MCA4K

4000 Channel Spectrometry Analyzer

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1 MCA4K Parameter Overview

Inputs:

- Linear input
  - 0 to 5V
- Input for single-wire scintillation probe
  - High Voltage 0-1500V Max 1.3mA;
  - Voltage set by software
  - Timing constant 1 μs
  - Under-shot compensation using a multi-turn trimmer, controlled by a built-in digital oscilloscope
  - High voltage readback for diagnostic purposes
- AD converter resolution 12 bit
- Sampling 80 MHz, Dead time 25 ns, shortest processed pulse 50 ns
- internal temperature monitoring for diagnostic purposes

Communication:

- USB 2.0 full speed, 12 Mbit/sec
- 4x TTL input for general use
- 4x TTL output for general use
- 3x LED indicator
  - Red – HV is on
  - Yellow – flashes when communicating, flashes quickly when communication error
  - Green – power, flashes when measuring

Power supply:

- 12V, stabilized from 1A AC adapter
- Built-in overvoltage and reverse polarity protection

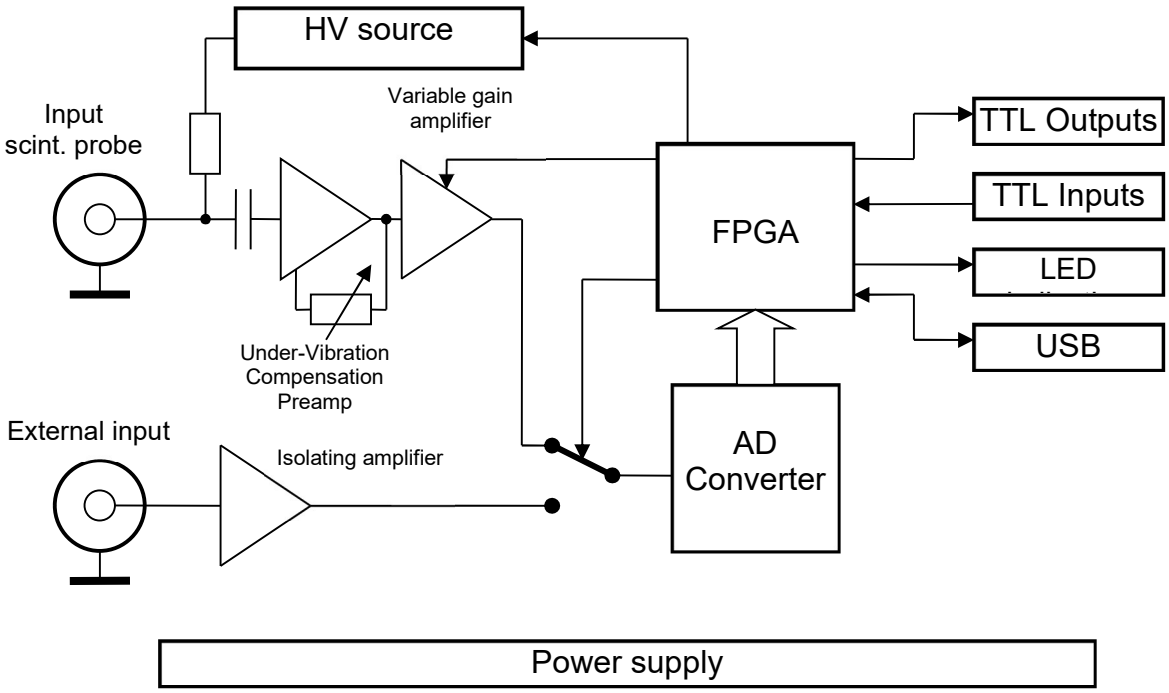
Signal Processing:

- Built-in digital oscilloscope for signal waveform control
- Amplitude analyzer with processing of accumulated pulses:
  - absolute maximum
  - First maximum
  - Not counting accumulated impulses
  - Number of accumulated pulses for evaluation of measurement quality

The analyzer is designed in such a way that additional accessories can be supplied to the instrument housing:

- Power Supply for Preamp
- Batteries
- Second spectrometer with second HV power supply

2 Block diagram of the device



The instrument contains two signal paths for the scintillation probe and a direct input to the AD converter.

The scintillation probe route is designed for a scintillation probe with a single-wire positive power supply. The signal is taken by a sensing resistor through a separating capacitor and fed to a shaping preamplifier with signal under-shot compensation. The following linear amplifier with variable gain adjusts the amplitude of positive pulses from the shaping preamplifier for the AD converter.

The second direct signal route is equipped only with an isolating amplifier, normalizing the amplitude for the AD converter.

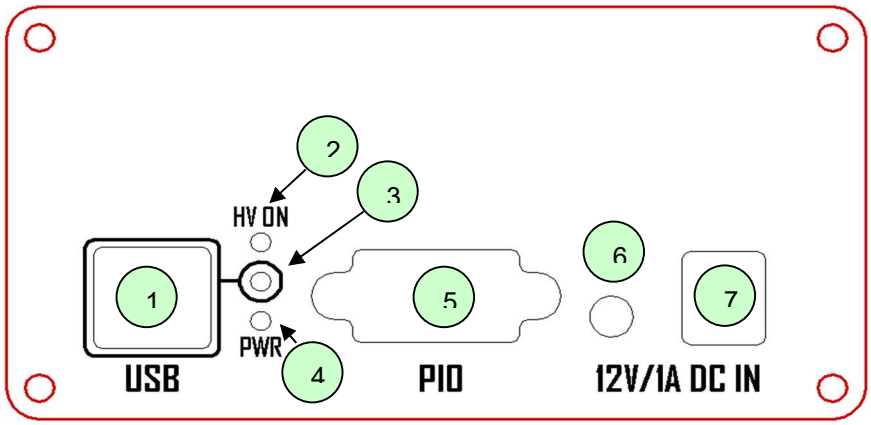
The AD converter samples the signal for digital processing in the FPGA gate array.

All signal processing functions are implemented in the FPGA gate array. The gate array also provides USB communication, HV power supply control, gain adjustment, signal path switching, LED indication, and auxiliary inputs and outputs.

3 External Connectivity

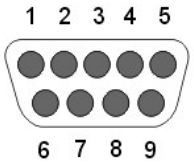
The signals are connected to two panels of the device – the communication panel and the signal panel

3.1 Instrument communication panel



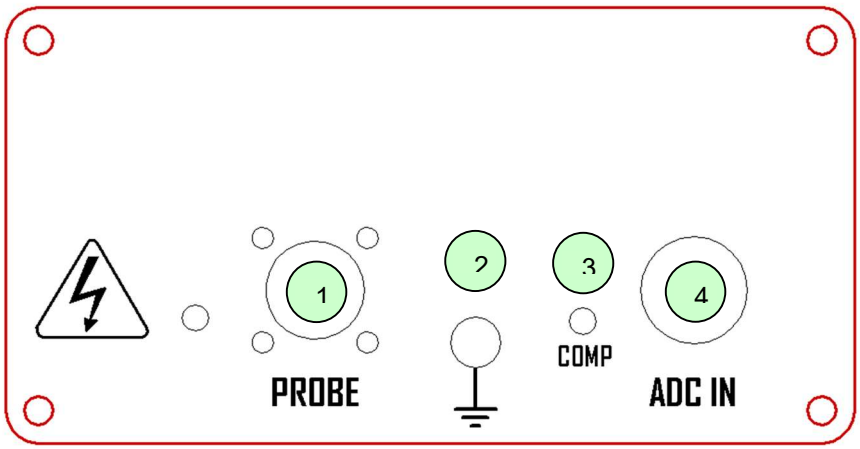
Position	Meaning	Description
1	Communication connector	USB Type B
2	HV ON	red high voltage indicator
3	USB Communication	Yellow indicator, flashes when communicating with the device, flashes very quickly when communication error
4	Power on/measurement indication	Green indicator, lights up when power is on, flashes when measurement is in progress
5	Parallel input and output	4x output and 4x TTL input
6	Power Switch	-
7	Power input	Power Adapter Input Connector 5.5/1.2mm 12V, 1A, Voltage Stabilized, Center+

Connection of the SUB-D 9 FEMALE connector of the parallel output.



Position	Description
1	TTL out 1
2	TTL out 2
3	TTL out 3
4	TTL out 4
5	GND
6	TTL and 6
7	TTL and 7
8	TTL and 8
9	TTL and 9

3.2 Instrument Signal Panel



Position	Meaning	Description
1	Scintillation Probe Input	Single-wire probe, voltage 0 to 1500V, MHV or SHV connector
2	Ground Socket	Reference point for zeroing protection
3	Scintillation probe compensation	Probe pulse undershot compensation
4	BNC input	Direct input converter, 0 to 5V, BNC connector

3.3 Connection cabling requirements

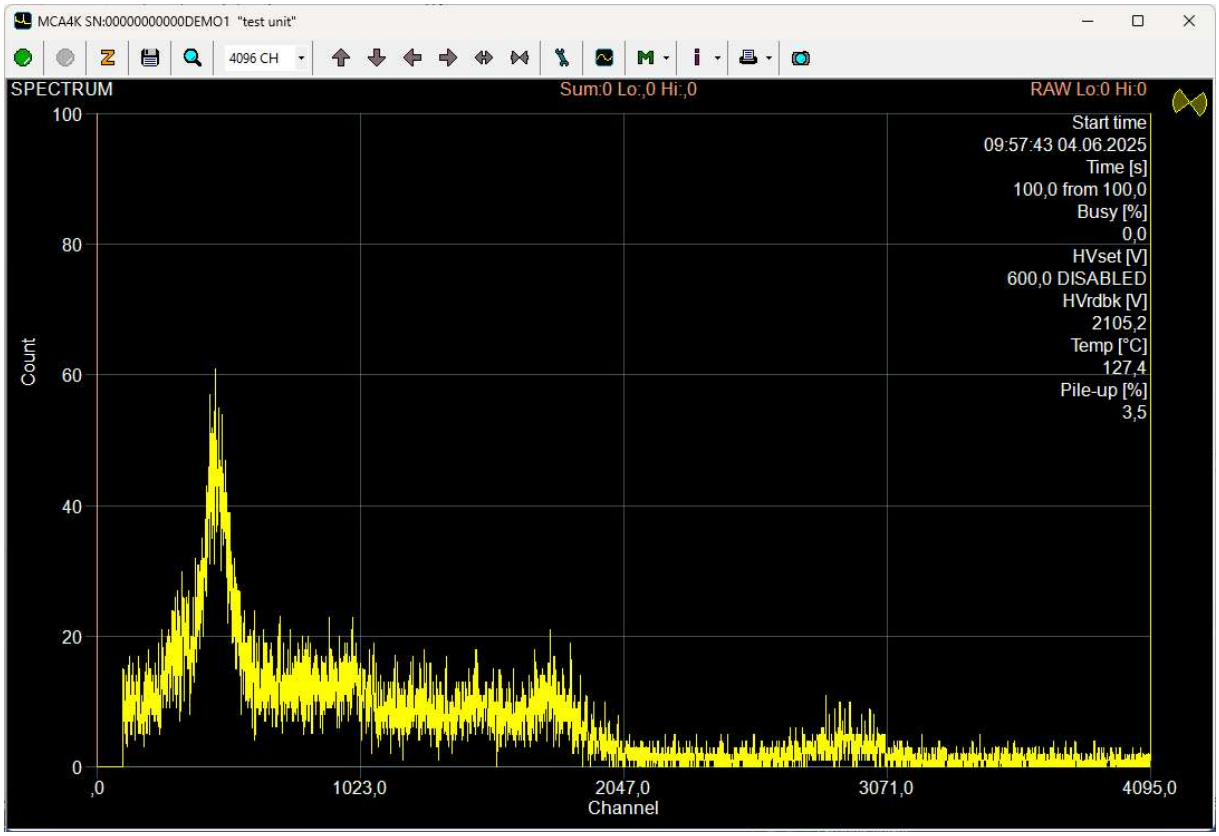
When connecting and installing the device, observe the following requirements:

- Use wiring with a maximum length of 1.8 meters from each connector to the appropriate device
- Connect the power supply with a cable with a minimum cross-section of 0.75 mm2
- Connect the USB communication port with a USB 2.0 full speed cable
- Connect the parallel input and output with a shielded cable, e.g. HELUKABEL TRONIC-CY (LiY-CY) 10x0.25 QMM/20008
- Connect the scintillation probe with a sufficiently sized coaxial cable, e.g. RG58, with a working voltage of at least 2000V
- Connect the direct input of the converter with a coaxial cable with a nominal impedance of 50Ω

4 Control Software

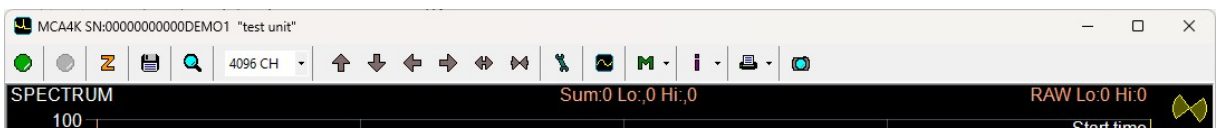
The control application allows basic measurements with the analyzer. The control software is written using the .NET Framework 2.0

4.1 Main program window



It is possible to use the cursor in the program, the cursor movement is by using the left to right arrow keys, or by using the mouse to mark a part of the progress into a block and press the ENTER key to expand the selected waveform. You can get back to the full range view by pressing BACKSPACE.

Cursor parameters are displayed above the waveform in the middle, cursor ranges directly in channels are on the right above the waveform



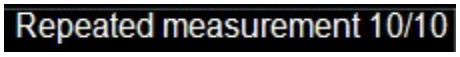
 Start - the measurement starts the spectrum measurement

 Stop - the measurement ends/interrupts the spectrum measurement

 Zero Counters - resets the internal memory of the analyzer, including the measurement time counter and dead time

 Save - saving spectrum data in CSV, TKA and CHN format

 Spectrum file viewer – viewer of previously saved CSV files, allows conversion to TKA and CHN



When measuring repeatedly, an indicator of how many measurements are currently in progress



In the case of repeated measurements, the indicator of the ongoing pause and the order of the pause between measurements



Start time - display of the time and date of the start of the measurement



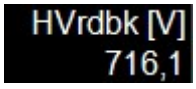
Time - display of the measurement time in seconds



Busy - display of the dead time of measurement in percentage, at the same time an indication that the correction for analyzer dead time (DTCA) and pulse length (DTCP) is active.



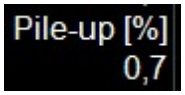
Display of the set voltage on the scintillation probe connector



Display of the measured voltage on the connector for the scintillation probe



Displaying the Internal Temperature of the Analyzer



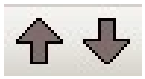
The ratio of accumulated pulses to the total number of pulses. If the non-counting of accumulated pulses is active, and there is no pulse without accumulation, it displays the number of accumulated pulses.

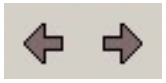


Number of Pulses in Window (Region Of Interest)



Conversion Gain – Analyzer resolution settings

 Yaxis resulution - change the resolution on the Y axis

 Cursor left/ Cursor right - move the cursor or select left/right

 Zoom – stretch the selected part of the progress

 Full scale - full scale display

 Setup - setting measurement parameters

 Scope - starting the internal oscilloscope

 Measurement - predefined measurement algorithms (Energy calibration, probe plate measurement, ROI window definition)

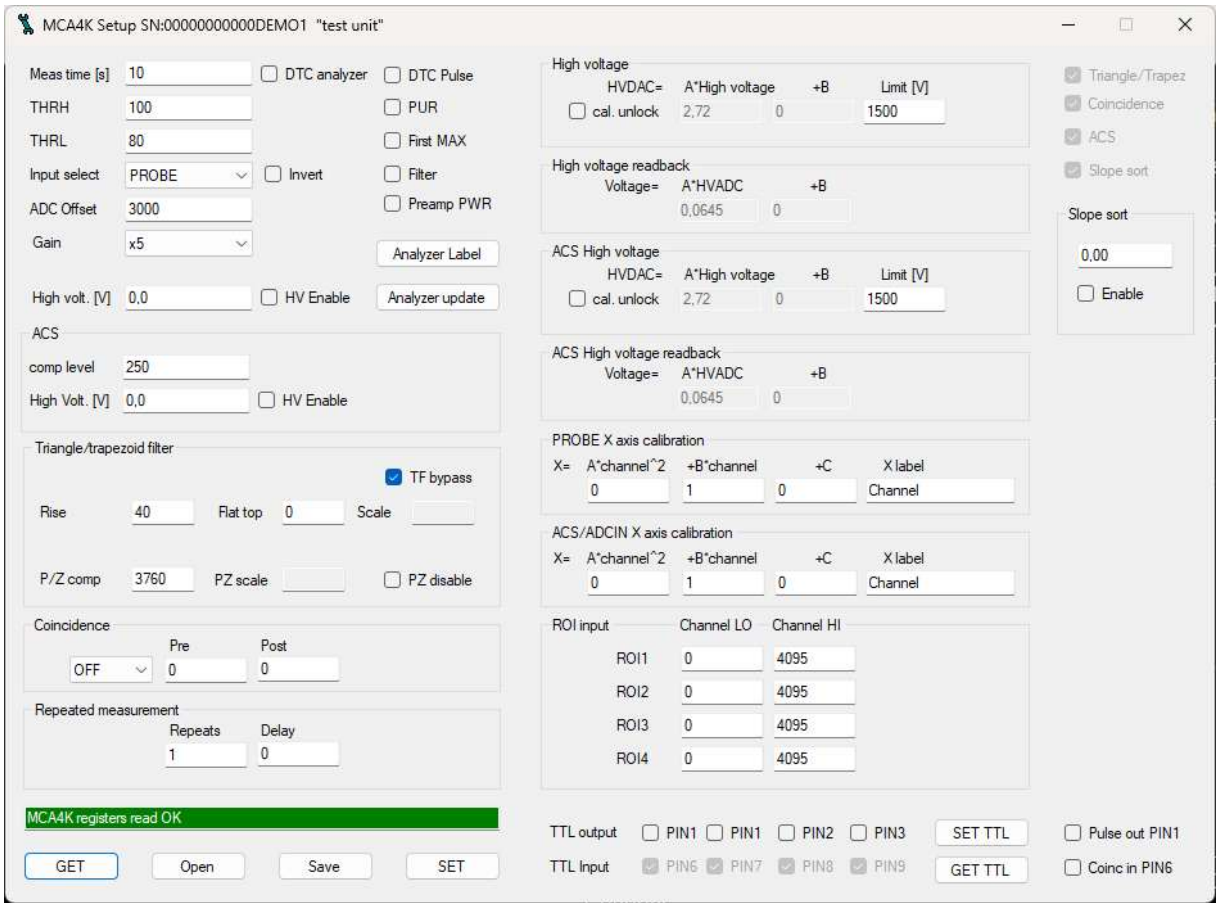
 Visible information – in the menu, it is possible to select what information will be displayed with the spectrum measurement, in the upper right corner.

 Print – Print menu, printer selection, spectrum print option selection, custom printing

 Screenshot - transfers the current contents of the window to the clipboard windows as an image

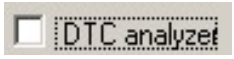
 Indicator of ongoing communication with the analyzer, if communication is in progress, it rotates

4.2 Setup – setting measurement parameters





Meas time - length of measurement in seconds



DTC analyzer - correction of the measurement time to the dead time of the analyzer



DTC pulse - correction of the measurement time to pulse length - pulse length is also included in the dead time

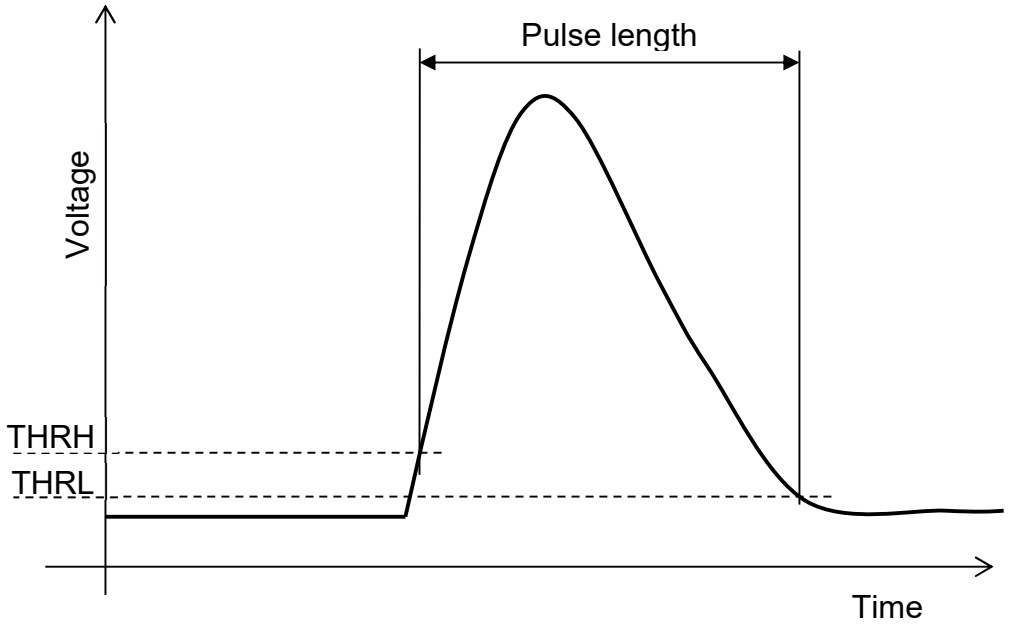


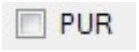
THRH – threshold level from which the start of the pulse in channels 0 to 4095 is counted



THRL - Pulse End Threshold Level in Channels 0 to 4095

For the correct function of the analyzer, it is necessary that the THRH>THRL, the meaning of the parameters is illustrated in the following figure

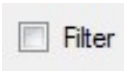




Not counting accumulated pulses by the analyzer

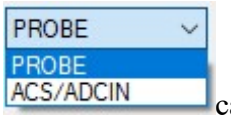


The pulse amplitude calculated by the analyzer is the first maximum of the pulse, unchecked the pulse amplitude calculated by the analyzer is the absolute maximum of the pulse.



