MSO21 Series Instruction Manual

Vimu Electronic Technology

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⚠Note :

- It is necessary to ensure that the voltage entering the device does not exceed the rated maximum input voltage of the device.
- For the desktop USB port, try to use the USB port on the main board of the chassis, and try not to use the USB port led by the USB extension cable. The power supply of the USB port directly output by the motherboard is more stable, which can better ensure the stability of USB transmission.

Computer System Requirements

- Windows 7 and above operating system;
- USB2.0 support ;

MSO21 Series Mixed Signal Oscilloscope Introduction :

The description and introduction of this book cover the following 2 models of mixed signal oscilloscopes MSO21AL and MSO21BL.

This series of products is a high-performance, economical mixed-signal oscilloscope. The functions supported by each model are listed in the table below.

	Oscilloscope	IO	Recorder	Logic analyzer	DDS	Sweeper
MSO21AL	√	√	√	√		
MSO21BL	√	√	√	√	√	√

Main features:

- Dual analog channel input, Differential input，dual channel 12bit ADC 100M real-time sampling rate, each channel bandwidth 10M;
- Rich trigger functions: optional analog or digital IO trigger source; edge and pulse width trigger type support;
- Powerful FFT function, supports 18 types of window functions; maximum 4194304 point FFT ; amplitude, average and peak hold 3 display modes supported; X-axis supports linear and logarithmic switching display ;
- Convenient FIR and IIR filter verification, the classic digital filter designed by QFilter can be used to filter and process the collected waveform in real time; at the same time, it supports the verification and comparison of two filtered waveforms;
- Powerful frame grabbing and playback functions, supporting up to 50,000 waveforms ;
- Single channel DDS analog output, maximum 2.5M sine wave; support sine, square, ramp, pulse, white noise, DC and ARB arbitrary waveform; support continuous, sweep and burst mode ;
- 8 digital IO, support input and output switching; support dual 32bit adjustable pulse output function ;
- Analog channel recorder with a maximum sampling rate of 10M, supporting continuous and uninterrupted recording function, providing long-term anomaly detection capabilities;
- MSO21BL can combine 1-channel DDS+2-channel oscilloscope to form a frequency Sweeper;
- 8 logic analyzer input, maximum 200M real-time sampling rate ;
- Protocol decoder, support analog channel and digital channel decoding ;
- 8MB/32MB large memory depth (*oscilloscope and logic analyzer share RAM*)
- Powerful SDK: cross-platform API and Qt example support (Windows (X86, X64, ARM64), Linux (X64, ARM) has been verified); Labview, Python example support; VmSignal digital signal processing library support

Parameters Table:

Oscilloscope

Channel	2
Impedance	1MΩ 25pF
Maximum real-time sampling rate	100MS/channel
Bandwidth	10MHz
Storage depth	8MB / 32MB①
ADC bits	12Bit
Coupling	AC/DC
Acquire method	Normal, Peak Detect
Voltage range	-24 V~ +24 V (probe X1) -240V~ +240V (probe X10)
Vertical Accuracy	±3%
Time base range	10ns/div-10s/div
Vertical sensitivity	10mV/div ~ 10V/div
Input protection	Diode embedding
Auto configuration	Yes (10Hz to 10MHz)
Trigger source	CH1, CH2 , DIO0-DIO7
Trigger mode	Auto, Normal, Single
Triggering conditions	No trigger, rising edge, falling edge, rising edge/falling edge, pulse width
Trigger level	adjustable
Trigger sensitivity	0.1-1.0 adjustable
Cursor measurement	have
Cursor display	frequency, voltage
Waveform save format	vmmso (proprietary), Excel and Bmp

⚠Waring:

1. Oscilloscope standard probe: X1 can measure -24V to + 24V voltage; X10 can measure -240V to + 240V. Use a probe with higher attenuation if measuring higher voltages.
2. Pay attention to the measurement of 110V/220V mains, not directly, otherwise there is a risk of short circuit. It is necessary to use an isolation transformer for the 110V/220V mains, and then measure after isolation.
3. The voltage standard of IO and logic analyzers is 3.3V, do not connect voltages higher than 3.3V to the IO port.

Spectrum Analyzer (FFT)	
Channel	2
Bandwidth	10MHz
Reference	V, dBV, dBmV, dBmW, dBu
FFT data points	8-1048576 per channel
FFT measurement	Harmonics (1-7), SNR, SINAD, ENOB, THD, SFDR
Window function	Support Rectangle, bartlett, triangular, cosine, hanning, bartlett_hanning, hamming, blackman, blackman_Harris, tukey, Nuttall, FlatTop, Bohman, Parzen, Lanczos, kaiser, gauss, dolph_chebyshev window function
Display method	Amplitude, average, peak hold
X-axis coordinates	linear, logarithmic

Filter Validation

Channel	2
Filter type	FIR window function method, FIR frequency sampling method, IIR
FIR window type	Rectangle, bartlett, triangular, cosine, hanning, bartlett_hanning, hamming, blackman, blackman_Harris, tukey, Nuttall, FlatTop, Bohman, Parzen, Lanczos, kaiser, gauss , dolph_chebyshev
IIR type	Butterworth, Chebyshev I, Chebyshev II, Ellipse

IO	
Digital IOs	8
I/O direction	Input, Output
Output type	0, 1, pulse (high and low double 32bit counter)
Pulse frequency	0.1Hz~10MHz
Pulse duty cycle	0.1~99.9
DAC Channel	1
DAC bits	12bit
DAC voltage range	0~3.2V

Data Recorder	
Channel	2 (shared oscilloscope channels)
Impedance	1MΩ 25pF
Coupling	AC/DC
Vertical resolution	12Bit
Voltage range	- 24 V ~ + 24 V (probe X1) - 240V ~ + 240V (probe X10)
Sampling Rate	1K~10MHz (1, 2, 5 steps)
Log file	Maximum 4G, the recording time is related to the sampling rate

⚠Note:

1. Sample Rate: single channel supports up to 10MHz, dual channel supports up to 5MHz. Because the recorder directly saves the collected data to the hard disk in streaming mode, if the hard disk speed or CPU speed is not enough, the maximum sample rate may not be reached..

Logic Analyzer	
Channel	8 (shared digital DIO channels)
Maximum sampling rate	200 MHz
Support voltage	3.3V

Decoder	
data source	CH1, CH2, DIO0-DIO7 ②
Support protocol	UART, IIC, SPI, CAN ③

DDS (supported by MSO20BL)	
Waveform	sine, square, ramp, pulse, white noise, DC, ARB
Sampling Rate	100MSa/s
DAC	14bit
Storage depth	4K
Output amplitude	±3V
DC bias	± 2V
Frequency Range	Sine 1mHz ~2.5 M Hz

	Square 1 mHz ~ 1 M Hz Ramp 1 mHz ~ 500KHz Pulse 1mHz~1MHz ARB 1mHz ~ 1MHz	
Frequency resolution	1mHz	
Frequency stability	$\pm 1\times 10^{-3}$	
Frequency accuracy	$\pm 5\times 10^{-3}$	
Output impedance	50Ω±10%	
Output amplitude	20mVpp~6Vpp	
Sine wave distortion	≤0.8% (reference frequency 1kHz)	
Square wave characteristics	**Duty cycle**	5 % ~ 95 %
	rise/fall time	< 20 ns (10% ~ 90%, typical, 1 kHz, 1 Vpp)
Ramp wave characteristics	**Linearity**	< 0.1% of peak output, (typical, 1 kHz, 1 Vpp, 100% symmetry)
	Symmetry	0% to 100%
Sweep		
Wave	Sine, Square, Ramp, ARB	
Type	linear	
Direction	up and down	
Sweep time	1ms~100s	
Trigger source	internal, external, manual	
Burst		
Waveform	sine, square, ramp, pulse, white noise, ARB	
Type	N cycle, gate	
Starting phase	0°~ 360°	
Internal cycle	10ms~100s	
Gate source	external trigger (DIO0-DIO7)	
Trigger source	internal, external, manual	

Frequency Scanner (supported by MSO20BL)	
Frequency Range	Sine 1Hz~5.0MHz
Sweep style	Linear, Log
Sweep graphics	Amplitude, Phase
Graphics style	X Linear and Log； Y Linear and Log

①: Support RAM with 8MB and 32MB configurations ;

The oscilloscope and logic analyzer share RAM.

For 8MB RAM, CH1, CH2, and logic analyzers, when one of CH1 and CH2 is turned on, you can collect up to 8MB/2 *(12bit occupies 2 bytes)* = 4MB of data at a time; When two are turned on, you can collect up to 8MB/2/2 *(12bit occupies 2 bytes)* = 2MB of data at a time; When the logic analyzer is turned on, up to 8MB of data can be collected at a time;

For 32MB RAM, CH1, CH2, and logic analyzers, when one of CH1 and CH2 is turned on, up to 32MB/2 *(12bit occupies 2 bytes)* = 16MB of data can be collected at a time; When two are turned on, up to 32MB/2/2 *(12bit occupies 2 bytes)* = 8MB of data can be collected at a time; When the logic analyzer is turned on, up to 32MB of data can be acquired at a time.

②: CH1, CH2 and the logic analyzer cannot be turned on at the same time, only two of them can be turned on at the same time.

③: More protocols are being added, please go to the official website to update the software.

