Digital Pulse Processor

APV82516

Instruction Manual

Version 1.0.0

2022, December

Safety Precautions / Disclaimer

Thank you very much for purchasing the digitizer APV82516 (hereinafter "This board") of TechnoAP Co., Ltd. (hereinafter "We"). Please read this "Safety Precautions / Disclaimer" before using this device, be sure to observe the contents, and use it correctly.

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

🚫 Prohibited matter

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

⚠️ Note

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

Warranty policy

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

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

- Content -

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1．**Overview**

1．1．**Overview**

TechnoAP's DPP (Digital Pulse Processor) product APV82516 (hereafter referred to as "this device") is a waveform analysis board equipped with 16 channels of high-speed, high-resolution ADC (1GHz, 14bit).

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

This document describes this equipment.

* In the text, "CH" is case-sensitive for signal input channels and "ch" is case-sensitive for bin number channels.

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

* APV in the model name indicates the VME standard size board type. A separate VME power supply rack (such as our APV9007) is required to supply power to this board type. In addition, the type of model in which this board is housed in a unit (chassis) and AC power supply can be used directly is marked with APU instead of APV. For example, the model in which the VME-type APV is installed in a unit is called APU. This manual also includes a description of the APU82516.

* When -14 or -12 is included in the model number, it indicates that the resolution of the built-in ADC is 14 bits or 12 bits. For convenience, the -14 or -12 is omitted and the model APV2516 is used.

* Functions can be added to this device as options. In this manual, such functions are clearly indicated as (optional).

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１．２． **Features**

The main features are as follows

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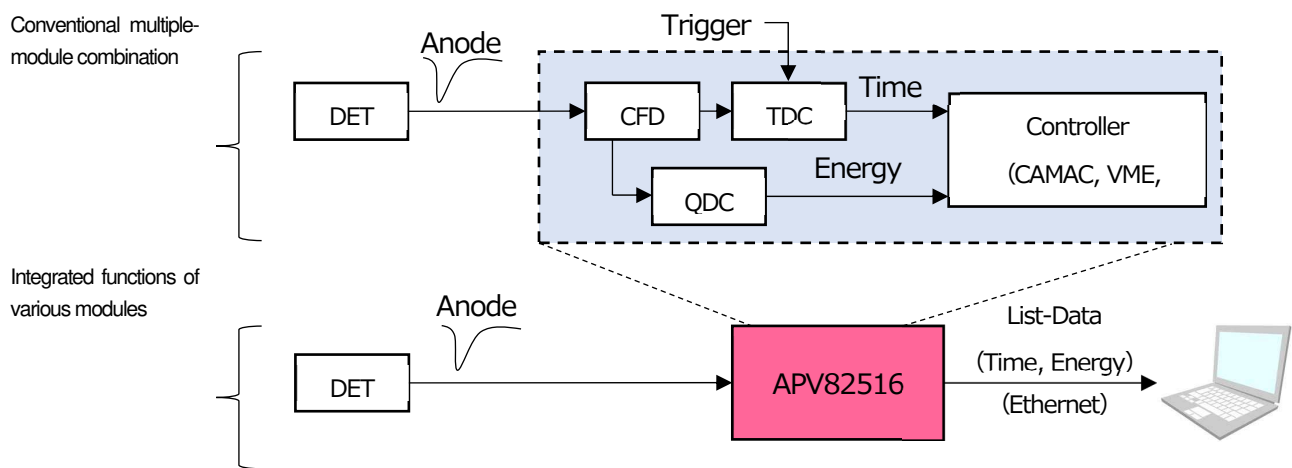

Figure 1　DPP configuration

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

2. **Specifications**

（1） Analog input

- Number of channel   16CH
- Input range   ±1V
- Input impedance   50Ω
- Coarse gain   ×1、x0.75、x0.5、x0.25、x0.15

（2） ADC

- Sampling frequency   250MHz
- Resolution   14bit

（3） Performance

- QDC output   2Mcps and more
- Time resolution   15.625ps

（4） Functions

- Operation mode   Histogram mode, List mode, Wave mode,
- Tranfer rate per event   Approx. 20Mbyte per second. In case of 14Byte (112Bit) per event.

（5） Option

- Functions   PSD, histogram, Waveform List mode, Pile-up waveform list mode, OR output

（6） Communication interface

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

（7） Current consumption

- ＋5V   3.0A (Max.)
- ＋12V   0.8A (Max.)
- －12V   0.4A (Max.)

（8） Forma

- VME type (VME6U)   APV82516
- Unit type   APU82516

（9） External dimensions

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

（１０） Weight

- VME type (VME6U)   Approx. 430g
- Unit type   Approix. 3100g

（１１） PC environment

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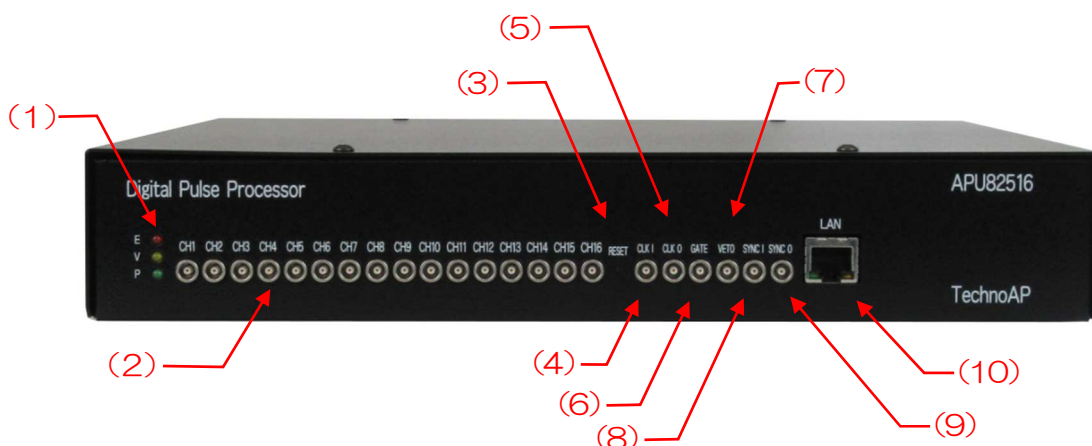- Screen resolution   Full HD (1920 × 1080)recommendec

3． **Appearance**

Photo1　APU82516

（1）	LED	P (green) lights up when power is turned ON, V (orange) and E (red) are not used
（2）	CH1～CH16	LEMO 00.250 compatible connector for signal input. Input range is ±1 V. Course gain is selectable from the application. Input impedance is 50Ω.
（3）	RESET	Communication function reset switch.
（4）	CLK-I	LEMO 00.250 compatible connector for external clock signal input. It is possible to synchronize with an external device by using an external clock. (When using an external clock, see When using an external clock below.
（5）	CLK-O	LEMO 00.250 compatible connector for external clock signal output. Outputs 25MHz LVTTL signal with 50% duty cycle.
（6）	GATE	LEMO 00.250 compatible connector for external GATE signal input; accepts LVTTL or TTL signals. Enables data acquisition while input is High.
（7）	VETO	LEMO 00.250 compatible connector for external VETO signal input; accepts LVTTL or TTL signals; disables data acquisition while high.
（8）	SYNC I	LEMO 00.250 compatible connector for external clear signal input. If you use multiple modules, need to connect to sync-o of other module.
（9）	SYNC O	LEMO 00.250 compatible connector for external clear signal output. If you use multiple modules, need to connect to sync-I of other module.
（10）	LAN	RJ45 connector for Ethernet cable. 1000Base-T.

