、分解能 14Bit[フルスケール(±1V にて)]
ADC Gain	8192、 4096、 2048、 1024、 512、 256ch
Digital processing	Trapezoidal Filter : 0.1 ～ 16us Fine Gain : x0.333 ～ x1.0 Baseline Restorer, Pileup Rejecter 等
Unit panel Switchs Buttons Connectors	[Front] HV status LED Emergency stop button High voltage monitor LED Dead time monitor LED External TTL input/output connector for expansion (AUX1 and AUX2) * Optional LAN connector POWER switch [Rear] DC input connector F.G terminal D-sub 9-pin connector for preamplifier power output MONITOR output connector Preamplifier signal input connector Bias shutdown input connector
High voltage power supply	* When changing the specifications, the maximum output voltage/current value may be different. Output voltage: Positive electrode, negative electrode, High-Z switchable [0V to 4000V ±5% (1GΩ load)] Output impedance: Approx. 200 kΩ Output current: Max.1mA Ripple: 20mVp-p(typ.) Supports automatic step-down by detecting bias shutdown signal
Preamplifier power supply	±12V, ±24V, NIM Standard compliant
Communication	Ethernet TCP/IP *Some models use UDP
Dimentions	210 (W) x 45 (H) x 275 (D) * without connectors
Weight	About 1800 g
Current comsumption	+12 V (about 0.8 A) + preamplifier power supply (±12 V, ±24 V) *Depends on the connected preamplifier
Environment of application opration	Microsoft Windows 7 or later 32Bit Screen resolution XGA (1024*768) or more
Accesories	Main device, application software, Instruction manual

11. Warranty policy

The guarantee conditions for "our products" are as follows:

- Warranty period: 1 year after purchase
- Guarantee: If the product fails during the warranty period, even if it was used correctly according to this instruction manual.
- Not covered by warranty: If the cause of failure is any of the following, we do not guarantee it.

（1） Failure/damage due to misuse, improper repair, modification, or disassembly.

（2） Failure/damage due to dropping.

（3） Failure/damage in harsh environments (high temperature, high humidity, sub-zero temperature, condensation, etc.).

（4） Other than the above, causes other than "our product".

（5） Consumable goods.

（6） Failure due to natural disasters such as fire, earthquake, water damage, lightning strike, or theft.

（7） When it is judged to be wet.

When using our products, you agree to all of the above items.

[Contact]

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[Agency, Distributor, Representative]

Warrenty

This product warranty promises to provide a free warranty for the product within the warranty period and within the warranty conditions.

Product	:	Digital Spctrometer
Model	:	APU101
S/N	:	
Warranty period	:	1 year after purchase
Purchase date	:	
Sales store	:	
Customer name	:	
Customer address	:	
Customer telephone	:	

* Please keep the product warranty certificate and proof of purchase date. This is required for warranty and repair.
* This product warranty will not be reissued, please keep it in a safe place.
* The service may be charged even during the warranty period. Please be sure to read the "Safety Precautions and Disclaimer" carefully and be sure to observe the contents.

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