Digitizer
Model: APV8516-14

Instruction Manual

1.0.1 Edition
March 2020

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Safety Precautions / Disclaimer

Thank you very much for purchasing the Digital Pulse Processor, Model: APV8102-14MWPSAGb (hereinafter ”This board”) Please read this "Safety Precautions / Disclaimer" before using this board, be sure to observe the contents, and use it correctly.

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

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 strong shock or vibration to this device.
- Do not disassemble or modify this device.
- Do not wet this device with water or condensation. Do not operate this device with wet hands.
- If there is heat generation, deformation, discoloration, odor, etc. in this device, stop using it immediately and contact us.

Caution

- Use this device at room temperature in the operating temperature range and use it so that there is no condensation.
- If there is smoking or abnormal heat generation in this device, turn off the power immediately.
- Be careful of static electricity because this device is a precision electronic device.
- Do not store this device in a dusty place or high temperature / high humidity place.
- Do not place devices that emit strong electromagnetic waves, such as mobile phones and transceivers, close to this device.
- This device may malfunction in environments with high electrical noise.
- The specifications of this device and related documents may be subject to change without prior notice.

Guarantee conditions

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

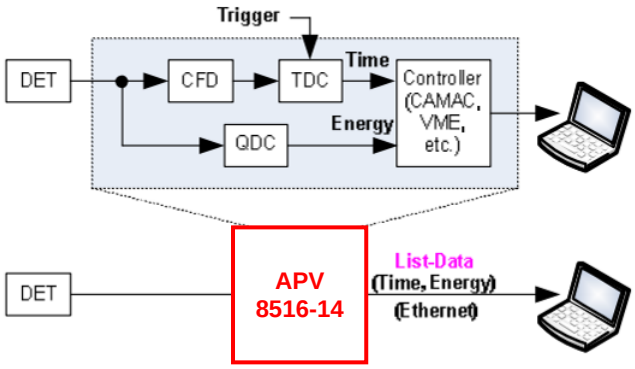
Warranty period	One year from date of purchase.
Guarantee contents	Repair or replacement will be carried out in case of breakdown even though you have used correctly according to this instruction manual within the warranty period
Out of warranty	We do not warranty if the cause of the failure falls under any of the following. 1. Failure or damage due to misuse or improper repair or modification or disassembly. 2. Failure and damage due to falling etc. 3. Breakdown / damage in harsh environments (high temperature / high humidity, under zero, condensation etc.). 4. Causes other than the above, other than "our products". 5. Consumables. 6. Natural disasters such as fire, earthquake, flood damage, lightning, etc. and breakdown due to theft. 7. When the cause of the malfunction is found to be wet

* Even during the warranty period, costs may be incurred for repair or replacement. Please read the contents of "Safety Instruction and disclaimer" carefully and use it correctly.

Contents

1. Abstracts

The APV8516-14 is a waveform analysis board for scintillation detectors. Each channel (16 CH.) is equipped with high-speed, high resolution ADC (500 MHz, 14-bit). The APV8516-14 can correspond to the high rates of more than 200 kcps per CH. in the list mode with using the Gigabit Ethernet (Gb Ether) connection.



Structure

*In this instruction manual, “List” and “Event” are equivalences.
*In this instruction manual, “Histogram” and “Spectrum” are equivalences.

1．1． Specification

1. Analog Input
   - Number of Channel: 16 CH.
   - Input Range: ±1 V
   - Input Impedance: 50 Ω

2. ADC
   - Sampling Frequency: 500 MHz
   - Resolution: 14-bit
   - SNR: 68.3dBFS@605 MHz

3. Performance
   - QDC Throughput: More than 1 Mcps
   - Time Resolution: 7.8 ps (LSB)

4. MCA
   - Measurement Mode: Wave Mode, Histogram Mode, List Mode
   - Event Transmission Rate: Approx. 10 Mbyte / sec.
     In case of 10 Byte (80 Bit) / Event, CH. total is 1 Mcps.

5. Communication I / F
   - LAN I/F: Ethernet TCP / IP 1000 Base-T (List data acquisition), UDP/IP (config data, states data sent / received)

6. Form
   - VME type: VME1U, 20mm (W) x 262mm (H) x 187mm (D), About 460g

7. Wattage
   +5V: 6.0 A (Max.)
   +12V: 0.8 A (Max.)
   -12V: 0.4 A (Max.)

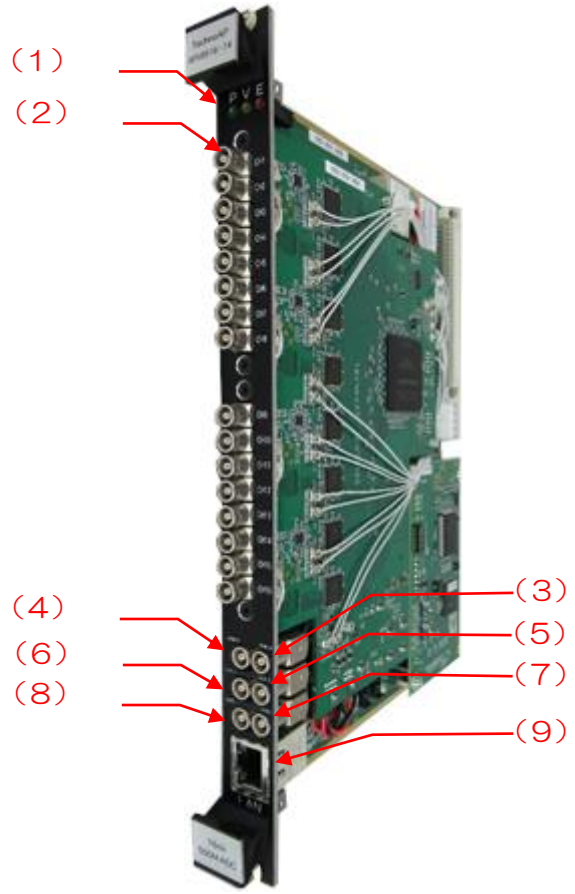
1．2． Operation System Requirements

- Microsoft Windows 7 or later

1．3． Revision History

Edition	Conteint	Date
1.0.0	First Edition	10 December 2019
1.0.1	Second Edition	4 March 2020

2. External



No.	Name	Contents
1	LED	P: Power ON V: Not used E: Not used.
2	CH1 to CH16	LEMO connector for signal input. Input range: ± 1V, input impedance: 50Ω.
3	SYNC-O	LEMO connector for synchronous timing signal output. Outputs a timing signal for adjusting the time between boards.
4	SYNC-I	LEMO connector for synchronous timing signal input. Input a timing signal to adjust the time between boards.
5	CLK-O	LEMO connector for external clock signal output. Outputs a 25MHz TTL signal.
6	CLK-I	LEMO connector for external clock signal input. It can be operated using an external clock. Turn on the power after inputting the 25MHz TTL signal.
7	VETO	LEMO connector for external VETO signal input. Disable data acquisition during “High”.
8	GATE	LEMO connector for external GATE signal input. Input TTL signal. Enables data acquisition while the input is “High”.
9	LAN	RJ45 connector for Ethernet cable. 1000Base-T.

Note: Use the SYNC-O and SYNC-I interconnected with a cable.

3. Preparation

3.1. Display

Recommended monitor resolution is more than FullHD (1920 x 1080)

3.2. Installation of the application

The application for APV8516-14 (hereinafter this application) runs on Windows. To use this software, it is necessary to install the EXE (executable file) of this application and the LabVIEW Runtime Engine of National Instruments on the PC used for measurement.

Installation of this application is performed by the installer included in the attached CD. The installer includes an EXE (executable) file and the LabVIEW Run-Time Engine, which can be installed at the same time.

The installation procedure is as follows.

1. Log in to Windows with administrator authority.

2. Execute “Setup.exe” in the “Installer” folder on the attached CD-ROM. Proceed with the installation interactively. The default installation destination is “C: ¥ TechnoAP”.

3. Execute "Start Button"-"TechnoAP"-"APV8516-14".

   To uninstall, select "APV8516-14" from "Add or Remove Programs" and delete it.

Recommended computer specifications are follows,
Microsoft Corp. Windows 7 32-bit or later
Recommended screen resolution: FullHD (1920 x 1080) or more.

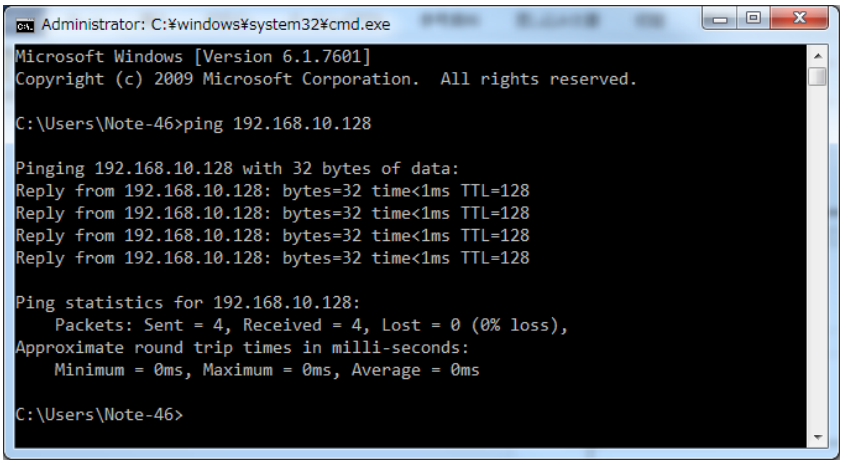
3.3. Power ON and IP Connection Confirmation

1. Confirm power on the PC and Switching Hub, and ON the VME power switch.

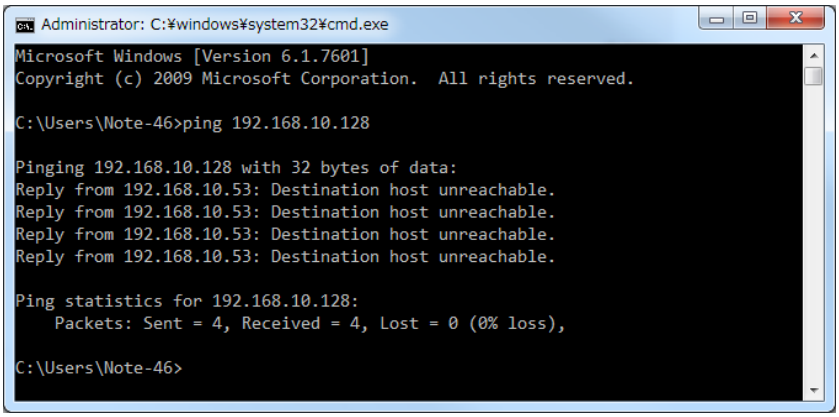
2. Please wait about 30 seconds

3. Execute the ping command at the Windows command prompt to check whether the device and the PC can be connected. Start the windows application “cmd.exe”. The IP address of this device shows on the board. The defalt of these boards is as follows.
   “ping 192.168.10.**128**”
   “ping 192.168.10.**129**”
   “ping 192.168.10.**130**”

∗Screen when communication settings are CORRECT

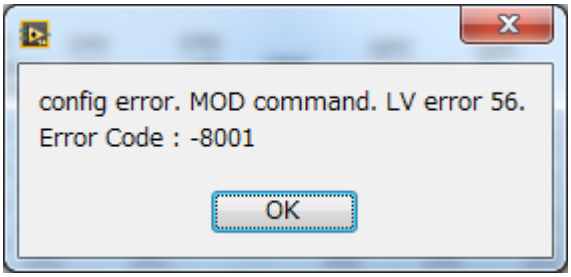


∗Screen when communication settings are INCORRECT



1. Start application “APV8516-14”

When starting this application, an error message indicating that connection with the device failed may be displayed.



Possible causes are:

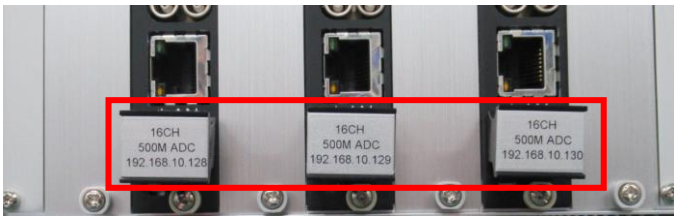
1. The port definition in the "System" section of the configuration file "config.ini" has an incorrect value.
2. The LAN cable on the PC is not inserted properly.
3. The LAN cable on the device is not properly inserted.
4. The power of this device remains OFF or the LAN cable is disconnected.
5. The network setting on the PC is set to DHCP.
6. IP address of TCP/IPv4 is not the range ”192.168.10.2” to “192.168.10.255”.
7. The power saving mode of the PC is working.
8. The PC's wireless LAN is enabled.