4．Setup

4．1．Installation of application

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

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

（1） Log in to Windows with administrative privileges.
（2） Run setup.exe in the Application (or Installer) folder on the accompanying CD-ROM. Proceed with the installation in an interactive manner. The default installation directory is "C:¥TechnoAP". In this folder, the application's executable file and the configuration file config.ini, which contains the configuration values, will be installed.
（3） Start button - TechnoAP - Execute APP82516.

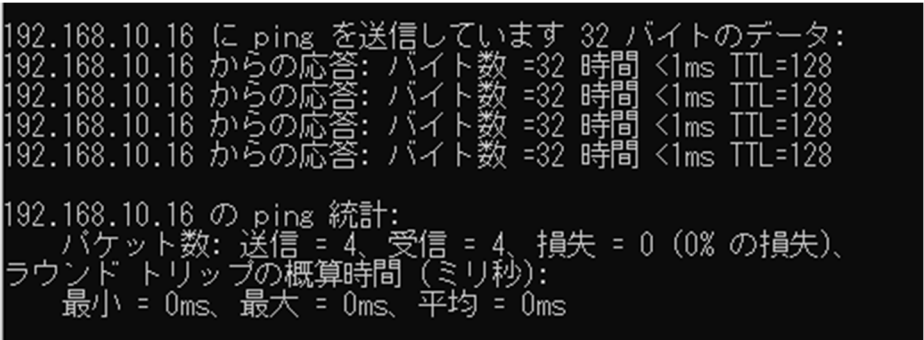To uninstall, go to Add or Remove Programs and select APV82516 to remove it.

4．2．Connection

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

４．３． **Setup of the network**

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

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

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

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

（３） Check the communication status between the PC and the device by executing the ping command at the Windows command prompt to see if the device and the PC are connected.
The IP address of the device is located on the board or on the back of the unit. The factory default network information for this device is as follows.

IP address	:	192.168.10.16
Sub-net mask	:	255.255.255.0
Default gateway	:	192.168.10.1

> ping 192.168.10.16

```
192.168.10.16 に ping を送信しています 32 バイトのデータ:
192.168.10.16 からの応答: バイト数 =32 時間 <1ms TTL=128
192.168.10.16 からの応答: バイト数 =32 時間 <1ms TTL=128
192.168.10.16 からの応答: バイト数 =32 時間 <1ms TTL=128
192.168.10.16 からの応答: バイト数 =32 時間 <1ms TTL=128

192.168.10.16 の ping 統計:
    パケット数: 送信 = 4、受信 = 4、損失 = 0 (0% の損失)、
ラウンド トリップの概算時間 (ミリ秒):
    最小 = 0ms、最大 = 0ms、平均 = 0ms
```

Figure 2　　Confirm communication connection, execute ping command

（４） Launch this application. Search for APV82516 from the shortcut icon APV82516 on the desktop or the Windows button and launch it.
(If an error message is displayed when this application is launched, stating that the connection with this device has failed, please refer to the troubleshooting described below.

5． **Application window**

5．1． **Startup window**

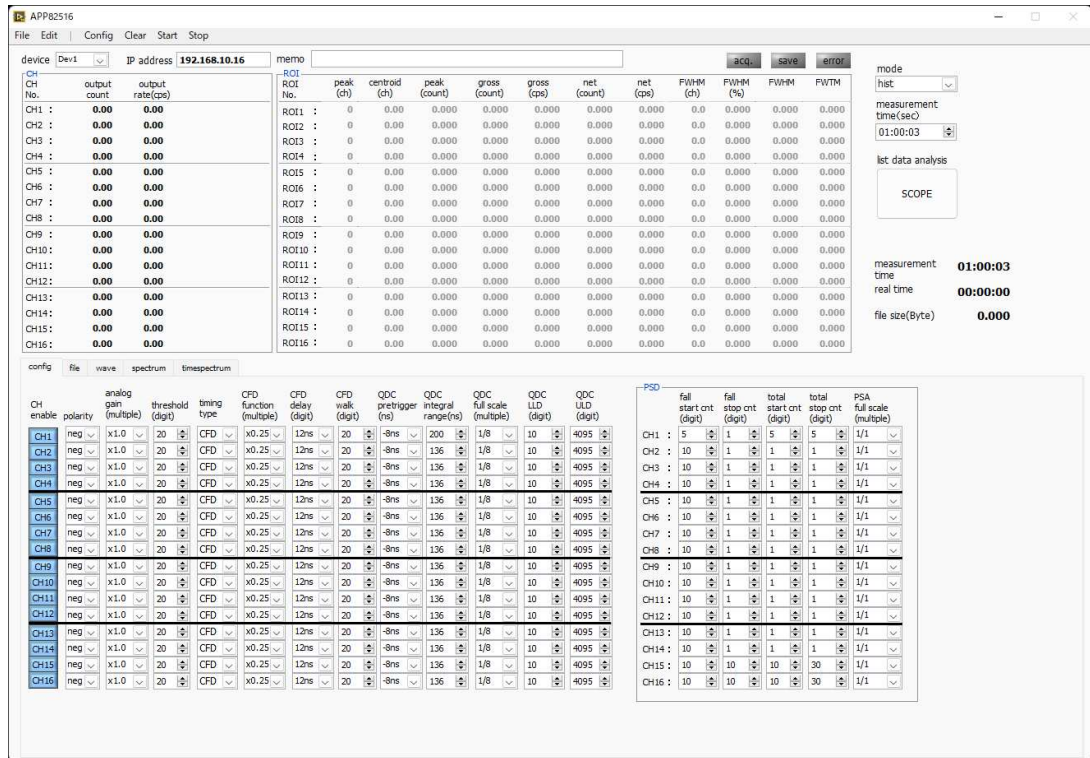When this application is run, the following startup screen will appear.

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

・Menu

File - open config	Load configuration file
File - open histogram	Load histogram data file
File - save config	Save current settings to a file
File - save histogram	Save current histogram data to file
File - save wave	Save waveform data file
File - save image	Save this application screen as PNG format image
File - quit	Quit application
Edit - copy setting of CH1	CH1 settings in the CH tab are reflected in all other CH settings
Edit - IP configuration	Change the IP address of this device
Config	Set all items to this device
Clear	Initialize histogram data in this device
Start	Start measurement to this device
Stop	Stop measurement to this device

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• tab

config	Settings related to input CH.
file	Settings related to file storage of data.
wave	Display of waveform data.
spectrum	Spectrum (histogram) display and ROI (Region Of Interest) setting.

• CH part

output count	Total number of counts processed by the signal
output rate(cps)	Output count per second

• ROI part

Displays the calculated results between ROIs

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

|	
device	Select the device to be measured
IP address	IP address of the target device. Define in the configuration file and display the IP address of the device selected in device.
memo	Optional text box. Use for measurement data management.
acq. LED	Flashing during measurement.
save LED	Flashes during data storage
error LED	Error indication
measurement time	Displays the set measurement time.
SCOPE	List data analysis applications.
real time	Real time (actual measurement time) of valid first CH.
file size(byte)	Displays the size of the list data file being saved. Displays the size in SI notation (0.789M, 10.100M, 1.230G, etc.).

