Measuring tools DAQ series

Operating manual

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Introduction

The DAQ series is a range of professional PC based instruments that offer all the functionality of conventional test equipment devices like: oscilloscope, logic analyzer, meter and many other features which are not normally available for typical stand alone measuring tools. PC based tools replace bulky and expensive test equipment, saving money and workbench space. They make switching between instruments quick and easy. The DAQ series uses a computer and its monitor to display waveforms. The Windows software, which is included in a set, allows simple analysis of registered signals. All standard oscilloscope or logic analyzer functions are also available. Depending on a model, the software allows you on: spectral analysis, measurement of time or frequency, measurement of voltage or logical analysis. They are constructed to provide the maximum simplicity for the user. The most important and the most often used options and parameters are directly accessible - the user has the possibility of quick change of parameters of the device.

The quick transfer of the data from device to computer across the USB port (also 2.0 version) assures high comfort of usage. By integrating several instruments into one small unit, PC based tools DAQ series are lighter and more portable. When used with a notebook computer, field engineers can carry a complete electronics lab in their PCs. The durable, metal case is protecting the device against influence of external factors (mechanical and electromagnetic).

PenScopeDAQ



The digital oscilloscope PenScopeDAQ is a single-channel instrument with maximum frequency of sampling 100MHz and resolution 8 bits. PenScopeDAQ possesses small sizes casing in shape of pen, and is powered directly from the computer throughout USB port.

Key features:

- maximum sampling rate : 100MHz,
- analog bandwidth 20MHz,
- resolution: 8 bits,
- data buffer size: 128KB (changeable),
- voltage ranges: 20mV/div to 5V/div (5 divisions, probe 1:1 for BNC version),
- maximum input voltage: ±25V (probe 1:1 for BNC version),
- input type: AC or DC,
- overload protection: 100V,
- input impedance: 1MΩ, 15pF,
- power supply: none required,
- small size casing in shape of pen

ScopeDAQ

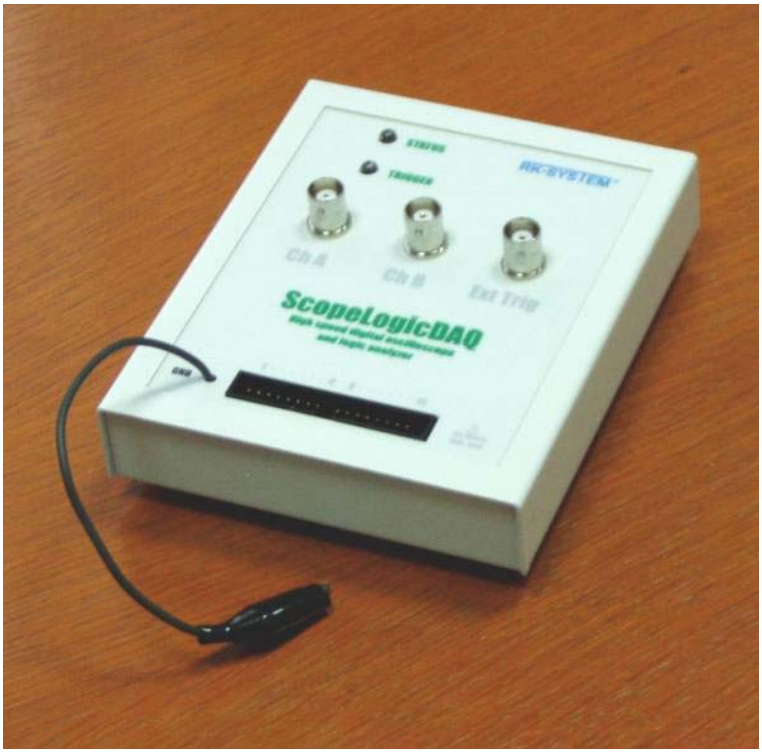


The ScopeDAQ is two-channel digital oscilloscope with maximum frequency of sampling 200MHz and 8-bit resolution.

Key features:

- maximum sampling rate: 200MHz (for one channel, for two channels 2x100MHz),
- number of channels: 2,
- analog bandwidth: 20MHz,
- resolution: 8 bits,
- data buffer size: 128KB (changeable, optional 512KB),
- voltage ranges: 20mV/div to 5V/div (5 divisions, probe 1:1),
- maximum input voltage: ±25V (probe 1:1),
- input type: AC or DC,
- external trigger input,
- overload protection: 100V,
- input impedance: 1MΩ, 15pF,
- power supply: external, 5V/1A

ScopeLogicDAQ



The ScopeLogicDAQ consists of two full-featured independent instruments in one compact package. The tool includes digital storage oscilloscope and logic analyzer. A number of options improve productivity and measuring quality.

Key features:

- maximum sampling rates:
  - 200MHz for active one analog and 8 digital channels,
  - 100MHz for 2 analog and 16 digital channels,
- number of channels: 2 analog, 16 digital,
- analog bandwidth: 20MHz,
- resolution: 8 bits,
- data buffer size: 128KB (changeable, optional 512KB),
- voltage ranges: 20mV/div to 5V/div (5 divisions, probe 1:1),
- maximum input voltage: ±25V (probe 1:1),
- input type: AC or DC,
- external trigger input,
- regulated level of “logical one” for digital inputs (threshold),
- overload protection: 100V,
- input impedance: 1MΩ, 15pF,
- power supply: external, 5V/1A

LogicDAQ



The LogicDAQ is PC based logic analyzer with 200MHz maximum sampling rate.

Key features:

- maximum sampling rates:
  - 200MHz for 16 channels,
  - 100MHz for 32 channels,
- data buffer size: 128KB (changeable, optional 512KB),
- external clock input,
- regulated level of “logical one” for digital inputs,
- power supply: external, 5V/1A

Installation

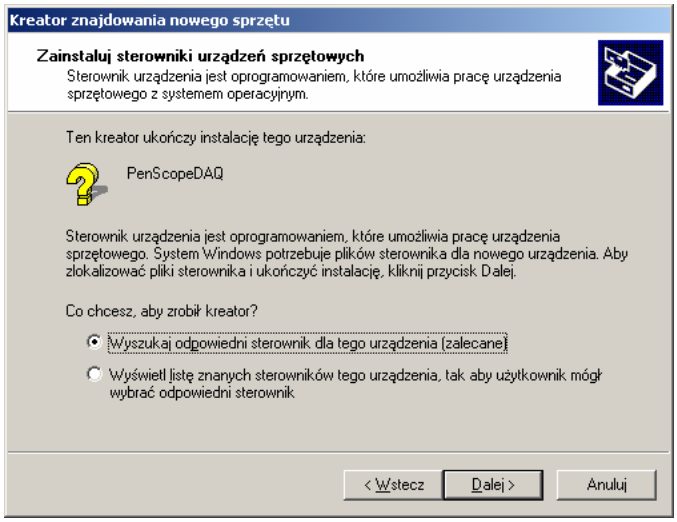
Hardware Installation

All instruments DAQ series are equipped with USB interface. To install DAQ hardware, connect data cable to the device and free USB port. For devices powered from external power supply, external power adapter should be also connected and turned on. Windows environment automatically detects connection of the device and will try to install proper drivers. The user should choose installation from specified source and browse directory *Drivers* present at included CD. Installation process can differ, depending on installed version of operating system.

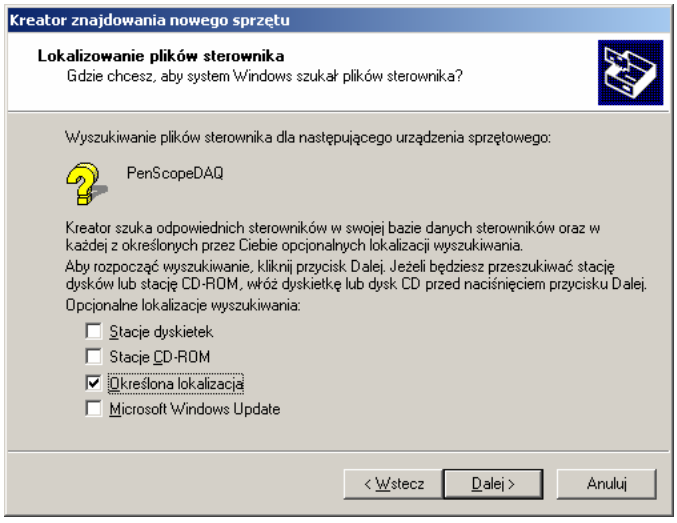


Below you can see diver installation procedure on Windows 2000. Please note that the screenshots can be different, for different versions of Windows system, but the procedure is very similar.

1) Windows will automatically detect the DAQ device and then initiate the *'Found New Hardware Wizard'*. In this step select *'Search for suitable driver for my device (recommended)*' and click *Next*:



2) In this step select *'Specify a location'* and click *Next*:



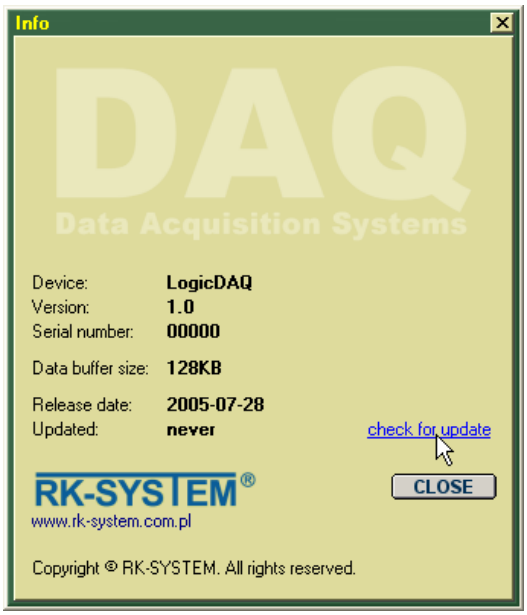
3) Point the **daq.inf** file being located on the enclosed CD-ROM in the *Drivers* directory.

Software installation

To install software onto PC please insert disc into CD drive and run **daqsetup.exe**. Follow the on-screen instructions to complete installation process. After installation a shortcut for DAQ software will be available on users desktop. Additional shortcut will be added also to *Start* > *Programs* menu to folder *RK-SYSTEM*.

