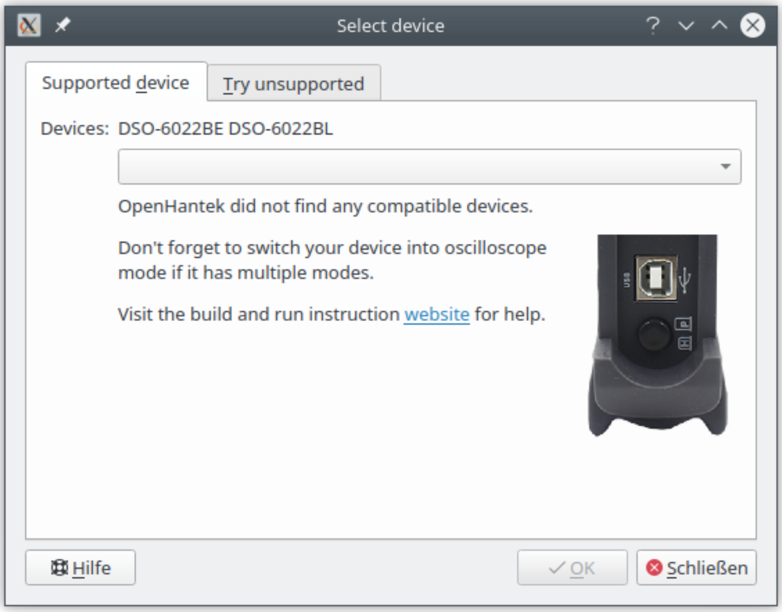
OpenHantek6022 User Manual

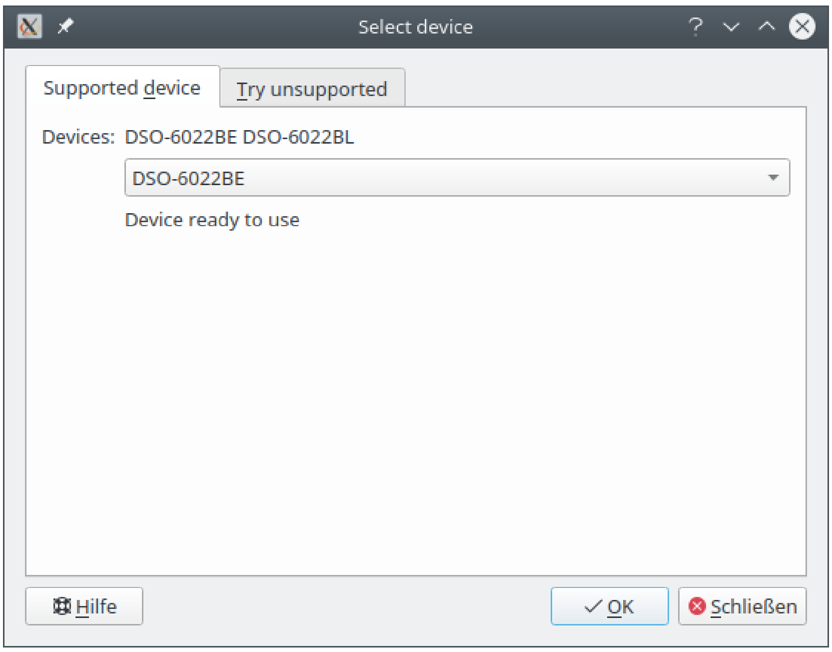
The digital storage scope Hantek6022 has two identical measurement inputs, CH1 (yellow) and CH2 (blue) and a calibration output (right side). The input impedance is 1 MOhm || 25 pF.
Each input section contains an 8 bit ADC (analog to digital converter) that allows to sample the input voltage at a chosen time rate and to transfer the digital value to the PC via USB where it will be processed and displayed.

Starting OpenHantek6022



The scopes Hantek6022 contain a Cypress EzUSB processor that controls the data sampling and the USB transfer. The device does not contain a flash, the firmware must be loaded into the RAM at 1st program start after powering the device.
The uploaded firmware is lost after switching off the scope or disconnecting the USB, so the device can never be *bricked*.