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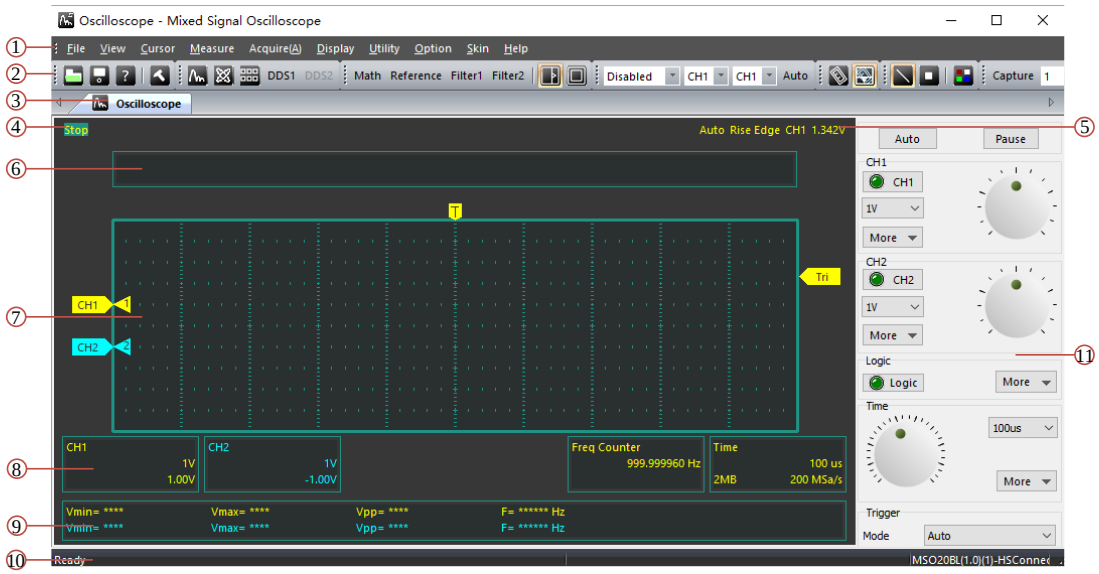
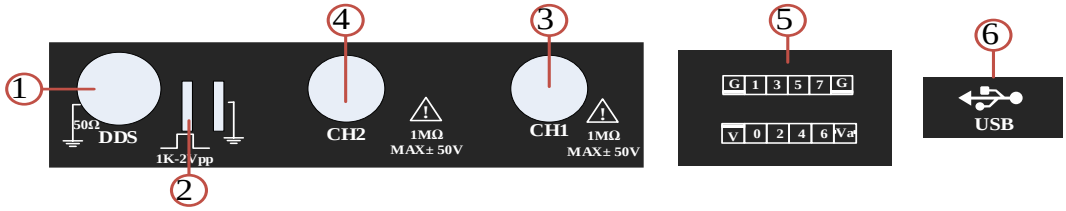
1. Software Basic Operation

1.1. Main interface



①Menu bar
②Toolbar
③Function switching Tab
④Oscilloscope running status display
⑤Trigger status display
⑥Global waveform preview
⑦Waveform display area
⑧Channel label display area
⑨Measurement display area
⑩Status bar
⑪control area

1.2. Hardware Interface Description

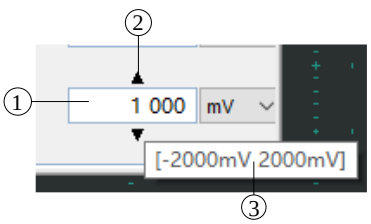


①DDS output port
②1K-2Vpp square wave output port
③Oscilloscope CH1 input port
④Oscilloscope CH2 input port
⑤DIO and logic analyzer interface
G: reference ground
V: 3.3V
Va: DAC output port
0~7: IO port
⑥UBS Type-C interface

1.3. Use of the number edit box

①In the editing area , after the cursor gets the focus, you can directly modify the number.

Note: After the modification of the number is completed, it is necessary to click outside the edit box or other controls to make the edit box lose focus, so that the set number can be made valid and updated.



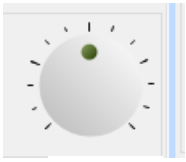
Number Edit Box

② **Fine-tuning arrows** , click the up and down arrows of the fine-tuning, you can directly modify the number, and it becomes valid and updated in real time.

③**The bubble prompt** is used to display the valid input range of the edit box. If it is out of range, there will be an exclamation mark prompt.

1.4. knob

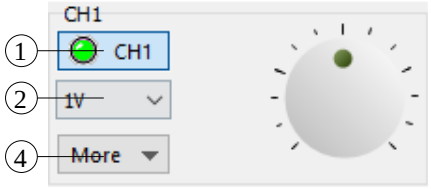
The knob can quickly adjust the scale range, and supports mouse click and drag, scroll wheel and keyboard arrow adjustment.



Knob

2. Vertical System

The MSO20 series has 2 analog channels CH1 and CH2. The vertical control systems of the 2 channels are independent of each other, and the setting methods are exactly the same. The following uses CH1 as an example for introduction.



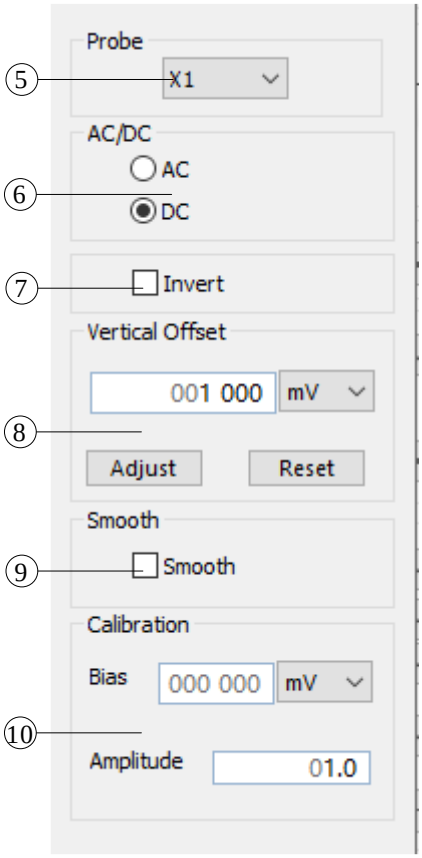
2.1. Basic settings

① CH1 channel control switch:

Turn on/off CH1 channel.

②③Vertical gear:

That is, the voltage value represented by each grid in the vertical direction of the display screen, usually expressed as V/div. When adjusting the vertical scale, the waveform display amplitude will increase or decrease, and the scale information in the channel status label at the bottom of the screen will also change in real time.



0V position as the center, quickly adjust the vertical scale : 

when the mouse is at the label position, roll the mouse wheel, you can quickly adjust the vertical scale of the corresponding channel and zoom the waveform with the label position 0V as the center .

Specify the voltage position as the center, and quickly adjust the vertical scale : the mouse is at  the fast zoom position, and scroll the mouse wheel, and  the corresponding voltage can be centered , and the vertical scale of the corresponding channel can be quickly adjusted to zoom the waveform.

④More

Channel "More" settings menu control button.

2.2. More settings

⑤ Probe ratio:

The attenuation ratio of the probe. There is a switch on the oscilloscope probe to adjust the attenuation ratio of the probe.

For example, if the probe switch is set to X10, the probe will attenuate the signal by 10 times, and then input the channel CH1; now if the software is set to X1, the displayed signal is 1/10 of the measured signal; if the software is adjusted to X10, the software will multiply the measured voltage by With 10, the software can display the same amplitude as the measured signal.

⑥Coupling :

Set the channel's AC and DC coupling to filter out unwanted signals.

For example: The measured signal is a square wave signal with DC bias.

● When the coupling mode is "DC": Both the DC component and the AC component contained in the signal under test can pass through.

● When the coupling mode is "AC": the DC component contained in the signal under test is blocked.

⑦Invert :

The signal read back from the measurement is displayed in reverse phase.

Quickly adjust the probe ratio, coupling and inversion: When the mouse is at CH1 the label position, click the right mouse button to pop up a quick setting menu for setting.

⑧Vertical offset:

Vertical offset, that is, the offset of the channel signal zero position of the waveform in the vertical direction relative to the center of the screen.

- The vertical offset can be adjusted by dragging the channel offset label ;CH1
- The digital edit box in ⑧ can directly set the offset;
- The "fine-tuning" button can fine-tune the offset and adjust the offset label to the nearest scale position; double- CH1 click the mouse at the label position to quickly fine-tune the offset;
- The "Reset" button can reset the offset and adjust the offset label to the 0 scale position; CH1 click the middle mouse button on the label position to quickly reset the offset.

⑨Smooth processing:

This function simply averages 3 points of the collected signal to achieve the effect of smooth waveform; if you want more accurate filtering processing, please use QFilter to design the filter, and use Filter1 and Filter2 to verify the effect.

⑩Channel Calibration:

When leaving the factory, the device has been calibrated, and generally do not adjust the settings here.

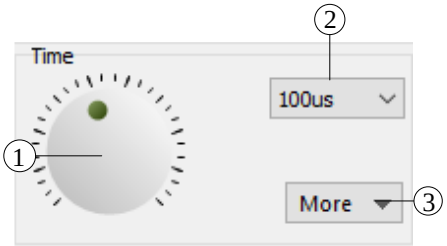
Amplitude calibration: For example, input 3.0V, the measurement result is 3.2V, just fill in the result of 3.0/3.2 into the amplitude calibration.

Offset calibration (mV): For example, the input signal is a sine wave from -1V to 1V, and the measurement result is -0.9V to 1.1V. Just fill in the offset calibration with -100.

3. Horizontal System and Sampling System

3.1. Horizontal system

Horizontal time base (also known as horizontal scale), that is, the time value represented by each division in the horizontal direction of the display screen, usually expressed as s/div. The adjustable range of the horizontal time base is related to the model.



① ②Horizontal time base:

①The time base can be adjusted quickly;

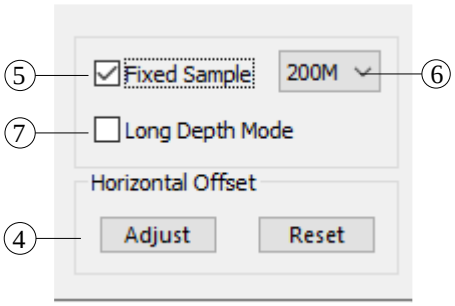
②The time base scale can be adjusted directly.