Software updates

RK-SYSTEM is continuously updating DAQ software to provide new options, inaccessible in old software version, and remove noticed bugs, so it is advisable to check for the latest version after installation. RK-SYSTEM provides upgrades, free of charge. In order to check software for update run **Updater** application, located in *Start* > *Programs* menu in folder *RK-SYSTEM*. Follow on-screen instructions to carry through update process. Updatec can be also startded directly from DAQ application by clicking *check for update* in *Info* window ( ).



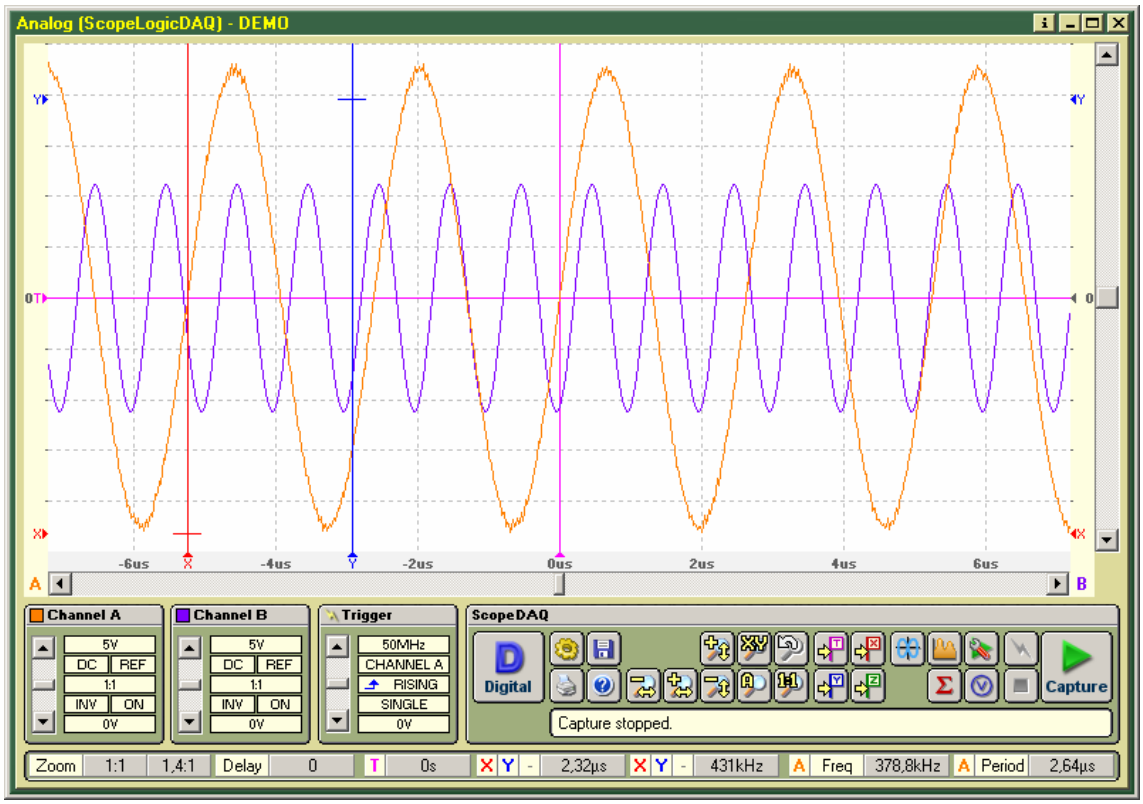
The user's manual

The software automatically detects model of DAQ device. After running it by clicking on *Scope* icon, fact of detection of DAQ hardware is signaled by double flash of red LED diode situated in casing of device. In case of PenScopeDAQ it is the *STATUS* diode, in case of the other DAQ models it is the diode named *POWER*.

General principles

The software designed for instruments DAQ series consists of two parts: analog - oscilloscope and digital - logical analyzer. Depending on device type, Analog Window or Digital Window can be inaccessible. The large buttons *Analog* and *Digital* realizes the possibility of switching between both parts of the software. This function is also realized by pressing *Ctrl* + *Tab* key.

Analog window



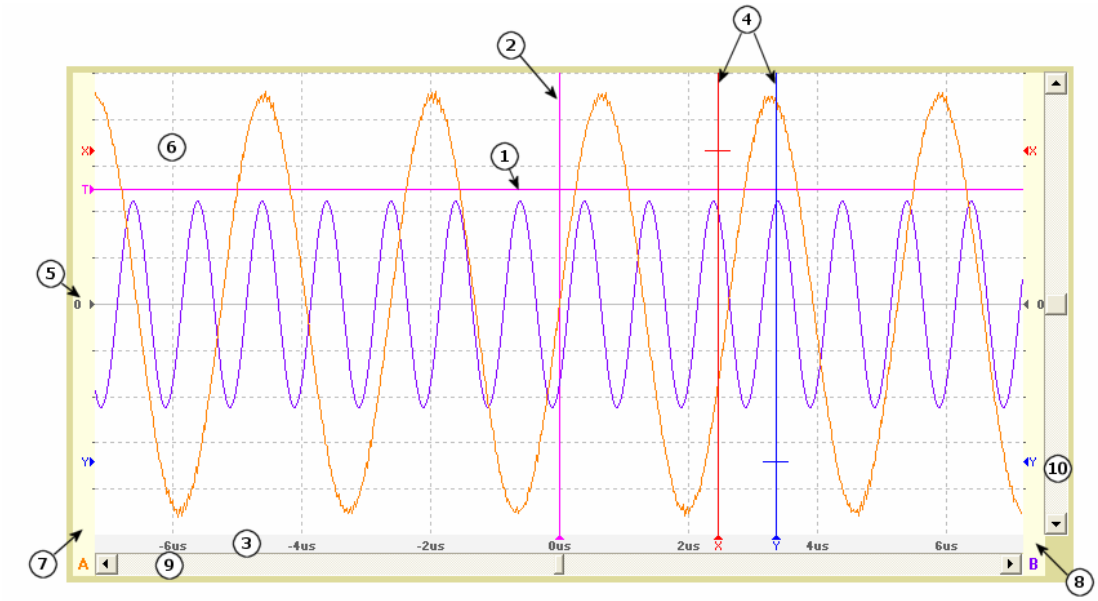
The common way to examine electrical signals is time domain analysis, using an oscilloscope. The time domain is used to determine amplitude, time and phase information, which is necessary to describe an electrical system. The Analog window represents a signal registered in the time. It permits also simple analysis of a signal like the spectral analysis, the measurement of the time or frequencies, the measurement of the voltage.

It consists of the following elements:

- The central area, initially empty, is used to display views of the data, which are read from the DAQ hardware.
- Channel A, Channel B field - configuration of analog inputs
- Trigger field - allows to set trigger options
- ScopeDAQ area - allows to execute the most commonly used functions
- Information bar (at the bottom of the main window)

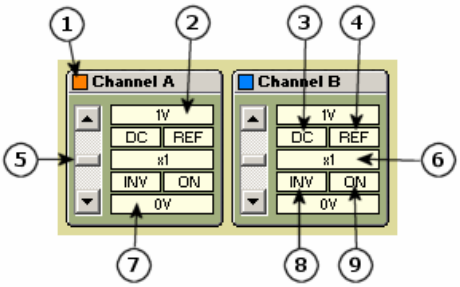
Analog Window - Display Area

This area diplays captured data in graphical form. Data may be scrolled and zoomed by clicking on one of zoom icons. Time differences or frequency can be measured using four cursors.

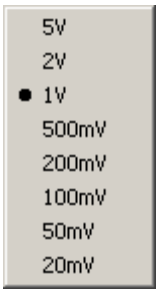


1. Threshold level.
2. T cursor (Trigger). The cursor consists of two lines: vertical and horizontal. The vertical line of T cursor shows the point in which the signal state corresponds to the trigger conditions settings. The position of vertical line (of T cursor) is determined by the pre-/post trigger buffer size setting in Analog/Digital Setup Window. The line divides time domain in two parts: post trigger – „positive time" and pre trigger – „negative time".
3. Time ruler. The zero value of time (0s) is always in position of T cursor.
4. Cursors.
5. Indicator of zero value (0V).
6. Signal display area.
7. Amplitude ruler for channel A with the indicators of cursors and indicator of zero value (0V).
8. Amplitude ruler for channel B.
9. Horizontal scroll bar – allows moving registered signal towards time ruler.
10. Vertical scroll bar – allows moving the signal area vertically. After clicking the right button of the mouse the vertical scroll bar sets in zero position.

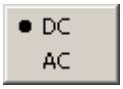
Configuration of analog inputs



1. Channel color indicator. After clicking in field the user can change the color separately for each of the two channels.
2. Range indicator. By activating the choice a menu appears displaying available voltage ranges.



3. By activating the choice AC/DC, the text changes from AC to DC or vice versa. In the hardware, a capacitor is switched into (AC) or out of (DC) the signal path.

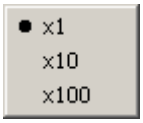


4. Reference signal. By activating the choice REF a popup menu appears, displaying:



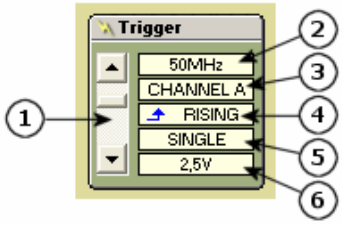
Save – save current waveform as reference signal,
On/Off – show or don't show a reference signal.

5. Offset Scroll Bar.
   To set offset to zero click on the offset scroll bar with the right mouse button.
6. Probe attenuation. Available values are: 1, 10, 100.



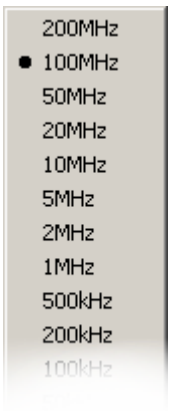
7. The value of offset in volts,
8. Invert signal:
   INV - signal not inverted,
   INV - signal inverted.
9. Turn on/off channel:
   ON - channel is turned on,
   OFF - channel is turned off.