5. 2. config tab
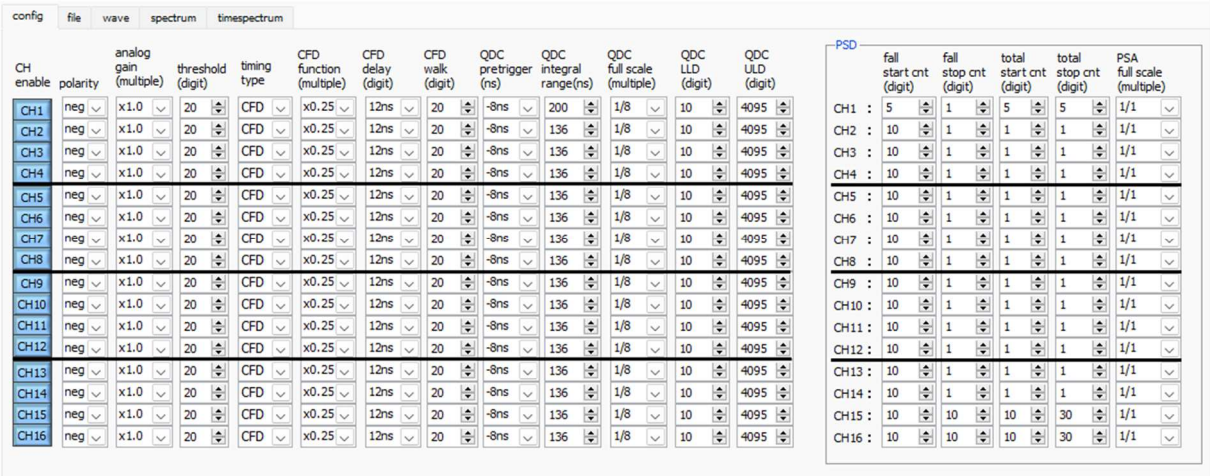
Figure 4   config tab

| CH enable	CH Enable/Disable. Normally, all CHs are set to "enable" state
polarity	Input signal polarity. Select pos for positive polarity or neg for negative polarity.
analog gain (multiple)	Select the analog gain (amplification value) from x1 from x0.15.
threshold (digit)	Sets the threshold for waveform acquisition of the input signal. The unit is digits. The setting range is 0 to 8191. set a value greater than the noise level while viewing the raw waveform in wave mode.

Constant Fraction Timing is realized by digital signal processing using FPGA
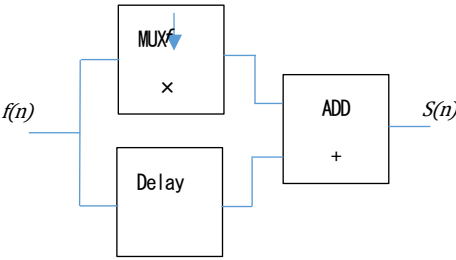
$$s(n) = fv(n) - v(n - delay)$$

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

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

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

Furthermore, by using FPGAs to perform pipelined calculations, a series of calculations is performed very quickly, with a calculation time of approximately 100 ns or less, resulting in low dead time and high throughput.
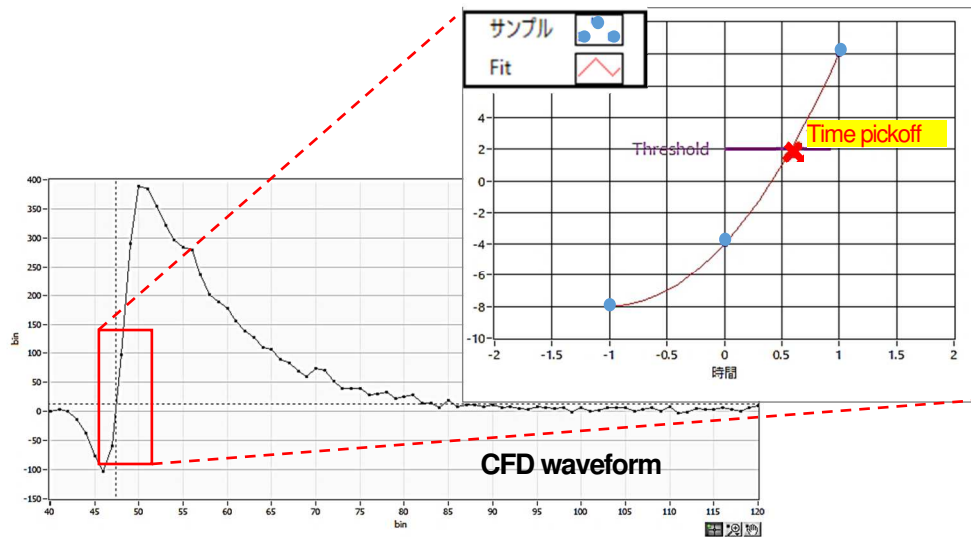
timing type   Select the waveform to be time-stamped from CFD or LE waveform.

LE   Leading Edge Timing (LET and LED agree)

The timing at which a certain trigger level t is reached. (Trigger acquisition timing is different for different wave heights, such as 'a' and 'b', and different times for different wave heights.
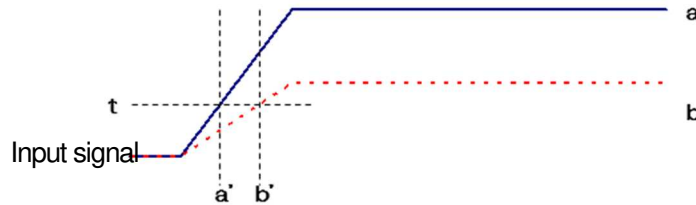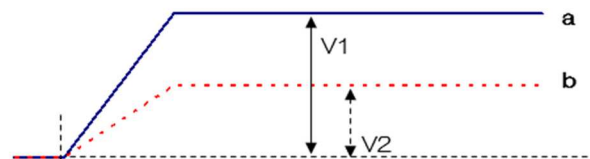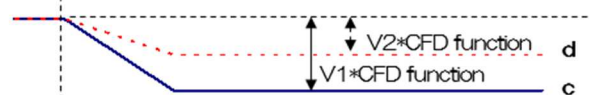
Figure 5   Thinking of Leading Edge Timing

CFD   Constant Fraction Disicriminator Timing

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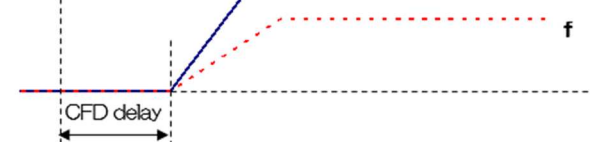
Input signal a and b

Inverts input signal multiplied by CFD function

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

Let g be the waveform obtained by adding c and e above, and let h be the waveform obtained by adding d and f above
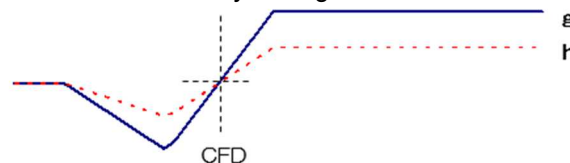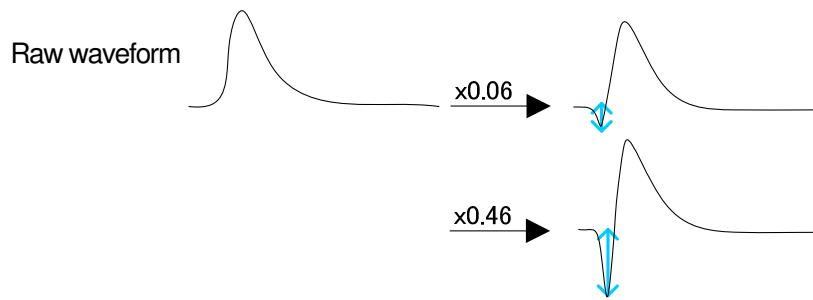
Figure 6   Thinking of Constant Fraction Disicriminator Timing