④Horizontal offset:

The offset of the time zero position of the waveform relative to the center of the screen in the horizontal direction.

- The horizontal offset can be adjusted by dragging the horizontal offset label;
- The "fine-tuning" button can fine-tune the horizontal offset, and adjust the horizontal offset label to the nearest scale position; double-click the mouse at the label position to quickly fine-tune the offset;
- The "Reset" button can reset the horizontal offset and adjust the offset label to the 0 scale position; click the middle mouse button on the label position to quickly reset the offset.

3.2. Sampling system



⑤⑥Fixed sampling rate:

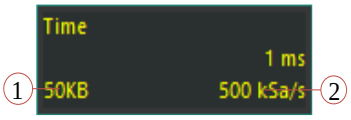
Turn off the automatic adjustment of the sampling rate according to the time base, and fix the sampling rate to the sampling rate selected by ⑥ .

⑦ Long storage mode:

The storage depth refers to the number of waveform points that the oscilloscope can store in one trigger acquisition. It reflects the storage capacity of the acquisition memory.

In the long memory mode, the screen update frequency will be reduced, but the number of waveform points acquired each time will be longer.

Note: When the trigger mode is single and normal, the long storage mode is automatically turned on.



Sampling Rate:

Sampling is a process in which the oscilloscope converts analog signals into digital signals at certain time intervals and stores them sequentially. The sampling rate is the reciprocal of this interval.

①Sampling rate and ②Storage depth are displayed in the time base tab bar at the bottom of the screen at the same time, and the sampling rate can be changed indirectly through the horizontal time base or modifying the fixed sampling rate.

Note: Keep the sampling rate more than 2 times of the signal under test. If the sampling rate is too low, it will cause distortion of the acquired waveform, waveform aliasing or waveform loss.

Logic analyzer sample rate:

The sampling rate of the logic analyzer refers to the process that the oscilloscope collects the compared digital signals according to a certain time interval, and the sampling rate of the logic analyzer is the reciprocal of the time interval. The sampling rate of the logic analyzer is always the same as the sampling rate of the analog channels.

Acquire method:

The acquisition method is used to control how to generate waveform points from sample points. The menu "acquire method" can set the sampling point acquisition method. This series of oscilloscopes supports two methods: normal and peak detection.

- normal

  In this mode, the oscilloscope samples the signal at equal time intervals to reconstruct the waveform. For most waveforms, using this mode can produce the best display effect.

- peak detection

  In this mode, the oscilloscope collects the maximum and minimum values of the signal within the sampling interval to obtain the envelope of the signal or narrow pulses that may be lost. Using this mode can avoid signal aliasing, but the displayed noise is relatively large. In this mode, the oscilloscope can display all pulses at least as wide as the sampling period.

4. Trigger System

Triggering refers to setting certain trigger conditions according to requirements. When a certain waveform in the waveform stream meets this condition, the oscilloscope will capture the waveform and its adjacent parts immediately and display them on the screen. When a digital oscilloscope is working, no matter whether the instrument is triggered stably, it is always collecting waveforms continuously, but only when the trigger is stable can it have a stable display. The trigger module ensures that each time base scan or acquisition starts from the trigger condition defined by the user, that is, each scan is synchronized with the acquisition, and the captured waveforms overlap to display a stable waveform.

①Trigger mode:

MSO20 series oscilloscopes provide three trigger modes: Auto (Auto), Normal (Normal) and Single (Single), and the default is Auto (Auto).

● Auto (Auto): In this trigger mode, if the specified trigger condition is not found, the oscilloscope will be forced to trigger and acquire to display the waveform. This trigger mode is suitable for unknown signal levels or when DC needs to be displayed, and when trigger conditions occur frequently and no forced trigger is required.

● Normal: In this trigger mode, the oscilloscope will trigger and acquire only when the specified trigger condition is found. This trigger mode is suitable for low repetition rate signals, when it is only necessary to acquire specific events specified by the trigger settings, and when it is necessary to prevent the oscilloscope from automatically triggering in order to obtain a stable display.

● Single: In this trigger mode, only when the specified trigger condition is found, the oscilloscope will trigger and acquire once, and then stop. This trigger mode is applicable to the situation where only a single acquisition of a specific event is required and the acquisition results are analyzed. After the Single is triggered, the running state of the oscilloscope is "Stop".

②Trigger source:

Both analog channels CH1-CH2 and digital channels DIO0-DIO7 can be used as trigger sources. The channel used as the trigger source can work normally whether it is opened or not. It should be noted that if the DIO is set to output mode, the trigger may not work properly.

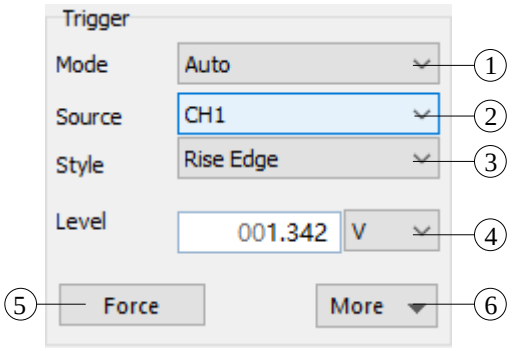
③Trigger type:

MSO20 series oscilloscopes support edge and pulse width trigger types.

- edge trigger

  Edge trigger supports rising edge, falling edge and rising/falling edge.

  ■ Rising edge: Trigger on the rising edge of the input signal and the voltage level meets the set trigger



level.

- Falling edge: Trigger on the falling edge of the input signal and the voltage level meets the set trigger level.
- Rising/Falling Edge: Trigger on the rising or falling edge of the input signal and when the voltage level meets the set trigger level.

- pulse width trigger

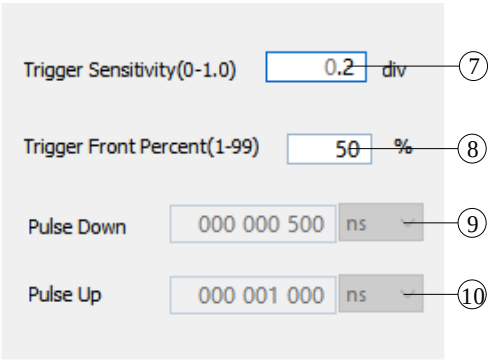
  Trigger on positive or negative pulses of specified width. Pulse width trigger supports positive pulse width (>), positive pulse width (<), positive pulse

Width (<>), Negative Pulse Width (>), Negative Pulse Width (<), and Negative Pulse Width (<>).

- Positive Pulse Width (>): Trigger when the positive pulse width of the input signal is greater than the "Pulse Width Upper Limit".
- Positive Pulse Width (<): Trigger when the positive pulse width of the input signal is smaller than the "Pulse Width Lower Limit".
- Positive Pulse Width (<>): trigger when the positive pulse width of the input signal is between the "Pulse Width Lower Limit" and "Pulse Width Upper Limit".
- Negative Pulse Width (>): Trigger when the negative pulse width of the input signal is greater than the "Pulse Width Upper Limit".
- Negative Pulse Width (<): Trigger when the negative pulse width of the input signal is smaller than the "Pulse Width Lower Limit".
- Negative Pulse Width (<>): trigger when the negative pulse width of the input signal is between the "Pulse Width Lower Limit" and "Pulse Width Upper Limit".

④Trigger level:

Set the trigger threshold voltage of CH1 and CH2 analog channels.



⑤ Force trigger:

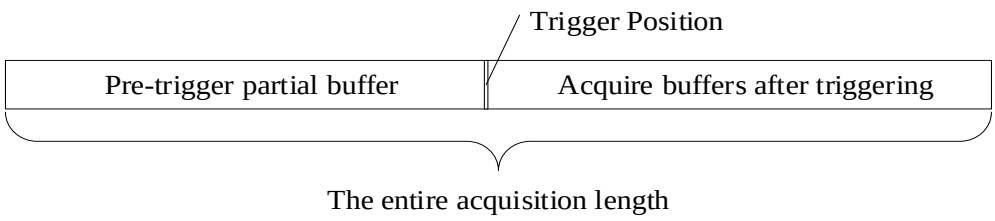
When the trigger mode is Normal, click the "Force" button to force a waveform to be collected and displayed.

⑦Trigger sensitivity:

When detecting a trigger, how much sensitivity is used to eliminate glitch interference.

⑧ Pre-trigger ratio:

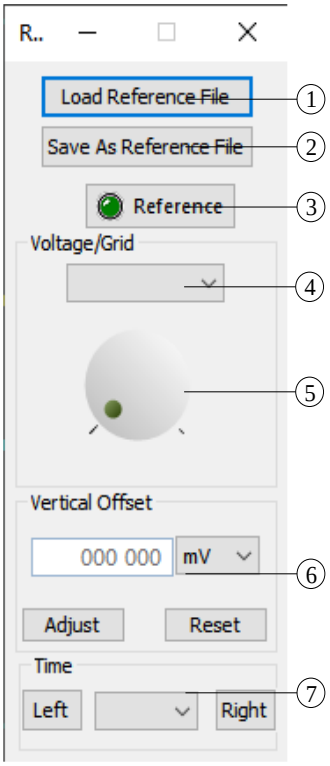
Sets the fraction of the pre-trigger portion of the buffer.



⑨⑩Pulse width upper limit/pulse width lower limit:

Set the upper limit and lower limit time of the pre-trigger pulse width.

5. Reference Waveform



The acquired waveform can be kept as a reference waveform file; when the reference waveform file is opened, it can be displayed as a comparison waveform.