Sampling parameters



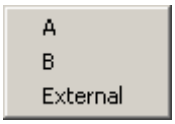
1. Threshold voltage scroll bar. The threshold level is showed on field 6. The field number 6 shows the voltage (in Volts) that the trigger channel must cross in order for a trigger event to occur. You can change value for the trigger threshold using Threshold voltage scroll bar. To set threshold to zero (0V) click on the scroll bar using the right mouse button.

2. Sampling rates. By activating the choice a popup menu appears, displaying a number of available sampling rates:



Note that content of the popup menu can vary for different DAQ devices.

3. Trigger source. The trigger event occurs when the signal level for the specified channel crosses a threshold. Available sources: Channel A, Channel B, External Source (Trigger source is not available for PenScopeDAQ).



4. Edge type – rising or falling.



5. Trigger type.



The trigger type can be set as:

Auto
Starts collecting immediately and collects and displays data continuously.

Repeat
Starts collecting only when a trigger event occurs. After displaying the data it waits for the next trigger event.

Single
Starts collecting only when a trigger event occurs and stops after displaying the data.

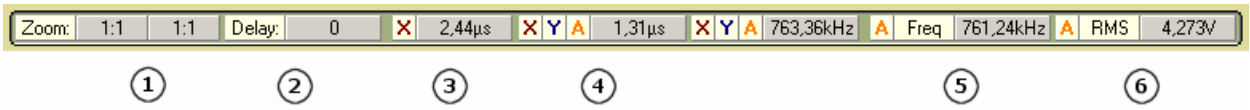
6. The field shows the voltage (in Volts) that the trigger channel must cross in order for a trigger event to occur. By clicking on the field with the right mouse button the user can turn on or turn off cursor T.

Control buttons

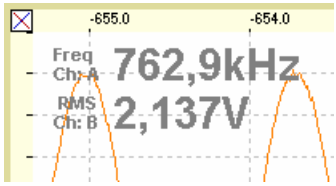


Button	Description	Key st.
Digital	Opens digital window (available for **ScopeLogicDAQ**).	Ctrl + Tab
	Opens configuration window, which allows setting data buffer size.	
	File operations: save/read project file or configuration file, save screen as a bitmap.	
	Prints waveform.	
	Opens help window.	
	Increases/decreases the data magnification. X-axis (time axis) magnification.	
	Increases/decreases the data magnification. Y-axis (voltage, amplitude axis) magnification.	
	Zooms the data between cursors X and Y.	
	Displays the whole data buffer.	
	Zooms 1:1 – 1 sample on 1 pixel.	
	Displays the data with previously set zoom factor.	
	Moves the data display to trigger position: cursor T	Ctrl + T
	Moves the data display to cursor X, Y or Z.	Ctrl + X Ctrl + Y Ctrl + Z
	Opens XY plot.	
	Opens FFT window.	
	Displays analog/digital setup window.	Ctrl + S
	Mathematical operations on channels: A + B, A – B, B – A.	
	Opens additional multimeter window.	
Capture	Executes data capture process.	Enter
	Forces trigger when DAQ device is waiting for a trigger.	Space
	Stops data capture process	Esc

Information Bar



1. Magnification factor. X axis, Y axis magnification. Click on the field to set 1:1 factor.
2. Capture delay value.
3. Position of chosen cursor (time or sample number)
4. Time interval, frequency, voltage between two chosen cursors.
5. The value of frequency, period or voltage for chosen channel.
6. The value of frequency, period or voltage for chosen channel. Fields 5 and 6 have additional property. After clicking the right mouse button on right part of these fields, is possible to turn on (or turn off) on-screen measure info.

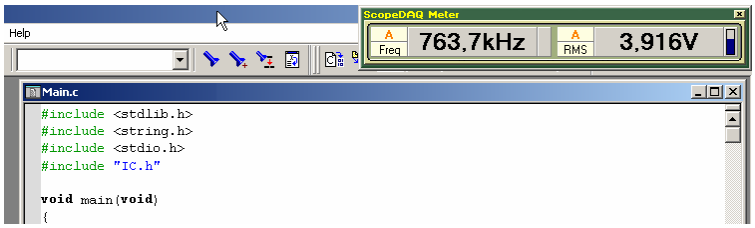


After clicking the left mouse button on some elements of the information bar causes that they are changing cyclically the meaning. In this way the user can configure the information bar depending on his current needs.

Multimeter bar

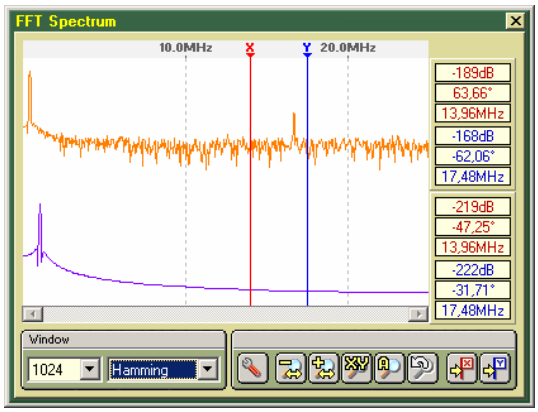


Useful function of the software is universal **ScopeDAQ Meter** in the form of the small window displaying present values measured in the digital form. This tool, run by pressing button, can display current value of voltage: mean (AVG), RMS, Peak-Peak, and frequency or time period. Type of the displayed value, and the number of the channel, it is possible to change by clicking on area of the type or the flag of the channel. Selected area of the value it is possible to "freeze" through clicking on them. This value, drawn with blue color, isn't being refreshed then.
The window of the ScopeDAQ Meter possesses this feature that windows of other applications aren't covering it. This operation provides a possibility of tracing the code of the application and watching the consequence of execution of this code in the inspected device, e.g. change of the voltage or the frequency.



Spectral analysis (FFT)

Software is offering the possibility to display the spectral analysis of the registered signal. The click of button opens the additional window containing the chart of the spectrum.

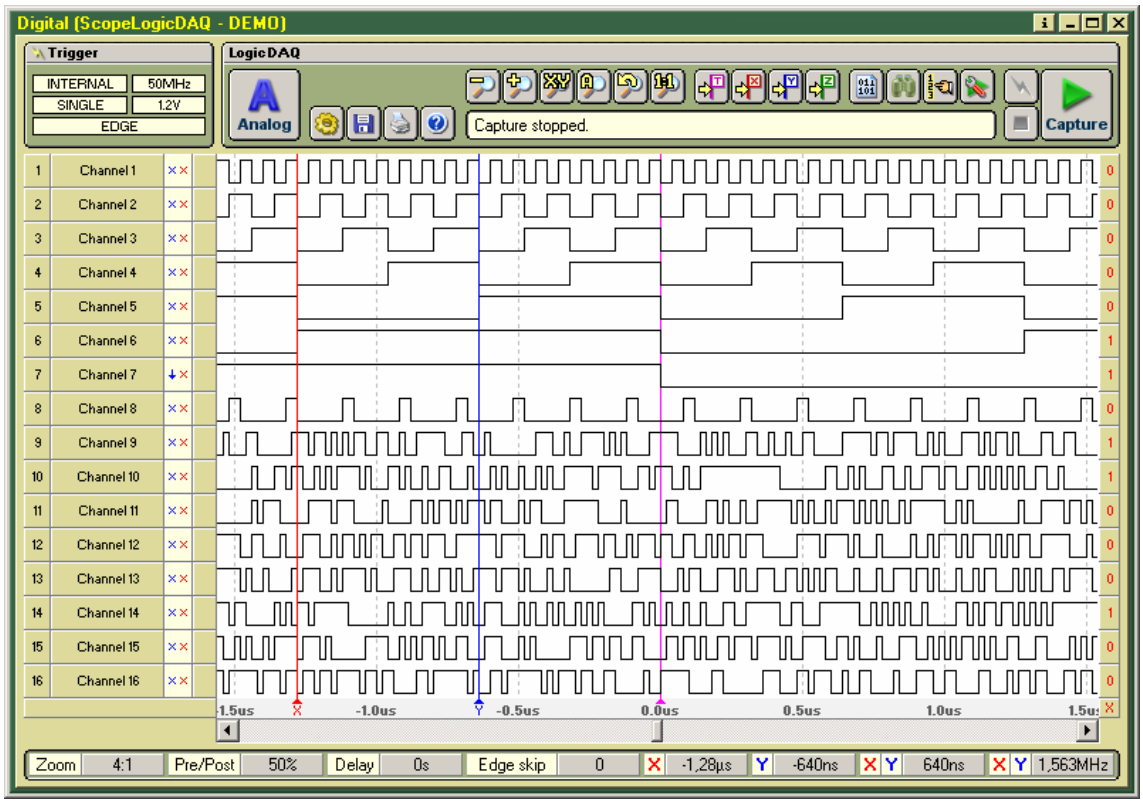


The analysis of execution is easier thanks to cursors showing the frequency in the place of their setting as well as the value of the amplitude and phase. Also magnifying of the fragment of the spectrum, the change of the type and the size of FFT window are possible. The window is offering also the possibility of change the method of displaying the vertical axis of the graph (linear or logarithmic).

XY plot

The function will be available soon.

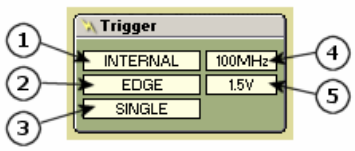
Digital window



Digital Window displays logical state of a signal in time domain. It permits to do simple analysis of signals like measurement of time or frequency. It consists of the following elements:

- Trigger field - allows to change trigger parameters,
- LogicDAQ field - used to execute the most commonly used functions,
- The central area (the Desktop) - is initially empty and is used to display views of the data which are read from the DAQ hardware,
- Information bar (at the bottom of the main window).

Sampling parameters



1. Clock sources. After clicking the field the user can choose: a) internal clock with adjustable frequency (the frequency can be set in the field number 4), b) external clock.
2. Trigger condition – shows the current trigger condition. To specify Trigger condition the user should choose one of the following options: *Edge*, *Pattern*, *Edge or Pattern*, *Edge and Pattern*. Selected condition will trigger the capture process.
3. Trigger type.



The trigger type can be set as:

Auto
The DAQ instrument continuously captures and displays data without waiting for trigger.

Repeat
The DAQ instrument is waiting for the trigger condition. The data are continuously captured into the pre-trigger buffer. When the trigger occurs, it starts filling the post-trigger buffer. When the post trigger buffer is full, data capture stops and the data is displayed. All the cycle repeats till the user click *STOP* button.