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

Raw waveform

x0.06

x0.46

CFD delay   Sets the CFD delay time; set from 4ns to 16ns in 1ns increments

Raw waveform

2ns

24ns
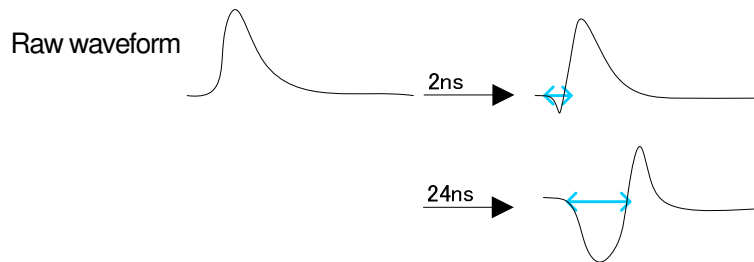
CFD walk   Sets the threshold value to be time-stamped. The unit is in digits, and the value is set near the 0 crossing position while watching the CFD waveform in wave mode.

Time Stamp

WALK

16   TechnoAP Co., Ltd.
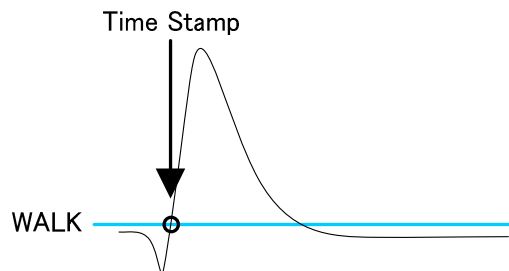
QDC pre trigger (ns)   Selects the timing to start waveform shaping for integral value calculation from

0ns, -8ns, -16ns, -24ns, -32ns, -40ns, -48ns, -56ns, and -64ns.

Integration is started from the previous time by the

amount of the pretrigger setting.

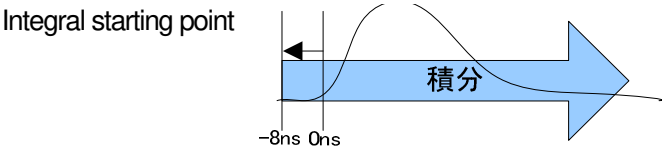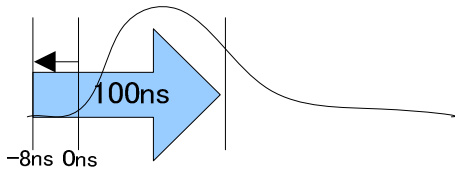Integral starting point

積分

−8ns 0ns

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

In case of Integral range 100 ns   In case of Integral range 200 ns

100ns   Integral range 200ns

−8ns 0ns   −8ns 0ns
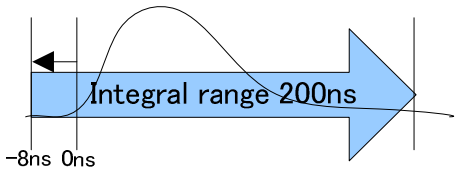
QDC full scale   Sets the gain of the QDC data. Select the setting from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32,

1/64, 1/128, 1/256, or 1/512 to set the QDC value to 8191 or lower

積分値400

−8ns 0ns

1/1 → QDC値 = 400

1/2 → QDC値 = 200
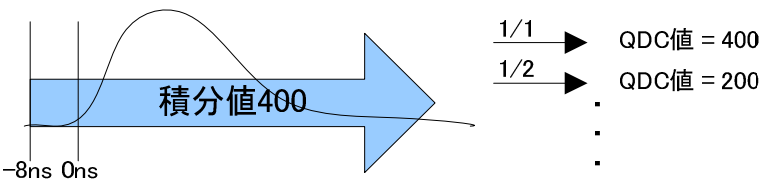
QDC LLD (digit)   Sets the LLD (Lower Level Discriminator) of the QDC. The unit is digits. Set a value

smaller than ULD. The setting range is from 0 to 8191.

QDC ULD (digit)   Sets the ULD (Upper Level Discriminator) of the QDC. The unit is digits. Set to a value

greater than the LLD. The setting range is from 0 to 8191.

PSA (Pulse Shaping Analysis) operation settings, including RISE for the rising edge of the waveform, FALL for the falling edge, and TOTAL for the entire waveform, as additional data in the list mode. In PSA operation, if the input waveform is negative polarity, it is inverted to positive polarity, and the waveform is always positive polarity.

PSD	fall start cnt (digit)	fall stop cnt (digit)	total start cnt (digit)	total stop cnt (digit)	PSA full scale (multiple)
CH1 :	5	1	5	5	1/1
CH2 :	10	1	1	1	1/1
CH3 :	10	1	1	1	1/1
CH4 :	10	1	1	1	1/1

Figure 7　PSA related setting

・PSA part

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

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

Example of FALL value calculation:

For example, if threshold: 50, fall start cnt: 5, fall stop cnt: 25, and PSA full scale: 1/1, the FALL value exceeds threshold and integrates 25 points from the 5th point, the blue boxed area in the figure below. The integrated value is then multiplied by PSA full scale to obtain the FALL value of the list data.
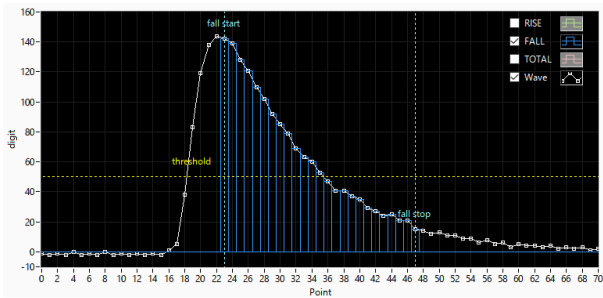
Figure 8　　Example of FALL coverage setting

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

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

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Example of TOTAL value calculation:

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

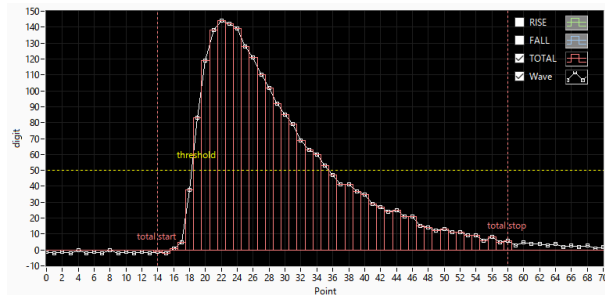Figure 9   Example of TOTAL coverage setting

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

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mode   Select the operation mode

    hist   Integrates the input signal and displays the spectrum

    wave   Digitizes input signals and displays waveforms

    list   For an input signal, time, CH, and integral information can be output and saved as a binary file as a single event. It is also used to obtain time spectra and PSD 2D histograms.

    list-wave   Waveform data is appended after the list data and output. * Option

    list-pileup   Waveform data is inserted in the list data and output in case of pile-up. * Option

    list-coinc-wave The coincidence list data and waveform data are output together. (The coincidence is valid only for CH1 and CH2. * Option

measurement time   Specify the measurement time. The maximum is 8760 hours.