① Load the reference file:

Open the reference file.

②Save as a reference file:

Save the waveform of CH1 and CH2 as reference files.

③Reference waveform switch:

Turns the reference file waveform on or off.

④Vertical scale:

Adjust the vertical scale of the reference waveform.

⑤Vertical offset:

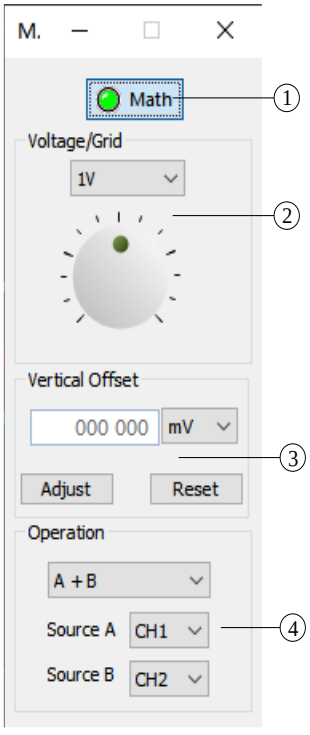
Vertical offset, that is, the offset of the channel signal zero position of the waveform in the vertical direction relative to the center of the screen.

- The vertical offset can be adjusted by dragging the channel offset label ;
- The digital edit box in ⑤ can directly set the offset;
- The "fine-tuning" button can fine-tune the offset and adjust the offset label to the nearest scale position; double-click the mouse at the label position to quickly fine-tune the offset;
- The "Reset" button can reset the offset and adjust the offset label to the 0 scale position; click the middle mouse button on the label position to quickly reset the offset.

⑥ Time axis:

Adjust the time base offset of the referenced waveform.

6. Math



Math supports adding, subtracting, multiplying and dividing the waveform of channel A and channel B.

① Math channel switch:

Turn on/off the Math channel.

②Vertical scale:

Adjust the vertical scale of the Math waveform.

③Vertical offset:

Vertical offset, that is, the offset of the channel signal zero position of the waveform in the vertical direction relative to the center of the screen.

- The vertical offset can be adjusted by dragging the channel offset label ;
- ③ The digital edit box in ③ can directly set the offset;
- The "fine-tuning" button can fine-tune the offset and adjust the offset label to the nearest scale position; double-click the mouse at the label position to quickly fine-tune

the offset;

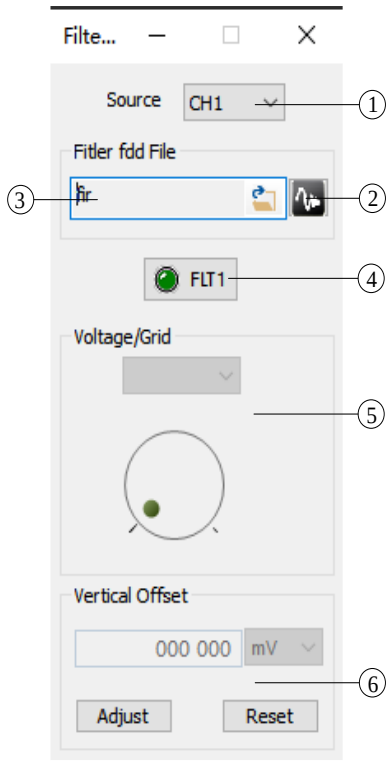
- The "Reset" button can reset the offset and adjust the offset label to the 0 scale position; Math click the middle mouse button on the label position to quickly reset the offset.

④Mathematical operation:

Set Math's data source A, data source B and operation method.

7. Filter

Directly use the digital filter designed by QFilter to filter the collected data and display the filtering result in real time. It is convenient to view and compare the filtering effect of the filter. The settings of Filter1 and Filter2 are exactly the same, and the following uses Filter1 as an example to introduce.



① Filter data source selection:

Support CH1, CH2, Ref and Math as the data source of Filter.

②QFilter digital filter software:

Start the QFilter digital filter design software.

③Filter fdd file selection:

QFilter design file selection, and display the corresponding file name.

④Filter1 channel switch:

Turn on/off Filter1 channel.

⑤Vertical scale:

Adjust the vertical scale of the Filter1 waveform.

⑥Vertical offset:

Vertical offset, that is, the offset of the channel signal zero position of the waveform in the vertical direction relative to the center of the screen.

- The vertical offset can be adjusted by dragging the channel offset label ;FLT1
- The digital edit box in ⑥ can directly set the offset;
- The "fine-tuning" button can fine-tune the offset and adjust the offset label to the nearest scale position; double- FLT1 click the mouse at the label position to quickly fine-tune the offset;
- The "Reset" button can reset the offset and adjust the offset label to the 0 scale position; FLT1 click the middle mouse button on the label position to quickly reset the offset.

8. Measurement

8.1. Automatic measurement

8.1.1. automatic button

After connecting the input signal, click Auto the measurement button to start the automatic measurement function of the oscilloscope. The software will be based on The amplitude and frequency of the input signal are automatically adjusted on the vertical and horizontal scales.

Note: The waveform auto-setting function requires that the frequency of the signal is not less than 50 Hz, and the amplitude is not less than 50 mV. If this parameter condition is not satisfied, the

waveform auto-setting function may not work.

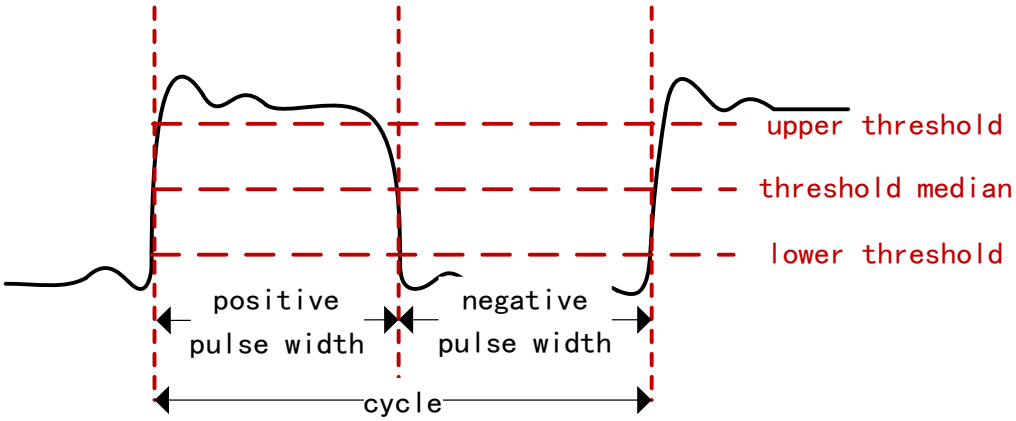
8.1.2. Measurement parameters

Click the menu "Measurement"->"Measurement" to open the measurement parameter interface supported by each channel.

Click the menu "Measurement" -> "Measurement Display" to open/close the measurement parameter display area at the bottom of the software.

Note: If there is no signal input from the current measurement source, or the measurement result is not within the valid range (too large or too small), the measurement result will be invalid, and "*****" will be displayed on the screen, please re-input the signal or set the signal.

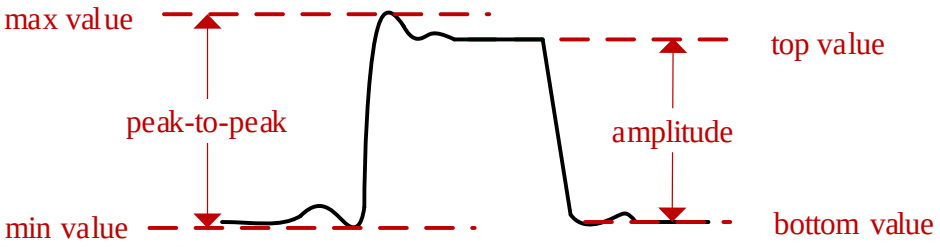
Time parameter



Note: The default values for Upper Threshold, Mid Threshold and Lower Threshold are 90%, 50% and 10% respectively.

1. **Period:** Defined as the time between the mid-threshold crossings of two consecutive, like-polarity edges.
2. **Frequency:** Defined as the reciprocal of period.
3. **Positive pulse width:** The time difference from the mid-threshold value of the rising edge of a pulse to the mid-threshold value of the immediately following falling edge.
4. **Negative pulse width:** The time difference from the threshold midpoint of the falling edge of a pulse to the threshold midpoint of the immediately following rising edge.
5. **Positive duty cycle:** The ratio of positive pulse width to period.
6. **Negative duty cycle:** The ratio of negative pulse width to period.

Voltage parameter



1. **Maximum value:** the voltage value from the highest point of the waveform to GND (ground).
2. **Minimum value:** the voltage value from the lowest point of the waveform to GND (ground).
3. **Peak-to-peak value:** the voltage value from the highest point to the lowest point of the waveform.
4. **Top value:** the voltage value from the flat top of the waveform to GND (ground).
5. **Bottom value:** the voltage value from the flat bottom of the waveform to GND (ground).
6. **Amplitude:** the voltage value from the top to the bottom of the waveform.
7. **Average:** The arithmetic mean over the entire waveform area. Calculated as follows:

$$\text{Average} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Among them, x_i is the measurement result of the i-th point, and n is the number of measured points.

8. **RMS value:** the root mean square value on the entire waveform or gated area, the calculation formula is as follows.

$$\text{RMS} = \sqrt{\frac{\sum_{i=1}^{n} x_i^{\,2}}{\text{n}}}$$

Among them, x_i is the measurement result of the i-th point, and n is the number of measured points.

9. **Period effective value:** root mean square value within a period, the calculation formula is as above.
10. **Standard Deviation:** The root mean square value of the waveform with the DC component removed. Calculated as follows:

$$\text{StdDev} = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - Average\right)}{\text{n}}}$$

Among them, x_i is the amplitude value of the i-th point, Average is the average value of the waveform, and n is the number of measured points.