Single
The DAQ instrument is waiting for the trigger condition. The data are continuously captured into the pre-trigger buffer. When the trigger occurs, it starts filling the post-trigger buffer. When the post trigger buffer is full, data capture stops and the data is displayed. This option captures a single set of data.

4. Sampling rate. By activating the choice with a mouse, a popup menu appears, displaying a number of available sampling rates. When external clock is used this field indicates external clock mode.
5. Threshold voltage. The threshold voltage level is the level that the logic analyzer uses to establish whether the signal is a logical high or –low at the moment it samples the signal.

LogicDAQ main buttons

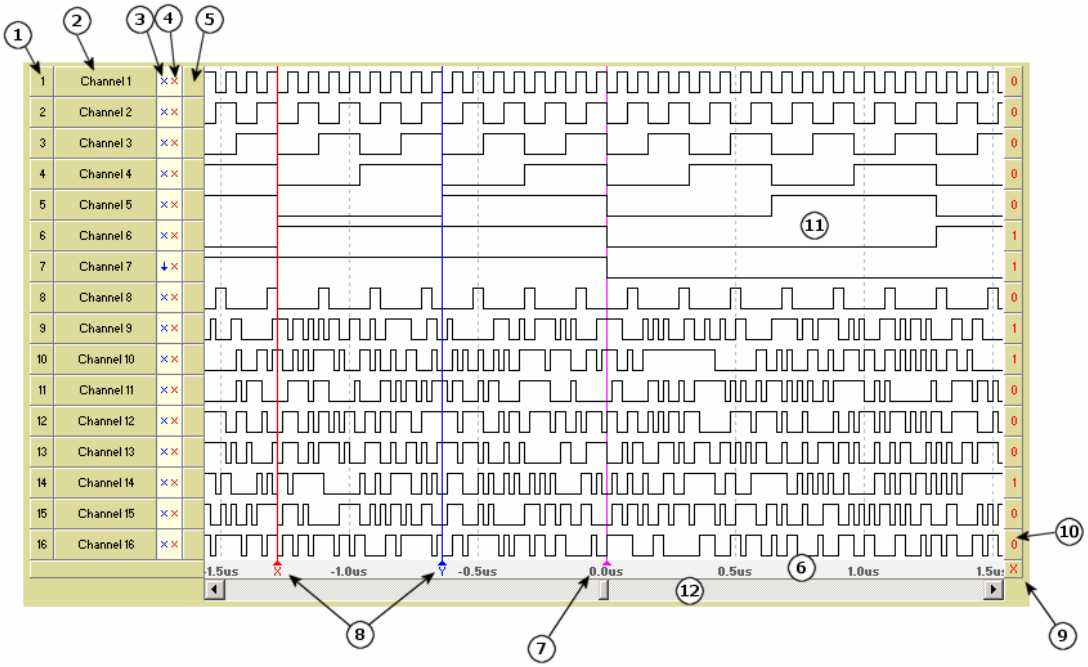


Button	Description	Keys
Analog	Opens analog window (ScopeLogicDAQ only).	Ctrl + Tab
	Opens configuration window, which allows setting data buffer size.	
	File operations: save/read project file or configuration file, save screen as a bitmap.	
	Prints waveform.	
	Opens help window.	
	Increases/decreases the data magnification. X-axis (time axis) magnification.	
	Zooms the data between cursors X and Y.	
	Displays the whole data buffer.	
	Zooms 1:1 – 1 sample on 1 pixel.	
	Displays the data with previously set zoom factor.	
	Moves the data display to trigger position: cursor T.	Ctrl + T
	Moves the data display to cursor X, Y or Z.	Ctrl + X Ctrl + Y Ctrl + Z
	Displays signals in text fashion: binary and hexadecimal - *Text Display*	
	Allows to search for a bit combinations (patterns)- *Search Pattern*	
	Allows to set channels parameters: name, color, etc.– *Channels*	
	Displays analog/digital setup window.	Ctrl + S
Capture	Executes data capture process.	Enter
	Forces trigger when DAQ device is waiting for a trigger.	Space bar

	Stops data capture process.	Esc

Timing diagrams

This area diplays captured data in graphical form. Data may be scrolled and zoomed by clicking on one of zoom icons. Time differences or frequency can be measured using four cursors.



1. Channel numbers. Order can be changed using drag'n'drop feature. Additionally a popup menu is available displaying following options.
   Hide channel – hides selected channel
   Show all channels – shows all hidden channels
   Reset order – resets channels to default order
   Change color – changes color of the channel

2. Channel name. After clicking in the field it is possible to change the name of chosen channel. Popup menu available as described previously

3. Indicator of the edge, which causes trigger event – here: falling edge on channel 1. Clicking on the blue indicator allows setting the edge, which causes trigger event. The user can choose one of the following: rising edge, falling edge or any edge. Popup menu offers following options:
   Reset edge – restores default setting of the edge which causes trigger event and channel,
   Reset pattern – restores default setting of the signals pattern which causes trigger event,
   Reset edge and pattern – restores default setting of the edge and signals pattern.

4. Pattern triggering indicator. Clicking on the red indicator allows setting the signal level, which causes trigger event. The user can choose one of the following: low state (0), high state (1), any state.

5. *Edge counter/skipper* information panel. These tools are described **Digital tab** section of **Parameters of the sampling process (Capture setup)**.

6. Time ruler. The zero value of time (0s) is always in position of T cursor.

7. T cursor (Trigger). The cursor shows the point in which the signal states correspond to the trigger conditions of settings. The position of vertical line (of T cursor) is determined by the pre-/post trigger buffer size setting in Analog/Digital Setup Window. The line divides time domain into two parts: post trigger – „positive time" and pre trigger – „negative time".

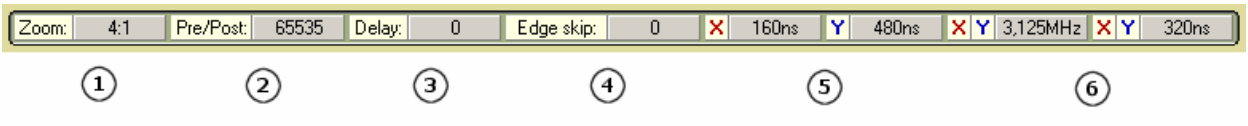
8. X, Y, Z cursors.

9. Type of cursor for which values are displayed (on field number 10). Clicking on this field allows choosing one of the cursors: X, Y or Z.

10. The field shows state of signal in point where the chosen cursor: X, Y or Z is currently set.
11. Signal display area.

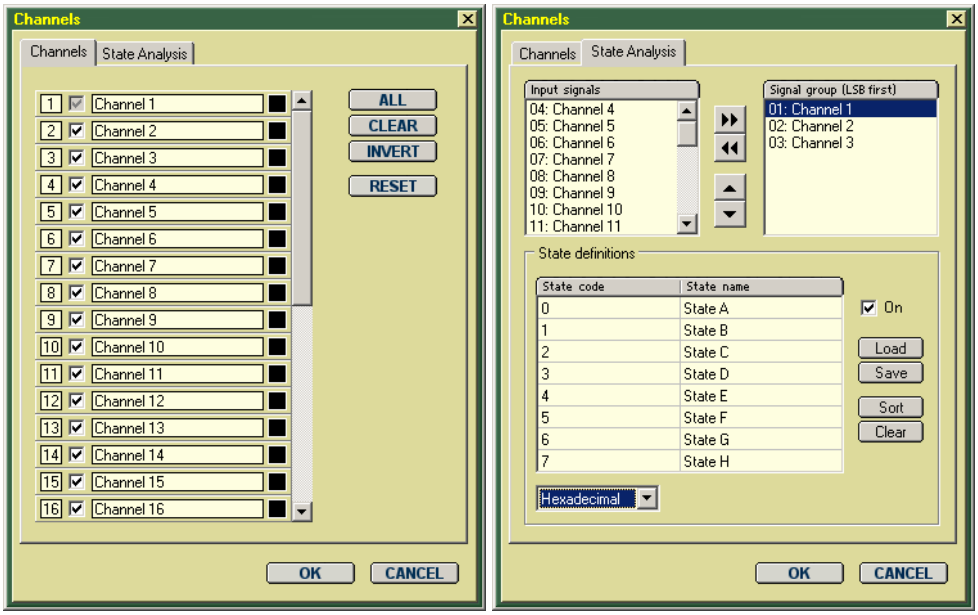
12. Horizontal scroll bar – allows moving registered signals towards time ruler.

Information bar



1. Magnification factor.
2. Pre and Post Trigger buffer division.
3. Capture delay value.
4. Quantity of skipped edges before trigger or quantity of registered edges if the function *Edge counter (after Trigger)* was enabled.
5. Position of chosen cursor (time or sample number).
6. Time interval or frequency between two chosen cursors.

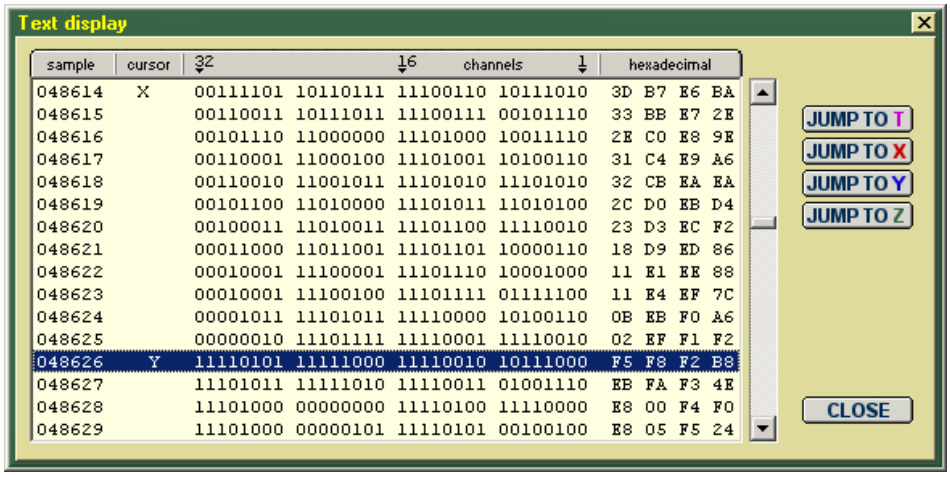
Channels window



In *Channels* tab the user can define own names assigned to each channel, hide unused or change the color of displayed channels. To hide selected channel unselect proper check box. Hidden channel will register the data and captured data may become visible again by enabling the channel. In order to highlight selected channel click the square near the name of the channel and to choose the color from the palette. Buttons located at right window side perform following functions: ALL – selects all channels to display, CLEAR – hides all channels, INVERT – inverts channel selection, RESET – restores default channel names and colors.