After starting the program, OpenHantek6022 searches for a supported device (either a Hantek6022BE or Hantek6022BL) by checking the USB VID/PID (vendor ID and product ID) of all connected USB devices.
6022BE: VID 0x04B4 / PID 0x6022
6022BL: VID 0x04B4 / PID 0x602A



If a scope is found the firmware will be uploaded and the VID is changed from 0x04B4 to 0x04B5 while keeping the PID unchanged. Selecting OK starts the scope.

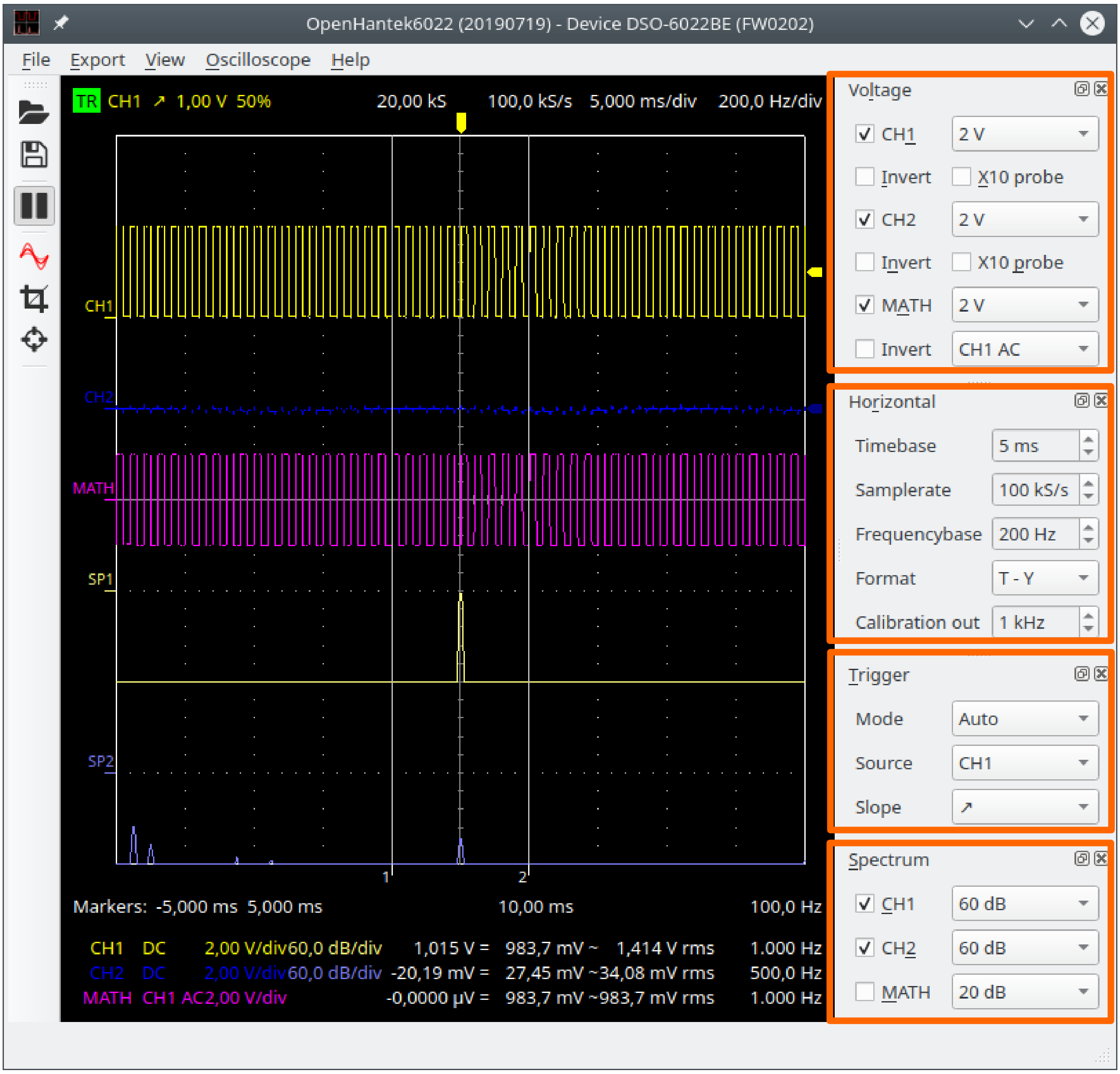
Running OpenHantek6022

The OpenHantek6022 program resembles the typical view of a real hardware oscilloscope, so anyone who has experience with scopes (including analog devices) should be able to operate it. Those who lack this experience should keep in mind that a scope is a complex measuring instrument, so a basic understanding of how it works is required to perform correct measurements.

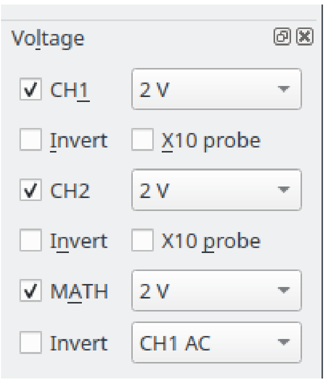
The program version, device type and firmware version are displayed in the upper line of the window. This information helps when reporting issues.

The scope functions can be controlled by the four sections (orange) on the right: Voltage, Horizontal, Trigger and Spectrum.

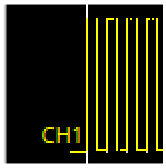
The selected settings are automatically saved when you exit and restored the next time you start the program.



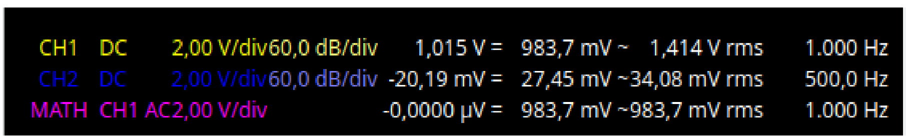
Voltage



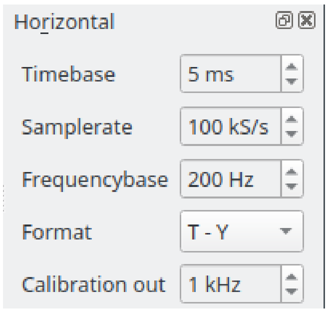
Both channels measure the voltage related to GND.
GND is directly connected also to the PC and to the main's GND so never ever connect GND of the scope to other voltages as it can destroy the scope and the PC!
This is not a limitation of this device but typical for most scopes, even for much more expensive ones.
Each channel can be selected or deselected by ticking CH1 or CH2. Input signal polarity can be Inverted.
The vertical position of the trace can be changed by dragging the name label left of the trace.



The default colors of the traces CH1 and CH2 correspond to the channel colors on the front of the scope hardware.