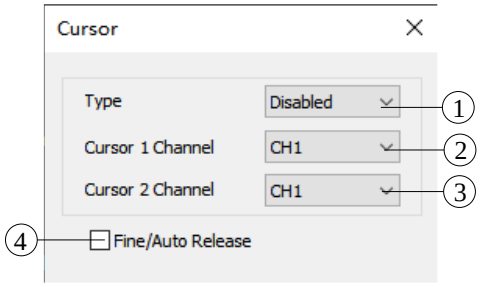
8.2. cursor measurement

Use the cursors to measure the X-axis value and Y-axis value of the selected waveform.

Before measuring with cursors, connect the signal to an oscilloscope and obtain a stable display.

The menu "Cursor" can open the cursor measurement dialog box or the toolbar 

also provides the same settings. The cursor measurement function provides three measurement cursors of X/Time, Y/Voltage and Track.



①Type :

Cursor type selection.

②Cur1 data source:

Select the Cur1 data source.

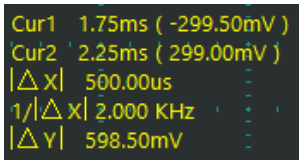
③Cur2 data source:

Select the Cur2 data source.

④Fine adjustment/automatic release:

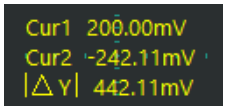
The cursor supports selection and the switch of the scroll wheel movement function.

8.2.1. X/Time



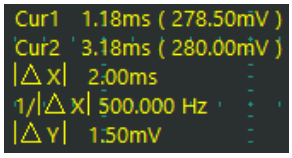
- Cur1: Cursor Cur1 X value and Y value
- Cur2: Cursor Cur2 X value and Y value
- |ΔX|: The absolute value of the difference between the X value of the cursor Cur1 and the X value of the cursor Cur2
- 1/|ΔX|: The reciprocal of the absolute value of the difference between the X value of the cursor Cur1 and the X value of the cursor Cur2
- |ΔY|: The absolute value of the difference between the Y value of the cursor Cur1 and the Y value of the cursor Cur2

8.2.2. Y/Voltage



- Cur1: Y value of cursor Cur1
- Cur2: Y value of cursor Cur2
- |ΔY|: The absolute value of the difference between the Y value of the cursor Cur1 and the Y value of the cursor Cur2

8.2.3. track



- Cur1: Cursor Cur1 X value and Y value
- Cur2: Cursor Cur2 X value and Y value
- |ΔX|: The absolute value of the difference between the X value of the cursor Cur1 and the X value of the cursor Cur2

- 1/|ΔX|: The reciprocal of the absolute value of the difference between the X value of the cursor Cur1 and the X value of the cursor Cur2
- |ΔY|: The absolute value of the difference between the Y value of the cursor Cur1 and the Y value of the cursor Cur2

8.3. hardware frequency counter

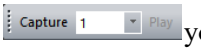
The hardware frequency counter can display the frequency of the trigger channel of the oscilloscope in real time. Switching the trigger source can switch the data source of the hardware frequency counter.

9. Frame Grab and Playback

The frame capture function can save each frame of data collected by the oscilloscope as a separate vmmso file in real time. A frame capture can capture up to 50,000 frames of data, which will be automatically divided into a group for easy playback and viewing.

Playback function, you can import the entire set of captured frame data into the playback dialog box at a time, and support manual and automatic playback of data.

9.1. Frame capture

In the frame capture toolbar, 

you can set the number of frames to be captured once and start the frame capture function. After the set number of frame captures is completed, the frame capture button will return to the unselected state.

9.2. play back

①File list:

Load file list.

② Loading:

Select the filegroup to load.

③Same capture frame:

Whether to load the same set of files at once.

④ Previous frame:

Display the previous frame data.

⑤Play :

Display current frame data.

⑥ Next frame:

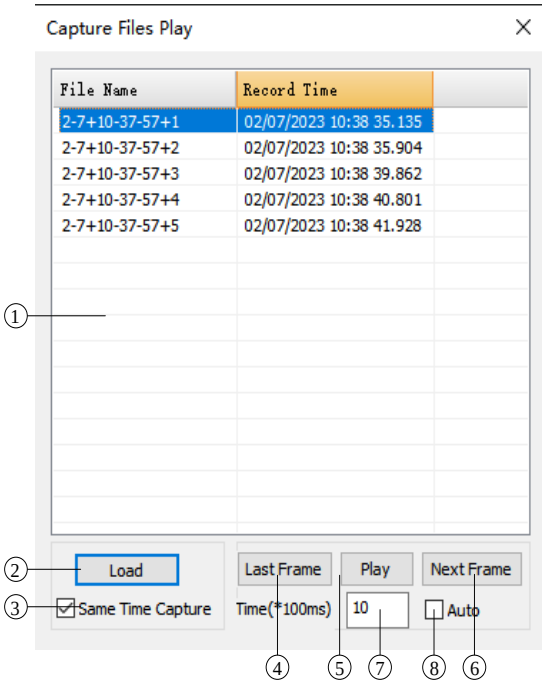
Display the next frame of data .

⑦ Autoplay time interval:

Autoplay time interval N*100ms .

⑧Auto play:

Autoplay loads groups of files.



10. Passed Test

10.1. Control settings

①Signal source:

Select the channel that passed the test.

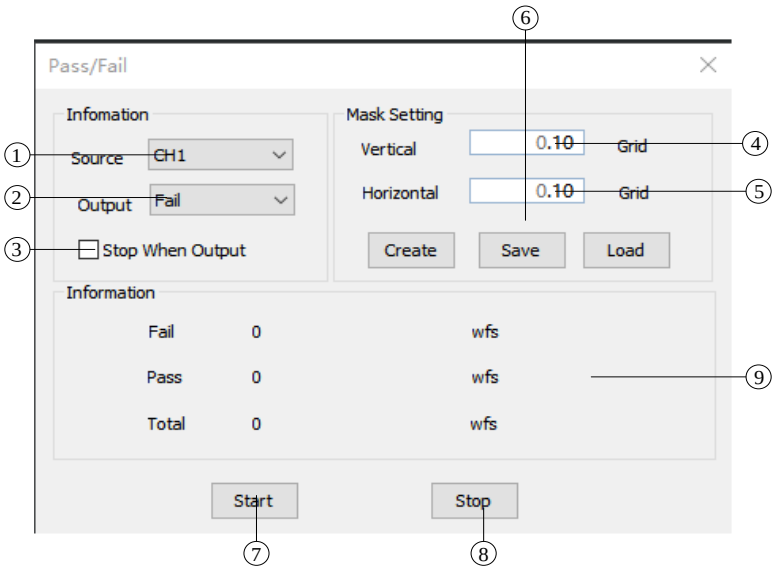
②Output:

Output when Pass or Fail is selected.

③The output stops immediately:

Pause acquisition when the output condition is met.

10.2. Rule settings:



④ Vertical:

Vertical Tolerance Range for Rules

⑤ level;

Rule Horizontal Tolerance Range

⑥ Create, save and load:

Create, save and load saved rule files .

⑦Start :

Start passing tests.

⑧Stop:

Stop passing the test.

⑨Information display:

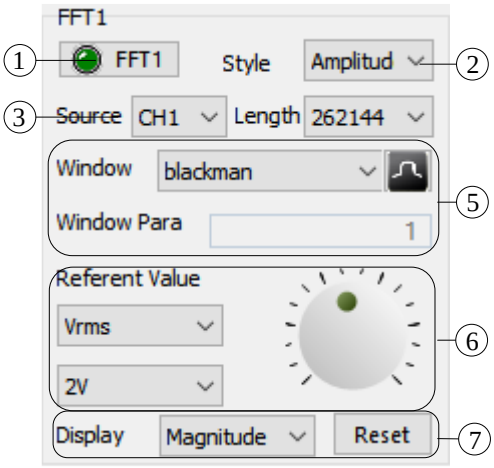
Display pass and fail statistics.

11. Spectrum (FFT)

The software supports 2 FFT channels. The control systems of the two channels are independent of each other, and the setting methods are exactly the same. The following takes FFT1 as an example for introduction.

Click the toolbar  icon to open the FFT spectrum interface.

11.1. FFT parameters



① FFT1:

FFT channel switch.

②Style:

Choose to display amplitude frequency, phase frequency.

③Signal source:

Select the signal source for the FFT channel.

④ Points:

Sets the number of points for the FFT.

⑤ window:

Window Type: Select the type of FFT windowing.

Button  : It can start the window characteristic software, which is used to display the time-domain and frequency-domain characteristic diagrams of the corresponding window function.

Window parameters: set the parameters of the window

⑥Reference value:

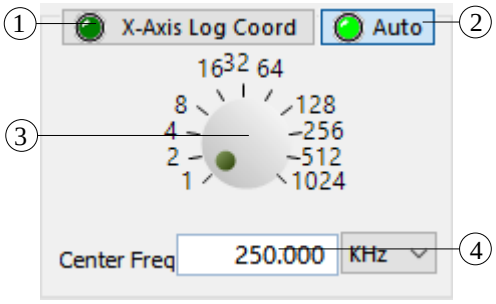
Sets the scale and units for the reference value .

⑦Display :

Set the display mode: amplitude, average and peak hold.

Reset: The average and peak hold data can be cleared and recalculated.

11.2. X axis setting



① X-axis logarithmic coordinates:

Display the x-axis logarithmically.

② Automatic:

Whether to automatically adjust the center frequency when switching the X-axis coordinate display mode.