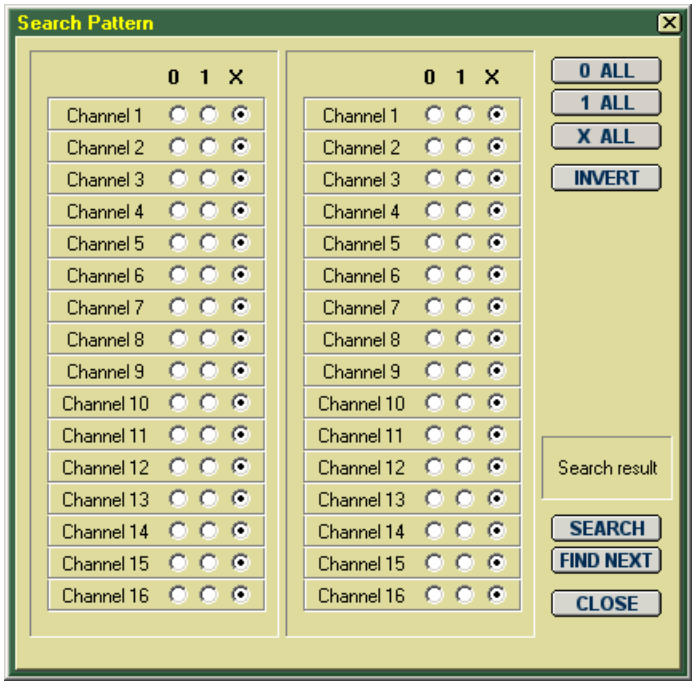
State analysis provides configuration of state analyzer tool. Wider description user can find in **State analysis** section.

Text Display window



Text Display window is used to display captured data in text fashion: binary and hexadecimal. A data sample is represented by each word: the least significant bit represents channel 1. Buttons “JUMP TO” allow locating the position of cursors.

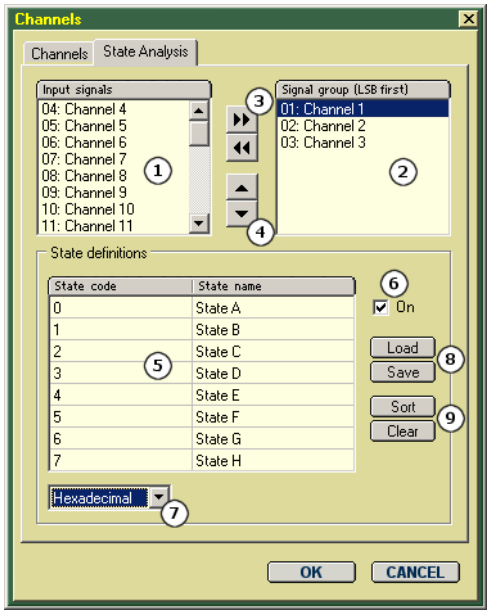
Search Pattern window



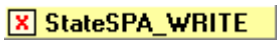
Search Pattern window allows finding pattern combinations in captured data. To specify pattern the user should select proper radio buttons (0 - low level, 1 - high level, X - “don’t care”) and press SEARCH. If specified pattern exists, cursor **X** will indicate first occurrence of it. Press FIND NEXT button to find other occurrences of selected pattern. The other buttons: 0 ALL, 1 ALL and X ALL allow to set identical state on all channels: low, high and “don’t care”. Button INVERT interchanges “zeroes” and “ones”.

State analysis

State analyzer is tool that facilitates constructional works of digital state machines and its analysis. Using some of analyzer lines, the user is able to define a bus and assingn a name to each state, which can appear on the lines. Configuration of this tool is available in window named **Channels** at **State Analysis** tab.



Input channels list (1) shows a roll of channels that may be used to create a group (2). In this group least significant bit of the bus is located at top-most position. Using buttons *Add channel* and *Remove channel* (3) the user is able to add or remove a channel from the group. Other buttons (4): *Move channel up* and *Move channel down* may be used to change succession of the channels. After definition of the group the user is able to assign names to each possible state that may appear (5). State values - decimal, hexadecimal or binary (7) - should be filled in column *State code*, its name may be typed in *State name*. Defined state names may be saved into file or restored (8). Next buttons (9) can be used to sort list of definitions or clear the list. Sorting also removes empty rows and duplicates. If tool is enabled (6) group of channels is pointed out with other background color at the digital part.
State analysis is realized using cursors. Place the cursor to see state name correspondig to actual state at lines. Name of the state is presented at left-bottom part of digital window. Click symbol of the cursor to cyclically change its type (X, Y, Z).



For an example: CPLD or FPGA implementation of Finite State Machine (FSM). A sample VHDL code and corresponding state analysis is presented below.

```
process (StateCURRENT)
begin
      case StateCURRENT is

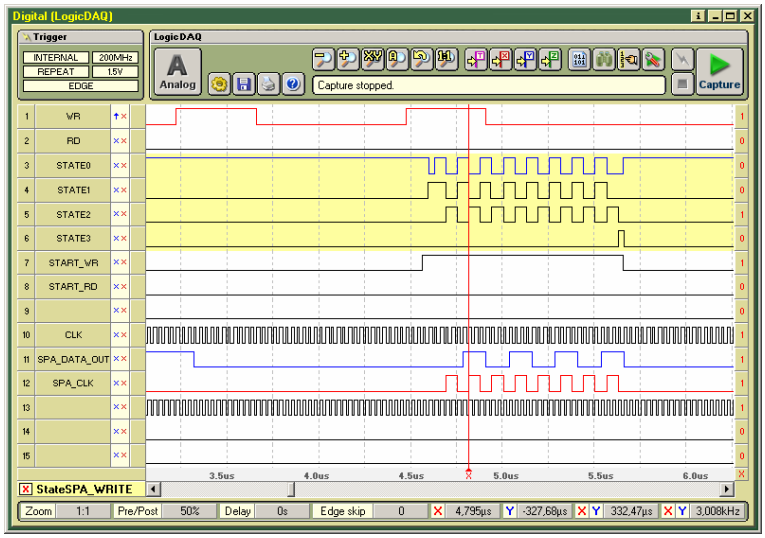
          when StateSPA_IDLE =>
               if (SPA.WRITE = '1' and SPA.READY = '0') then
                    StateNEXT <= StateSPA_WRITE;
               elsif (SPA.READ = '1' and SPA.READY = '0') then
                    StateNEXT <= StateSPA_READ;
               else
                    null;
               end if;

          when StateSPA_WRITE =>
               if (SPA.LENGHT = SENT_BITS) then
                    StateNEXT <= StateSPA_END;
               else
                    StateNEXT <= StateSPA_WRITE;
               end if;

          when StateSPA_READ =>
               if (SPA.LENGHT = SENT_BITS) then
                    StateNEXT <= StateSPA_READ_END;
               else
                    StateNEXT <= StateSPA_READ;
               end if;

          when StateSPA_READ_END =>
               StateNEXT <= StateSPA_END;

          when StateSPA_END =>
```

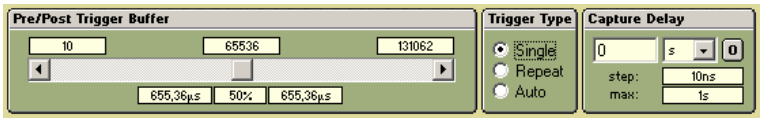


Parameters of the sampling process (Capture setup)

All parameters of the sampling process can be set in Analog/Digital Setup window. To open Analog/Digital Setup window click on the  button. The window is divided into two parts. The upper part of the window contains general settings like: Pre and the Post Trigger setting, trigger type setting and capture delay setting. The bottom part of

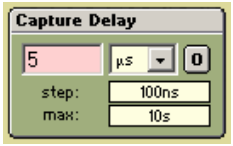
the window consists of two tabs: analog and digital. Depending on the type of DAQ instrument, which is currently used, some elements of Analog/Digital Setup Window can be inaccessible (for example Digital Tab for PenScopeDAQ).

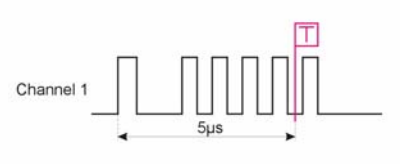
General settings



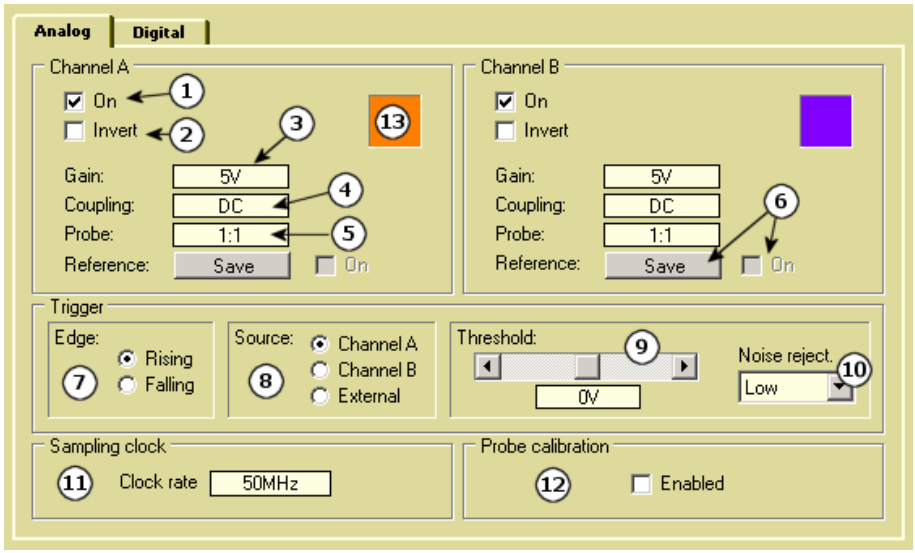
General settings concern the both analog and digital parts.