If the above does not work, try the following:
After checking the cable connection, restart this application.

3.4. Connection

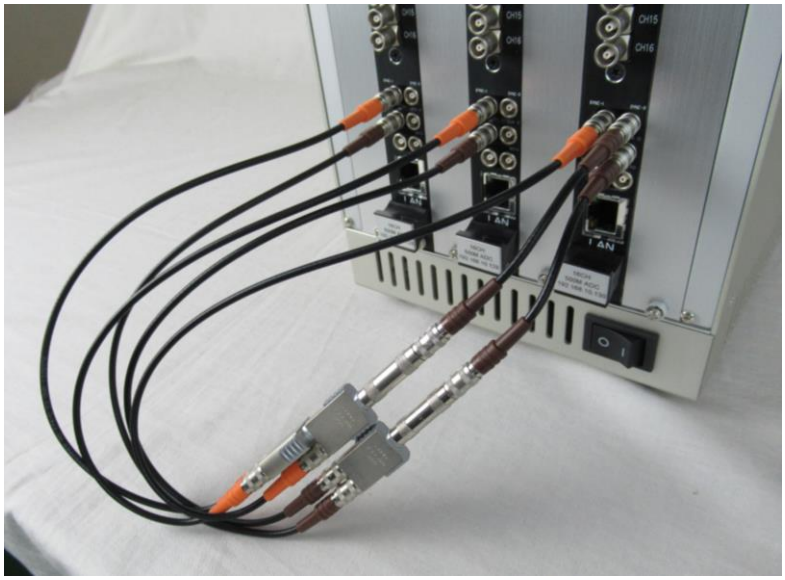
Please check the IP address each board.

Place of IP address



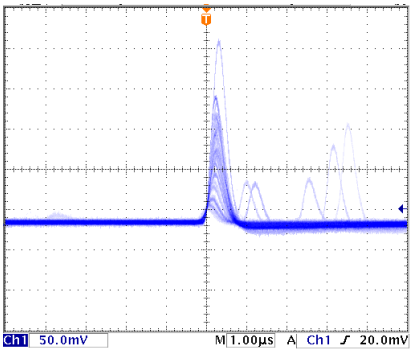
LEFT: **192.168.10.128** CENTER: **192.168.10.129** and RIGHT: **192.168.10.130**

Each clock-IO and sync-IO must be connected as follow.
Clock out of IP 130 module connect to clock input both IP 128 and IP 129 module.
Sync out of IP 130 module connect to sync input of all module.
Please be careful of there is two type cables.



3. 5. Setting of FAST filter

This board has a FAST filter to obtain time information of waveform acquisition and a SLOW filter to acquire energy (wave height).
First, set the FAST filter. The setting has the same characteristics as a general timing filter amplifier.



FAST filter (fast diff 50, fast integral 50)

1. DAC output setting

Connect the DAC output signal to the oscilloscope, select “DAC monitor CH” to the corresponding channel, and set “DAC monitor type” to “fast”.
Prepare the FAST filter signal from the DAC output of the DSP using an oscilloscope.

2. Constant setting of the FAST system differential circuit

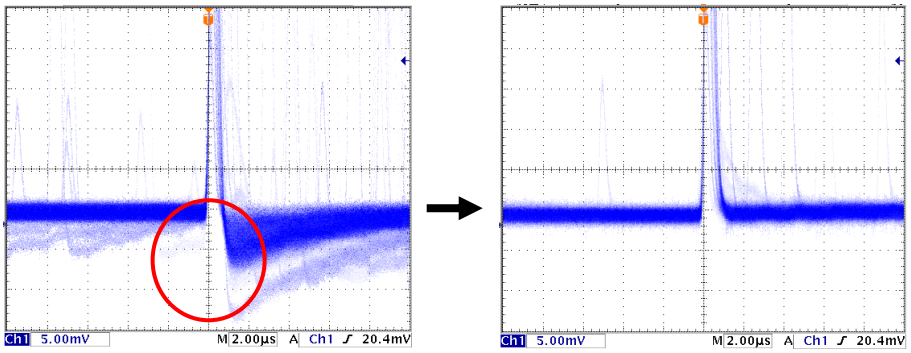
Set the constant of the FAST differential circuit in "fast diff". Select from "ext", "20", "50", "100", "200".

3. Constant setting of FAST system integration circuit

Set the constant of the FAST system integration circuit with "fast integral". Select from "ext", "20", "50", "100", "200".

4. FAST pole zero setting

Adjust the pole zero with “fast pole zero”. The default value is 0. Make settings on the oscilloscope as shown below. Adjustment is required every time "fast diff" or "fast integral" is changed, but it is not necessary to set as strictly as SLOW pole zero described later.



Before “fast polezero” adjustment **After** “fast polezero” adjustment

5. Reference settings

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

The following is a rough reference example.

Detector	Features	fast diff	fast integral
LaBr3	Rising time fast	20	Ext or 20
HPGe	High resolution	100	100

3. 6. Setting of SLOW filter

Set the SLOW filter to acquire energy (wave height).

1. DAC output setting

Connect the DAC output signal to the oscilloscope, select “DAC monitor CH” to the corresponding channel, and set “DAC monitor type” to “slow”.
Prepare the oscilloscope so that the SLOW filter signal can be seen from the DSP DAC output.

2. SLOW rise time setting

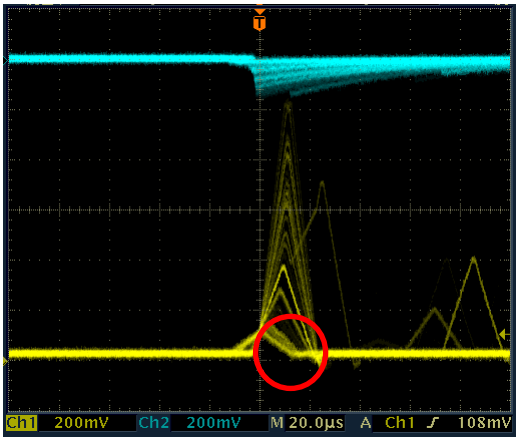
To set the same conditions as when the time constant of the linear amplifier is 6 μs, set 12000 ns. This value affects the energy resolution. Setting a shorter value enables higher counting but reduces the resolution. Conversely, if it is too long, counting may not be possible. The recommended value is 6000ns.

3. SLOW flat top time setting

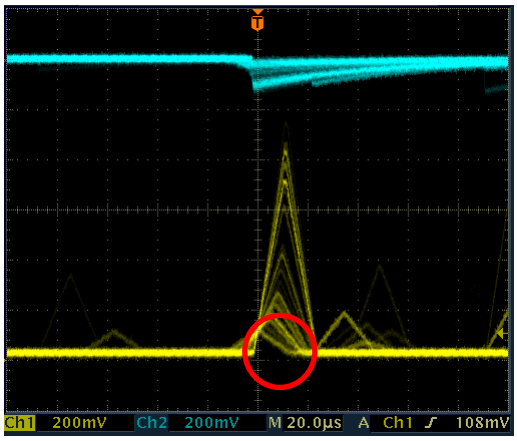
Set the value of the preamplifier to 0 to 100% of the rise time, twice the value of the slowest rise.

4. SLOW system pole zero setting

The default value is 680, but it depends on the detector, so set it to the optimal value with an oscilloscope.



Before adjustment (with undershoot)



After adjustment

3. 7. Setting of Threshold

The setting of the threshold affects the following three.

1. Threshold of FAST filter. Time stamping as the leading-edge timing (LET) is performed when this threshold is exceeded.

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

3. Used as the pile-up rejector threshold. Set this value to the lowest value that can be distinguished from noise when connected to the detector. The default value is 25.

There are two types, "fast trigger threshold" and "threshold".
"**Fast trigger threshold**" is the threshold for detecting signals from FAST filters.
"**Threshold**" is a threshold for identifying signals from slow filters.

"AUTOMATIC setting"

Set "0" to set the threshold automatically.

"MANUAL setting"

In the manual setting of the threshold, first input a somewhat large value other than 0 (about 100) and observe the Input Rate. Find a value that gradually reduces the threshold and increases the Input Rate. Since that value is the boundary between signal and noise, set it to about +3 to +10.

4. Window

4. 1. Startup window

The following opening screen is displayed when you carry out “Start”-“TechnoAP”-“APV8516-14”.

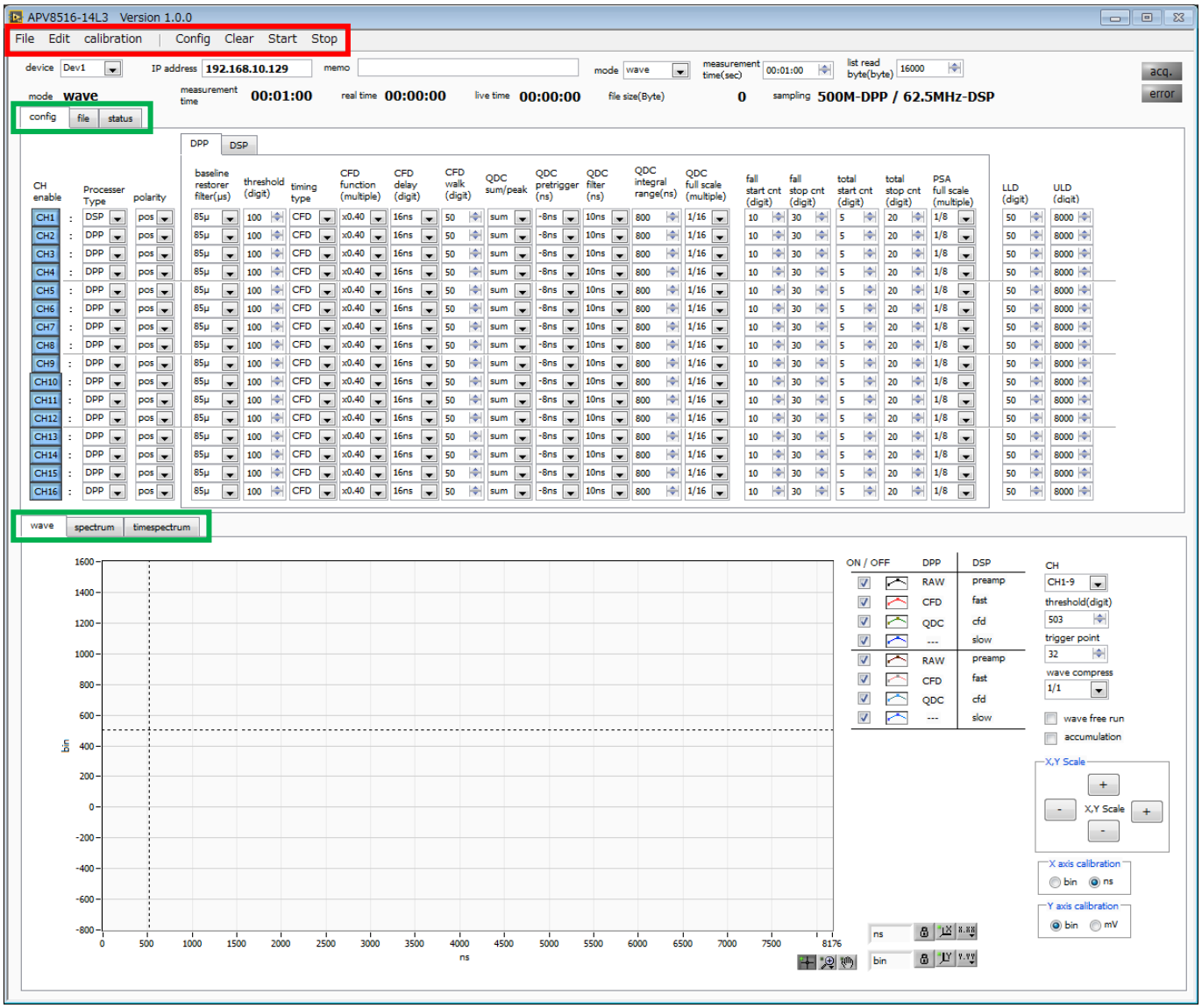


Fig. 4-1-1 Start window

Menu bar section

It is configured "File", “Edit”, “calibration”, “Config", "Clear", "Start", and "Stop".

