Guide to Picoscope 7
and pacemaker measurement

Created by: Barnabás Bőcskei-Antal

Budapest, 2026

1. INTRODUCTION

This note was written with the aim of providing both students and instructors with a clear and structured guide to the structure and operation of the digital oscilloscope software (PicoScope 7) and device (PicoScope 2204A) used in biophysics laboratory courses. Digital storage oscilloscopes (DSO) have become indispensable tools in modern electronics laboratories and are widely used in both physics and biophysics laboratory practice. Their primary function is the visualization, recording, and evaluation of time-varying electrical signals, thereby enabling a detailed analysis of the dynamic behavior of the investigated systems.

An oscilloscope is a measuring instrument that graphically displays the time dependence of electrical signals. During display, the horizontal axis of the screen represents time, while the vertical axis represents the measured electrical quantity, most commonly voltage. The resulting waveform provides direct information about the temporal evolution, shape, repetition, and possible transient behavior of the signal, allowing not only the instantaneous value but also the complete time-dependent behavior of the signal to be examined. Oscilloscope-based measurements are therefore particularly important when investigating fast or impulse-like processes.

When using a digital storage oscilloscope, the measured analog (time-continuous) signal is recorded by means of digital sampling. The sampling frequency determines how often the signal is recorded along the time axis. If sampling is not performed at a sufficiently high frequency, rapidly changing signal components, especially short-duration pulses, may become distorted (aliasing) or may remain completely undetected during display. At the same time, digital recording allows measured data to be stored in memory and analyzed and evaluated at a later time.

During oscilloscope operation, the digitized samples are stored in the internal memory of the device and displayed according to user-defined parameters. The time base setting determines the time interval shown along the x-axis, while the vertical sensitivity setting defines the voltage range visible on the y-axis. These parameters directly influence which details of the measured signal are visible and with what resolution they appear on the display.

Stable and well-interpretable signal visualization requires appropriate trigger settings. The trigger condition determines when signal acquisition starts, ensuring that the same portion of the signal is displayed consistently across repeated measurements. By selecting suitable trigger conditions, the oscilloscope can be configured to display exactly the signal phenomenon of interest for the given measurement task.

Many digital oscilloscopes—including the device used in this course—are also equipped with a signal generator (function generator) output. This enables the generation of electrical signals with defined shapes and parameters that can be directly applied to the input of the investigated circuit or system. Using the signal generator, the oscilloscope can serve not only as a measurement device, but also as a source for system excitation, allowing analysis of how variations in the input signal appear at the system output. This functionality is particularly useful when studying amplifiers, resonance phenomena, and impulse-like processes.

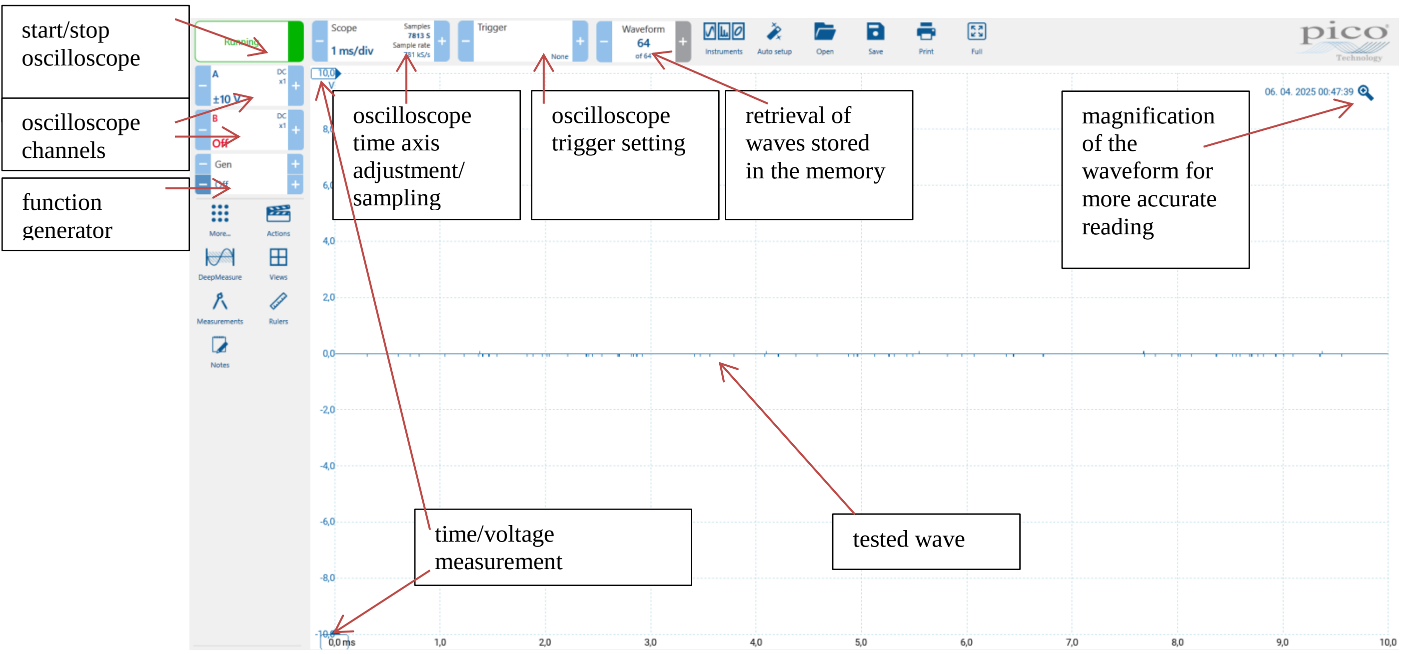
Digital storage oscilloscopes provide a variety of built-in measurement functions that automatically calculate quantities such as amplitude, period, frequency, or pulse width based on the displayed waveform. These measurements are directly related to the physical quantities represented on the horizontal and vertical axes and significantly facilitate quantitative signal analysis.