The input waveform will be filtered (moving average of 8 signal values in a row)



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can be either PROBE – the input is the scintillation probe preamplifier or ACS/ADC IN – external input



Input invert – invert input data, in case of using external input and negative pulse analysis



PWR Preamp – Activate the power supply to the preamp (if an expansion module is installed)



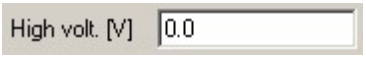
ADC Offset - setting the offset value on the input of the ADC converter of the analyzer range 0 to 4095, it does not have the same step as the channel width, for the scintillation probe the offset is about 3000, for the external input about 1000



the threshold signal level in the channels below which the evaluation of the baseline signal level is performed.



level in channels where the basic signal level is required

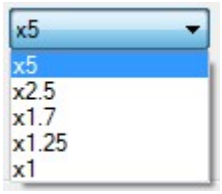


High voltage - setting the high voltage source in the range of 0 to 1500 volts, calibration curve see below



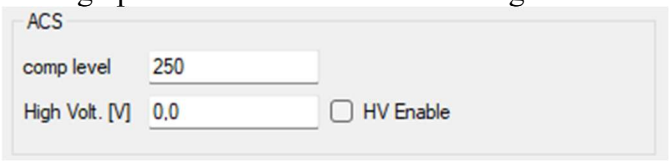
HV enable – enabling high voltage



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GAIN - amplifier gain adjustment with variable gain 1x to 5x

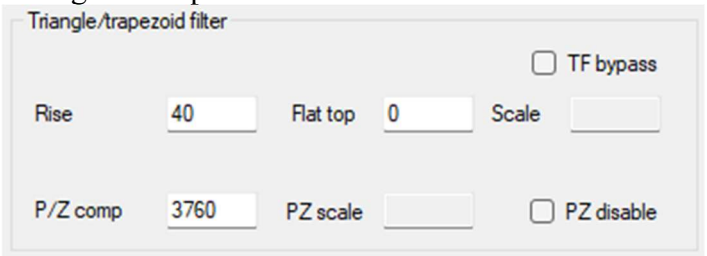
Setting up the anti-coincidence shielding module



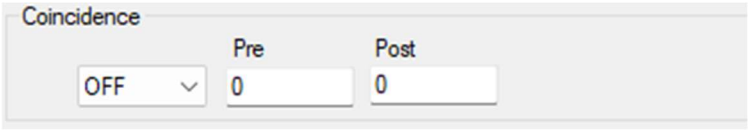
It is possible to insert a HV power supply and preamplifier module for anti-incident shielding into the device. This module is only experimental and its installation should be consulted with the device manufacturer.

Comp level – setting the ACS discriminator
High Volt. - High voltage setting for ACS module
HV enable – enabling high voltage for the ACS module

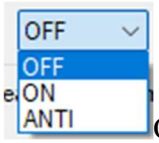
Triangular/Trapezoidal Filter



The firmware of the FPGA device has an implemented digital filter that allows the use of a triangular or trapezoidal filter in signal processing. The prerequisite for use is a short increase to the maximum of the signal and a slow discharge constant of the amplifier used.
Rise – filter rise time in multiples of 12.5 ns.
Flat top – the duration of the flat peak of the filter waveform in multiples of 12.5 ns.
P/Z comp – compensation of undervoltage of the signal when passing through a trapezoidal filter
TF bypass – bridging the triangular/trapezoidal filter
PZ disable – suppression of undervoltage compensation of the signal when passing through a trapezoidal filter

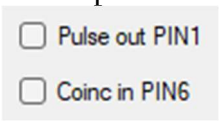


Coincidence can take on values



OFF – not used, ON – coincidence and ANTI – anticoincidence. It is also possible to set in multiples of 12.5 ns the interval when the (anti)coincidence is evaluated as valid before (Pre) and after (Post) the main pulse of the analyzer.

The coincidence input is both the main measurement route of the analyzer and either the internal ACS coincidence source (not used) or an external coincidence signal source fed to the TTL input connector, pin 6 activation is by checking the "Coinc in PIN6" box



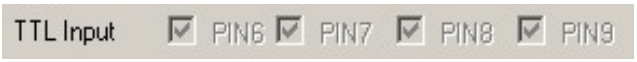
If the analyzer is used to generate a coincidence pulse for another instrument, the output of this pulse is available on pin 1 of the TTL output connector, after checking the "Pulse out PIN1" box. The coincidence pulse is generated from exceeding the THRH level and until the THRL level is reached.



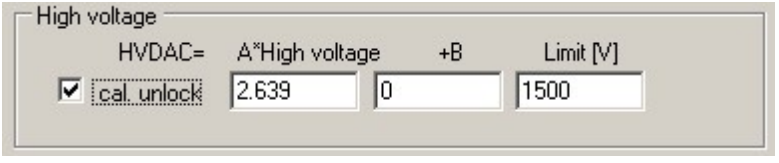
TTL output - setting digital outputs on the auxiliary connector



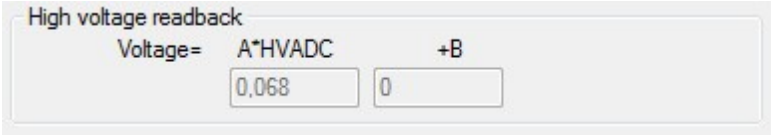
SET TTL - TTL output settings, independent of the rest of the settings



TTL input - TTL input status on the auxiliary connector



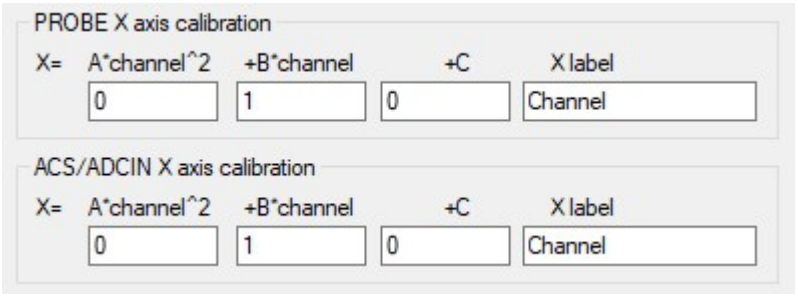
High Voltage Calibration Curve and High Voltage Setting Limit Setting Limit



Setting the High Voltage Reverse Reading Curve



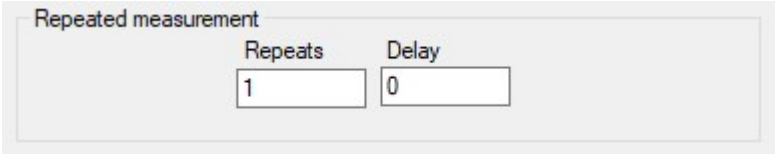
unlocking/locking the high voltage calibration curve setting



setting the X-axis calibration curve and X-axis description, separately for the selected PROBE or ACS/ADCIN input



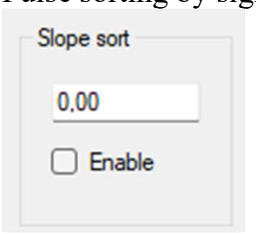
entering ROI The program checks the correct entry of ROI – number of channels. If the number of the initial channel (Channel LO) is higher than the end (Channel HI), the sum of the number of pulses in the ROI is calculated by adding up all pulses outside the specified ROI. By default, the sum of pulses from the initial channel to the end channel is counted.



repeated measurement – enter the number of measurement repetitions and the delay between measurements. The program saves periodically measured data in a CSV file, where the file name is supplemented with the string "-000000" for the measured data and for the data in the delay between measurements "-D-000000".

CAUTION: there may be losses in counting between individual files (data does not follow each other without spaces)

Pulse sorting by signal descending edge time



The analyzer allows you to sort the incoming pulses according to the time of the descending edge of the signal, by entering a boundary directive between the two categories. If the

function is activated (slope sort is not 0.00 and at the same time enable is checked), the spectrum is divided into two parts of 2048 channels each, and pulses with a faster edge are in channels 0-2047 and pulses with a slower edge are in channels 2048-4095.



GET TTL - retrieve the TTL state of the input, independent of the rest of the settings



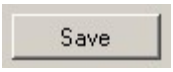
GET setup - reading parameters from the device



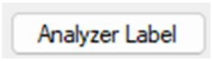
SET - setting of device parameters



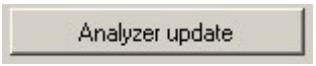
Open - loading the parameters of the device from the file, to set the device you need to press SET



Save - save the parameters of the device to a file



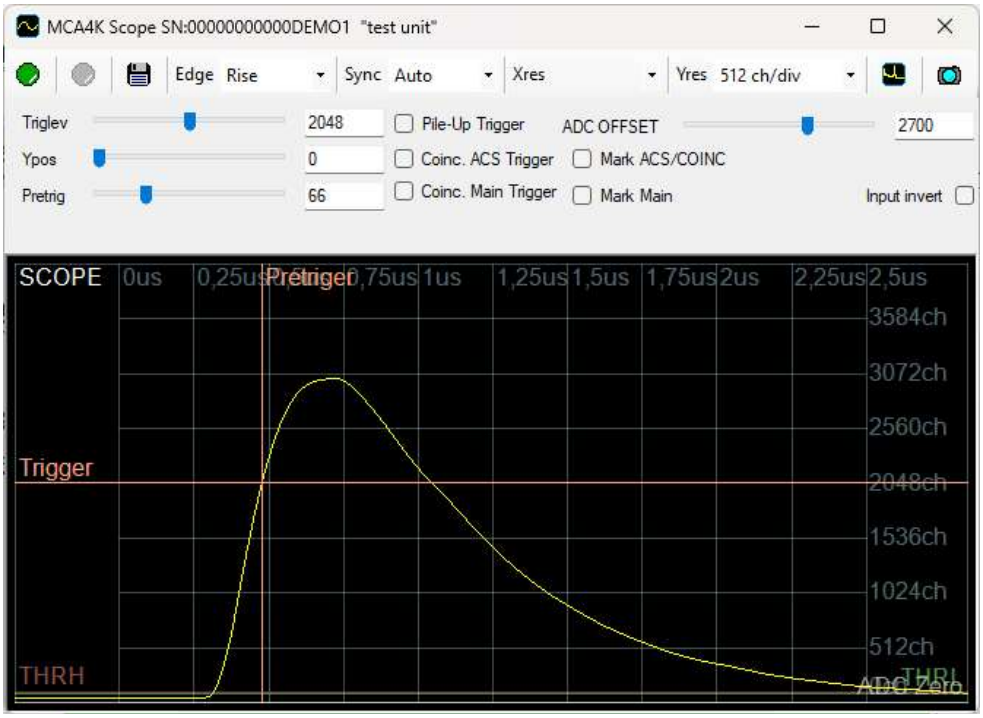
Analyzer label – enter the user name of the analyzer, suitable when using multiple analyzers with one computer



Analyzer update – perform an analyzer firmware update

4.3 Scope – digital oscilloscope

Built-in digital oscilloscope allows you to check signals from an external source or from a scintillation probe preamplifier



 Start - starts periodic reading of the oscilloscope memory

 Stop - terminates the periodic reading of the oscilloscope memory

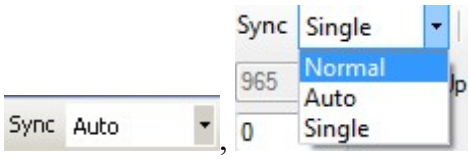
 Save - save pulse waveform data in CSV format

 Screenshot - transfers the current contents of the window to the clipboard windows as an image

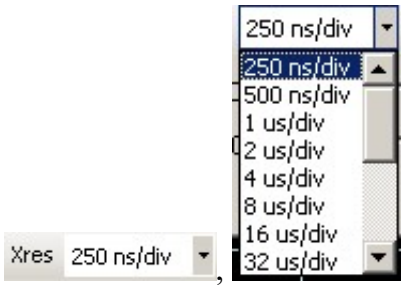


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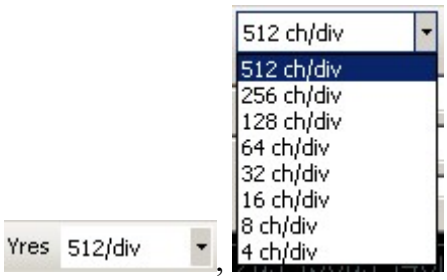

Edge - determination of the trigger edge



Sync - Sync type Auto – automatic, oscilloscope starts all the time, Normal – waiting for the triglev condition to be met and Edge is waiting for the triglev condition to be met, and Edge (one-time start)



Xres - resolution of the time base to 1 division of 250 ns, 500 ns, 1us, 2 us, 4 us, 8 us, 16 us, 32 us, 64 us, 128 us, 256 us, 512 us, 1024 us, 2048 us, 4096 us and 9192 us. Caution the change in resolution is made by changing the sample rate, aliasing (non-compliance with the sampling theorem) may occur



Yres - resolution on the Y axis. For a detailed study of the waveform, it is possible to change the resolution on the Y axis, this option works with the offset option. The baseline of the Y-axis is given by the offset option and the resolution by the Yres option.