File	open config	Reading the configuration file
	save config	Save the current settings to a file
	save histogram	Save current histogram data to a file
	save wave	Save the wave data
	save image	Save this device screen as PNG format image
	quit	Application termination
Edit	copy setting of CH1	Setting of CH1 in the “CH” tab is reflected by setting of all other CH
	IP configuration	Change IP address of current display device
	calibration	Calibrate the device when wave data is errow.
calibration		
Config		Apply all setting to each module
Clear		Initialization of histogram data in each module
Start		Send “Measurement start” to each module
Stop		Send “Measurement stop” to each module

Tab section

It is configured “config”, “file”, “state”, “wave”, “spectrum” and “timespectrum”

config	Each module setting and Setting about the measurement
file	Setting of waveforms and save of list data
state	Display state of each ch.
wave	Display of input waveform, when processer is DPP, Display waveform is RAW, CFD, QDC waveform. When processer is DSP, Display waveform is preamp, fast, cfd, slow waveform.
spectrum	Display of histogram from QDC or PEAK of list data
timespectrum	Display a time lag spectrum of CH1 and CH2 from time information of list data.

Device	Choose the DPP for targeted measurement.
IP Address	IP address. IP address of the selected device will be display
memo	You can enter notes
mode	You can select next mode. wave mode, hist mode, list mode
list read byte	When list mode, list data be saved per this parameter.
mode	It displays your setting mode.
measurement time	It displays your setting measurement time.
real time	It displays state of real time.
live time	It displays state of live time.
file Size (Byte)	It is a capacity of the list mode saved current file
sampling	DPP is 500 MHz. DSP is 62.5 MHz.
acq. LED	Blinking LED when during measurement.
error LED	Blinking LED when during occurrence of an error.

4. 2. Config Tab

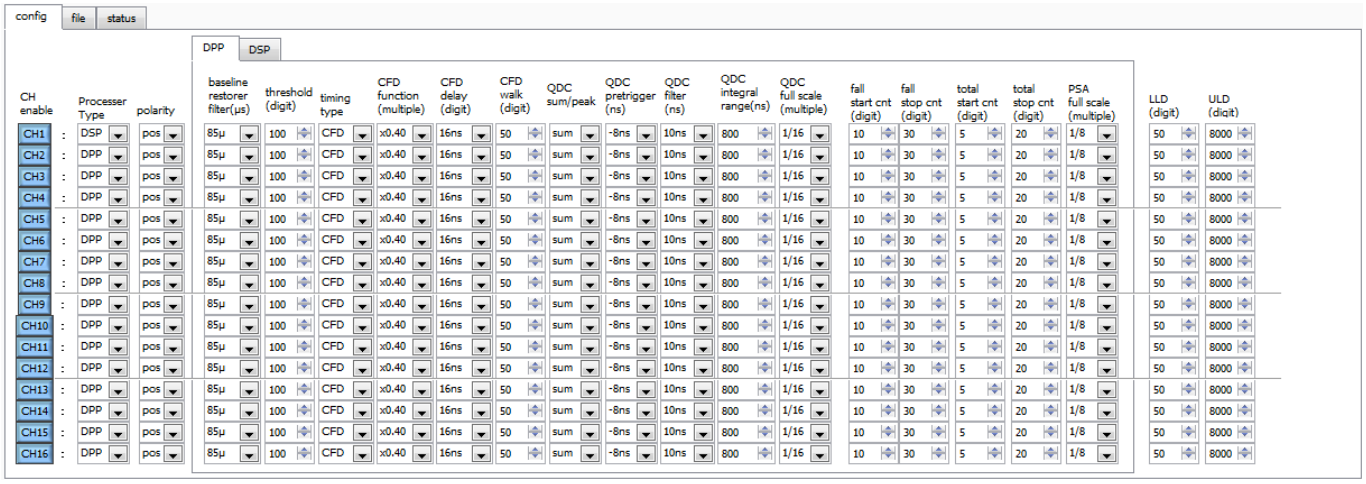


Fig. 4-2-1 Config Tab

Common setteing

Enable	Please enable all CH
processe type	You can select DSP or DPP. DSP sampling rate is 62.5MHz. Main measurement purpose is Semiconductor detector. Energy data generate from peak of trapezoidal filter. DPP sampling rate is 500 MHz. Main measurement purpose is direct anode signal from scintillator. Energy data generate from integral of raw wave or filter wave
Polarity	This select the polarity of the input signal.
LLD	Set the Lower Level Discriminator (LLD). It does not get the time stamp data and energe data if the energy data smaller than LLD. Please set LLD smaller than ULD. Range is 0 from 8191 digit.
ULD	Set the Upper Level Discriminator (ULD). It does not get the time stamp data and energy data if the energy data greater than ULD. Range is 0 from 8191 digit.

DPP setteing

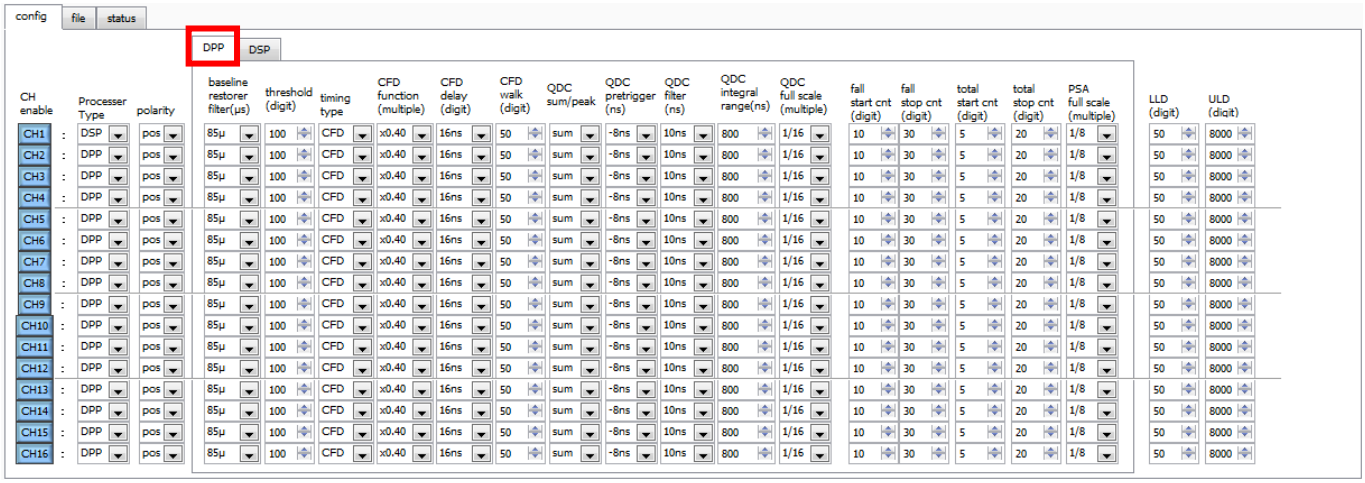
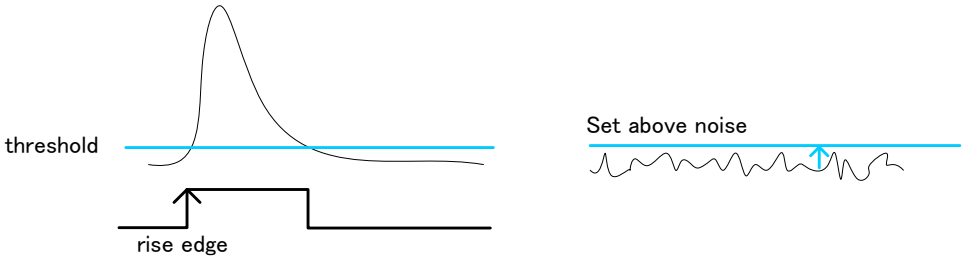


Fig. 4-2-2 DPP Tab in Config Tab

Baseline Restorer Filter	This set the time constat of the baseline restorer filter. Ext (Auto BLR off), Fast, 4 μs, 85 μs, 129 μs, 260 μs. Nomally set to 85 μs.
Threshold	Set the threshold. Unit is digit. Range is 0 to 8191.



Timing Type	Select the wavefrom for time stamp. You can select the CFD waveform and the LED (raw) waveform.

LET: Leading Edge Timing

It is the timing that has been reached to trigger. Timestamp timing is different by the signal height.

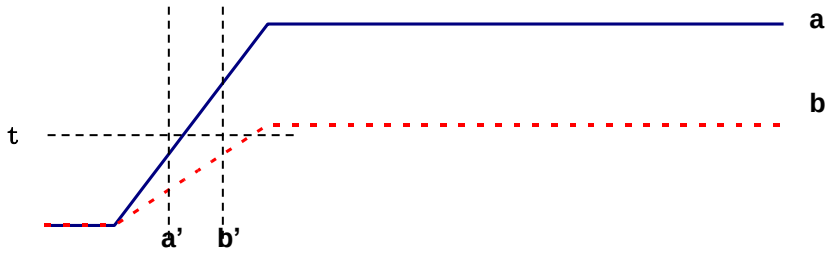


Fig. 4-2-2 How to use Leading Edge Timing

CFD: Constant Fraction Disicriminator Timing
Features of CFD wave form is the same even though different wave high.

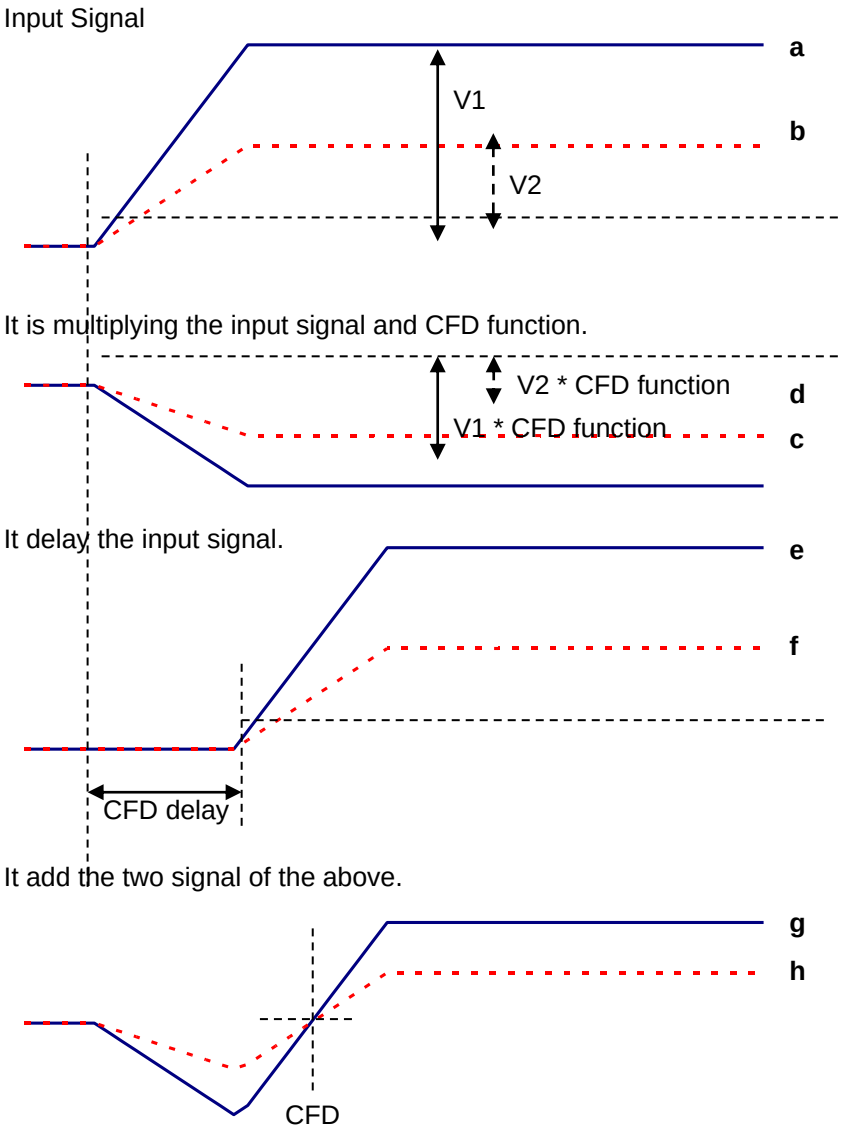
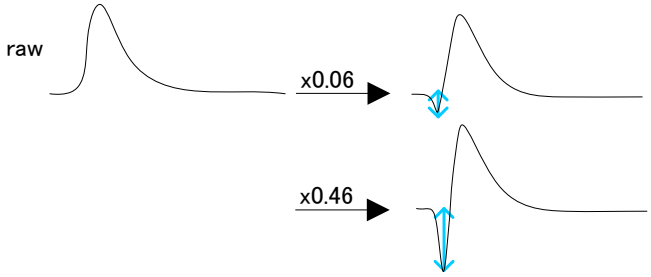


Fig. 4-2-3 How to use Constant Fraction Disicriminator Timing

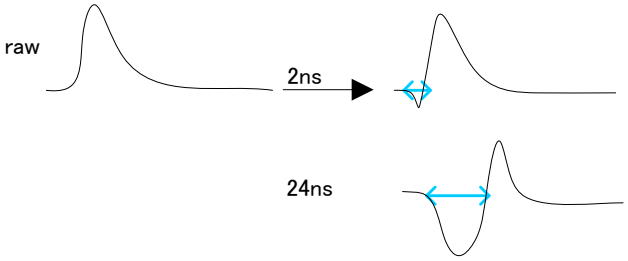
Timestamp timing is the same by CFD wave generation.

c, d: a and b multiplying the input signal and CFD function.
e, f: a and b delay the setting value.
g, h: it sam each wave.