In biophysics laboratory courses, oscilloscope-based measurements appear in several topics, including measurements on amplifiers, investigation of resonance phenomena, analysis of signals observed in sensor operation, ultrasonic measurements, and the study of impulse-like processes. In these cases, the oscilloscope serves as a fundamental tool for the visualization and interpretation of time-dependent electrical signals.

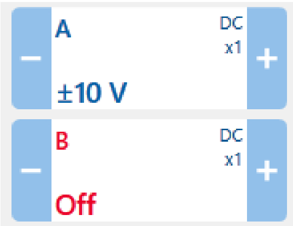
In the present note, oscilloscope-based signal evaluation is demonstrated using impulse-like signals, specifically pacemaker waveforms. These signals clearly illustrate the role of time and amplitude settings, as well as methods for determining pulse durations and voltage levels. The presented measurement and evaluation procedures are not limited to pacemaker signals but can be directly applied to other oscilloscope-based measurements of a similar nature. The aim of this note is to provide a practice-oriented overview of the structure and use of digital storage oscilloscopes and to support the understanding of fundamental settings and evaluation procedures applied during oscilloscope-based measurements.

2. THE STRUCTURE OF PICOSCOPE 7

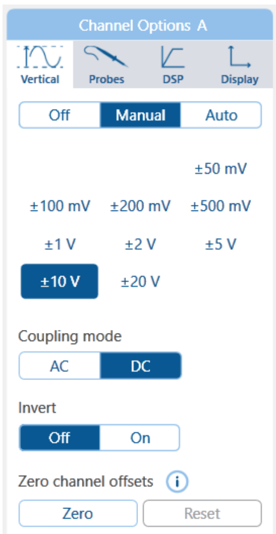
The figure below shows the Picoscope 7 program window and the main parts of the program.



Our Picoscope 2204A digital storage oscilloscope has two input channels (A/B) and a function generator output (Gen).



The channel status and the "y" step can be read in the channels status window. The "+" or "-" signals are used to adjust the "y" step in small steps.

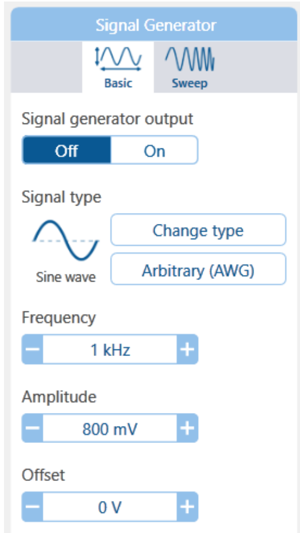


For further settings, click on the channel name (A/B) and the channel options window will appear. The settings that are important for us are those for the vertical scale. In manual mode, we can adjust the scale. In Auto mode, the program itself tries to select the optimal scale. During this mode, you can select the scale on the "y" axis. The tool we are using has 8 bit "y" resolution by default.

The "DC" setting for the coupling mode is well suited for all measurements performed in Medical Biophysics exercises.