ADC Offset - setting the offset value on the ADC input of the analyzer converter range 0 to 4095, as well as in the setup window



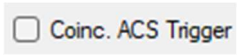
Input invert – invert the input data, in the case of using external input and negative pulse analysis, as in the setup window



Triglev - oscilloscope trigger level, range 0 to 4095.



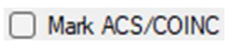
Triggering the oscilloscope by a signal of accumulating pulses.



Triggering the oscilloscope by a coincidence input signal.



Triggering the oscilloscope by the main input signal.



marking on the oscilloscope course of the active coincidence input.



marking on the oscilloscope of the active main input.

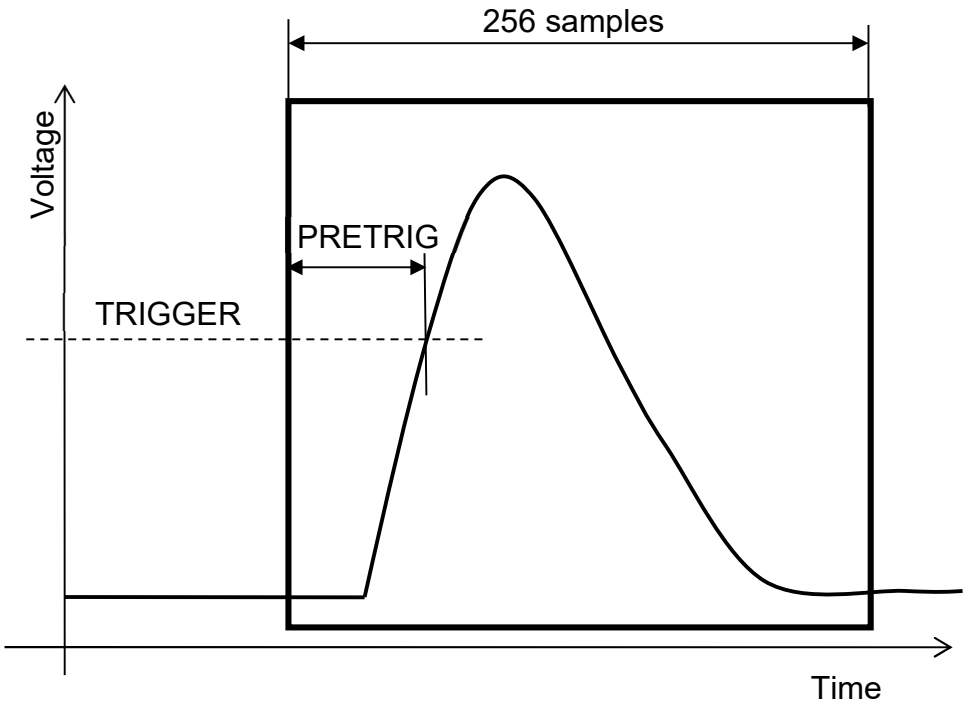


Ypos - For a detailed study of the waveform, it is possible to change the Baseline of the Y-axis.



Pretrig - Pretrigger determines how many samples y a total of 256 will be recorded before the Triglev and Edge condition

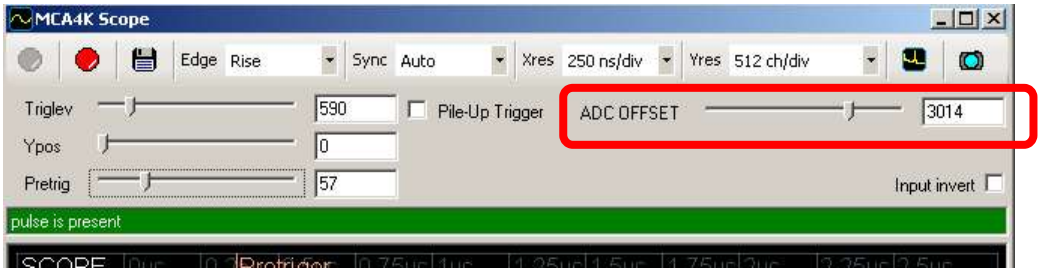
The relationship between Triglev and Pretrig is illustrated in the following figure



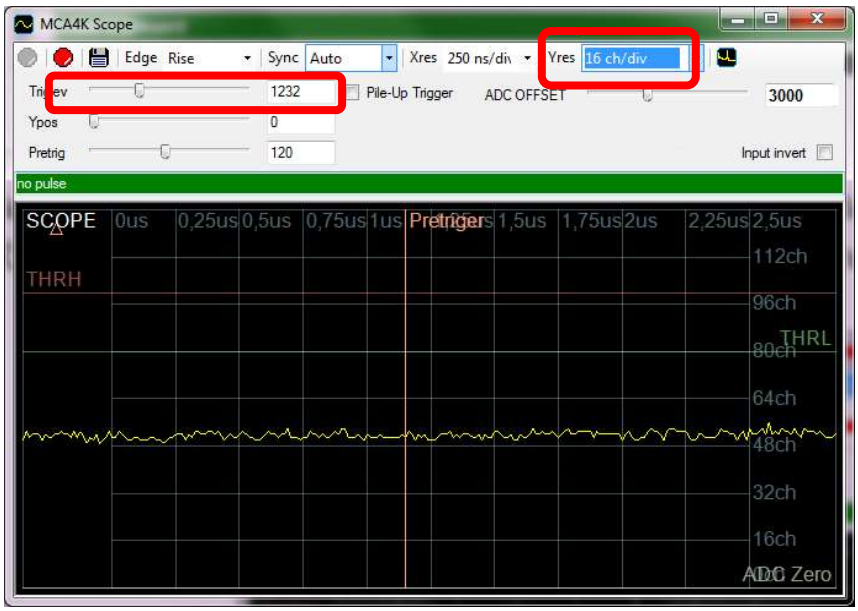
4.4 Signal Adjustment Using an Oscilloscope

- The analyzer processes positive pulses from the ADC IN or PROBE inputs.

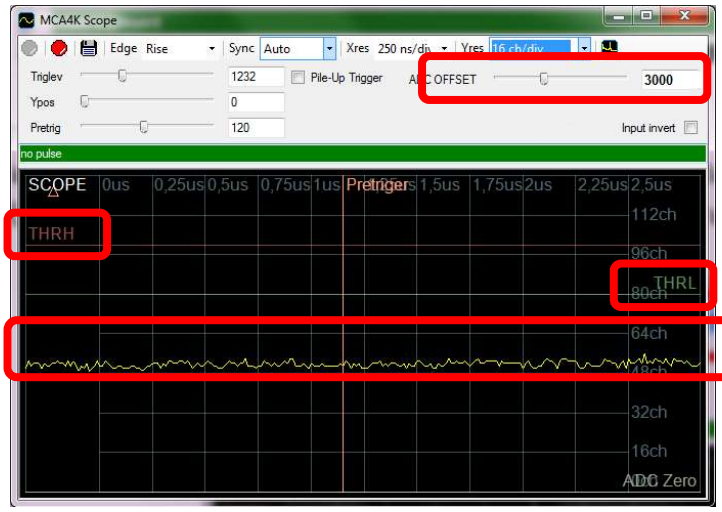
- When setting the signal, you must first set the DC signal offset value. Use the default ADC OFFSET value of 1000 to set the input from the ADC IN, and the default ADC OFFSET value of 3000 for the PROBE input.



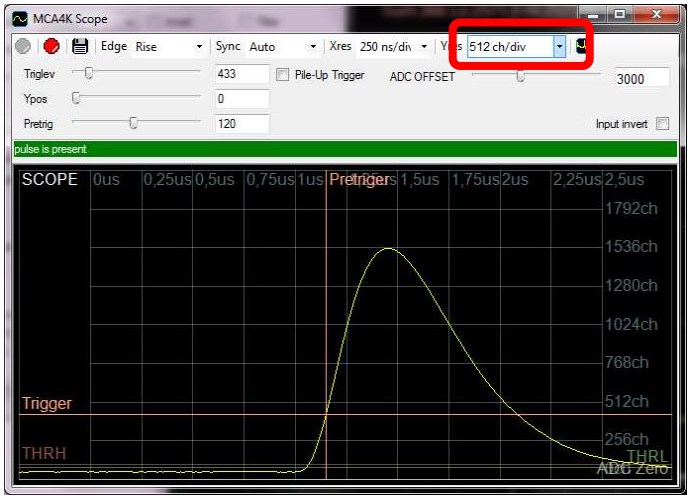
- Next, set the oscilloscope display using Y axis resulution and Y pos so that both THRH and THRL limits are visible. If you are using the default settings THRH=100 and THRL=80, set Ypos=0 and Yaxis resolution to 16/div



- By changing the ADC OFFSET and possibly changing the THRH and THRL levels, achieve a state where the baseline of the signal is below the THRH and THRL levels and at the same time there is no saturation to the zero signal level.



- Switch Y axis resolution to 512/div, bring pulses to the selected input

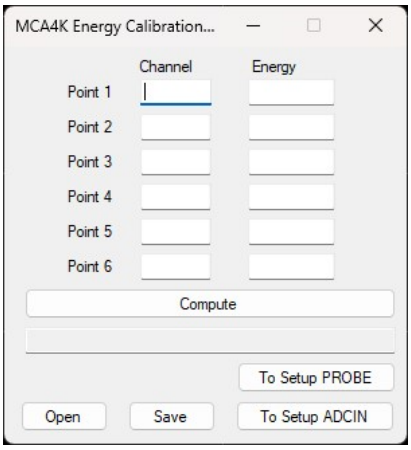


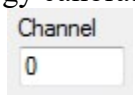
- If the ADC IN input is used, adjust the pulse sizes by changing the signal gain at the output of the connected apparatus.

- You can adjust the pulse size on the PROBE input by changing the high voltage size or changing the GAIN parameter in the setup.

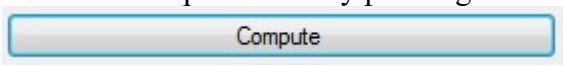
4.5 Energy Calibration

The energy calibration window is called up from  the Measurement menu, Energy calibration

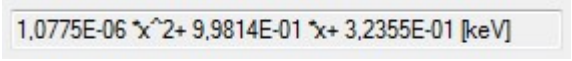


The program allows you to calculate the energy calibration using the least squares method at up to six points of the spectrum. To enter individual calibration points, it is necessary to enter the channels of the spectrum and the corresponding energy. Channels can also be entered from the spectrum measurement, with the energy calibration window open at the same time, if the input cursor is in one of the Channel fields 

In the spectrum measurement window, if only one channel is selected (not in the block), press Alt + Enter.

Calibration is performed by pressing the Compute button


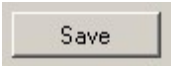
.

The calculated energy calibration equation appears in the row, under the Compute button


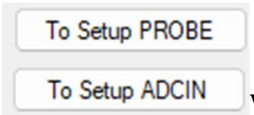
.



Open - load energy calibration points from the file.



Save - save energy calibration points to a file.