1) Pre/Post Trigger Buffer setting. The data buffer is divided into two parts: Pre-Trigger and Post-Trigger. While the oscilloscope or logic analyzer is waiting for trigger condition occurrence, it is continuously capturing data into Pre-Trigger buffer. When the trigger occurs it captures data into Post-Trigger part and displays the data. Pre-Trigger buffer contains data captured before the trigger; Post-Trigger buffer is filled with data captured after trigger. To capture more data before trigger occurrence slide the bar Pre/Post Trigger Buffer to the right and vice versa.
2) Trigger Type setting. Trigger Type can be set as:
   Auto - After clicking on Capture button the DAQ instrument continuously captures and displays it without waiting for trigger occurrence.
   Repeat - After clicking on Capture button the DAQ instrument is waiting for the trigger occurrence. The data are continuously captured into the pre-trigger buffer. When the trigger occurs, it starts filling the post-trigger buffer. When the post trigger buffer is full, data capture stops and the data is displayed. All the cycle repeats till the user click *STOP* button.
   Single - After clicking on Capture button the DAQ instrument is waiting for the trigger occurrence. The data are continuously captured into the pre-trigger buffer. When the trigger occurs, it starts filling the post-trigger buffer. When the post trigger buffer is full, data capture stops and the data is displayed. This option captures a single set of data.
3) Capture delay setting. The setting is useful when specified time delay is required between trigger occurrence and start of capture. Setting Capture delay value to non-zero allows to analyze events some time after the trigger has occurred without reducing the sampling rate. Minimum and maximum values depend on sampling rate; Capture delay value should be a multiple of minimum. The Capture delay option is available only for internal clock source (*Internal*) for Single and Repeat trigger types.





Analog tab

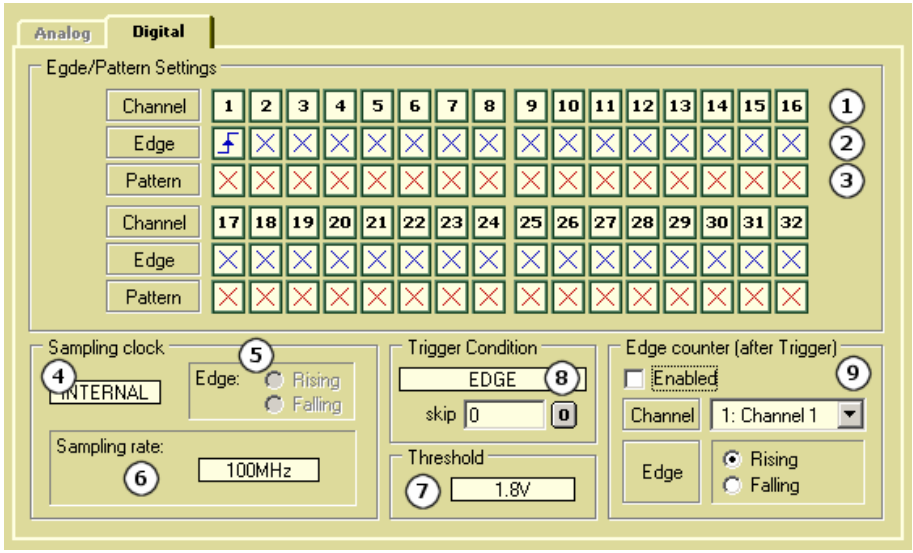


Analog Tab in Analog/Digital Setup Window, allows setting all the options responsible for analog part (oscilloscope).

1. Channel on/off.
2. Invention of the channel.
3. Range (gain) of analog channel. By activating the choice a popup menu appears displaying voltage ranges.
4. AC, DC switch. By activating the choice AC/DC, the text changes from AC to DC or vice versa. In the hardware, a capacitor is switched into (AC) or out of (DC) the signal path.
5. Probe attenuation. After clicking on it is possible to choose one of the values: 1, 10, 100.
6. Reference waveform: *Save* – saves current signal on HDD.
7. Trigger edge. In the Rising position triggering takes place on a rising slope of the signal to be measured and in the Falling position on a falling slope.
8. Trigger source. This selects which channel has to be used as the trigger input: Channel A, B or External.
9. Threshold level. Allows to set voltage that the trigger channel must cross in order for a trigger event to occur. (To set default - 0V - click on the threshold scroll bar with left mouse button).
10. Configuration of trigger noise filter. It lowers the trigger sensivity and requires more signal amplitude for stable triggering. This reduces the chance of falsely triggering on noise.
11. Sampling clock. By activating the choice a popup menu appears, displaying a number of available sampling rates.
12. Calibration of the measuring probe. If calibration of the probe is enabled the EXT TRIG connector is providing the function of the generator of the rectangular wave. The exact description is located in the chapter **Calibration of measuring probes**.
13. Color of the channel.

Most of the options are available also from main Analog window.

Digital tab

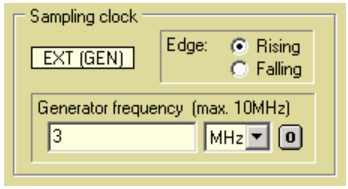


Digital Tab in Analog/Digital Setup Window, allows setting all the options responsible for digital part (logic analyzer).

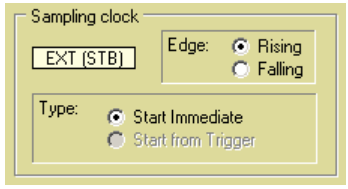
Edge/Pattern Settings allows configuration of the cause of trigger. Clicking on square icon changes the configuration of each channel (1). Edge type (2) - rising: , falling: , change of state (any edge): , disabled: - can be enabled for one channel. Pattern (3) will be defined if one or more icons will be different than "don't care" - low: 0 or high: 1. Clicking the right mouse button on any icon opens pop-up menu that allows resetting edge and pattern to default values.

Options grouped in **Sampling clock** area allow to define source of clock which will be used for data capturing. The user can set one of three options.
For *Internal* clock sampling signal is generated internally. Sampling rate for internal clock can be chosen after clicking on the Clock rate field. High clock rates provide higher sampling resolution and should be used for capturing quickly changing signals.
If *External (Generator)* is selected sampling clock must be provided by the user to external clock input. In this case data is captured on defined edge. In this mode capture process is realized similarly to internal clock source, except that

the sampling clock is taken from external source. This mode can be used to capture data with other frequency than listed, e.g. 3MHz. Additionally the user can precise frequecy of the generator to save time measurements.

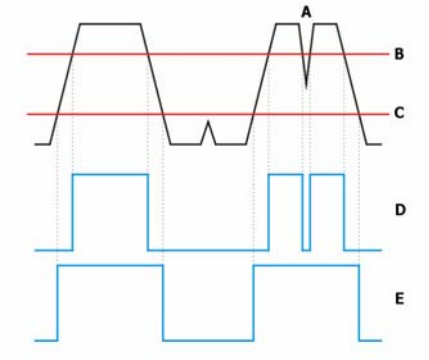


External (Strobe type) mode can be used to analyze bus transmissions (parallel or serial) when specified count of clock pulses is provided. In this case connect external clock input to bus strobe: WE, OE, SCK, etc. If number of clock pulses if not enough to fill the buffer, STOP button can be pressed to interrupt capture and display data. Cursor **T** will be put at last data in buffer showing number of captured samples.



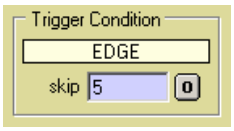
Start of capture process may start immediately after pressing Capture – *Start Immediate*, or after specified condition – *Start from Trigger* (option available soon).

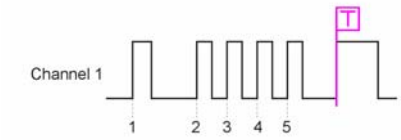
The **Threshold** (7) voltage allows determining logic level of a signal. If signal value is higher than this voltage it will be captured as "high".



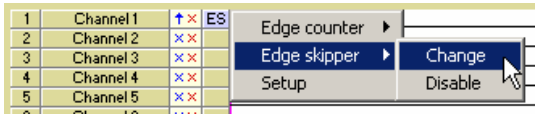
A – A signal which is sampled
B – Value of threshold 1
C – Value of threshold 2
D – Registered and displayed data for threshold 1
E – Registered and displayed data for threshold 2

To specify **Trigger Condition** (8) user should choose one of the following options: *Edge*, *Pattern*, *Edge or Pattern*, *Edge and Pattern*. Selected condition occurrence will trigger the capture process If *Edge* is selected as trigger condition and "skip" value is set to non-zero, the analyzer will count the edges (rising or falling) before the trigger occur. Thanks to that e.g. sixth rising edge on channel 1 can cause the trigger:

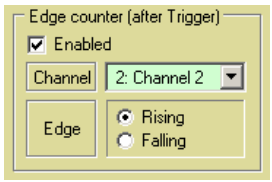


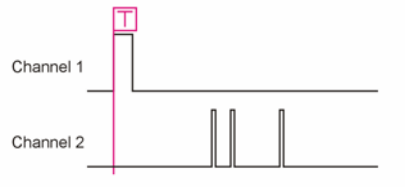


Configuration of *Edge skipper* is also available directly from digital window after clicking on *Edge counter/skipper* information panel. Enabled *Edge skipper* presents count of skipped edges at information bar.

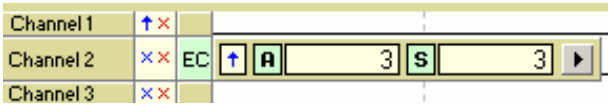


Edge counter (after Trigger) (9) allows for counting the quantity of edges (rising or falling) on one of channels after performing a trigger until filling of the buffer. It allows for example analyzing interferences or correctness of serial transmissions. This tool cannot be used together with *Edge skipper*. The quantity of registered edges is displayed at the information bar.
In the following example *Edge counter* will display three rising edges on the channel 2:

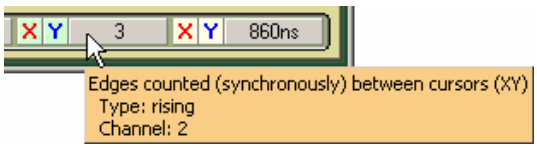




Count of edges is presented at additional panel at main window, located near channel for which this tool is enabled. This panel provides information about polarity of edges and values of asynchrous and synchrous counters.