5．2．1． list-pile ups * Option

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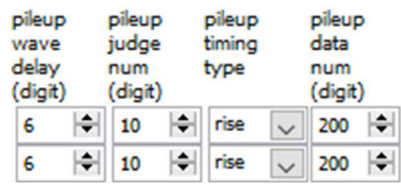

Figure 10　list-pile up related setting (Only the upper 2 channels are displayed.)

pileup wave delay(digit)	Sets the delay delay at the start of acquisition waveform capture. The unit is in digits. The default is set to 5 digits. The setting range is from 0 to 31 digits.
pileup jugde num(digit)	Sets the amount of the pileup waveform to be determined. The unit is in digits, which is correlated with the vertical axis (digits) corresponding to the amplitude of the waveform. Note that if this value is too small, even noise may be judged as a pileup.
pileup timing type	Selects the reference edge for pileup waveform output.

rise　　Rise

pileup　Pile-up

| pileup data num(digit) | Sets the number of data points for pileup waveform output. |

5．2．2． pile-up reject * Option

If the acquired waveform contains pileups, the event data can be removed by setting each CH.
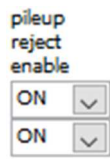

Figure 11　pile up reject related setting (Only the upper 2 channels are displayed.)

pile up reject　　Select the pile-up reject function

ON　　　　Enabled. Removes event data calculated on waveforms containing pileups.

OFF　　　Disabled. Outputs even event data calculated with waveforms containing pileups.

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５．２．３． OR output＊Optiong

LVTTL OR logic signal can be output from the AUX terminal on the front panel with detection timing limited to the energy range between LLD and ULD for each CH
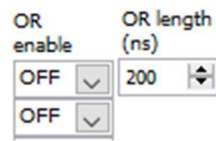

Figure 12　OR output related setting (Only the upper 2 channels are displayed.)

OR eable　　　　OR output enable/disable setting from the AUX terminal on the front panel.

OR length　　　　Sets the pulse width of the logic signal. The setting range is from 8ns to 1000ns.
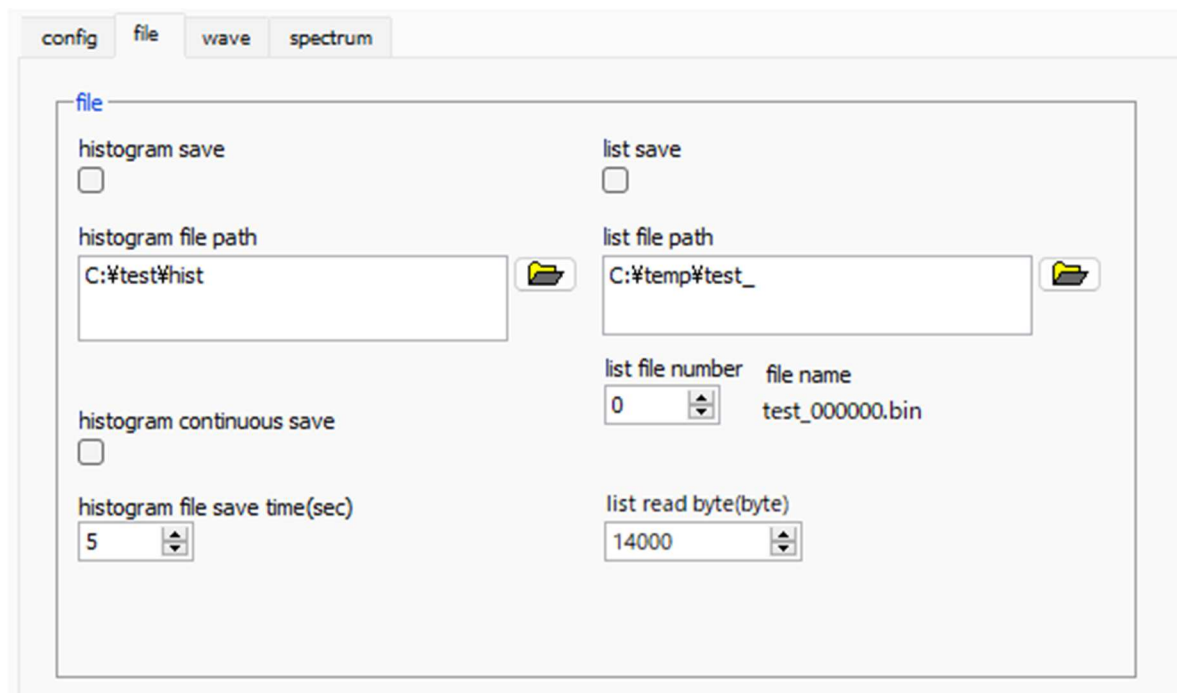
5．3．**file tab**

Figure 13　file tab

・file part

histogram save	Saves the histogram data displayed in the spectrum tab at the end of measurement to a file. The file is saved in the format described below.
histogram continuous save	Enables/disables continuous saving of histogram data to file at set time intervals Valid only when "hist" is selected in "mode".
histogram file path	Set the absolute path of the histogram data file. No extension is also possible. ***NOTE*** The file will not be saved with this file name, but will be formatted as follows based on this file name Example: If the histogram file path is set to C: ¥Data¥histogram.csv and the date and time is 2010/09/01 12:00:00, the data saving will start with the file name C: ¥Data ¥ histogram _201009 01_120000.csv
histogram file save time(sec)	Sets the time interval for continuous storage of histogram data. The unit is seconds. The setting range is from 5 to 3600 seconds

list save	Sets whether or not data in list mode is saved in a file
list file path	Set the absolute path of the listing data file. No extension is also possible.
	NOTE The file will not be saved with this file name, but will be formatted as follows based on this file name
	Example: If the list file path is set to C:¥Data¥list_.bin and the list file number is 0 as described below, data saving will start with the file name C:¥Data¥list_000000.bin
list file number	Sets the starting number of the number appended to the list data file, from 0 to 9999999, reset to 0 if the number exceeds 9999999.
file name	Displays the file name when the file is saved based on the list file path and list file number.
list read byte(byte)	Sets the size of the list data to be read out once.

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5.4. **wave tab**

The status of signal processing inside this device can be acquired as waveform data with this application. When adjusting signal processing before measurement, the preamp and slow signals from the MONI terminal are checked with an oscilloscope, and this function can do the same.
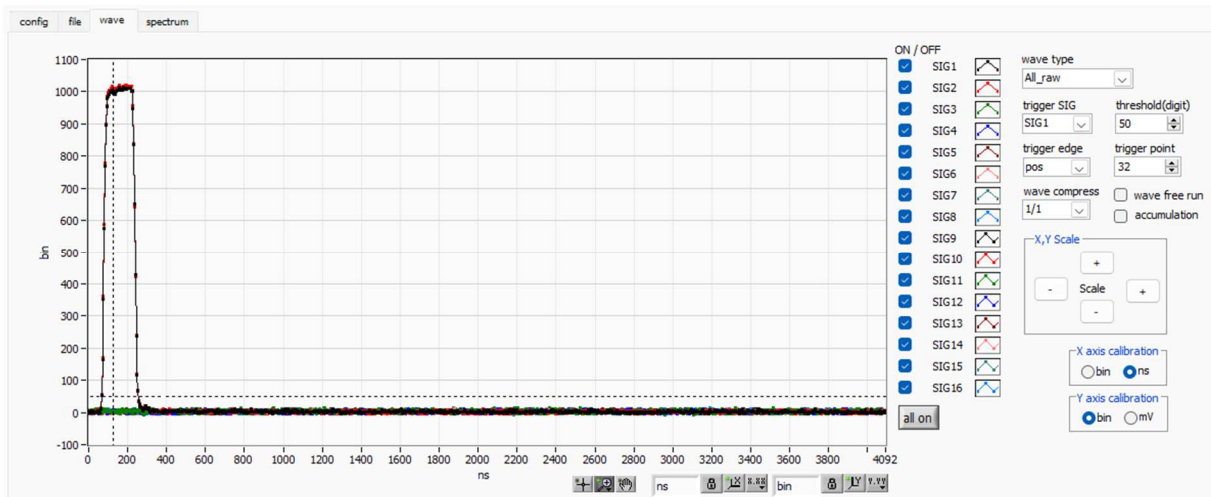

Figure 14   wave tab

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

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

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

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

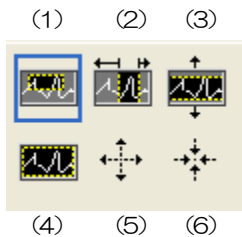Zoom. Click to select and execute the following six types of zooming in and out.