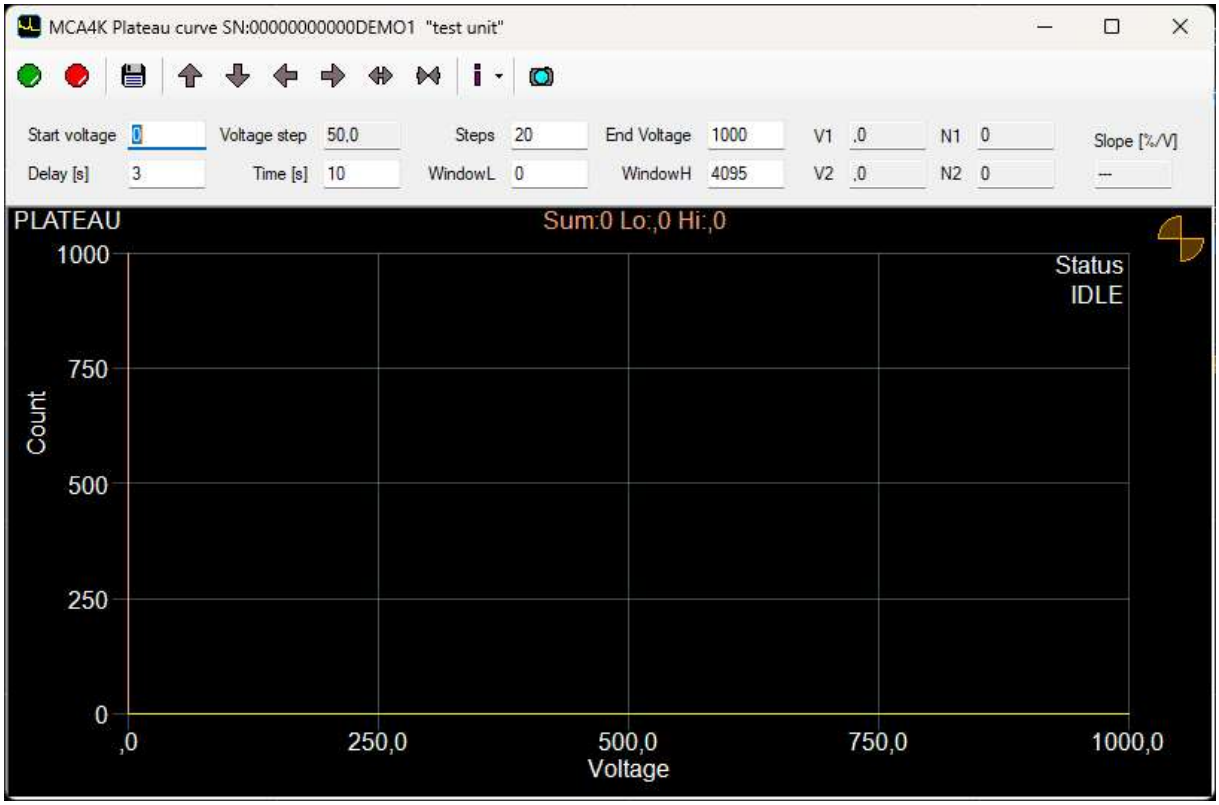


Writing the values of the energy calibration equation into the setup of the instrument, changing the values on the X axis of the spectrum for the respective axis.

If one or two calibration points are specified, the calculation of the equation of the line is used. At three or more points, the calibration curve is determined as a second-degree polynomial or by the method of least squares.

4.6 Detector/probe plate measurement

The plateau measurement window is called up from  the Measurement menu, item Plateau curve

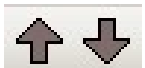


The meaning of the icons on the toolbar is similar to that of spectrum measurement

 Start of plate measurement

 Stop Plate Measurement

 Save - save pulse waveform data in CSV, TKA and CHN format

 Yaxis resulution - change the resolution on the Y axis

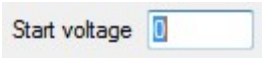
 Cursor left/ Cursor right - move the cursor or select left/right

 Zoom – stretch the selected part of the progress

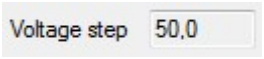
 Full scale - full scale display

 Visible information – in the menu, you can select what information will be displayed with the plate measurement, in the upper right corner.

 Screenshot - transfers the current contents of the window to the clipboard windows as an image



Start voltage – initial voltage of the plate measurement



Votage step – calculated size of the step of the stress at plata



Steps – number of stress steps when measuring a plate



End voltage - end voltage of plate measurement



Delay – delay after setting the high voltage, before the start of the measurement



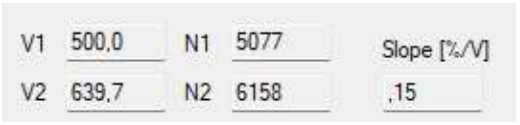
Time – length of measurement at constant voltage



Window low – the initial channel of the measurement window for counting pulses



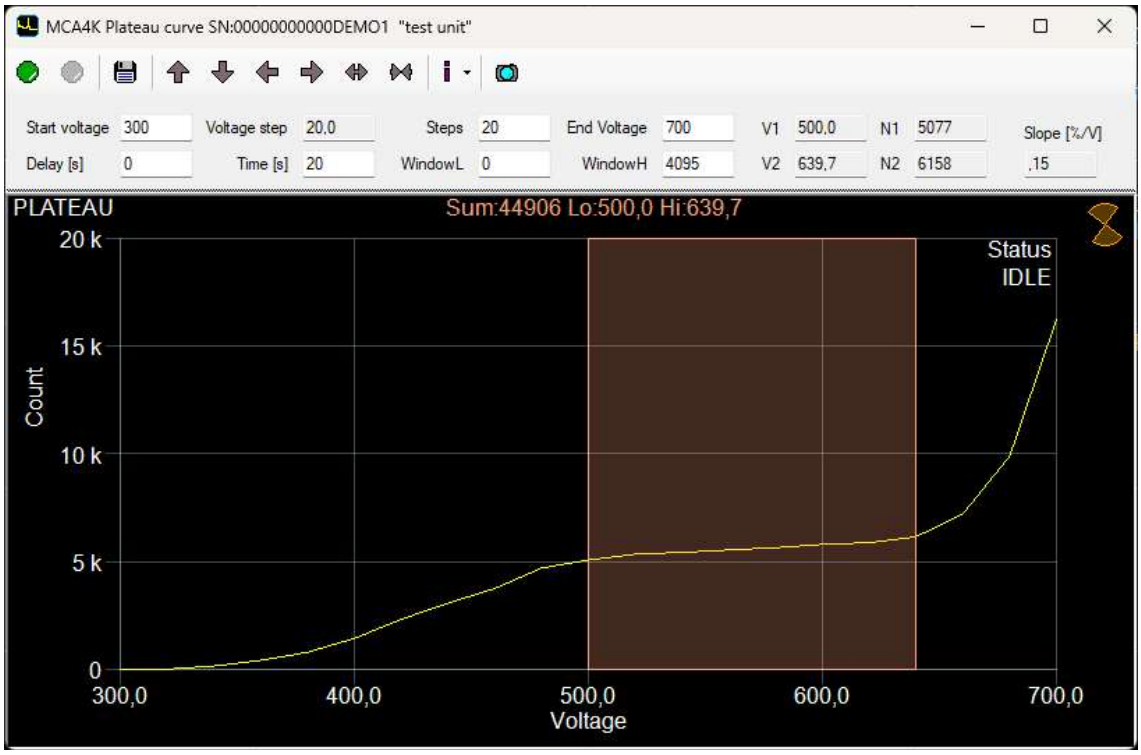
Window high – the end channel of the measuring window for counting pulses



Displaying the Cursor Position and Calculating the Curve Pitch Between Cursors

 Indicator of ongoing communication with the analyzer, if communication is in progress, it rotates

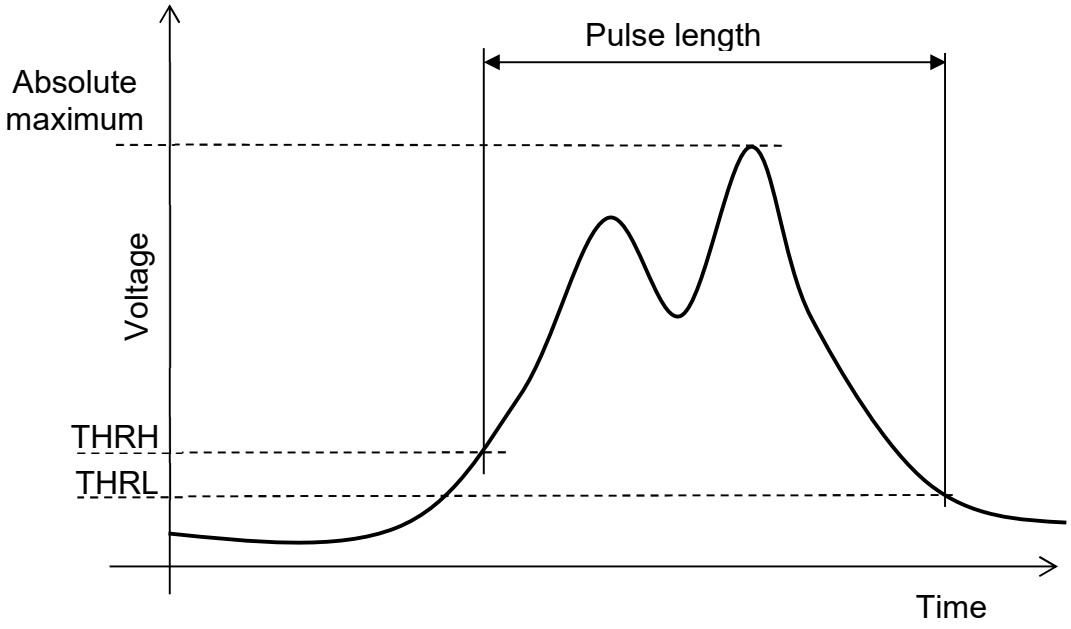
The resulting measured dependence can look like this (Sonda NS9502E and 137Cs):