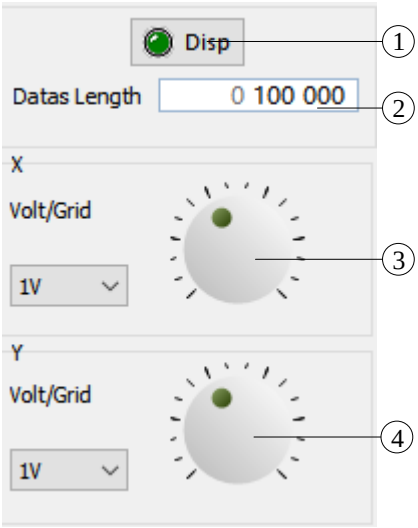
③X-axis enlargement ratio:

Select the data magnification scale for the X-axis.

④ Center frequency:

Set the frequency of the X-axis center point of the waveform.

12. Lissajous Graphics



Click the toolbar  icon to open the Lissajous interface.

①Display :

Lissajous graph switch.

②Data length:

Sets how much data is used to draw the Lissajous graph.

Note: If the data length is greater than the acquisition length of the oscilloscope, the acquisition length will be used to draw the graph.

③X:

Sets the voltage scale for the X-axis.

④ Y:

Sets the voltage scale for the Y-axis.

13. IO

Click the toolbar  icon to open the IO interface. DIO0~DIO7, the setting method is exactly the same. Let's take DIO0 as an example to introduce.

13.1. DIO

Logic analyzers, oscilloscope triggers, and DDS gating all use IO ports. When IO is used as input, it can be multiplexed. For example, if the oscilloscope triggers and selects DIO0, then DIO0 can also be used as the gate signal of DDS. If the IO port is blocked by other functions, it will turn gray if it cannot be set.

① IO switch:

Open and close the IO port.

②Input/Output:

Input and output switching.

③Input status:

Display the high and low level status of IO port input.

④ Output value:

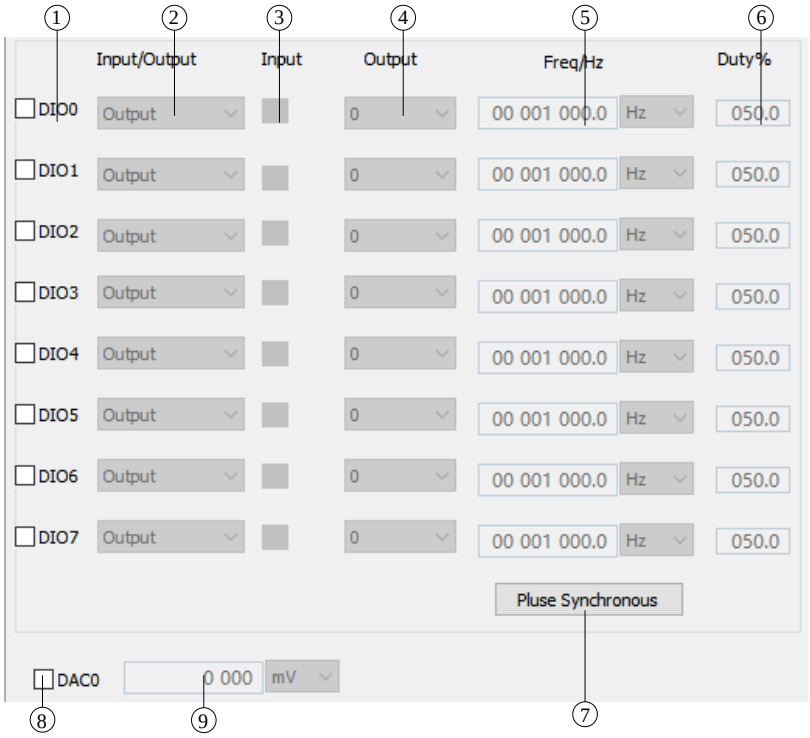
Set the output state of the IO port. Can be 0, 1 or pulse.

Pulse is output by 100Mhz CLK after frequency division by high 32bit counter and low 32bit

calculator.

Set the two 32bit counters by setting the frequency and duty cycle. 100M/frequency = high 32bit counter + low 32bit counter; duty cycle can adjust the ratio of high and low counters.

Note: At high frequencies, the duty cycle setting and output may deviate. For example, the pulse output is 10MHz, and the duty cycle is 45%. 100M/10M=10, 10*45%=4.5, the counter is an integer, so only 4 CLKs are high and 6 CLKs are low, and the actual output duty cycle is 40%.



⑤ Frequency;

Pulse frequency setting.

⑥Duty cycle:

Pulse duty cycle setting.

⑦ Multi-channel pulse synchronization:

The rising edges of multiple pulse channels can be aligned.

13.2. DAC

The DAC can output an adjustable voltage of 0~3.2V.

⑧DAC switch :

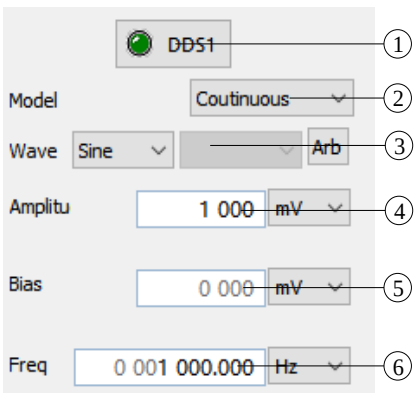
Turns the DAC output on and off .

⑨ Voltage :

Sets the output voltage of the DAC .

14. DDS

Click the toolbar DDS1 icon to open the DDS interface. DDS supports three modes: continuous, sweep and burst.



① DDS switch:

Turns on and off the DDS output .

② Mode switching :

Switch DDS output mode .

14.1. continuous

③Waveform:

Set the DDS output waveform type .

The storage location of ARB waveform is, software installation directory\dds-waves\8192.

Click the ARB button to open the VmArb DDS waveform generation software. Save the generated file mif to .\dds-waves\8192, which can be selected and set as output.

the WIDTH of the mif file should be 14 , the number of bits of the DAC should be 14bit; the DEPTH should be 8192 , and the storage depth of the DDS should be 8192 ;

④Amplitude:

Set the DDS output amplitude .

⑤ Offset:

Set the DDS output offset .

⑥Frequency:

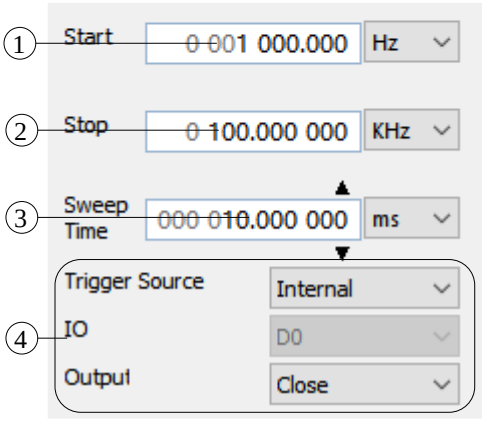
Set the DDS output frequency .

14.2. frequency sweep

Waveform, amplitude, and offset are the same as the continuous mode settings.

①Start frequency :

Set the sweep start frequency .



②Cut -off frequency :

Set the sweep cutoff frequency .

③Sweep time :

Set the scan duration .

④Trigger source :

Set the DDS trigger source.

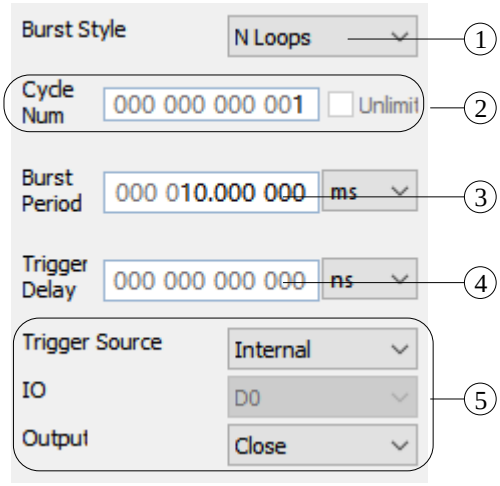
Internal: DDS internal timer triggers automatically. "Output" can synchronously output the start position of frequency sweep in the way of rising edge or falling edge, and the output port can use any one of DIO0~DIO7.

External: Use the rising edge or falling edge of any IO port of DIO0~DIO7 as the trigger of DDS frequency sweep.

Manual: Click the "Manual trigger" button to start the frequency sweep.

14.3. Burst

Waveform, amplitude, and offset are the same as the continuous mode settings. "Start Phase" can set the start phase of burst waveform.



①Burst type :

Burst type supports N cycle and gating .

14.3.1. N cycle

②Number of cycles :

Set the number of cycles of the burst waveform . "Infinite" can keep the number of cycles going until DDS is turned off.

③Burst cycle :

Set the burst period .

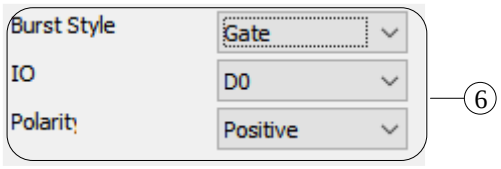
④Trigger delay :

setting the trigger, how long to delay to start outputting the burst waveform .

⑤ trigger source ;

Set the DDS trigger source .

Internal: DDS internal timer triggers automatically. "Output" can output the start position of the burst waveform synchronously in the way of rising edge or falling edge, and the output port can use any one of DIO0~DIO7.



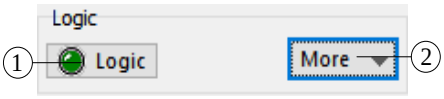
External: Use the rising edge or falling edge of any IO port of DIO0~DIO7 as the trigger of DDS burst waveform.

Manual: Click the "Manual trigger" button to start the frequency sweep.

14.3.2. gate

⑥ Gate control :

Set the IO port and polarity of the gate.