The maximum measurable input signal range is -5 V ... +5 V, values outside this range are clipped (shown as minimum or maximum value).
Each channel has an amplifier with selectable gain that allows the amplification of the input signal by the factor 1X, 2X, 5X or 10X, the available input voltage range decreases accordingly from ±5V to ±2.5V, ±1V and ±500mV.
Input sensitivity per division can be selected from 20mV/div up to 5V/div (1/2/5 steps) by the control field, e.g 2V.
The display's height is 8 div, marked with horizontal dotted lines on the screen.
The two supplied Hantek probes allow a signal attenuation of 1/10 (e.g. 12V input will be measured by the scope as 1.2V), so the possible maximum input voltage range is increased ten times to ±50V. The X10 probe setting eases the usage of this X10 range by multiplying the displayed value by 10 (the measured example value of 1.2V from above will be displayed correctly as 12V).
The MATH channel (purple color) allows simple calculations with measured signals: CH1+CH2, CH1-CH2, CH2-CH1, CH1*CH2, CH1 AC, CH2 AC
The subtract functions allow the measurement of voltages between two points in a circuit by measuring both with CH1 and CH2 and subtracting the values.
Math mode CH1*CH2 can be used to calculate the momentary power as product of voltage and current (when current is measured with a 1 Ω shunt in the GND line then 1 V in MATH display equates a power of 1 W). Or you can use a current probe.
The AC modes calculate the AC component of a channel by averaging over the sampled signal and subtracting this value from the samples, leaving only AC.
The scope also calculates typical values of each active channel and displays them in the colored bottom lines, the values from left to right are:
Channel name, coupling or math mode, voltage range, spectrum range, DC voltage (average), AC voltage, RMS voltage (i.e. sqrt(DC^2 + AC^2)), frequency.
A red channel marking (e.g. CH1) warns when the input signal exceeds the channel's physical input range and clipping has occurred.