If you have the devices connected in reverse, with opposite polarity, you can mirror the signal to the "x" axis by turning on the reverse, so you don't have to worry about polarity.

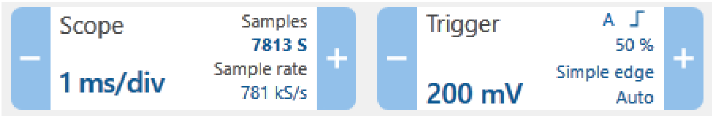
In the generator status window, you can see the status of the generator, the type of signal being generated, its amplitude and frequency.



In the generator status window you can turn on the signal generator output, select the signal type, frequency, amplitude and offset.

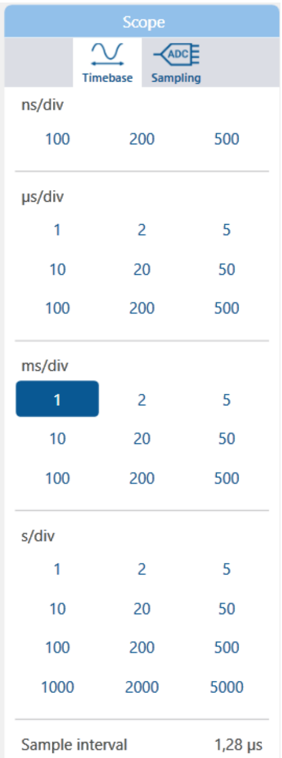
The device we are using can output up to 2V DC when a DC voltage is selected and 2V amplitude with a sinusoidal signal. The maximum selectable frequency is 100 kHz.

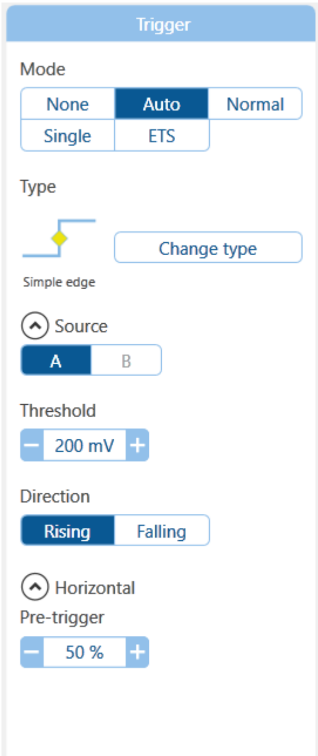
Attention!! The offset reduces the magnitude of the signal that can be output, so be careful when making the settings.



The scope and trigger status windows provide quick information about the "x" step and the trigger signal setting.

Click on these to access the detailed settings.



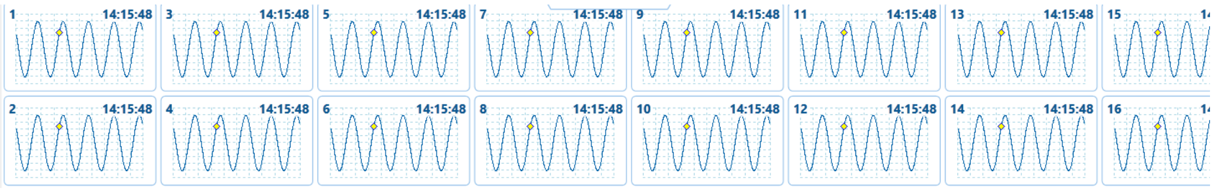


The "x" step can be set between 100 ns/div and 5000 s/div. If needed, we can change the sampling frequency under the "Sampling" tab, but we cannot adjust the length of the data acquisition, it is always factory set to the given "x" step.

When setting the trigger signals, three modes are most commonly used. The off mode (None) is used when we want to monitor a continuous change in the signals, typically for slow signals. For Normal mode, the trigger type set (in most of our measurements, the single edge gives satisfactory results) is controlled at selected thresholds on the rising or falling edge for each signal that meets the trigger conditions. The sampling of all detected signals is recorded. In Single mode, the first signal that satisfies the trigger conditions starts the capture, and then the capture stops after the given sampling time. The trigger can also be set in the program window using a yellow diamond symbol. Moving it up and down adjusts the level of the trigger, moving it right and left adjusts the pre-control, positioning the capture signal along the "x" axis.

The recorded signals can be retrieved for evaluation by clicking on the "Waveform" button. The number of recorded samples is shown in the middle of the button. From the displayed row, you can retrieve any recording by clicking on the signal shape.