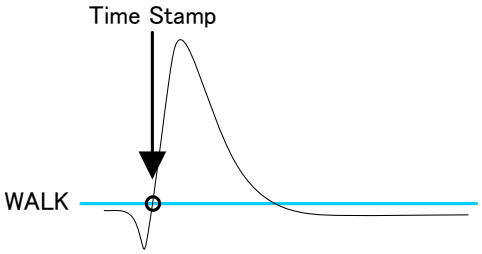
CFD Function	This magnification uses to reduce the input signal. Select value: ×0.03, ×0.06, ×0.09, ×0.12, ×0.15, ×0.18, ×0.21, ×0.25, ×0.28, ×0.31, ×0.34, ×0.37, ×0.40, ×0.43, ×0.46.



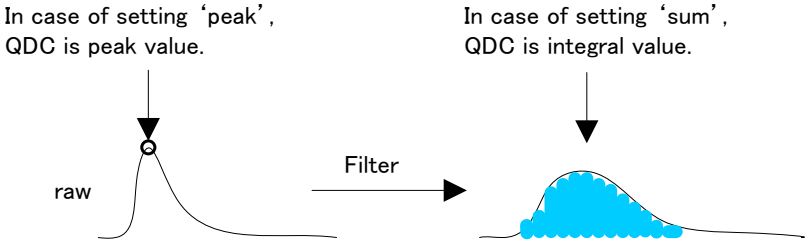
CFD Delay	Set the time of delay for CFD signal generation. Select value: 1 ns to 24 ns, every 1 ns.



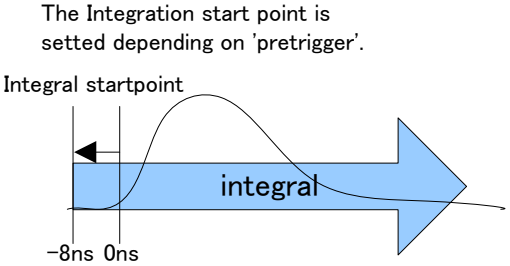
CFD Walk	Set the value for timestamp. Nomally set 15 digits.



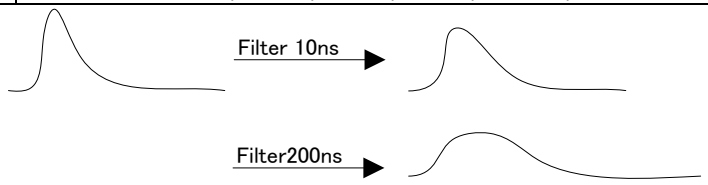
QDC Sum or Peak	Set the type of QDC data. Type select from the PEAK and SUM. PEAK is the peak value of raw signal. SUM is the integral value of QDC waveform.



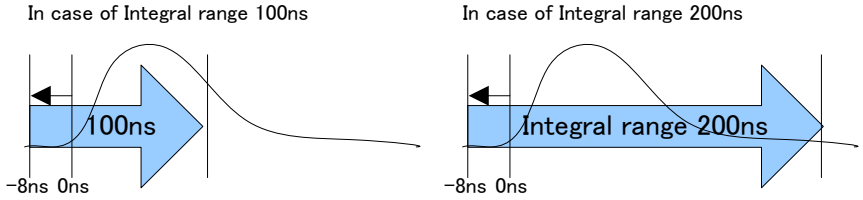
QDC Pretrigger	Set the time of the integral start point for QDC waveform. Select value: 0 ns, -8 ns, -16 ns, -32 ns, -40 ns, -48 ns, -56 ns, -60 ns.



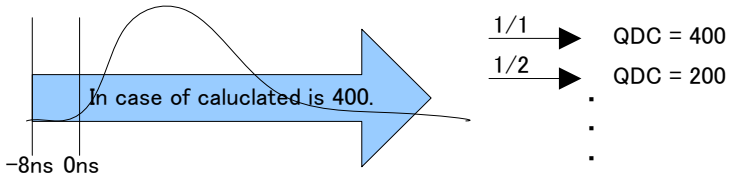
QDC Filter	Set the time constant of QDC waveform generation. Select value: Ext, 10 ns, 20 ns, 50 ns, 100 ns, 200 ns



QDC Integral Range	Set the integral time of QDC waveform. Range is 0 ns from 32000 ns.



QDC Full Scale	Set the gain of QDC integral value. Select value: 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512.



fall start cnt	This is start position to calculate a fall integral. The point that exceeded the threshold is start point. Setting range is 1 to 16383 (16383 ns = 16383 x 1 ns).
fall stop cnt	This is stop position to calculate a fall integral. Set range of integral. Setting range is 1 to 16383 (16383 ns = 16383 x 1 ns). The value must be greater than the fall start cnt.

Example: In case of Threshold = 50, fall start cnt = 5, fall stop cnt = 25, PSA full scale = 1/1
Start point is 5th point that exceeded the threshold. Integration range is 25 point from start point. And integraled value is multiplied by PSA full scale. Integration range is blue frame of below picture.

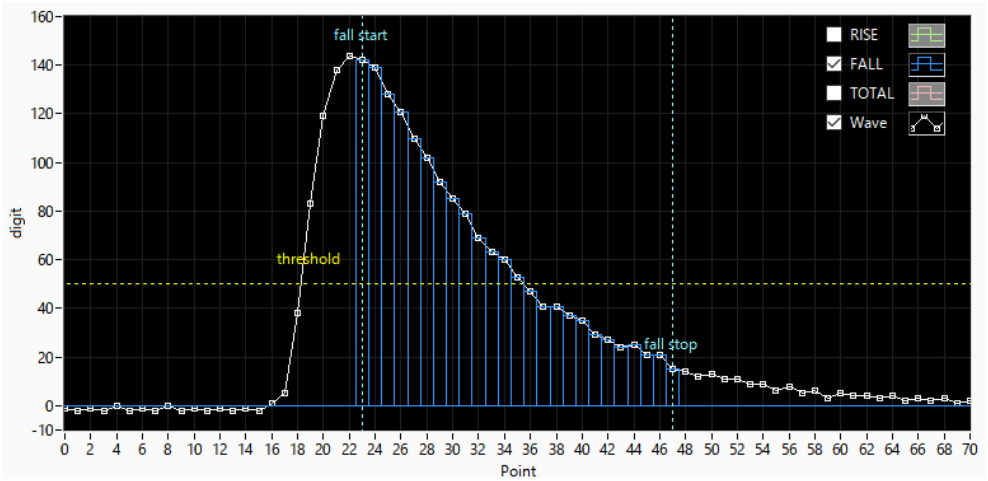


Fig. 4-2-3 How to calucurated FALL value

total start cnt	This is start position to calculate a total integral. Set the range in front of the threshold. Setting range is 1 to 498 (498 ns = 498 x 1 ns).
total stop cnt	This is stop position to calculate a total integral. Set range of integral. Setting range is 1 to 16383 (16383 ns = 16383 x 1 ns).

Example: In case of Threshold = 50, total start cnt = 5, total stop cnt = 50, PSA full scale = 1/1
Start point is in front of 5 point that is exceed threshold. Integral range is 8 point. Integral range is red frame in below picture. And integraled value is multiplied by PSA full scale.

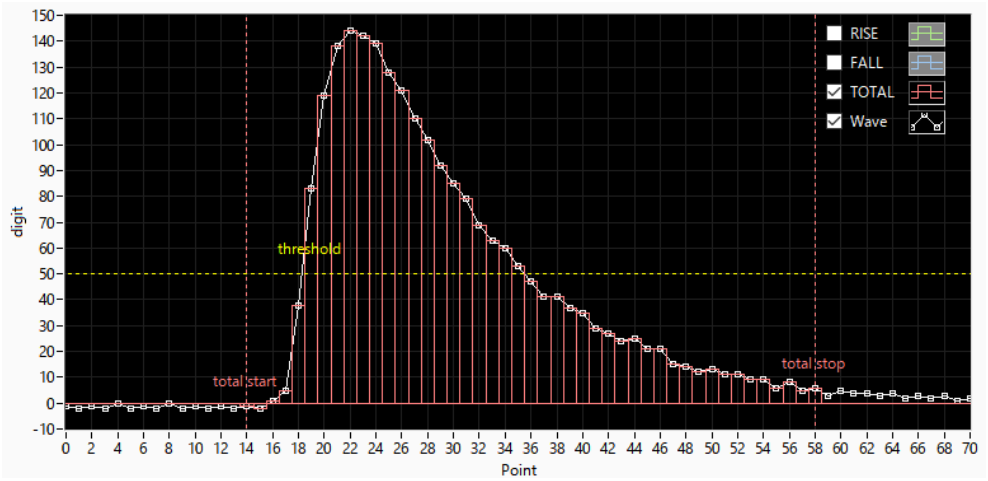


Fig. 4-2-4 How to calucurated TOTAL value

PSA full scale	You can select from next. 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512.
Time Spectrum On/Off	Select the enable of the time spectrum. Please do not ON If you want to get only the list data. If you ON at the high rate count, the acquisition of data is slow.

DSP setteing

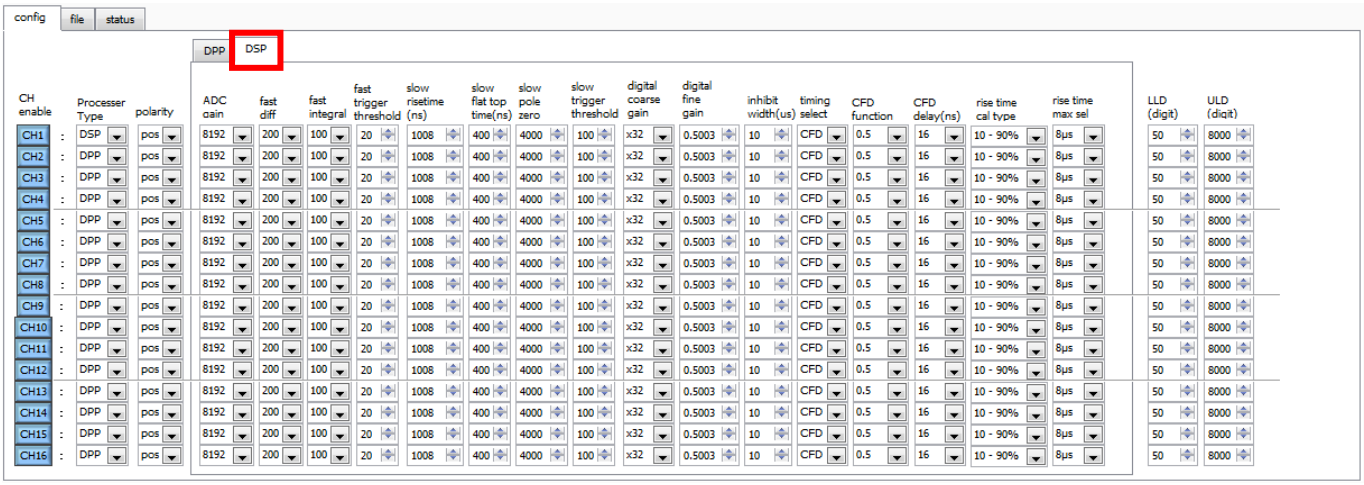


Fig. 4-2-5 DSP Tab in Config Tab

ADC gain	Select maximum ch. 8192, 4096, 2048, 1024, 512, 256 ch.
fast diff	This is differential value of fast timing signal.
fast integral	This is integral value of fast timing signal.
fast trigger threshold	Set threshold of fast timing signal. The unit is digit. Fast timing signal be generated from ADC value of preamp input signal. Timing signal be used timestamp timing of time information.
slow rise time	Set rise time of slow filter. Slow filter is trapezoidal filter. The unit is nano second.
slow flattop time	Set flat top time of slow filter. The unit is nano second.
slow pore zero	Set the pole zero of slow filter.
slow trigger thereshlold	Set threshold of slow filter signal. The unit is digit. If upper this threshold on slow filter, energy value be gifted from the peak of slow filter.
digital coarse gain	Select the digital gain of slow filter.
digital fine gain	Select the fine gain of slow filter.
inhibit width	Ajust the inhibit width of reset type Ge detector.
timing select	Select the timestamp timing to CFD or LE. The detail this function sees DPP.
CFD function	Select the function of CFD. The detail this function sees DPP.
CFD delay	Select the delay of CFD. The detail this function sees DPP.
rise time cal type	Select the ratio of rise time measurement time.
rise time max sel	Select the maximum time of rise time measurement. If you select the 8 us value, the minimize value of time bin is 2 ns. Another the minimize time bin is 4 ns.