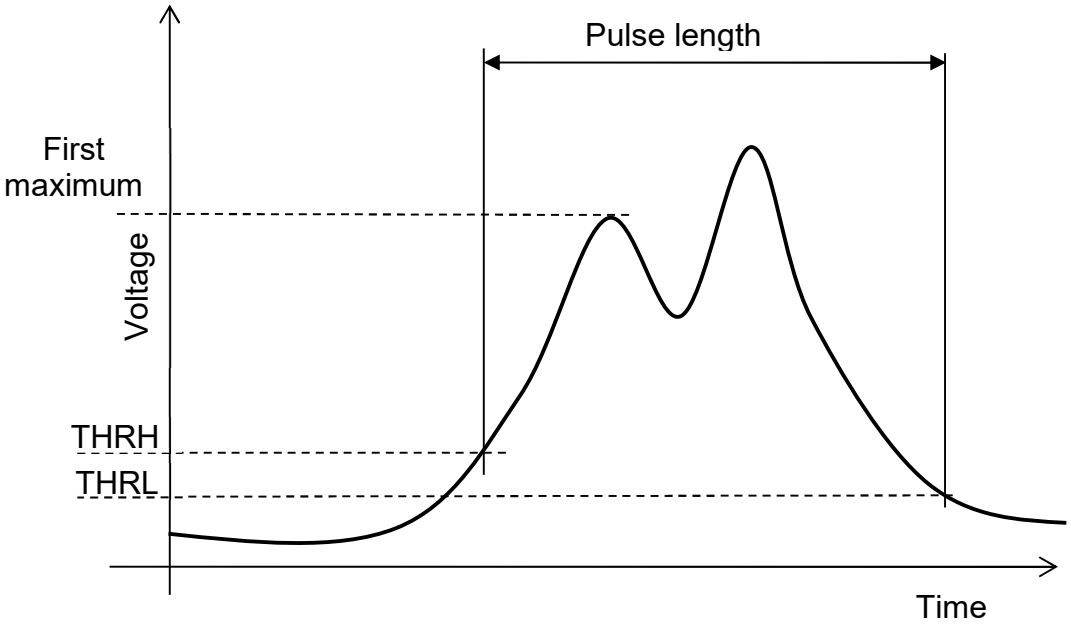
4.7 Additional Pulse Analyzer Settings

The analyzer allows you to set how pile-up will be processed

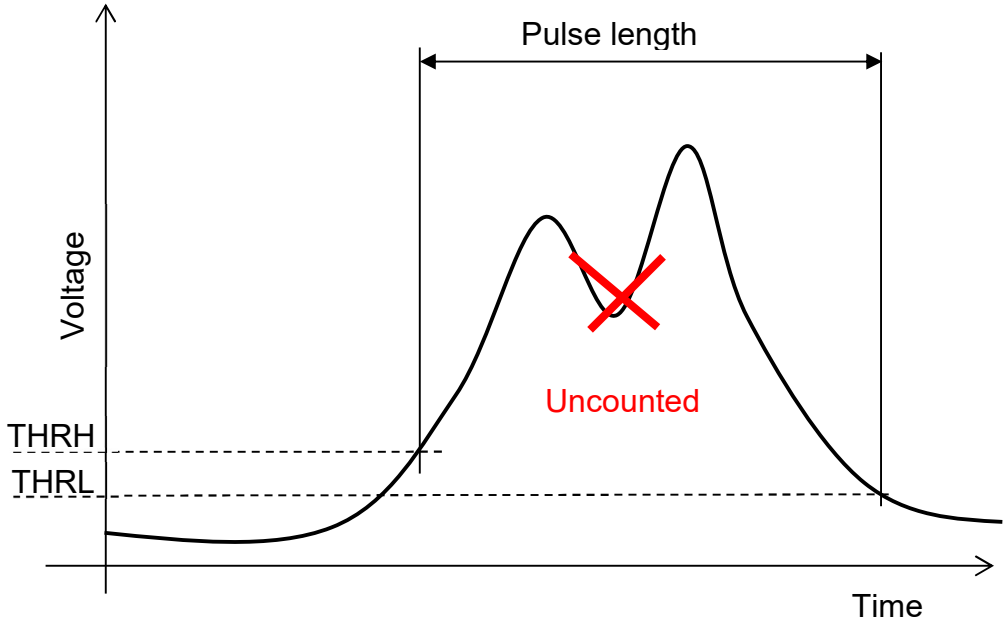
By default, the analyzer handles the absolute maximum pulse, which is bounded by the THRH and THRL levels.

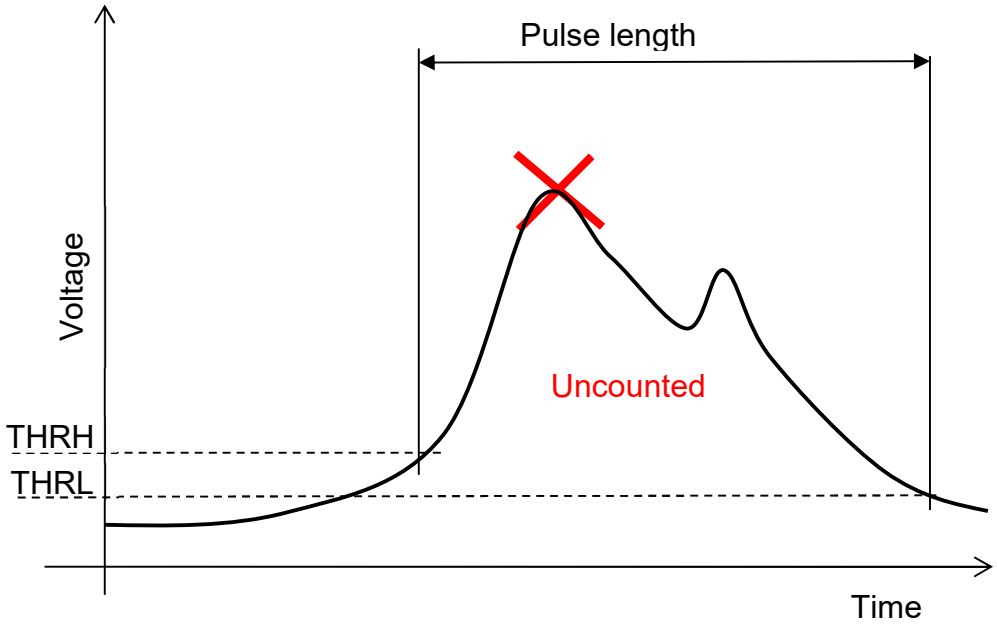


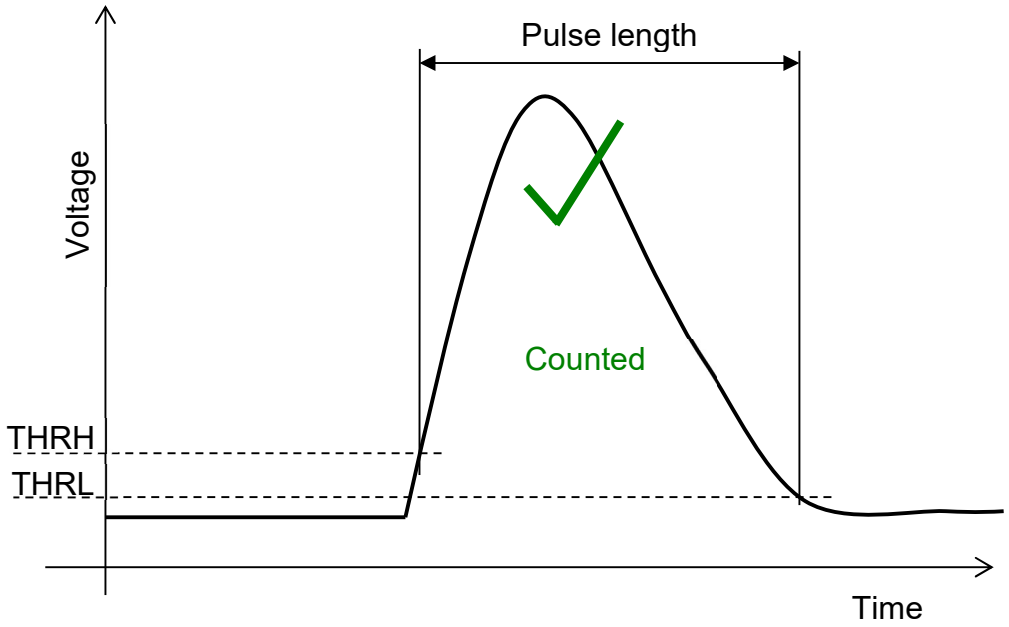
By checking the "First MAX" checkbox, the analyzer handles the first maximum pulse, which is bounded by the THRH and THRL levels.



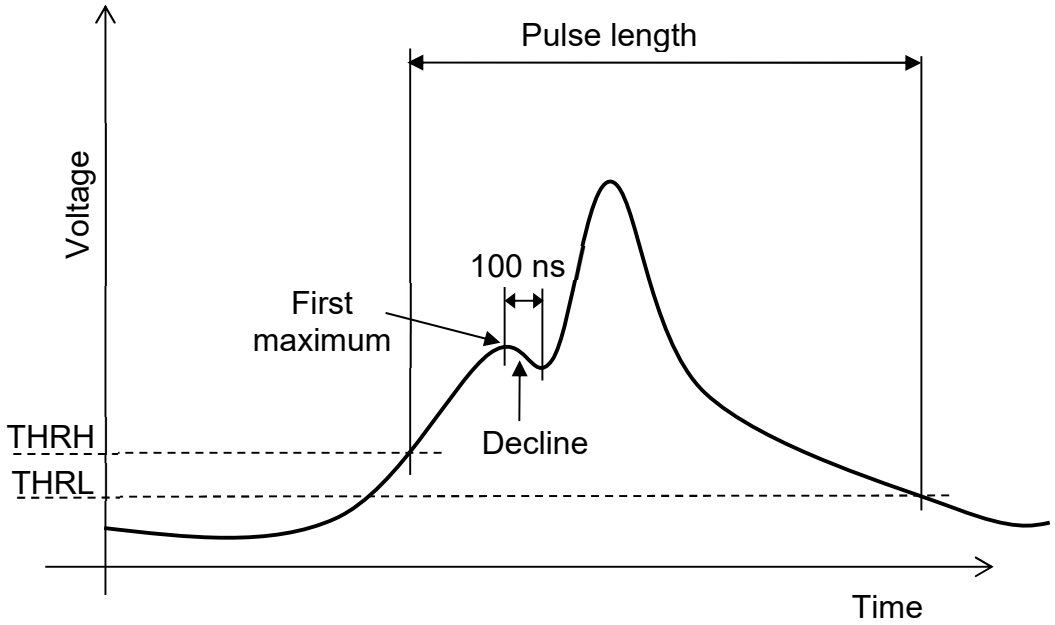
By checking the "PUR" (Pile-Up Reject) box, the analyzer will not process (count) pulses that have a local minimum. The analyzed pulse is bounded by THRH and THRL levels.







The evaluation of the local maximum and the decision on the PUR is made according to the following figure



If the signal, after reaching its maximum, begins to decline and decreases for at least 100 ns, this condition is evaluated as the first maximum.

If the signal then begins to rise, it is an accumulation of impulses. Either the pulse is not counted and the number of accumulated pulses is incremented, or the absolute maximum is evaluated and the number of accumulated pulses is incremented.

In environments with strong interference, or when it is necessary to improve the signal-to-noise ratio, the analyzer is equipped with an optional filter at the input, performing a moving average with 8 consecutive signal values.

4.8 Sorting by descending edge of the signal

for each pulse, the length of the descending edge from the maximum to the THRL value is calculated, which can be 0 to 4095 samples, in multiples of 12.5 ns.

In the slope field, the directive is entered in the format

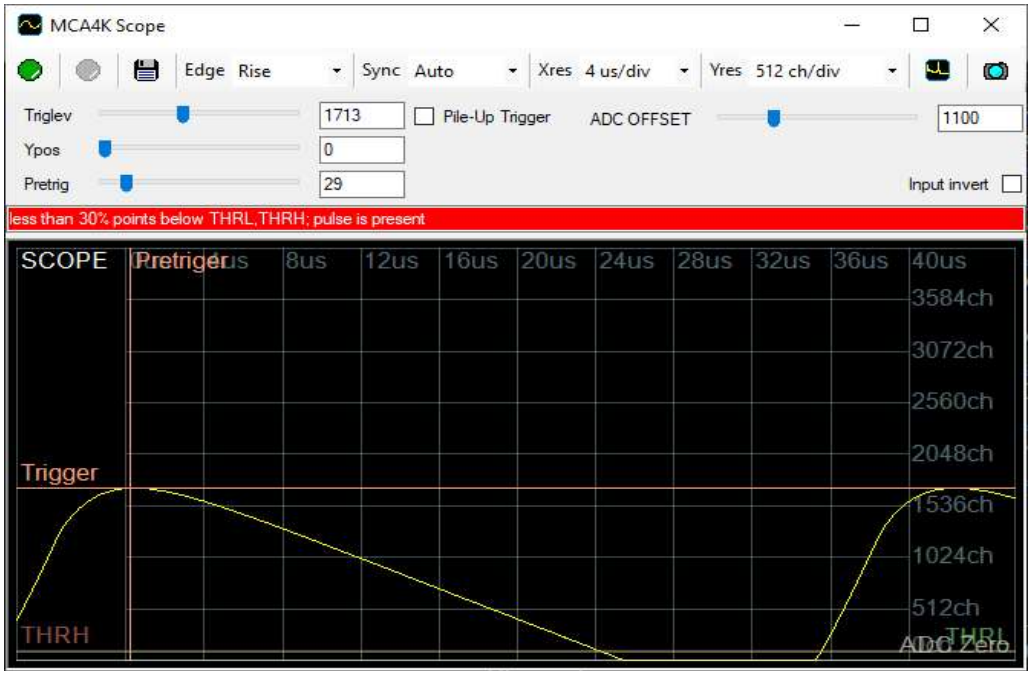
$$\frac{y(MAX)-y(THRL)}{MAX-THRL}$$

- If the measured guideline is steeper, the resulting pulse will be counted in channel 0 to 2047.
- If, on the other hand, the measured guideline is identical or milder, the impulse will be counted in channel 2048 to 4095.
- The resolution of the analyzer in this case is half, i.e. 2X 2048 channels.
- The amplitude of the pulse is also halved.
- The energy (amplitude) range is the same as in the case of the full resolution of the analyzer.