Figure 15　Graph　Zoom in and out tool

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

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

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

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

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

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

Pern tool   Allows you to grab the plot and move it around on the graph.
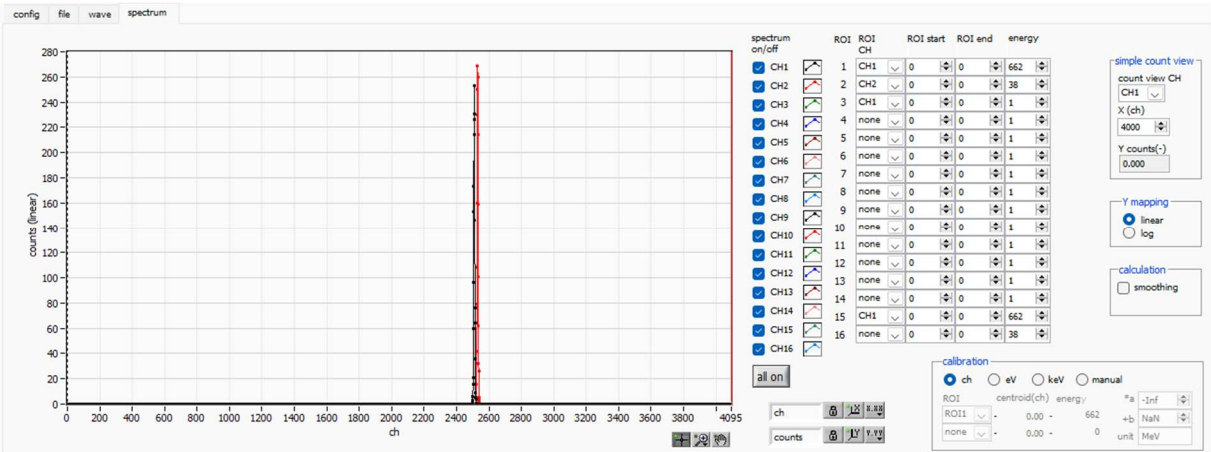
5．5． **spectrum tab**

Figure 16 spectrum tab

Graph	Histogram graph, which displays the energy histogram during measurement if histogram is selected in mode in the config tab or if list is selected in mode and the energy spectrum ON/OFF checkbox is enabled.
Legend checkbox	Selection of whether to display a histogram for each CH in the graph.
ROI CH	Select the CH number to which the ROI (Region Of Interest) is to be applied; up to 8 ROIs can be set for a single histogram.
ROI start	Start position of the ROI. The unit is the unit selected in the calibration described below.
ROI end	End position of the ROI. The unit is the unit selected in the calibration described below.
energy	Definition of energy value at peak position (ch), set as 1173 or 1332 (keV) for Co-60. When "ch" is selected in the calibration described below, the peak between ROIs is detected and keV/ch is calculated from the peak position (ch) and the set energy value and applied to the result of the calculation of the FWHM.
calibration	X-axis units. X-axis labels will change according to the setting

	ch	Display in units of ch (channel); units such as FWHM of FWTM of ROI are optional.
	eV	The slope a and the intercept b of the linear function y=ax+b are calculated and set on the X-axis so that ch is eV by two-point calibration of the two types of peaks (center values) and energy values in a histogram.
	keV	The unit of keV is displayed. Example: If there are 1173.24 keV of Co-60 at 5717.9ch and 1332.5 keV of Co-60 at 6498.7ch, a is automatically calculated as 0.20397 and b as 6.958297 from the two-point calibration.
	manual	Set the slope a, the intercept b, and the unit label of the linear function

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	y=ax+b arbitrarily and set them on the X axis. The units can be set arbitrarily.
Y mapping	Select the mapping for the Y axis of the graph. The Y-axis labels will change according to the settings.
	linear straight line
	log logarithm
smoothing	Smoothing function to calculate half-widths when statistics are low.
simple count view	The counts displayed on the graph can be read simply.

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6．Measurement

As an example, we describe the operation procedures for energy spectrum measurement, list measurement, PSD measurement, and time spectrum measurement when using a LaBr3(Ce) detector (hereafter referred to as "detector")
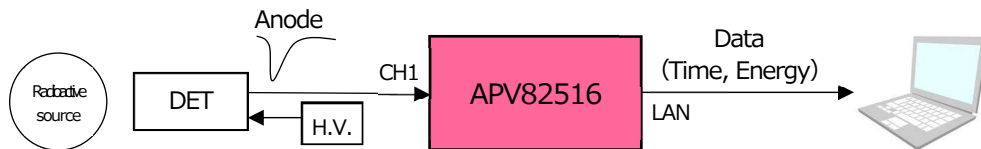
6．1．Histogram mode

6．1．1．Environment

Figure 17　Configuration for measurement

6．1．2．Power supply and connection

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

6．1．3．Application startup and configuratiom

（1）　Double-click the APP82516 shortcut icon on the desktop to launch this application. Immediately after startup, a network connection between this application and the device will be established. If a connection error occurs during this process, please refer to the troubleshooting described below.
（2）　Click on Menu Config to send all settings to this device. After execution, the histogram data in DPP will be initialized.

6．1．4． Waveforme confirmation

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

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

Figure 18　Waveform Measurement Settings

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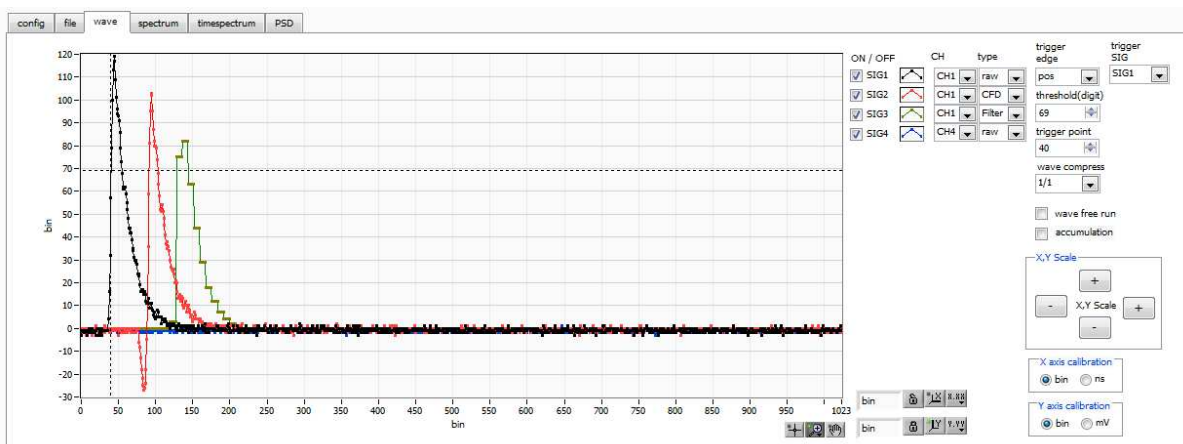