4. 3. File Tab

Fig. 4-3-1 File Tab

Histogram Save	It will save the histogram data at the time of measurement end. It is enabling when “mode” selects “hist”.
Histogram Continuous Save	It can select the enable of continues save at the set time intervals. It is enabling when “mode” selects “hist”.
Histogram File Path	Set the absolute path of the histogram data. You can also choose NOT to extension. **!! Caution !!** File name format is as follow. Example: “histogram file path” set “C:¥Data¥histogram.csv”, “histogram file save time (sec)” set “10” Date is 2010/09/01 and 12:00:00. File name format of the start is “C:¥Data¥histogram_20100901_120000.csv”. After 10 second is “C:¥Data¥histogram_20100901_120010.csv”. *It may be off by one second increments.
Hisutogram File Save Time (sec)	Set the time interval of continue save of histogram data. Unit is second. Range is 3600 second from 5 second.
List Save	Choose whether you want to save the data. It is enabling when “mode” selects “list”.
List File Number	Set the start value of the list data number. Range is 999999 from 0. It will return to 0 if it exceeds 999999.

4. 4. Status Tab

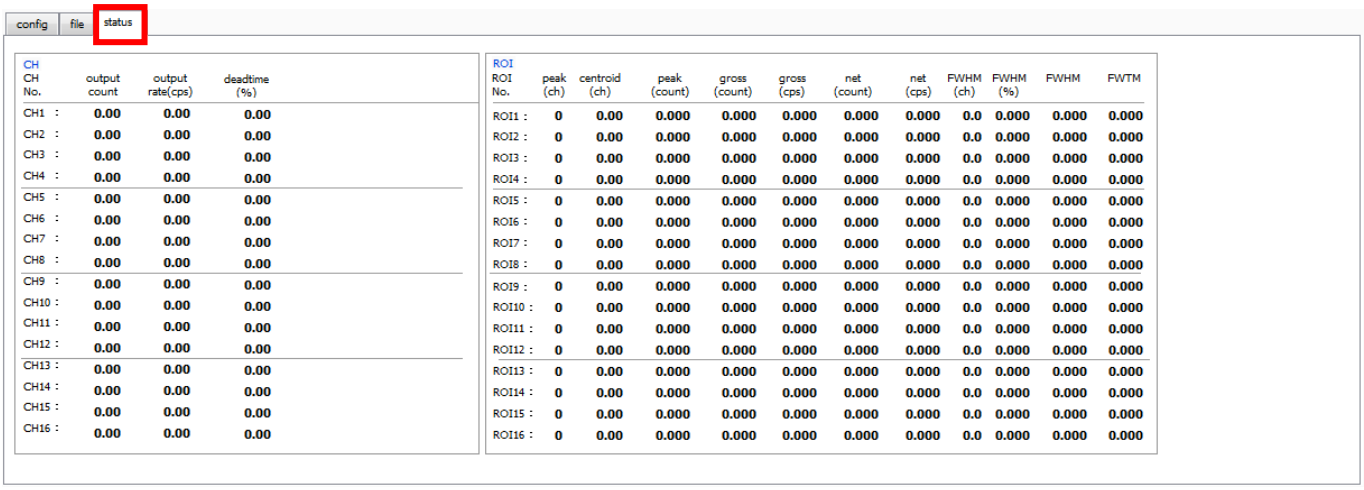


Fig. 4-4-1 Status Tab

output count	Output total count. Output event number of total.
output rate (cps)	Output count rate. Number of the output events / second.
deadtime (%)	Deadtime ratio
peak (ch)	CH of the maximum count
centroid (ch)	Calculated center value (CH) by the total of all counts
peak (count)	Maximum count
gross (count)	The sum of the count between ROI
net (count)	The sum of the count obtained by subtracting the background between the ROI
net (cps)	Count of CPS obtained by subtracting the background between the ROI
FWHM (ch)	Half Width at Half Maximum (ch)
FWHM (%)	Half Width at Half Maximum (%). Half Width at Half Maximum / ROI Definition Energy x 100
FWHM	Half Width at Half Maximum
FWTM	1/10 width

4. 5. Wave Tab

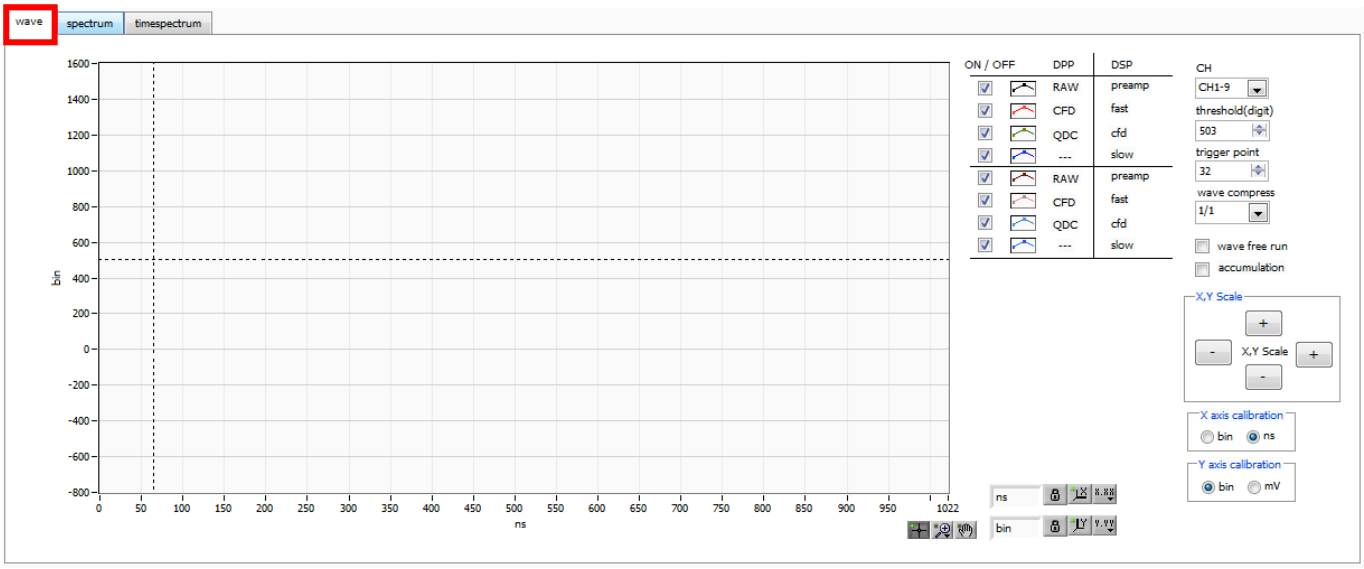


Fig. 4-5-1 wave tab

Graph: Waveform graph. It is enable when “mode” selects “wave”.

On/Off	Select the ON/OFF of the wave display. APV8516 can display the 8 waveforms.	
CH	Select the CH of the waveform display.	
Type	Select the type of the waveform display.	
	raw	‘raw’ is the raw waveform that was BLR processing from DPP. 1point is 2ns.
	CFD	‘CFD’ is the CFD waveform that was CFD shaping.
	Filter	‘Filter’ is the waveform tha was the filter shaping.
	preamp	‘preamp’ is the waveform from DSP. 1point is 16ns.
	fast	‘fast’ is timing signal from DSP.
	cfd	‘cfd’ is the waveform from DSP.
	slow	‘slow’ is the fileter waveform from DSP.
Threshold	Set the threshold value of the trigger. Set is possible by moving the cursor in the graph.	
Trigger Point	Set the start point of the display waveform. Set is possible by moving the cursor in the graph.	
wave compress	You can see the compress waveform.	
Wave Free Run	‘ON’ is displayed the waveform of the trigger free. ’OFF’ is displayed the waveform of the triggered.	
Accumlation	Select the accumulation of the waveform.	
XY Scale	Adjust ‘Xscale’ and ‘Yscale’ at the button. Extension is ‘＋’. Reduction is ‘－’.	
X Axis Calibration	Select the unit of ‘X-axis’.	
Y Axis Calibration	Select the unit of ‘Y-axis’. * ’mV’ is a reference value.	
X Axis Range	Dialog will be displayed if you right-click on the graph. “自動スケール” is auto scale. If you want to change the minimum or maximamu value, placed the mouse pointer on top of the numerical value, it can be changed by clicking or double-click.	
Y Axis Range	Dialog will be displayed if you right-click on the graph. “自動スケール” is auto scale. If you want to change the minimum or maximamu value, placed the mouse pointer on top of the numerical value, it can be changed by clicking or double-click.	
	This is tool of the cursor moving. It can move the ROI cursor on the graph if you want to set the ROI.	
	This is zoom. It can select the zoom type as the follow.	
	Pan tool. It can move the graph by this icon.	

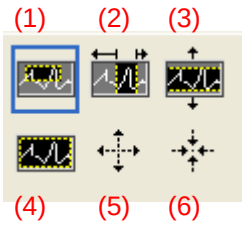


Fig. 4-5-2 zoom in or zoom out Tool

(1) Tetragon	It surrounds the area using the mouse. And it will be zoom.
(2) X-Zoom	This will zoom along the X-axis.
(3) Y-Zoom	This will zoom along the Y-axis.
(4) Fit Zoom	This will be auto scale.
(5) Zoom out to center a point	Click a center point of the zoom out.
(6) Zoom in to center a point	Click a center point of the zoom in.

4. 6. Spectrum Tab

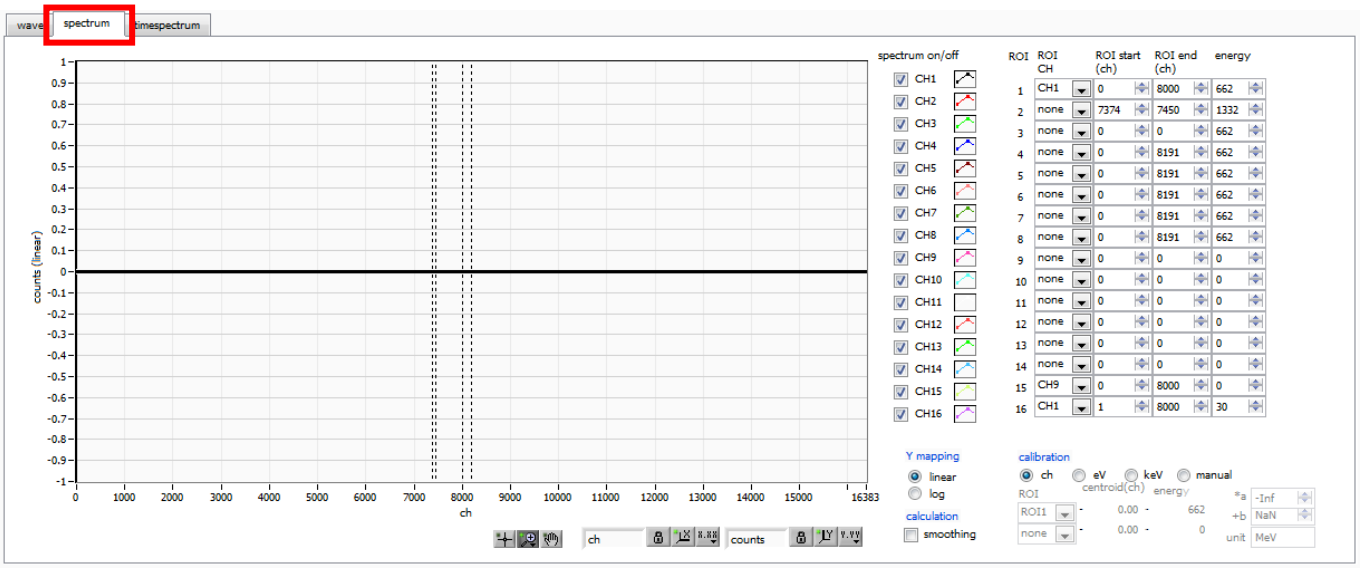


Fig. 4-6-1 Spectrum Tab

Graph: Energy Spectrum. It is enabling when “mode” selects “hist” or “list”. If “mode” is “list”, you need to ON of “Spectrum ON/OFF”

Spectrum on/off	It makes the setting of wether or not to display the histogram of each CH in the graph.	
ROI CH	Set the CH of the ROI. It can set the maximum eight ROI per a CH.	
ROI Start (ch)	Set the start point of the ROI. Unit is ch.	
ROI End (ch)	Set the end point of the ROI. Unit is ch.	
Energy	It defines the energy value of the peak ch. Example 60Co set 1173 (keV) or 1332 (keV). If set “ch” of “calibration”, it will detect the peak between the ROI. The FWHM is calculate by the peak and the energy.	
Calibration	Select the unit of X-axis. X-axis Label will be changed by the setting.	
	ch	Display unit is ch.
	eV	Display unit is eV. If you set the two ROI, it run a two-point calibration. X-axis will be converted to the unit eV by the slope and intercept of the primary function y = ax + b.
	keV	Display unit is KeV. If you set the two ROI, it run a two-point calibration. X-axis will be converted to the unit KeV by the slope and intercept of the primary function y = ax + b.
	Example	If 5717.9 ch is 1173.24 keV of Co-60 and 6498.7 ch is 1332.5 keV of Co-60, it be calculated 0.20397 of slope and 6.958297 of intercept.
	manual	You can set manual value of the slope and the intercept.
Y mapping	Select the mapping of Y-axis. Y-axis Label will be changed by the setting. Linear Log	
Smoothing	This is a smoothing function if the statistics are less. You can get a FWHM faster than nomal.	
Simple count view	Set the view CH and x-ch. Count will be displayed.	
Gauss fit	It runs a Gaussian fit between ROI.	