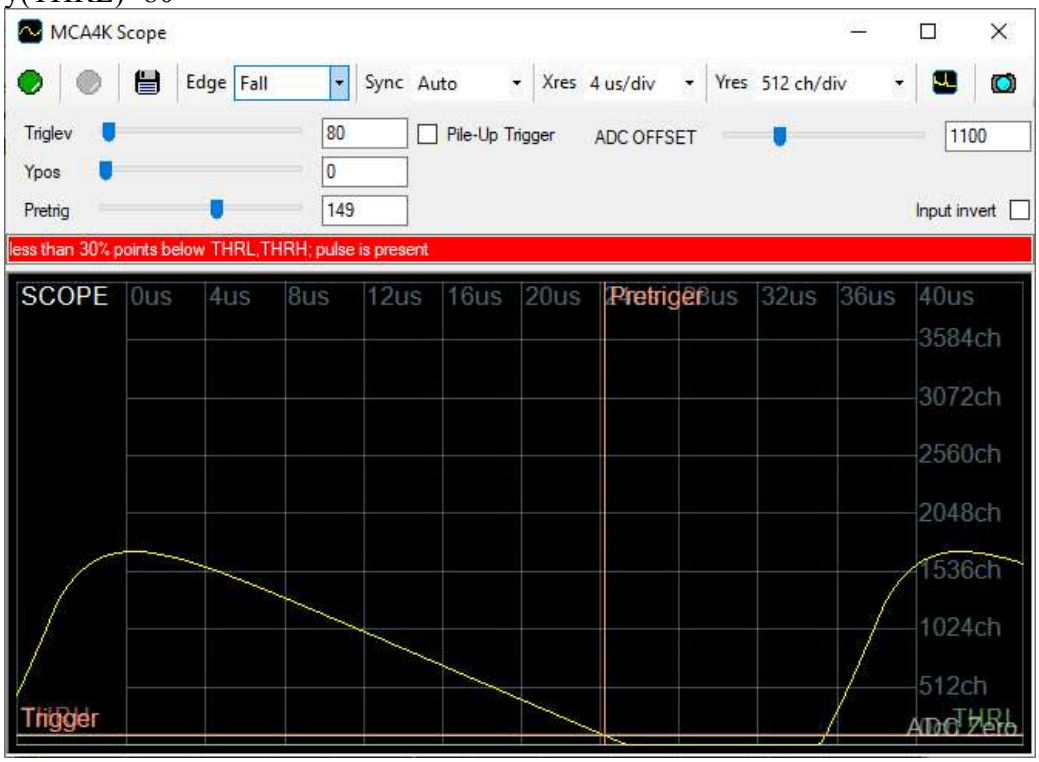
For example:
pulses from the triangle generator amplitude approx. 800mV

Case 1: 20% rise 80% descent

MAX=29*16=464
y(MAX)=1713



THRL=149*16=2384
y(THRL)=80

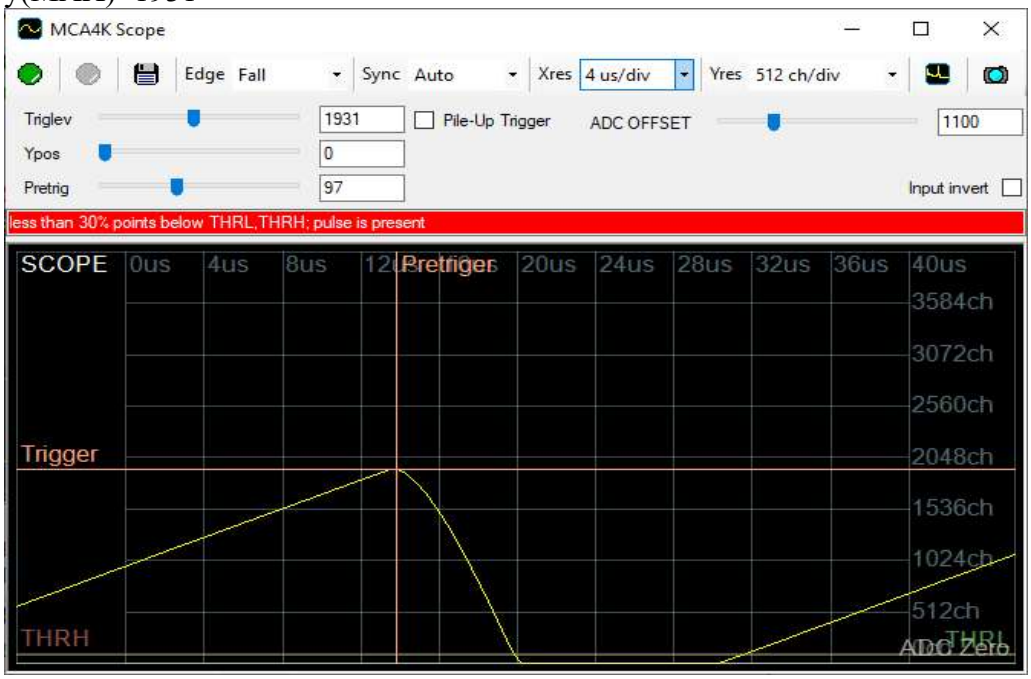


$$\frac{y(MAX)-y(THRL)}{MAX-THRL}=\frac{1713-80}{2384-464}=\frac{1633}{1920}=0{,}85$$

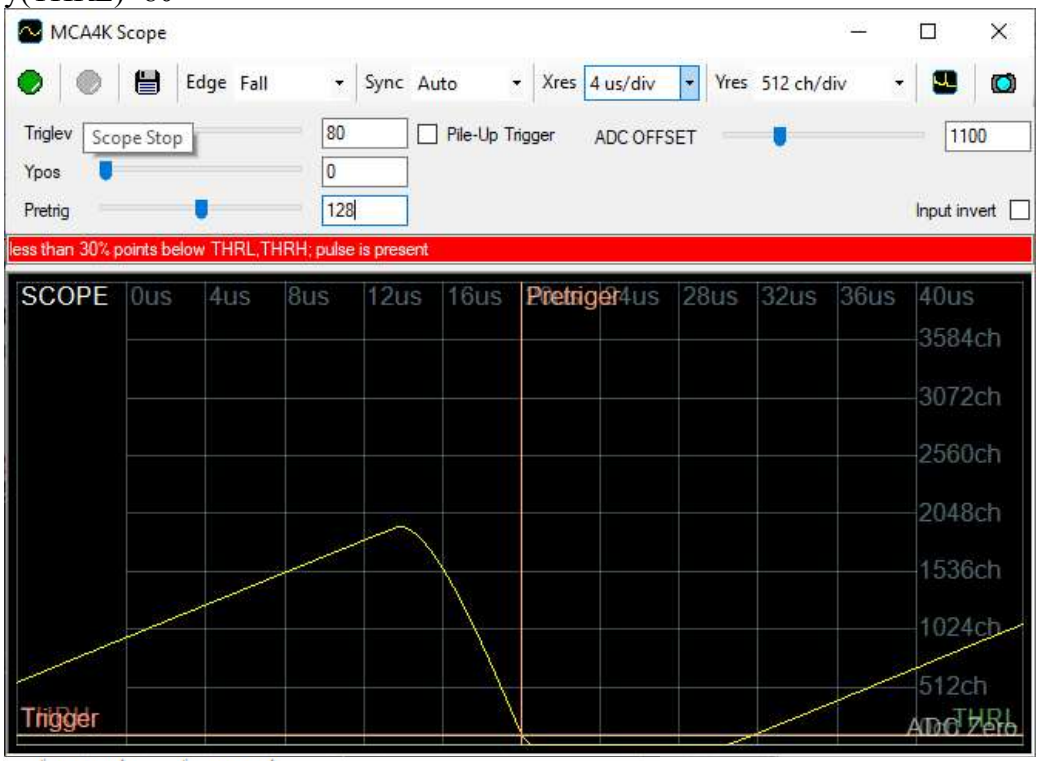
The descending edge directive is therefore 0.85

Case 2: 80% Rise 10% Descent

MAX=97*16=1552
y(MAX)=1931



THRL=128*16=2048
y(THRL)=80

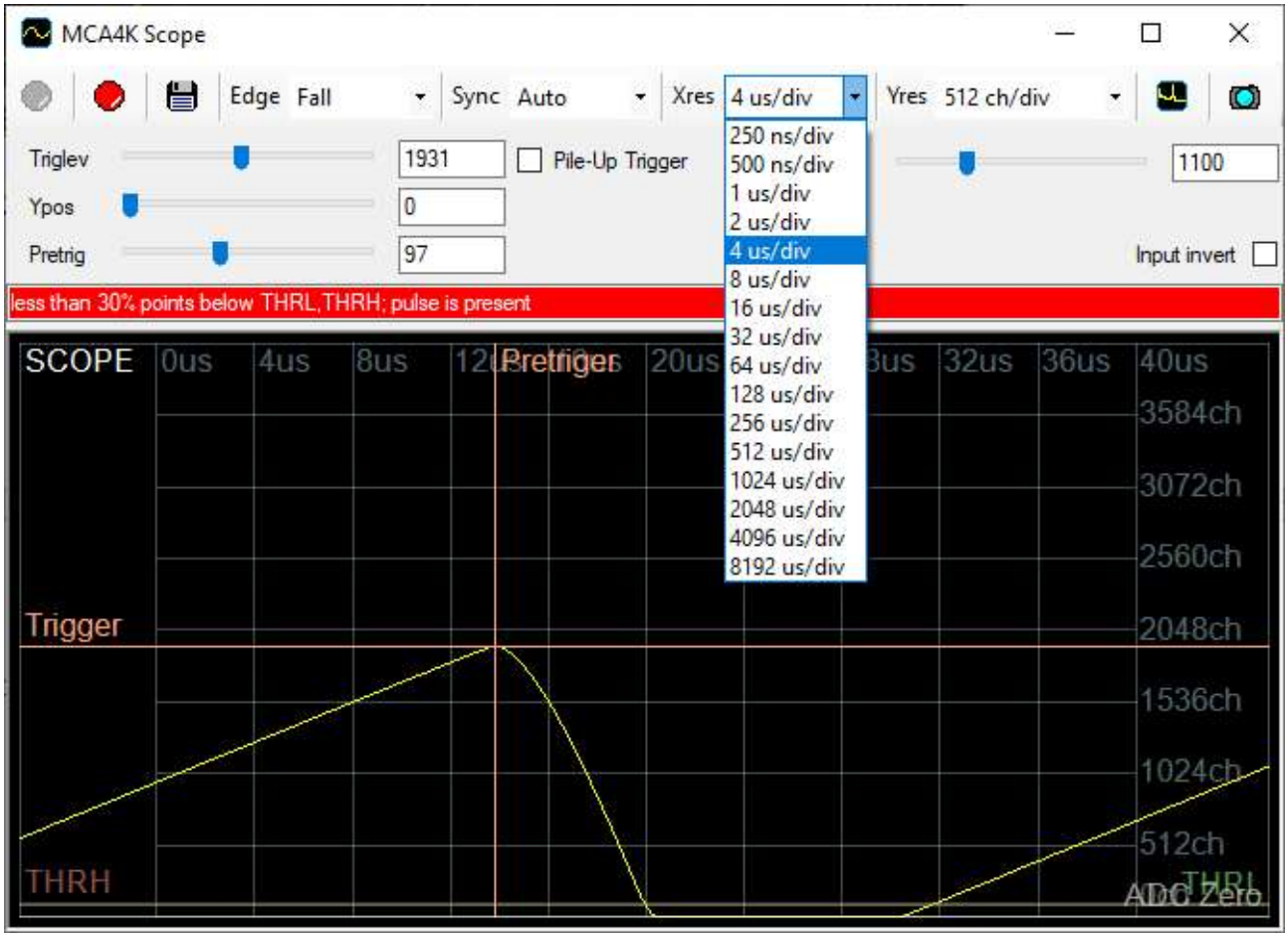


$$\frac{y(MAX)-y(THRL)}{MAX-THRL}=\frac{1931-80}{2048-1552}=\frac{1851}{496}=3{,}73$$