Figure 19　Waveform Measurement Window

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Note the following

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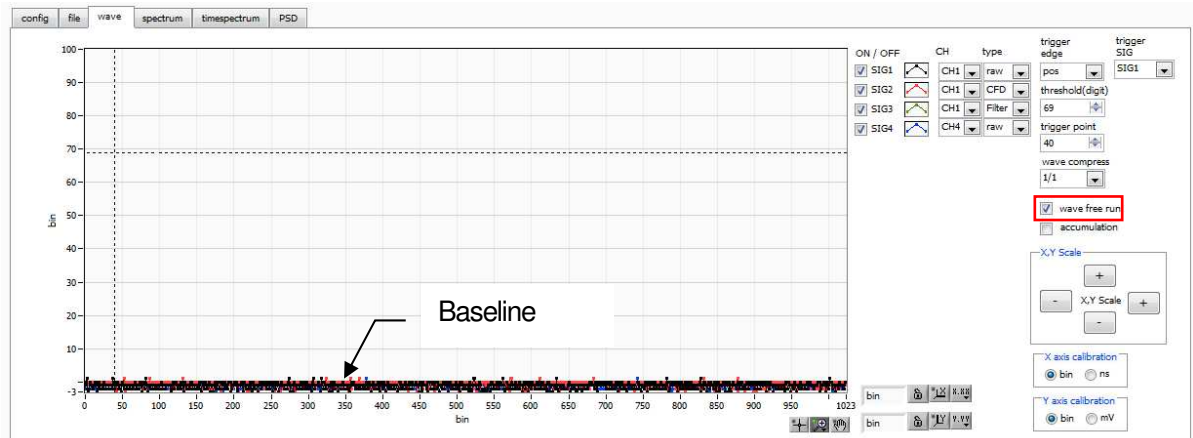

Figure 20　Baseline confirmation in progress

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

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

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6．1．5． Measurement start

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

Figure 21　Threshold setting in config tab

Open the spectrum tab, confirm the settings shown in the figure below, and then click on the menu Clear > Start. After execution, you will see the spectrum as shown below.
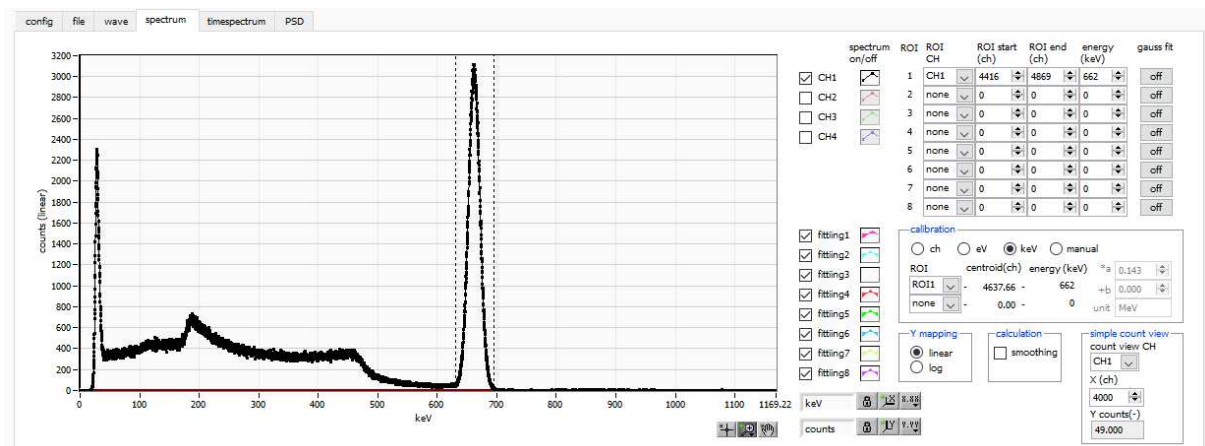
Figure 22　Histogram mode measurement in progress

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

6．1．6． End of measurement

To end the measurement, click on the menu Stop.

6．2．　List mode

6．2．1．　Preapration

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

6．2．2．　Confirmation of energy spectrum

In histogram mode, note the following

- The output rate (cps) is the number of events per second, and check (1) in the figure below to see if it is too low or too high compared to the assumption. In the list mode, 16Byte of data is obtained for each event, so for example, if output rate (cps) is 500kcps, 8MB/sec (500kcps x 16Byte) of data will be stored per second.

- Check the graph in the spectrum tab to see if there is any abnormality in the shape of the spectrum, especially if excessive noise data is being acquired.
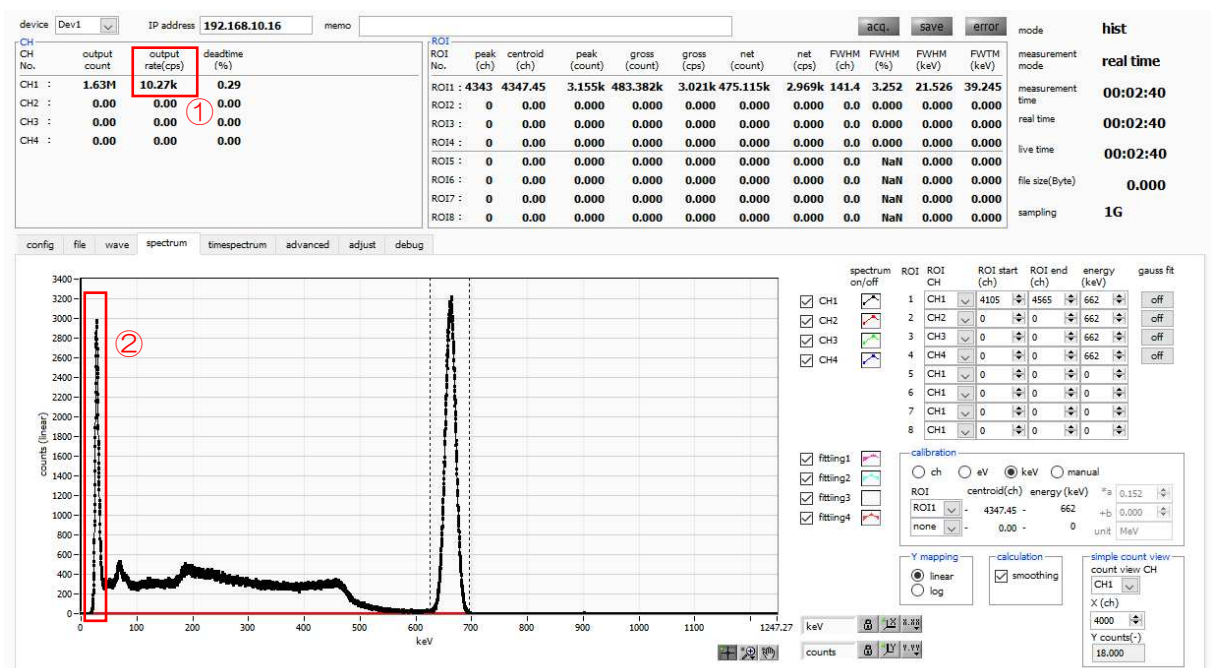
Figure 23　Precautions before measurement in list mode

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6．2．3． Setting

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

list save　　　　　　　Chechk

list file path　　　　　Reference file path

list file number　　　Arbitrary from 0 to 99999999. Be careful not to duplicate.