5. File

5.1. Histogram Data File

File format	Tab-delimited text format
File name	Arbitrary file name
Structure	“Header”, “Calculation”, “Status” and “Data”.

Header parts

These parts save every CH as follow.

Measurement Mode	Measurement Mode
Measurement Time	Measurement Time (Unit: sec.)
Real Time	Real Time
Start Time	Measurement Start Time
End Time	Measurement End Time

*Be saved each CH.

POL	Polarity
TGE	Waveform display trigger CH
TGC	Waveform trigger polarity
RJT	Waveform getting threshold
CCF	CFD Function
CDL	CFD Delay
CWK	CFD Walk
CTH	CFD Threshold
FLK	Baseline Time Constant
PTS	QDC Pretrigger
LIG	QDC Filter Time Constant
LIT	QDC Sum or Peak
AFS	QDC Integral reduction
CLD	QDC LLD
CUD	QDC ULD
TTY	Timing Type

Only once is saved as follow.

MOD	Mode
MTM	Measurement Time
MEMO	Memo

Calculation Parts

These parts save every ROI. They are the calculated value between ROI. They saved only devicd in the display.

ROI_Ch	Set CH.
ROI_Start	ROI Start position CH
ROI_End	ROI End position CH
Enegy (keV)	ROI energy (keV)
Peak (ch)	Peak CH at calculated (ch)
Centroid (ch)	Centroid CH at calculated (ch)
Peak (count)	Peak counts at calculated
Gross (count)	Gross sum counts at calculated.
Gross (cps)	Gross cps at calculated.
Net (count)	Sum counts that attracted a background.
Net (cps)	Cps that attracted a background.
FWHM (ch)	Full width at half maximum (ch)
FWHM (%)	Energy resorution of full width at half maximum (%)
FWHM (keV)	Energy value of Full width at half maximum (keV)
FWTM (keV)	Energy resorution of full width at tenth maximum (keV)

Status Parts

*These parts save every CH

Input Total Count	Total Counts
Throughput Count	Throughput Counts
Input Total Rate	Total Count Rate
Throughtput Rate	Throughput Count Rate
Dead Time	Dead Time Ratio

Data Parts

Histogram data of each CH. Maximam: 8192 points

5. 2. Wave Data File

File format	Tab Separated Values Type
File name	Arbitrary file name
Structure	“Header”, “Calculation”, “Status” and “Data”.

Header parts

These parts save every CH as follow.

Measurement Mode	Measurement Mode
Measurement Time	Measurement Time (Unit: sec.)
Real Time	Real Time
Start Time	Measurement Start Time
End Time	Measurement End Time

*Be saved each CH.

POL	Polarity
TGE	Waveform display trigger CH
TGC	Waveform trigger polarity
RJT	Waveform getting threshold
CCF	CFD Function
CDL	CFD Delay
CWK	CFD Walk
CTH	CFD Threshold
FLK	Baseline Time Constant
PTS	QDC Pretrigger
LIG	QDC Filter Time Constant
LIT	QDC Sum or Peak
AFS	QDC Integral reduction
CLD	QDC LLD
CUD	QDC ULD
TTY	Timing Type

Only once is saved as follow.

MOD	Mode
MTM	Measurement Time
MEMO	Memo

Status Parts

*These parts save every CH

Outtput Count	Output Counts
Outtput Rate	Output Rate
Dead Time	Dead Time Ratio

Data Parts

Waveform data of each CH.

5. 3. List Data File

File format	Binary File, Big Endian File

When you select DPP.
128 Bit (16 Byte, 8 WORD) / event

Bit127			112
	TDC [55..40]		
111			96
	TDC [39..24]		
95			80
	TDC [23..8]		
79	72	71	64
TDC [7..0]		TDCFP [7..0]	
63	61	60	48
0		Energy [12..0]	
47	46	36	35 32
0	0		CH [3..0]
31			16
	FALL [15..0]		
15			0
	TOTAL [15..0]		

Fig. 5-3-1 List Data (128 Bit)

Bit127 to Bit72	TDC counts. 56 Bit. 1Bit = 2 ns
Bit71 to Bit64	TDCFP counts. 8 Bit. 1 Bit = 7.8125 ps
Bit60 to Bit48	Energy. 13 Bit.
Bit47	Selected proceccer type. 0: DPP, 1: DSP
Bit35 to Bit32	CH. 4 Bit. 0: CH1, 1: CH 2,,, 15: CH 16.
Bit31 to Bit16	FALL value. 16 Bit.
Bit15 to Bit0	TOTAL value. 16Bit.

When you select DSP.
128 Bit (16 Byte, 8 WORD) / event

<table>
<tr><td colspan="16">Bit127
TDC [52..39]
112</td></tr>
<tr><td colspan="16">111
TDC [38..23]
96</td></tr>
<tr><td colspan="16">95
TDC [22..7]
80</td></tr>
<tr><td colspan="7">79
TDC [6..0]
73</td><td colspan="4">72
TDCFP [3..0]
69</td><td colspan="5">68
0
64</td></tr>
<tr><td colspan="3">63
0
61</td><td colspan="13">60
Energy [12..0]
48</td></tr>
<tr><td>47
0</td><td colspan="10">46
0
36</td><td colspan="5">35
CH [3..0]
32</td></tr>
<tr><td>31
SEL</td><td colspan="3">30
0
28</td><td colspan="12">27
RISE [11..0]
16</td></tr>
<tr><td colspan="16">15
0
0</td></tr>
</table>

Fig. 5-3-1 List Data (128 Bit)

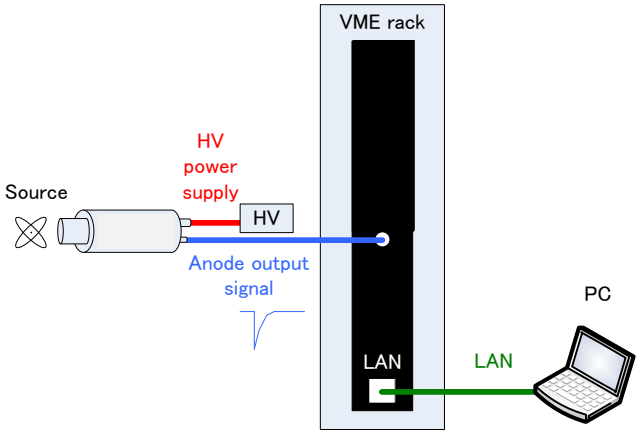
Bit127 to Bit73	TDC counts. 53 Bit. 1 Bit = 16 ns
Bit72 to Bit69	TDCFP counts. 4 Bit. 1 Bit = 1 ns
Bit60 to Bit48	Energy. 13 Bit.
Bit47	Selected proceccer type. 0: DPP, 1: DSP
Bit35 to Bit32	CH. 4 Bit. 0: CH1, 1:CH2,,, 15: CH 16.
Bit31	Rise Max Sel. 0: rise time max. 8 μs and 1 Bit = 2 ns, 1: rise time max16μs 1Bit = 4ns. If the rise time data is 4095, data is error. In next case, error occur. When the wave data is pileup. When calculated value is overflow.
Bit27 to Bit16	RISE time value. 12 Bit.

6. Measurement

As an example, the operation procedure of energy spectrum measurement, list measurement, when using a LaBr3 (Ce) detector (hereinafter, detector) is described.

6.1. Measurement of energy spectrum in histo mode

（1） Experimental environment

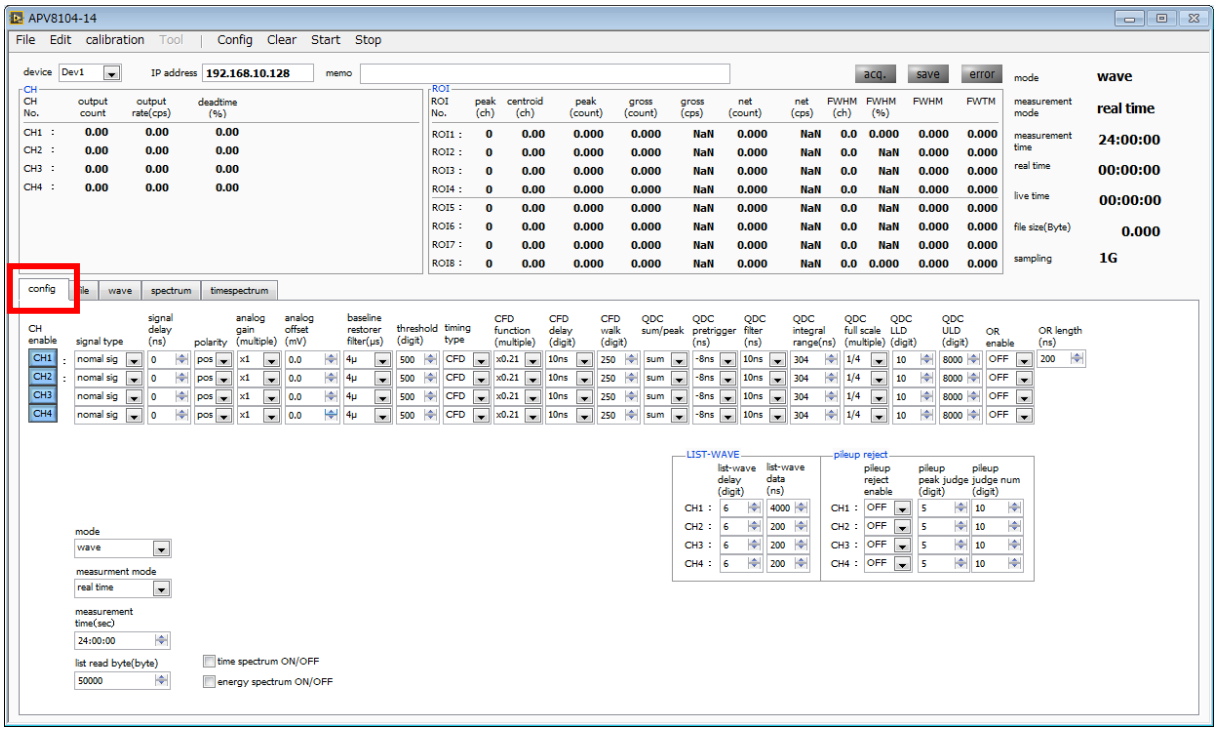


Experimental environment of energy spectrum measurement

	Make sure that all the devices VME rack, HV (high voltage power supply), PC are OFF.
	Connect the detector and HV with the SHV connector cable.
	Connect the anode output signal from the detector to the CH1 of this unit with the LEMO connector coaxial cable. For BNC connectors, please use the BNC-LEMO conversion adapter.
	Connect the device to the PC with a LAN cable.
	Turn on the VME powered crates
	Turn on the PC. Launch this application.
	Turn on the high voltage power supply and apply a voltage corresponding to the detector.
	In this example, Cs-137 source is used.