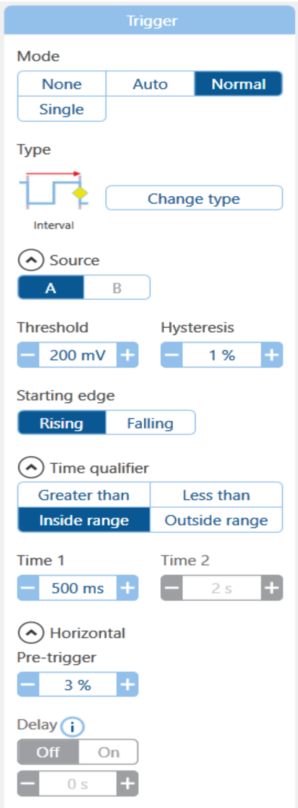
If you click on the "Waveform" button while a signal is running, the sampling is automatically stopped. All signals recorded up to the moment of stopping can be recalled for evaluation.



Recorded signals can be evaluated using a ruler and magnifying tool. These will be explained in the next chapter using a concrete practical example.

3. MEASURING PACEMAKER SIGNALS IN PICOSCOPE 7

Below is one possible method for examining pacemaker signals in Picoscope 7. The first step is to connect the device to be tested (in this case the pacemaker) to one of the inputs of the oscilloscope. Since the pacemaker is considered to be an astable multivibrator with a very small (<1%) fill factor, although the signals are regular, they are difficult to test because of their short (<1ms) length. To alleviate this problem, a special setup file (pacemaker_preset) has been created to automatically find and record pacemaker pulses with high confidence. To use the setup file, the pacemaker must be connected to input A!



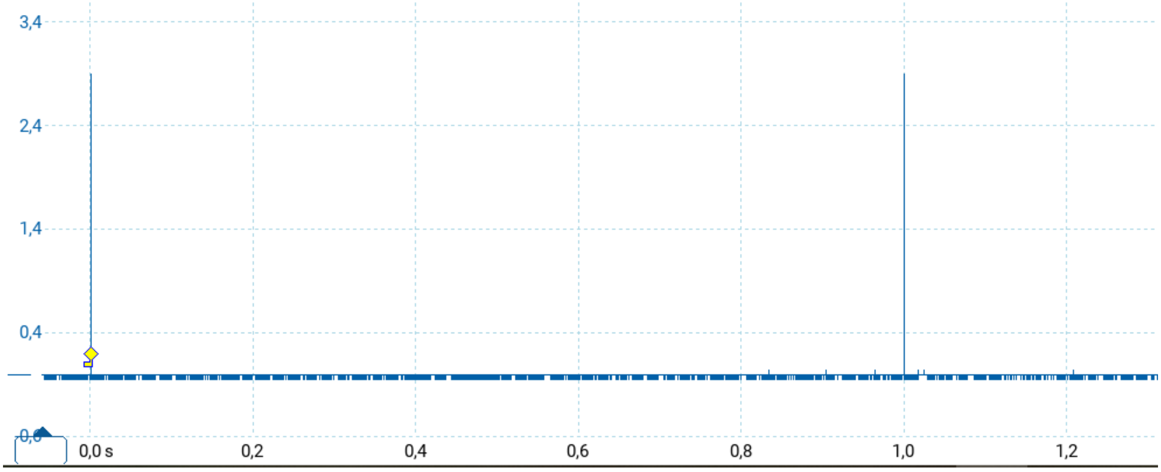
If the pacemaker_preset file is not available and the pacemaker signals would be set manually, the recommended setting is:

"x" step - 200 ms/div
"y" step - 5 V/div
Operating mode - Normal
Trigger type - Interval
Threshold - 200 mV
Timing amplifier - Internal range
Time 1 - 500 ms
Time 2 - 2 s
Hysteresis - 1%