15. Logic Analyzer

① Logic :

Turn on/off the logic analyzer .

②More :

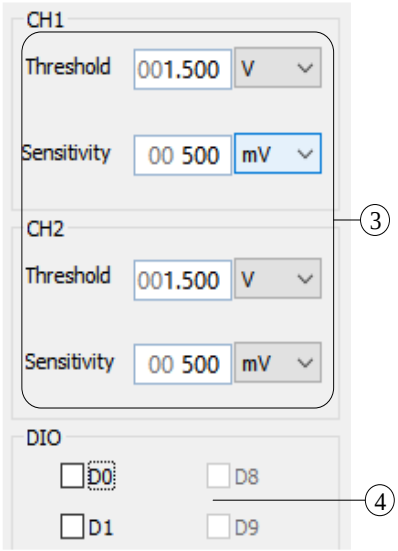
Open the more parameter setting interface of the logic analyzer.

③Threshold and Sensitivity:

Sets the threshold and sensitivity voltage for converting analog channel voltages to digital logic .

④ DIO :

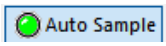
Check Show logic analyzer data channels .



16. Decoder

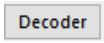
The decoder can decode and process the data of analog and digital channels according to the set protocol .

Auto Sample Rate:

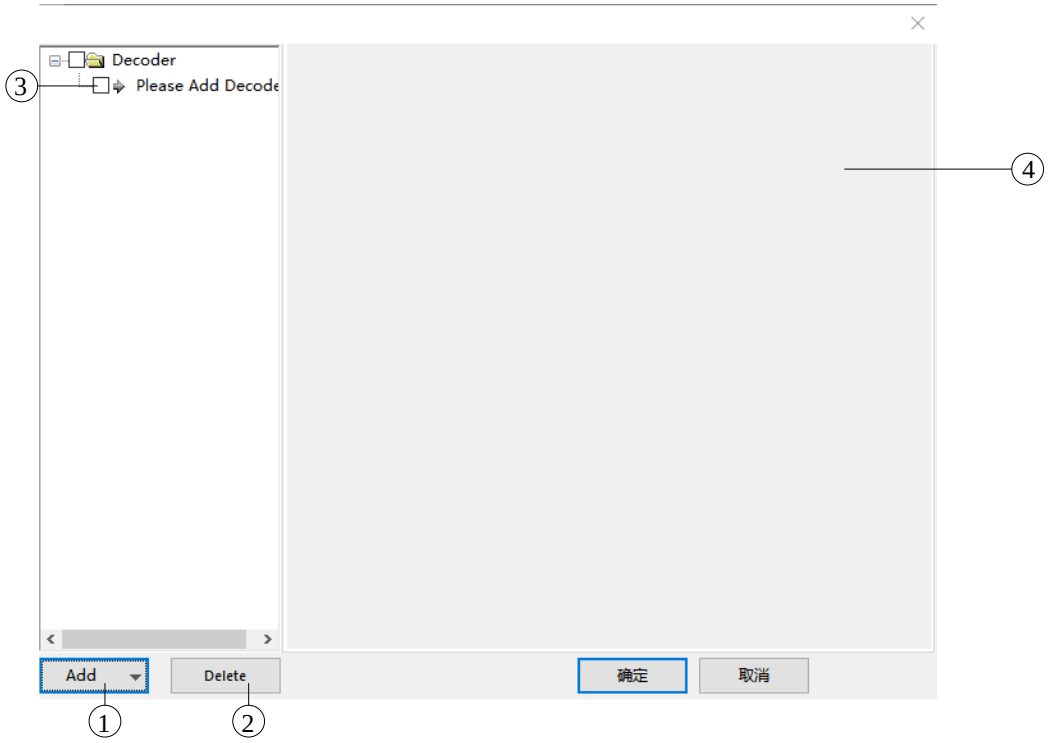
Button 

to turn on the auto sample rate function (on by default).

Automatic sampling rate, which can automatically turn on the fixed sampling rate function, and set the horizontal sampling rate, the protocol setting baud rate or 20 times or more of the CLK frequency; avoid under-sampling leading to incorrect data collection. If the protocol used has no baud rate or CLK frequency, the horizontal sample rate will be set to the maximum sample rate. Fixed sampling rate, which can be modified at the time base, more buttons, and fixed sampling rate.

Click 

the button to open the decoder setting interface.



16.1. Main interface

①Increase :

Add protocol decoder .

②Delete :

Remove a protocol decoder.

③Decoder list :

Displays the list of decoder that have been added .

④Protocol settings :

Set the corresponding parameters of the protocol .

16.2. Quick Setup

On the Protocol tab 

, click the right mouse button to pop up the Quick Settings menu. You can close the corresponding protocol display, modify the data display format and export the data.

There are two buttons on the left and right of the display channel of the protocol analysis 

, which can quickly display the entire part of the decoder with data.

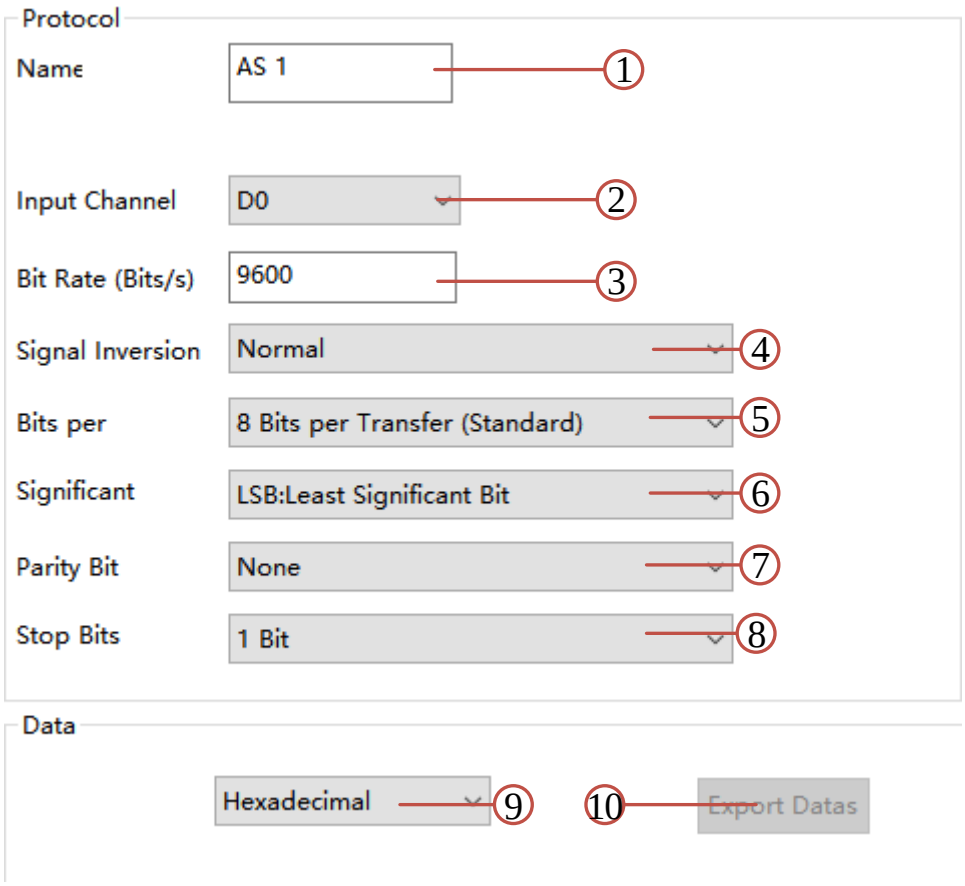
16.3. Async Serial (UART) protocol

Async Serial A decoder can only analyze data from one source. For UART, there are two sources of RX and TX, and two decoders can be added for analysis.

DIO0~DIO7 only support 3.3V voltage. When collecting the pins of RS232 and RS485 transceiver chips, if the level is not 0-3.3V, you need to use the analog channels CH1 and CH2 to collect.

①Name :

Interface protocol label display name .



② Source :

The data source for the decoder.

③Baud rate :

Set the baud rate of the protocol .

④ Polarity :

RS232 stipulates that the level of logic "1" is -5V~-15V, and the level of logic "0" is +5V~+15V. When collecting RS232, it needs to be set to Inverted.

⑤ data bit ;

How many bits of data are transferred at a time.

⑥Bit sequence :

MSB-first, LSB-first selection .

The UART default LSB generally does not need to be modified.

⑦Validation method :

Calibration method selection .

⑧ Stop bit :

Stop bit setting .

⑨Display format :

Data format setting for decoder display .

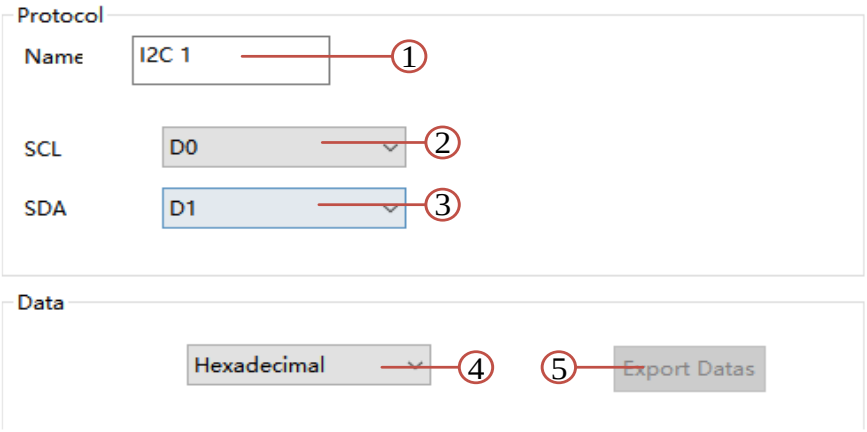
⑩Export data :

Save the result of the decoder to a file .