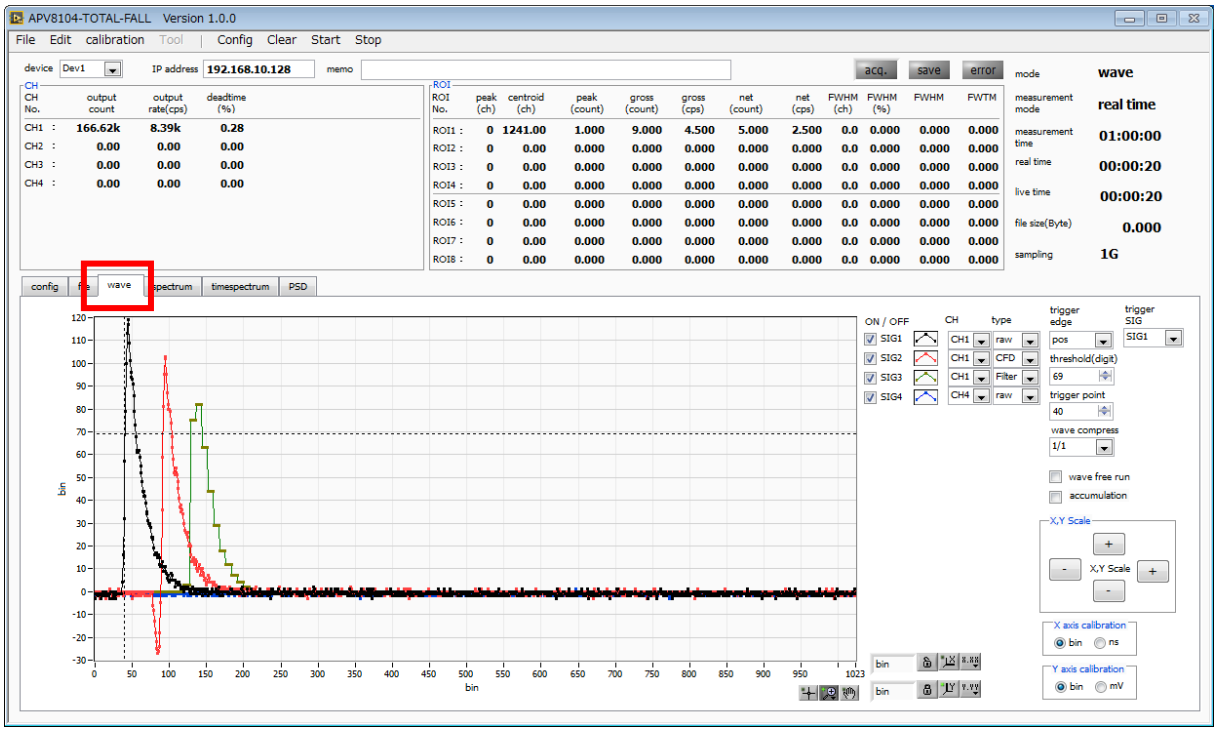
（2） Waveform measurement

First, check the signal from the detector input in the waveform mode.
In the "config" tab, make the following settings and then click the "Config" menu.



Setting of waveform measurement

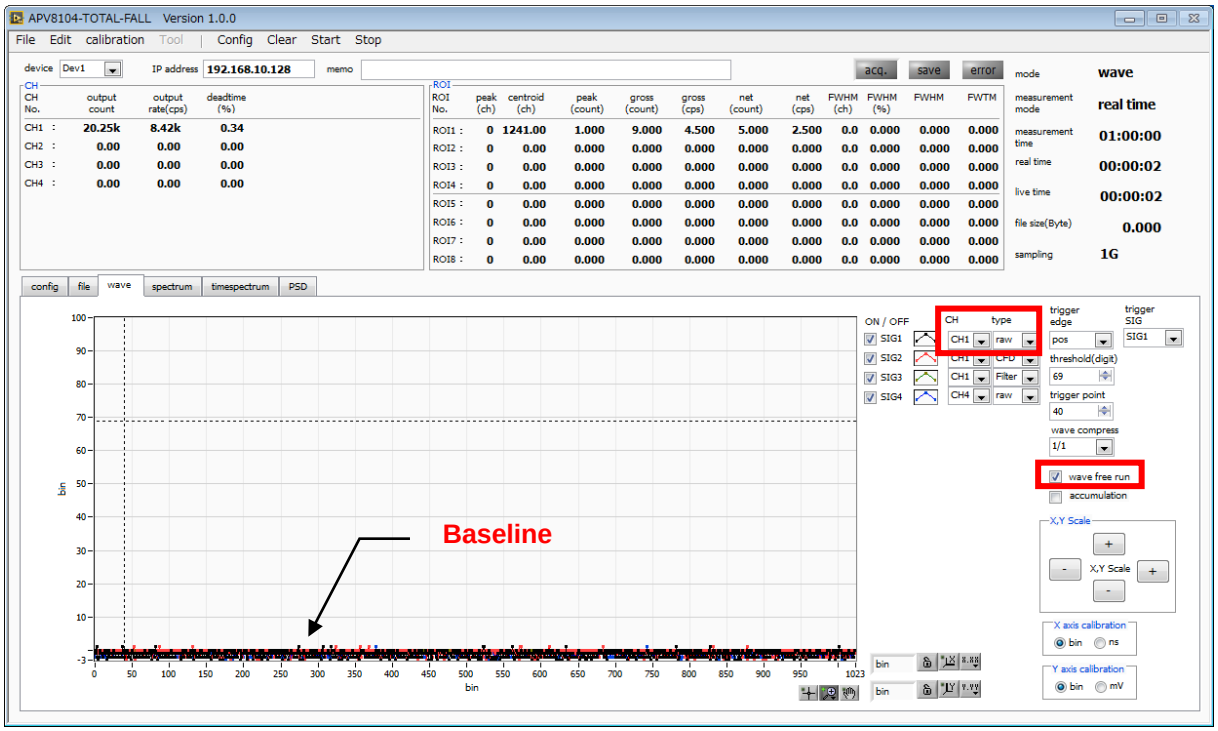
Open the "wave" tab and check the settings shown below, then click the menu "Clear" → "Start". You can check the waveform from the detector on the graph.



waveform measurement

Please note the following points.

If the signal displayed, it may not be triggered, so first check the "wave free run" in the "wave" tab and check the menu "Config" → "Clear" → " Please execute "Start". You can check baseline and roughly how much wave height signal comes.



Verifying baseline

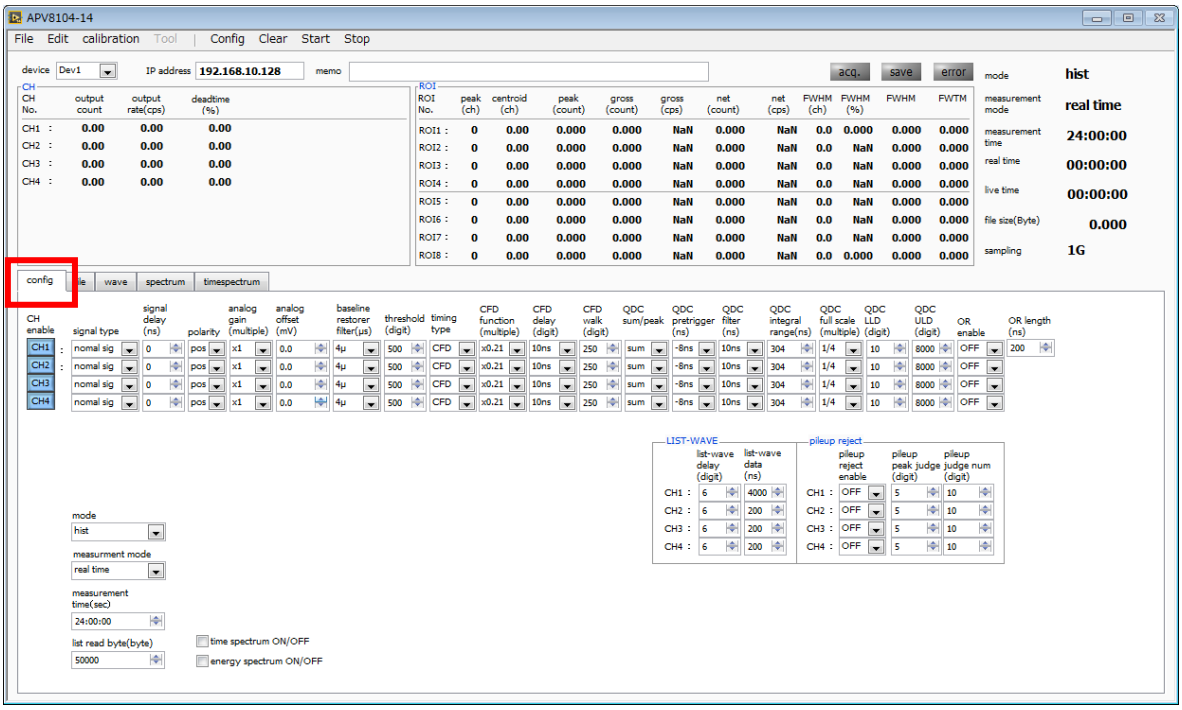
Next, uncheck "wave free run", gradually raise "threshold" from around 10, and keep a note of the "threshold" value that can capture the waveform firmly as shown in the previous page. We will use this memo for further settings as well.

Check if the wave height is too large to saturate. If the wave height is large, please set the "analog gain" to "× 1" or lower the applied high pressure, etc., to lower the amplitude of the input signal to this equipment.

The measured data can be saved in the menu "File" - "save wave"

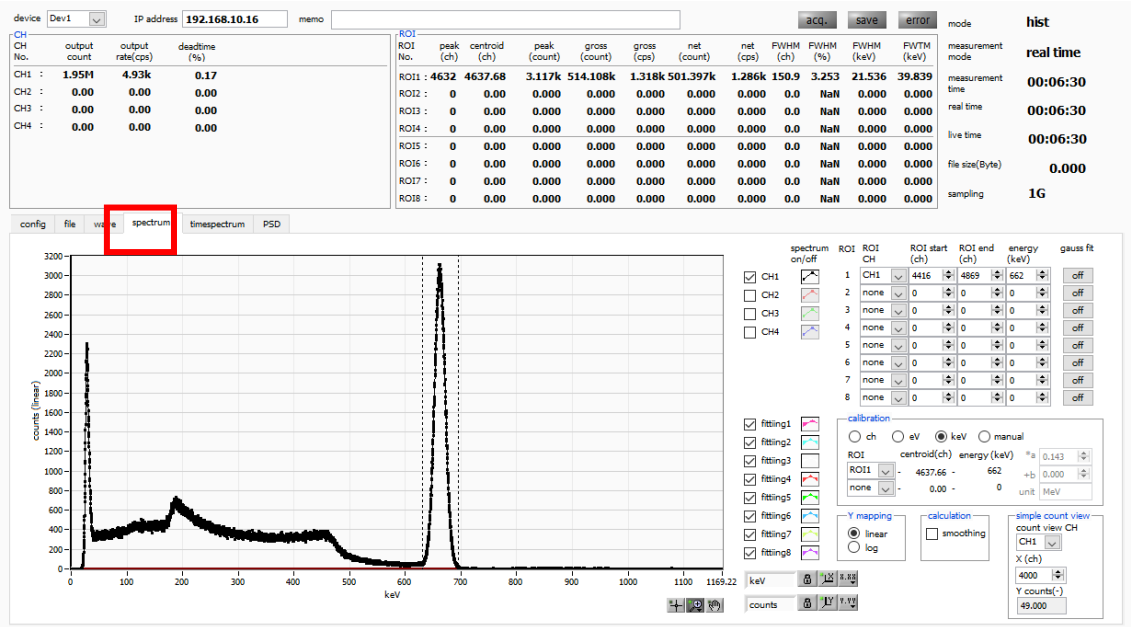
（3） Measurement of Energy spectrum

When measuring the spectrum, make the following settings on the "config" tab, then click the "Config" menu. Set the "threshold" value kept in the waveform measurement to "threshold" in the "config" tab.



Config tab

Open the "spectrum" tab and check the settings shown below, then click the menu "Clear" → "Start". After execution, the following spectrum will be displayed.



Energy spectrum measurement

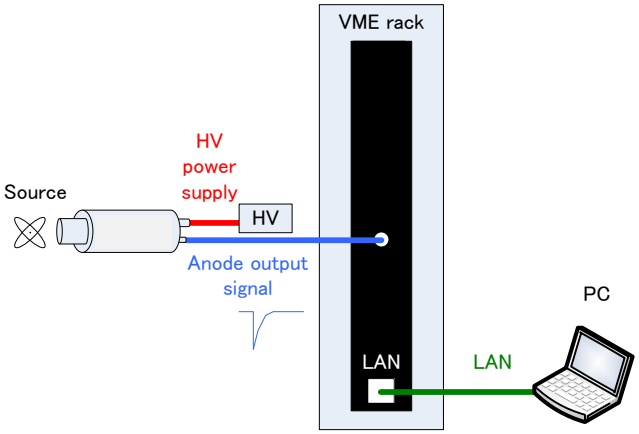
Please note the following points.