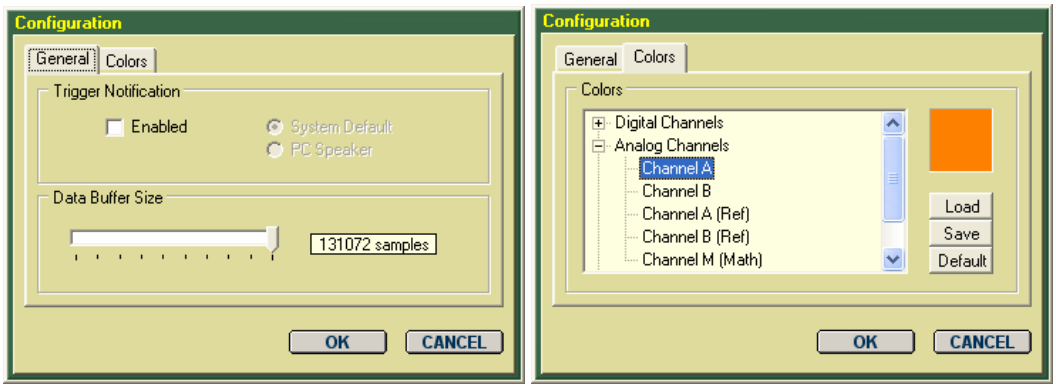


Asynchrous counter presents number of edges counted by the instrument independently on selected sampling frequency. This counter registers also very short pulses that cannot be registered and by the instrument and displayed because of to low sampling frequency. **Synchrous counter** shows number of edges counted only by the software. Different values of both counters suggest existence of glitches.
By *Edge counter* enabled there is a chance to count edges in registered signal between two cursors. For that purpose the user should set this function in one of last two panels of information bar.



General configuration of the software

General configuration of the software is realized in window named **Configuration** available after click on  button located at main form of Digital window.



Tab *General* provides following options:

- notification of the trigger with PC Speaker or system default sound,
- change of size of data buffer.

In tab *Colors* user can change color of selected elements of the display: graphs, cursors, backgroud, grid, etc. Color schemes can also be loaded or saved to file.

General principles of work

Calibration of measuring probes

After every connection of the measuring probe, if measurements are made with division factor other than 1:1, the probe calibration is necessary. In order to execute this operation correctly it is necessary to execute following steps:

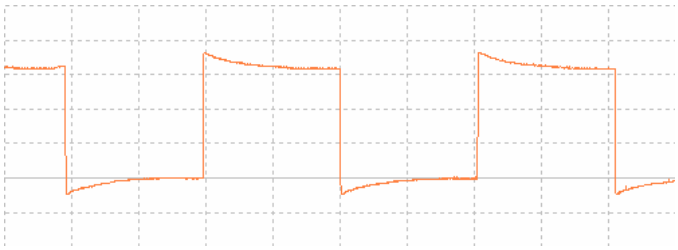
1. Connect the measuring probe to the device, set division ratio on 10. Put the measuring pin into the EXT TRIG connector.

2. Run software and set following parameters:
   a. probe correction ratio to: 10x,
   b. measuring range: 1V
   c. input type: DC
   d. sampling rate: 1MHz
   e. trigger type: REPEAT
   f. trigger source: channel which the probe was connected to
   g. threshold: 1V

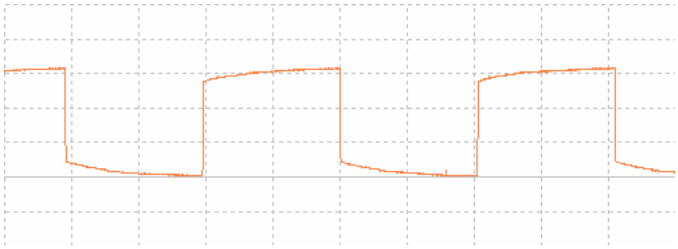
3. Run the process of sampling by pressing *Capture*.

4. Check the shape of registered signal and correct the trimmer if necessary.

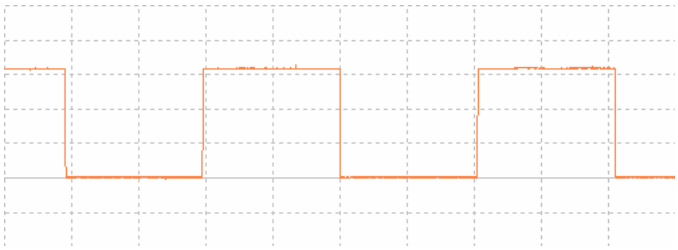
Measurements, when using the not-compensated probe, are able to make falsifying effects. Undercompensated probe will be suppressing higher frequencies; overcompensated probe will amplify them.



Overcompensated probe



Undercompensated probe



Probe compensated correctly

Project, settings and data files

Software is offering the possibility of saving project and settings. In order to save project and settings to file, the user should click  button. To save settings with current configuration of sampling process to the file, "Settings File" type should be chosen from type of file menu. If you choose "Project File" type, both configuration of sampling process and registered signals will be saved.

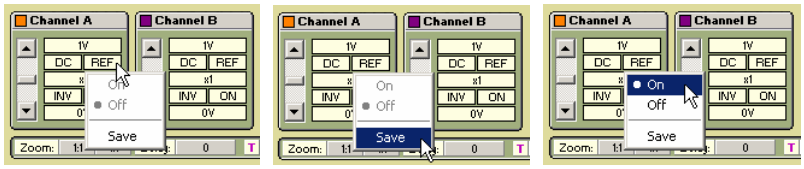
Collected data can also be saved to data files – binary or text.

Binary data file (Analog)	Files – generated separately for each channel – contains series of data registered directly by Analog-Digital Converter.
Binary data file (Digital)	File contains set of 32-bit words. Least Significant Bit corresponds to first channel, channel 32 is represented by MSB.

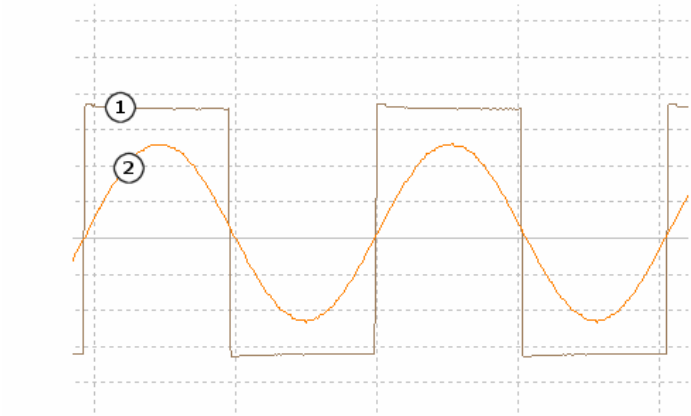
Text data file (Analog)	File contains data organized into following columns: **sample_number** number of sample (counted from 0) **time** time in seconds **channel_A_value** voltage value at channel A (in volts) **channel_B_value** voltage value at channel B – if available (in volts)
Text data file (Digital)	File contains data organized into following columns: **sample_number** number of sample (counted from 0) **time** time in seconds **hexadecimal_value** 32-bit word, first channel is LSB **binary_values** binary value (1 or 0) of each channel, channel #32 as the first

Reference graphs

The possibility of saving registered signal as reference signal is very useful feature of DAQ instruments.



In any moment of measurements the user can save registered signal on hard disc and treat it as reference waveform. The reference waveform can be turned on (displayed) or turned off, depending on requirements. When reference waveform (1) is visible on display area (ref is turned on) the user can compare all incoming waveforms (2) to a reference signal.



Waveform reference feature allows easily creating waveform reference libraries to compare to your live waveforms.

Constructional limitations of the digital instrument

The oscilloscope is basically a graph-displaying device – it draws a graph of an electrical signal. Oscilloscope is the most useful instrument available for testing circuits because it allows user to *see* the signals at different points in the circuit. Oscilloscopes are indispensable tools for anyone designing, manufacturing or repairing electronic equipment. Their usefulness is not limited to the world of electronics. With the proper transducer, it can measure all kinds of phenomena.

When you attach a digital (PC based) oscilloscope probe to a circuit, in the analog-to-digital converter (ADC) in the acquisition system samples the signal at discrete points in time and converts the signal's voltage at these points to digital values called sample points that are then stored in memory as waveform points. Together, the waveform points make up one waveform record.

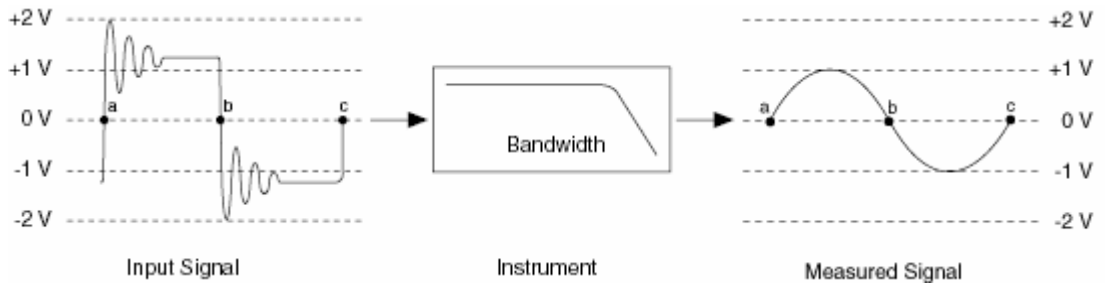
Modern PC based oscilloscopes offer some powerful advantages over conventional analog oscilloscopes. However, if the operator of the digitizing oscilloscope does not have an understanding of the concepts involved with such units, errors and/or misinterpretation of data may result.
Some of the primary reasons that digitizing oscilloscopes have limitations include:

1. Digitizing oscilloscopes have a finite sampling frequency,
2. Because digitizing oscilloscopes *sample* data, the operator must understand and work within the rules of the Nyquist Sampling Theorem if reliable data is to be obtained,

To create a waveform accurately, the PC based oscilloscope must gather a sufficient number of samples after the initial trigger. In theory a digital scope needs at least 2 samples per period (one full cycle of a regular waveform) to faithfully reproduce a sine wave, otherwise the acquired waveform will be a distorted representation of the input signal. In practice, the minimum acceptable sample rate depends on your desired wave-shape measurement accuracy. For simplicity, let's use a sine-wave example. With two sample points per cycle (the Nyquist limit), amplitude errors can be up to 100%. A 1-V amplitude sine wave can appear as a grounded signal, a flat line on the screen.