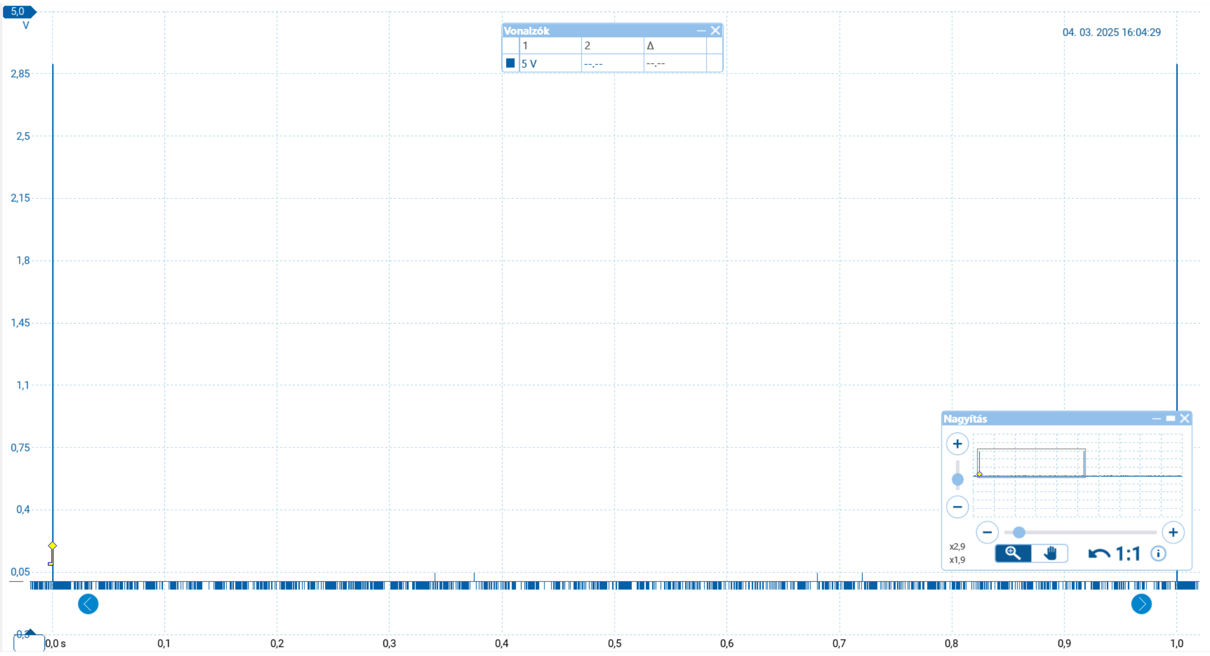
The horizontal pre-tirgger can be set to any value. The source should be the channel to which the pacemaker is connected.

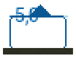
With these settings, erroneous data recording due to noise can be successfully filtered out and most pacemaker signals can be found with a period time between 500ms and 2s and an amplitude of at least 200 mV. The typical period time is 1 s, but deviations from this may occur.

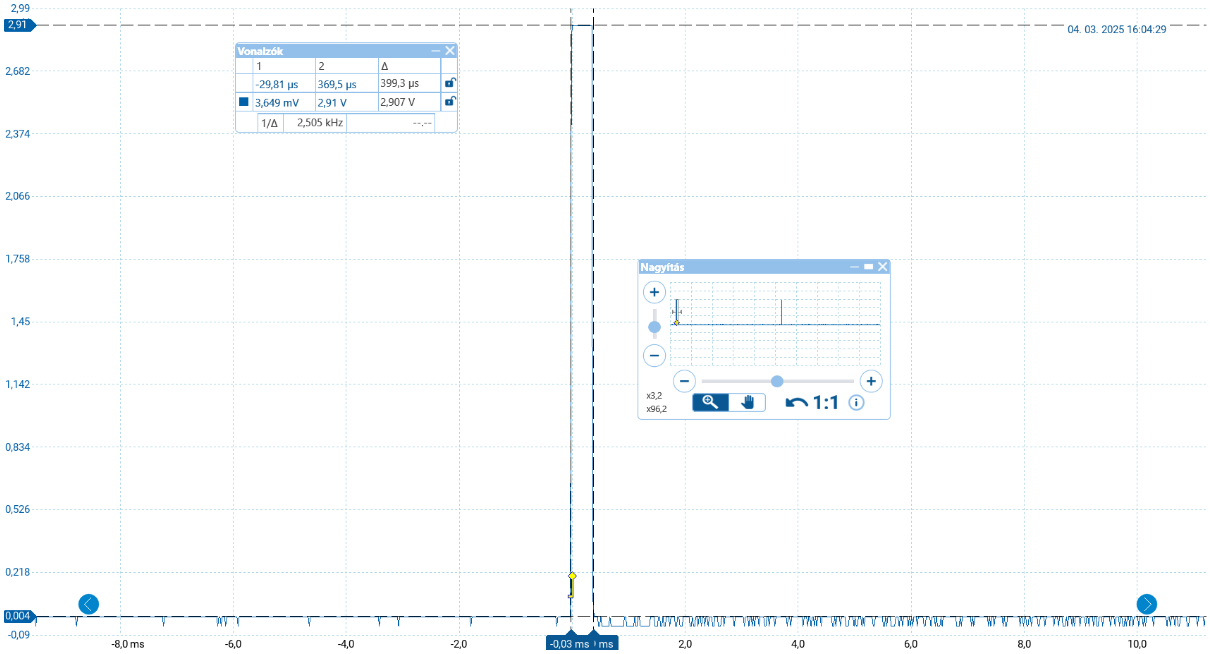
The figure below shows a sequence of pacemaker signals recorded using the setup file.