list file size(byte)　　Size of the list data file. If this size is exceeded, the list file number is automatically moved up by one and saved in a new file.
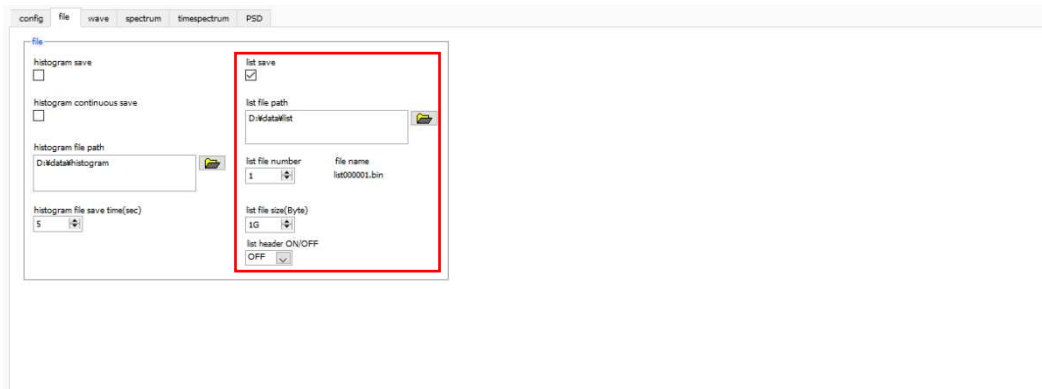
Figure 24　Settings related to saving list data in the file tab

6．2．4． Measurement start

Click the menu Config → Clear → Start. After execution, when an event is detected and list data is acquired, the file size (Byte) in the red frame in the figure below will increase.
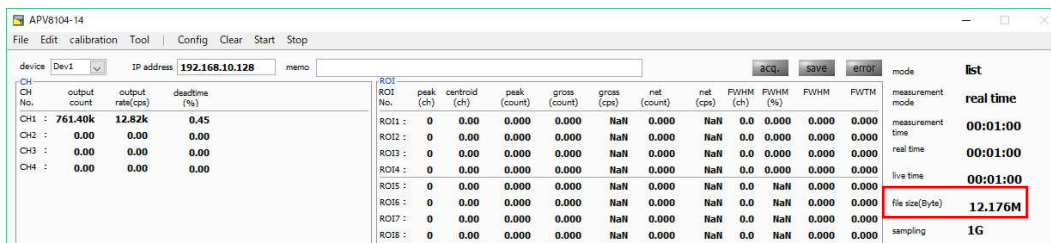
Figure 25　list data measurement and saving window

6．2．5． End of measurement

To end the measurement, click on the menu Stop.

７． **Quit**

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

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8. **File**

8. 1. **Histogram data file**

（1） File format
CSV text format, separated by commas
（2） File name
Set arbitrarily
（3） Component
・Header part

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

*Saved for each CH below

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

*Save to single below

MOD	Moe
MTM	Measurement time
MEMO	memo

・Calculation part

*Saved for each ROI below

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

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

・Status part

*Saved for each CH below

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

・Data part

Histogram data per channel. Maximum 8192 points.

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8.2. **List data file**

（1） File format
 Binary, network byte order (big-endian, MSB First) format
（2） File name
The file number is the file path set in the "list file path" in the "config" tab, with 0's and 6 digits appended to it. For example, if list file path is set to D:¥data¥123456.bin and file number is set to 1, the file size is D:¥data¥123456_000001.bin.

When list file size is reached, the file being saved is closed. After that, it automatically moves up the list file number by one, opens a new file, and continues to save the data in the file.
（3） Component
128 bits per event (16 bytes, 8 WORD) + waveform data

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

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

Bit111	96
TOTAL[15..0]	
95	80
FALL[15..0]	
79	64
real time[55..40]	
63	48
real time[39..24]	
47	32
real time[23..8]	
31 24 23	16
real time[7..0] real time fixed fraction[7..0]	
15 12 11	0
CH[3..0] QDC[11..0]	

Figure 26　list data format (list with PSA)

- Bit111 to Bit96 　　TOTAL (waveform falling partial integral) value. Unsigned 16-bit integer.
- Bit95 to Bit80 　　FALL (total integral of waveform) value. Unsigned 16-bit integer.
- Bit79 　　WAVE data presence/absence. If yes, 1.
- Bit78 to Bit25 　　TDC. 54Bit. 4ns per Bit.
- Bit24 to Bit17 　　TDC FP. 8Bit. 15.625ps per Bit.
- Bit15 to Bit12 　　CH. channel number. 4Bit. 0 for CH1, 15 for CH16.
- Bit11 to Bit0 　　QDC (integral value). Unsigned 12-bit integer. The summed value of the waveforms between the set ranges from where the collected waveforms are filtered, and the threshold is exceeded.

8．3． **List-wave and list pile-up wave data file * Option**

（1） File format
Binary, network byte order (big-endian, MSB First) format
（2） File name
Set arbitrarily
（3） Component

　① List with PSA (in case of list data part 112Bit)

Bit111	96
TOTAL[15..0]	
Bit95	80
FALL[15..0]	
Bit79	64
real time[55..40]	
63	48
real time[39..24]	
47	32
real time[23..8]	

31	24	23	16
real time[7..0]		real time fixed fractions [7..0]	

15	13	12	0
CH[2..0]		QDC[12..0]	

wave number[15..0]
header[31..16]
header[15..0]
wave data[15..0] × wave number 分

Figure 27　list-wave and list pile-up data format (list with PSA)

-
- Bit111 to Bit0 　　　same list data fomat.
- Waveform data 　　wave number. 16Bit. number of waveform points
- Waveform data 　　wave data. 32bit per waveform. 16384digit offset. Waveform information for wave number is added.
  - CH1 header 　　0x57415630 (=WAV0)
  - CH2 header 　　0x57415631 (=WAV1)
  - CH3 header 　　0x57415632 (=WAV2)
  - CH4 header 　　0x57415633 (=WAV3)
  - CH5 header 　　0x57415634 (=WAV4)

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

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9. Troubleshooting

9. 1. Connection error occurs

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

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

    [System]

    PCConfigPort = 55000

    PCStatusPort = 55001

    PCDataPort = 55002

    DevConfigPort = 4660

    DevStatusPort = 5001

    DevDataPort = 24

    SubnetMask = "255.255.255.0"

    Gateway = "192.168.10.1"

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

    IP address   192.168.10.128

    Sub-net mask   255.255.255.0

    Default gateway   192.168.10.1

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

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

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

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

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

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

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

9. 2. Command error occurs

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

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9.3. **Histogram is not displayed**

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

（1） Set CH1 to ON at plot ON in the histogram tab.
（2） Check if input total rate (cps) and throughput rate (cps) are counting.
（3） Set DAC monitor CH to CH1 and DAC monitor type to pre-amp, and check that the pre-amp wave height is not too small or too large, and that it is within 1V.
（4） Set DAC monitor type to fast and check if the FAST filter signal is output.
（5） Set the DAC monitor type to slow and check if the SLOW filter signal is output.
（6） Make sure that the fast trigger threshold and slow trigger threshold values are not too small or too large, and while watching the input total rate (cps) and throughput rate (cps) counts, change the settings from 100 to 30 or so.
（7） Right-click on the X and Y axes of the graph to set auto scale.

9.4. **Change IP address**

Refer to the attached "Instruction Manual: How to Change the IP Address of the APG5107-Equipped

Product". (If you do not have the attached document, please contact us.

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