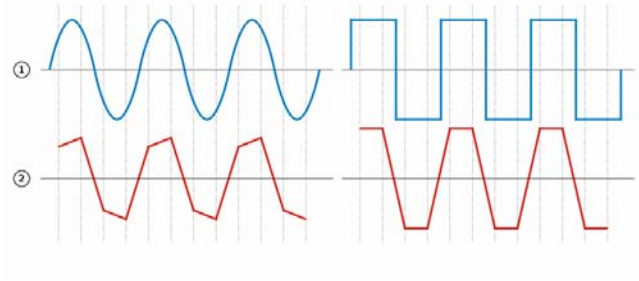
With four points per cycle, the worst-case error can be up to 30% of the true amplitude. With 10 points per cycle, the amplitude error drops to roughly 2% worst-case. With sample rates not harmonically related to the input signal and with more than two points per cycle, the averaged frequency measurement is very accurate.

Bandwidth determines an oscilloscope's fundamental ability to measure a signal. Adequate bandwidth helps to resolve high-frequency changes. Most of digital oscilloscopes specify two bandwidths - Analog and “Real-Time”. Analog bandwidth describes the frequency range (in Hz) in which a signal can be acquired accurately. This limitation is determined by the inherent frequency response of the input path, which causes loss of amplitude and phase information. Analog bandwidth is the frequency at which the measured amplitude is 3 dB below the actual amplitude of the signal. This amplitude loss occurs at very low frequencies if the signal is AC coupled and at very high frequencies regardless of coupling. When the signal is DC coupled, the bandwidth of the amplifier extends all the way to the DC voltage. The following figure illustrates the effect of analog bandwidth on a high-frequency signal.

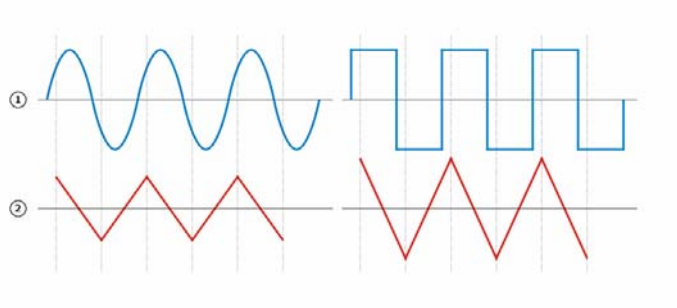


The second bandwidth, called the “Real-Time” Bandwidth, defines the maximum frequency the instrument can acquire by sampling the entire input waveform in one pass, using a single trigger, and still gather enough samples to reconstruct the waveform accurately. The following example describes the “real-time” bandwidth.

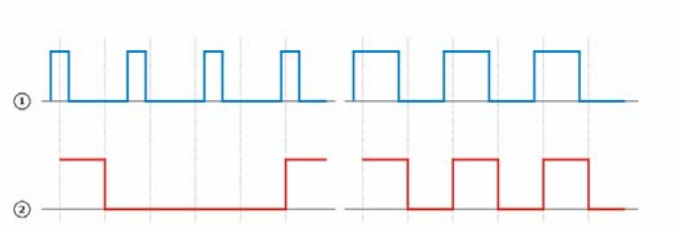
Frequency of input signal is 4 times lower than selected sampling rate.
(1) – Shape of input signal
(2) – Measured and displayed signal



Frequency of input signal is 2 times lower than selected sampling rate.
(1) – Shape of input signal
(2) – Measured and displayed signal



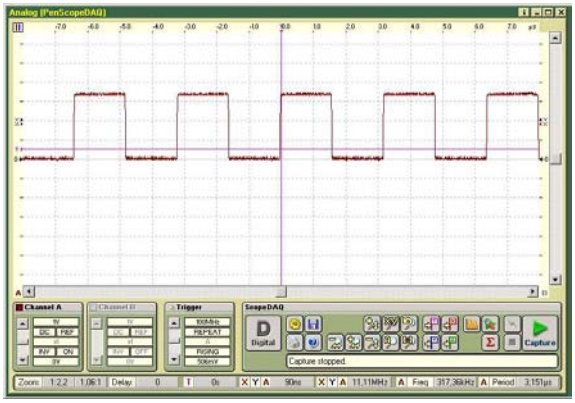
The same effect occurs for logic analyzers:
(1) – Shape of original signal on input
(2) – Measured and displayed signal



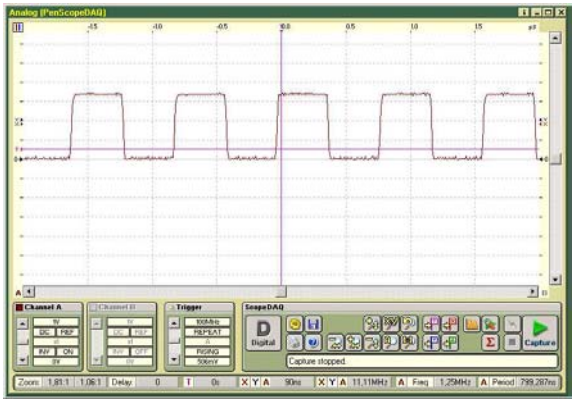
For some DSOs, the real-time bandwidth theoretically exceeds the analog bandwidth. But since the input path distorts any signal above its frequency limit, the real-time bandwidth can only be equal to or less than the analog bandwidth. Even though a DSO may sample at a higher bandwidth than its analog bandwidth, the analog bandwidth establishes the highest frequency the scope can accurately capture.

Measuring examples - PenScopeDAQ

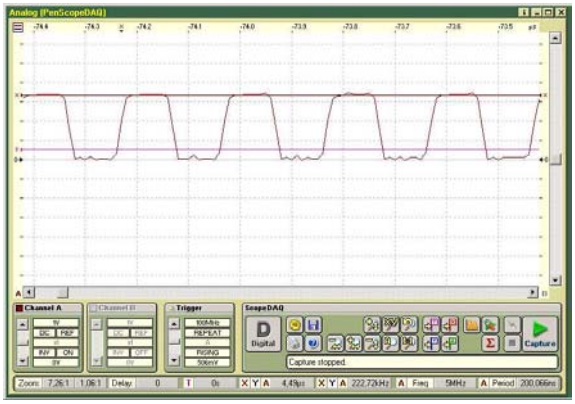
Below we present a few examples to illustrate how PenScopeDAQ measures input signals about the same amplitude but various frequencies. We provide square signal to the PenScopeDAQ's input with 3,3V amplitude and frequencies from 321,5kHz to 40MHz. Settings of PenScopeDAQ were the same for each frequency of input signal: sampling rate 100MHz, voltage range 1V.



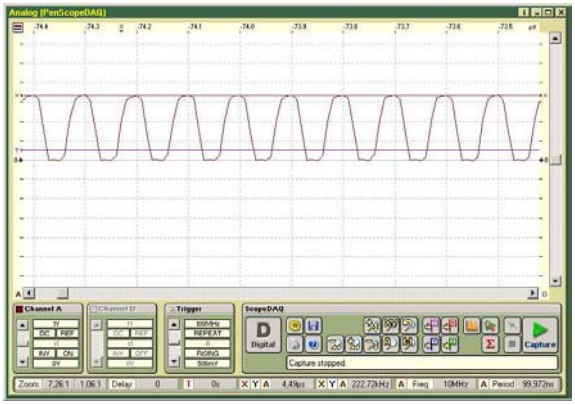
1. Frequency 321.5kHz



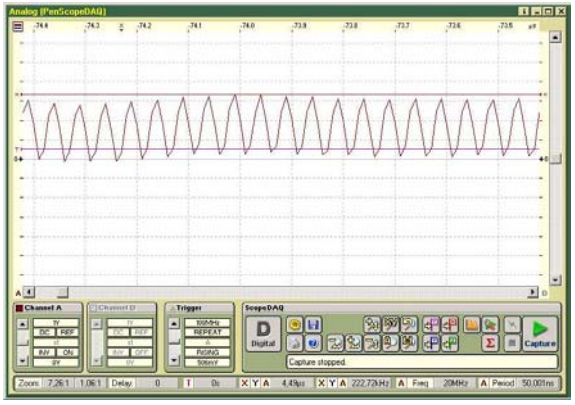
2. Frequency 1.25MHz



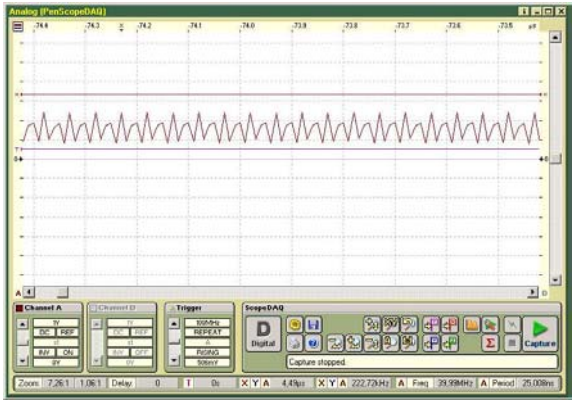
3. Frequency 5MHz



4. Frequency 10MHz



5. Frequency 20MHz



6. Frequency 40MHz

On the screenshots (1) and (2) you can see that there are no distortions of the input signals measured with PenScopeDAQ. Also for (3) and (4) measured signal in near to square. Maximal signal frequency you can measure using PenScopeDAQ is 20MHz. As shows picture (5) the input signal is sampled to slow to see accurate square waveform but generally there is no problem with bandwidth. 40Mhz input signal (6) cannot be acquired accurately. This limitation is determined by the input path, which causes lost of amplitude and phase information (analog bandwidth) and too low sampling rate.

Final remarks

RK-SYSTEM assumes no responsibility on any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein.

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