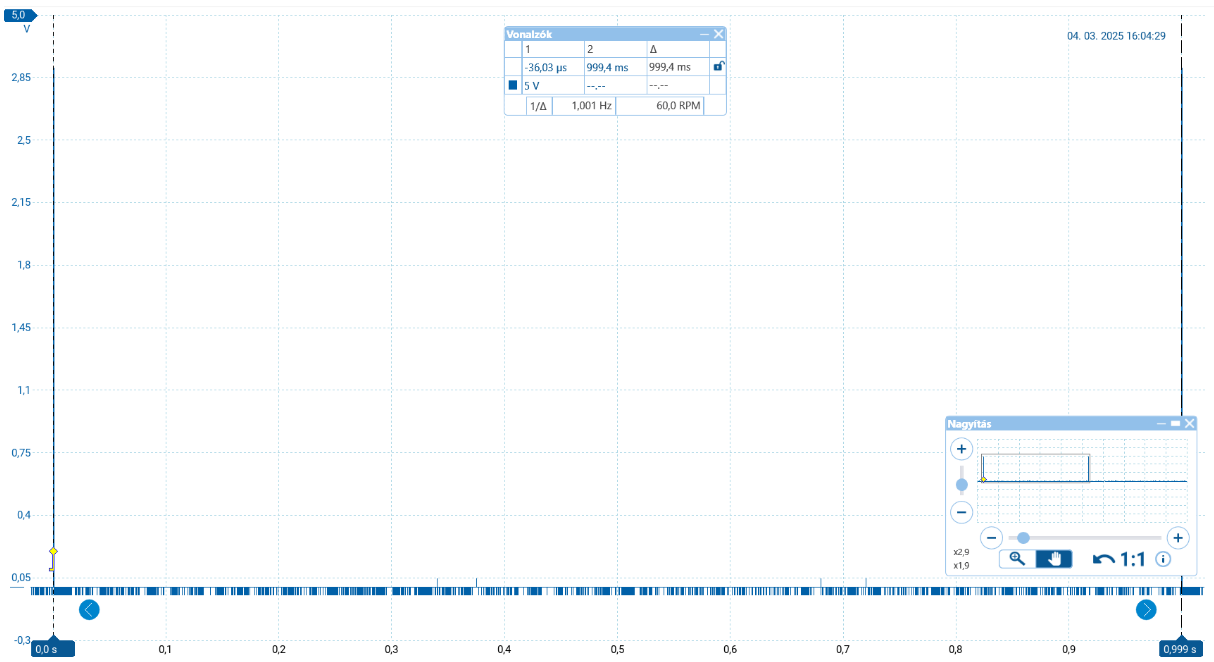
To evaluate the signals, click on the magnifying glass in the top right corner of the signal series window. 
A window called "Zoom" will then appear. You can zoom in using the sliders in the window or by dragging the mouse around the signal shapes.



This is followed by a measurement using the ruler tool available in the program. By default, the ruler is positioned at the top of the "y" axis  or the left edge of the "x" axis.  There are 2-2 of each marker available. By placing them at the bottom and top of the signal, or at the beginning and end of the signal, the voltage and length of the signal can be determined with high accuracy. These values can be read from the rulers window.



As a last step, it is also a good idea to measure the period length. You can cancel the magnification by sliding the magnification window, or by clicking on the 1:1 button in the magnification window, or by closing the magnification window. Then set the sliders on the "x" axis to two consecutive marks. Since the passive time of the signal sequence is three orders of magnitude longer than the active time, the adjustment error does not play a significant role here.



To test the pulse generator practice signal generator devices, it is recommended to switch off the trigger and use a 500 ms/div "x" step. For manual generation of pacemaker signals, it is recommended to reset the "x" step to 200 ms/div. At this point, a "Single edge" trigger with a 200 mV threshold can be used…..Done☺