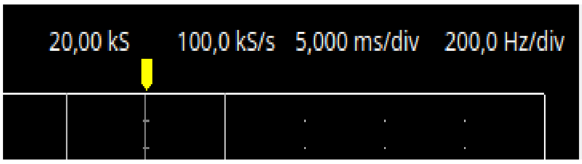
Horizontal



The displayed time range of the trace can be selected by <u>Timebase</u> between 10ns/div and 100 ms/div in 1/2/5 steps. The display's width is 10 div, marked with vertical dotted lines on the screen.
The optimal <u>Samplerate</u> will be selected automatically but the user can also change this manually within the realistic range. The maximum sample rate is 15 MS/s when sampling two channels.
If only CH1 is used, the maximum sample rate is doubled to 30MS/s.
The effective sample size used for display, calculations and export is always 20 kS. For (effective) sample rates lower or equal 1 MS/s a 10X oversampling is used, i.e. to get 20 kS @ 1 MS/s the scope samples 200 kS @ 10 MS/s and averages over 10 samples each to decrease the noise floor by 10 dB and increase the effective sample width of the 8bit ADC to almost 10 bit.
(It's exactly 9.66 bit, each 4X oversampling adds one bit, 4X → 9bit, 16X→10bit, ...).

The <u>Frequencybase</u> setting selects the resolution of the spectrum in Hz/div.

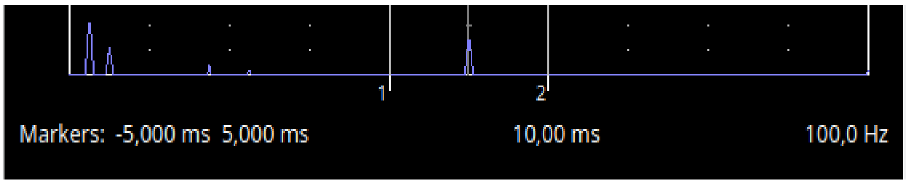
An overview of all settings is also visible top right of the trace window.



<u>Format</u> selects T-Y (i.e. normal scope display, voltage (Y) over time (X)) or X-Y (CH1=X, CH2=Y, the position on the screen can be changed by dragging the channel markers CH1 and CH2 left of the traces window).

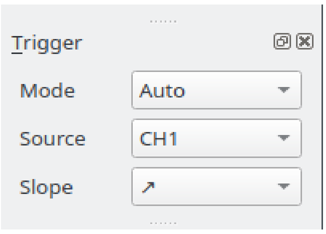
<u>Calibration out</u> selects the frequency of the calibration output (a 2 Vpp square wave) on the right of the scope, set to 1 kHz at each program start. The frequency can be selected between 50 Hz .. 100 kHz in 1/2/5 steps.

Two <u>Markers</u> (vertical lines, marked with 1 and 2) allow time measurement (and the corresponding frequency) of the traces by dragging the lines. New markers can be positioned also by click and drag inside the trace window.