The descending edge directive is therefore 3.73

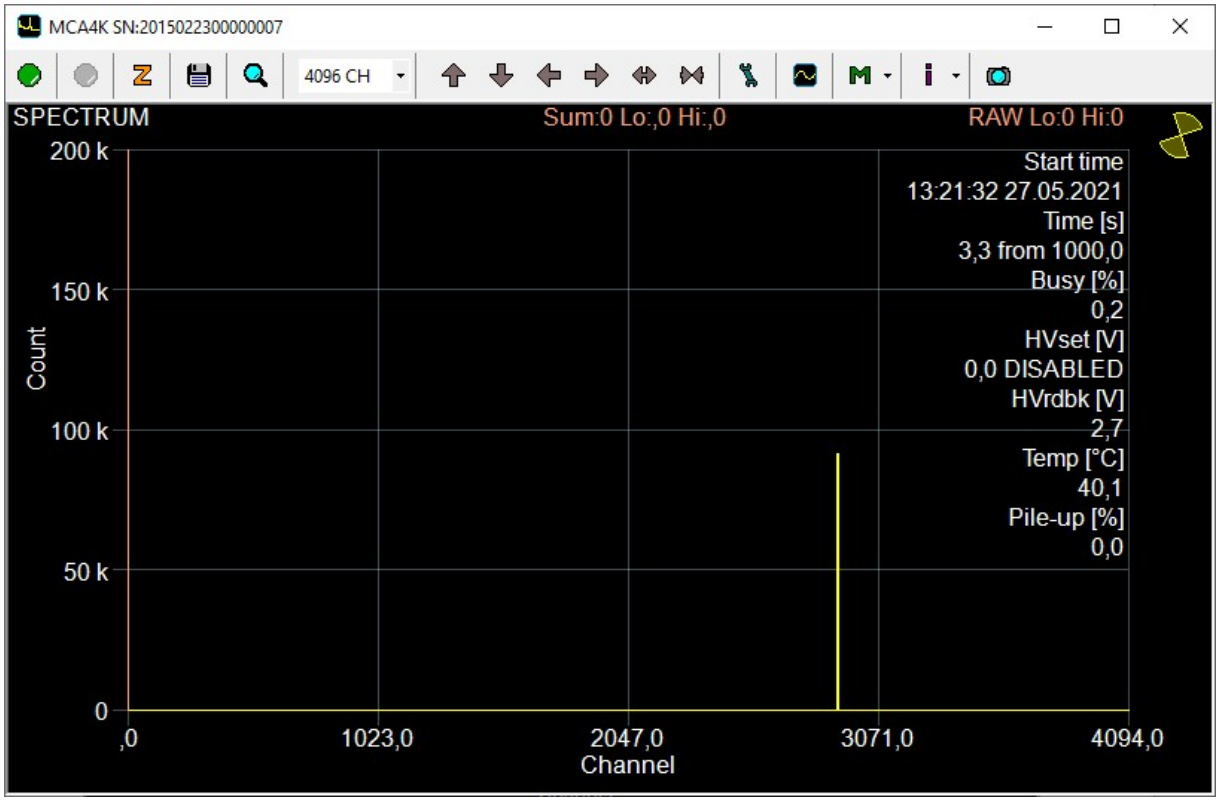
Why is the X-axis multiplied by 16 in the calculation?

In the ocyloscope, Xres is set to 4 us/div, i.e. the time per waveform is 16 times larger compared to the basic resolution of 250 ns/div. One division on the oscilloscope in the X axis is 8*16 divisions of 12.5 ns.



When measuring, if we enter Slope=3, for example, the pulses from case 1 will be in the higher half of the channels and the pulses from case 2 will be in the lower half of the channels:

Case 1



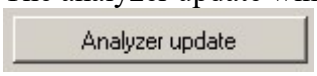
Case 2



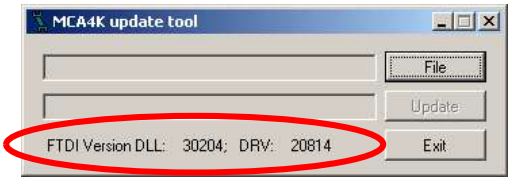
4.9 Update analyzer firmware

1. Before changing the firmware, the following conditions must be met:

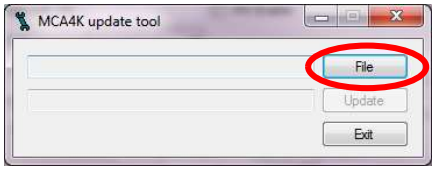
   - Disconnect all cables from the analyzer, except the USB cable
   - Provide uninterruptible power to the analyzer
   - Provide uninterruptible power to your connected PC
   - If possible, do not run any program other than MCA4K on the computer to update the firmware

2. The analyzer update window is called up by pressing the button 

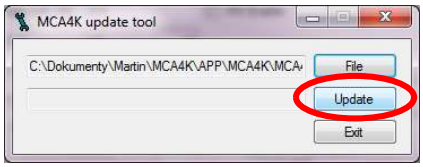
in the setup window.



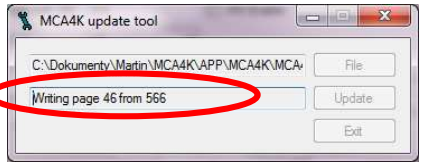
3. The FTDI driver version is displayed in the MCA4K update tool window



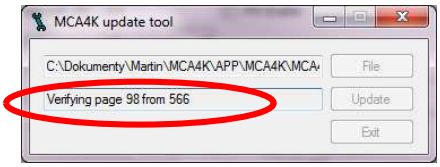
4. Select the alternative firmware of the analyzer by pressing the "File" button



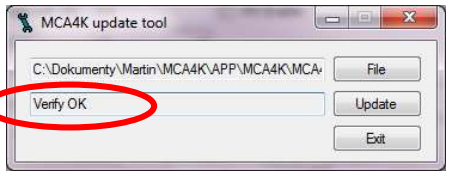
5. The update process starts by pressing the "Update" button, the first part of the process is writing the firmware to the device



6. After writing, the memory content is verified



7. The process is terminated with a "Verify OK" listing

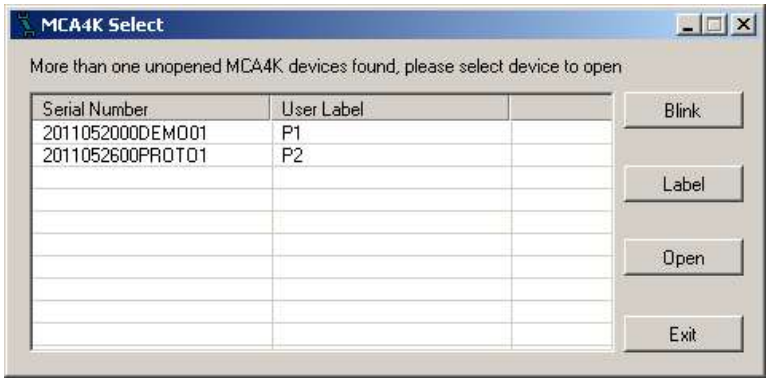


8. The firmware will be active when the analyzer is turned off and on.
9. If the process does not end with a "Verify OK" listing:

- **Do not switch off the appliance**
- Quit the program
- disconnect the USB cable from the computer
- Wait about 20 seconds
- connect the USB cable to your computer
- Run the program
- Repeat the firmware update process from point 1.

4.10 Connect multiple devices to one computer

The control software can control multiple devices connected to one computer. A separate instance of the control program can be run for each connected device. The program detects the presence of multiple MCA4K devices. If the control program for each device is not already running, the device selection dialog box is displayed before starting the program.

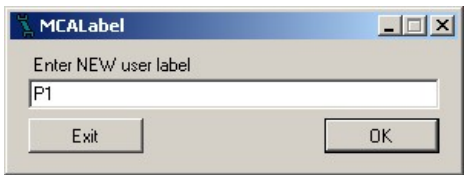




after pressing the button on the device, the yellow LED communication flashes 3 times



For easier identification of the device, a user description is stored in the device, it can be changed by pressing the label button





opening communication with the device and starting the program



End of the program

4.11 Command-line parameters

The program can be run with parameters.

The first parameter is the name of the program settings file. After starting the program with the parameter, everything in the device is automatically set, just like when you press the buttons in Setup Open and SET.

```
mca4k.exe setup.csv
```

When the parameters are loaded from the file via the command line, the high voltage is automatically blocked. This blocking can be canceled and the high voltage can be unblocked by the second parameter of the program, which must be "1" (one)

```
mca4k.exe setup.csv 1
```

When entering the file name as a parameter, the program is in the mode of use during mass measurement, when minimal interaction of the operator with the program is assumed. Therefore, in this case, it is not possible to change the measurement parameters during the program runtime. At the same time, the program informs in the title bar of the main window and setup about the name of the file with measurement parameters.

To change the parameters during the program runtime, the third parameter can be used. If the third parameter is set to "1" (one), it is possible to change the measurement parameters during the program runtime.

```
mca4k.exe setup.csv 1 1
```

4.12 Keyboard shortcuts

Ctrl + C	Spectrum Window, Spectrum View, Oscilloscope, and Plateau: Transfers the current contents of the window to the clipboard windows as an image
Alt + Enter	Energy Calibration window: In the spectrum measurement window, if only one channel is marked (not in the block) you press Alt + Enter, the current channel number will be inserted into the energy calibration.

5 Version

Version	Description	Date
1	First Edition of the Document	6.6.2011
2	Addition of Oscilloscope mode	12.7.2011
3	Keyboard shortcuts addition	9.9.2011
4	Addition of energy calibration calculation	2.12012
5	Addition of ROI calculation and firmware update of the analyzer	17.1.2012
6	Added the ability to use multiple analyzers with the program	14.2.2012
7	Formal Document Modifications	17.2.2012
8	Changes to setup and keyboard shortcuts	6.6.2015
9	Addition of remeasurement and ROI to setup, removal of BLR function	30.3.2023
10	Addition of TF filter description, coincidence and ACS module	29.7.2024
11	Addition of the calculation of the plate directive in the measurement of the probe plate and the function of sorting according to the descending edge of the pulse, addition of the possibility of parameterization from the command line	4.6.2025
12	Addition of the possibility of parameterization from the command line	28.9.2025
13	Modification of energy calibration transfer to setup and description of command-line parameters	22.10.2025
14	Formal Document Modifications	29.10.2026