1. Check CH 1 of "spectrum on / off" so that CH 1 spectrum can be displayed.
2. When analyzing peaks, set ROI. For details, refer to "5.5.spectrum tab".

The measured data can be saved in the menu "File" - "save histogram".
To end the measurement, click the menu "Stop".

6. 2. List measurement

（1） Experimental environment



Experimental environment of energy spectrum measurement

	Make sure that all the devices (VME rack, HV (high voltage power supply), PC) are OFF.
	Connect the detector and HV with the SHV connector cable.
	Connect the anode output signal from the detector to the CH1 of this unit with the LEMO connector coaxial cable. For BNC connectors, please use the BNC-LEMO conversion adapter.
	Connect the device to the PC with a LAN cable.
	Turn on the VME powered crates
	Turn on the PC. Launch this application.
	Turn on the high voltage power supply and apply a voltage corresponding to the detector.
	In this example, Cs-137 source is used.

（2） Confirm input waveform

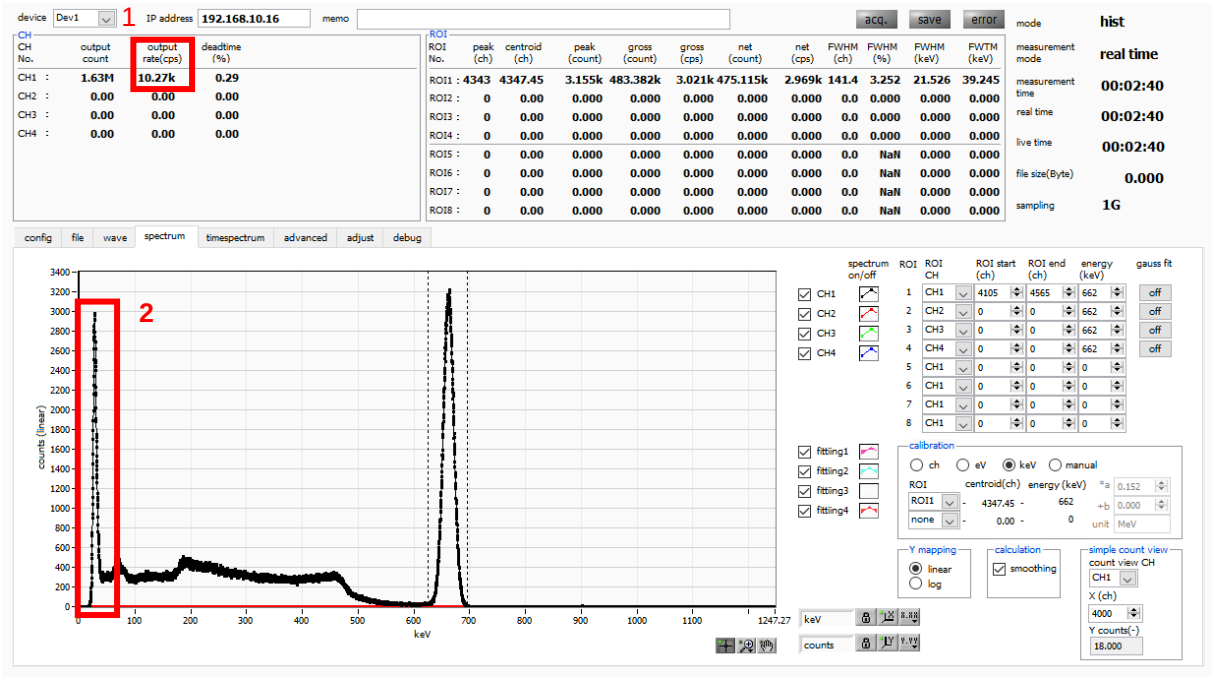
confirmer the same as above in "6.1. Energy spectrum measurement in histo mode (2) Waveform measurement".

（3） Confirmation of energy spectrum

Confirm the same as above in "6.1 Energy spectrum measurement in histo mode (3) energy spectrum measurement".

Please note the following points in this application.

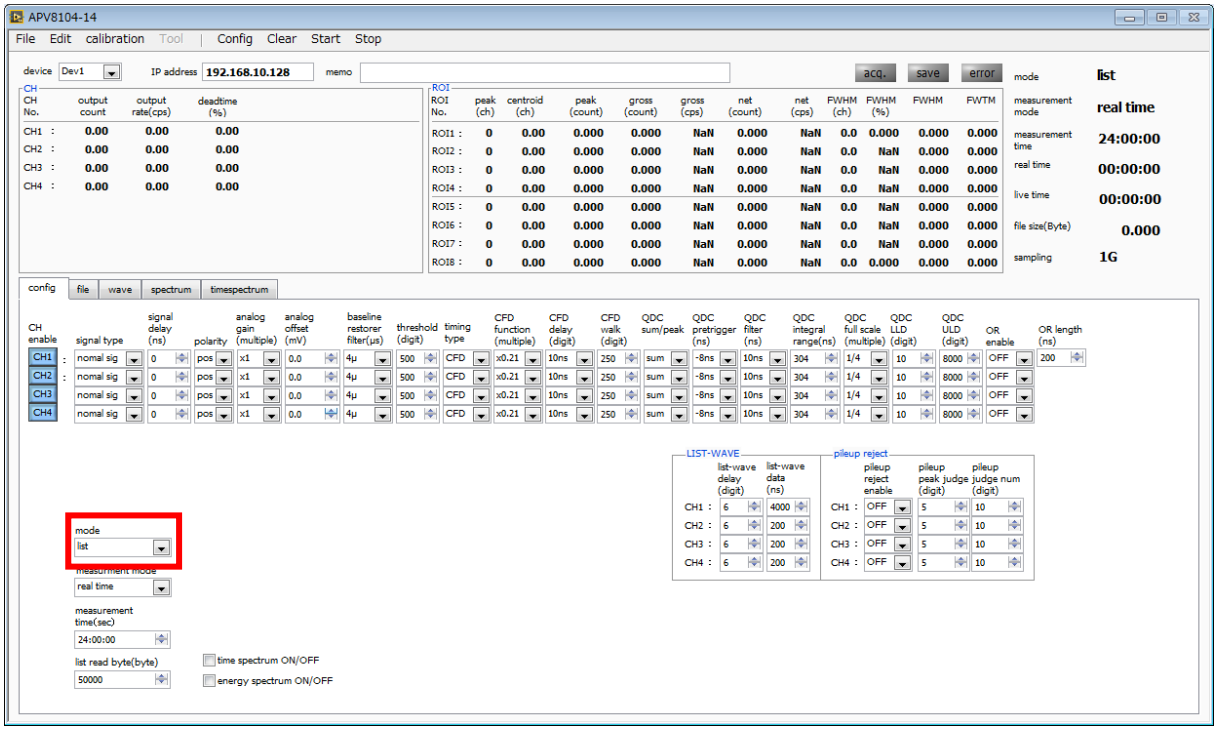
output rate (cps)	It is the number of events earned per second, and check whether it is too low or too high for the assumption (① in the next page). In the dump mode, 144 bytes of data are acquired for each event. As an example, if "output rate (cps)" is 1 Mcps, 144 MB / sec (1 Mcps × 144 Byte) of data is stored in memory per second.
“Spectrum” tab	Confirm whether there is no abnormality in the shape of the spectrum, especially whether you have not excessively acquired noise data (② in the next page).



Precautions before list mode measurement

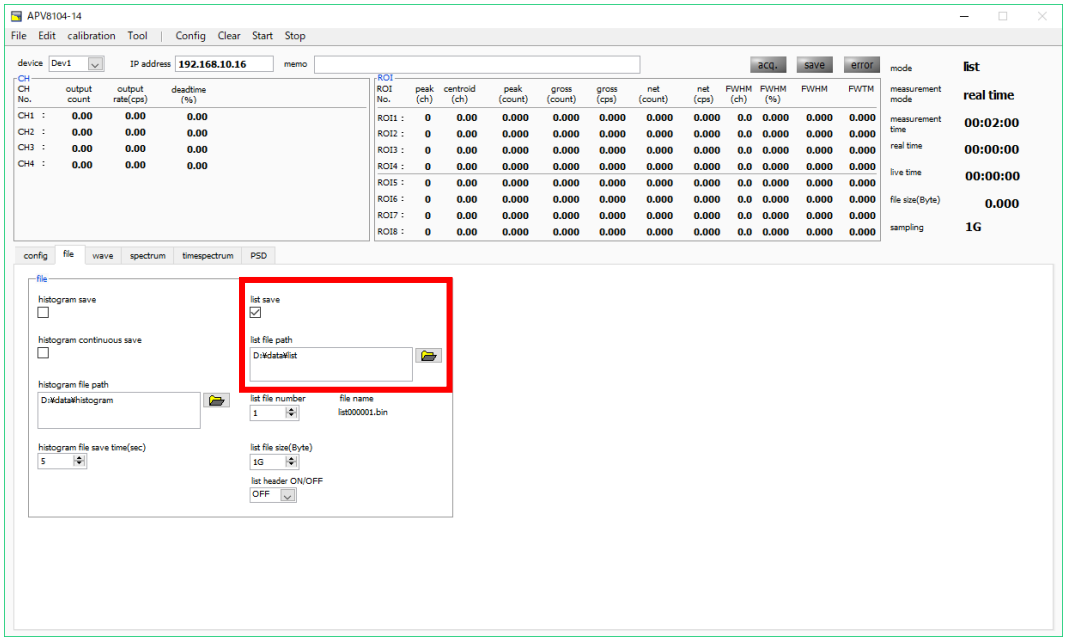
（4） List measurement

Start List measurement. In the "config" tab, set "mode" to "list".



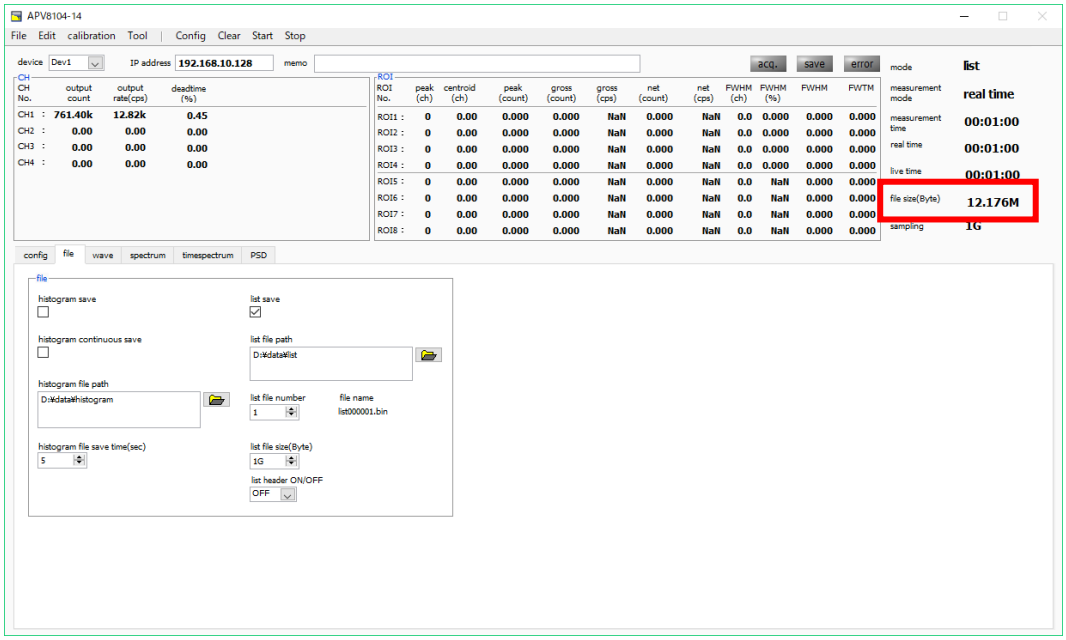
config tab

To save the list data, set the following items in the "file" tab.
"List save": Check
"List file path": Reference file path
"List file number": Any value from 0 to 999999. Be careful not to duplicate them.
"List file size (Byte)": size of list data file. When this size is exceeded, "list file number" is automatically increased by one and saved in a new file.



Save setting related to list data in file tab

Click the menu "Config" → "Clear" → "Start". After execution, if the event is detected and the list data is acquired, the following "file size (Byte)" will increase.



list data measurement and saving screen

To end the measurement, click the menu "Stop".

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