The digital phosphor function (red icon) simulates a slow fade out of traces to detect short events.
The zoom function (square icon) displays a new window below the main window with zoomed time range equating the markers distance.
The cursor function (round icon) opens an extra section and allows measurement of time or frequency span and levels.

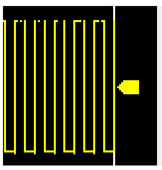
Trigger

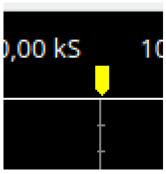


Triggering allows to display a stationary trace by fixing a rising or falling Slope of the signal of the selected Source channel to a defined position on the screen. The triggering is done in software by searching for the trigger condition in the sampled values and skipping the necessary amount of leading samples to position the trace accordingly.

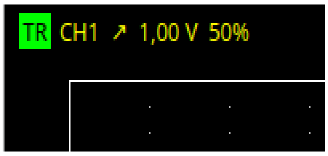
Trigger Mode can be:
- Auto (display a running trace even if no trigger point is detected)
- Normal (display no trace without active trigger, hold the last triggered trace)
- Single (display a new trace every time the space bar is pressed)

Hitting the space bar stops and restarts the display during auto and normal mode.



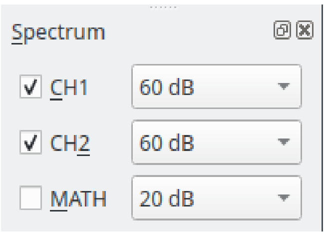


The trigger level (voltage) can be selected by dragging the small colored (e.g. yellow) arrow to the right of the recording window. The trigger position on the screen can be selected by dragging the colored (e.g. yellow) arrow at the top of the window.

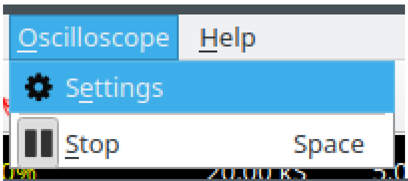


Trigger status(TR = triggered, TR = not triggered), source, slope, level and position are displayed in the upper left corner of the trace window.

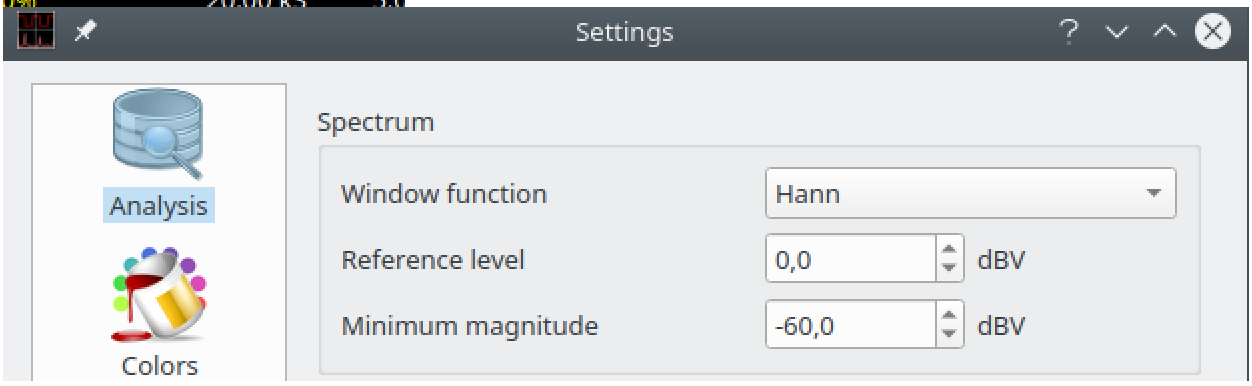
Spectrum



The program calculates the voltage spectrum of the three channels using the discrete FFT and displays the results if enabled.
The displayed values are shown as dBV
where 0 dBV equals 1 V rms.