16.4. IIC protocol

Do not mix analog channels CH1, CH2 and digital channels DIO0~DIO7 together, because

different types of channels have different ways of processing data at the pre-stage, which will cause a time difference; it may lead to incorrect protocol analysis results.



①Name :

Interface protocol label display name .

②③Information source SCL, SDA :

The data source for the decoder.

④ Display format :

Data format setting for decoder display .

⑤ Export data :

Save the result of the decoder to a file .

16.5. SPI protocol

Do not mix analog channels CH1, CH2 and digital channels DIO0~DIO7 together, because different types of channels have different ways of processing data at the pre-stage, which will cause a time difference; it may lead to incorrect protocol analysis results.

①Name :

Interface protocol label display name .

②③④ ⑤Information sources MOSI, MISO, SCK and CS :

The data source for the decoder.

⑥Data digits :

The number of data bits transferred at one time.

⑦Bit sequence :

MSB-first, LSB-first selection .

⑧ Clock Polarity (CPOL) :

Clock polarity selection .

⑨ Clock sampling edge (CPHA) :

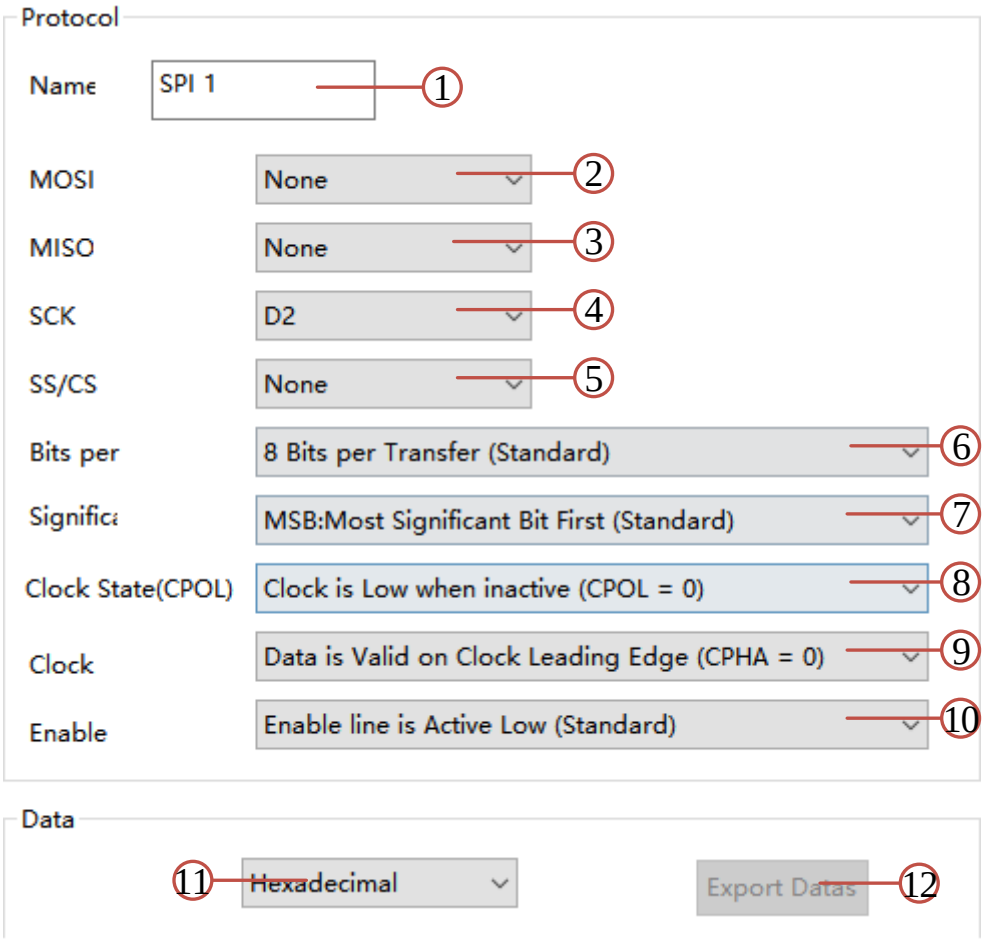
Clock sampling edge selection .

⑩Display format :

Data format setting for decoder display .

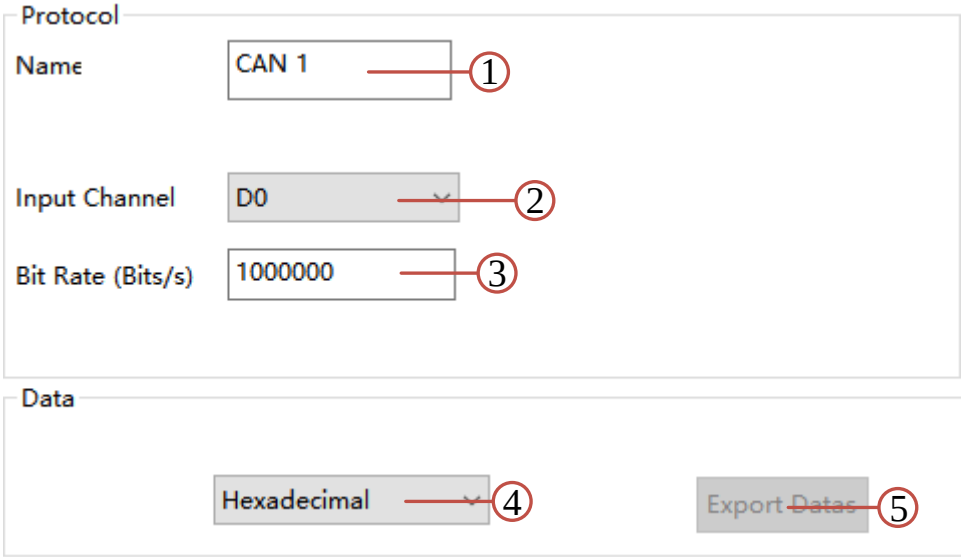
⑪Export data :

Save the result of the decoder to a file .



16.6. CAN protocol

DIO0~DIO7 only support 3.3V voltage. When collecting the pins of the CAN transceiver chip, if the level is not 0-3.3V, you need to use the analog channels CH1 and CH2 to collect.



①Name :

Interface protocol label display name .

② Source :

The data source for the decoder.

③Baud rate :

Set the baud rate of the protocol .

④ Display format :

Data format setting for decoder display .

⑤ Export data :

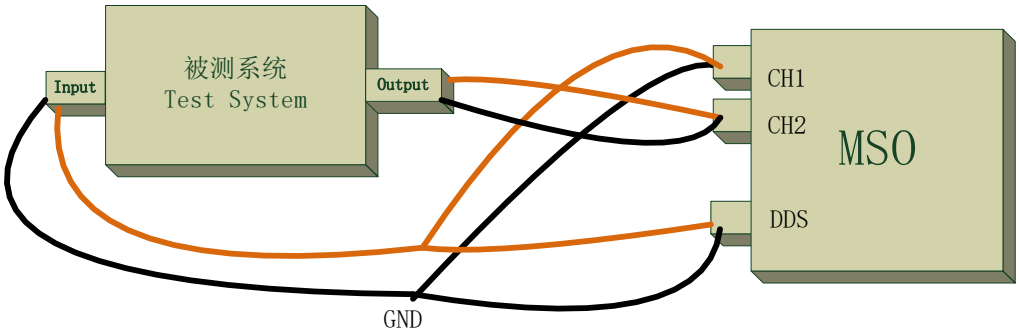
Save the result of the decoder to a file .

17. Sweeper

Click the icon to start the sweeper.

The working principle of the frequency sweeper: the output of DDS is input to the system under test as an excitation signal; CH1 measures the input signal of the system under test; CH2 measures the output signal of the system under test. The frequency and phase changes of CH2 and CH1 are calculated by software algorithms; plot the amplitude and phase changes of different frequency signals after passing through the system under test; This is the frequency characteristic and phase frequency characteristic curve.

Frequency sweeper wiring diagram:



The DDS setting is the same as the previous DDS chapter in continuous mode, the sine wave setting is the same; Care should be taken to adjust the amplitude of the DDS so that the input and output signals do not exceed the maximum range of the oscilloscope.

The settings for CH1 and CH2 are the same as for the oscilloscope channel in the previous section; Try to make the channel acquisition range slightly larger than the actual signal voltage; For example, the amplitude of the measured signal is +-3.3V, and the acquisition range can be set to +-4V; If the acquisition range is set to +-40V, the final result accuracy will be lower than if it is set to +-4V.

Note: For signals below 5Hz, such as 1Hz signals, it takes 1 second to complete a cycle, if there are too many acquisition cycles, the sweep process will need to wait longer. At present, the acquisition method of only two cycles is used, and another problem will arise: the number of cycles is small, and the amplitude of the waveform may not be as stable as that of multiple cycles, resulting in fluctuations in sweeping results of less than 5Hz.

18. Data Recorder

Click on the icon to start the data recorder.

The AC/DC, probe, and trigger settings of the data recorder are identical to those of the oscilloscope section. It should be noted that the input range is set, and the input range needs to be set according to the actual voltage range of the measured signal. The input range should be larger

and as close as possible to the actual voltage range of the measured signal, so that the recorder hardware can use a higher amplification ratio and the acquired signal accuracy is higher.

 Toolbar functions unique to data recorder: wave contrast, auto layers and synchronized timeline.

- Wave contrast, it can draw the open file in a waveform interface to facilitate contrast;
- Automatic layer, according to the position of mouse click, automatically switch the Tab corresponding to the waveform file;
- Synchronized timeline, when moving waveforms, synchronize to move other tabs.