The applied Window function as well as the reference point for the spectrum calculation can be changed in this menu:
Oscilloscope/Settings/Analysis



Typical window functions are Hann (raised cosine), Gauss or Flat top. The first window has the best frequency selectivity (narrowest bandwidth) while the last window allows accurate amplitude measurements. Gauss is in between.
The Flat top window is typically employed on data where frequency peaks are distinct and well separated from each other. If the frequency peaks are not guaranteed to be well separated, the Hann window is preferred because it is less likely to cause individual peaks to be lost in the spectrum.
The frequency range of the spectrum can be selected in the Horizontal section, the maximum frequency is limited to the Nyquist frequency, i.e. ½ sampling rate.
A lower sampling rate yields a narrower frequency lobe and increases the selectivity while a higher sampling rate allows to display a wider frequency range.
Important: Sampling signals with spectral components above the Nyquist frequency leads to aliasing, i.e. the higher spectral components are mirrored into the lower frequency range. This is not a limitation of this device, but should be considered.

The default Reference level of 0 dBV converts a 1 V rms sinusoidal signal into a displayed 0 dB amplitude frequency peak.
Professional audio measurements typically use dBu (aka. dBm),
0 dBu = 0.775 V rms which corresponds to a reference level of -2.2 dBV.

The Minimum magnitude setting hides the noise floor and calms the display; all spectral components below this level are not displayed.

Further functions

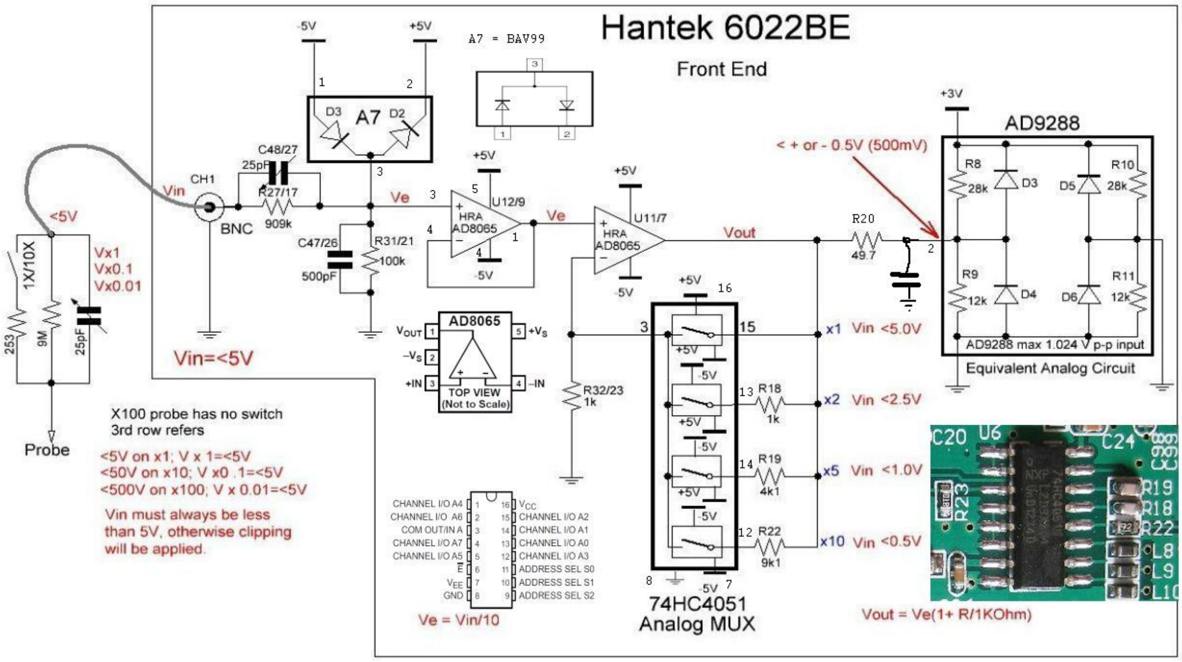
Cursor Measurements

Tbd.

Data Export

Tbd.

Hantek 6022 Analog Front End (1 Channel)



Hantek 6022 Digital Back End